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Vol. 3



Part 12

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

and
METALLURGICAL ABSTRACTS

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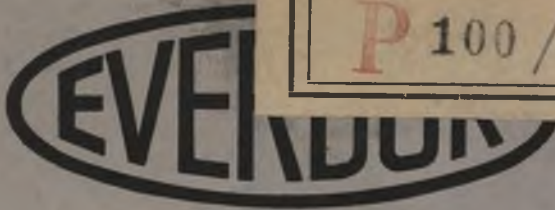


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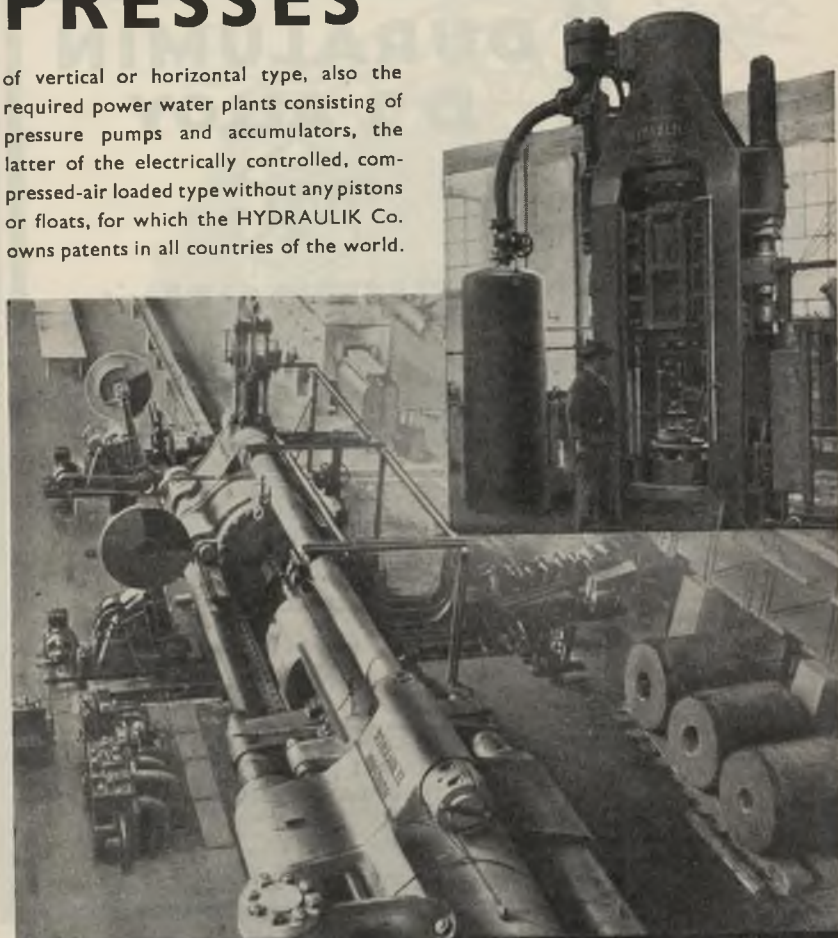
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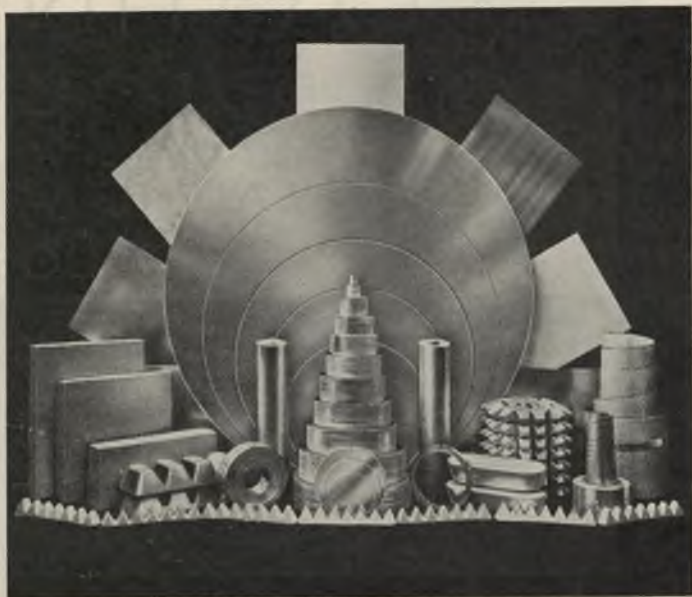
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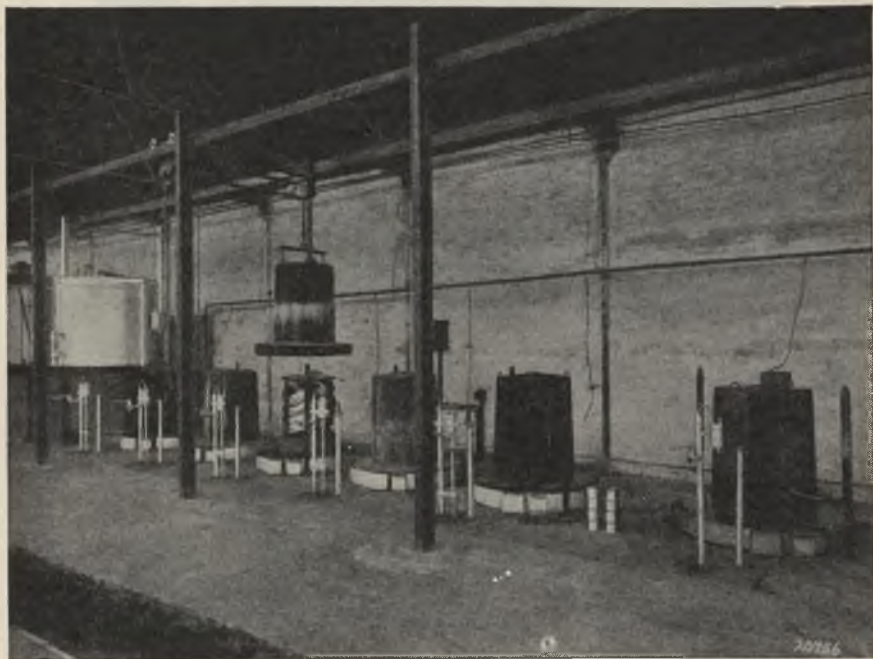
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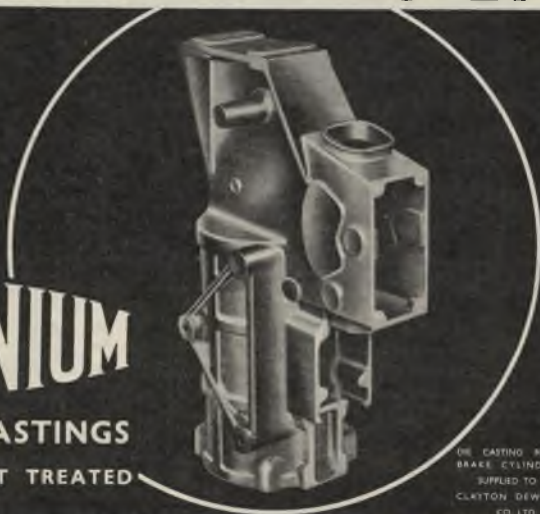
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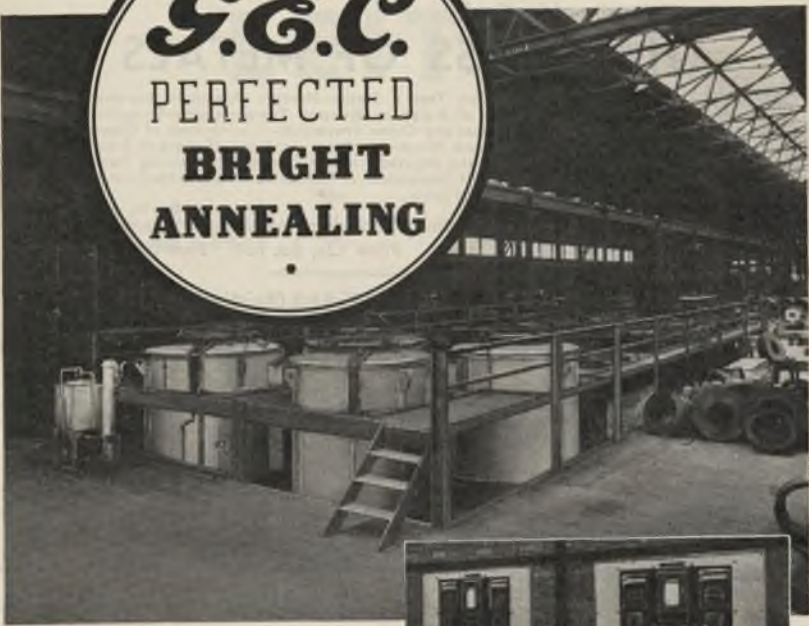
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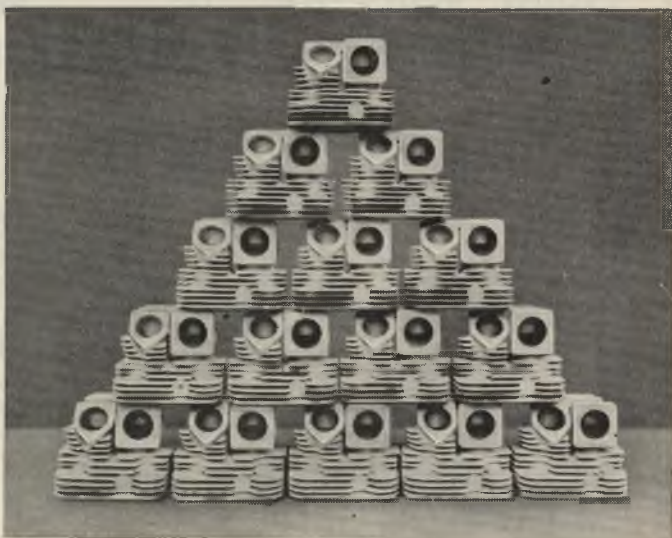


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Furnace requirements in heat-treatment.

In general the chief requirements of a furnace for heat-treatment may be set out as follows:

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- (4) *Ease and speed in heating up the furnace to the required temperature.*
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Accurate control of the temperature to which the steel is heated in any heat-treatment process is an obvious necessity. The permissible tolerance varies with the different processes, but for accurate work a tolerance of $\pm 5^{\circ}$ C. may be regarded as adequate. Accuracy of this order is attainable in properly designed modern gas furnaces especially when automatic temperature control is used. Unfortunately it is not sufficient that the pyrometer reading should remain within the prescribed limits. The load is what matters and unless all parts of the load are maintained within those limits the quality of the product will suffer. Uniformity of temperature can only be obtained by careful furnace design and accurate adjustment of all burners and flues. These adjustments will only remain accurate if the fuel characteristics are uniform and hence the importance of using a high-grade fuel. It is a great advantage of town gas that it can be burnt in burners of almost any size so that where it is difficult to obtain the required heat distribution with one burner or combustion chamber, it is possible to use a number of burners, each separately adjustable. If work is to be carried out to schedule with the minimum of waste, furnaces must be reliable in themselves and depend as little as possible on the human element which is always liable to error. If the furnaces are to be relied on the reliability of the fuel supply is of the first importance. Town gas is the most reliable of fuels.

In heat-treatment atmosphere, control may be as important as temperature control, and is more easily obtained with town gas than with any other fuel.

A store of invaluable information on the heat-treatment of steel and on furnace practice is contained in the treatise issued by the British Commercial Gas Association entitled "The Heat Treatment of Steel." It is issued quite free on application to the Association's address, 1 Grosvenor Place, S.W.1.

All needing expert advice on furnace practice should write to the Association who will put the inquirer in touch with the body best equipped to assist him.

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An interesting booklet has recently been published by Johnson, Matthey & Co., Limited, which contains a considerable amount of information regarding the various products and services offered by their organization.

The requirements of various trades have been drawn up under separate headings, and it is intriguing to discover the number of industries which need to make use of the precious metals or their alloys in one form or another.

On perusal of the pages of this booklet it is readily conceivable that there are many products and processes in modern industry where problems of destructability due to corrosion, erosion, or influence of heat have been solved by the application of silver, platinum, or precious metal alloys.

A section of the publication is devoted to the products supplied for scientific and research organization, and this includes references to the various types of platinum laboratory apparatus for which the name of Johnson Matthey is known throughout the world.

Notes on the history of the Johnson Matthey organization show how it has developed from the days of Queen Anne to the present day. Copies of the booklet may be obtained upon request from the Head Office, Hatton Garden, London, E.C.1.

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DECEMBER, 1936

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INSTITUTE NEWS AND ANNOUNCEMENTS

Annual General Meeting and Dinner.

NEXT month there will be sent to all members a circular letter containing a detailed programme of the Annual General Meeting, to be held at the Institution of Mechanical Engineers, on Wednesday and Thursday, March 10 and 11, 1937. On the day preceding the opening session visits to works will be arranged; these will be additional to visits to take place after the meeting—in the afternoon of March 11.

The Annual Dinner will be held in the evening of Wednesday, March 10, at the Trocadero Restaurant; afterwards facilities will be available for members to meet one another during a light musical entertainment.

President's Visit to the United States of America.

In the course of his recent visit to the United States, Mr. W. R. Barclay spoke at a joint dinner of the Iron and Steel Division and the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. Mr. Barclay has since received a letter from Mr. E. H. Dix, Jr. (Chairman of the Institute of Metals Division) desiring him to convey to the Institute of Metals "the very best wishes not only of the American Institute of Mining and Metallurgical Engineers but of those of us in this country who are members of the Institute of Metals."

Membership Additions.

The following were elected on December 10:

As Members.

