

Vol. 2.

Part 3.

The Monthly Journal of the
**INSTITUTE OF
METALS**



and

METALLURGICAL ABSTRACTS

MARCH, 1935

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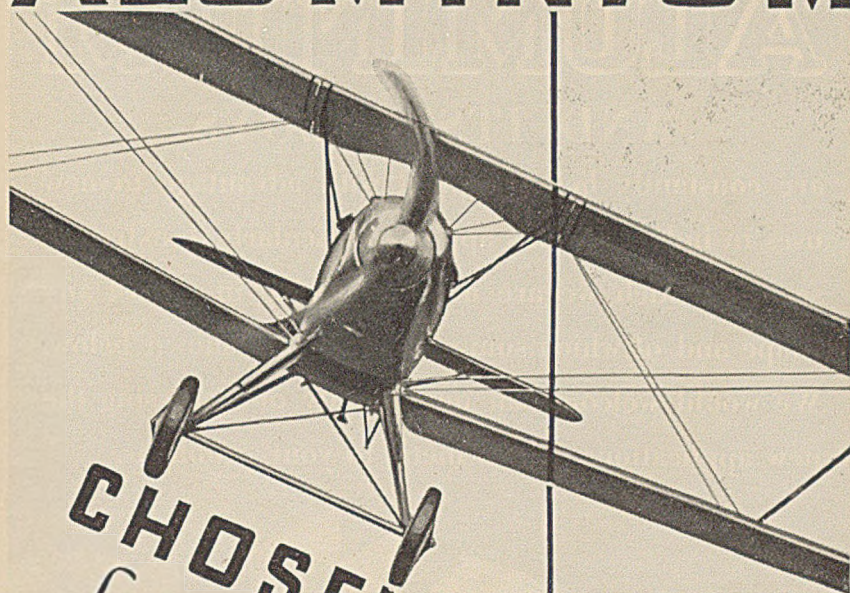
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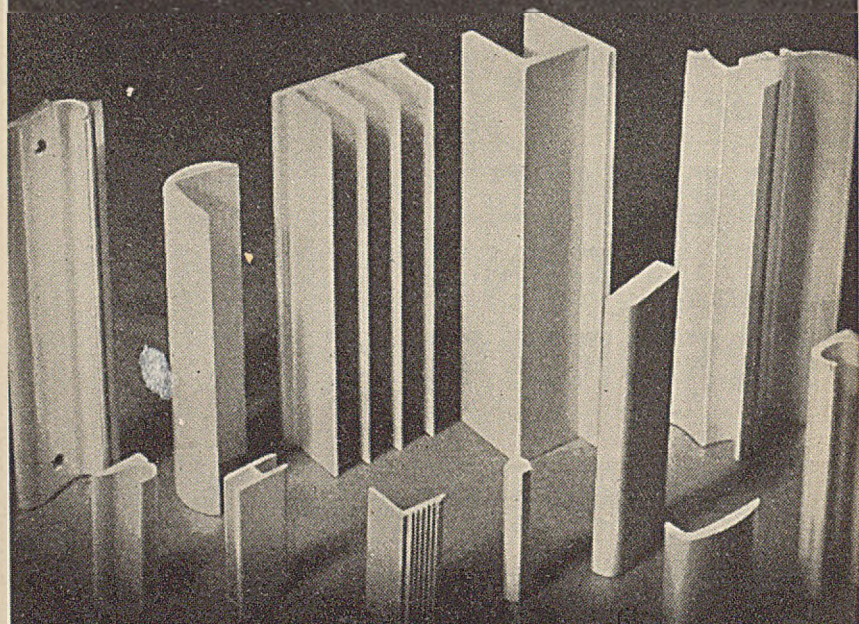
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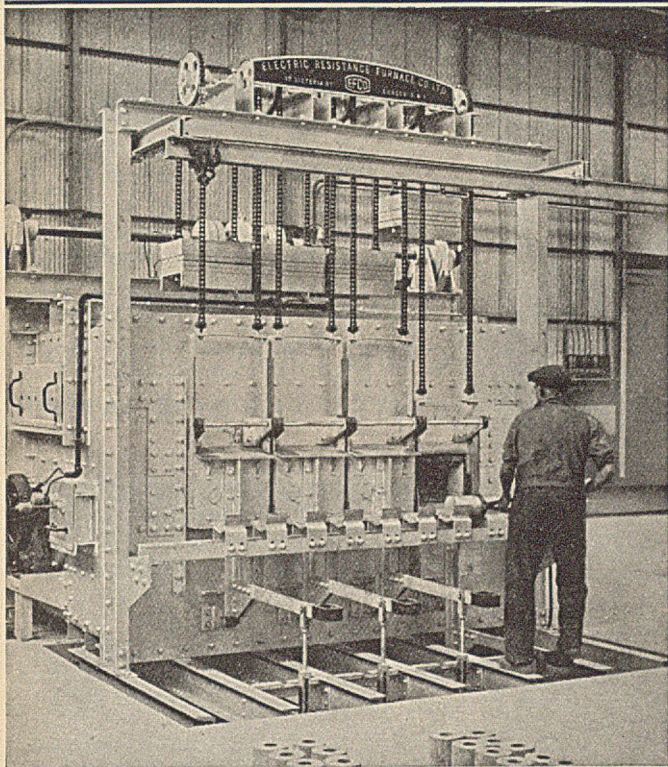
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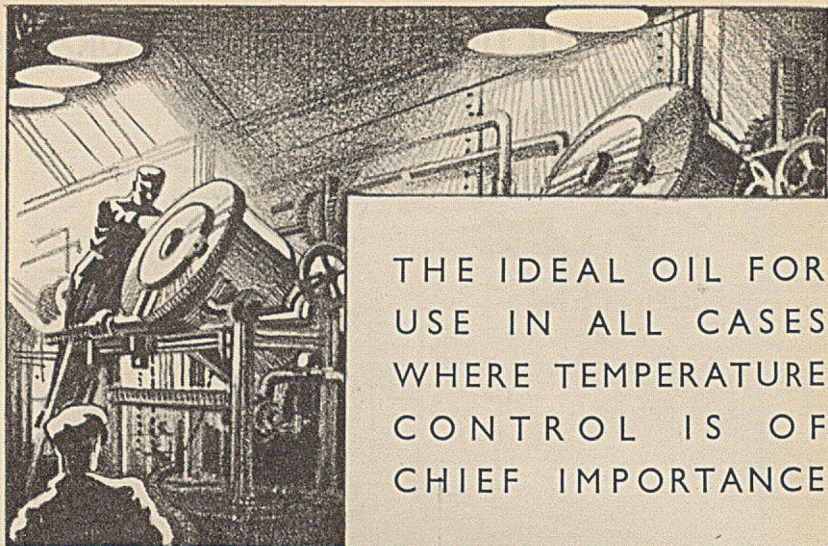


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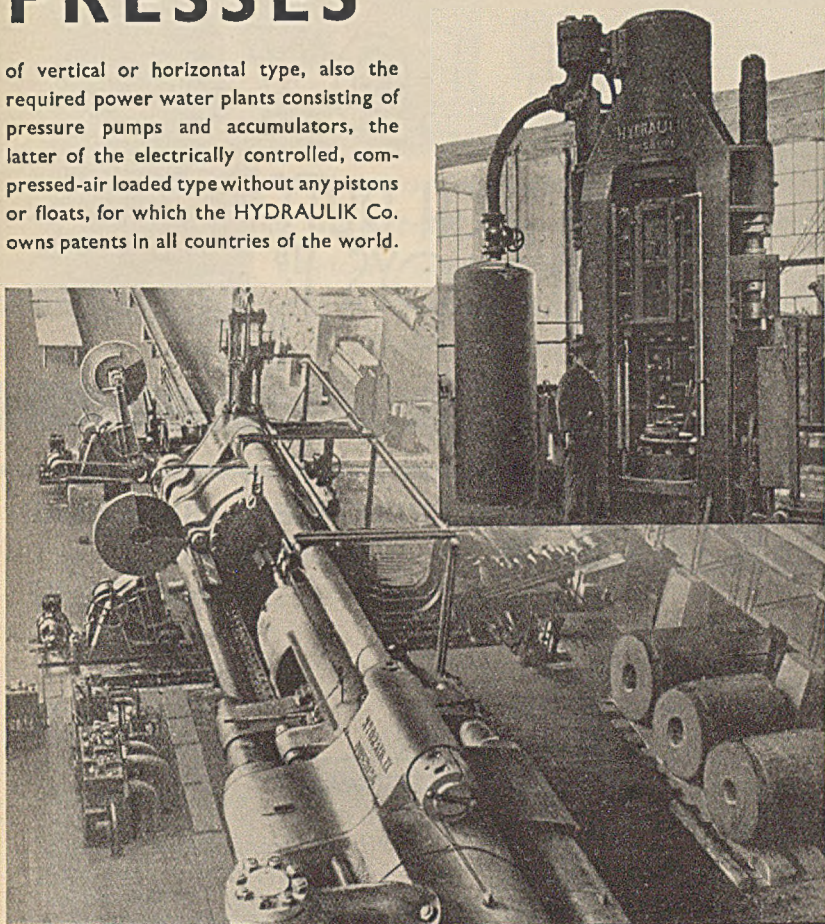
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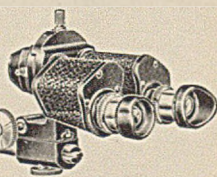
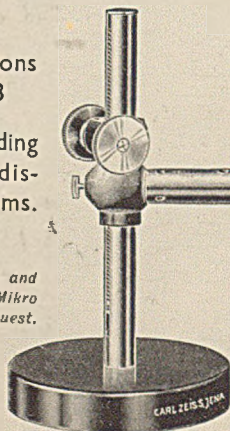
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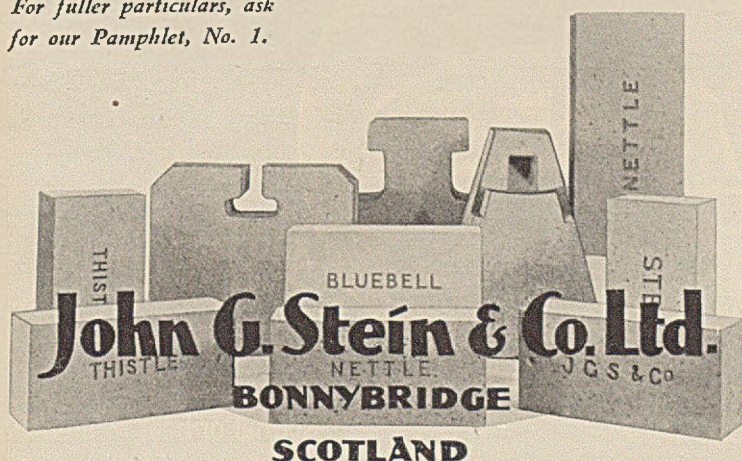
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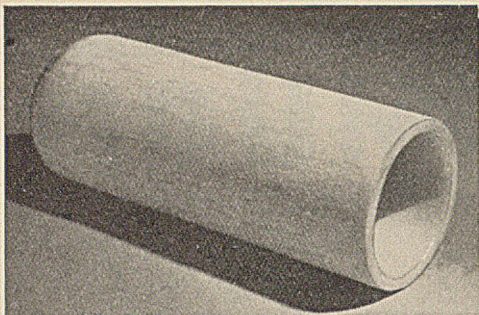


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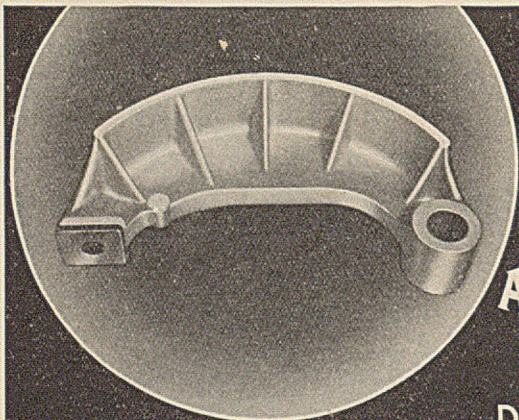
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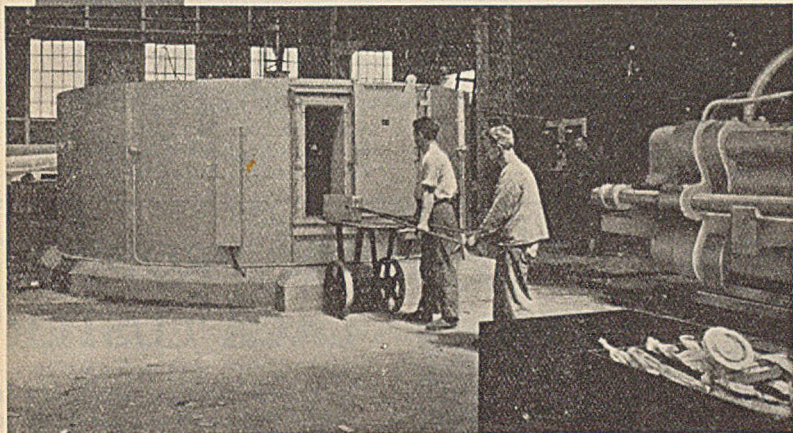
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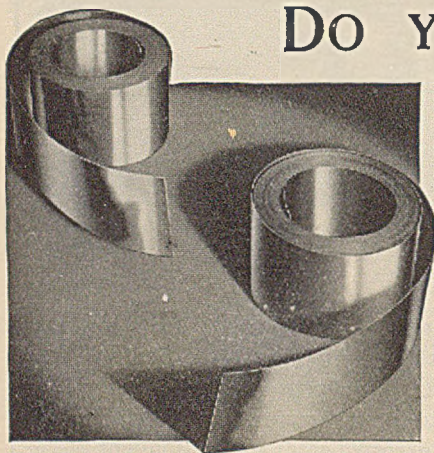
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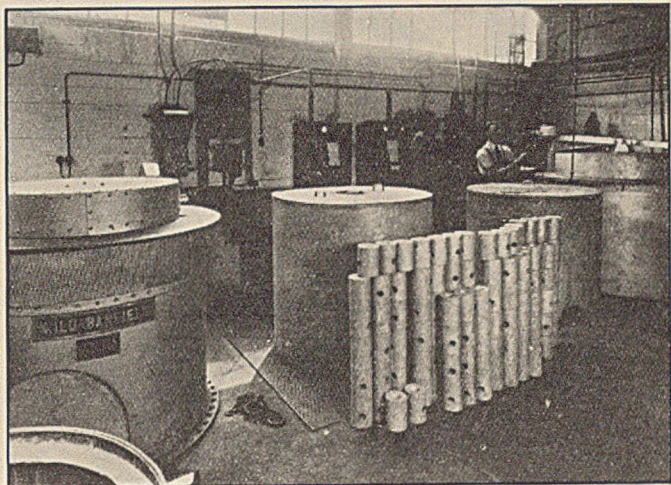
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MARCH, 1935

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INSTITUTE NEWS AND ANNOUNCEMENTS

Annual General Meeting, London.

March 6 and 7, 1935.

THE Twenty-Seventh Annual General Meeting of the Institute was held on March 6 and 7 in the Hall of the Institution of Mechanical Engineers (by kind permission of the Council of the Institution), the retiring President, Dr. Harold Moore, C.B.E., in the Chair. Following the presentation of the Report of Council* and the Report of the Honorary Treasurer,* the election of the following Officers for 1935-1936 was announced:

President :

HAROLD MOORE, C.B.E., D.Sc., Ph.D.

Vice-Presidents :

W. R. BARCLAY, O.B.E.
CECIL H. DESCH, D.Sc., Ph.D.,
F.R.S.

Members of Council :

LIEUTENANT-GENERAL SIR RONALD
CHARLES, K.B.E., C.M.G., D.S.O.
ENGINEER VICE-ADMIRAL SIR ROBERT
DIXON, K.C.B., D.Eng.
R. GENDERS, M.B.E., D.Met.
A. H. MUNDEY
THE HON. R. M. PRESTON, D.S.O.
H. B. WEEKS

Afterwards there were presented and discussed papers Nos. 685-696, as enumerated on p. 79 of the February issue of this *Journal*.

In the evening of March 6 the Annual Dinner and Dance was again successfully held at the Trocadero Restaurant, over 250 members and guests being present. The toast of "The Institute of Metals, coupled with the name of the President," was proposed by Sir Richard Redmayne, K.C.B. (President of the Institution of Civil Engineers). Dr. Moore replied. Sir Clement Hindley, K.C.I.E., M.A., responded to the toast of "The Guests," which was proposed by Dr. Richard Soligman.

In the afternoon of March 7, a party of members visited the Battersea Power Station. On both days of the meeting members lunched together informally at St. Ermin's Restaurant.

* See *Monthly J. Inst. Metals*, 1935, Feb., 86-94.

A full account of the meeting, including a record of the discussions and written communications on the papers, will be published in the half-yearly volume of the *Journal* (Vol. LVI), which is to be posted to members in June. In the volume will be reprinted in permanent form all the March meeting papers that have previously appeared in the *Monthly Journal*.

On the day before the Annual General Meeting, members of the Institute participated in a Joint Meeting (organized by the Institution of Automobile Engineers) to discuss the subject of "Cold-Pressing and Drawing." The meeting was well attended and three papers—presented respectively by Dr. H. J. Gough, M.B.E., F.R.S., Dr. Cecil H. Desch, F.R.S., and Professor Dr. G. Sachs—were discussed.

Educational Tour to Germany.

A party of about 40 student members and others eligible to take part in the Educational Tour to Germany is due to start from London on April 7, returning on April 15. An outline of the tour was given in the February issue of the *Monthly Journal*.

Carried out at an inclusive cost of £11, the tour should be helpful to those who take part, as it will provide them not only with technical information regarding German works but also with opportunities for social contacts with university students and others in Germany.

Forthcoming Meetings and Elections.

Members are reminded that the Annual May Lecture will be given in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, at 8 p.m., on Wednesday, May 8, when Professor W. L. Bragg, F.R.S., will deliver a discourse entitled "Atomic Arrangements in Metals and Alloys." Visitors are cordially invited to the Lecture. Members will shortly receive cards of invitation that are available for the use of visitors.

In connection with the lecture, an election of members is being arranged on April 4. Persons whose membership applications are in the Secretary's hands not later than that date

Institute News and Announcements

can be elected in time for participation as members at subsequent meetings of the Institute, including not only the May Lecture, but also the Annual Autumn Meeting which is to be held in Newcastle-on-Tyne from September 9 to 12.

The subscriptions of persons joining the Institute on April 4 cover the extended period ending June 30, 1936.

Papers are invited for the Autumn Meeting; these should be submitted in duplicate (in the style described in the *Monthly Journal*, 1934, Oct., p. 433) to the Secretary not later than April 30.

Membership Additions.

The following persons were elected on February 14, 1935:

As Members.

BARCLAY, Donal James, Birmingham.
BOLLENRATH, Franz, Dr.-Ing., Berlin-Johannisthal, Germany.
BUDD, John Cecil, London.
BURTON, Herbert Henry, Sheffield.
BURWOOD, Douglas Sidney, B.Sc., A.R.S.M., Bristol.
de MARTINI, Francesco, Milan, Italy.
LACEY, Gerard William, B.Sc.(Hons.), London.
LAGERQVIST, Joel, Sundbyberg, Sweden.
MCGOWAN, Sir Harry Duncan, K.B.E., LL.D., London.
MANNOX, Frank Cecil, Birmingham.
PAM, Edgar, O.B.E., A.R.S.M., London.
POWELL, (Miss) Dorothy P., M.A., Southampton.
TURNER, Philip George, Birmingham.

As Student Members.

REEVES, Leslie Norman, Nkana, Northern Rhodesia.
SHOWELL, Donald Wilfrid Dugard, Birmingham.
TIMMS, Cyril Arthur, Birmingham.
WILMOT-SMITH, Charles Nicholas, B.A., Bristol.

Work of Dr. Rosenhain, F.R.S.

Melbourne University Commemoration.

Professor J. Neill Greenwood, D.Sc., of the University of Melbourne, is

taking steps to perpetuate, in a worthy manner, the memory of the late Dr. W. Rosenhain, F.R.S., a graduate of Melbourne University and a Past-President of the Institute of Metals.

The new Physical Research Laboratory—devoted for the time being to the study of lead and its alloys—is to be named "The Rosenhain Memorial Laboratory." In it will be placed the Rosenhain metallurgical microscope and also the sets of *Journals* of the Institute of Metals and of the Iron and Steel Institute, which Dr. Rosenhain bequeathed to his old University. Professor Greenwood has issued an appeal to past-students of the Metallurgy Department to subscribe to a fund for the construction of a special book-case to contain the volumes, thereby giving them an opportunity to become associated personally with the memorial. There will be hung over the fire-place in the Laboratory a plaster cast—showing the profile of the late Dr. Rosenhain—taken from the metal plaque which was presented to the Institute of Metals on the occasion of its Coming-of-Age Celebrations in 1929. It is anticipated that the formal opening of the Laboratory will be made part of the forthcoming Commencement functions. At a later date it is proposed to organize a capital fund to finance a "Rosenhain Memorial Scholarship," which will be tenable in the new Laboratory.

International Congress of Mining and Metallurgy.

There has now been completed the organization of the Metallurgy Section of the International Congress of Mining and Metallurgy, to be held in Paris in October, 1935. The officers of the section are:

President of Honour: M. D. de Wendel.

President: M. Albert Portevin.

Vice-Presidents: MM. Chovenard (non-ferrous alloys), Cornu-Thénard (heat-treatment), Durand (ferrous alloys), Flusin (manufacture of non-ferrous products), Galibourg (testing), Girardet (foundry work), Perrin (manufacture of ferrous products).

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 April issue of the Monthly Journal should reach the Editor not later than March 25.

MR. A. J. AIERS has left Coventry on his appointment as Works Superintendent to The British Oxygen Company, Limited, Edmonton.

MR. PERCY R. CLARK has been elected Chairman of the Roumanian section of the Institution of Petroleum Technologists.

PRINCIPAL C. A. EDWARDS, F.R.S., who is now on a visit to the United States, delivered to the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers the Annual Lecture on February 21, his subject being "Gases in Metals."

SIR HENRY FOWLER, K.B.E., LL.D., D.Sc. (Past-President), has returned from his voyage to Australia and New Zealand.

DR. H. J. GOUGH, M.B.E., F.R.S., has been awarded the Institution of Mechanical Engineers' Thomas Lowe Gray Prize for a paper (jointly contributed) on "Design of Crane Hooks and Other Components of Lifting Gear."

PROFESSOR DR.-ING. E. J. KOHLMAYER, Berlin, received an invitation to take an official part in the 30-year "Jubilee" of Professor Mostovich, which was recently celebrated at Ordschonikidse (formerly Wladikawkas).

MR. E. SPURR has left Bradford to take up a post in the Isle of Wight with Messrs. Saunders-Roe, Ltd., builders of flying-boats.

SIR HAROLD YARROW, Bart., C.B.E., was married on Feb. 6 to Rosalynde, twin daughter of Sir Oliver Lodge, F.R.S. (one of the Institute's May Lecturers) and the late Lady Lodge. Sir Harold has been a member of the Institute since 1915.

Birth.

DEELEY.—On Feb. 28, 1935, at Pentreath, Kenley Road, Norbiton, Surrey, to Muriel Yvonne (*née* Webster-Brown), wife of Richard B. Deeley, A.R.S.M., B.Sc.—a son.

Death.

SIDNEY.—On Saturday, March 9, 1935, after a brief illness, Leicester Philip Sidney, Editor of the *Metal Industry*.

LETTER TO THE EDITOR

**Metal Industries Exhibition, Osaka,
May 10-31, 1935.**

Dear Sir,

We have the honour to inform you that the "Metal Industries Exhibition" will take place in the BOEKKAN, the Commercial House, in Osaka, from May 10 to 31, 1935, under the joint auspices of AGNE and the *Nikkan Kogyo Shinbun-sha* (*The Daily Industrial News*). The "Metal Industries Exhibition" will be the

largest ever opened in Japan and the regulations are shown in separate papers.*

We shall be very glad if you would kindly insert a notice in your publication about the "Metal Industries Exhibition."

Soliciting you to induce business organizations, traders, or industrialists to take part in the Exhibition.

Sincerely yours,

C. H. TONAMY,
Editor, *Kinzoku* (*The Journal of Metals*).

Okamoto, near Kobe, Japan.

* These can be obtained from the Headquarters of the Institute.

LOCAL SECTIONS NEWS

The present session's activities of the six Local Sections will come to an end on April 11, when, in connection with the Annual General Meeting of the London Local Section, there will be an open discussion in the rooms of the Society of Motor Manufacturers and Traders, Ltd., 83 Pall Mall, S.W.1, at 7.30 p.m., the subject being "The Use and Significance of Specifications."

The committees of the various Local Sections are now engaged in preparing their programmes for the session 1935-1936, and will be glad to receive offers of papers. The names and addresses of the Honorary Secretaries of the sections are given on pp. 89-91 of the February issue of the *Monthly Journal*. At the annual meeting of the Local Sections Committee, to be held in London on May 8 in connection with the May Lecture, it is expected that the Secretaries of the various Sections will be in a position to present outline programmes for the coming session, as well as reports of work accomplished during the past year.

SYNOPSIS OF PAPERS TO BE READ IN MARCH.

Birmingham Section.

Bearing Metals. By R. T. Rolfe. (*March 19.*)

The following will be dealt with: lubrication requirements of a bearing material; relative friction of hard and soft materials; mode of operation of conventional bearing alloy; bearing conditions and design; bearing alloys used in commercial practice; constituents of tin-base bearing alloys; commercial tin-base bearing alloys; the comparative uses of tin-base and lead-base bearing alloys; variation of structure and quality by variation in rate of cooling of tin-base alloys; the adhesion of the joint; commercial practice in lining; detailed procedure for lining; centrifugal lining; failures of white-metal linings; the lead-base alloys; copper-tin bearing alloys; the phosphor-bronzes; the leaded bronzes; copper-lead alloys; "self-lubricating" alloys; zinc-base bearing alloys; aluminium-base bearing alloys; synthetic resins as bearing materials.

London Local Section.

Annual General Meeting and Open Discussion on The Use and Significance of Specifications. (*April 11.*)

North-East Coast Section.

A Modern Copper Refinery. By R. D. Burn, M.Sc. (*March 22.*) (Joint meeting with the Society of Chemical Industry.)

The paper will take the form of a description of the whole process of electro-refining, from blister copper to the finished market shapes. It will be based on the refinery of the Ontario Refining Company, Ltd., Copper Cliff, Ontario, Canada (affiliate of the International Nickel Company of Canada, Ltd.), which has a potential annual capacity of 120,000 short tons, and with which the author has personal contact.

A brief description will be given of the production of blister copper from the ore, and this will be followed by a more detailed description of the production of anodes from the blister—the electrolysis and production of cathodes.—the smelting of cathodes, and the casting of finished shapes, *viz.* wirebars, cakes, billets, &c.

Reference will be made to the production of precious metal by-products, which include selenium and tellurium.

The lecture will conclude with a description of the lay-out of the refinery and the drawing up of a simplified flow-sheet, and will be illustrated with lantern slides.