ARGUELLES, Angel Severo, B.S., Ch.E., Manila, Philippine Islands.
BAKER, William Albert, B.Sc., London.
BERGER, Maurice, Brussels, Belgium.
BLACKWELL, Harold Alexandre, Liverpool.
BROADFOOT, Eric Henry, Birmingham.
CHACE, Thomas B., Chicago, Ill., U.S.A.
CRAGGS, Harold Brabant, Pelaw-on-Tyne.
FORREST, George, B.Sc., Banbury.
HALL, Edward Patterson, B.Sc., Phillipsdale, R.I., U.S.A.

HARDY, Charles, New York City, U.S.A.

IZOD, Edwin Gilbert, Addlestone.

MILLER, Mike Anthony, A.B., Ph.D., New Kensington, Pa., U.S.A.

MIRAMON, Pierre, Paris, France.

PARKER, Henry George, London.

PARLANTI, Conrad A., Herne Bay.

PHILPOT, Harold Percy, B.Sc., Benares, India.

PLUTE, Frederick, B.A., London.

PREECE, Engineer Vice-Admiral George, C.B., London.

RAO, Emani Surya Prasada, B.Sc., Chatrapur, Orissa Province, India.

REYNOLDS, Oswald Garnet, Melbourne, Australia.

RIGBY, Richard, B.Eng., Ph.D., London.

SCHERZER, Karl, Dr.jur., Lammersdorf (Kreis Monschau), Germany.

VON SELVE, Gustav, Thun, Switzerland.

STEPHENS, Charles, London.

As Student Members.

ANDREWS, Kenneth William, Manchester.

BOYLE, Leonard, Tynemouth.

DAVIES, Dai Ashton, Billingham-on-Tees.

HULL, Charles, B.A., Cambridge.

PARKER, Rowland, B.A., Witton, Birmingham.

RAYNOR, Geoffrey Vincent, B.A., B.Sc., Oxford.

SWINDELLS, Norman, B.A., Cambridge.

The undermentioned have been elected in accordance with the special arrangements made by the Council for the election of members of the American Institute of Mining and Metallurgical Engineers who are under the age of 33 years (see *Monthly J. Inst. Metals*, 1936, Sept., p. 429).

ANSEL, Gerhard, M.Sc., Pittsburgh, Pa., U.S.A.

COHEN, Morris, Sc.D., Cambridge, Mass., U.S.A.

ESAREY, Bernard John, B.S., Ch.E., Indianapolis, Ind., U.S.A.

HENTSCHEL, Robert A. A., Sc.D., Bridgeport, Conn., U.S.A.

SHOEMAKER, John Earle, M.S., Youngstown, O., U.S.A.

DE STRYCKER, Professor Robert Emile, Louvain, Belgium.

Personal Notes

Beilby Memorial Awards.

From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators representing the Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished original work, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering, and metallurgy.

Awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct

advancement in knowledge and practice.

The administrators of the Fund are the Presidents, the Honorary Treasurers, and the Secretaries of the three participating Institutions, who will be glad to have their attention directed to outstanding work of the nature indicated, not later than January 1, 1937. Correspondence on this subject should be addressed to the Convener, Sir George Beilby Memorial Fund, Institute of Chemistry, 30 Russell Square, London, W.C.1.

Required for Library.

The Librarian would be glad to receive a gift of the undermentioned issue to complete the Institute's file: *Journal du Four Électrique*, 1936, July.

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 January issue of the Monthly Journal should reach him not later than December 27.

DR. AUBREY BURSTALL, M.Sc., who has been Technical Adviser to the Aluminium Plant and Vessel Company, Ltd., for the past three years, has been appointed Professor of Engineering in the University of Melbourne. He sails for Australia on January 2.

MR. O. W. ELLIS, M.Sc., who has been duly elected a trustee of the American Society for Metals following his recent nomination to this office, has arranged to visit England next summer. He has been invited to present to the Institute of British Foundrymen at Derby in June, the exchange paper on behalf of the American Foundrymen's Association.

MR. W. H. L. LYTHGOE has been appointed Chief of the Technical Department of W. T. Henley's Telegraph Works Company, Ltd., Gravesend.

SIR ROBERT MOND, M.A., LL.D., F.R.S., has been elected foreign

Associate of the Académie des Inscriptions et Belles Lettres, in place of the late King Fuad.

MR. W. SINGLETON has resigned from the position of Research Manager of the Research Laboratories of Goodlass Wall and Lead Industries, Ltd., at Perivale, Middlesex, but for the time being he will continue his connection with the Company as Technical Adviser. Communications should be addressed to him at 38 Wembley Park Drive, Wembley (Telephone: Wembley 2234).

Obituary.

MR. F. G. MARTIN, B.Sc., died on October 23 at the age of 58 years. He was elected a member in 1918, and delivered the Seventh Autumn Lecture on "Non-Ferrous Metals in the Shipping Industry" at the Liverpool Autumn Meeting in 1928.

MR. GEORGE E. MURRAY, M.Sc., Assistant General Superintendent of The Consolidated Mining and Smelting Company of Canada, Ltd., died on November 8 at Trail, B.C. He had been a member of the Institute since 1926.

LOCAL SECTIONS NEWS

MEETINGS IN DECEMBER AND JANUARY.*

Birmingham Section.

Powder Metallurgy. By J. C. Chaston, B.Sc., A.R.S.M. (*January 7.*)

The historical aspect of the development of metallic powder manufacture will be outlined and the methods which are available for the production of metals in the form of fine powders will be reviewed. Particular attention will be devoted to modern industrial processes. The uses of metal powders for paints, for magnetic core materials, and as a basis for the production of formed parts and billets by a process of moulding and sintering will be described. An account will be given of some recent developments in the latter process of "powder metallurgy," and its possibilities will be briefly discussed.

London Section.

Copper. By R. D. Burn, M.Sc. (*January 14.*)

A brief description will be given of the flotation concentration of copper and the effect that its application has had on recovery methods and world copper production. Modern smelting and refining will be discussed with some reference to particular methods of recovery characteristic of certain ore deposits. The various grades and types of copper available to the industry at the present time will be dealt with, with some indication of their differences and applications, including autogenous welding. Reference will be made to recent advances in connection with copper production and the trend of probable developments. In conclusion a short film will be shown illustrating production in a modern smelter and refinery.

North-East Coast Section.

Recent Improvements in Refractory Materials. By P. B. Robinson, M.Met. (*December 19.*)

The author will discuss the need for improvement in refractory materials, the difficulties encountered in bringing about improvements and the methods by which these difficulties are being overcome, with certain examples of improved refractories recently developed. The qualities necessary in refractory materials for different purposes will be dealt with, and the constitution of fireclay and the effects of various mineral impurities associated with it examined. The difficulties in laboratory testing will be pointed out, and the need for properly controlled works' tests stressed. The improved refractories described will include silica for coke-oven walls and gasworks, a low spalling silica brick for hot patching and use in rotary furnaces, a specially tough and abrasion-resistant silica brick for steelworks, a high alumina firebrick, and a composite magnesite-chrome brick which has all the good points of a first-class magnesite brick and in addition is entirely non-spalling. The paper will conclude with a reference to joints and the importance of suitable jointing material, and to the repair of coke-oven walls by means of a spray of cement.

Shipyard Metals. By M. A. W. Brown, M.Sc. (*January 11.*)

An introductory historical survey will be given of the use of metals in shipbuilding and marine engineering. The general modern requirements and uses of metals in the building of ships and their engines will be dealt with, and more detailed considerations of some of these will be discussed with reference to "Yard" methods of fabrication and conditions under which ships' materials

* For places and times of meetings, where not given, the green folder programmes already issued should be consulted.

Local Sections News

are exposed in service (ferrous metals, *e.g.* wrought iron, steels, and cast iron—plates, bars, rivets, and castings—special steels; non-ferrous metals, *e.g.* copper, zinc, tin, nickel alloys, and white metals). The application of various methods of electric welding in modern shipbuilding, aspects of marine corrosion and its prevention; the work of the shipyard "Chemist" and the testing of "Yard" materials, and possible developments in connection with the use of shipyard metals will also be touched upon.

Scottish Section.

Magnesium Alloys. By A. J. Murphy, M.Sc. (*January 11.*)

The author will deal chiefly with the production, properties, and applications of magnesium alloy castings: compositions of alloys; procedure in the foundry, flux treatment, sand addition agents, sand control; general characteristics of magnesium castings; mechanical properties, machining characteristics; corrosion-resistance, protective treatments; constitution; heat-treatment, effect on microstructure and mechanical properties; fatigue-strength; and considerations in design.

Sheffield Section.

Technical and Industrial Development in the Electrochemical Surface Treatment of Metals. By S. Wernick, Ph.D., M.Sc. (*January 15.*)

During the last decade, far-reaching steps have occurred in the technical and industrial development of metal finishes produced by electrodeposition and electrochemical processes generally. Among the more important are the greatly improved status of chromium plating as a stainless deposit and cadmium plating as a corrosion-resisting finish; the advent of "new" stainless deposits—the most outstanding of which are in the platinum group of metals, in particular, rhodium; the work which has been carried out in the deposition of alloys; and certain "anodic" processes of which the anodic oxidation of aluminium is the most important industrially. At the same time, methods for improving the quality and speeding-up the production of the "older" finishes have been perfected. The production of bright deposits, *e.g.* bright nickel plating, has resulted in appreciable economies in metal finishing. Side by side with these developments, considerable improvement in plant used in plating processes has occurred. This has entailed the solution of numerous chemical engineering problems. Increasing use is made of semi- and fully-automatic plant. Motor-generator sets are being displaced by rectifier equipment as a source of current supply—this being a peculiarly British development. Lastly, the methods of laboratory control of plating processes have progressed considerably with resultant improvement in the products of the electrodeposition industry.

International Electrodeposition Conference.

The first International Electrodeposition Conference, organized by the Electrodepositors' Technical Society, will be held in London on Wednesday and Thursday, March 3 and 4, 1937. The opening ceremony will take place at British Industries House, and will be followed by luncheon. At the first session, to be held in the afternoon of March 3, papers will be presented under the general heading "Electrodeposition Practice Abroad," while at the second session, in the evening, the subject will be "Electrodeposition of Base Metals." The third session, in the morning of March 4, will be devoted to papers on "The Properties of Electrodeposits," the closing session, held in the afternoon, being concerned with "Electrodeposition of Precious Metals."

Papers have been accepted from Belgium, Czechoslovakia, France, Germany, Holland, Switzerland, the U.S.S.R., and the United States of America.

The Conference will conclude with a reception and dinner. Members desiring to take part in the Conference should communicate with the Honorary Secretary to the Conference, H. Wynne-Williams, 12A Raleigh House, Larkhall Estate, S.W.8 (Telephone: Mac. 2162).

MEETINGS OF OTHER SOCIETIES

FRIDAY, DECEMBER 18.

INSTITUTE OF BRITISH FOUNDRYMEN, LANCA-SHIRE BRANCH, JUNIOR SECTION.—A. J. Hinton: "Mounting Patterns on Plate and Plaster." (College of Technology, Manchester, at 7.30 p.m.)

INSTITUTE OF BRITISH FOUNDRYMEN, MIDDLES-BROUGH BRANCH.—J. Pell: "Plate and Machine Moulding for Repetition Castings." (Cleveland Institute, Corporation Road, Middlesbrough, at 7.45 p.m.)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—N. P. Inglis: "The Relationship Between Mechanical Tests of Materials and Their Working Conditions." (Mining Institute, Newcastle-upon-Tyne, at 6 p.m.)

SATURDAY, DECEMBER 19.

INSTITUTE OF BRITISH FOUNDRYMEN, EAST MIDLANDS BRANCH, LINCOLNSHIRE SECTION.—F. E. Mather: "Moulding Pumps without Patterns." (Technical College, Monks Road, Lincoln, at 7 p.m.)

MONDAY, DECEMBER 21.

INSTITUTE OF BRITISH FOUNDRYMEN, SCOTTISH BRANCH, FALKIRK SECTION.—R. Ballantine: "Developments in the Production of Ingot Mould Castings." (Temperance Café, Lint Riggs, Falkirk, at 7.15 p.m.)

INSTITUTE OF WELDING, NORTH-EASTERN (TYNESIDE) BRANCH.—E. B. Partington: "Welding of Non-Ferrous Metals." (Cleveland Institute, Corporation Road, Middlesbrough, at 7.30 p.m.)

MONDAY, JANUARY 4.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP.—S. Robson: "The Manufacture of Spelter." (Burlington House, Piccadilly, London, W.1, at 8 p.m.)

WEDNESDAY, JANUARY 6.

INSTITUTION OF BRITISH FOUNDRYMEN, LONDON BRANCH.—Consideration of Technical Subcommittee Reports. I.—Recommendations of Non-Ferrous Sub-Committee for Two Lead Gun Metals. (Charing Cross Hotel, London, W.C.2, at 8 p.m.)

THURSDAY, JANUARY 7.

INSTITUTE OF BRITISH FOUNDRYMEN, SHEFFIELD AND DISTRICT BRANCH.—P. Longmuir: "Some Foundry Characteristics—Iron, Steel, Brass." Joint Meeting with Foundry Trades Technical Society. (King's Head Hotel, Change Alley, Sheffield, at 7.30 p.m.)

FRIDAY, JANUARY 8.

INSTITUTE OF WELDING, MIDLANDS BRANCH. H. S. Jeffs: "Electric Resistance Welding with Modern Production Conditions." (James Watt Memorial Institute, Gt. Charles Street, Birmingham, 3, at 7.15 p.m.)

INSTITUTION OF ELECTRICAL ENGINEERS, METEOR AND INSTRUMENT SECTION.—W. F. Randall: "Nickel-Iron Alloys of High Permeability, with Special Reference to Mumetal." (The Institution, Savoy Place, Victoria Embankment, London, W.C.2, at 7 p.m.)

SATURDAY, JANUARY 9.

INSTITUTE OF BRITISH FOUNDRYMEN, LANCA-SHIRE BRANCH.—J. Timbrell: "Mechanical Aids for Increased Foundry Production." (Eng'neers' Club, Albert Square, Manchester, at 4 p.m.)

INSTITUTE OF BRITISH FOUNDRYMEN, SCOTTISH BRANCH.—N. C. Blythe: "Mechanization in the Foundry." (Royal Technical College, Glasgow, at 4 p.m.)

MONDAY, JANUARY 11.

INSTITUTE OF WELDING, NORTH-EASTERN (TYNESIDE) BRANCH.—H. E. L. Martin: "Distortion, Residual Stress, and Heat Penetration in Respect to Welded Joints." (Armstrong College, Newcastle-upon-Tyne, at 7.30 p.m.)

TUESDAY, JANUARY 12.

INSTITUTE OF BRITISH FOUNDRYMEN, LANCA-SHIRE BRANCH, BURNLEY SECTION.—J. Hill: "Science and its Use to the Practical Foundryman." (Municipal College, Ormerod Road, Burnley, at 7.15 p.m.)

WEDNESDAY, JANUARY 13.

ELECTRODEPOSITORS' TECHNICAL SOCIETY.—D. J. Macnaughtan and W. H. Tait: "The Tinning of Steel Strip by Electrodeposition." Joint Meeting with Iron and Steel Institute. (Northampton Polytechnic Institute, St. John Street, Clerkenwell, London, E.C.1, at 8.15 p.m.)

INSTITUTE OF WELDING.—H. W. G. Hignett: "Welding Non-Ferrous Metals—Some Problems." (Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 6.30 p.m.)

INSTITUTE OF WELDING, SCOTTISH BRANCH.—E. S. Waddington: "Modern Developments in Welding." (Royal Philosophical Institute, 207 Bath Street, Glasgow, at 7.30 p.m.)

ROYAL SOCIETY OF ARTS.—O. F. Bloch: "Applications of Photography to Scientific and Technical Problems." (The Society, John Street, Adelphi, London, W.C.2, at 8 p.m.)

THURSDAY, JANUARY 14.

INSTITUTE OF WELDING, SCOTTISH BRANCH.—E. S. Waddington: "Modern Developments in Welding." (Heriot Watt College, Edinburgh, at 7.30 p.m.)

SATURDAY, JANUARY 16.

INSTITUTE OF BRITISH FOUNDRYMEN, SCOTTISH BRANCH, FALKIRK SECTION. Professor R. Hay: "Porosity in Castings." (Temperance Café, Lint Riggs, Falkirk, at 6 p.m.)

NOTICE TO AUTHORS OF PAPERS

1. Papers will be considered for publication from non-members as well as from members of the Institute. They should be addressed to The Secretary, Institute of Metals, 36 Victoria Street, London, S.W.1.
2. Papers are accepted for publication in the *Monthly Journal* and subsequently in the *Journal*, and not necessarily for presentation at any meeting of the Institute.
3. Papers suitable for publication may be classified as :
 - (a) Papers recording the results of original research ;
 - (b) First-class reviews of, or accounts of, progress in a particular field ;
 - (c) Papers descriptive of works' methods, or recent developments in metallurgical plant and practice.
4. *Manuscripts* and illustrations must be submitted in duplicate, and an abstract, for publication, must accompany each paper. Manuscripts must be typewritten (double-line spacing) on one side of the paper only, and authors are required to sign a declaration that neither the paper nor a substantial part thereof has been published elsewhere. MS. not accepted will be returned within 6 months of receipt.
5. *References* should be collected at the end of the paper, and set out in the following style : (1) W. Hofmann and W. Jäniche, *Z. Metallkunde*, 1936, 28, 1 (*i.e.* year, volume, page).
6. *Illustrations*. Each illustration must have a number and description; only one set of numbers must be used in one paper. *Line figures* must be drawn in India ink on smooth white Bristol board, tracing paper, or good-quality drawing paper. Co-ordinate paper is not desirable, but if used must be blue-lined with the co-ordinates to be reproduced *finely* drawn in Indian ink. All lettering and numerals, &c., *must* be in *pencil*. Figures should be drawn approximately twice the size intended for reproduction. *Photographs* must be restricted in number, owing to the expense of reproduction, and must be trimmed to the smallest possible of the following sizes, consistent with adequate representation of the subject : 3 in. deep by 4 in. wide (two photomicrographs to a plate); 3 in. deep by 2½ in. wide (four to a plate); 2 in. deep by 2½ in. wide (six to a plate). Magnifications of photomicrographs should be given in each case. Photographs for reproduction should be loose, not pasted down.
7. *Tables or Diagrams*. Results of experiments, &c., may be given in the form of tables or figures, but (except in exceptional circumstances) not both.
8. *Overseas Authors*. Authors resident in countries distant from Great Britain are requested to name, if possible, agents in Britain to whom may be referred matters concerning their papers, including proofs for correction. Translations from foreign languages should preferably be accompanied by a copy of the MS. in the language of the author.
9. *Reprints*. Individual authors are presented with 50, two authors with 70, and three with 90, reprints (in cover). Authors may elect to receive their reprints from the *Monthly Journal* (without discussion) or from the *Journal* (complete with discussion). Additional reprints are obtainable at rates to be obtained from the Editor.

CREEP OF LEAD AND LEAD ALLOYS. PART I.—CREEP OF VIRGIN LEAD.*

By J. McKEOWN,† M.Sc., Ph.D., MEMBER.

SYNOPSIS.

Tensile creep tests have been made on specimens of virgin lead in the form of extruded rod, extruded pipe, and extruded cable-sheath. The tests on rod have been made at room temperature and at 80° C., while the tests on pipe and cable-sheath have been made at room temperature only. The effect on the minimum creep rate of the working produced in flattening cable-sheath and in bending and straightening pipes has been investigated, and this effect has been found to be very marked. It has been shown that results obtained from worked samples may give an erroneous impression of the creep characteristics of the unworked, extruded product.

In the extruded products the effect of initial grain-size on the minimum creep rate has been investigated, and it has been shown that in extruded virgin lead the larger the initial grain-size the higher the resistance to creep at low stresses.

INTRODUCTION.

THIS work has been carried out as part of a research on the properties of lead conducted by the British Non-Ferrous Metals Research Association, and the present paper is a description of the methods used and the results obtained over a period of more than 4 years on virgin leads of high purity. Many tests have also been carried out on several alloys of lead, and it is hoped to present the results of such tests at a later date.

The work was commenced with the intention of obtaining comparative data on the creep of lead and some of the common lead alloys, and a very pure lead was chosen as a basis of comparison. It was assumed at the outset that the only important variable in the raw materials was composition, high-purity leads being assumed to recrystallize at room temperatures after cold-work. Preliminary results showed, however, that the problem was not so simple, but was complicated by a number of unsuspected variables. At present it appears likely that the smallest number of variables exists in the case of the very pure virgin lead, but the investigation is by no means complete.

A considerable amount of work has been done by other investigators on the creep of lead and lead alloys, and data have been published by

* Manuscript received July 1, 1936.

† Investigator, British Non-Ferrous Metals Research Association.

• Note to Abstractors and Other Readers.—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LX, 1937. Reference should accordingly be as follows: *J. Inst. Metals*, 1937, 60 (Advance copy).

McKeown : Creep of Lead and Lead Alloys

Archbutt,¹ Townsend and Greenall,² Dean and Ryjord,³ Moore and Alleman,⁴ Clark and Upthegrove,⁵ Chaston,⁶ Moore, Betty, and Dollins,⁷ and Betty.⁸ In a large proportion of this work the initial conditions of the lead specimens were inadequately studied; the composition not being given exactly, the average grain-size not determined, and the state of age-hardening in those alloys which are susceptible to ageing ignored. Again some of the tests were made on specimens cut from cable-sheathing which had been flattened, and the influence of flattening on the results was not taken fully into consideration.

Moore, Betty, and Dollins have found that "there seemed to be some evidence that lead and lead alloys with large crystalline grains resist creep somewhat better than do lead and lead alloys with small grains." Betty carried out some work on single crystal specimens of commercially pure lead. He found that the strain-time diagrams (creep curves) for the single crystals were quite different from those of poly-crystalline specimens of the same material. In the latter, creep was due to both deformation within the grains and to disturbances at the grain boundaries. According to Betty the mechanism of creep in single-crystal specimens of commercially pure lead was by slip on that octahedral plane on which the resolved shear stress was a maximum.

In the paper by Moore, Betty, and Dollins⁷ the question of the effect of the cold-working produced by the flattening of the cable-sheath from which the specimens were machined has been considered, and the authors stated that all the results of tensile tests on specimens cut longitudinally and specimens cut transversely from the sheet showed no difference. They stated that if the effect of flattening was to be noticeable it would have appeared in the tensile tests. On this point the present writer cannot agree with Moore and his colleagues. The amount of cold-work produced in the flattening of the sheaths was very small and the temperature of annealing, being room temperature, was very close to the recrystallization temperature of the materials. Such small amounts of work would not affect the ultimate tensile strength of the materials appreciably, but results given later in this paper show that they do affect the behaviour of the materials in creep at stresses well below the ultimate tensile strength. Some recent work carried out by O. F. Hudson and the present writer has shown that annealed copper worked by overstraining only 0.05 per cent. at room temperature had a definite limit of proportionality induced in it by this treatment. Subsequent annealing of the copper specimen for 2 hrs. at 500° C. failed to remove this range of proportionality of stress to strain and did not, in fact, reduce it.

Again even small amounts of working tend to cause lead and lead

Part I.—Creep of Virgin Lead

alloys to recrystallize at room temperature, and the extent to which this recrystallization and consequent grain-refinement has progressed will depend on both the extent of the cold-work and the time elapsing since the working was applied. H. F. Moore and his colleagues have recognized that grain-size is an important factor in determining the resistance to creep of lead and lead alloy specimens, and yet they have not investigated the effect on grain-size of the flattening process to which their specimens were subjected before testing. It would appear reasonable to conclude that the behaviour of a flattened specimen under creep conditions would be dependent on the time elapsing between flattening and loading the specimen, that is, on the extent to which recrystallization and grain-growth had progressed.

As is shown later in the present paper the effect of flattening on the resistance to creep of lead specimens is not confined to the changes in grain-size alone, and a further factor is present. This factor is apparently that of retention of cold-working, but exactly how it operates is at present unknown although its effect in increasing the resistance to creep is clearly indicated. This factor, the effect of small amounts of cold-working, is obviously of very great importance in the practical consideration of creep of lead and lead alloys, since in practice almost every application of these materials is accompanied by some small amount of cold-working during the installation of the materials in service. A cable during installation is unwound from a drum, thus cold-working the lead sheath, lead pipe is supplied in coils, and sheet lead in rolls.

From the point of view of reproducing service conditions as closely as possible during tests of a material, it would appear that in tests of lead cable-sheathing and water-pipe internal pressure creep tests would be more satisfactory. These tests would subject the material to compound stresses similar in nature to those experienced in service, but unfortunately such tests are by no means easy to carry out successfully. Internal pressure creep tests have been made by Moore and Alleman⁴ and also by Chaston.⁶ In the former work the rate of creep on the diameter of lead cable-sheaths was measured, while in the latter the length of life to failure was alone investigated. Measurement of diametral creep of lead sheaths present considerable difficulties, and the method of Moore and Alleman was not quite satisfactory as part of the circumference of the sheath was prevented from creeping by the attachment of part of the measuring apparatus. Another difficulty met with in testing of this type is the lack of uniformity of thickness of the wall of the sheath or pipe being tested, this giving rise to uneven distribution of stress and consequent uneven creep.

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PRESENT WORK.

Materials.

The materials used in this work are listed below and a spectrographic analysis is also added.

Material.	Initial Average Grain Area, mm. ² .	Remarks.
1 1/4 in. diam. rod	0.84	Extruded on pipe press
1 1/4 " "	0.01	" " " "
Cable-sheath, 1 in. outer diam., 3/4 in. inner diam.	0.37	" " on cable press
1/2 in. bore x 6 lb./yd. pipe	0.15	" " on pipe press

Spectrographic Analysis.

Material.	Composition, Per Cent.						
	Sn.	Sb.	Cd.	Cu.	Ag.	Bi.	Zn.
Coarse-grained rod	Nil	<0.002	0.00002	<0.0005	<0.0005	0.0005	Nil
Fine-grained rod	"	Nil	0.0001	0.001	0.001	0.001	0.001
Cable-sheath	"	<0.002	0.0005	<0.0001	0.0007	0.0006	Nil
Pipe	"	0.002	0.0001	0.0008	0.0008	0.0005	"

Other elements sought but not detected—As, Te, Tl.

Chemical analysis for iron gave the following results:

Material.	Iron, Per Cent.
Coarse-grained rod	0.0005
Fine-grained rod	0.0005
Cable-sheath	0.0006
Pipe	0.0006

(1) Long-Time Creep Tests at Room Temperature.

(a) *Tests on extruded rod specimens.*—The creep tests to be described here were commenced in August, 1932, and some of the specimens are still under test. The work has been carried out mainly in a basement laboratory where the temperature is not subject to wide daily fluctuations. The maximum temperature recorded during the past 4 years was 23.5° C. (summer) and the minimum 12.5° C. (winter). The difference between maximum and minimum temperature during

Part I.—Creep of Virgin Lead

a 24-hr. period rarely exceeded 3° C. For by far the greater part of the time the temperature was between 15°–18° C.