RECENT TRENDS AND FUTURE DEVELOPMENTS IN METALLURGICAL RESEARCH.

AN ADDRESS TO THE LONDON LOCAL SECTION OF THE INSTITUTE OF METALS, DELIVERED ON NOVEMBER 8, 1934.

By HAROLD MOORE, C.B.E., D.Sc., Ph.D., PRESIDENT.

DEFINITIONS are always dull, but sometimes necessary, and I feel that I must start by defining one or two terms in the rather vague title of this address, and by indicating the limits within which I shall try to keep. By "recent" I mean, quite arbitrarily, during the last ten years. It is less easy to define "metallurgical research," but I think that it may be said that metallurgical research becomes increasingly the application of physics and physical chemistry to the study of metals (and alloys) in the metallic state. One of my friends, who kindly read the draft of this address, suggested that I had overlooked the importance of mathematics. As metallurgical research becomes less empirical and more exact and quantitative, the scope for mathematical treatment widens. The work of G. I. Taylor indicates the great possibilities in the mathematical treatment of the theory of the deformation of metals. On the practical side also, as in hot- and cold-rolling, the deformation of metals is a subject peculiarly suitable for the application of mathematics. In my opinion, metallurgists who have taken their studies in physics, chemistry, or mathematics to a standard beyond the ordinary, are likely to play a very important part in future metallurgical research.

In this address I am mainly concerned with metallurgical research intended for practical industrial application, but first I want to say a word or two about what, for want of a better expression, is sometimes termed "theoretical metallurgy." In the field of metals, as in all other subjects which can be studied scientifically, knowledge is being sought for its own sake in many University and other laboratories; but it has seemed to me (I should be glad if I were proved to be wrong in this) that this type of work is being pursued to a greater extent in some other countries than in our own, so far as metals are concerned. I do not forget that pure research in metallurgy, of the highest importance and value, is in progress in several laboratories in this country, but to judge from published papers, considerably more workers have been engaged in research of this type, in, for example, Germany.

In this connection I view with misgiving any tendency, in our

University metallurgical schools, to concentrate on industrial research having some definitely practical and limited objective. There is pressing demand for immediately useful work of this kind, and the scope for its extension has no apparent limits. It is, however, the special province of the industrial research laboratories, whilst we look to the Universities to extend the boundaries of knowledge without too much regard to the practical application of the results. The partnership of science and industry is amazingly successful. Its success is indeed the outstanding feature of the past ten years, although there may be some question whether the best ultimate use has been made of the results. Undoubtedly the problems which, for example, transport in all its forms presents to metallurgical science lead to great scientific advances. I think, however, that it is necessary to guard against the danger of industry appropriating to its own purposes the resources which should be devoted to pure science. I should be the last to suggest that no industrial research should be carried out in the Universities; indeed my view is the more the better, provided that pure science continues to be adequately supported. To me, the ideal relationship between the metallurgical industries and the metallurgical schools in the Universities would be that industry should, co-operatively or otherwise, help to support University metallurgical research without directing or controlling it.

C. H. Desch, in his fascinating book "The Chemistry of Solids" (which is much more concerned with metallurgical research than its title might seem to indicate), aptly illustrates the primary importance of work in pure science in his observations on the investigations of Faraday which have led to such far-reaching practical developments. "Yet Faraday was an 'experimental philosopher,' one whose sole aim was to learn something of the workings of nature. He had in mind no practical application of his discoveries, and never concerned himself with the invention of machines. He was even sceptical of the possibility of using electromagnetic methods in place of the primary battery. His work was guided throughout by the purely theoretical conviction of the unity of natural forces. . . . Little as he would have expected it, industry has gained enormously by his decision to investigate fundamental principles. . . . It remains true that practical inventions mostly arise as the unforeseen by-products of studies which had as their aim the discovery of relations between the phenomena of nature."

The decade has been unparalleled in its output of metallurgical research, and great advances have been made in every direction. It seems to me, however, that the main bulk of the work has been the

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logical and orderly development or exploitation of the fundamentally new ideas which had emerged more than ten years ago, and that the last ten years have not given us much that is really new in this sense. Take, for example, the discovery of methods of producing single crystals. Already in 1924, methods had been standardized and much fine work had been done in the study of the properties of single crystals. Enormous progress has been made since then, but generally on lines already evident ten years ago. There are, of course, a few remarkable examples of really new fundamental ideas in metallurgy less than ten years old. Although Haigh before 1917 began to realise the destructive action of corrosion and fatigue acting together, the idea of corrosion-fatigue as a definite and prevalent type of failure scarcely took shape before 1926. Since then it has developed into a big and most important subject of research, on which we have learned a great deal, although there is as yet no universally accepted explanation of its mechanism. Possibly an even better example is the development, still in a very early stage, of Hume-Rothery's theories of the relation between the properties of alloys and the atomic structure of the component metals. Again it is only within the last ten years that protective oxidized surface films, on which resistance to corrosion so commonly depends, have been isolated in a continuous form from the metals they protect.

If my analysis is correct, recent metallurgical research has consisted mainly in the refinement of old, and the application of new, physical methods to the continued exploration of numerous fields of work which had been opened up earlier. The characteristics and behaviour of metallic crystals (single or in polycrystalline aggregates), elastic and plastic properties, and thermodynamic equilibrium in many alloy systems, have been intensively studied by a variety of physical methods of increasing precision. Such work has been greatly assisted by the development of methods for preparing many metals in a state of high purity, and by the availability, in reasonable quantity, of metals which a few years ago were rare or practically unobtainable. X-ray methods, applied to the determination of crystal structures and parameters, to the determination of limits of solid solubility and of equilibrium diagrams of alloy systems generally, have reached a high degree of accuracy. Much attention has been given, in alloy systems, to transformations in the solid state and to the equilibrium conditions and changes on which precipitation-hardening depends. Incidentally, the phenomenon of precipitation-hardening or age-hardening, for some years in the period under review regarded as exceptional, has been found to be quite common and is being put to practical use in many alloys. Much evidence, of a very diverse kind, has accumulated in support of

the theory that a mosaic structure exists in metal crystals—some kind of periodic discontinuity or disturbance of structure within the crystal. The influence of casting structure, the structural changes and other effects occurring in subsequent hot- and cold-working and in various types of heat-treatment have been investigated from the practical point of view, whilst the mechanism of deformation and failure has been the subject of much fundamental work. Metallographic methods have been improved. There has been great development in the study of surface phenomena of different kinds. Electron diffraction, comparatively a newcomer among the physical methods applied to the study of metals, has already added to our knowledge of metal surfaces and films, and promises to be a powerful weapon. On the more practical side, interaction with gases, corrosion and oxidation at high temperatures are diverse surface phenomena giving rise to a vast amount of work because of the serious troubles they cause.

It is, however, the position and future of metallurgical research undertaken for industrial purposes, with which I am primarily concerned to-night, and I would now like to consider some particular problems of this kind. Here the difficulty is to know where to begin in so vast a field. Some little time ago the Metallurgy Research Board of the Department of Scientific and Industrial Research undertook an enquiry into the directions in which research is of special importance to the metals industries at the present time. A broad and far-sighted view was taken of the type of research on which the future development of industry must be based, and the Board was not specially concerned with day-to-day problems. General phenomena, such as the thermodynamics and physical chemistry of metallurgical reactions in smelting, refining and melting, gases in metals, non-metallic inclusions, surface films on molten metals, oxidation and scaling at elevated temperatures, macrostructure and the structure of cast metals generally, age-hardening, internal stress, intercrystalline failure and equilibria in alloy systems, were considered as of primary importance. Processes such as welding, hot- and cold-working of metals, and the factors controlling surface finish were regarded as presenting many unsolved problems. The physical properties of metals and alloys over a wide range of temperature is a field by no means adequately covered yet; for example, the measurement of the viscosity of molten metals and of other properties controlling "fluidity" may offer great experimental difficulty, but quantitative information would have practical value.

More recently—in fact during the last few months—the British Non-Ferrous Metals Research Association has conducted an enquiry among its members as to subjects on which it might most usefully

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undertake research. Since the membership of the Association includes a large proportion of the manufacturers of non-ferrous metals and alloys in this country, and also many important producers of the raw metals and users of finished products, the replies received are specially interesting as indicating the directions in which the non-ferrous industries themselves see need for further research. The metals chiefly concerned are copper, aluminium, zinc, lead, nickel, and tin, but the less abundant metals are not excluded. No fewer than 130 subjects of research were suggested. To enumerate these here would not be appropriate, but the general headings under which the proposals group themselves have provided me with a practical classification for the rest of my address. These six main classes are Melting and Solidification; Working of Solid Metals to Finished Shapes; Heat-Treatment; Mechanical and Physical Properties at all Temperatures of Possible Use; Oxidation, Corrosion and Protection; and Electrodeposition. This classification is by no means complete and there remains a large miscellaneous group. I propose to say a little about some aspect of recent work in each of these main groups of practical problems, and about the directions in which work may be expected to proceed in the immediate future. Anything like full treatment would demand far too much time and would indeed be beyond my powers. A selection of directions of research in which I happen to be specially interested is all I can attempt. The questions with which I shall deal will be mainly those affecting quality of non-ferrous metal products. The problem as to how far it may pay industrially to improve a particular product is often a difficult though vital economic question but is in general outside the scope of this paper. I think that it may be said, however, that the dividing line is continually shifting in the direction of higher quality, and such processes as vacuum melting, and such materials as metals of extreme purity, which initially at any rate may be relatively costly, tend to find more and more application.

MELTING AND SOLIDIFICATION.

The aim is to produce a finished casting, or an ingot for working, substantially free from all superficial or internal defects which may have any adverse effect during subsequent fabrication or in service. The high surface finish now demanded in many products may be greatly influenced by ingot quality.

One of the most important subjects in this group is that somewhat vaguely described as "gases in metals." The simplest case is that of solution of a gas in a liquid metal and its evolution during solidification,

the solubility usually being much lower in the solid than in the liquid metal. Frequently involved, however, are the physical and chemical equilibria between a gas mixture (such as a furnace atmosphere), a layer of slag, and a liquid alloy which may contain dissolved oxide as well as gases in solution. The equilibrium changes gradually or suddenly with change of temperature or change of state and may be powerfully influenced by such factors as a film of oxide on the liquid metal surface. Steel in an open-hearth furnace or a Bessemer converter is one of the most complex cases. Precise knowledge of the composition and quantity of gases dissolved in molten steel, or of the controlling factors and conditions of equilibrium, is meagre; yet empirical skill based on experience and on trial and error, is so great that there can be produced, at will, a rimming steel ingot with its thick outer shell of nearly pure iron, its zone of correctly placed blowholes and its relatively impure core, or on the other hand a solid ingot of composition approaching uniformity, practically free from cavities of any kind, large or small. Each of these widely different types of ingot has its special merits and uses. This is a remarkable instance of the empirical character of many successful metallurgical processes, but we cannot but believe that as practice becomes more based on accurate scientific knowledge progress will become more certain and rapid.

Extensive investigation, both fundamental and practical, on gas-metal equilibria has been made during recent years. Thorough revision of earlier determinations of the solubility of gases in molten metals has been made possible through improvements in technique and apparatus. In this connection, advances in the preparation of refractories securing chemical inertness, non-permeability to gases and freedom from absorbed gases, together with new methods for the micro-analysis of gases, have been particularly helpful.

The reactions, both physical and chemical, between metal and gas have been worked out in some detail for copper and, more recently, for aluminium. Investigation of the equilibria of copper, oxygen, and hydrogen under various conditions has shown that, on solidification, copper may be rendered unsound not only by the evolution of dissolved hydrogen but also by the evolution of steam resulting from chemical reaction between dissolved copper oxide and hydrogen. Unsoundness resulting in this way occurs in several copper alloys, and the study of similar reactions in other metals and alloys is likely to be very helpful in overcoming unsoundness due to gas.

The manner in which molten metals may become contaminated by gases has been widely investigated. It has been shown that gases will not only dissolve in metal melts by the physical process of solution

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but that contamination may occur in consequence of chemical reaction. The main source of gas contamination of aluminium melts has been shown to be the reaction of water vapour (derived from the combustion of furnace fuel) and molten aluminium, whereby insoluble aluminium oxide is formed and the hydrogen passes into the melt. The solid metal may deteriorate on storage by corrosion so that a hydrated corrosion product is formed and hydrogen is absorbed by the metal. During melting, the hydrated corrosion product decomposes and the molten metal becomes saturated with hydrogen.

Several methods have been developed for removing dissolved gases from defective melts such as "pre-solidification" and the passage of nitrogen and of gaseous volatile halogens or halogen compounds.

If the evolution of gas on solidification giving rise to gas-cavities (blowholes) balances sufficiently closely the contraction of the metal on solidification, a casting may be produced showing very little piping or shrinkage cavities. A great tonnage of the cheaper steels is produced on this principle, ingots almost free from piping being obtained which can be rolled to final form with very little discard. Conversely, if metals are freed from gas, before casting, in order to produce solid castings, shrinkage may increase considerably and measures may have to be taken to counteract the effects of undue shrinkage.

Results of much practical value may be confidently expected from further research in which principles recently established are applied to various types of non-ferrous alloys. Simpler methods for the degassing treatment of molten metals, and melting methods minimizing contamination by gas are likely to be developed. Control of shrinkage and the position of shrinkage cavities will be obtained. Practical work of this type will be greatly assisted by the accurate determination of gas solubility in metals and its variation with temperature, and by the determination of the composition of the gases which, by their evolution during solidification, cause unsoundness.

The main causes of discontinuities in ingots and castings are gas evolution (with which I have dealt), entrapping of injected gases, contraction giving rise to shrinkage cavities, cracking during cooling, and non-metallic inclusions. Contraction on solidification has been the subject of much work aiming at directional solidification. Obviously, if a volume of liquid metal solidifies from the bottom upwards, the liquid-solid interface remaining roughly horizontal, there will be no pipe or other contraction cavity. The Parsons-Duncan method for casting steel ingots aimed at this effect, and a similar result is sought by casting steel ingots on copper stools, the copper with its high heat conductivity abstracting heat most rapidly from the bottom of the

ingot. The "R.W.R." process, which is being applied to the casting of aluminium and its alloys, employs the same principle of directional solidification but has other features intended to eliminate gas-cavities and non-metallic inclusions as well as piping. The process consists in pouring the metal into a mould pre-heated to the melting point of aluminium in order to prevent solidification during pouring. When the mould is full, a copper plate is fixed over the open top and the whole mould then inverted. Water is sprayed on to the underside of the copper plate, and the consequent rapid abstraction of heat in that direction causes progressive solidification from the bottom upwards.

The growth of coarse columnar crystals, which would naturally result, is avoided by vibrating the mould during solidification with a definite amplitude and frequency. This is claimed also to drive gases and impurities to the top of the ingot. The process certainly seems capable of producing aluminium ingots which are sound, clean, and fine-grained. Further and wider application of the principle of directional solidification in casting metals and alloys generally seems to be highly probable.

The Hazelett process is more revolutionary. Even when metals are required in the form of thin sheet or wire, the universal practice has been to cast them into relatively thick ingots on which much energy has to be expended in reducing their cross-section by rolling, forging, or other hot- or cold-working operation. It would seem rational, although possibly very difficult, to get much nearer the final form while the metal offers the least resistance to change of shape, *i.e.* while it is liquid. This is what the Hazelett process attempts to do, by combining casting and working into one operation; it may be described as a method of casting a rolled strip. Details of the process, which was developed in America, are difficult to obtain in this country, and very little has been published about it.* Sheets of about 18 in. wide and 0.25 in. thick are produced by pouring molten metal through a funnel on to slowly revolving water-cooled rolls. The length of sheet is limited only by the amount of liquid metal available. The process is being applied to brass and to steel, but must clearly be applicable to other alloys also.

Vacuum-melting is now used on a manufacturing scale for some relatively high-priced products. The high-frequency furnace greatly facilitates melting in a vacuum or in other controlled atmospheres, especially for high-melting-point materials. Melting in a vacuum not only obviates contamination by furnace atmospheres, but may be employed for the removal of gases and other impurities. In this con-

* Since this was written, the process has been described in British Pat. 421539, accepted Dec. 17, 1934.

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nection may be mentioned the very high degree of purity now obtainable commercially in a number of metals. Zinc and aluminium (the French *aluminium raffiné*), of over 99.99% and oxygen-free H.-C. copper are examples. Extremely pure tin, lead, and magnesium are available in quantity. Much further progress may be expected in this direction, and it is fairly certain that increasing purity in the metals from which alloys are made up will result, in some cases, in remarkable differences in properties; for example, resistance to corrosion may be powerfully influenced.

Cracking during cooling after solidification is commonly due to stress (often contraction stresses) developing in the casting while it is in a range of temperature in which the metal is both weak and brittle. The "hot-tear" in steel castings is a troublesome instance. The determination of mechanical properties at different stages of the cooling of the casting, starting at temperatures just below solidification, is being attempted with some success. Quantitative knowledge of this kind would be valuable, and there is here a large field for investigation.

It is evident that the processes of melting and solidification offer a big range of problems. These can only be solved by much research and the accumulation of quantitative information on many properties of metals, liquid and solid, in relation to their environment, which have so far been incompletely studied. Inverse segregation may be mentioned as one special question on which the work already carried out, although good and valuable, has by no means provided a complete and universal explanation of what appears to be a general phenomenon.

WORKING OF SOLID METALS TO FINISHED SHAPES.

Under this heading may be classified a group of problems closely related to those in the previous group (melting and solidification), for the structure and other characteristics of the ingot, apart from composition, may considerably influence its behaviour in working. A full understanding of behaviour in hot-working demands far more knowledge than we now possess of elastic and plastic properties over the range of temperature in question. The effects of cold-working on properties have been very fully studied for many materials in recent years, but much remains to be done on such questions as surface finish, control of internal stress, and effect of cold-working and of subsequent heat-treatment on elastic properties.

Powder metallurgy is an interesting development, although perhaps somewhat remote from the usual processes of working. The term is applied generally to processes by which powdered metals are moulded

and worked into final forms without being melted. The powders may be produced by granulation, grinding, distillation followed by rapid condensation, reduction of oxides or dissociation of other compounds at temperatures below the melting point of the metal, or by electrolysis of aqueous or molten electrolytes. The chemical and electrolytic methods for producing metal powders are the most interesting, and are likely to lead to further developments. Tungsten filaments have been produced for many years by sintering and subsequent working of compressed tungsten powder, the method being necessitated by the refractory properties of tungsten. Cutting tools with tungsten carbide or some similar compound as the basis have also been known for some time. The prospect of utilizing the commoner metals in the form of powder has now to be considered. For example, copper powder produced by electrodeposition, if carefully dried, may be produced free from oxygen and of high purity. Particle size and shape, which may both be important, can be controlled. Nickel powder obtained by the decomposition of nickel carbonyl seems likely to be capable of being used in a similar way.

The application of pressure alone to a metal powder generally results in a porous material, which, however, may be specially suitable in this form for such a purpose as a self-lubricating bearing. By subsequent application of heat and some form of working the porous mass may be consolidated. In a recent process for the production of oxygen-free high-conductivity copper, copper particles are produced electrolytically and the powder, after drying, is treated with hydrogen to remove any surface oxidation and is compressed into billets or extruded into rods.

Some advantages and potentialities of powder metallurgy may be summarized as follows:

- (1) Metal powders may be produced in a state of high purity;
- (2) Alloys made from mixture of two or more metal powders are free from troubles associated with the casting process, such as segregation, shrinkage, and coarse structure; their composition can also be controlled with extreme accuracy;
- (3) In the case of parts moulded under pressure in dies, there are no losses from melting, cropping, or machining, and high-speed production is possible;
- (4) Metals which are wholly or partially immiscible in the liquid state may be compounded from powders. Alloys may be prepared which are difficult to melt by reason of, say, very high melting point, or rapid oxidation or vaporization of some constituents;

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- (5) By suitable distribution of different metal powders in the mould or die, composite metal parts could be built up to give, for instance, a wear or corrosion-resistant surface.

Powder metallurgy thus appears to offer a large and profitable field for future research.

HEAT-TREATMENT.

The application of some form of heat-treatment for the improvement of properties, or the removal or modification of the effects of a casting or working operation becomes increasingly important in metallurgy. I will refer only briefly to what is now a familiar subject, that of precipitation-hardening. The establishment of the dependence of this phenomenon on the occurrence of a sloping line in the constitutional diagram concerned led to a most fruitful search for alloys showing precipitation-hardening. Many systems of alloys have regions of composition in which the phenomenon is to be found, and in the last few years a variety of alloys (in addition to the earlier Duralumin, "Y" alloy, and their derivatives) have been introduced which are manufactured because of the good properties obtainable in them by precipitation-hardening treatments; many of these are copper alloys of various types. In metallurgical industry, which as I have already mentioned is still so largely empirical, this particular development is specially noteworthy as an outcome of purely scientific work. Although so much intensive work on precipitation-hardening has been carried out during the last few years, there is scope for much more, and for the accurate determination of the ternary and still more complex equilibrium diagrams which will show where alloys capable of precipitation-hardening are likely to be found. Work is also in progress intended to give a clearer conception of the precise mechanism of the changes causing hardening of this type. Although the general explanation is established and accepted according to which precipitation-hardening is a result of the breakdown of a supersaturated solid solution on "ageing" or "tempering," the exact nature of the initial stages of this breakdown, in which most of the increase in hardness may occur, is still in doubt.

MECHANICAL AND PHYSICAL PROPERTIES.

Undoubtedly the most marked feature of the work of the last few years in this group of subjects has been the attention given to creep and to fatigue. These two modes of failure are very dissimilar, but have one troublesome characteristic in common. Time being one of the



main factors, creep and fatigue testing require long periods of stress application, and no method of accelerating the tests is completely successful.

In fatigue, possibly the most significant recent work is that of Gough and his colleagues on crystalline structure in relation to failure by fatigue. Study of the influence of the intercrystalline boundary on the deformation and fracture by fatigue and of the comparative behaviour of single crystals and of polycrystalline aggregates has shown that the characteristics of deformation and failure of specimens consisting of two and three large crystals are essentially the same as observed in the failure of monocrystalline specimens.

Gough considers that the general problem of fatigue is concentrated in the fatigue of a single crystal. In a single crystal of a ductile material it is undeniable that fatigue failure is inseparably associated with failure of elasticity by the process of slip. The primary problem of the real nature of slip cannot yet be considered to be fully solved but an important advance has been achieved in the study of the fatigue problem if it can be accepted that failure by fatigue is merely a special case of failure under all forms of stressing actions, including that by static and impulsive forces. Very recently a combined stress-fatigue testing machine has been developed at the National Physical Laboratory, and is giving results of the highest importance.

Creep, the continued gradual deformation under load, is characteristic of metals at temperatures above their recrystallization temperature and is accordingly significant, in most engineering materials, at relatively high temperatures. Here its practical importance lies in the engineering demand for materials to withstand stress at high temperatures. In recent years a large amount of work has been carried out on the determination of the "limiting creep stress" of many materials at different temperatures, this being the stress at which the deformation in a given time will not exceed a given (very small) amount, the definition of limiting creep stress thus being more or less arbitrary. Metals of low melting point (*e.g.* lead) and their alloys are, at atmospheric temperatures, in many cases above their recrystallization temperatures, and accordingly show continuous creep. This enables the mechanism of creep to be studied in these materials under relatively simple conditions capable of close control, and permitting the use of methods not possible at high temperatures.

An important aspect of creep phenomena is their dependence on grain-size. White and Clark, in America, claim to have shown that above the equicohesive temperature or lowest temperature of recrystallization, a metal in a coarse-grained condition will creep at a lower

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rate than the same metal in a fine-grained condition, the reverse holding at temperatures below the equicohesive temperature.

There is an apparently unlimited field for further work in these two subjects of fatigue and creep. On the practical side more knowledge is needed of the behaviour of many materials subjected to stresses of these types, whilst study of the structural characteristics of these modes of failure must help greatly in establishing general theories of deformation and failure of metals.

A practical aim of the investigation of fatigue and creep is to abolish them altogether as modes of failure in service. In actual practice, the life of structural and engineering materials (apart from obsolescence of design, which becomes a more and more serious factor) is mainly determined by wear or by corrosion. The study of mechanical wear or abrasion, as in bearings and surfaces of all kinds exposed to rubbing contact under pressure, is still in an extremely empirical state, and recent discussions have shown much divergence of opinion on the factors controlling the behaviour of white bearing metals for example.

Abrasion tests are regarded with doubt, and are difficult to express quantitatively. Lubrication is not a metallurgical question, but obviously has a most important relation to questions of wear. The precise nature of "seizing" is a problem of considerable theoretical as well as practical interest. Increasing severity of conditions of service has led to progress in the improvement of materials and surfaces exposed to wear, *e.g.* centrifugal casting of bronze for bearings and worm-wheels has diminished porosity and given better properties, bronze-backed white metal bearings have advantages for some conditions of use, and cadmium-base bearing alloys are being developed. The part played by oxidation of wearing surfaces is important in some cases, and friction oxidation (the relatively rapid oxidation of some metal surfaces when exposed to dry friction in air or other oxidizing medium) is a phenomenon demanding more investigation. A simpler but rather peculiar case is that of cylinder-bore wear in internal combustion engines, found to be due mainly to corrosion of the cylinder walls by condensed moisture.

The subjects of wear, abrasion, and lubrication provide a number of complex borderline problems calling for the collaboration of physicists, chemists, metallurgists, and engineers.

CORROSION.

The outstanding feature in corrosion research in recent years has been concentration on the study of protective oxidized films. It is now

evident that resistance of metals to corrosion is nearly always due to the existence of such films. The factors controlling their formation, character, protective action, and repair when damaged are becoming better understood, and means of encouraging the forming of such films (as by relatively small alterations in composition of the alloy) have been worked out for a number of materials. It is now a commonplace that resistance to corrosion is often conferred by additions to an alloy of metals with a high affinity for oxygen.

Atmospheric corrosion, and its initial stage of tarnishing, have been the subjects of much investigation. Film formation, the character of the film and the effect of variations in the atmosphere on the film are again the main aspects of the work. The importance of extremely thin films may be emphasized in this connection. The increasing use of metals in architecture, exterior and interior, leads to a demand for resistance of a high order to tarnishing and corrosion and the preservation of a uniform surface of attractive appearance. In fact, there are few of the vast fields of applications of metals in which corrosion of some kind is not an important factor.

For some time to come, the study of corrosion seems likely still to be centered on film formation, and rapid practical advance may be expected.

There is one feature of corrosion research which cannot be considered entirely satisfactory from the scientific point of view, and that is the extreme empiricism of some of the tests necessarily employed. Much practical corrosion investigation consists in exposing a variety of materials, often selected on rather slender grounds for want of better reasons, to corroding conditions of a variable and uncontrolled kind, not susceptible of precise measurement, and seeing what happens. The effects noted are often not capable of being expressed numerically with satisfaction. In spite of these drawbacks this type of exposure testing is undoubtedly very necessary and useful at the present stage of our knowledge, but we may hope to work towards something better.