As the tests were to be carried to fracture and as previous experience had shown the difficulties met with in applying extensometers of the clamping type to lead specimens, it was decided to adopt the type of specimen shown in Fig. 1 and to measure the extension between the shoulders by the rods *BB* shown. These rods were cut from the same supply of extruded lead bars, and consideration of the arrangement will show that changes of length due to changes of temperature are eliminated from changes of length due to stress. The separation of fine lines scribed on the strips of platinum foil was measured by means of a measuring microscope reading to 0.01 mm. The parallel length or gauge length of the specimen was 10 cm., and assuming that all the extension occurs

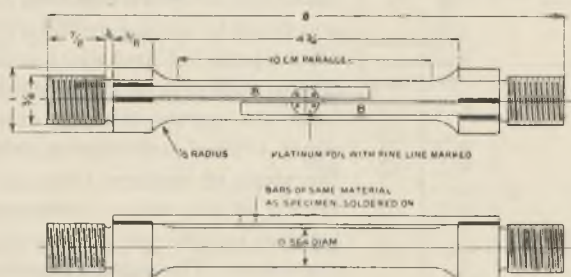


Fig. 1.—Specimen for Long-Time Creep Tests on Extruded Rods.
(Dimensions in Inches.)

on the parallel length the strain may be read to 10^{-4} . The reading to 0.01 mm. is by vernier, and in tests at 400 lb./in.² and over, a greater accuracy of strain reading than $\pm 1 \times 10^{-4}$ is not claimed. For the tests at 200 and 300 lb./in.² this form of measurement was not sufficiently sensitive, and the extensometer shown in Fig. 2 was devised for these tests. In this instrument the lever *E* allows a magnification of 10 : 1. The rod *A* is of aluminium and the bracket *D* of Invar; the length of the aluminium rod being to the gauge length of the test specimen in the inverse ratio of their coefficients of expansion. Measurements of extension of the specimen were made on the end of the lever *E* and the fixed bracket beneath it, scribed lines on platinum foil being used as before, and hence the strain could be read to $\pm 1 \times 10^{-5}$. The range of movement of the end of the lever *E* was not allowed to exceed 3 mm., and when this movement was reached the lever was re-set by means of the nut *B* which had a ball seating on the Invar bracket.

In the foregoing it has been assumed that all the extension occurs on

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the parallel length of 10 cm., and that this assumption was substantially valid was shown by the surface of the specimens when they had been strained about 3 per cent. This amount of strain was sufficient to give a roughening of the surface due to displacement of the grains, and this roughening could not be detected beyond the parallel portion of the specimen.

The specimens were machined from the $1\frac{1}{4}$ -in. diam. coarse-grained bar to the dimensions shown in Fig. 1, and the stresses applied ranged from 700 to 200 lb./in.². The results of the tests are given in full in Table I, and the creep curves obtained are shown in Fig. 3. The curves all show that the initial rate of creep is rapid but diminishes and tends to become relatively constant after a period of time which is dependent on the applied stress. It would appear from the curves that an extension of about 4-5 per cent. has to occur before the stage of uniform creep is reached. In Fig. 4 the creep curves are shown for tests on two virgin leads of different grain-sizes. The coarse-grained material, already dealt with in Fig. 3, had an average grain area of 0.84 mm.², while the fine-grained material had an average grain area of 0.01 mm.². The very great difference in creep characteristics of these two materials is clearly shown in Fig. 4, and as shown in Table I a great difference also exists in the values of elongation and reduction of area.

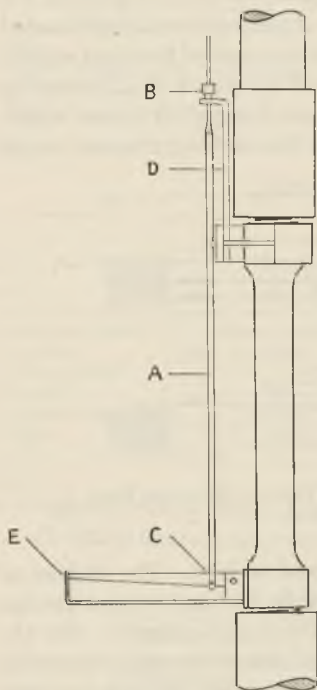


Fig. 2.—Extensometer used in Tests at Low Stresses.

It may be noted that in the coarse-grained material as the applied stress is decreased the elongation at fracture and the reduction in area are decreased. In the fine-grained material, on the other hand, the elongation at the lower stress is greater than that at the higher stress.

In Fig. 5 an attempt has been made to subject the results of the tests to logarithmic plotting. In the case of the coarse-grained material a fairly good straight line passes through the points for 400, 500, 600, and 700 lb./in.², but the points for 300 and 200 lb./in.² are well off the line. This, however, is readily explained by an examination of Fig. 3, where it

Part I.—Creep of Virgin Lead

TABLE I.—Long Time Creep Tests on Virgin Lead Specimens at Room Temperature.

Material.	Average Grain Area at Commencement of Test, mm. ² .	Stress, lb./in. ² .	Life, Days.	Extension, Per Cent. on 10 cm. B = Broken, U = Unbroken.	Reduction in Area, Per Cent.	Minimum Creep Rate, Strain/Day × 10 ⁴ .
Coarse-grained extruded rod. Specimens machined from 1½ in. diam. rod.	0.84	200	660	0.33 *	...	0.04
		300	942	2.0 U	...	0.17
		400	1482	21.0 U	...	0.72
		500	585	19.0 B	50	1.44
		600	210	24.0 B	72	4.17
		700	66	30.5 B	97	13.8
Fine-grained extruded rod. Specimens machined from 1½ in. diam. rod.	0.01	500	311	87 U	94	10.6
		600	70	60 B	98.5	47.7
Extruded cable-sheath	0.37	500	384	15.3 U	...	2.03
		600	89	20.0 *	...	12.58
Flattened cable-sheath	0.16	500	327	29.0 B	...	1.70
		600	69	25.0 B	...	10.0
Extruded pipe	0.14	500	330	17.6 U	...	3.9
Extruded pipe bent on former of 22 in. diam. and straightened.	0.11-0.15	500	230	11.3 U	...	...

* Test discontinued.

will be seen that at the two low stresses the specimens have not been sufficiently long under test to have reached the stage of minimum creep rate. In fact it seems possible that a period of 10-15 yrs. will have to elapse before the specimen at 300 lb./in.² reaches this stage in the test.

(b) *Tests on virgin lead cable-sheath.*—Virgin lead cable-sheath having an outer diameter of 1 in. and a wall thickness of ⅓ in. was extruded under ordinary conditions but in straight lengths and without any cable core. This material was tested in the two conditions: (1) as sheath and (2) after flattening. The tests were made with two objects in view: (a) to determine if the rate of creep of an extruded pipe specimen was of the same order as that of an extruded rod, and (b) to determine the effect of flattening the sheath on its creep characteristics. The specimens tested as sheath were fitted with a type of end shown in Fig. 6 (a), and some preliminary work showed that the effect of the heating produced during the casting of the ends did not extend to more than 1 in. beyond the inner parts of the ends. To make certain that no such

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effect would influence the test results the gauge length of 10 cm. on each specimen was taken at a distance of 3 in. from the end holders.

The flattened specimens were produced by slitting a length of the sheath longitudinally, opening it out uniformly by hand and then applying the flattening by squeezing between two planed boards in a vice. The specimen shown in Fig. 6 (b) was then machined from the flattened sheath and gripped as shown. Two stresses only were used in these tests, namely, 500 and 600 lb./in.², and the creep curves obtained

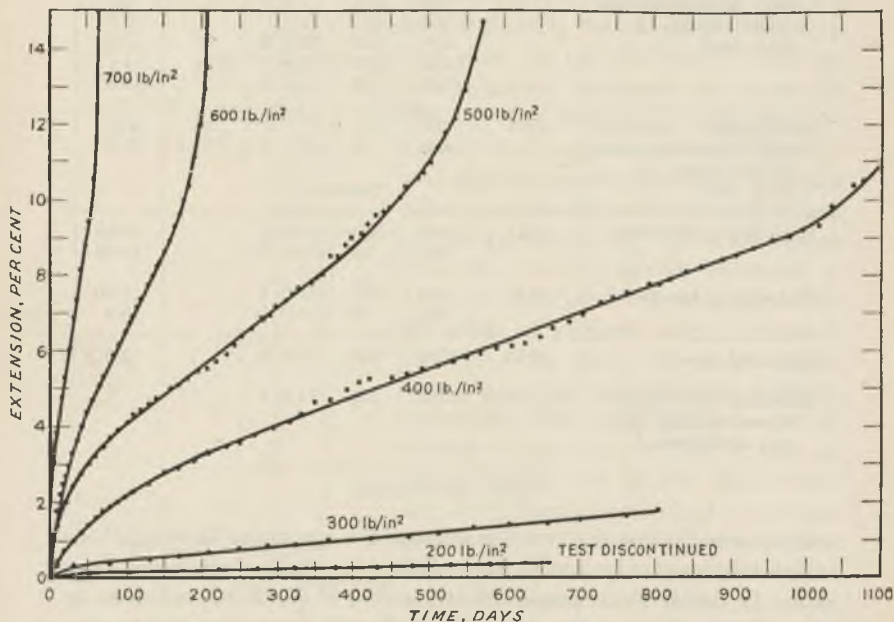


FIG. 3.—Tensile Creep Tests on Specimens of Coarse-Grained Extruded Rod at Room Temperature.

are shown in Fig. 7, the results being given in Table I. A third sheath specimen was tested at 500 lb./in.² after it had been annealed for 2 hrs. at 100° C. The original sheath had an average grain area of 0.37 mm.². Annealing for 2 hrs. at 100° C. produced an average grain area of 0.49 mm.², while annealing for 2 hrs. at 250° C. produced an average grain area of 1.8 mm.².

The effect on the creep characteristics of the flattening process is clearly shown in Fig. 7. The creep rate was reduced by the working produced in the flattening and during the two initial stages of the creep test, *i.e.* up to the stage of final rapid and increasing creep rate, the

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extension of the flattened specimen was less than that of the sheath at the same stress. The refinement in grain-size brought about by flattening the sheath is indicated in Table I.

As shown in Fig. 7, the sheath specimen tested at 500 lb./in.² after annealing for 2 hrs. at 100° C. has given a type of creep curve entirely

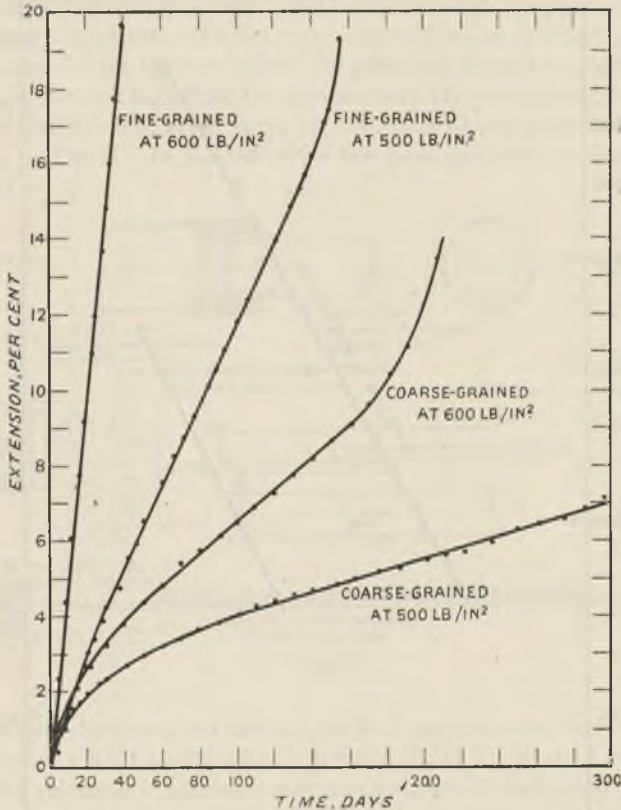


FIG. 4.—Tensile Creep Tests at Room Temperature on Coarse- and Fine-Grained Extruded Rods.

different from that of the extruded or flattened specimens. The primary stage of rapid but decreasing rate of creep is absent in the annealed specimen, and a very decided change in the rate of creep occurred about 35–40 days after the commencement of the test. The creep rate between 50 and 190 days was fairly constant and was higher than that of the “as extruded” specimen at the same stress.

An examination of Table I shows that at stresses of 500 and 600

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lb./in.² both sheath and flattened sheath specimens have a higher minimum creep rate than the rod specimens. In the case of the sheath specimens this is probably due to the finer grain-size alone. On the count of grain-size alone one would expect flattened sheath specimens

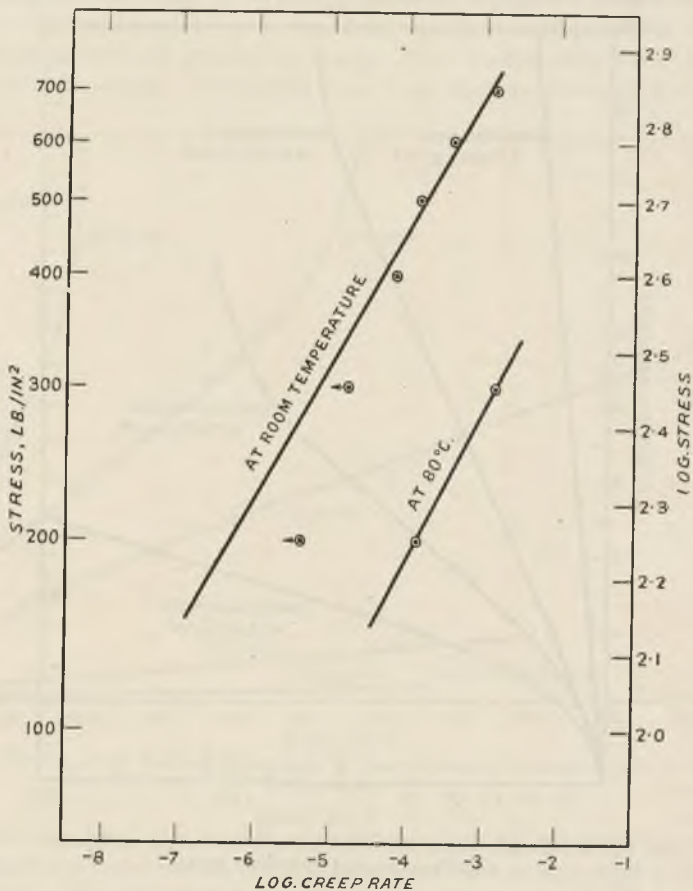


FIG. 5.—Tensile Creep Tests on Coarse-Grained Extruded Rods.

to have a higher minimum creep rate than they have given and certainly a higher creep rate than the sheath specimens. It appears from the results that grain-size is not the only factor influencing minimum creep rate in these materials, and that the effect of working produced in the flattening process is to stiffen the material and increase its resistance to creep.