Corrosion-fatigue was the subject of a comprehensive Autumn Lecture before this Institute two years ago, but has made further progress since. At this stage of my address these may be good reasons for saying little on the question. It must be mentioned, however, for its great practical and theoretical importance and as a subject very nearly new in the period under consideration. Its prevention as a cause of failure and its theoretical explanation are giving rise to some of the most valuable and significant work of the present time. A suggested explanation of poor resistance to the effect of fatigue stressing in an

Future Developments in Metallurgical Research

environment which is only mildly corroding in the usual sense is that the continuity of the protective film is disturbed by the alternations of stress, or strain. The breaking of the film at a particular point localizes corrosion, this in turn concentrating the stress. This attractive explanation, here sketched somewhat crudely, does however present some theoretical difficulty

Closely allied with corrosion is protection by coatings of various kinds. The use of non-ferrous metal coatings for protection of other metals, chiefly steel, is the basis of a number of great industries. Hot-dipping processes, such as galvanizing and tinning, remained substantially unchanged for many years, no doubt because of their comparative efficiency and success. The enormous increase in resistance of steel sheet to corrosion conferred by an extremely thin coating of tin applied by simple means should not be forgotten when the porosity of the tin coating and its very occasional failure (perhaps in a tinned fruit container) are the occasion of complaint. Nevertheless, there is room for improvement, and the demand for better protection is the cause of a good deal of research. A necessary first step is the development of better methods of testing the protective efficiency of coatings, and progress has been made in this respect as regards both tin and zinc coatings. Scientific control is being applied to the old rule-of-thumb processes of manufacture. Research on galvanizing has been directed to fitting pyrometric control to the bath and improving the pickling and fluxing operations and the design of the kettle: to the determination of the effect of additions to the bath, pretreatment in molten salts, annealing after dipping, and prevention of embrittlement of the steel. As a result, coatings are now being produced on a more economic basis which are more attractive in appearance, more resistant to corrosion, and capable of withstanding severe deformation without cracking or peeling.

Metal-spraying processes have their special uses and are applicable *in situ* and to articles too large or too thin for ordinary hot-dipping. A number of metals which cannot be applied by hot-dipping may be sprayed, and research has led to several developments. In some cases (aluminium on steel for example) the protective action of a sprayed coating may be rendered more efficient by heat-treatment. This has become a cheap and effective method for protecting iron and steel from high-temperature oxidation.

Protective metal coatings may also be applied by mechanical processes and by cementation. There appears to be great scope for research in this wide field of the application of non-ferrous metals and alloys as thin protective coatings.

Moore: Recent Trends and

ELECTRODEPOSITION.

Silver plating, nickel plating and a few other processes reached a fairly advanced stage of development a long time ago, and little further progress was made for a good many years. More recently, a large demand for attractive plated finishes of high quality, as in the motor-car industry, and the competition of alternative finishes has tended to force up quality. The introduction of chromium plating has stimulated interest in further possibilities in plating processes, and the formation of a technical society for the subject in this country, just under ten years ago, has provided a focus for the increased attention being given to electrodeposition. In consequence of this revival of interest, research has been active in several countries in the last ten years. Much of this has been co-operative work, as in this country and the United States. Whilst it is difficult to single out any striking discoveries great progress has been made in the scientific knowledge of electrodeposition and in the improvement of known, and the introduction of new, processes. In addition to the metals more commonly deposited, the electrodeposition of cadmium, tin, the precious metals, rhodium, platinum, palladium, iridium, and other metals has been considerably developed by research. The directions in which progress may be sought are in the improvement of preliminary cleaning processes, the control of porosity and adhesion, and the production of more ductile deposits capable of subsequent drawing. Chromium plating (on a nickel undercoat) of the high standard now obtainable is remarkably resistant and durable, but, even so, because of its tendency to cracking its application is less wide than it might be. Control of properties in this case might lead to even greater development of this popular protective process. The deposition of alloys is attractive and may be an important field. Electrodeposition is well established for repair work (*i.e.* building up worn parts to size) and for the production of surfaces resistant to abrasive wear and to oxidation at raised temperatures, but further research seems well worth while in these directions. There are also interesting possibilities in the further development of processes of manufacturing such products as sheet and tube by direct deposition.

SPECTROGRAPHIC ANALYSIS IN METALLURGY.

This subject, although not falling within any of the classes mentioned, may be referred to briefly because of its potential value in metallurgical research, and as a further example of the application of precise physical methods to the study of metals. Accurate knowledge of the composition

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of the specimens of metals and alloys, on which much laborious testing and examination may be carried out, is obviously of the first importance. In work on an extensive series of alloys chemical analysis for impurities as well as main components is often a substantial part of the total work to be done. The possibilities of the spectrograph are well worth considering in this connection, as well as in their industrial application to quantitative routine and control analysis. While a great deal remains to be done and exaggerated claims should be avoided, rapid progress has been made during the last few years; indeed the present position is very largely the result of the last ten years' work. At present, metallurgical spectrographic analysis is shown to greatest advantage in the control of purity of metals such as aluminium, copper, lead, tin, nickel, and zinc. In many cases traces of impurities can be estimated with certainty and accuracy. In speed and in the amount of labour involved, the spectrograph has a great advantage over practically any chemical method. Chemical methods are likely to remain the ultimate standards for some time to come, the spectrograph becoming an increasingly useful and widely applied adjunct, but even here it would be rash to fix limits to the accuracy which may in time be attained by the spectrograph alone. It also has special fields in the testing of material for segregation, in the analysis of thin coatings, inclusions and other material available only in very small quantity.

No one is more conscious of the imperfections of this review than its author. If it has any merits they are due to the help generously given by my fellow-workers of the British Non-Ferrous Metals Research Association and by other friends. I have taken useful material, with little or no acknowledgment, wherever I have found it. I can only hope that the review has made the same impression on you as on myself, of boundless fields of research offering fascinating possibilities of the extension of knowledge, and in their practical developments promising great extension of the useful applications of metals for the benefit of mankind.

I cannot conclude this address in a better way than by quoting again from Desch's book.* "The inspiration of modern science must come from the original investigators, seeking for nothing but a more profound understanding of the workings of nature, and provided with the facilities for observation and experiment. Linked with them in the most intimate contact that the organization of university and industrial laboratories can make possible, come the workers in applied science, connected closely on the other hand with the technologists, charged

* *Loc. cit.*

Future Developments in Metallurgical Research

with carrying into practice the results of scientific research. It is neither necessary nor possible to draw sharp dividing lines between those classes, but they may be broadly distinguished. All may unite in doing honour to great discoverers, such as Faraday, for all alike may trace their activities back to the products of their genius."

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METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 2

MARCH 1935

Part 3

I.—PROPERTIES OF METALS

(Continued from pp. 41-50.)

***The Effect of Cutting Single-Crystal Plates of Aluminium with Knife Edge.** Sadajiro Isotani (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1933, [A], 15, 353-356).—[In English.] The effect of cutting with a knife edge an aluminium plate composed of a large single crystal was investigated by means of X-rays. When a single-crystal plate of aluminium was cut in this way it was broken up into microcrystals; these were so arranged in an imperfectly fibrous manner that the axis of the fibre was parallel both to the cut made by the knife edge and to the plane of the test-piece irrespective of the initial orientation of the crystallographic axes of the single crystal. As for the relationship between the maximum angle of rotation of the microcrystals around the fibre axis, the thickness of the test-piece, and the angle of the knife edge, it was found that the maximum angle of rotation of the microcrystals decreased almost in a linear relation according to whether the test-piece became thicker, irrespective of the velocity of cutting, and also decreased slightly when the angle of the knife edge increased. The range of the influence of cutting on the test-piece increased almost in a linear relation with increase of the thickness of the test-piece, and decreased slightly with increase of angle of the knife edge.—S. G.

***The Magnetostriction of Pure and Alloyed Bismuth Single Crystals [High Sensitivity Dilatometer].** Alexander Wolf and Alexander Goetz (*Phys. Rev.*, 1934, [ii], 46, 1095-1107).—The magnetostriction of single crystals of bismuth has been detected in steady fields of 20-25 kilogauss, and is positive parallel to the trigonal axis and negative at right angles to it. The moduli of magnetostriction (m), defined by $\Delta l/l = \frac{1}{2}m/H^2$, are $+5.7 \times 10^{-18}$ and -7.0×10^{-18} with errors of about 10%. The results are in good agreement with those of Kapitza (*Proc. Roy. Soc.*, 1932, [A], 135, 537), for fields of brief duration (10^{-6} seconds), and hence magnetostriction in a real crystal does not involve a time lag of more than 10^{-2} seconds. The effect of dissolved atoms of tin, lead, and tellurium has been investigated. Lead and tin have a relatively small effect on the magnetostriction parallel to the trigonal axis, but affect the magnetostriction perpendicular to the axis in a remarkable way, the coefficient first diminishing (numerically), and then changing sign; one part of tin is equivalent to roughly five parts of lead as regards this effect. Tellurium causes a (numerical) fall in both moduli, but does not change the sign of the effect. Details are given of the construction of a very sensitive dilatometer using a thermo relay, a method which is more sensitive than an ordinary interferometer.—W. H.-R.

***Copper-Embrittlement.—III.** L. L. Wyman (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 205-213; discussion, 213-217).—See *J. Inst. Metals*, 1933, 53, 689.—S. G.

A New Process for Forming the Strain Figure on Copper. Yogorô Kato and Nagao Hayami (*J. Soc. Mech. Eng. Japan (Foreign Edn.)*, 1931, 34, 78-81).—[In English.] Abridged from the Home Edition, 1931, 34, 1416-1423. See *J. Inst. Metals*, 1932, 50, 147; 1933, 53, 290.—J. W. D.

* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

***Influence of Residual Deformations on the Elastic and Plastic Properties of Copper Wire.** V. D. Kuznetsov and V. A. Semenzov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1933, 3, 1316-1329).—[In Russian.] The influence of plastic deformations during bending on the mechanical properties of polycrystalline copper wire has been investigated with reference to (1) the change in elastic limit in different azimuths under a force of constant direction; (2) the consecutive increase in strength in all azimuths; (3) the influence of a deforming force of variable direction; (4) the change in elastic limit in all directions through plastic deformations in certain azimuths; and (5) the effect of time on the mechanical properties of specimens which have been strengthened.—N. A.

***The Diffusion of Zinc in Copper and Its Alloys.** Yoshito Yamauchi (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1932, [A], 15, 67-95; *Brit. Chem. Abs.*, 1932, [A], 800).—[In English.] The rate of absorption of zinc vapour per unit area of copper (ΔW) in an atmosphere of hydrogen at 400°-655° C. is given by $\Delta W = Ae^{-B/T}$ where A and B are constants. ΔW for rolled copper is lower than for cast copper at temperatures below the recrystallization point. The zinc loss from α -brass on heating varies with the zinc content (C) of the brass according to the equation $\Delta W = ae^{bc}$, where a and b are constants. Brass containing β or $\alpha + \beta$ loses zinc on heating according to the same law as that which controls absorption of zinc by copper. Addition of lead, iron, manganese, and especially tin increases the rate of zinc loss from brass on heating, whereas addition of aluminium appreciably reduces this rate.—S. G.

***The Ignition Temperature of Solid Materials [Magnesium].** Clement R. Brown (*Quart. Nat. Fire Protect. Assoc.*, 1934, 34, 135-145; *C. Abs.*, 1935, 29, 345).—The 3 principal causes of diversity of results in the determination of the ignition temperatures of materials are lack of agreement on definition, variations in experimental methods used, and variations in the materials themselves. Rate of air-flow, size of specimen, and rate of heating have not previously been studied sufficiently to establish the relation between them and minimum ignition temperature. A rising-temperature marker is described in which the difference between furnace and specimen temperatures is employed in the criterion of ignition temperature. It was found that as the rate of air-flow or rate of heating is increased, the ignition temperature passes through a minimum. The ignition temperature of a number of materials was determined; that for magnesium is 507° C. The apparatus is described and detailed conditions in which the values were obtained are given.—S. G.

***Investigations on Pure α , β , and γ -Manganese.** Fritz Brunke (*Ann. Physik*, 1934, [v], 21, 139-168).—Pure α -manganese was prepared by sublimation *in vacuo*, β -manganese by quenching the α -form from 1100° C., and γ -manganese by electrolysis of a manganese salt solution. The electrical conductivity of the 3 forms was found to be: α 0.14, β 1.1, and γ 4.4 ohm⁻¹ cm⁻¹, and the corresponding temperature coeff. between 20° and -79° C. 1.7, 13.6, and 53×10^{-4} .—v. G.

***The Mechanical Behaviour of Single Crystals of Mercury.** E. N. da C. Andrade and P. J. Huttlings (*Proc. Roy. Soc.*, 1935, [A], 148, 120-146).—This work was undertaken, primarily, to determine whether glide on selected planes is a characteristic of pure metal, or is due to impurities. The impurities present in the best mercury used did not exceed 1 part in 10⁶. The rhombohedral faces are glide-planes, and the short diagonal is the glide direction. The crystal twins under strain on a plane through the long diagonals of 2 opposite faces, acting as glide-planes. In simple glide, twinning takes place when the twinning plane makes an angle of 45° with the axis of the crystal wire, at least if the glide direction coincides approximately with the projection of the tension on the glide-plane. The rhombohedral face and the hexagonal basal plane are equally close-packed, but the former contains a much more

closely-packed line than does the latter. It is suggested that this is why the former acts as glide-plane in preference to the latter, on which glide has never been detected. Double and triple glide can occur according to the ordinary laws. Hardening on one set of glide-planes hardens the whole crystal. The critical shear stress at -43°C . is 9.3 gm./mm.^2 . The very purest mercury gives, in the early stages of stretch, an average spacing of the glide-planes equal to 0.0054 cm. , which agrees closely with that for ordinary pure mercury and for mercury deliberately contaminated. The appearance of preferred glide-planes separated by about 15,000 lattice spacings is thus not due to impurities or dissolved gas. Under constant stress, the single crystal flows at a rate which diminishes to a constant value.—J. S. G. T.

***Diamagnetism of Mercury Crystals.** Eckhart Vogt (*Ann. Physik*, 1934–1935, [v], 21, 791–803).—v. G.

***Investigations on Condensation Phenomena in Mercury Vapour.** P. C. Ho (*Proc. Cambridge Phil. Soc.*, 1934, 30, 216–224).—S. G.

***The Surface Ionization of Potassium on Molybdenum.** R. C. Evans (*Proc. Cambridge Phil. Soc.*, 1933, 29, 522–527).—Experiments are described in which the efficiency of ionization of potassium at a hot molybdenum surface was investigated. The degree of ionization observed is consistent with the most recent measurements of the electron work-function of molybdenum.—S. G.

On the Temperature Coefficient of the True Specific Heat of Nickel. Erhard Ahrens (*Ann. Physik*, 1934, [v], 21, 169–181).—v. G.

***A Note on Magnetostriction in Single Crystals of Iron and Nickel.** F. C. Powell (*Proc. Cambridge Phil. Soc.*, 1931, 27, 561–569).—A theoretical discussion of the theory of magnetostriction of a crystal when the magnetization is saturated.—S. G.

***Erratum: Thermal Expansion and the Ferromagnetic Change in Volume of Nickel.** Clarke Williams (*Phys. Rev.*, 1935, [ii], 47, 88).—Corrections to a diagram in a previous paper; see *Met. Abs.*, this volume, p. 44.—W. H.-R.

Discontinuities in the Magnetic Resistance in Ferromagnetism [Nickel]. G. Alocco and A. Drigo (*Nuovo cimento*, 1934, 11, 224–226; *Sci. Abs.*, 1934, [A], 37, 724).—Considering the discontinuities of resistance found by Heaps (*Met. Abs.*, 1934, 1, 227) in nickel wire magnetized longitudinally, it is shown that facts are not in favour of its being connected with the Barkhausen effect, but that it results from electromagnetic induction due to a cycle of magnetization in a twisted wire.—S. G.

***Discontinuities of Magnetoresistance [in Nickel].** C. W. Heaps (*Phys. Rev.*, 1934, [ii], 46, 1108).—A note. The sudden jumps in resistance associated with jumps in the magnetization of strained nickel wire found by H. (*Met. Abs.*, 1934, 1, 227) are not due to disturbance of bridge balance as suggested by Alocco and Drigo (preceding abstract). This source of error was guarded against.—W. H.-R.

***Directions of Discontinuous Changes in Magnetization in Monocrystal Bars and Discs of Silicon-Iron.** R. F. Clash, Jr., and F. J. Beck, Jr. (*Phys. Rev.*, 1935, [iii], 47, 158–165).—W. H.-R.

***The Action of Positive Ions of Cæsium on a Hot Nickel Surface.** P. B. Moon (*Proc. Cambridge Phil. Soc.*, 1931, 27, 570–577).—Experiments on the emission of secondary electrons from hot nickel surfaces bombarded by Cs^+ ions at normal incidence show that the emission is a function of bombarding voltage and target temperature. The emission is negligible below 300 v., and increases steadily with further increase of the bombarding voltage, increasing to 4% at 4000 v. with the target at 950°C . Increase of temperature causes the secondary emission to diminish. If positive ions are allowed to evaporate from the hot target the number of Cs^+ ions leaving the surface may, in certain conditions, be equal (with an accuracy greater than 1%) to the number arriving in the incident beam.—S. G.

***Secondary Electron Emission from a Nickel Surface Produced by Positive Ions of Mercury.** Rafi Mahommed Chaudhri (*Proc. Cambridge Phil. Soc.*, 1932, 28, 349-355).—A beam of positive ions of mercury produced from an arc in mercury vapour and fired on a surface of nickel produces an emission of electrons. For a fresh untreated nickel target the electron emission is of the order of 1.5% for ion energies less than about 600 electron-volts, and increases to about 15-20% at 2000 electron-volts. After degassing thoroughly at red heat the secondary electron emission is found to decrease to about half the value observed with a dirty target. Continued bombardment with mercury ions leads to a progressive decrease in the emission, which approaches a final steady state after some hrs. In this steady state the ratio is about 2.3% at 2000 electron-volts. After degassing afresh, the same process is repeated. Tests were carried out to assure that the emission is in reality one of electrons from the struck target, and that it is due to the impact of the positive electrons.—S. G.

On the Polymorphism of Metals [Iron and Tin]. V. N. Svechnikov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, 253-267).—[In Russian.] A review of the literature on the polymorphic transformation in iron and tin.

—N. A.

***The Evolution of Gas from Tungsten on Heating in a Vacuum.** S. V. Ptizin (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, 1189-1194).—[In Russian.] The gas evolution from tungsten in electronic tubes has been studied and the characteristics of tungsten in a vacuum obtained.—N. A.

***The Heat of Adsorption of Hydrogen on Tungsten.** J. K. Roberts and B. Whipp (*Proc. Cambridge Phil. Soc.*, 1934, 30, 376-379).—A method is described for measuring the heat of adsorption of hydrogen on a clean tungsten filament. The value obtained is 2.8×10^4 cal./mol.—S. G.

***Influence of a Grain-Boundary on the Deformation of a Single Crystal of Zinc.** Richard F. Miller (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 135-143; discussion, 143-145).—See *Met. Abs.*, this volume, p. 5.—S. G.

***Special Zinc for the Manufacture of Battery Plates.** A. Burkhardt and G. Sachs (*Metallwirtschaft*, 1934, 13, 809-813, 838).—Zinc sheet with a specially high resistance to corrosion by sulphuric acid is obtained by casting the metal at 3°-10° C. above the melting point, avoiding heating at any time above this temperature. Overheated metal must be cast and remelted to regenerate it. The beneficial effect of this low-temperature casting is attributed to the fine state of subdivision of the impurities, which do not segregate to the grain boundaries as in normally melted metal.—v. G.

***Investigation of the Mechanism of the Hot-Galvanizing of Iron. III.—Determination of the Effect of Temperature on the Solubility of Nickel-Steels, Chromium-Steels, and Manganese-Steels in Molten Zinc.** Heribert Grubitsch (*Monatsh.*, 1934, 65, 122-128).—Curves are given showing the amount of steel dissolved by molten zinc in 1 hr. at 450°-590° C. For steels with 3.6-25.4% nickel the curves show a minimum at 460°-480° C., a maximum at 500° C., and a second minimum at 510°-520° C.; the 25% nickel-steel dissolves rapidly above 520° C. and the second minimum is only poorly marked. For steels with 4-9% chromium the curve is horizontal up to 480° C., rises slightly to a maximum at 490°-500° C., falls again to a minimum at 515° C., and then rises slowly again at higher temperatures. The steel with 2.6% manganese gives a curve which rises slowly and regularly with rise in temperature. The curve for the 1.6% manganese-steel reaches a small maximum at 490° C., and a minimum at 520° C., and the curve for the 11.6% manganese-steel shows a steeper rise at lower temperatures, a well-marked maximum at 480° C., and a very flat minimum at 530°-540° C., after which it rises slowly.

—A. R. P.

*The Optical Constants of the Alkali Metals. M. I. Sergeev and M. G. Chernihovskiy (*Zhurnal eksperimental'noy i teoreticheskoy Fiziki* (*J. Exper. and Theoret. Physics*), 1934, 4, 235-241).—[In Russian.] Expressions are derived for the absorption and dispersion of light by alkali metals based on the hypothesis of almost free electrons and on the correctness of Nordheim's expression for the potential of individual ions. Comparison is made with experimental data for the reflection coeff. of sodium and potassium.—N. A.

*On the Change of Resistance of the Alkali Metals in a Magnetic Field. M. Korez (*Zhurnal eksperimental'noy i teoreticheskoy Fiziki* (*J. Exper. and Theoret. Physics*), 1934, 4, 421-427).—[In Russian.] The resistance calculated by Nordheim's method for the case of almost free electrons is compared with that obtained experimentally.—N. A.

*Comparative Studies of Creep of Metals [Iron, Nickel, Cobalt, Silver, Iron-Chromium-Nickel Alloy, and Iron-Chromium-Silicon Alloy] Using a Modified Rohn Test. C. R. Austin and J. R. Gier (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 53-73; discussion, 73-74).—See *Met. Abs.*, 1934, 1, 379.—S. G.

Properties of Metals at Low Temperatures. V. A. Smirnov and A. S. Fal'kevich (*Khimistroti*, 1934, 6, 466-474; *C. Abs.*, 1935, 29, 19).—[In Russian.] A discussion, based on foreign literature.—S. G.

Fourth Report of the Committee on Atomic Weights of the International Union of Chemistry. G. P. Baxter, (Mme.) M. Curie, O. Hönlischmidt, P. Le Beau, and R. J. Meyer (*J. Amer. Chem. Soc.*, 1934, 56, 753-764).—See *Met. Abs.*, 1934, 1, 339.—S. G.

*Surface Motion of Sputtered Particles. R. W. Ditchburn (*Proc. Cambridge Phil. Soc.*, 1933, 29, 131-135).—Using glass and metal targets evidence of surface motion for particles of sputtered cadmium, as with vaporized cadmium, was obtained.—S. G.

*The Equilibrium of Atoms and Ions Adsorbed on a Metal Surface. R. C. Evans (*Proc. Cambridge Phil. Soc.*, 1933, 29, 161-164).—Mathematical. The rate of attainment of equilibrium, in order to interpret data on the rate of evaporation of the alkali metals adsorbed on hot tungsten, is studied.—S. G.

*A Quantum Mechanical Theory of Energy Exchanges Between Inert Gas Atoms and a Solid Surface. J. M. Jackson (*Proc. Cambridge Phil. Soc.*, 1932, 28, 136-164).—Mathematical.—S. G.

*Theories of the Spectral Selective Photo-Electric Effect [Electron Theory of Metals]. Clarence Zener (*Phys. Rev.*, 1935, [ii], 47, 15-16).—Theoretical. Different models of the variation of potential at the surface of an alkali metal, covered with a monomolecular layer of gas and then with an outer layer of alkali atoms, are discussed from the point of view of photo-electric efficiency.—W. H.-R.

*The Photo-Electric Thresholds of Some Turned Metallic Surfaces. J. S. Hunter (*Proc. Roy. Soc. Edinburgh*, 1934, 54, 102-108).—By means of the valve electrometer the long wave-length photo-electric thresholds have been determined for copper, silver, antimony, bismuth, tin, lead, nickel, iron, zinc, aluminium, brass, and cast steel in the turned state. The specimens were turned down on a lathe, using no lubricant, and at once transferred to the cell. The thresholds found approximate to those for the same metals when the surface is partially outgassed, but are at much greater wave-lengths than those found for the totally out-gassed state. H. concludes that the turned surface is partially denuded of occluded gases. The composition of the brass is not stated.—W. H.-R.

Voltage Drop in Sliding Contacts. R. M. Baker (*Electric J.*, 1934, 31, 448-450).—The volt-amp. curve of an oxide-free contact (such as a graphite brush on a gold ring) is a straight line, but if oxide films are present (as when a graphite brush bears on a copper or iron ring) the voltage drop decreases as

the current increases. This is evidently due to breakdown of the oxide film. In an appendix, the effects of the degree of roughness of the contacting faces and the distribution of the contact areas are discussed.—J. C. C.

On the Question of the Surface Conductivity of Metals. A. W. Maue (*Naturwiss.*, 1934, 22, 648).—From a brief discussion of the effect of surface electron waves on the electrical conductivity of a metal, it is concluded that these electrons may pass into another surface state or into a space state when they collide with the crystal lattice.—A. R. P.

***Faraday's Law as a Basis of Electromagnetic Theory.** H. B. Phillips (*J. Math. and Phys. (Mass. Inst. Technol.)*, 1933, 12, 259-273).—S. G.

***Further Development of High-Frequency Resistances.** P. Wenk (*Physikal. Z.*, 1934, 35, 635-654; *Chem. Zentr.*, 1935, 106, I, 282-283).—High-frequency resistances produced by cathodic sputtering of 2 metals (platinum and gold or palladium) are variable within several % over long periods of time. This instability of the film is attributed to the presence of non-conductive modifications of the metals; change of temperature produced by the passage of the current converts the amorphous metal into the crystalline. On annealing the freshly sputtered films at 600°-700° C., this transformation takes place immediately, and a sharp increase in the conductivity occurs. By this procedure it is possible to prepare reproducible resistances between 10^{-1} and 10^{10} ohms. having low self-inductance, low capacity, and low temperature coeff. and without appreciable skin effect.—A. R. P.

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II.—PROPERTIES OF ALLOYS

(Continued from pp. 50-55.)

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	Cu, %.	Si, %.	Ni, %.	Mg, %.	Fe, %.
W	4.16	0.59	0.52
X	3.59	0.63	0.59	0.73	1.39
Y	4.05	0.23	1.99	1.62	0.55
Z	1.26	4.60	...	0.55	0.55

The casting shrinkage decreases from 0.185 in./ft. for W to 0.164 in./ft. for Z, the change on quenching from - 0.0040 in./ft. to + 0.0010 in./ft. and the change on ageing from - 0.0012 in./ft. to - 0.0001 in./ft. in the same order. On reheating, Y alloy shows the least change (max. about + 0.001 in./ft.), Z expands at most + 0.002, X + 0.005, and W + 0.023 in./ft.—the higher the reheating temperature the sooner the maximum change is attained. Reheating at 177° C. for the longest time did not materially affect the strength, although W, X, and Y showed an increase in the early stages, with a subsequent decrease. At 205° C. X and Y showed substantial decreases, while W and Z were not materially affected. Subjection to higher temperatures causes marked decrease in the strength of all the alloys, the higher the temperature the greater the decrease. In view of the results obtained the standard normalizing treatment is deprecated.—R. B. D.

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†**The Endurance Strength of Light Metal Castings**. W. Linicus and E. Scheuer (*Metallwirtschaft*, 1934, 13, 829-836, 849-855).—Tables summarizing

results found in the literature are given and amplified by the authors' own work. Sand-cast Silumin is entirely, and chill-cast Silumin almost, insensitive to notch effects and the effects of casting skins. Aluminium alloys with a low copper content are relatively resistant to sea-water corrosion, whereas those containing magnesium are much more prone to attack. Cooling conditions have little effect on the endurance strength of Silumin, which can be increased by 40% by ageing.—v. G.

***Determination of the Creep Limit of Aldrey and Pure Aluminium.** —Irmann and W. Müller (*Aluminium*, 1935, 17, 7-10).—Tests carried out on aluminium and Aldrey by the accelerated creep method of Pomp and Höger, show that the method gives results a little lower than those obtained in prolonged endurance tests provided that the test is made over a period of 25-35 hrs. and that the rate of elongation is about 0.0012%/hr. Aldrey with a breaking strain of 35.4 kg./mm.² has an endurance strength of 29.9 kg./mm.²; hard-drawn aluminium with a breaking strain of 19.3 kg./mm.² has an endurance strength of 12.8 kg./mm.².—A. R. P.

***Solubility of Silicon in Aluminium in the Solid State at Different Temperatures.** P. J. Saldau and M. V. Danilovitch (*Izvestia Instituta Fiziko-Khimicheskogo Analisa* (*Ann. inst. anal. phys.-chim.*), 1933, 6, 81-90).—[In Russian.] See *Met. Abs.*, 1934, 1, 564.—S. G.

Aluminium-Silicon Alloys. Metallgesellschaft A.-G. (*Met. Ind. (Lond.)*, 1935, 46, 100-101).—A letter amplifying data given in a paper by W. C. Devereux (see *Met. Abs.*, this volume, p. 29). A development of Alpax (Silumin), known as Alpax Beta (un-heat-treated) or Alpax Gamma (heat-treated) has the composition: silicon 12, manganese 0.5, magnesium 0.1-0.5%, and aluminium the remainder. This is an age-hardenable alloy, having particularly good casting qualities. The mechanical properties are tabulated, and the advantages of these two forms of the alloy are described.—J. H. W.

The Heat-Treatable Aluminium Casting Alloys. P. Barrand (*Bull. Assoc. Tech. Fonderie*, 1934, 8, 369-373; and (abstract) *Rev. Fonderie moderne*, 1934, 38, 236-237).—A general review is given of the development of heat-treatable aluminium alloys, and a comparison is made of those at present more commonly used.—R. B. D.

***Notes on the Cadmium-Nickel System.** Carl E. Swartz and Albert J. Phillips (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 333-336).—See *J. Inst. Metals*, 1933, 53, 696.—S. G.

New Cadmium-Silver-Copper Bearing Alloys. Athel F. Denham (*Automotive Ind.*, 1934, 71, 640-642).—Cadmium alloys with a small amount of silver and less than 1% of copper show a tendency to soften at 93°-120° C., the material regaining its hardness after prolonged operation and retaining it on cooling. The melting-point is 327° F. (164° C.). The alloys are readily bonded or soldered to bearing shells, possess superior compressive strength and hardness to tin-base metals at operating temperatures, do not require increased clearance, and cause no excessive wear on crankshafts.—P. M. C. R.

***Solubility of Oxygen in Solid Copper.** F. N. Rhines and C. H. Mathewson (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 337-353).—See *Met. Abs.*, 1934, 1, 381.—S. G.

***Influence of Silver on the Softening of Cold-Worked Copper.** H. C. Kenny and G. L. Craig (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 196-203; discussion, 203-204).—See *Met. Abs.*, 1934, 1, 341.—S. G.

***Structure of Tin-Bronzes.** J. Verö (*Z. anorg. Chem.*, 1934, 218, 402-424).—The tin-copper system has been re-examined in the range 13-38% by thermal and micrographic examination, particular care being taken to obtain equilibrium by prolonged annealing. The solid solubility of tin in copper is 13.3% at 795° C., 16% at 586°-520° C., and 14% at room temperature. The peritectic reactions $\alpha + \text{liquid} = \beta$, $\beta + \text{liquid} = \gamma$, and $\gamma + \text{liquid} = \phi$

take place at 797°, 756°, and 742° C., respectively, the corresponding composition ranges being 13.3–26.1, 25.7–30.5, and 28.0–33.2% tin. The reaction $\beta = \alpha + \gamma$ occurs at 586° C. in the range 16–25.2% tin, the reaction $\gamma = \alpha + \delta$ at 520° C. (16–32.5% tin), the reaction $\phi = \gamma + \eta$ at 640° C. (34.2–38.0% tin), the reaction $\gamma + \eta = \varepsilon$ at 630° C. (34–38% tin), the reaction $\gamma + \varepsilon = \delta$ at 590° C. (31.7–33.1% tin), and the reaction $\varepsilon = \delta + \eta$ at 582° C. (32.5–38% tin). The $\alpha + \beta$ field extends to 22% tin at 797° C. and to 24.5% tin at 586° C., the $\beta + \gamma$ field to 27% tin at 756° C., the $\gamma + \phi$ field to 30.8% tin at 742° C. and to 36% tin at 640° C., the $\gamma + \varepsilon$ field to 35.1% tin at 630° C., the $\varepsilon + \eta$ from 34.1 to 38% tin at 582° C., and the $\alpha + \gamma$ -field to 26.8% tin at 520° C. The compound Cu_3Sn solidifies within a range of not more than 2°–3° C.

—A. R. P.

Tin- and Aluminium-Bronzes. C. Panseri (*Atti Sindacati Provinciali Fascisti Ingegneri Lombardia*, 1934, July; *Light Metals Res.*, 1935, 3, 314).—A detailed study of the structure of these bronzes, giving some indication of their casting properties.—I. M.

†**Manganese-Bronze and Brass.** Wesley Lambert (*Found. Trade J.*, 1934, 51, 369–371, 372; discussion, 1935, 52, 45–50).—Read at a joint meeting of the London Local Section of the Institute of Metals and the London Branch of the Institute of British Foundrymen. The metallurgical features of manganese-bronze, the characteristic features of the α - (α - β)-, and β -brasses, and the foundry technique in the manufacture of the alloy are discussed. The casting temperature is 960° C., and, in the case of crucible melting using several pots, the contents of each pot should be transferred to a preheated ladle. Overheating must be studiously avoided.—J. H. W.

***Note on Frictional Resistance of Steel and Brass in Shrink Fits.** W. H. Swanger (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 165–171; discussion, 172–175).—See *Met. Abs.*, 1934, 1, 342.—S. G.

***Strength and Ageing Characteristics of Nickel-Bronzes.** E. M. Wise and J. T. Wise (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 218–242; discussion, 243–244).—See *Met. Abs.*, 1934, 1, 342.—S. G.

New Gold Alloys. L. Sterner-Rainer (*Deut. Goldschmiedezcit.*, 1933, 36, 29–30; *C. Abs.*, 1934, 28, 3365).—Reviews the composition and properties of gold alloys containing gold and zinc; gold and chromium; gold, chromium, copper, and silver; gold, silver, molybdenum, copper, nickel, and chromium; gold and silicon; gold and aluminium; gold, silver, palladium, and platinum.—S. G.

The Use of Cadmium to Simplify the Making of [Gold Dental] Crowns. Jos. C. Polenaar (*Brit. J. Dental Sci.*, 1934, 79, (1401), 258–264).—Translated from *Tydschrift voor Tandheilkunde*, 1934, 14, Jan.; see *Met. Abs.*, 1934, 1, 568.—J. C. C.

***Observations on the Rare Earths. XXXVIII.—Electrolytic Production of Amalgams of the Rare Earths. II.—Decomposition of Lanthanum Amalgam for the Recovery of the Free Metal.** R. E. Meints, B. S. Hopkins, and L. F. Audrieth (*Z. anorg. Chem.*, 1933, 211, 237–240).—Lanthanum amalgam can be readily obtained by electrolysis of a 20% solution of the chloride monohydrate in alcohol using a current density of 0.02 amp./cm.² at a mercury cathode (20 v.). After 30 hrs. the product contains 2.5–3% lanthanum. To recover the free metal the carefully washed (alcohol and ether) and dried amalgam is heated at 235° C. *in vacuo* to give a grey powder containing 15% lanthanum; this powder is then heated at 600° C. *in vacuo* in a crucible made of rare earth oxides and alumina, until all the mercury is removed, and finally at 1000° C. to melt the metal.—A. R. P.

Type Metals. H. Vance White (*Metal Progress*, 1934, 26, (6), 17–21, 56).—The special properties desirable in linotype, stereotype, monotype, electrotypes, and hard foundry alloys are discussed with reference to the preparation, working conditions, and remelting of each.—P. M. C. R.

***Equilibrium in the Lead-Zinc System, with Special Reference to Liquid Solubility.** R. K. Waring, E. A. Anderson, R. D. Springer, and R. L. Wilcox (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 254-263; discussion, 263).—See *Met. Abs.*, 1934, 1, 569.—S. G.

***The Lithium-Magnesium Equilibrium Diagram.** Otto H. Henry and Hugo V. Cordiano (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 319-332; discussion, 332).—See *Met. Abs.*, 1934, 1, 382.—S. G.

Ultra-Light Alloys of Great Strength. S. A. Pogodin (*Izvestia Instituta Fiziko-Khimicheskogo Analisa* (*Ann. inst. anal. phys.-chim.*, 1933, 6, 295-310; *C. Abs.*, 1934, 28, 390).—[In Russian.] A review of physico-chemical properties of commercial magnesium and of the physico-chemical properties and phase diagrams of the alloys of magnesium with metals of groups I, II, and III of the periodic table. A bibliography of 62 references is given.—S. G.

A New Magnetic Alloy ("1040") with High Initial Permeability. Hans Neumann (*Arch. tech. Messen.*, 1934, 4, (42), 1168).—The alloy (approximate composition Ni 72, Fe 11, Cu 14, Mo 3%) is stated to possess higher initial permeability and coercive force than Mu-metal, the hysteresis losses being considerably decreased. Graphs show the permeability, degree of magnetization, hysteresis losses, and remanence of the material, as measured on thin rings; other properties are summarized.—P. M. C. R.

***The Alloys of Praseodymium with Copper.** G. Camneri (*Metallurgia italiana*, 1934, 26, 869-871).—The system contains 4 compounds, PrCu_5 , melting point 962°C ., PrCu_2 , melting point 841°C ., PrCu , melting point 563°C ., and PrCu , formed by a peritectic action at 824°C . There are also 3 eutectics at 85% copper and 891°C ., at 55% copper and 791°C ., and at 17.5% copper and 472°C . All the alloys are hard and brittle. Characteristic microstructures are illustrated.—A. R. P.

***The System Praseodymium-Gold.** Armando Rossi (*Gazz. chim. ital.*, 1934, 64, 748-757).—Four compounds exist, viz. AuPr_2 formed by a peritectic reaction at 710°C ., AuPr melting at 1350°C ., Au_2Pr melting at 1210°C ., and Au_3Pr melting at 1200°C . The 4 eutectics occur at 17 atomic-% gold and 600°C ., 63.3 atomic-% gold at 1140°C ., 72 atomic-% gold at 1050°C ., and 89 atomic-% gold at 808°C . The metals have only a very limited mutual solubility. On prolonged annealing of praseodymium-rich alloys at 600°C the hexagonal form is converted into a face-centred β -modification with $a = 5.100$. The specific heat of 99.5% praseodymium (silicon and carbon impurities) between 20° and 100°C is 0.0486 ± 0.0007 , corresponding with an atomic heat of 6.85.—A. R. P.

***The Parachor of Thallium in Amalgams.** Luigi Belladen with A. Triolo (*Gazz. chim. ital.*, 1934, 64, 461-465; *C. Abs.*, 1935, 29, 17).—Measurements of the parachor of thallium in different concentrations in amalgams showed that there is a positive anomaly at approximately 21.9. The density and the surface tension are linear functions of the concentration. The results indicate that thallium dissolved in mercury is not in the monatomic state but combined either with the mercury or with other thallium atoms to form polyatomic molecules. The following data give the % concentration of thallium, d_{18} values, γ_{18} (dynes/cm.), P_{H_2} values, and P_{Tl} values, respectively: 2, 13.5129, 511, 70.66, 85; 4.80, 13.4393, 514, 71.09, 87.3; 9.09, 13.3512, 520, 71.87, 86.3; 18.00, 13.1550, 532, 73.29, 87.1; 28.95, 12.9228, 547, 75.58, 84.1.—S. G.

*[Contribution] to Our Knowledge of the Replaceability of Zinc [in Alloys] by Magnesium and Vice-Versa. I.—On the Miscibility of Mg_2Sb_2 and Sb_2Zn_3 and the Structure of Their Solid Solutions. Karl Löhberg (*Z. physikal. Chem.*, 1934, [B], 27, 381-403).— Mg_2Sb_2 dissolves up to 46 atomic-% of Sb_2Zn_3 , whereby the axial ratio of the trigonal crystals is increased from $c/a = 1.581$ to $c/a = 1.636$; the intensity of the X-ray lines indicates a structure of the Pauling type, the distribution of the zinc atoms in the magnesium positions

being such that only the magnesium atoms of the binato lattice points are displaced by zinc, those at the other points not being displaceable.—K. S.

*The High-Zinc Region of the Copper-Zinc Phase Equilibrium Diagram. E. A. Anderson, M. L. Fuller, R. L. Wilcox, and J. L. Rodda (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 264-292).—See *Met. Abs.*, 1934, 1, 574.—S. G.

†Intermetallic Solid Solutions. Eric R. Jette (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 75-90; discussion, 90-93).—See *Met. Abs.*, 1934, 1, 576.—S. G.

†Contribution to the Development of Heat-Resisting Alloys. — Piwowarsky (*Chaleur et Ind.*, 1934, 15, (167), 159-166).—See *Met. Abs.*, 1934, 1, 346.
—J. C. C.

A Metallurgical Survey of Engineering Materials. Josiah W. Jones (*J. Inst. Production Eng.*, 1935, 14, 21-48).—See *Met. Abs.*, this volume, p. 14.
—J. C. C.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 56-58.)

New Etching Reagent for Macro-Examination. Alexander Matting (*Autogene Metallbearbeitung*, 1934, 27, 353-355).—The reagent, due to Adler, consists of 25 c.c. distilled water, 3 grm. copper ammonium chloride, 50 c.c. conc. hydrochloric acid, and 15 grm. ferric chloride. Photographs are shown of welds in steel, copper, bronze, and aluminium, etched with this and other reagents.—H. W. G. H.

*Oxide Films on Liquid Metals Studied by Means of Electron Diffraction. R. O. Jenkins (*Proc. Phys. Soc.*, 1935, 47, 109-122; discussion, 123-124).—Electron-diffraction patterns obtained by reflection from molten lead, zinc, bismuth, and tin show that the surfaces of these metals are covered with thin oxide films. These films consist of small electron-optically flat oxide crystals resting on their {001} faces. The inner potentials and crystal structures of these oxides are found, and they enable the films to be identified as definite chemical compounds. The films can be removed from the molten metals by nickel gauze, and it is possible to obtain their electron-diffraction patterns by transmission. These patterns show that although the composition of the films remains unaltered, their removal disturbs the crystal orientation and gives the crystals an approximately Maxwellian distribution of orientations about their original direction.—J. S. G. T.

The Function of Recovery in Recrystallization. M. O. Kornfeld (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, 235-252).—[In Russian.] A review of the literature, with a bibliography of 38 references.—N. A.

*The Texture of Cold-Rolled Aluminium for Different Degrees of Deformation. G. S. Shdanow [with L. Altshuler] (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1933, 3, 1331-1347).—[In Russian.] Changes in the texture of rolled aluminium after deformation of 50-95% have been investigated, especially in the region 80-95%. Regular shifting of the maxima on the {200} ring in the Debye diagrams occurs, depending on the degree of rolling. The changes in the X-ray diagrams for {111} have been measured quantitatively and are explained as changes in the position of one of the stable orientations of the crystals in the texture of aluminium during deformation. The orientation about the [112] axis in the texture of rolled aluminium disappears on addition of impurities.—N. A.

*X-Ray Determination of the Structure of FeAl₃ (Preliminary Communication). E. Bachmetew (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki (J. Exper. and Theoret. Physics)*, 1934, 4, 292-293).—[In Russian.] Single-

crystal specimens of FeAl_3 were examined by Laue's method. The compound has a rhombic lattice, the identity periods in the direction of the main axes being 15.485, 8.111, and 11.915 Å. The translational group of FeAl_3 is determined as Γ_v'' .—N. A.

***Structure and Origin of the Copper-Cuprous Oxide Eutectic.** L. W. Eastwood (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 181-188; discussion, 188-195).—See *J. Inst. Metals*, 1933, 53, 700.—S. G.

***The Temperature Function of X-Ray Reflection in the Neighbourhood of the Melting Point of a Crystal [of Bismuth].** Robert B. Jacobs and Alexander Goetz (*Phys. Rev.*, 1935, [ii], 47, 94-95).—A note. According to the Debye-Waller law the intensity of X-ray reflections should decline continuously with increasing temperature. With single crystals of bismuth the intensity of 3rd order Mo, K_α radiation reflected from Bi (111) decreased to a minimum at 210° C., and then increased to the highest observed temperature of 265° C. In some cases hysteresis effects were noted, and depended on the thermal history of the crystal.—W. H.-R.

***The Texture of Rolled α -Brass.** G. S. Zhdanow and V. I. Iveronova (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, 911-924).—[In Russian.] The textures of copper and 5 α -brasses with different zinc contents and the pole figures {111}, {200}, and {220} for the three degrees of intensity, indicate that the texture of the metal depends on the zinc content up to 10%, when the brass texture is established, and this changes only slightly with increase of zinc. Zinc produces a merging of the (111) and (100) textures of copper, but has no effect on the (112) texture as shown by the pole figures and by photographs taken with a special texture camera. The latter also indicates that the number of unoriented crystals increases with increase in the zinc content. The texture of α -brasses with a low zinc content is analogous to that of gold and silver.—N. A.

***Monochromatic K_α Radiation of Cobalt.** E. I. Sovz and V. L. Heyfez (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, 1238-1241).—[In Russian.] Monochromatic K_α radiation of cobalt was obtained by the use of an iron filter prepared by electrodeposition of iron on aluminium foil.—N. A.

***An X-Ray Study of Orientation Changes in Cold-Rolled Single Crystals of Alpha Brass.** Carl H. Samans (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 119-133; discussion, 134).—See *Met. Abs.*, this volume, p. 15.—S. G.

***An X-Ray Study of the Gold-Iron Alloys [and Some Magnetic and Age-Hardening Properties].** Eric R. Jette, Willard L. Bruner, and Frank Foote (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 354-359; discussion, 359-360).—See *Met. Abs.*, 1934, 1, 347.—S. G.

***X-Ray Studies on [and Solid Solution Limits in] the Nickel-Chromium System.** Eric R. Jette, V. H. Nordstrom, Bernard Queneau, and Frank Foote (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 361-371; discussion, 371-373).—See *Met. Abs.*, 1934, 1, 347.—S. G.

***The Crystalline Structure of the Phases LaMg and CeMg .** Armando Rossi (*Gazz. chim. ital.*, 1934, 64, 774-778).— LaMg has $a = 3.952$ Å., and CeMg $a = 3.884$ Å. In the first case $d = 4.36$ and in the second case $d = 4.63$ (found 4.48).—A. R. P.

***Changes in the Breadth of the X-Ray Interference Lines of Palladium by Electrolytic Saturation with Hydrogen.** E. Nühring (*Ann. Physik*, 1934, [v], 21, 303-319).—Measurements of the lattice constants of palladium saturated with hydrogen have confirmed the results of earlier work. The lines show a considerable broadening which follows a definite law, and it is concluded, therefore, that the lattice symmetry deviates slightly from the cubic on absorption of hydrogen.—v. G.

*The Crystalline Structure of the Phases PrSn_3 and PrPb_3 . Armando Rossi (*Gazz. chim. ital.*, 1934, 64, 832-834).— PrSn_3 melts at 1160°C ., has $a = 4.704$ Å. and $d = 7.88$ (found 7.60). PrPb_3 melts at 1150°C ., has $a = 4.857$ Å. and $d = 10.98$ (found 10.60).—A. R. P.

*Crystal Orientations Developed by Progressive Cold-Rolling of an Alloyed Zinc [containing 1 Per Cent. of Copper and 0.1 Per Cent. of Magnesium]. M. L. Fuller and Gerald Edmunds (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 146-153; discussion, 153-157).—See *Met. Abs.*, 1934, 1, 348.
—S. G.

*X-Ray Investigations of Transformation Processes. I.—On the Use of the Weissenberg X-Ray Goniometer in Following Transformation Processes. I. Böhm and P. Feldmann (*Z. physikal. Chem.*, 1934, [B], 27, 425-430).—By moving the film carrier of an X-ray goniometer during the photographing of a specimen undergoing a transformation, the changes which occur in the interference lines are continuously reproduced. The technique of the method and the apparatus required are described with reference to their application to the study of the recrystallization of platinum sponge.—K. S.

*X-Ray Investigation of the Mechanism of the Transformation from Face-Centred Cubic Lattice to Body-Centred Cubic. Zenji Nishiyama (*Kinzoku no Kenkyu*, 1934, 11, (12), 561-589).—[In Japanese.] A new mechanism is proposed for the transformation of face-centred to body-centred cubic lattice on the basis of experiments with a single crystal of an iron-nickel alloy containing 29.90% nickel.—S. G.

On the Determination of Crystal Structures with Many Parameters. A Graphical Method Based on Intensity Determinations. Käthe Schiff (*Z. Krist.*, 1934, 88, 255-259).—W. H.-R.

†Precision Methods of Measuring the Parameter of the Atomic Crystalline Space-Lattice. V. I. Iversonova (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, 459-475).—[In Russian.] The theory of the subject is discussed and the methods of Dehlinger and Glocker, Sachs and Weerts, and of Preston are described. The influence of the accuracy of measurement of the X-ray lines on the accuracy of the parameter results is pointed out. Methods of preparing the specimens and choice of radiation are given.—N. A.

*The Use of X-Rays of Long Wave-Length for the Solution of Special Problems in Crystal Structure. H. O'Daniel (*Z. Krist.*, 1934, 88, 304-316).
—W. H.-R.

*The Weissenberg Reciprocal Lattice Projection and the Technique of Interpreting Weissenberg Photographs. M. J. Buerger (*Z. Krist.*, 1934, 88, 356-380).—W. H.-R.

*On a Thermal Theory of Cathodic Dispersion and Emission of Secondary Electrons. N. D. Morgulis (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki (J. Exper. and Theoret. Physics)*, 1934, 4, 499-506).—[In Russian.] The subject is examined from the thermal point of view, and expressions are developed connecting the number of atoms and electrons evaporated by the ionic bombardment with the thermal constants of the metal and the energy of the ions.—N. A.

*Graphical Method for Investigating X-Ray Diagrams of Rotation. N. J. Seljakov and E. I. Sovz (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki (J. Exper. and Theoret. Physics)*, 1934, 4, 620-626).—[In Russian.] A method for investigating the X-ray diagrams of rotation of a crystal about a given axis, and a calculation for the case of a cubic crystal are given. The orientations of single crystals of copper and aluminium obtained by recrystallization have also been determined.—N. A.

IV.—CORROSION

(Continued from pp. 58-61.)

***Solubility of Cadmium in Certain Organic Acids.** Paul Fortner and Heinrich Lukas (*Pharm. Zentralhalle*, 1934, 75, 557-562; *C. Abs.*, 1935, 29, 399).—An experimental study presenting classified data on the solubility of cadmium in acids such as lactic, succinic, tartaric, citric, oxalic, and in wine.—S. G.

Copper and Its Protection by Oxidation. L. W. Haase (*Chem. Fabrik*, 1934, 7, 329-330).—Protective oxide films on copper invariably contain cuprous oxide, the film consisting of a mixture of this oxide and finely-divided copper without a sharp line of separation from the body of the metal. The cuprous oxide appears to be formed by reaction between the outer cupric oxide film and the copper surface, and its formation is accelerated by the presence of electrolytes which favour the production of copper ions.—A. R. P.

Food Industry Metals. Nickel and Monel Metal for Cannery Equipment. — (*Canning Ind.*, 1934, 4, 69-71, 89-90).—The mechanical and corrosion-resisting properties of these materials are discussed with reference to their use for food-processing plant. Their resistance to attack by specific food products is described, and an illustrated review of typical applications is given. —C. E. H.

†**Tarnishing of Silver and Its Prevention.** E. Raub (*Mitt. Forschungsinst. Edelmetalle*, 1934-1935, 8, 61-67, 77-84, 105-112).—A comprehensive review and discussion of every aspect of this subject is given under 3 headings: mechanism of tarnishing and methods of testing tarnish resistance; the effect of alloying constituents on the resistance of silver to tarnishing; and methods of surface protection, e.g. plating with a platinum metal or chromium, plating with a resistant metal and heat-treatment to produce a diffusion layer, &c. Recent patent literature is critically reviewed.—A. R. P.

Corrosion of Tinned-Iron Containers. O. Carrasco (*Giorn. chim. ind. appl.*, 1934, 16, 329-334; and *Food*, 1934, 4, 48-52; *Brit. Chem. Abs.*, 1935, [B], 27).—Cans containing preserved foodstuffs always undergo corrosion ultimately; the extent of the action varies greatly with the nature of the tinplate, and the presence of appreciable quantities of sulphur increases the rate of corrosion appreciably. Other important factors are storage temperature, p_{H_2} , slow cooling after sterilization, insufficient free space above the contents, and presence of colouring matter which may act as a depolarizer. The case of corrosion of various specimens of tinplate is discussed in relation to their chemical and mechanical properties; the former do not yield any direct correlation, but a low hardness (Erichsen) appears to be accompanied by a high corrosion-resistance.—S. G.

The Use of Bureau of Standards Soil Corrosion Data in the Design and Protection of Pipe-Lines. K. H. Logan (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 138-152; discussion, 153-155).—See *Met. Abs.*, 1934, 1, 350.—S. G.

***The Action of Cream and Butter Fat on Metals, and the Influence of Metals on the Quality of Butter and Clarified Butter.** W. Mohr and A. Eichstaedt (*Proc. World's Dairy Congress, Milan*, 1934, Sect. II, 95-100; *C. Abs.*, 1934, 28, 5545).—Metals in pure form or plated were completely or half immersed in cream during heating and during heating and scouring. V₂A steel 99%, 95% aluminium and tinned copper were not attacked and had no injurious effect. With chromium-plated copper there was no harmful influence on the quality of the butter, but the covering was brittle, exposing the underlying metal. Nickel became black and lost weight, causing a decrease in the quality of the butter. Copper, brass, and iron were dissolved, with the usual oily or metallic taste in the butter. Aluminium in combination with other metals is not recommended. V₂A steel and tinned and enamelled metals proved most satisfactory.—S. G.