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(c) *Tests on extruded pipes.*—Virgin lead pipe ($\frac{1}{2}$ in. bore \times 6 lb./yd.) which was specially extruded in straight lengths was obtained for these tests. The specimens were loaded longitudinally, an end grip of the form used for the cable-sheath specimens and shown in Fig. 6 (a) being employed.

A test at a stress of 500 lb./in.² was made on the pipe in the “as received” condition, and the creep curve obtained is shown in Fig. 8. The shape of the curve is typical for extruded virgin lead, but the rate of creep is much higher for the pipe material than for the coarse-grained rod material. The creep curve for the latter at the same stress is also given in Fig. 8. In the curve for the pipe specimen another feature

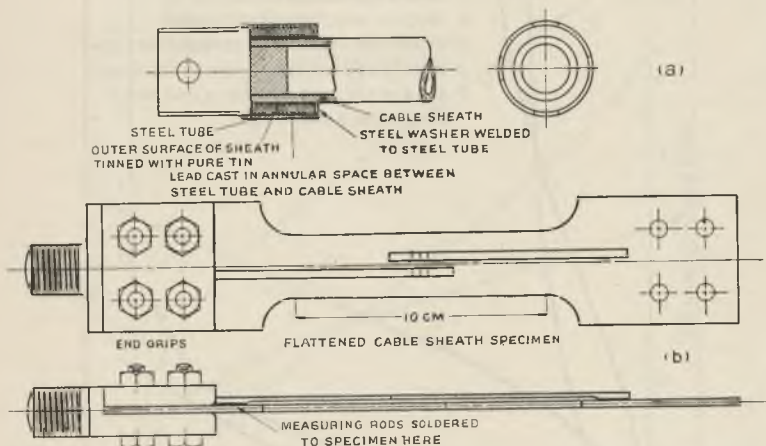


FIG. 6.

which may be noted is that the stage of uniform creep rate does not commence until the extension is between 8 and 9 per cent., whereas in the rod specimen it commences at an extension of 4 per cent.

As lead pipe is generally supplied in coils, and has to be uncoiled before being used, it was considered that a test on a specimen which had been subjected to somewhat similar treatment would be of interest. Accordingly a length of the straight pipe was bent to the arc of a circle on a former having a diameter of 22 in. (the usual diameter of coils of pipe of this bore and weight) and then straightened uniformly by hand. It is clearly recognized that this procedure does not exactly reproduce the conditions met with in ordinary coiled pipe, where the original coiling is done while the pipe is still hot from the extrusion press and the uncoiling and straightening are done some considerable time later when

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the pipe has had time to recover at room temperature by slow recrystallization. The method was adopted mainly to enable fairly straight specimens to be obtained, a difficult matter when a length of pipe coiled in the works was used.

A trial length of the pipe was bent and straightened and a section cut out of the middle and prepared for microexamination. When

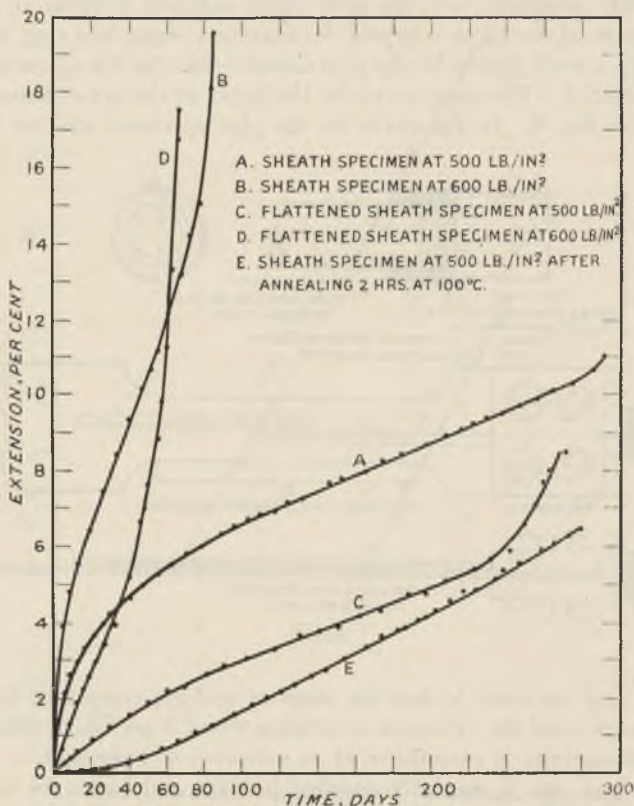


FIG. 7.—Tensile Creep Tests at Room Temperature on Cable-Sheaths.

examined 4 hrs. after bending and straightening it was found that in the diametrically opposite zones of maximum bending stress the average grain-size was 0.11 mm.², compared with the original 0.14 mm.², but there was no evidence of recrystallization. In the diametrically opposite zones of zero bending stress no change in grain-size had occurred and there was no evidence of recrystallization or working. The same specimen, when examined 15 days later, showed an irregular grain-size

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in the zones of maximum bending stress, and the average grain area was practically unaltered.

The creep specimen was first bent and immediately straightened, then fitted with ends and loaded at 500 lb./in.² about 4 hrs. after bending and straightening. The creep curve obtained from this specimen is shown in Fig. 8, and is remarkable in that the initial stage of rapid but diminishing creep is absent.

The curve so far consists of two stages, an initial stage of uniform rate of creep for the first 30 days, followed by a second stage of uniform

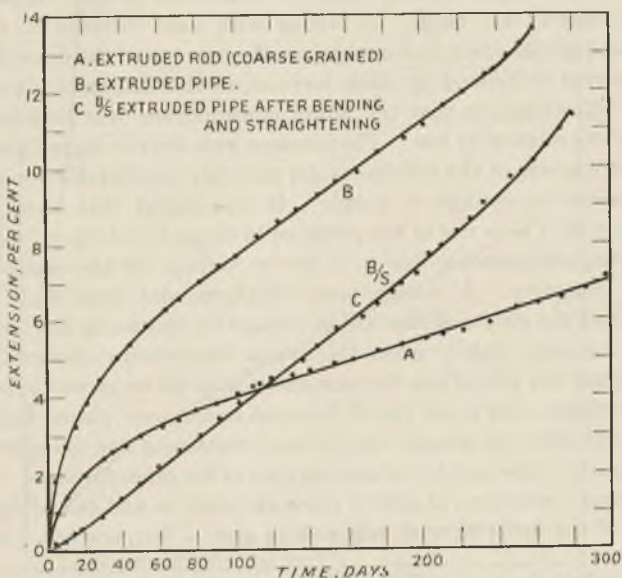


FIG. 8.—Tensile Creep Tests at Room Temperature and at 500 lb./in.².

but higher creep rate. There is a fairly abrupt change in the direction of the curve about 32 days from the commencement of the test. Very slight change has occurred in the minimum creep rate as a result of the bending and straightening.

(2) Long Time Creep Tests at 80° C.

Lead pipe may be used to carry water at temperatures up to 100° C.; lead used in sulphuric acid plant is frequently subjected to a temperature in the region of 80° C., and lead cable-sheath may be used at temperatures round about 50° C. In view of this it was decided to carry out some tests at 80° C. to determine the effect of temperature

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on the rate of creep, the elongation and the life of specimens of virgin lead.

The specimens used in these tests were made from $1\frac{1}{4}$ in. diam. bar of the coarse-grained material to the same dimensions as the specimens shown in Fig. 1. The measuring bars B.B. were replaced by brass bars extending beyond the end of the furnace, and the extension was measured by the separation of fine lines scribed on platinum foil soldered at the ends of these brass bars.

Tubular wire-wound electric furnaces were used, the winding being of 30 S.W.G. Brightray wire and the resistance of each furnace was approximately 800 ohms. In series with each furnace a variable resistance of 220 ohms was used to set the current at the desired value. The current consumed by each furnace on the 220 volts circuit was about 0.23 amps., so that the power consumption over long intervals of time was reasonably low. The furnaces were heavily lagged and hence the temperature of the specimens did not vary appreciably for average fluctuations in voltage of supply. It was found that there was a tendency for a slow rise of temperature to occur about 5 p.m. each day, this being undoubtedly due to a rise in voltage on the mains of the supply company. A simple form of thermostat was made up to counteract the effects of this rise in voltage by increasing the resistance of the furnaces slightly when the rise in temperature occurred. The thermostat was placed in a furnace identical in all ways with one of the creep furnaces, and as all the 15 furnaces in use were placed in parallel across the 220-volt supply the furnace containing the thermostat reacted in the same way to voltage changes as the other furnaces. It was found that a resistance of only 3 ohms switched in and out of the main circuit of the furnaces was sufficient to give a temperature control of $\pm 2^{\circ}$ C.

Determination of temperatures on different parts of the specimen showed that the extreme ends where the specimen was screwed into the shackles were about 3° C. lower than the centre of the gauge length.

The variable temperature junction of an iron Eureka thermo-couple was enclosed in fine glass tubing and placed so as to touch the centre of the parallel length of the specimen. A special timing switch was used to connect each of the 15 couples at regular intervals to the circuit of a three-thread Cambridge recorder, and a record of temperature of each specimen was obtained every 23 minutes.

The procedure adopted in commencing a test was as follows: the furnace was switched on about 9.30 a.m., and the temperature of the specimen had reached 80° C. about 2 p.m. About 2 hrs. were taken to steady the temperature at this figure and the load was then applied,

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the readings on the cathetometer of the scribed lines on the platinum foil being taken immediately before and after the application of the load.

Creep curves at 300, 200, and 100 lb./in.² are shown in Fig. 9, and it is seen that the rate of creep diminishes very rapidly with diminishing stress. The curve obtained at 300 lb./in.² is a typical form, *i.e.* a primary stage of rapid but diminishing rate of creep followed by a stage of sensibly constant rate of creep, then a third stage of rapidly increasing rate of creep progressing towards failure of the specimen. At 100

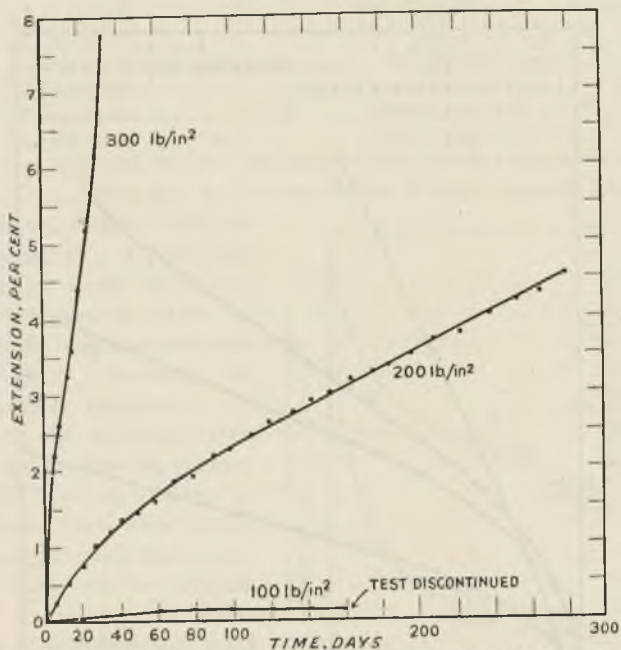


FIG. 9.—Tensile Creep Tests at 80° C. on Coarse-Grained Extruded Rod. Specimens Machined from 1½-in. diam. Rod.

lb./in.² the amount of creep for the first 45 days was only 0.13 per cent., and no further creep took place up to 150 days, when the test was discontinued.

The creep rates have been plotted on Fig. 5, and so far as one can judge from only two points the tests at 80° C. give a line parallel to that given by the tests at room temperature when logarithm of creep rate is plotted against logarithm of stress.

Only the specimen stressed at 300 lb./in.² at 80° C. has broken up to date, its life was 48 days, the elongation 34 per cent. on 10 cm. (approximately $8\sqrt{A}$) and the reduction in area 100 per cent.

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(3) Effect of Long Time Annealing at 80° C. on a Specimen of Virgin Lead.

A disc was cut from the 1½ in. diam. coarse-grained rod, and a photomicrograph taken in the "as received" condition. The specimen was then placed inside one of the creep furnaces and held at 80° C. for a total time of 500 hrs., examination of the grain-size being made at 24, 100, 250, and 500 hrs. No change in grain-size occurred, nor was there any other evidence of change in this specimen.