Prevention of Corrosion in Ice-Making Plant. A. Freundlich (*Z. ges. Kälte-Ind.*, 1933, 40, 191–192; *Brit. Chem. Abs.*, 1935, [B], 1).—Cf. *Met. Abs.*, 1934, 1, 79. The use of homogeneous iron material and the choice of a metal plating of the ice cell are important factors affecting the resistance to corrosion. Air content and brine concentration must also be considered. The brine should be less than 20%; sodium phosphates are especially suitable for control of p_H .—S. G.

***Study of the Effect of the Method of Immersion of Specimens in Corrosion Tests.** Jean Cournot and Marcel Chaussain (*Compt. rend.*, 1934, 199, 1410–1411).—Specimens of pure aluminium, Duralumin, Armco iron, and ordinary steel were immersed vertically for 20 days in artificially normalized sea-water at 35° C. as follows: (1) alternate immersion and withdrawal; (2) partial immersion, in which the specimen, originally totally immersed, became exposed during the test owing to evaporation of the liquid; (3) total immersion immediately below the surface, distilled water being added periodically as required; and (4) total immersion at a depth of about 500 mm. The resulting losses in weight showed that the method of immersion had a considerable effect on the amount of corrosion, the direction in the case of the light alloys being opposite to that in the case of the ferrous alloys. In the former case, the second method caused the greatest corrosion, but with the ferrous alloys the first method caused by far the greatest corrosion. This is in accordance with the nature of the products of corrosion. The method of immersing specimens in an evaporating medium (method 2) is recommended for the study of the corrosion of aluminium and magnesium and their alloys and for the study of certain methods of surface protection.—J. H. W.

†Methods of Studying the Corrosion of Metals and Alloys by Gases at High Temperatures and Their Applications. A. Portevin, E. Pretet, and H. Jolivet (*Chaleur et Ind.*, 1934, 15, (167), 167–199).—See *Met. Abs.*, 1934, 1, 304, 589. Includes a brief discussion.—J. C. C.

On the Importance and Present Position of Corrosion Research. W. Wiederholt (*Chem. Zeit.*, 1935, 59, 25–28).—A review of modern concepts of the mechanism of corrosion and of methods of testing the resistance of metals to corrosion.—A. R. P.

V.—PROTECTION

(Other than Electrodeposition.)

(Continued from p. 61.)

Recent Work on the Protection of Light Alloys. Georges Chaudron (*Métaux et Machines*, 1935, 19, (252), 18–20).—Factors promoting corrosive attack are classified as: (1) nature and conditions of attacking medium; (2) nature of the metal; (3) conditions of use. A list is given of the solution potentials of aluminium, magnesium, 5 light alloys, zinc, cadmium, iron, nickel, copper, mercury, gold, and platinum towards calomel and hydrogen electrodes, and its use in selecting suitable metals for electrodeposition on light alloys is illustrated. A brief reference to anodic oxidation is followed by an account of the Allumag alloys, analyses of which are tabulated together with those of other “self-protecting” alloys (Anticorodal, Birmabright, Duranalium, K.S.S., &c.). The results of corrosion tests (intermittent immersion in sodium chloride solution, and continuous attack by oxygenated sea-water) are compared graphically for Allumag and an alloy of the Duralumin class.—P. M. C. R.

The Protection and Decoration of Aluminium and Its Alloys by Anodic Treatment. II.—Practice. S. Wernick (*Indust. Chemist*, 1934, 10, 231–233, 265–267).—Cf. *Met. Abs.*, 1934, 1, 351. A review of the properties and some uses of anodized aluminium.—A. R. P.

***Production of Iron Alloyed with Aluminium from Ferran [Bimetal].** I. E. Gorshkov and J. A. Zenter (*Trudi Nauchno-Issledovatel'skogo Instituta Legkikh Metallov—"Niisaluminiumi"* (Trans. Sci. Res. Inst. Light Metals—"Niisaluminiumi"), 1933, (3), 65-78).—[In Russian.] Ferran sheets 1.3 and 6 mm. thick, obtained by rolling aluminium into iron, have been annealed at 600°-900° C. for 1-6 hrs. in an electric furnace and the depth of diffusion of the aluminium studied in relation to temperature, time of heating, and carbon content of the iron. The mechanical properties and resistance to heat of the resulting aluminium-plated iron have also been determined. The aluminium layer on each side being 5, 10, and 20% of the thickness of the iron. Carbon slightly decreases the rate of diffusion of aluminium into the iron; thus in 3 hrs. at 700° C. an aluminium coating 3 mm. thick diffuses to a depth of 275 μ into iron with 0.1% carbon and to a depth of 240 μ into iron with 0.25% carbon. With decrease in annealing temperature the depth of diffusion is less; thus at 600° C. it reaches a depth of only 80 μ in 3 hrs. With an increased thickness of aluminium diffusion is greater, reaching a depth of 400 μ with a 1.2 mm. layer compared with 275 μ for a 0.3 mm. layer. Time of heating has a similar effect to temperature. Iron increases in weight by 150 mg./cm.² on heating to 900° C. for 144 hrs., whereas Ferran increases by 10 mg. At 1000° C. for 144 hrs., the corresponding increases in weight are 500 and 120 mg. With an aluminium layer 1 mm. thick only pin-hole oxidation occurs in Ferran, whereas an iron surface is completely oxidized, and at 1100° C. iron is completely oxidized, whereas Ferran is stable. In an oxidizing atmosphere at 800° C. sheet-iron increases in weight by 25-30 mg. every 24 hrs., whereas Ferran increases by only 2 mg. In a gas mixture containing 15% of sulphur dioxide the rate of oxidation of sheet-iron at 800° C. is 10 times as great as that of Ferran and the iron is completely destroyed after 144 hrs. In a reducing atmosphere (petroleum vapour) Ferran is also more stable than iron. Rolled Ferran 1 mm. thick has a tensile strength of 50-70 kg./mm.², which decreases on annealing to 33-35 kg./mm.², and after diffusion to 30-32 kg./mm.². The corresponding elongations are 1.5, 30, and 25%, respectively. In the bending test, Ferran cracks after 1-2 bends, but after diffusion it withstands 5-7 bends.—D. N. S.

Sales Appeal of Hot-Dip Zinc Coatings. Wallace G. Imhoff (*Iron Age*, 1934, 134, (21), 10-13).—The finishes used in galvanizing are classified as: black, flower, pearl, frosted, and burned spangles, the pearly spangle being the most desirable. The applications of these finishes and the methods of producing them are described, and the precautions to be observed in finishing in general are set out.—J. H. W.

Tentative Specifications for Zinc Coating (Hot Dip) on Hardware and Fastenings (A 153-33 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 113-116).—Cover zinc coatings applied by the hot-dip process to hardware and fastenings such as builders' hardware, pole line hardware, hardware for farm implements, bolts, nuts, screws, nails, rivets, awning pulleys and fittings and other miscellaneous general hardware. These specifications are not intended to apply to coating on marine hardware or on articles formed after coating.—S. G.

Accelerated Tests of Nickel and Chromium Plating on Steel. Paul W. C. Strausser, Abner Brenner, and William Blum (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (1), 28-37).—Same as *J. Res. Nat. Bur. Stand.*, 1934, 13, 519-526; see *Met. Abs.*, this volume, p. 20.—A. R. P.

Doublé Sheets and Their Working. Karl Halfmann (*Z.V.d.I.*, 1934, 78, 1421-1422).—A short account is given of the method of manufacture and use of brass, nickel, and copper-coated steel sheets prepared by welding the metals together and rolling the ingot into a doublé sheet.—K. S.

Metallizing Process Comes to the Fore. R. J. McWaters (*Canad. Mach.*, 1934, 45, (12), 62-67).—A description is given of the successful application of the Schoop process to the protection of steel shafting: in some cases the added material was of steel or "18:8," in others of zinc. The process has also been applied to the production of thin Babbitt linings in iron or steel bearing boxes.

—P. M. C. R.

Remarks on the Protection of Steel and Iron by Metallic Cementation. G. Meker (*Chaleur et Ind.*, 1934, 15, 328).—A letter claiming priority over "calorization" for a process introduced by M. in 1923, in which the articles are cemented for 3-6 hrs. at 900°-1000° C. in powdered iron-aluminium alloy containing about 50% of aluminium. The ductility of the coatings is discussed.

—J. C. C.

The Painting of Metal Surfaces. Preliminary Treatment. P. S. Symons (*Decorator*, 1934, 33, 28-30).—Instructions are given for the preparation of aluminium, zinc, galvanized iron, and Tungum for painting.—C. E. H.

VI.—ELECTRODEPOSITION

(Continued from pp. 62-64.)

***Black Chromium Plating.** H. Pollack (*Chem.-Zeit.*, 1935, 59, 56).—A black chromium plate suitable for use as an "absolute black body" can be obtained from an electrolyte containing 250-400 grm./litre of chromic acid and 0.8-1.2% of acetic acid but no sulphuric acid; the bath is operated at more than 1000 amp./dm.² (11-14 v.) and is kept at below 15° C. by a system of water cooling. The black plate can be applied directly on to steel or iron or on an intermediate coat of bright chromium plate. If the undercoat is of nickel plate, this must be free from occluded hydrogen and from internal stress.—A. R. P.

A Study of Chromium Plating. J. Glaymann (*Sci. et Ind.*, 1933, 17, 278-280, 321-324; *C. Abs.*, 1934, 28, 3309).—A review of the theoretical principles and present-day technique of chromium plating.—S. G.

Recent Developments in the Electrodeposition of Nickel. A. W. Hotherhall (*Bur. Information on Nickel*, 1935, 12 pp.).—S. G.

Nickel Plating of Aluminium. R. W. Müller (*Metallbörse*, 1935, 25, 51).—Aluminium can be readily nickel-plated in any of the usual baths if it is first coated with a thin film of iron by immersion, after the usual cleaning operations, in a hot mixture of water 100 litres, ferric chloride solution (*d* 1.45) 2-5 litres, and hydrochloric acid (*d* 1.16) 1-5 litres.—A. R. P.

Procedure in Nickel Plating. Ray Goodsell (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (1), 15-18; discussion, 18-19).—Practical hints with suitable bath compositions for cleaners, copper-plating, and nickel-plating solutions are given.—A. R. P.

Most Common Defects Shown by Deposits of Nickel. O. Macchia (*Industria chimica*, 1933, 8, 571-574; *C. Abs.*, 1934, 28, 3308).—The causes of various types of defects shown by nickel electrodeposits, and the methods for treating the plating bath to eliminate such defects, are summarized.—S. G.

[Nickel] Plating Plant Lay-Out. A. J. Lupiev (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (1), 7-14).—A labour-saving lay-out of a nickel-plating plant is described in detail.—A. R. P.

The Microstructure of Electrodeposited Coatings. A. W. Hotherhall (*Met. Ind. (Lond.)*, 1935, 46, 151-152).—Abstract of a paper read and discussed at a joint meeting of the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, Birmingham Metallurgical Society, and Staffordshire Iron and Steel Institute) and the Midland Centre of the Electrodepositors' Technical Society. The microstructure and hardness of several electrodeposited metals and the effect of various factors in causing variations

in those properties were described. The discussion was concerned with the formation of twins in electrodeposited metals, non-adherence, hydrogen effects, and the relation between surface finish and grain-size.—J. H. W.

Metal Protection by Electrodeposition. S. Wernick (*Met. Ind. (Lond.)*, 1935, 46, 78–80, 104–106).—The preparatory processes in plating and the processes of plating with nickel, chromium, and tin, the use of high p_H nickel solutions, the anodic deposition on ferrous metals, the deposition of platinum metals, the anodic treatment of aluminium, and the application of anodized aluminium are described, and the question of specifications of electrodeposits is discussed.—J. H. W.

VIII.—REFINING

(Continued from p. 23.)

***Bismuth in Copper: Its Effects, Determination, and Some Experiments on Its Elimination.** C. O. Bannister and W. M. Doyle (*Bull. Inst. Min. Met.*, No. 363, 1934, 34 pp.; and (discussion), No. 364, 1935, 29 pp.; also (abstract) *Analyst*, 1935, 60, 33–34).—Bismuth may be completely eliminated from copper by heating the metal in the form of turnings or powder in a current of hydrogen, nitrogen, carbon monoxide, or coal gas at temperatures below the melting point; the bismuth diffuses towards the surface and then sublimes either as metal or, if the copper contains oxygen and an inert gas is used, as oxide which is more volatile than the metal. In hydrogen, elimination of bismuth starts at 500°–550° C. and is completed in 2 hrs. at 950°–1000° C., but stops if the metal is allowed to sinter or melt. In nitrogen, removal of bismuth starts at 450°–470° C., and from blister copper is complete in 2 hrs. at 870° C. The process may be used for removing bismuth from copper wire up to 0.025 in. diameter. Many curves are given showing the rate of elimination of bismuth under various conditions in hydrogen and nitrogen. Bubbling gas through molten copper fails to effect any elimination of bismuth. For the determination of bismuth in copper, addition of 0.25 gm. of ferrous ammonium sulphate to a solution of 10 gm. of the metal in nitric acid followed by precipitation of the iron and bismuth by sodium carbonate at 100° C. is recommended; the precipitate is collected, washed, and dissolved in sulphuric acid, potassium iodide and sulphur dioxide added, and the filtered solution used for the usual colorimetric determination.—A. R. P.

***On the Production of Metallic Lithium by Electrolysis.** S. A. Pletneva and A. T. Ivanov (*Redkie Metalli (Rare Metals)*, 1934, (3), 40–43).—[In Russian.] Deals mainly with the electrolysis of lithium chloride. A section deals with purification by remelting under vaseline at 200° C., whereby the impurities settle out and the pure metal can be decanted.—D. N. S.

IX.—ANALYSIS

(Continued from pp. 64–67.)

On Some Spectrographic Experiences with High-Frequency Excitation. K. Ruthardt (*Metallwirtschaft*, 1934, 13, 869–871).—The use of the high-frequency spark in spectrographic analysis is described.—v. G.

†**Present Position of the Spectrographic Determination of Minor Constituents in Metals.** H. Moritz (*Z.V.d.I.*, 1934, 78, 1453–1456).—Recent work is reviewed and some simplified spectrographic methods are described.—K. S.

Modern Spectroscopy.—I–III. Herbert Dingle (*J. Roy. Soc. Arts*, 1934, 83, 234–245, 258–272, 283–301).—Cantor Lectures.—S. G.

***Simple Method of Distinguishing the More Common Light Metal Casting Alloys.** M. Bosshard (*Aluminium*, 1935, 17, 13–15).—Light metal casting alloys can be divided into 5 main groups as follows: (I) copper-aluminium

base (American alloy, Alufont, "Y" alloy, &c.); (II) zinc-aluminium base (German alloy Cindal); (III) silicon-aluminium base (Silumin and its varieties, Anticorodal, Pantal); (IV) magnesium-aluminium base (Magnalium, Peraluman, K.S.-Seewasser, and Hydronalium); (V) magnesium alloys (Elektron). In addition certain alloys belong to a combination of these groups, e.g. copper-zinc-aluminium alloys (I/II), Alcoa and Copper-Silumin (I/III), and Zinc-Silumin (II/III). Any casting alloy can be placed in one of these groups by applying simple tests comprising treatment with (A) 20% sodium hydroxide solution, (B) 1:7 hydrochloric acid, (C) 1:1 nitric acid, and (D) a solution containing cadmium sulphate 5 grm., sodium chloride 10 grm., and hydrochloric acid 20 c.c. per 100 c.c. A drop of the reagent is placed on the metal and the reaction observed; with A on alloys of groups I, II, I/II, II/III, and I/III the drop becomes black, on group III greyish-brown, and on group IV white; Elektron remains unattacked. With B on the same spot (after washing off A) the black colour disappears completely with II and partly with I/II and II/III, no change occurs in I, III, and I/III, and V is vigorously dissolved. With C after A the black colour disappears completely from I and I/II and partly from II/III and I/III, the spot is unchanged with III, and with V vigorous dissolution occurs. With D (without previous treatment with A, B, or C) I, III, and I/III give no reaction or only a slight change in colour, II and IV give a grey colouration or deposit, and the remaining groups give a grey deposit.—A. R. P.

Palladium-Copper Alloys in Industry. Rapid Analysis for Inspection and Control. E. E. Halls (*Indust. Chemist*, 1934, 10, 313-314).—A 60:40 Pd-Cu alloy is extensively used for electrical contacts instead of the more expensive 15% Ir-Pt alloy; both alloys have a Vickers' pyramid hardness of 260. The Pd in the former alloy can be determined as follows: the alloy is dissolved in *aqua regia* and the Pd precipitated with KCl and C_2H_5OH as K_2PdCl_6 , the filtrate being used for the determination of Cu. The K_2PdCl_6 is redissolved in hot H_2O and the Pd precipitated as metal by boiling with $H-CO_2K$; the washed Pd is ignited, reduced, and weighed.—A. R. P.

***Dithio-Oxamide as a Micro-Reagent for the Elements of the Platinum Group.** H. Wölbling and B. Steiger (*Mikrochemie*, 1934, 15, 295-301).—Small amounts of Ru in HCl solution give an emerald-green, and larger amounts a deep blue, colour, whilst much Ru gives a blue-black precipitate with a 0.2% solution of $(CSNH_2)_2$; the reaction is specific for Ru. Pd salts give dark red silky needles and Pt salts reddish-violet needles; the reactions in both cases do not interfere with the Ru test. Ir and Rh do not react with the reagent, and Os imparts a brown colour to the ester layer when the solution is shaken with $(CSNH_2)_2$ and $CH_3CO_2C_2H_5$.—A. R. P.

***On the Separation of Aluminium and Iron from Beryllium with Ortho-Oxyquinoline.** V. M. Zvenigorodskaya and T. N. Smirnov (*Rare Metals*, 1933, (5), 32-33).—[In Russian.] In the separation of Al and Fe from Be by precipitation with O-oxyquinoline addition of $H_2C_2O_4$ prevents complete precipitation of the Al (cf. Berl-Lange "Chemisch-technische Untersuchungsmethoden" (8th edition), 1932, (II), 1105), but has no action on the Fe.—D. N. S.

Detection and Determination of Lead in Solder. D. B. Iokhel'son (*Ukrainskii Khimicheskii Zhurnal* (*J. chim. Ukraine*), 1934, 9, Wiss.-tech. Teil, 111-115; *C. Abs.*, 1935, 29, 424).—[In Ukrainian.] The Pb can be determined by first precipitating as $PbCrO_4$ in a buffered solution and then determining the CrO_4^{--} iodometrically, or the $PbCrO_4$ precipitate can be dissolved in NaOH and the Pb determined colorimetrically as sulphide.—S. G.

***The Method of Quantitative Spectrographic Analysis for Rapid Determination of Magnesium, Manganese, Silicon, and Iron in Duralumin.** P. A. Bajulin, A. A. Baskakow, and A. R. Striganow (*Zhurnal tekhnicheskoy Fiziki* (*J. Tech. Physics*), 1934, 4, 578-586).—[In Russian.] Homologous line pairs are



selected for the determination of 0.3-0.7% Mg or Mn, of 0.1-0.7% Fe or Si, and of 3.5-5% Cu. The Cu spectrum is correlated with the Duralumin spectrum by the pair of lines Al 3050.1 Å. and Cu 2961.2 Å. The electrical conditions are controlled by the Cu lines 2492.2 and 2489.6 Å. The results are accurate within 10% of the absolute amount of the constituent present.—N. A.

A Rapid Micro-Method for the Determination of Manganese. I. M. Kornmann (*Mikrochemie*, 1934, 15, 289-294).—A modification of the $(\text{NH}_4)_2\text{S}_2\text{O}_8$ method for the colorimetric determination of Mn in Cu, Fe, Ni, Co, and Al alloys using only small amounts of material is described.—A. R. P.

A New Method for the Potentiometric Determination of Mercury. G. Spacu and I. G. Murgulescu (*Bul. Soc. Științe Cluj*, 1934, 7, 552-558; *Chem. Zentr.*, 1934, 105, II, 3530-3531).—[In French.] The method depends on the titration of the neutralized HNO_3 solution of the metal with $[\text{Cu en}_2](\text{NO}_3)_2$ solution (en = ethylenediamine) in the presence of much KI using an amalgamated Pt wire as indicator electrode.—A. R. P.

A New Volumetric Method for the Determination of Mercury. G. Spacu and V. Armeanu (*Bul. Soc. Științe Cluj*, 1934, 7, 621-630; *Chem. Zentr.*, 1934, 105, II, 3531).—[In French.] The method is similar to that described in the preceding abstract except that dithio-oxamide is used as indicator, the solution becoming violet at the end-point.—A. R. P.

Contribution to the Determination of Silicon in Alloys of Aluminium. Henri Shehyn (*Naturaliste Canadien*, 1935, 62, 13-32).—In the usual procedure for determining Si in Al alloys, e.g. Silumin, there is danger of loss of Si as volatile hydrides and in the various filtrations. The following method avoids these sources of error and gives more accurate results in a much shorter time. The sample (0.5 gm.) is treated in a 125 c.c. Cu dish with 1 gm. of Na_2O_2 and 2 c.c. of H_2O , the dish being covered with a Cu lid during the violent reaction which ensues. Reaction is completed by heating with a further 10-12 c.c. of H_2O for 30 minutes on the water-bath, the solution is transferred to a glass beaker, the dish rinsed with 7 c.c. of HCl, and the solution evaporated with 17 c.c. of 70-72% HClO_4 until heavy white fumes are evolved, then for another 15 minutes. After cooling, the soluble salts are extracted with 70 c.c. of 10% HCl, the SiO_2 is collected, washed with 10% HCl, then with H_2O , ignited and weighed, and its purity is tested by the usual $\text{HF-H}_2\text{SO}_4$ process.—A. R. P.

A New Method for the Gravimetric Determination of Silver. P. Spacu (*Bul. Soc. Științe Cluj*, 1934, 7, 568-570; *Chem. Zentr.*, 1934, 105, II, 3531).—[In French.] The neutral or slightly acid HNO_3 solution of the metal is treated with KCNS until the AgCNS first precipitated redissolves; the hot solution is then treated with a hot concentrated solution of *trans* $[\text{Co en}_2(\text{CNS})_2](\text{CNS})$ and the orange-yellow precipitate which settles readily is collected in a porcelain filter crucible, washed first with a 1% solution of the reagent then with 96% $\text{C}_2\text{H}_5\text{OH}$ and finally with $(\text{C}_2\text{H}_5)_2\text{O}$, dried *in vacuo* at room temperature and weighed as $[\text{Co en}_2(\text{CNS})_2][\text{Ag}(\text{CNS})_2]$, which contains only 20.78% Ag. (en = ethylenediamine).—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from p. 68.)

Use of the Polarizing Microscope in the Study of Inclusions in Metals. S. L. Hoyt and M. A. Scheel (*Metals Technology*, 1934, (Sept.), *A.I.M.M.E. Tech. Publ.* No. 567, 1-19).—The use of the reflecting polarizing microscope for the identification of optically active, glassy and crystalline inclusions is described, and photomicrographs of examples from ferrous metallurgy are given to

illustrate the results. The authors do not claim that this method will replace any quantitative methods now in use, but point out that there is a use for the reflecting polarizing microscope in the study of inclusions in metals.—S. G.

A New Objective for Metallurgy. H. Wrighton (*J. Roy. Microscop. Soc.*, 1933, [iii], 53, 328-329).—A photomicrograph of lamellar pearlite taken at 2500 diameters with a new 2.25 mm. objective, immersed in monobromide of naphthalene, and having a N.A. of 1.60, shows a resolution of 200,000 lines/in. at one point. Lamellæ of 160,000 lines/in. are separated with ease and clarity.—J. C. C.

A Method of Eliminating Lens-Flare from Gauss and Vertical Illuminators. E. E. Jelley (*J. Roy. Microscop. Soc.*, 1934, [iii], 54, 18-22).—Lens-flare when using prism or cover-glass reflectors for vertical illumination may be overcome by plane-polarizing the light before reflection down the microscope tube and placing an analyzer over the eye-piece in the extinction position. The light reflected by the object is then modified (and thus alone transmitted by the analyzer) by a quarter-wave plate of mica, which may be mounted on a cover-slip and oiled to the front lens of the objective. With oil-immersion lenses, a very thin flake of mica may be inserted in the oil between objective and object.—J. C. C.

The High-Frequency Induction Furnace in the Metallurgical Research Laboratory. W. W. Stevenson (*Indust. Chemist*, 1934, 10, 486-490).—Types of high-frequency induction furnaces and refractories for melting ferro-alloys and steels are described.—A. R. P.

Use of Spectrum Analysis for Rapid Sorting of Metals [Styloscope]. Ya. P. Abramson (*Zavodskaya Lab.*, 1934, 3, 140-144; *C. Abs.*, 1935, 29, 382).—[In Russian.] A description is given of the construction and use of a spectroscopic apparatus known as the Styloscope, invented in the U.S.S.R., for the detection of metals in steel alloys.—S. G.

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

(Continued from pp. 68-69.)

A Short Review on the Examination of Material of Metal Aircraft Propellers. I. G. Shulgin (*Tekhnika Vozdushnogo Flota (Technol. Aerial Navy)*, 1934, (1), 76-87).—[In Russian.] The chemical analysis, metallographic structure, mechanical properties, and X-ray control of foreign and Soviet metallic aero-propellers are given.—N. A.

***Rubbing-Tests for the Wearing Properties of Babbitt.** M. S. Volobuev (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1933, 13, (9), 72-73).—[In Russian.] The specimens were rubbed in an Amsler machine by rotating steel discs pressed against them under 20 kg./mm.² pressure at 220 r.p.m. The wear after 200,000 revolutions is given in the following table:

	Composition, %.						Brinell Hardness.	Loss in Weight on Rubbing.
	Sn.	Pb.	Cu.	Sb.	As.	Cd.		
1	86.81	0.28	5.98	6.93	...	...	28.9	0.0024
2	10.42	72.90	1.62	12.33	1.27	1.46	22.4	0.0035
3	1.28	81.13	1.62	15.97	...	...	18	0.0060
4	41.56	40.05	4.42	13.97	...	...	18	0.0070

—D. N. S.

Determination of the Degree of Smoothness of Metal Surfaces. E. Franke (*Oberflächentechnik*, 1934, 11, 25-27; *C. Abs.*, 1934, 28, 3356).—Methods for testing surface smoothness are reviewed. An acoustic method has been developed recently by which a needle is carried over the surface and the vibrations, transformed into acoustic sounds, give a measure of the smoothness; the smoother the surface the higher the sound. The Herbert pendulum is described; it measures relative surface hardness and smoothness. Surfaces with very high smoothness (axles, &c.) can be produced by burnishing, whereby the surface is polished under the high pressure of 3 rolls.—S. G.

***The Flexibility of Sheet Duralumin.** P. A. Vargunin (*Tekhnika Vozdushnogo Flota (Technol. Aerial Navy)*, 1934, (2), 87-88).—[In Russian.] Experiments have been carried out to determine the relation between the width of the test-piece and the number of bends after different thermal treatments. The number of bends increases with decreasing width. Cold-worked and hardened Duralumin strip can be bent 6-6.5 times when 10 mm. wide but only 4-5 times when 40 mm. wide. After annealing, the bendability is 2-2.5 times greater. Cross-rolled metal gives lower bending values, which are also influenced by the width.—N. A.

Tentative Definitions of the Terms Consistency and Plasticity (E 24-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1169; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1245).—S. G.

Acceptance-Rejection Requirements in Specifications. H. F. Dodge (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 877-890).—See *Met. Abs.*, 1934, 1, 392.—S. G.

***Concerning the Effect of Notches and Laws of Similitude in Material Testing.** A. Nadai and C. W. MacGregor (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 216-228).—See *Met. Abs.*, 1934, 1, 392.—S. G.

***Some Factors Affecting Strain Measurements in Tests of Metals.** R. L. Templin (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 182-194; discussion, 195-201).—See *Met. Abs.*, 1934, 1, 360.—S. G.

Tentative Method of Test for Linear Expansion of Metals (B 95-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 279-288; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 733-742).—This method is intended especially for determining the expansion of oxidation-resistant alloys at temperatures up to 1000° C.—S. G.

***A High-Speed Fatigue Testing Machine and Some Tests of Speed Effect on Endurance Limit.** G. N. Krouse (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 156-160; discussion, 161-164).—See *Met. Abs.*, 1934, 1, 361.—S. G.

Characteristics of Strength of Metals at High Temperatures. M. Roš and A. Eichinger (*Chaleur et Ind.*, 1934, 15, (167), 211-221).—See *Met. Abs.*, 1934, 1, 313.—J. C. C.

Tentative Method of Test for Long-Time (Creep) High-Temperature Tension Tests of Metallic Materials (E 22-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1147-1156; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1223-1231).—Covers tests within the range from room temperature to 2000° F. (1093° C.).—S. G.

Tentative Method of Test for Short-Time High-Temperature Tension Tests of Metallic Materials (E 21-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1138-1146; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1214-1222).—Covers short-time high-temperature tension tests of metals within the range from room temperature to 2000° F. (1093° C.).—S. G.

Tension Testing of Metals—New Methods. R. L. Templin (*Metal Progress*, 1935, 27, (2), 29-32).—A discussion of the new A.S.T.M. standard methods E 8-33, E 6-32 T, E 4-33 T, and E 9-33 T. The importance of a standardized type of grip is emphasized, especially in the testing of specimens with threaded and shouldered ends, of wire, tubes and thin sheet. Standard forms and

dimensions of test-pieces are reproduced, and the conception of "yield-strength," and the "set method" for its determination, is reviewed. Some stress is laid on the need for improved extensometers and their careful maintenance.—P. M. C. R.

†**Material Testing Machines.**—II. C. H. Gibbons (*Baldwin Locomotives*, 1934, 13, (2), 31-39; and *Instruments*, 1934, 7, 253-255; 1935, 8, 18-20).—See *Met. Abs.*, this volume, p. 28. This historical review of the development of tensile testing machines is continued.—J. C. C.

Characteristics of the Huggenberger Tensometer. R. W. Vose (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 862-873; discussion, 874-876).—See *Met. Abs.*, 1934, 1, 361.—S. G.

***The Impact Strength of Commercial Zinc Alloy Die-Castings.** E. A. Anderson and G. L. Werley (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 176-181).—Charpy impact test-specimens, 525 in number, were cut from 77 commercial zinc-base die-castings and subjected to impact tests in comparison with test-bars cast to the same size. All of the test-specimens were so cut as to leave one unmachined die-cast face. In conducting the Charpy impact test, the specimens were placed in the machine in such a manner as to place this die-cast face under tension. The results obtained indicate a close agreement between the impact strength of the machined specimens and of specimens die-cast to size. No conclusion is reached regarding the correlation of these values to the over-all strength of the original die-casting.—S. G.

Tentative Methods of Impact Testing of Metallic Materials (E 23-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1118-1130; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1201-1213).—S. G.

***Effect of Thickness on the Accuracy of Rockwell Hardness Tests on Thin Sheets.** R. L. Kenyon (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 229-238; discussion, 239-243).—See *Met. Abs.*, 1934, 1, 516.—S. G.

***Contribution to the Study of the Hardness of Crystals in Different Directions [Abrasion or Rubbing Tests].** (Mme.) Duch-Bernelin (*Z. Krist.*, 1934, 88, 323-325).—Describes a machine in which a groove is cut in a sample by the motion across it of an endless wire band under constant conditions of speed, tension, &c., and the hardness estimated from the time taken.—W. H.-R.

Tentative Methods of Verification of Testing Machines (E 4-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1157-1168; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1233-1244).—S. G.

RADIOLOGY

X-Ray Investigations of Gas-Welded Copper Locomotive Fireboxes. W. Grimm (*Autogene Metallbearbeitung*, 1934, 27, 385-388).—The flaws, which are disclosed, are classified into 3 groups: blowholes and oxide inclusions, incomplete fusion, and cracks. The manner in which these are shown by X-rays is explained and illustrated by typical radiographs, with sketches showing the corresponding cross-sections.—H. W. G. H.

***Determination of the Depth of Defects in Metals and Other Articles by X-Rays.** P. G. Orlov (*Niimash (Bull. Sci. Res. Inst. Machine Building and Metal Treat.)*, 1934, (7), 58-66).—[In Russian.] The "Localisator" apparatus is described. The position of a defect is indicated by the apparatus within 0.5 mm.—N. A.

X-Ray Inspection of High Alloy Castings. F. K. Ziegler and D. W. Bowland (*Metal Progress*, 1934, 26, (6), 22-26).—An illustrated account is given of routine X-ray testing in a foundry producing castings containing a high proportion of nickel and chromium.—P. M. C. R.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 70-72.)

Advances in the Melting and Casting of Non-Ferrous Metals. R. Genders (*Met. Ind. (Lond.)*, 1935, 46, 55-58, 77).—The defects liable to occur in melting non-ferrous metals and alloys are briefly summarized. The use of vacuum melting for the production of high-purity metals and of alloys otherwise unworkable, and of the Durville and R.W.R. (inverting mould) methods of casting sound aluminium alloys is described.—J. H. W.

Non-Ferrous Practice. C. A. Howe (*Found. Trade J.*, 1934, 51, 337-339).—Abstract of a paper read before the Junior Section of the Lancashire Branch of the Institute of British Foundrymen. The practice of sand-casting brass and other copper alloys and alloys of aluminium and nickel and of white metal is described.—J. H. W.

On the Production of Dense Aluminium Castings. Edmund Richard Thews (*Metallbörse*, 1935, 25, 81-82, 113-114, 146).—Modern practice in the melting and casting of aluminium and its alloys is described in detail with especial reference to the use of fluxes and gas-treatment for removing porosity and to the correct preparation of moulds.—A. R. P.

The Practice of Melting Aluminium. A. v. Zeerleder (*Light Metals Rev.*, 1935, 1, 279-291).—Translation in abstract from *Aluminium*, 1934, 17, 196-201; see *Met. Abs.*, this volume, p. 30.—R. B. D.

The Deoxidation of Copper Alloys. H. Nipper (*Bull. Assoc. Tech. Fond.*, 1934, 8, 256).—Abstract of a paper read before the Institut de Fonderie.

—R. B. D.

Melting and Casting of Special Brasses. W. E. Herrmann (*Giesserei*, 1935, 22, 52-55).—In making special β -brasses the value of $6(\% \text{ Al}) + 2(\% \text{ Sn}) + 1.2(\% \text{ Ni}) + 0.9(\% \text{ Fe}) + 0.5(\% \text{ Mn}) + \% \text{ Zn}$ must be 46-49%, and lead, arsenic, and bismuth must be absent. The alloying elements are best added as a "hardener" alloy; thus for making a brass containing copper 57.2, zinc 35.3, manganese 1.5, iron 1.5, nickel 3, and aluminium 1.5% the hardener is made by melting 20 kg. of copper with 60 kg. of 50% ferromanganese under a glass slag and adding 90 kg. of 66.6% ferro-nickel, 150 grm. of 10% phosphor-copper to deoxidize the melt and increase its fluidity, and finally 30 kg. of aluminium. In making 100 kg. of the brass, 54.7 kg. of copper are melted under borax and deoxidized with 0.3% of 10% phosphor-copper; 35.3 kg. of zinc are then added followed by 10 kg. of the hardener, and the metal is cast at 1000°-1100° C. after first thickening the flux with sand.—A. R. P.

Large Brass or Bronze Products Cast Centrifugally. Edwin Cone (*Iron Age*, 1934, 134, (24), 24-26).—A brief description of the plant and equipment used in the centrifugal casting of large brass and bronze parts in a large modern foundry.—J. H. W.

Birmingham Small Non-Ferrous Products Trade. A. L. Molineux (*Met. Ind. (Lond.)*, 1935, 46, 71-74).—The production of widely diversified small products in various non-ferrous alloys is described.—J. H. W.

The Doehler Brass-Casting Process. C. R. Norwood (*Met. Ind. (Lond.)*, 1935, 46, 91-95).—The Doehler process is a plate-moulding process of casting 60:40 brass, giving castings with a smoother and neater appearance than the majority of die-castings in a similar alloy. The moulds are made of a mixture of 1 part of plaster of Paris to 2 of asbestos fluff, made into a thin cream with water, and dried at 500° F. (260° C.) for 24 hrs. The patterns are made of a tin-base alloy containing antimony 10, lead 6, and copper 6%, by means of a pressure die-casting machine, usually of the plunger type. For intricate castings where undercuts in the pattern are necessary, the pattern castings are made in a low-temperature bismuth-lead-tin alloy. This can be run out

by immersing the mould in boiling water. Mould drying is of the utmost importance. Kieselguhr can be used instead of asbestos for the mould material, which cannot as a rule be used twice. The method of casting is described in detail.—J. H. W.

The Die-Casting of Non-Ferrous Metals. I.—Die-Casting in Yellow Metal. A. H. Munday (*Met. Ind. (Lond.)*, 1935, 46, 59–61).—The mechanical properties and requirements of aluminium—"bronzes" and high-tensile brasses suitable for die-casting are described, and the composition and treatment of the metals for the dies are briefly discussed.—J. H. W.

The Die-Casting of Non-Ferrous Metals. II.—The Zinc-Base Die-Casting Industry. D. Kirkwood, Jr. (*Met. Ind. (Lond.)*, 1935, 46, 61–63).—The properties and requirements of influence of lead and tin on impact strength, and the finishing of zinc-base die-casting alloys are described.—J. H. W.

The Die-Casting of Non-Ferrous Metals. III.—Aluminium Die-Castings. Freeman Horn (*Met. Ind. (Lond.)*, 1935, 46, 63–65).—The production of pressure and gravity die-castings, slush castings, and centrifugal castings in aluminium alloys containing copper or silicon or both is described, and the heat-treatment and modification of these alloys are discussed.—J. H. W.

The Selection of Alloys for Die-Castings. Herbert Chase (*Elect. Manufacturing*, 1934, 14, (4), 13–14, 31; *C. Abs.*, 1935, 29, 437).—A general review.—S. G.

***Steels for Die-Casting Dies.** Sam Tour (*Metals Technology*, 1934, (Sept.), *A.I.M.M.E. Tech. Publ.* No. 568, 1–16).—S. G.

***On the Strength Test of Moist Moulding Sands.** Kaoru Taketi (*J. Soc. Mech. Eng. Japan (Foreign Edn.)*, 1931, 34, 38–41).—[In English.] Abridged from the Home Edition, 1931, 35, 556–565. A comparison was made of the tension test using Nielsen's and Grubb's methods, of the transverse test using Doty's method, of the shear test using Dietert's method, and of the compression test using the A.F.A. standard method, with a medium-grained moulding sand of 7 different moulding contents and 3 kinds of moulding sands, coarse, medium, and fine, each having 2 different moulding contents. It was concluded that to get the correct testing method it is necessary to have perfect test-pieces, and measuring the plasticity of the sand is very important for judging the facility of moulding with it, and in these respects the compression-test method with a satisfactory test-piece is most important. The best test-piece is one rammed 3 times from both ends of the container by the A.F.A. standard rammer for the compression test-piece into 50 mm. diameter and a height of 75 mm., a smaller diameter and a shorter height being unreliable. A loading rate of 100 grm. per second is most suitable for testing.—J. W. D.

The Effect of Additions of Clay and Water on the Strength of Green and Dry Oil-Sand. H. Nipper (*Bull. Assoc. Tech. Fond.*, 1934, 8, 373–382).—The green and dry strengths for various oil (1–4%), clay (0–8%), and water (0–3%) additions are reported.—R. B. D.

A Comparison of Some Wet Methods Used for the Fineness Test of Sands and Clays. R. C. Hills (*Trans. Amer. Found. Assoc.*, 1934, 42, 101–128).—The modes of operation are described in detail and the advantages and disadvantages compared and contrasted of the following methods: elutriation, pipette, manometer, A.F.A. settling, and hydrometer. The effects of different electrolytes and the amounts of them used, and of the character and temperature of the water are described.—R. B. D.

The Scientific Testing of Foundry Sands and the Establishment of an Economic Study of Moulding Sand. — Aulich (*Bull. Assoc. Tech. Fond.*, 1934, 8, 261).—Abstract of a paper read before the Institut de Fonderie.

—R. B. D.

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

(Continued from p. 72.)

Treatment of Coppersmiths' Waste. C. C. Downie (*Machinist (Eur. Edn.)*, 1935, 78, 801E).—Scrap from coppersmiths' material contains copper and lead or copper and antimony, and the waste from one material is worked off against that from another. The treatment consists in recovering the lead by removing the alloying metal. The two kinds of waste both containing lead, are weighed out according to their chemical analysis, and melted together in a crucible, the copper forming an alloy with the antimony. The molten contents of the crucible are transferred to a settling pot, and the lead which remains molten is run off into pig-moulds. The lead-copper-antimony crust is drained of surplus lead and sent to a smelter for complete separation.

—J. H. W.

Losses from Recovery Rinse Tanks. Joseph B. Kushner (*Met. Ind. (N.Y.)*, 1935, 33, 14-16).—The magnitude of the possible losses of precious metals in rinsing tanks which are not frequently changed is shown by mathematical analysis.—A. R. P.

XV.—FURNACES AND FUELS

(Continued from pp. 72-73.)

Application of Reversed Combustion to Industrial Furnaces. Gérard Richard (*Chaleur et Ind.*, 1934, 15, (169), 1009-1017).—See *Met. Abs.*, 1934, 1, 365.—J. C. C.

Heating of Rotatory Melting Furnaces and Their Application in Different Branches of Metallurgy. J. Boutigny (*Chaleur et Ind.*, 1934, 15, (169), 995-1008).—See *Met. Abs.*, 1934, 1, 365.—J. C. C.

The Development of Electric Resistance Furnaces in U.S.A. Étienne Soubeyran (*Chaleur et Ind.*, 1934, 15, (169), 1310-1314; discussion, 1314-1315).—Read before the 3rd Congrès du Chauffage Industriel. A general review.—J. C. C.

Electric Heating. E. Openshaw Taylor (*Heat-Treat. and Forging*, 1934, 20, 597-599).—The use of electric furnaces for heat-treating and melting is discussed.—J. H. W.

The Electrical Annealing and Ageing of Light Metals. E. Fr. Russ (*Metallwirtschaft*, 1934, 13, 931-933).—Some electric resistance furnaces with air circulation are described.—v. G.

Use of Electric Furnaces in Industrial Heat-Treatment. Glynne Lobley (*Metallurgia*, 1935, 11, 61-64, 86).—The application of the electric furnace to industrial heat-treatment is reviewed with special reference to the advantages of electrical heating, heating costs, arrangement of heating elements, forced-air circulation, temperature control, and charge progress recordings. Consideration is also given to types of furnaces, both batch and continuous, and to the special types of furnaces used for nitriding.—J. W. D.

Use of Metals in Furnace Construction. — Bassal (*Chaleur et Ind.*, 1935, 15, (169), 1120-1142).—See *Met. Abs.*, 1934, 1, 365, 521. Includes discussion.

—J. C. C.

A New Method of Coal-Dust Firing. — Fries (*Fuel Economist*, 1935, 10, 693-694).—From *Technische Blätter*. The Krämer system of coal-dust firing in which the drying, milling, sifting, and combustion of the fuel are combined in one furnace construction, requiring no auxiliary apparatus, is briefly described.—J. S. G. T.

Tentative Specifications for Classification of Coals by Rank (D 388-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 500-506; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 834-840).—Cover the classification of coals

by rank, i.e. according to their degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite.—S. G.

Tentative Specifications for Classification of Coals by Grade (D 389-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 507-508; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 841-842).—Cover the classification of coals according to quality, as determined by calorific value, ash and sulphur content, and ash-softening temperature. Other properties, such as resistance to breakage, screen size, and caking properties, are under consideration.
—S. G.

XVI.—REFRATORIES AND FURNACE MATERIALS

(Continued from p. 73.)

Refractories and Sand for the Non-Ferrous Industries. Alfred B. Searle (*Met. Ind. (Lond.)*, 1935, 46, 75-77).—The requirements of refractories used in the non-ferrous foundry, the effect of the method of firing on the life of the refractory, refractories for particular metals, and the requirements for foundry sands are briefly discussed.—J. H. W.

Special Super-Refractories. — Maire (*Chaleur et Ind.*, 1934, 15, (169), 1176-1179).—See *Met. Abs.*, 1934, 1, 366.—J. C. C.

Some Furnace Cements. Anon. (*Eng. Rev.*, 1934, 48, 414, 419).—A list of 21 refractory cements, indicating special conditions of use, and in some cases the physical properties and method of application.—P. M. C. R.

Gas Permeability, Compressive Strength, Heat Conductivity, Thermal Expansion, Heat Capacity, and Tendency to Spalling of Refractory Bricks in Relation to the Porosity. Heinrich Herbst (*Feuerungstechnik*, 1934, 22, 115-116).—Curves are given showing the changes which occur in the above properties with variations in the porosity of fireclay bricks (softening point 1650° C.). With increasing % porosity the gas permeability increases slowly at first, then very rapidly above 30%, the compressive strength is constant up to 20% then falls very rapidly between 35 and 45%, and the heat capacity falls linearly from 0 to 100%. The curves for the other properties are similar to the strength curve.—A. R. P.

Tentative Method of Chemical Analysis of Magnesite Refractories (C 18-34 T). — (*Amer. Soc. Test. Mat. Tentative Specifications*, 1934, 375-381; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 784-790).—S. G.

Tentative Specifications for Ground Fireclay (C 105-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 371-372; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 780-781).—Cover ground fireclays which are intended to be used in the laying-up of refractory clay bricks.—S. G.

Tentative Method of Panel Test for Resistance of Refractory Brick to Thermal and Structural Spalling (C 38-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 390-397; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 796-803).—S. G.

†Insulation Against Heat Losses. Anon. (*Fuel Economist*, 1935, 10, 680-682).—Data and characteristics relating to various heat insulators, including asbestos, 85% magnesia, slag wool, rock wool, sponge felt, air cell, glass silk, and aluminium foil are briefly discussed.—J. S. G. T.

Tentative Methods of Testing High-Temperature Heat Insulation (Compression, Flexure, Shrinkage) (C 93-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 382-386; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 791-795).—S. G.

Tentative Definitions of Terms Relating to Refractories (C 71-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 400; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 806).—Defines: silica fireclay, ground fireclay, and high-temperature bonding mortar.—S. G.

†The Refractories Industry in the Second Russian Five-Year Plan. Carl Heinrich Peters (*Feuerungstechnik*, 1935, 23, (1), 7-8).—Recent modifications of the second five-year plan, so far as the production of refractories is concerned, are referred to, and details of the present plan are tabulated.—J. T.

XVII.—HEAT-TREATMENT

(Continued from p. 73.)

Precipitation-Hardening. P. D. Merica (*Metal Progress*, 1935, 27, (1), 31-35, 60).—The process of precipitation-hardening is discussed in the case of the silver-copper system. The possibilities of such treatment are reviewed, with reference to Duralumin, the gold-copper alloys, beryllium-bronze, and certain white metals.—P. M. C. R.

***Relation of the Mechanical Properties of Sheet Duralumin to the Method of Cooling During Hardening.** P. A. Vargunin (*Tekhnika Vozdushnogo Flota (Technol. Aerial Navy)*, 1934, (2), 86-87).—[In Russian.] The effects of 3 different methods of cooling on the mechanical properties of sheet Duralumin have been investigated after annealing at 500° C. for 40 minutes: (a) quenching in water at 20° C.; (b) quenching in water at 20° C. with immediate removal; and (c) air-cooling. The mechanical properties obtained are: tensile strength (a) 43.50, (b) 41.95, and (c) 39.03 kg./mm.²; elongation (a) 21.90, (b) 20.35, and (c) 19.36%.—N. A.

†**Annealing of Copper Alloys.** R. S. Pratt (*Metals and Alloys*, 1935, 6, 1-6, 10).—Modern practice in the annealing of bronze, brass, and nickel-brass is critically reviewed. Numerous graphs are given, showing the variation in hardness, tensile properties, and grain-size with the annealing temperature, as well as photomicrographs of characteristic structures produced by annealing and over-annealing; a *bibliography* of 31 references to recent literature is given.—A. R. P.

XVIII.—WORKING

(Continued from pp. 74-75.)

Copper Specks on Aluminium Wires. M. Bosshard (*Aluminium*, 1935, 17, 16).—Figures are given showing the deleterious effect of even minute quantities of copper on the surface of aluminium wire; thus a pure aluminium wire with 0.00065 grm. of copper per dm.² of surface suffered a loss of 15% in tensile strength and 74% in elongation in the salt-spray test over 6 months compared with a clean wire of the same material. In workshops in which it is impossible to keep the two metals apart it is recommended that the finished aluminium wire be pickled in cold 30-50% nitric acid for 15 minutes when it is required in the hard-drawn state, or, when required soft, be annealed at 300°-320° C. for 1-3 hrs. in fused sodium hydroxide containing 10% of sodium nitrate.

—A. R. P.

Ductile Tungsten. Samuel L. Hoyt (*Metals and Alloys*, 1935, 6, 11-18).—An historical account is given of the development of methods of working tungsten with especial reference to the work of Coolidge on the manufacture of tungsten wire.—A. R. P.

***Dependence of Specific Pressure on the Temperature and on the Elongation Factor in the Extrusion of Magnesium.** V. A. Bobrov (*Trudi Nauchno Issledovatel'skogo Instituta Legkikh Metallov—"Niisalumini"* (Trans. Sci. Res. Inst. Light Metals—"Niisalumini"), 1933, (3), 31-50).—[In Russian.] The specific pressure in extrusion of magnesium has been determined at temperatures up to 400° C. and elongations (μ), of 4.7, 15, 22.5, and 50% in a hydraulic

30-ton press, and the curve of $P = f(H_p)$ recorded (P is the pressure on the manometer, and H_p the movement of the ram). The specific pressure can then be calculated by the expression $p = K(P_{av} - 1) \frac{S_0}{S}$, where p is the average specific pressure during extrusion of the metal from the mould, P_{av} the average pressure inside the working cylinder, S_0 the area of the ram, S the cross-section of the container, and K a constant. The graph $p = f(t)$, when μ is constant, may be divided into 2 parts: in the first p falls linearly from room temperature to 150° C., and in the second (above 150° C.) p falls in a curve concave to the temperature axis. Thus with $\mu = 22.5\%$ at 100° C. $p = 114$, at 150° C. 98.4, at 225° C. 55, at 275° C. 28.1, at 375° C. 19.8, and at 400° C. 20.4 kg./mm.². The expression $p = f(\mu)$ when t is constant, can be expressed as $p = K \log \mu$, where K is a constant. With more than 50% elongation, p begins to increase more rapidly, especially at low temperatures. With a conical opening to the mould p is less than with a cylindrical one, the difference increasing with decrease in temperature and increase in elongation. When extrusion is almost completed, a funnel-shaped opening appears in the specimen, the volume of which depends on the shape of the area of contact of the specimen and ram. A convex ram increases the funnel, while a concave one diminishes it, or removes it altogether. With increase in elongation, the funnel extends along the axis of the rod to 20–25% of the total length.

—D. N. S.

***Determination of the Value of Specific Pressure in Extrusion of Elektron and Its Dependence on the Temperature and on the Elongation Factor.** V. A. Bobrov (*Trudi Nauchno-Issledovatel'skogo Instituta Legkikh Metallov—"Niisaluminiumi"* (Trans. Sci. Res. Inst. Light Metals—"Niisaluminiumi"), 1933, (5), 32–43).—[In Russian.] The tests were carried out with Elektron containing manganese 0.25, aluminium 8, and zinc 1.2%, and with elongations μ of 1.8, 4.0, 7.2, and 15%. Extrusion below 100° C. produced complete destruction or shattering of the specimens. Specific pressure increases sharply with decrease in temperature and with increase % elongation. Thus at 100° C. with $\mu = 1.8$, specific pressure $p = 38.3$ kg./mm.², and with $\mu = 7$, $p = 110$; at 200° C. with $\mu = 1.8$, $p = 23$, and with $\mu = 7.4$, $p = 71.7$; at 400° C. with $\mu = 1.8$, $p = 9.5$, and with $\mu = 7$, $p = 17.6$. The relation $p = f(\mu)$ when t is constant is given by the graph $p = K \log \mu$, where K is a proportionality factor. When the mould is conical in shape, the pressure is less than when it is cylindrical.—D. N. S.

***The Hot Mechanical Working of Light Alloys.** V. M. Aristov (*Niimash* (Bull. Sci. Res. Inst. Machine Building and Metal Treat.), 1934, (1), 42–60; (4), 39).—[In Russian.] The macrostructure and mechanical properties of chill-cast light metal alloys and the effects thereon of hot deformation by forging, rolling, pressing, and punching are discussed and tabulated.—N. A.

***Phenomena During Wire-Drawing of Copper-Zinc Alloys.** M. P. Slavinsky and A. S. Tumarev (*Trudi Nauchno-Issledovatel'skogo Instituta Legkikh Metallov—"Niisaluminiumi"* (Trans. Sci. Res. Inst. Light Metals—"Niisaluminiumi"), 1933, (5), 51–62).—[In Russian.] The power consumed in drawing 80:20, 67:33, and 60:40 brass wire has been measured by a specially designed dynamometer. The temperature of the wire emerging from the die depends mainly on the degree of reduction, but only slightly on the composition, and varies between 75–150° C. with a reduction of 15–75% per pass. The electrical resistance and tensile strength depend only on the total reduction and not on the speed and degree of reduction per pass, since recrystallization, which removes work-hardening, is not sufficiently rapid at the temperatures indicated. On drawing at 100°, 200°, or 300° C., the temperature of the wire rises 55°, 65°, and 125° C., respectively, with a reduction of 20%. The mechanical properties of wire drawn at 100° C. differ little from those of cold-

drawn wire. 80:20-brass has a tensile strength of 46, 40, and 35.8 kg./mm.² when drawn at 100°, 200°, and 300° C., respectively; 67:33 and 60:40 brasses break when drawn at 200° C. The tensile strength of unstretched wires at 15°–600° C. has been determined. The wires show a reduction in area before fracture only up to 300° C. At 550° C. 60:40 brass is again capable of plastic deformation, but cannot be drawn on account of its low strength. The tensile strength of wire 3.14 mm. diam. of the above 3 brasses at 15° C. is 38.7, 39.5, and 43 kg./mm.²; at 550° C. 16, 1, 16, and 3.6 kg./mm.², respectively.—D. N. S.