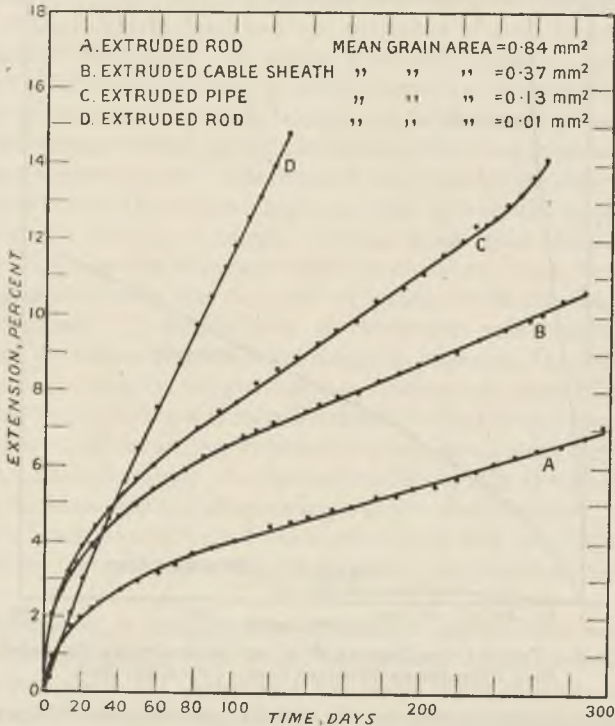


Fig. 10.—Tensile Creep Tests at Room Temperature. Effect of Grain-Size. Stress = 500 lb./in.².

GENERAL DISCUSSION OF THE RESULTS OF THE TESTS.

(a) Effect of Grain-Size on Creep of Lead in the "As Extruded" Condition.

In Fig. 10 the creep curves at 500 lb./in.² of four specimens having different grain-sizes are shown, and the grain-sizes and some creep data are given in Table II. An examination of the figure and the table

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shows that the amount of creep in 100 days and the minimum creep rate are both directly dependent on the grain-size. It may be noted,

TABLE II.—*Grain-Size and Creep of Extruded Lead at a Stress of 500 lb./in.².*

Material.	Average Grain Area, mm. ² .	Minimum Creep Rate, Strain/Day × 10 ⁴ .	Amount of Creep in 100 Days, Per Cent.
1¼ in. diam. rod	0.01	10.6	11.8
½ in. bore × 6 lb./yd. pipe	0.14	3.9	7.7
1 in. outer diam. × ⅜ in. thick cable-sheath	0.37	2.03	6.65
1¼ in. diam. rod	0.84	1.44	4.05

however, that tests to show the higher resistance to creep of the coarser-grained specimens had to be carried out beyond a period of 40 days before conclusive evidence was obtained. All the four specimens dealt with here have been tested in the "as extruded" condition without subsequent thermal or mechanical treatment.

In Fig. 11 the minimum creep rate and the amount of creep in 100 days at a stress of 500 lb./in.² have been plotted against the mean grain area, and these curves indicate that decreasing the mean grain area below 0.1 mm.² decreases very seriously the resistance to creep; this, of course, refers to grain-size produced by extrusion alone. The curves also indicate

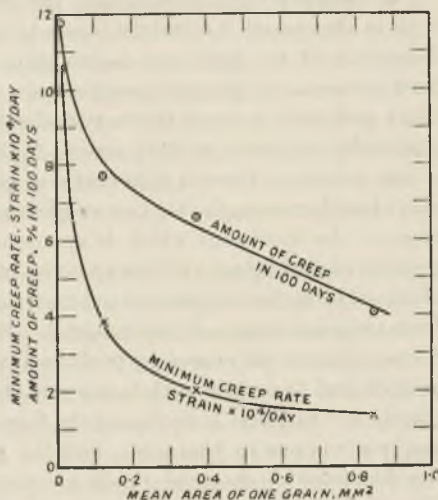


FIG. 11.—Tensile Creep Tests at Room Temperature. Effect of Grain-Size. Stress = 500 lb./in.².

that the rate of increase of resistance to creep with increase of grain-size becomes less marked as the mean grain area increases above ½ mm.².

Clark and White⁹ tested hot-rolled brasses of two different grain-sizes in creep at different temperatures, and found that for a given alloy the fine-grain brass was more resistant to creep than the coarse-grain below a certain temperature range, but above this range the coarse-grained material was the more resistant to creep. Since the materials

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were known to differ only in respect to their grain-size and, therefore, only in respect to the relative amounts of boundary and crystalline material, it was concluded that above this temperature range the boundary material was the weaker and below this temperature range the crystalline material was the weaker.

It was then found that this temperature range was the lowest temperature of recrystallization of the material after severe cold-working. It therefore appeared that the "equi-cohesive" temperature was coincident with the lowest temperature of recrystallization.

The observed fact that above a certain temperature the fine-grained material creeps more rapidly than the coarse-grained material is in accord with the early theories of Beilby and Rosenhain, who attributed viscous properties to boundary materials above the equi-cohesive temperature. It therefore appears that above this temperature creep may be considered as a form of viscous flow.

If we apply this conception to the case of the extruded leads dealt with in this paper it certainly seems to explain the differences in creep behaviour of the fine- and coarse-grained materials. The tests have been carried out at room temperature which, for the very pure lead dealt with here, is above the recrystallization temperature of the worked materials, and hence we may assume that the crystal boundary material is the weaker. Certain observations made during the tests confirm this view, for example, (1) the roughening or strain etching of the surfaces of the specimens which is apparently brought about by relative movement of the grains within a viscous matrix, (2) the higher elongation obtained from the fine-grained rod material compared with that obtained from the coarse-grained rod material. Further, the observed fact that the elongation of coarse-grained lead increases, while that of fine-grained lead decreases, with increase of stress, is explained by this view. Clearly as the stress is increased the flow tends to become more plastic and less viscous in character, but the greater end-blocking effect in the fine-grained material tends to minimize the increase in plastic flow, the net effect being that in the fine-grained material the boundary movement decreases more rapidly than the plastic deformation increases, while in the coarse-grained lead the plastic deformation increases more rapidly than the boundary movement decreases, with increase of stress.

It appears certain that throughout any of these creep tests both plastic and viscous flow are occurring, the former predominating in the early stage of the test. In this respect reference may be made to the work of Andrade¹⁰ on lead. He considered that in a creep test at constant stress on a lead wire the flow was made up of two parts:

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(1) the plastic, or, to use his own expression, the β flow, and (2) the purely viscous flow.

Andrade suggested a formula to represent the flow of lead under creep conditions :

$$l = l_0 (1 + \beta t^{\frac{1}{2}}) e^{kt}$$

where l is the length at any time t , the initial length being l_0 , β and k being constants. An attempt has been made to fit this formula to the curves in Fig. 10, but this has not been very successful, due to two causes. In the first place the curves in Fig. 10 were not obtained at constant stress. Further, Andrade suggested that in his formula $t^{\frac{1}{2}}$ should probably be replaced by a function of t , which approximates closely to $t^{\frac{1}{2}}$ for small values of t but which, as t increases, ultimately becomes constant.

(b) Effect of Cold-Working on Creep.

If in an extruded lead a change in grain-size is brought about by a small amount of cold-work in specimens prior to the creep tests being commenced, the relation between grain-size and resistance is no longer a simple one. Thus, flattening cable-sheath produced some slight refinement in grain-size but increased the resistance to creep in the early stages of the test. Bending and straightening of pipe produced in the zones of maximum bending stress slight refinement of grain-size, but, once more, the resistance to creep in the early stages of the test was increased.

In his work on lead wires already referred to, Andrade has shown that large preliminary strains put the wires in a state to flow viscously, and the present tests on flattened cable-sheath and bent and straightened pipes confirm this statement. The effect of such working is much more pronounced in the early stage of the test than during the stage of uniform creep, *i.e.* the stage where viscous flow always predominates. In this respect it may be noted that the bending and straightening of the pipe has apparently a greater effect in promoting viscous flow than had the flattening of the cable-sheath, for, in the former case, the initial stage of mainly plastic flow is missing, and the creep curve obtained has the characteristic shape associated with purely viscous flow.

The curves given in Fig. 12 show very clearly the effect of preliminary cold-working on the subsequent creep characteristics of a specimen of the coarse-grained rod. The curve *A* is the creep curve at 600 lb./in.² of a specimen tested in the "as extruded" condition. The curve *B* is the creep curve of a specimen which was elongated in tension 5 per cent. on the gauge-length and then tested in creep under a load which would have produced a stress of 600 lb./in.² on the cross-sectional area of the

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specimen before overstrain. The latter specimen has given a creep curve in which the early stage of the ordinary creep curve, considered to be due mainly to plastic deformation, is absent. It seems probable, therefore, that the curve obtained from the overstrained specimen represents flow largely viscous in character.

A similar specimen elongated 5 per cent. in tension, sectioned and aged at room temperature, was found 15 minutes later to have a grain-size approximately $\frac{1}{2}$ that before working. Later very slight recrystal-

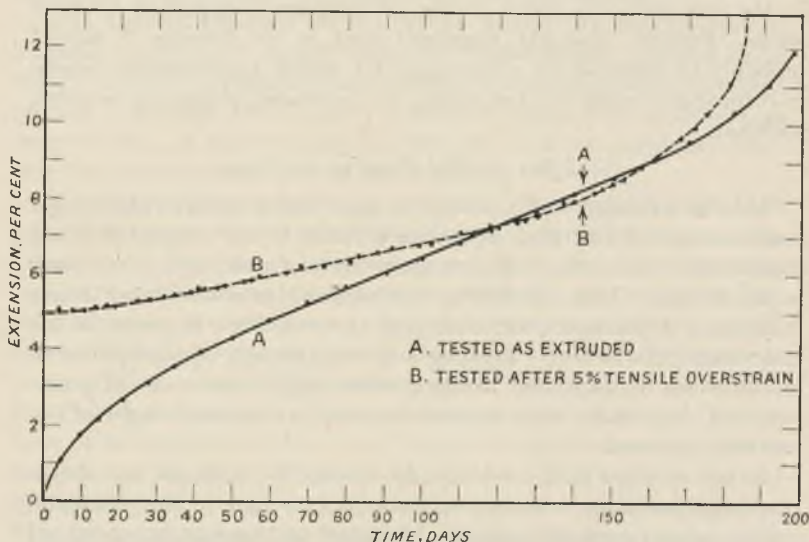


FIG. 12.—Tensile Creep Tests at Room Temperature on Coarse-Grained Extruded Rod. Stress = 600 lb./in.².

lization was detected, but the further grain refinement was small. It is of interest to note that while the minimum creep rate of the original material was 4.17×10^{-4} strain per day the creep rate of the overstrained material was 2.0×10^{-4} strain per day and the relative mean grain areas 0.84 and 0.46 mm.², respectively. It would appear, therefore, that in this test as also in the tests on the flattened cable-sheath and the bent and straightened pipe specimens, the effect of the cold-working in increasing resistance to creep is much more pronounced than the decrease in creep resistance which would be expected as a result of the reduction in grain-size.

The overstrained specimen had a life of 186 days and a total extension (including the original 5 per cent. overstrain) of 30 per cent. A cross-section was taken on the parallel length away from the fracture within

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a few hours of failure, and a grain count gave the mean grain area as 0.42 mm.^2 . From this it appears probable that the grain-size had not altered appreciably during the creep test, and if this be so it tends to confirm the statement that the flow occurring during the test was mainly at the grain boundaries. Specimens of this lead which had been rapidly overstrained $12\frac{1}{2}$ per cent. in tension were found to have completely recrystallized within 1 hr. The creep specimen on the other hand had at the commencement of the creep test an average grain-size of 0.46 mm.^2 , during the test was stretched much more than 12.5 per cent. in tension, but had not recrystallized. This suggests that during the creep test the plastic deformation within the grains was insufficient to bring about recrystallization, and that the movement which did occur took place at the grain boundaries.

Intercrystalline Cracking of Lead.

In several of the specimens tested in creep at low stresses intercrystalline cracking has been clearly observed. It has been mentioned previously that during a test the grain boundaries show on the surface of the specimen after an extension of approximately 3 per cent. At a later stage in the test some of the grain boundaries have been observed to open in the form of deep cracks, with a separation of adjacent grains. This has been observed most clearly in the coarse-grained specimens at stresses of 400 and 500 lb./in.² and also in the specimen overstrained 5 per cent. before testing. Intercrystalline cracking of lead may thus occur under steady stress conditions (creep) as well as under the influence of alternating stresses.

In a recent paper by J. N. Greenwood,¹¹ intercrystalline cracking under creep conditions of a specimen of lead sheet at a stress of 500 lb./in.² has been referred to and illustrated.

It is clearly recognized that the work recorded here is by no means exhaustive, and further investigation of the creep of lead is proceeding. The work done has shown the very great importance of a complete knowledge of the history of the materials tested, and in this connection it may be noted that a very extensive research is being carried out in the University of Melbourne under the direction of Professor J. N. Greenwood.¹² This work, details of which have very recently come to hand, aims at a complete investigation of the effect of small amounts of impurities on the mechanical properties of lead with particular reference to recrystallization, grain-size, and creep characteristics. This work and the work of the present author have shown the problem to be a very complex one, but it is felt that a thorough investigation of the effect of previous thermal and mechanical history on the creep characteristics

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of lead at room temperature will materially assist in the elucidation of the many problems presented by the study of creep in other materials at elevated temperatures.

ACKNOWLEDGMENTS.

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THE CONSTITUTION OF SILVER-RICH ANTIMONY-SILVER ALLOYS.*

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SYNOPSIS.

The liquidus curve of the system silver-antimony is determined accurately in the range 0-25 atomic per cent. of antimony. A new peritectic horizontal is found at 702.5°C. , at which temperature the α solid solution reacts with the liquid to form the β solid solution which has a close-packed hexagonal structure. The phase boundaries of the α and β solid solutions are determined accurately at temperatures above 300°C. The general form of the diagram when drawn in terms of electron concentration resembles that of the system silver-tin. The critical points determined are examined from the point of view of Stockdale's theory of integral atomic ratios.