Handling of Workable Aluminium Alloys in the Workshop, Especially by Plastic Deformation. G. Eckert (*Aluminium*, 1935, 17, 11–12).—Brief practical hints are given on the forging, rolling, bending, and deep-drawing of numerous aluminium alloys and on their heat-treatment.—A. R. P.

On Gold Leaf and Gold Beating. Th. Wolff (*Metallbörse*, 1935, 25, 114–115, 146–147, 178).—An account is given of the methods used in the preparation of gold leaf and of its peculiar properties.—A. R. P.

Some Notes on Hot Brass and Bronze Stampings. W. Hayes (*Met. Ind. (Lond.)*, 1935, 46, 52–54, 77).—It is claimed that the wastage experienced in castings, porosity, and difficulty in machining are obviated by the use of hot-stamping, and the applications of this method of manufacture are described.—J. H. W.

***Testing the Drawing Properties of Rolled Zinc Alloys.** E. H. Kelton and Gerald Edmunds (*Trans. Amer. Inst. Min. Met. Eng.*, 1934, 111, Inst. Metals Div., 245–252; discussion, 252–253).—See *Met. Abs.*, 1934, 1, 627.—S. G.

***Relation Between Deep-Drawing and Tensile Properties of Various Metals.** M. H. Sommer (*Z.V.d.I.*, 1934, 78, 1195–1201).—Same as *Amer. Inst. Min. Met. Eng. Tech. Publ. No. 541*. See *Met. Abs.*, 1934, 1, 626.—K. S.

The Working of Monel Metal. Anon. (*Métaux et Machines*, 1935, 19, (252), 35).—Optimum cutting speeds and appropriate feeds are tabulated for cast and rolled Monel metal for 15 depths of cut. Directions are given for the choice and material of tools in drilling, threading, and milling.—P. M. C. R.

XIX.—CLEANING AND FINISHING

(Continued from p. 75.)

The Cleaning of Metals. VI.—Degreasing by Means of Organic Solvents. S. Wernick (*Indust. Chemist*, 1934, 10, 479–481).—Vapour, liquid, and liquid-vapour plants for the degreasing of metals with trichlorethylene are described.—A. R. P.

New Cleaning Materials in the Metal Industry. Edmund Walter (*Mitt. Forschungsinst. Edelmetalle*, 1935, 8, 112–117).—Various degreasing baths (simple immersion and electrolytic) are briefly described, and the mechanism of their operation discussed. The necessity of maintaining plating baths free from suspended particles of impurities is illustrated with reference to nickel; addition of “Nekal” (a sulphonic derivative of naphthalene and isopropyl alcohol) to nickel-plating baths is claimed to give smoother plates and to prevent adhesion of hydrogen bubbles.—A. R. P.

Metal-Cleaning Preparations. Alfred B. Searle (*Chemist and Druggist*, 1934, 121, 462–463; *C. Abs.*, 1935, 29, 521).—The functions of detergents and abrasives for cleaning various metals are discussed. Special recipes are given for articles of steel, silver, copper, gold, pewter, and aluminium.—S. G.

The Preparation of Metal Articles for Electroplating, Colouring, and Lacquering. H. Krause (*Werkstatt u. Betrieb*, 1934, 67, 350–352, 382–384).—The term “preparation” includes not only cleaning, but the removal of scale, thin layers of oxide, and grease. The purposes of grinding, polishing, and

pickling are explained, and appropriate methods are indicated for articles of different sizes and for several types of alloy. Degreasing with alkaline or organic solvents is described with reference to iron, nickel, copper, zinc, tin, lead, and aluminium, and their principal alloys, as is electrolytic degreasing. Compositions of suitable pickling baths are given, and a final section emphasizes the importance of rinsing.—P. M. C. R.

†**Colouring of Aluminium and Aluminium Alloys.** H. Krause (*Mitt. Forschungsinst. Edelmetalle*, 1934, 8, 67-72, 93-98; and *Metallwaren-Ind. u. Galvano-Tech.*, 1935, 33, 8-11, 29-31).—A critical review of methods of oxidizing the surface of aluminium and colouring the oxide film with inorganic pigments is followed by an account of tests made with permanganate, chlorate, and copper salt colouring baths such as are used for bronze and brass. None of the baths tried gave such adherent and protective coatings as those produced by anodic oxidation, but quite good coatings were obtained with Czochralski's bath using copper nitrate instead of cobalt nitrate, with a 0.5-1% permanganate solution containing 0.5% of copper nitrate and a little nitric acid, and by the Jirotko process using the bichromate, hydrogen peroxide, and ferric chloride bath.—A. R. P.

The Etching of Coloured Letters, Plaques, &c. on Metal Articles. Anon. (*Illust. Z. Blechindustrie*, 1934, 63, 1335-1336).—The purely solvent effects of most etching reagents may be so modified by the addition of suitable selenium compounds that black or coloured, firmly adherent deposits may be obtained on metallic surfaces. The method is applicable not only to cast iron and all classes of steel, but to copper, brass, bronze, zinc, lead, tin, and Stellite. The composition of the etching reagent is given for iron, steel, and the copper alloys.—P. M. C. R.

Finishing Electric Heaters [Lacquering Aluminium Frames]. Howard Burns (*Indust. Finishing (U.S.A.)*, 1934, 10, (9), 15-16).—Aluminium frames of electric heaters are usually finished in an ivory or plain brown or in a wrinkled brown lacquer; they are first pickled in a hot caustic cleaner until they become black, then rinsed, dipped in a mixture of nitric and sulphuric acids until they are white again, rinsed, dried, sprayed thickly with lacquer, baked at 125°-150° C. for 3 hrs. to produce a wrinkled effect, cooled, and finished with a brown coat next day.—A. R. P.

Coating and Decorating Tin Plate. J. W. McHugh (*Indust. Finishing (U.S.A.)*, 1934, 10, (12), 15-16, 18, 20).—Modern lacquers for tinplate are made from synthetic varnishes pigmented with titania; they dry completely in 18 minutes at 107° C., and remain sufficiently flexible for some months to withstand severe forming operations.—A. R. P.

Finishes for Zinc and Aluminium Die-Cast Parts. H. Chase (*Synthetic and Applied Finishes*, 1934, 5, 203-205; *Brit. Chem. Abs.*, 1935, [B], 32).—Particular care in cleaning, before finishing, is essential, due to the variable porous nature of the castings. Baked-on glyptal enamels are preferred to cellulose lacquers for finishing; aluminium will withstand a higher stoving temperature than zinc. Plating is more costly.—S. G.

XX.—JOINING

(Continued from pp. 75-78.)

Good Cable Splicing Pays Big Dividends [Wiped Solder Joints]. Ray Blain (*Telephone Eng.*, 1934, 38, (2), 11-12, 34; (4), 15-16, 34).—For wiping cable joints, 40:60 or 38:62 tin-lead solder is recommended. Attention is directed to the importance of bringing the solder to the correct temperature when making "pot" wiped joints, and an account is given of the use of a tempera-

ture indicator known as "Dillon's Temperometer." The operations of making straight horizontal, "Y," and vertical joints are described in some detail.

—J. C. C.

Brazing with Silver Solders. Robert H. Leach (*J. Amer. Weld. Soc.*, 1934, 13, (12), 23-27; and (abstract) *Iron Age*, 1934, 134, (15), 37-38).—Much of the article is repetition of information given previously by L. (*J. Inst. Metals*, 1930, 43, 648). The physical properties, corrosion-resistance, and methods of using silver solders are discussed. The A.S.T.M. specification alloys are mainly considered, but reference is made to low-melting point solders for special purposes.—H. W. G. H.

Tough Machine Parts Copper Brazed in Electric Furnace. H. E. Scarbrough (*Metal Progress*, 1935, 27, (2), 44-46).—The copper brazing of small machine parts of high quality is effected in a box-type electric furnace, the reducing atmosphere for which is supplied by an automatic controller, which produces the desired mixture of gases by the partial combustion of town gas and natural gas. The pieces are degreased by the furnace gases before the melting-point of the copper brazing powder is reached; the maximum temperature employed is 1150° C. Special types of work are described.—P. M. C. R.

The Fusion Welding of Aluminium and Its Alloys. Hugo Buchholz (*Welding Ind.*, 1934, 2, 331-336; 1935, 2, 375-377).—Gas welding and hammer welding of pure aluminium are compared; the mechanical properties obtained are about the same, but the corrosion-resistance of hammer welds is said to be less than that of gas welds. Oxy-hydrogen welds are considered to be more brittle than oxy-acetylene welds on account of solution of hydrogen in the molten metal. The tensile strengths of untreated welds made by either method are given as about 50% of the strength of the annealed parent metal. The peculiarities of alloys and methods of treatment of welds to produce good mechanical properties are discussed. When hard-rolled sheet is welded, a zone of large grains is formed on each side of the weld. This may be avoided by jumping-up the edges before welding so as to produce critical deformation, and consequent fine-grained crystallization of the whole seam after hammering and annealing. A special filler-rod is mentioned which gives a fine-grained deposit without after-treatment. The corrosion-resistance of unhammered welds is stated to be not appreciably lower than that of the parent metal. The relation of welding technique to design and the welding of casting alloys are discussed. The welding of age-hardenable alloys is not recommended.

—H. W. G. H.

Recent Practical Experience in the Gas-Welding and Hammer-Welding of Aluminium Sheet. Anon. (*Illust. Zeit. Blechindustrie*, 1935, 64, 40-41).—The action of the oxy-hydrocarbon burner, in using which illuminating gas, methane, or benzol may be substituted for acetylene, is compared with that of the oxy-hydrogen flame. Tables give results of tensile tests on gas-welded aluminium sheet for a number of thermal and mechanical treatments of the weld, and also for hammer-welded sheet. An account is given of the gas-welding of aluminium heating coils and of light alloy castings.

—P. M. C. R.

***Resistance Welding of Thin-Gauge Duralumin.** N. F. Ward (*J. Amer. Weld. Soc.*, 1934, 13, (12), 8-13).—The factors affecting the quality of welds—current strength, electrode pressure, shape, and size, and duration of current application—are reviewed, and an account is given of experiments made to determine the optimum conditions for material 0.018-0.032 in. thick. A synchronous control to the machine, calibrated by oscillograph, was used, and two series of tests were made; first, with constant pressure and time and varying current, and, secondly, with different pressures and currents and constant time. The mechanical and metallurgical results are given in detail, and are illustrated by curves and photomicrographs.—H. W. G. H.

***Welding of Aluminium-Magnesium Alloys (Magnalium, Altmag).** V. M. Boiko, and K. P. Voshtshakov (*Autogennoe Delo (Autogenous Practice)*, 1934, (4), 16-21).—[In Russian.] The mechanical properties, microstructure, soundness under X-ray examination, and composition of welds made by various methods in sheets of Altmag (aluminium with magnesium 5-6, manganese 0.5-0.6, and titanium 0.2%) have been determined. The best results are obtained by arc welds made by Bernardoss' method using a flux composed of calcium fluoride 20, lithium chloride 30, potassium chloride 20, magnesium chloride 20, and manganese chloride 10%. The best conditions for welding sheets of various thicknesses are given. Gas welding can be used for structures of complicated design and cross-section.—D. N. S.

Spot-Welding Light Alloys. The Sciaky System. Anon. (*Flight*, 1934, Dec. 20; and (abstract) *Light Metals Rev.*, 1935, 1, 269-271).—The deterioration of the mechanical properties due to the application of heat usually caused in the electrical spot-welding of Duralumin is claimed to be overcome in the Sciaky process by the association of a definite cycle of mechanical pressures with a definite cycle of electric current. This is attained by automatic control. The strength and uniformity of the welds is claimed to be high. Both fixed- and pincer-type portable machines are made and incorporate a spot-light device to indicate the precise position of the weld.—R. B. D.

***The Welding of Copper by Means of the Electric Arc and the Strengths Obtained Thereby.** Friedrich Neumann (*Thesis: Tech. Hochschule, Berlin*, 1933, 48 pp.).—The paper is divided into 3 main sections: (1) a discussion of the temperature conditions during welding and the effect of high thermal conductivity of the metal to be welded; (2) an investigation of metallic-arc and carbon-arc welding of copper on orthodox lines; (3) relates to the development of an improved metallic-arc method. This new method differs from others in requiring no preheating of the parent metal. An uncoated rod is connected to the positive pole of a d.c. welding generator, capable of delivering 250-300 amp. at unusually high voltage. The large energy input produces increased temperature at the cathode—the work—and so, it is claimed, enables welds of satisfactory microstructure to be obtained with high welding speeds and without preheating. This method does not overcome the difficulty of pinholing, which is common to all methods of fusion welding copper which contains oxygen. It is suggested that the remedy may be found by further research with coated electrodes.—H. W. G. H.

Bronze Propellers Welded. Anon. (*Welding J.*, 1934, 31, 360).—Two 14-ton propellers were repaired in Italy by metallic-arc welding. Eroded areas were chipped out and built up, manganese-bronze electrodes and d.c. being used.—H. W. G. H.

Blowpipe Welding of Lead. Anon. (*Soudeur-Coupeur*, 1934, 13, (12), 1-31).—A series of articles deals comprehensively with the fabrication of lead by the oxy-acetylene blowpipe. Detailed instructions in technique, a comparison of the process with the older plumbing methods, applications in chemical and electrical work, and homogeneous lead lining are the principal items discussed.—H. W. G. H.

The Working of Monel Metal: Joining. Anon. (*Métaux et Machines*, 1934, 18, 353-354).—Summarized directions are given for oxy-acetylene and electrical welding, soft soldering, silver soldering, and brazing of Monel metal.

—P. M. C. R.

Arc Welding of Tantalum Sheets. Anon. (*Welding Ind.*, 1934, 2, 330; and *Welding J.*, 1934, 31, 340).—Welding is carried out under carbon tetrachloride, the seam being held about $\frac{1}{4}$ in. below the surface. Carbon electrodes are used with normal polarity; the open circuit voltage is 50, falling to about 25 v. across the arc. Material of thickness 0.025 in. requires about 60 amp.

—H. W. G. H.

The Welding of Non-Ferrous Metals and Alloys. W. E. Benbow (*Met. Ind. (Lond.)*, 1935, 46, 66-70, 80).—The welding of copper, nickel, aluminium and their alloys, of platinum and allied metals, and of magnesium alloys is described, and the applications of this method of joining are illustrated.

—J. H. W.

Recent Developments in Welding as Applied to the Foundry Industry. R. Tyler and L. C. Percival (*Found. Trade J.*, 1935, 52, 15, 20, 41-43).—A review. A recently-developed process of low-temperature welding is claimed to possess all the advantages of the cast-iron fusion-welding and of the bronze-welding processes and to have eliminated all their disadvantages.—J. H. W.

Contribution to the Question of Weld Stresses. Hans Bühler and Wilhelm Lohmann (*Elektroschweißung*, 1934, 5, 221-229).—Cf. *Met. Abs.*, 1934, 1, 525. The stresses, likely to be caused when a patch is welded into a vessel, are investigated with circular test-pieces into which circular patches are welded. It is concluded that it should be possible to repair mild steel vessels by patching without serious difficulty. The risk of crack formation is minimized by multi-layer welding, the runs rapidly succeeding one another, or by using thick electrodes. The risk appears to be less with gas welding; rightward welding is recommended.—H. W. G. H.

Some Measurements of Residual Stress in Arc-Welded Steel Plates. R. E. Jamieson (*J. Amer. Weld. Soc.*, 1934, 13, (12), 17-22).—Rectangular plates were provided with grooves on two parallel edges. These grooves were filled with weld metal and the deformations, parallel to them, were measured. The plates were then sawn into strips, the changes in lengths of which were measured. The results show the distribution of plastic and elastic deformation, and residual stress.—H. W. G. H.

A.C. vs. D.C. Welding. R. K. Hopkins (*Welding Eng.*, 1934, 19, (12), 15-17).—A thoughtful comparison, based on practical experience with heavy pressure-vessel welding.—H. W. G. H.

Mass Production and Projection Spot-Welding. Paul A. Schmatz (*Elektroschweißung*, 1934, 5, 204-210).—Spot- and projection-welding are compared; machines and electrodes used for the latter process are described.—H. W. G. H.

The Use of Resistance Welding in Aeronautical Construction. Mario Scialky (*Machine moderne*, 1934, 28, 587-590).—Aeronautical construction demands members of high strength, usually designed to sustain severe stresses in one direction only, and hence mainly of rolled or forged construction. S. prefers welding to riveting in such cases on grounds of cheapness and reliability, provided that the welding process does not destroy the additional strength conferred on the members by their previous thermal or mechanical treatment; hence, he considers stainless steel superior to the light alloys for a variety of purposes, some of which are enumerated.—P. M. C. R.

A Large Automatic Butt-Welding Machine and Its Evolution. E. Rietsch (*Elektroschweißung*, 1934, 5, 201-204).—An 800 kva. flash-welding machine for cross-sections up to 25,000 sq. mm. (984 sq. in.) is described. The movements of the machine, preheating, flashing, and upsetting, are entirely automatic and compensate for difference in cross-section, uneven contact, or dirty surfaces.—H. W. G. H.

Suitable Plant for Welding Workshops. P. Bardtke and A. Matting (*Autogene Metallbearbeitung*, 1934, 27, 372-377).—A review of the various methods available for supplying the welding gases to the welding nozzle. Constant pressure (with central oxygen and acetylene regulation), equal-pressure (with injector- and non-injector blowpipes), and differential-pressure (in which the gas pressures are in the proportion of the specific gravities) systems are discussed. An account of tests on the various systems is given, from which it is seen that the equal-pressure method possesses the most advantages. Some equal-pressure blowpipes are constructed to have slight injector effect in order

to prevent oxygen entering the acetylene pipe-line if the acetylene pressure is accidentally reduced.—H. W. G. H.

Modern Designs in Welding Blowpipe Construction. H. Kemper (*Autogene Metallbearbeitung*, 1934, 27, 343-345).—Three modern blowpipes are described: (1) the multi-flame "Linde-Welder" for steel welding; (2) the "Carba Roller-Burner," the nozzle of which is supported on two rollers, which are revolved by actuating a trigger at the grip; (3) the "Aga Shielded-Flame Burner," in which the oxy-acetylene welding flame is surrounded by small air-acetylene flames, preserving a reducing atmosphere in the vicinity of the weld puddle.

—H. W. G. H.

Welding Blowpipes. R. Meslier (*Rev. soudure autogène*, 1934, 26, (250), 9-12).—An illustrated review of modern French blowpipes.—H. W. G. H.

***Safety Valves for High-Pressure Acetylene Apparatus.** E. Sauerbrei and J. Matthes (*Autogene Metallbearbeitung*, 1934, 27, 356-360).—The results of tests on 18 different makes of valve are summarized. The modern diaphragm valve is found to be reliable and efficient.—H. W. G. H.

Rapid Determination of Acetylene in Generator Water. E. Sauerbrei and W. Scheruhn (*Autogene Metallbearbeitung*, 1934, 27, 341-343).—A volumetric method is described.—H. W. G. H.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 78-80.)

Tentative Specifications for Aluminium Sheet and Plate (B 25-24 T). ——— (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 174-178; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 668-672).—S. G.

Aluminium in Building. E. Herrmann (*Aluminium*, 1935, 17, 20-28).—Suitable aluminium alloys for various building purposes and their characteristic properties are described, together with methods of working and joining them. Some beautiful examples of the architectural use of aluminium are illustrated.—A. R. P.

Aluminium Cap-Piece on Washington Monument. E. H. Dix (*Metal Progress*, 1934, 26, (6), 32-34).—The pyramid which forms the cap of this monument was cast, in 1884, from aluminium made presumably by Deville's reduction process; a band of gold-plated copper carrying lightning conductors and collecting points surrounds its base. The aluminium proved on recent inspection to be in excellent condition, while the gold has almost disappeared and the copper has undergone some attack. The analysis of the aluminium is quoted, and the circumstances influencing its original selection are described.

—P. M. C. R.

Aluminium for Roofing and Other Architectural Purposes. Anon. (*Illust. Z. Blechindustrie*, 1934, 63, 1511-1512).—Aluminium sheet (99.2-99.5% pure), 18-27 in. wide and 0.6-0.8 mm. thick, is proposed for roofing, guttering, waterproof casing for chimneys and trapdoors, &c. Sheets should be fastened together with nails or rivets of identical material, or hand-soldered, using an oxy-acetylene welding burner, a compressed-air-acetylene or compressed-air-coal-gas burner, and a solder rich in aluminium. The method is briefly described, and recent examples of aluminium roofing on an industrial scale are enumerated.—P. M. C. R.

Aluminium Roofing Materials. Friedrich Liebe (*Illust. Z. Blechindustrie*, 1935, 64, 8-9, 42-43).—Suitable materials are aluminium sheet of 99.5% purity, Aluman, and Mangal. Protection by the M.B.V. (oxidation) process is recommended: materials so protected can safely be used for gutters, channels, &c., as well as for roofing. Directions are given for the proper insulation of the

material from concrete, sandstone, and other metals, and for appropriate slopes and falls. Methods of attachment are illustrated for several classes of work.

—P. M. C. R.

Light Metals and Their Applications in Railway Work. F. Reidemeister (*Organ Fortschr. Eisenbahnwesens*, 1935, 90, (2), 32-38).—The properties of 7 common light alloys are summarized and compared with those of cast iron and 3 types of steel. The disadvantages of light alloys consist in their lower elastic modulus, their consequent liability to buckling, their low resistance to certain types of corrosion, the loss of strength caused by heating in certain cases, and the element of doubt as to the influence of the time factor: advantages are reduced weight and higher speed, with the possibility of more frequent stops if demanded by commercial conditions; increased freight capacity, and lower cost. Applications are classified and described. Remarkable instances are the light alloy trucks used in America for transporting coal and sulphur-rich ores in order to minimize corrosion, the piston-rods and connecting-rods of locomotives, and the extended use of light alloys in rail motors, and in the equipment of breakdown vans.—P. M. C. R.

A Metal Picker for Looms. Anon. (*Silk and Rayon*, 1935, Jan.; *Light Metals Rev.*, 1935, 1, 313).—A new style of picker in aluminium alloy has been introduced in various sizes for silk and rayon, and for the weaving of woollens and worsted.—I. M.

Aluminium to be Used in New [U.S.] Army Pusher Boat. Anon. (*Daily Metal Trade*, 1935, Jan. 17; *Light Metals Rev.*, 1935, 1).—In a small pusher boat for use in the Pittsburgh Harbour by the Army Engineer Corps, the cabin is designed for the use of aluminium so as to prevent the narrow-beamed vessel from becoming top-heavy.—I. M.

Thickness of Aluminium to be Used in Addition to Copper Filters (For Therapeutic X-Ray Work). Anon. (*Amer. J. Roentgenology*, 1934, July; *Light Metals Rev.*, 1935, 1, 326).—The thickness of aluminium used should only be sufficient to absorb the heavy metal filter secondary radiation.—I. M.

Copper Cylinder Heads. H. W. Risteen (*Automotive Ind.*, 1934, 71, 593).—A note on comparative tests made at the Michigan College of Mining and Technology on cylinder heads of copper, cast iron, and a cast aluminium alloy. The effects of material and compression ratio are shown graphically in their relation to spark advance for incipient detonation.—P. M. C. R.

***The Action of Copper on Yeast.** Marc H. Van Laer (*Ann. Brasserie*, 1934, 32, 225-229, 241-248).—The effect of additions of copper salts, and of contact with metallic copper, on the activity and reproduction of yeasts has been examined under various conditions. Copper is found to have only a slightly toxic action when fermentation is conducted at high temperatures, but the effect is greater at low temperatures.—C. E. H.

Tentative Specifications for Copper-Silicon Alloy Plates and Sheets (B 96-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 236-238; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (1), 692-694).—Cover plates and sheets for pressure vessels.—S. G.

Tentative Specifications for Sheet Copper-Silicon Alloy (B 97-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 243-246; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (1), 699-702).—Cover sheet commonly used for drawing, forming, stamping, and bending.—S. G.

Tentative Specifications for Copper-Silicon Alloy Rods, Bars, and Shapes (B 98-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 239-242; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (1), 695-698).—S. G.

Tentative Revisions of A.S.T.M. Standards. Revision of Standard Specifications for Steam or Valve Bronze Sand-Castings (B 61-23). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1187-1188; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (1), 1259).—It is proposed to omit the word "sand"

from the title, and to revise sections 3 (a) and 5 (a) (composition and tensile properties).—S. G.

Tentative Revisions of A.S.T.M. Standards. Revision of Standard Specifications for Sand-Castings of the Alloy: Copper 88 per Cent.; Tin 8 per Cent.; Zinc 4 per Cent. (B 60-28). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1188; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1260).—It is proposed to omit the word "sand" from the title, and to revise sections 1 (scope), 3 (a) (composition), and 5 (a) (tensile properties).—S. G.

Tentative Revision of A.S.T.M. Standards. Revision of Standard Specifications for Composition Brass or Ounce Metal Sand-Castings (B 62-28). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 1187; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 1259).—It is proposed to omit the word "sand" from the title, and to revise sections 3 (a) and 5 (a) (composition and tensile properties).—S. G.

Saving Effected by Good Plumbing Brass. J. A. Farley (*Valve World*, 1933, 30, 102-104).—A discussion on the quality and uses of the various metals entering into the manufacture of high-grade plumbing brass work.

—J. W. D.

Tentative Specifications for Pig Lead (B 29-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 155-160; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 662-667).—Cover lead in pig form, made from ore or other material, by processes of reduction and refining, and not reclaimed lead. Lead complying with these specifications is intended to be refined lead, produced by lead producers who use well-recognized and accepted processes for smelting and refining their products. Reclaimed lead, which is prohibited by these specifications, is a commercial product obtained by the recovery of metallic lead and its alloys by the simple reclaiming process of melting, drossing, and casting. These specifications deal with 3 grades, designated Grade I, corroding lead; Grade II, chemical lead; Grade III, common lead.—S. G.

Tentative Specifications for Magnesium-Base Sand-Castings (B 80-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 212-215; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 684-687).—Cover alloys having a sp. gr. of 1.9 or less; 5 alloys are specified.—S. G.

Tentative Specifications for Magnesium-Base Alloy Sheet (B 90-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 216-219; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 688-691).—Cover alloys having a sp. gr. of 1.8 or less; 2 alloys are specified.—S. G.

Tentative Specifications for Magnesium-Base Alloy Forgings (B 91-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 204-207; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 678-681).—Cover fully-worked (i.e. worked sufficiently during the forging operations to develop maximum properties) commercial magnesium-base alloy forgings having a sp. gr. of 1.9 or less; 5 alloys are specified.—S. G.

Tentative Specifications for Magnesium-Base Alloy Ingot for Remelting (B 93-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 210-211; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 682-683).—These alloys have a sp. gr. of 1.9 or less; 11 alloys are specified.—S. G.