I.—INTRODUCTION.

THE system silver-antimony was investigated by Petrenko¹ whose equilibrium diagram indicates that the solid phases consist of a silver-rich solid solution containing up to 15 per cent. by weight of antimony, a compound Ag_3Sb , and pure antimony. By means of X-ray crystal analysis, Westgren, Hägg, and Eriksson,² and Broderick and Ehret³ showed that a phase with a close-packed hexagonal structure exists between the compound Ag_3Sb and the α -solid solution, a fact which had been indicated by the electrolytic solution potential measurements of Raeder.⁴ This new phase may be denoted $\beta\beta$, and the present paper describes a detailed investigation of the phase boundaries in the α and β regions.

II.—EXPERIMENTAL

(a) *Materials Used.*

The silver used was electrolytic silver grain supplied by Messrs. Johnson, Matthey & Co., Ltd., and was of a purity of 99.997 per cent. The antimony was kindly presented by Messrs. The Cookson Lead and

* Manuscript received September 9, 1936.

† Jesus College, Oxford.

‡ Royal Society Warren Research Fellow, Oxford.

§ The X-ray investigators call this phase ϵ , and use the symbol ϵ' for the Ag_3Sb phase. Apart from the possible confusion between ϵ and ϵ' , this nomenclature obscures the close resemblance of the β phases in the systems silver-tin and silver-antimony.

Note to Abstractors and Other Readers.—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LX, 1937. Reference should accordingly be as follows: *J. Inst. Metals*, 1937, 60 (Advance copy).

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Antimony Co., Ltd., and was of 99.917 per cent. purity, the chief impurities being iron 0.041, lead 0.025, and copper 0.012 per cent.

(b) Cooling Curve Technique.

The cooling curves were taken by a method developed for the accurate determination of freezing point depressions. The details of the technique are being published elsewhere.⁵ The method consisted essentially in melting 120 gm. of silver under powdered charcoal in a cylindrical graphite crucible provided with a graphite lid in which holes were bored for the admission of a thin silica thermocouple sheath, a silica stirrer, and a thin silica tube by means of which a small sample of the alloy could be removed. After adding the antimony with thorough stirring of the molten alloy, the current through the electrically-heated crucible furnace was adjusted so as to give a rate of cooling of not more than 2° C. per minute at the arrest point. As the temperature approached that of the expected liquidus point, a small sample of the alloy was sucked up the silica tube and removed for analysis; in this way difficulties caused by segregation in the final solid ingot* were avoided, and the composition of the melt a few minutes before the beginning of crystallization was readily determined. The alloy was thoroughly stirred throughout the determinations of the arrest points. It was then reheated, and more antimony was added for the next experiment. Four additional points are included in which the composition was determined from the weights of metals used.

The temperatures were measured by means of a platinum/platinum-rhodium (13%) thermocouple in conjunction with a Carpenter-Stansfield potentiometer of double the usual sensitivity, the coils of which had been accurately calibrated at the National Physical Laboratory. By using strictly standardized conditions, and taking a number of precautions in the potentiometer adjustments, it has been possible to obtain an accuracy of $\pm 0.3^\circ$ C. for the freezing points of alloys which show pronounced arrests.

In the present system, a change of 0.1 per cent. in composition is equivalent to roughly 1° C. in the liquidus temperature, so that the accuracy of the liquidus curve is limited more by the precision with which the exact composition of the alloy can be determined, than by the accuracy with which the arrest point can be measured.

* Experience shows that errors of several per cent. may be introduced if the composition is determined by the analysis of portions of the final ingot, and this error may be accentuated if the alloy is stirred, since the stirring may cause agglomeration of the first portions to solidify.

It has been found that the method of determining the composition of the melt by sampling is liable to give slightly high results for some silver alloys, because the sample is sometimes very slightly richer in the solute element than the melt from which it is taken. For this reason four liquidus points based on synthetic compositions are included in Table I, and marked †. These are very slightly below those obtained by the method of sampling. This discrepancy between the results based on analysis, and on synthetic compositions has been thoroughly investigated, and is fully discussed in the paper referred to above.⁵ For the points based on synthetic compositions, the composition is considered exact, and the results accurate to $\pm 0.3^\circ$ C. For the remaining points it is considered that the errors do not exceed the limits ($+ 0.9^\circ$ C.); by this notation it is meant that the values are not more than 0.9° too high, and not more than 0.4° too low. All temperatures were deduced from the measured electromotive force of the thermocouple by means of deviation graphs from the table of Roeser and Wensel,⁷ and the *absolute values*, as distinct from the relative accuracy, therefore depend on those of Roeser and Wensel.

(c) *Preparation of Alloys for Annealing and Quenching Experiments.*

The alloys were prepared in quantities of approximately 20 gm. by melting the two metals under charcoal in small Salamander crucibles, and were cast in $\frac{1}{4}$ -in. diameter sand moulds in order to reduce inverse segregation which was then small, and insufficient to interfere with the results.

(d) *Annealing and Quenching Experiments.*

The alloys were annealed in evacuated hard glass tubes, and were quenched in water. For short anneals, the temperature was kept constant within $\pm 0.3^\circ$ C. by hand control, whilst for the long anneals use was made of Foster temperature regulators which maintained the furnace temperatures constant to within $\pm 1.5^\circ$ C. The general arrangements have already been described.⁶

(e) *Calibration of Thermocouple.*

All temperatures were measured by a platinum/platinum-(13% rhodium) thermocouple standardized against the freezing points of silver (960.5° C.), copper-silver eutectic (778.8° C.), pure aluminium (659° C.), and zinc (419.5° C.). Intermediate temperatures were obtained by means of a deviation graph from the table of Roeser and Wensel.⁷

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(f) *Microscopic Examination and Etching Reagents.*

Alloys consisting of the β -phase were very brittle, the individual crystals showing a great tendency to fall apart, but this difficulty was overcome by careful hand sawing and grinding. The twinned crystalline structure of the α -phase was best revealed by etching with a mixture of chromic and sulphuric acids, whilst the presence of chilled liquid in this phase was shown by etching with ammonia and hydrogen peroxide, which revealed the structure of the α -phase only after a long period, but attacked the chilled liquid more rapidly. The latter reagent was also suitable for the determination of the $\alpha/\alpha + \beta$, and $\alpha + \beta/\beta$ boundaries, the β -phase being revealed as a bluish or brownish constituent in contrast to the white α . The structure of the β -phase was best revealed by a mixture of nitric and chromic acids, which was also suitable for the determination of the β solidus, and the $\beta/\beta + \gamma$ solubility curve.

(g) *Analysis.*

All the specimens from the cooling curve experiments, and all the critical specimens near the phase boundaries were analyzed, both silver and antimony being determined. After dissolving the alloy in sulphuric acid, the silver was precipitated as chloride by means of hydrochloric acid. The silver chloride was then filtered off and weighed, and the antimony determined by titration with permanganate after the addition of the required amount of hydrochloric acid. As shown by Pugh,⁸ the success of this method depends on the correct adjustment of the relative amounts of sulphuric and hydrochloric acids present. Under the required conditions the standardization of the permanganate by metallic antimony agreed exactly with that by sodium oxalate, and the sums of the percentages of silver and antimony as determined by analysis varied between 99.96 and 100.04.

III.—EXPERIMENTAL RESULTS.

The results of the cooling curve experiments are given in Table I, whilst the critical annealing experiments on either side of the phase boundaries are shown in Table II. The full details of the additional annealing experiments which confirm these results are submitted for deposition in the library of the Institute.* The data included in the Tables, as well as the results of the additional experiments, are shown in Fig. 1,† which is almost self-explanatory.

* These tables may be consulted in the Institute's library.

† The liquidus points for alloys 9 and 11 are not shown in the figure.

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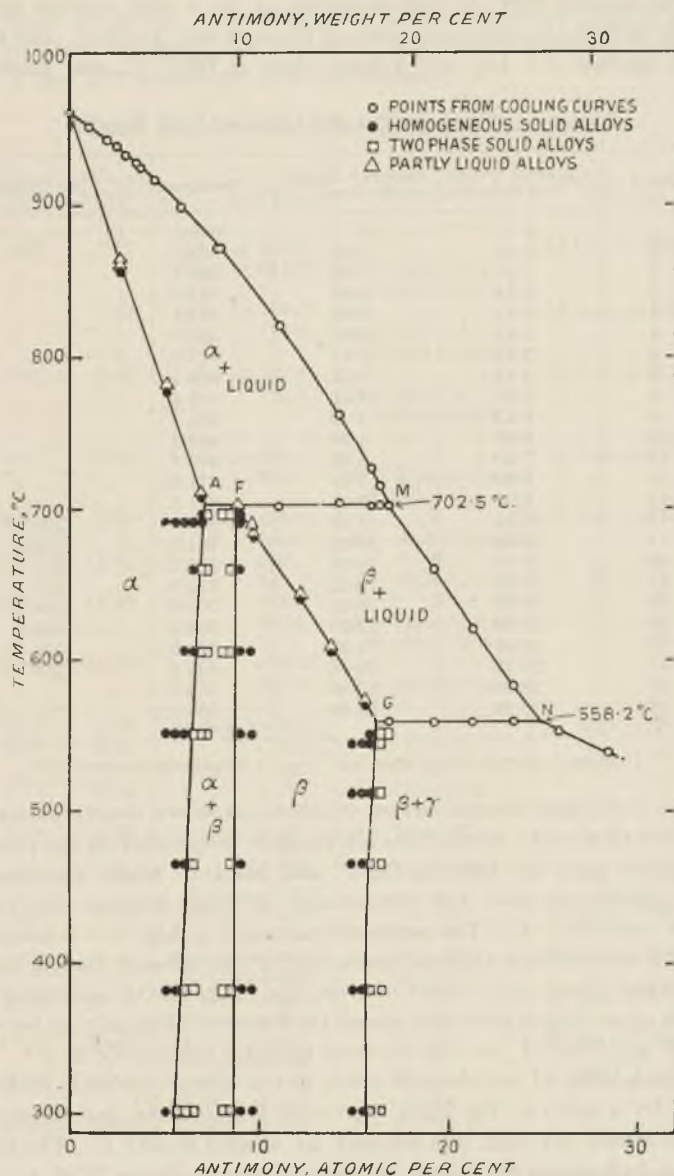


FIG. 1 (see footnote to p. 648).

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The liquidus curve for the deposition of the α solid solution agrees closely with the freezing point data of Heycock and Neville.⁹ The peritectic reaction $\alpha + \text{Liq.} \rightleftharpoons \beta$ takes place at 702.5° C., and produces

TABLE I.—*The Liquidus and Cooling Curve Results.*

No.	Antimony, Weight Per Cent.	Antimony, Atomic Per Cent.	1st Arrest.	2nd Arrest.
...	0	0	960.5	...
1	1.13	1.00	951.5	...
2	2.16 †	1.92	942.7	...
3	2.24	1.99	942.5	...
4	2.81	2.50	937.1	...
5	3.35	2.98	932.5	...
6	3.94	3.51	927.6	...
7	4.21 †	3.75	924.1	...
8	5.06	4.51	916.4	...
9	6.11 †	5.45	905.1	...
10	6.66	5.95	898.2	...
11	7.40 †	6.62	889.8	...
12	8.80	7.88	871.3	...
13	8.95	8.01	871.5	...
14	12.35	11.10	820.0	700.9 *
15	15.84	14.29	761.2	703.0
16	17.70	16.00	725.7	701.7
17	18.15	16.42	714.8	702.2
18	18.69	16.92	700.9	558.2
19	21.26	19.30	659.4	558.0
20	23.41	21.31	619.9	558.4
21	25.73	23.48	582.4	558.1
22	28.25	25.86	552.9	...
23	30.98	28.45	538.5	...

* Unstirred, stirrer firmly fixed in.

† Synthetic compositions.

only a very slight thermal arrest, which is not shown clearly unless the alloy is well stirred. In the three alloys where proper stirring was possible the arrest point lay between 701.7° and 703.0° C., whilst the quenching experiments gave the temperature as lying between the limits 702.0° and 703.1° C. The peritectic reaction $\beta + \text{Liq.} \rightleftharpoons \gamma$ produced a much more definite thermal arrest, and in four different cooling curves the arrest points only varied between the limits 558.0° and 558.4° C., whilst quenching experiments placed the horizontal line as lying between 557.9° and 558.5° C., so that the most probable value is 558.2° C.* The solid solubility of antimony in silver is 7.2 atomic per cent. (8.05 per cent. by weight) at the 702.5° peritectic temperature, and diminishes to 5.5 atomic per cent. (6.2 per cent. by weight) at 300° C. The limits of the β -phase are 8.8 atomic per cent. antimony at the 702.5° C. peritectic temperature, and 16.3 atomic per cent. antimony at the 558.2° C.

* The values given by Petrenko lie between 557° and 562° C.

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peritectic horizontal. The range of solubility diminishes slightly as the temperature decreases, and at 300° C. the β solid solubility limits are at 8.6 and 15.6 atomic per cent. of antimony.