Tentative Specifications for Magnesium-Base Alloy Die-Castings (B 94-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 249-251; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 703-705).—Cover die-castings having a sp. gr. of about 1.8.—S. G.

Modern Methods of Bearing Preparation in Locomotive Work. Karl Martin (*Organ Fortschr. Eisenbahntechnik*, 1935, 96, 23-27).—A marked refinement of grain, resulting in improved performance, is produced in white-metal bearings by casting under pressure and subsequent surface rolling. A combined casting and finishing machine is described; the structure obtained by its use is com-

pared with that resulting from ordinary casting and machining. A tin-antimony-copper alloy is considered throughout.—P. M. C. R.

New Role of Titanium in Steels and [Aluminium] Alloys. George F. Comstock (*Metal Progress*, 1935, 27, (1), 36-41).—Titanium, either as the tetrachloride or "Webbite" (7% titanium, remainder aluminium), produces beneficial effects on the strength and grain-size of many light alloys. A table shows the results of varying additions of titanium compounds in the case of an 8% copper-aluminium alloy.—P. M. C. R.

Tentative Specifications for Zinc-Base Alloy Die-Castings (B 86-34 T). — (*Amer. Soc. Test. Mat. Tentative Standards*, 1934, 252-255; and *Proc. Amer. Soc. Test. Mat.*, 1934, 34, (I), 706-709).—Two alloys are specified.

—S. G.

Zirconium. A. Likhatshev and E. Kastyleva (*Redkie Metalli (Rare Metals)*, 1934, (1), 43-48).—[In Russian.] The source of ores, world production from 1902 to 1931, applications and prices are discussed.—D. N. S.

Notes on a New Constructional Material. J. F. Kesper (*Obst. u. Gemüse-Verwertung Industrie*, 1934, 21, 547-549; *Chem. Zentr.*, 1935, 106, I, 298).—A new material for the canning industry is described consisting of a zinc alloy with a low aluminium content plated on both sides with pure aluminium. It has a high chemical stability and a high elongation, can be given a high polish, and be readily stamped and deep-drawn, is easily soldered, and can be given a high strength by tempering at 150°-300° C. to promote diffusion of the aluminium into the zinc.—A. R. P.

Development of Piping Materials. M. W. Link (*Valve World*, 1934, 31, 47-54).—In a review of the developments in the materials used during the past 25 years for pipes, tubing, valves, stuffing boxes and packings, and gaskets used in installations for generating and conveying steam, oil, water, air, and gas, reference is made to cast, rolled, and forged brass, cast and forged nickel-copper alloys, copper, nickel, and aluminium. The effects of high temperatures and pressures on such materials, and the necessity for standardization are also discussed.—J. W. D.

Application of Materials for Cast Steel Valves and Fittings. A. M. Houser and H. L. Moe (*Valve World*, 1935, 32, 9-12).—Brasses and bronzes, due to their high coeff. of expansion, are not suitable materials in combination with iron or steel for valve seatings, discs, or disc facings at temperatures above 500° F. (260° C.). Copper-nickel alloys ($\frac{2}{3}$ nickel and $\frac{1}{3}$ copper) are more satisfactory at moderate temperatures, and for temperatures up to 850° F. (455° C.) an alloy containing nickel 50, copper 35, tin 12 is most serviceable. For higher temperatures cobalt-chrome-tungsten alloys are suitable, but their application is limited to such parts as can readily be surfaced by welding. Cobalt-chrome-tungsten and copper-nickel-tin alloys also give very satisfactory results for power-plant service in combination with a low-carbon stainless steel.—J. W. D.

***Valve-Seat Wear.** C. G. Williams (*Automobile Eng.*, 1935, 25, 23-24).—Measurements were made of the wear or "sinkage" of a number of valve insert materials, including nickel-coated inserts; a copper-zinc alloy (Cu 82.5, Zn 14.6, Al 1.0, Ni 0.72, Si 0.76%); an "aluminium-bronze," Monel metal, and a nickel-beryllium alloy (Ni 60.0, Fe 16, Cr 15, Mo 7, Mn 2, Be 0.7%). Low wear was obtained with Stellite seats, the tryposited nickel seats, and with inserts of Monel metal and of the nickel-beryllium alloy. With the copper-zinc alloy and the "aluminium-bronze" there were marked signs of grooving on the valve face, and with the latter alloy pitting of the valve face. The nickel-coated inserts showed no signs of cracking or disintegration of the 0.053 in. coating.—J. W. D.

Non-Ferrous Metals and Alloys in Building Construction. Sydney W. Davis (*Met. Ind. (Lond.)*, 1935, 46, 33-38).—The applications of copper, lead,

zinc, tin, steel, Monel metal, chromium plating and aluminium in all branches of building construction are discussed.—J. H. W.

Non-Ferrous Metals and Alloys in General Engineering Practice. Josiah W. Jones (*Met. Ind. (Lond.)*, 1935, 46, 39-43, 65).—Modern practice in casting, continuous heat-treatment, the directional effect of rolling, strength/weight ratios, the extrusion process and low-melting point alloys, die-casting, cold-pressing and bearing metals are each briefly discussed.—J. H. W.

Non-Ferrous Metals in the Automobile Industry. L. B. Hunt (*Met. Ind. (Lond.)*, 1935, 46, 44-48, 51).—The use of light alloys for weight reduction in automobile construction, unsuitable applications of aluminium, the use of copper-silicon and magnesium alloys, die-casting alloys, sheet and strip material, and bearing metals are discussed.—J. H. W.

Non-Ferrous Metals in Electrical Engineering. S. V. Williams (*Met. Ind. (Lond.)*, 1935, 46, 49-51).—The use of non-ferrous metals and alloys in the construction of various parts of electrical machinery and apparatus is described.—J. H. W.

XXII.—MISCELLANEOUS

(Continued from pp. 80-81.)

The Metal Industries. A Symposium on Their Record in 1934 and Prospects for 1935. Copper. William G. Schneider. Zinc. W. R. Ingalls. Tin. C. L. Mantell. Lead. F. E. Wormser. Nickel and Its Alloys. Robert C. Stanley. Aluminium. S. K. Colby. Gold and Silver. G. H. Niemeyer. Platinum, Palladium, Rhodium. Charles Engelhard. Secondary Metals. T. A. Wright. The Brass Rolling Mill. W. J. Pettis. The Brass Foundry. H. M. St. John. Metal Plating and Finishing. A. K. Graham. Jewelry Making. C. M. Hoke (*Met. Ind. (N.Y.)*, 1935, 33, 3-10).—Brief reviews.—A. R. P.

The Primitive Smelting of Copper and Bronze. T. A. Rickard (*Bull. Inst. Min. Met.*, No. 364, 1934, 26 pp.).—The methods used by primitive negroes and Peruvians in the production of copper and bronze are described in detail.—A. R. P.

The World's Vanadium Industry. I. A. Bronstein (*Redkie Metalli (Rare Metals)*, 1934, (4), 29-42).—[In Russian.] A review with statistics of ore production, &c.—D. N. S.

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XXIV.—BOOK REVIEWS

(Continued from pp. 87–88.)

Metallographie des Aluminiums und seiner Legierungen. Von V. Fuss. Med. 8vo. Pp. viii + 219, with 203 illustrations and 4 folding pages of diagrams. 1934. Berlin: Julius Springer. (Geh., R.M. 21; geb., R.M. 22.50.)

The author has set himself to prepare a book on the metallography of aluminium which shall be as complete and up-to-date as possible, and at the same time sufficiently compact for ready reference by busy people who want the meat without the trimmings. In this he has undoubtedly succeeded. The compression of the subject-matter has been thorough: descriptions of the methods and apparatus used for making constitutional diagrams are wholly absent, and a single page suffices for a description of the special technique necessary for preparing aluminium specimens for microscopic examination.

There is a somewhat lengthy description of the chief types of binary and ternary diagrams met with in aluminium alloy systems, which English readers may find heavy going, after which the author embarks on the section which comprises the bulk of the book, namely an individual study of some 43 binary and 26 ternary systems. Many of these are dealt with in very great detail, and if the treatment of others is necessarily very brief because the systems have been only partially elucidated, the authority for the information given is quoted by copious references to a bibliography of some 600 original papers. Mention must also be made of a 10-page chapter dealing with the mechanism of age-hardening, and of brief sections dealing with the use of the microscope in the investigation of non-metallic inclusions, corrosion phenomena, &c.

The book is very well printed on good paper, and the photographs and diagrams leave nothing to be desired. It undoubtedly contains a vast amount of information, very compressed; much of it is not easily accessible elsewhere if but seldom required. The high price can scarcely fail to discourage many would-be purchasers.—H. W. L. PHILLIPS.

Gmelins Handbuch der anorganischen Chemie. Achte, völlig neu bearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. System Nummer 35: Aluminium. Teil B, Lieferung 2: Die Verbindungen des Aluminiums. Sup. Roy. 8vo. Pp. 309–613, with 33 illustrations. 1934. Berlin: Verlag Chemie G.m.b.H. (R.M. 49.)

The present section of Gmelin's handbook deals with the derivatives of aluminium with silicon, arsenic, antimony, bismuth, lithium, sodium, potassium, ammonium, rubidium, caesium, beryllium, magnesium, calcium, strontium, barium, zinc, cadmium, mercury, and iron. Under each of the elements named, complex compounds of aluminium compounds with the corresponding compound of the element named are discussed. Phase-diagrams for many of the systems are given, and the general properties of the complexes are detailed. In the section aluminium-silicon, the relationships of the many aluminium silicates, including clays and kaolin, are considered. The aluminates of all the elements named are considered under the appropriate headings.

This section contains accounts of a vast number of complex compounds of aluminium which are not to be found anywhere other than in the original literature. The book is a most useful one, it is compiled in an able and understanding manner, and it is carefully printed. It can be warmly recommended.—JAMES F. SPENCER.

Introduction à la Chimie des Alliages Métalliques. Par Albert Portevin. (Extrait du Traité de Chimie minérale, Tome XII.) Sup. Roy. 8vo. Pp. 179–271, with 85 illustrations. 1934. Paris: Masson et Cie.

This is a most able dissertation on the fundamental properties of alloys, especially relating to their composition. It summarizes in general and in mathematical terms the present know-

ledge of all types of alloys, as distinct from specific classes containing definite elements. The factors which have had most influence on the development of theoretical knowledge in this direction are the application of the law of equilibrium in heterogeneous systems, the creation of microscopic technique, the employment of physico-chemical methods, and the use of the X-ray spectrograph. After surveying briefly various definitions, the stages in microscopical study and general considerations of chemical constitution and structure, the author proceeds to discuss the simple equilibrium diagram based on the Phase Rule. He considers, in succession, various aspects of the following main types: (1) two-phase systems, including a summary of the process of solidification and the rôle of diffusion therein; (2) invariant 3-phase equilibrium; (3) eutectic solidification, eutectoid transformations, and the influence of surfusion; (4) transition points and incomplete peritectic reactions; (5) miscibility in the liquid state; (6) definite compounds; (7) labile and metastable equilibrium, and the limit of solubility; (8) the equilibrium diagram for ternary alloys, including discussions on the nature and significance of equilibrium curves and surfaces in space; (9) predetermination of the reference triangle and the partial triangles representing quasi-binary sections; (10) pseudo-binary alloys; (11) structure, its genesis, morphology, and relation to equilibrium conditions; (12) physico-chemical treatment of alloys not in equilibrium. Finally, there are sections on segregation, liquation, and corrosion. The descriptions and the diagrams throughout are very clear.

—W. A. C. NEWMAN.

Eléments de Métallurgie. Par A. Jacquot et D. Tombeck. (Bibliothèque de l'Enseignement Technique.) Troisième édition, rédigée conformément aux nouveaux programmes de l'enseignement technique. Technologie des Marchandises, 2e. année, 3e. partie. Demy 8vo. Pp. viii + 363, with 222 illustrations. 1934. Dunod. (Br., 17 francs; cart., 19 francs; relié, 22 francs.)

In this third edition the majority of the original features may be found. In some 262 pages the whole of the metallurgical field, including non-ferrous and ferrous metals and alloys and also the problems of working, is covered. It may thus be expected that but brief reference is made to any of these various items. Nevertheless, the book serves as a good introduction to the subject. It offers, however, no great advantage for other than French people. At the end a large number of exercises are set, mostly simple in character. The educational value of representing in graphs the annual variations of such factors as the price of copper, the steel production, the prices of zinc, tin and lead, &c., is doubtful.—W. A. C. NEWMAN.

Werkstoffnormen Stahl, Eisen, Nichteisenmetalle. (DIN Taschenbuch 4.) 8. Auflage. Demy 8vo. Pp. 164, illustrated. 1934. Berlin: Beuth-Verlag G.m.b.H. (R.M. 4.)

This is the eighth edition of this book. All the original features are retained and in addition there is new information, so far as non-ferrous metals are concerned, on sheets and strips of brass, copper, and aluminium, and on drawn brass rods. These handbooks contain much useful and essential data on the mechanical properties of various classes of alloys, and these data are set out in a clear manner.—W. A. C. NEWMAN.

Prinzipien der Galvanotechnik. Von Jean Billiter. Med. 8vo. Pp. iv + 326, with 86 illustrations. 1934. Wien: Julius Springer. (Geb., R.M. 25.50.)

An introduction of 16 pages summarizes the electrochemical basic principles. Then follow 80 pages dealing with the general conditions governing satisfactory metal deposition and about 200 pages devoted to processes of pre-treatment, testing, &c., and to the special requirements for securing good deposits of individual metals. This book forms a valuable addition to the literature of the subject, dealing with it in a thorough and masterly way, which will be appreciated by research workers and others who desire a modern scientific treatise.

The author includes a number of excellent photomicrographs and quotes recent English research to a much greater extent than is usual in foreign books. These and other references and the stimulating way in which the scientific problems are put forward add greatly to the value of the book.

The practical plater would scarcely turn to this treatise for workshop recipes, but his increasing interest in the scientific basis of his craft should make it of great value to him, and so far as English-speaking countries are concerned a translation would be welcome.

Electroplating. A Survey of Modern Practice, Including Nickel, Zinc, Cadmium, and Chromium. By Samuel Field and A. Dudley Weill. Second Edition. (Revised and enlarged.) Cr. 8vo. Pp. x + 256, with 55 illustrations. 1935. London: Sir Isaac Pitman and Sons, Ltd. (7s. 6d. net.)

The new edition of this well-known book will be welcome to a wide circle of practical platers and technical students, who desire an account of approved modern methods of plating. The authors write clearly, and after fully explaining the principles and describing the plant em-

ployed in electrodeposition give detailed accounts of processes for obtaining all the commonly used electrodeposits. Copper, silver, gold, nickel, zinc, cadmium chromium, other metals, and alloys each has a chapter to itself, and the anodic oxidation of aluminum and metal colouring are also dealt with.

The treatment appears to be up-to-date, and due attention is paid to recent developments which have resulted from the active research carried out at the Research Department, Woolwich, and elsewhere.

The Modern Coppersmith. A Manual on the Working of Non-Ferrous Sheets and Tubes. By L. A. Voss. Cr. 8vo. Pp. xiii + 375, with 160 illustrations. [1934.] New York: Edwin A. Scott Publishing Co., Inc., 45 W. 45th St. (\$5.00, post free.)

The first chapter of this volume deals with the materials used by the coppersmith; the properties of copper, brass, bronze, nickel, Monel metal, "German Silver," aluminum, solders, welding rods, and fluxes, are briefly—rather too briefly—discussed. The second chapter describes his tools; hammers, hand and power saws, mandrels, swage blocks, forges, and blowpipes. Then follow three chapters on manipulation, in which the various jointing methods, soldering, welding, brazing, and riveting, are considered at length. The application of these methods to specific examples, such as varnish pots, jacketed pans, expansion bends, and the forming of bends, branches, and intricate shapes is explained in detail.

This is a very interesting and useful book on an ancient craft. Its interest, however, is sometimes in conflict with its usefulness, for considerable space is devoted to the obsolete methods used by craftsmen, to whom the oxy-acetylene blowpipe and the hydraulic press were unknown. At the same time, such a modern development as atomic hydrogen welding is accurately described.—H. W. G. HIGNETT.

La Soudo-Brasure Oxy-Acétylénique des Métaux et Alliages. Pp. 125. Paris: Office Centrale de l'Acétylène et de la Soudure Autogène. (10 francs.)

With the indifference to meaning which is displayed by so many of our technical terms, "soudo-brasure" is known, in this country, as bronze-welding. A better term would be "pseudo-welding," since the process employs welding technique to produce a brazed joint. This excellent little book gives a comprehensive survey of the principles, practice, and province of a method which has rapidly gained popularity, not only in repair work, but also for joining unweldable materials, and in cases of fabrication in which the attaining of welding temperatures is undesirable. In the first part of the book, the characteristics of the process, the physico-chemical principles involved, and the materials and technique employed are described. The second part gives details of the application to steels, galvanized iron or steel, cast- and malleable-irons, copper, brasses, and bronzes. The printing and illustrations are good: there is a table of contents, but no index.—H. W. G. HIGNETT.

Buffing and Polishing Methods. Reference Book and Complete Instruction Manual. Third Edition. Pp. 56. 1934. Waterbury, Conn.: Lea Manufacturing Co. (\$1.)

The polishing and buffing of all the common non-ferrous metals, cast iron, malleable iron, and steel using a proprietary polishing material is described in a series of 80 recipes; comparison is also made with standard practice. The first few pages contain a useful account of the principles of polishing and buffing and of the preparation, care, and maintenance of polishing wheels.—A. R. POWELL.

(1) Die Drehwechselfestigkeit genuteter Stäbe und die Erhöhung der Dauerhaltbarkeit durch Oberflächendrücken. Von W. Meyer. Die Qualifikation der Werkstoffe mit Hilfe der Werkstoffdämpfung. Von O. Föppl. Pp. iii + 73 + 8, with 42 illustrations. (2) Die Biegewechselfestigkeit genuteter Stäbe und die Erhöhung der Dauerhaltbarkeit durch das Oberflächendrücken. Von Hermann Wiecker. Pp. iii + 52, with 22 illustrations. (3) Die Biegewechselfestigkeit einer Keilverbindung (Passfederanordnung) und die Erhöhung der Dauerhaltbarkeit durch das Oberflächendrücken. Von H. Koch. Eine neue Keilform mit besserer Dauerhaltbarkeit der Welle. Von O. Föppl. Pp. iv + 68, with 39 illustrations. (4) Resonanz zwischen Mast- und Leitungsseilschwingungen und die Dämpfung dieser Schwingungen mit Resonanzdämpfern. Von O. H. Look. Pp. iv + 59 with 47 illustrations. 1934. Berlin: NEM-Verlag G.m.b.H. ((1) R.M. 3.60; (2) R.M. 2.70; (3) R.M. 3.60; (4) R.M. 3.6.)

The four handy paper-covered pocket books are Nos. 18-21 of the *Mitteilungen des Wöhler-Instituts, Braunschweig*. The first three deal with the newer methods of testing constructional

materials by applying alternating torsional or bending stresses to test-pieces. The effect of surface pressure upon the life of the test-pieces is also investigated. The strengths of keyways and shafts are investigated in No. 20 (3) of these books. No. 21 (4) is concerned with resonance phenomena in pylons. The little booklets give the results of work carried out at the Wöhler Institut by distinguished investigators. They are authoritative in character, are nicely printed, and well illustrated. Each is provided with an adequate bibliography.—J. S. G. THOMAS.

Low Temperature Physics. By L. C. Jackson. Post 8vo. Pp. vii + 122, with 34 illustrations. 1934. London: Methuen & Co., Ltd. (3s. net.)

Low temperature research, although the pioneer work of Dewar and of Travers was carried out in England, has been almost completely in abeyance in this country during the last 25 years. The centre of gravity of such research had moved to Leiden in Holland where Kammerlingh Onnes succeeded in liquefying helium in 1908. It is interesting to learn that plants manufacturing liquid hydrogen are now in operation at Cambridge, Oxford, and Bristol, while plants for liquefying helium are in operation at Cambridge and Oxford. Considerable work on the properties of materials, including metals, at extremely low temperatures has been carried out in these last few years; its record is, for the most part, found in the Communications of the Leiden Laboratory. The author of this little book worked in that Laboratory, and I know of no one more competent to review that work for English readers. Here he has presented in an attractive form a very readable account of researches carried out mainly in the region of temperatures 1° – 20° abs. The subjects discussed include: the production and measurement of very low temperatures, liquid and solid helium, specific heats, electrical conductivity (including superconductivity) of metals and alloys, and magnetic phenomena at very low temperatures. All are adequately reviewed in brief, and ample references are given to original papers dealing with the various subjects.

The book amply fulfils the publishers' intention in issuing their series of monographs on physical subjects. I unhesitatingly commend the work to all interested in recent developments in experimental physics. It is a very good three shillings' worth.—J. S. G. THOMAS.

Neuere massanalytische Methoden. Von E. Brennecke, K. Fajans, N. H. Furman, und R. Lang. Mit einem Vorwort von W. Böttger. (Die Chemische Analyse. Band XXXIII.—Sammlung von Einzeldarstellung auf dem Gebiete der chemischen, technisch-chemischen und physikalisch-chemischen Analyse. Begründet von B. M. Margosches.) Roy. 8vo. Pp. xi + 211. 1935. Stuttgart: Ferdinand Enke. (Geh., R.M. 18; geb., R.M. 19.80.)

This, the thirty-third volume of the well-known series of monographs on various branches of analytical chemistry founded by Margosches as long ago as 1907, deals with new methods which have been introduced into volumetric analysis during the past five or six years, a period in which great strides have been made in this science by the introduction of new reagents for standard solutions and for indicators. After an opening chapter, in which methods of avoiding errors in acidimetric and alkalimetric titrations are discussed, there follow chapters describing the uses of ceric sulphate, iodates and bromates, and chromous salts for the titration of oxidizable and reducible substances; finally, the last two sections deal with oxidation-reduction indicators and adsorption indicators for precipitation titrations. The whole provides a very excellent review and description of these important advancements and should, therefore, be of value to all analysts who wish to keep up-to-date in their work.

As in all the other volumes of this series, the book is exceedingly well produced, arranged, and printed, is singularly free from errors of any kind, and is well supplied with references to the original literature. Since all the authors are among the pioneers in the work described, the subject-matter has all the essential detail which can be given only by those who have had practical experience in these new fields of analysis.—A. R. POWELL.

German-English Chemical Technology. An Introduction to Chemistry in English and German. By Alexander King and Hans Fromherz. Demy 8vo. Pp. xvii + 324. 1934. Leipzig: Max Weg; London: Thomas Murby & Co. (12s. 6d. net.)

The authors in their preface claim that this book is intended to be a more or less comprehensive introduction to chemistry in English and German written with the aim of educating students of chemistry in the two most important scientific languages. The English and German texts are given side by side on opposite pages of the book and, when an expression is used for the first time, it appears in italics in both languages; indexes of the italicized words are given at the end of the book. The text is divided into 5 sections, dealing respectively with principles of chemistry, inorganic chemistry including metallurgy, organic chemistry, physical chemistry, and atomic structure.

The idea of the book is certainly excellent, but its value would have been considerably enhanced by a more judicious selection of material. As an introduction to chemistry it covers far too wide a field, and consequently much of the information given is exceedingly scrappy, some is definitely misleading, and a small amount is quite inaccurate. Thus phosphorus is said to be "generally obtained from bone ash" the calcium phosphate in which is "treated with sulphuric acid to set free phosphoric acid which is then heated in an electric furnace the free element being produced"; in the German text it is stated that carbon and silica are added to the furnace charge but the English translator appears to have overlooked this. Tin is said to be separated from silicates and rocks "partly by elutriation" and "partly by melting out on an inclined plane (liqutation)." In the account of the blast-furnace smelting of iron ores it is stated that *linings* of silica or limestone are added as a flux. Electrolytic iron is said to glow in the air (pyrophoric iron). Many other similar examples of this loose style have been noted.

From internal evidence it appears that the German section was written first and then translated into English; in this operation the exact meaning of the German sentence has frequently been distorted, and sometimes there is no counterpart of a word italicized in the German section. It is a pity that such a novel and valuable method of enabling English and German students to acquire a working knowledge of the scientific idiom of each other's language has been spoilt to some extent by what appears to be carelessness either in writing or in correcting the proofs, but, even as it stands, the book should provide students with a considerable working knowledge of a useful foreign language in so far as its scientific use is concerned.

—A. R. POWELL.

Handbuch der anorganischen Chemie. Von R. Abegg, Fr. Auerbach, und I. Koppel. In vier Bänden. Vierter Band. Dritte Abteilung. Die Elemente der achten Gruppe der periodischen Systems. Zweiter Teil B: Verbindungen des Eisens. Roy. 8vo. Pp. xxvi + 675-875, with 198 illustrations in the text. 1935. Leipzig: S. Hirzel. (Geh., R.M. 28.)

The present volume treats the chemistry of iron compounds. The first chapter (40 pp.), compiled by Rochrich, deals with iron and iron compounds in homogeneous catalysis, whilst the second chapter (60 pp.), by Elnecke, deals with the catalytic action of iron and iron compounds in heterogeneous systems. Then follows a chapter on the analytical chemistry of iron (20 pp.) by Bondi and Kurtenacker. Colloidal chemistry of iron (40 pp.), by Deutsch, and colloidal physics of iron (43 pp.), by Heller, complete the volume.

There is much material in this volume not usually found in a handbook on inorganic chemistry, but this only serves to make the volume more interesting to read. The authors are to be congratulated on their choice of material and on the method of treatment. The various subjects are dealt with exhaustively, but nowhere does one feel the matter has been overemphasized.

The book is a really good one, and it will have a stimulating effect on those who read it. It is to be warmly recommended.—JAMES F. SPENCER.

Achema Jahrbuch. Jahrgang 1931-1934. Berichte über Stand und Entwicklung des Chemische Apparatewesens. Begründet von Max Buchner. Herausgegeben unter Mitwirkung von Fachgenossen aus Wissenschaft und Technik von der Dechema. Demy 8vo. Pp. 236 + 44. 1934. Hannover: Deutsche Gesellschaft für Chemisches Apparatewesen E.V. (R.M. 10.)

This account of recent developments in the construction of chemical apparatus published on the occasion of the 7th Achema Exhibition in Cologne, 1934, contains brief accounts of the progress made in Germany in chemical construction since the 6th Exhibition was held in Frankfurt in 1930, and in addition forms a useful buyer's guide to over 2000 different products manufactured by nearly 300 firms. Of interest to the non-ferrous metallurgist are brief articles on welding nickel and other non-ferrous metals, the use of nickel and its alloys in the chemical industry with data on their resistance to corrosion, and the use of X-ray apparatus for testing metals.—A. R. POWELL.

Directory of Iron, Steel, and Non-Ferrous Alloys used in Design of Machines. Third Edition. (Supplement to "Machine Design," 1933, Sept.) Demy 8vo. Pp. 30. Cleveland, O.: Johnson Publishing Co., Penton Bdg. (25 cents.)

This is a useful list of ferrous and non-ferrous alloys arranged alphabetically under their proprietary names with brief notes of their composition and uses in apparatus and machinery of all kinds. The name of the American manufacturer of the alloy is given in all cases.

—A. R. POWELL.



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