TABLE II.—*Annealing and Quenching Experiments.*

Antimony, Weight Per Cent.	Antimony, Atomic Per Cent.	Time and Temperature (° C.) of Final Anneal.	Microstructure.	Previous Annealing Treatment.
3.00	2.67	$\frac{1}{2}$ hr. at 856.3°.	α	24 hrs. at 700° C.
"	"	1 hr. at 861.3°.	α + trace of chilled liquid.	" "
5.71	5.09	$\frac{3}{4}$ hr. at 776.8°.	α	2 $\frac{1}{2}$ days at 650° C.
"	"	" 779.9°.	α + trace of chilled liquid.	" "
7.82	6.99	1 hr. at 707.3°.	α	5 $\frac{1}{2}$ days at 691° C.
"	"	" 710.5°.	α + trace of chilled liquid.	" "
9.98	8.94	1 hr. at 698.0°.	β	5 $\frac{1}{2}$ days at 691° C.
"	"	" 700°.	β + minute trace of chilled liquid.	" "
10.92	9.80	" 680.8°.	β	13 days at 525° C.
"	"	" 682.9°.	β + chilled liquid.	" "
13.57	12.21	" 640°.	β	" "
"	"	" 642.2°.	β + chilled liquid.	" "
15.39	13.88	" 605.2°.	β	" "
"	"	" 607.4°.	β + minute trace of chilled liquid.	" "
17.37	15.70	" 569.6°.	β	" "
"	"	" 572.0°.	β + chilled liquid.	" "
5.71	5.09	21 days at 302°.	α	5 $\frac{1}{2}$ days at 691° C.
6.27	5.60	" 302°.	α + β	" "
"	"	" 382°.	α	" "
6.76	6.04	" 382°.	α + trace of β .	" "
"	"	14 days at 465°.	α	" "
7.38	6.59	10 days at 551°.	α + trace of β .	" "
"	"	" 606°.	α	" "
7.88	7.04	5 days at 659°.	α + trace of β .	" "
"	"	5 $\frac{1}{2}$ days at 691°.	α	none.
8.18	7.32	3 days at 696°.	α + β	10 days at 606° C.
9.55	8.55	21 days at 302°.	α + β *	10 days at 606° C.
"	"	3 days at 696°.	α + β *	" "
10.08	9.03	21 days at 302°.	β	5 $\frac{1}{2}$ days at 691° C.
"	"	3 days at 696°.	β	" "
17.12	15.47	21 days at 302°.	β	10 days at 544° C.
"	"	10 days at 544°.	β	none.
17.56	15.88	14 days at 465°.	β + trace of γ .	10 days at 544° C.
"	"	10 days at 512°.	β	" "
18.22	16.48	10 days at 551°.	β + a little γ .	" "

* In these α + β alloys which lie near to the α + β/β boundary, the relative amount of the β phase increased slightly when the alloys which had previously been annealed at a high temperature were re-annealed at a lower temperature. This indicates that the α + β/β boundary in Fig. 1 is not vertical, but inclined slightly to the left at lower temperatures.

IV.—DISCUSSION.

In Fig. 2, the equilibrium diagrams of the silver-rich silver-tin and silver-antimony alloys are compared, the diagrams being drawn in terms of electron concentration. The β -phase in the system silver-tin has also a close-packed hexagonal structure,¹⁰ and it is clear that the two equilibrium diagrams resemble one another both as regards the higher peritectic temperatures, and the general form of the diagram. In both systems the composition corresponding with the electron concentration 1.5 lies near the centre of the β -phase area. In other alloy systems it is well known that phases with the body-centred cubic or β -manganese structures tend to occur at this electron concentration. The present work, therefore, confirms that the same electron concentration can also give rise to a group of close-packed hexagonal structures, since this structure at the electron concentration 1.5 is found also in the systems silver-indium,¹¹ copper-germanium,¹² and copper-gallium.¹³ The diagrams in Fig. 2 show that in terms of electron concentration both the $\alpha/\alpha + \beta$ and the $\alpha + \beta/\beta$ boundaries in the system silver-antimony are displaced in the direction of lower antimony content compared with those in the system silver-tin. The $\beta/\beta + \gamma$ boundary is displaced in the same direction at higher temperatures, but at lower temperatures this boundary gives a much narrower range of composition in the system silver-tin.

The phase boundaries in the present work were determined accurately and may be surveyed in the light of Stockdale's hypothesis¹⁴ that critical points occur at integral atomic ratios. The point *A* in Fig. 1 representing the limiting composition of the α -solid solution may be placed at 7.2 ± 0.1 atomic per cent. of antimony. This does not correspond with any simple ratio of numbers up to 12, but if numbers up to 24 are permitted, as in parts of Stockdale's paper, the ratio $\frac{1}{14} = 7.14$ per cent. agrees within the limits of experimental error. The point *F* representing the composition of the β -phase at the peritectic temperature lies at 8.8 ± 0.10 atomic per cent. of antimony, the nearest integral ratio being $\frac{2}{23} = 8.70$ per cent. The difference between these values is small, but the β solidus curve suggests that the point *F* corresponds with a slightly higher antimony content than that required by the ratio $\frac{2}{23}$. The point *G* representing the composition of the β -phase at the lower peritectic temperature may be placed at 16.3 ± 0.1 atomic per cent. antimony, and definitely differs from the ratio $\frac{1}{6} = 16.67$ per cent. which is the nearest ratio involving numbers up to 24. The same ratio appears definitely distinct from the composition of the point *M* on the liquidus which lies at 16.9–17.0 atomic per cent. anti-

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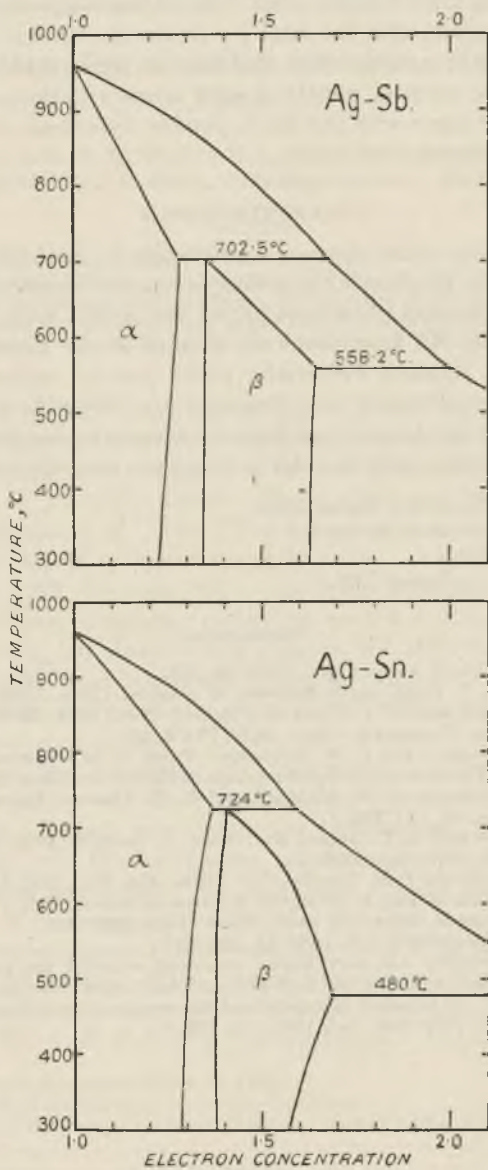


FIG. 2.

Silver-Rich Antimony-Silver Alloys

mony, but the lower liquidus point N lies at the composition 25.0 ± 0.1 which corresponds with the ratio $\frac{1}{4}$. Of the five critical points determined, it may be said, therefore, that only one corresponds with the ratio of small whole numbers, but the A point agrees with the ratio $\frac{1}{11}$. Two points do not agree with the whole number hypothesis, whilst for the fifth the conclusion is uncertain.

ACKNOWLEDGMENTS.

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THE OLD CHEMISTRY DEPARTMENT,
THE UNIVERSITY MUSEUM,
OXFORD.

August, 1936.

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- ¹³ Dr. A. J. Bradley has very kindly examined some of the present authors' CuGa alloys containing the β -phases, and has found close-packed hexagonal structures. It is hoped that details of this work will be published shortly.
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AN ALUMINIUM STATUE OF 1893: GILBERT'S "EROS."*

By PROFESSOR R. S. HUTTON,† M.A., D.Sc., FELLOW, and RICHARD SELIGMAN,‡ Ph.nat.D., PAST-PRESIDENT AND FELLOW.

SYNOPSIS.

The freedom from serious corrosion of the "Eros" statue in Piccadilly Circus, London, after 38 years' exposure and the fact that it is made of un-alloyed aluminium are recorded. Whether the metal used in 1893 was produced by the old chemical or new electrolytic process is undecided, but the results of analyses of specified examples of old aluminium are reported.

THOSE who took part in the Annual Dinner of the Institute in March, 1935, will remember the jocular suggestion of one speaker that a statue of a distinguished and popular member should be cast in aluminium and erected in Piccadilly Circus. The speaker was unaware that a statue in aluminium of "Eros" had formed part of the Shaftesbury Memorial in Piccadilly Circus for over 40 years!

In June, 1893, the memorial to the great philanthropist was unveiled—"the only aluminium monument erected in England . . . the work of a young, but already rising sculptor, Mr. Alfred Gilbert, R.A.," as Mr. H. R. Williams described it at the unveiling. At the same ceremony the Duke of Westminster spoke of "This beautiful work of art, which will not soon perish." It may well be asked how many metallurgists, with the knowledge of atmospheric corrosion phenomena available to-day, would have endorsed the opinion of the Duke of Westminster. Indeed, even before the year was out there were not wanting those who foresaw disaster, and in September, 1893, the late Edmund Gosse wrote that "the monument already looks dingy and decayed." We know now, however, that the Duke was right, and the imaginary metallurgists of 1893 would have been at fault.

During the building of the present Underground Station at Piccadilly Circus the statue was removed to, and subjected to cleansing at the foundry of Mr. A. B. Burton in Thames Ditton. Almost immediately

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after its re-erection the statue was damaged in a revel during the night of December 31, 1931, and had to be dismantled once more for repair.

The present authors thought that such an opportunity to inspect the metal should not be missed, and after considerable difficulty received permission to visit the foundry.

Although the cleansing operations had been completed it was quite evident that nothing in the nature of deep-seated corrosion had taken place during the 38 years which had elapsed since the statue was cast. The surface, Mr. Burton stated, had been covered with a layer of corrosion products about $\frac{1}{16}$ in. thick. This had been removed with scrapers, leaving a perfectly smooth surface, only discoloured by the subsequent exposure to the smoke and other atmospheric contamination of Piccadilly Circus.*

It appeared to be of considerable interest to ascertain the composition of the metal. The intricacy of the casting made it appear that an alloy must have been used, but the evident resistance to corrosion seemed to contradict this view. As no massive piece of the statue was then available for chemical analysis, some minute drillings, resulting from the repair work, were examined spectrographically by Mr. D. M. Smith, B.Sc., of the British Non-Ferrous Metals Research Association, after they had been carefully washed in very dilute hydrochloric acid. Mr. Smith subsequently re-examined the plates secured in 1932 in the light of his later knowledge of the spectrographic analysis of aluminium¹ and reported the figures given in col. I of Table I.

Mr. Smith emphasized that the numerical estimates are, in all cases, only approximate and should not be regarded as accurate to more than one significant figure. Subsequently, Mr. Pitts kindly supplied a small piece cut, many years before, from the skirt of the figure, which Mr. Smith analyzed with the result given in col. II, Table I.

Whilst these analyses do not show perfect agreement, they do show that no alloy had been used, and it is certainly remarkable that such a casting, reproducing the fine details of Gilbert's work, had been made in "pure" aluminium at so early a date. The bow, Mr. Pitts informed the authors, was re-cast in an alloy at a later date.

Most of those familiar with the metal will also be surprized at the small amount of the impurities revealed, and it was very desirable, therefore, to ascertain the origin of the metal and, particularly, whether it was made by the electrolytic or by a purely chemical process. In this

* Mr. F. E. Pitts who, in 1918, acquired the firm of Broad, Salmon & Company, Ltd., by whom the statue was originally cast, informed the authors that a similar amount of corrosion products had been removed by electrically driven wire brushes, when the statue had been removed from Piccadilly Circus for safety during the war of 1914-1918.

An Aluminium Statue of 1893: Gilbert's "Eros"

TABLE I.—Analyses.

	I.	II.	IIa.	III.	IV.	V.	VI.	VIa. Chem. Anal.	VII.	VIIa. Chem. Anal.	VIII.	IX.	X.
Iron	0.6-0.7	0.27	0.30	ca. 1.00	ca. 1.00	0.7	> 1.00	1.77	0.3	0.35	0.27	1.08	0.90
Silicon	0.5	0.60	0.76	ca. 1.00	ca. 1.00	0.8	0.4	0.39	0.5	0.66	0.15	1.94	0.81
Copper	0.02	0.01	...	> 0.03	0.02	> 0.03	0.05	0.06	0.25	...	0.35	...	...
Manganese	0.02	0.004	...	0.04	0.03	0.007	0.015	0.01	0.04	...	...	...	...
Titanium	trace	trace	...	0.015	0.03	0.005	0.025	0.03	0.008	...	trace	...	...
Calcium	trace	trace	...	ca. 0.001	ca. 0.001	ca. 0.001	0.001	0.05	0.001	...	...	...	...
Magnesium	ca. 0.01	0.001	...	trace	trace	trace	0.001	...	0.001	...	...	...	...
Silver	...	...	...	det.	det.	det.	n.det.	...	n.det.	...	...	...	...
Lead	ca. 0.005	trace	...	det.	det.	n.det.	0.07	...	trace	...	...	...	...
Gold	...	...	...	n.det.	n.det.	det.	n.det.	...	n.det.	...	...	...	...
Zinc	ca. 0.005	n.det.	...	det.	n.det.	det.	n.det.	0.02	trace	...	...	...	...
Gallium	trace	trace	...	n.det.	n.det.	n.det.	trace	...	trace	...	...	...	...
Tin	< 0.03	n.det.	...	n.det.	n.det.	n.det.	n.det.	0.08	n.det.	...	...	...	...
Sodium	0.001	0.002	0.10
								to					
								0.004					

det. = presence detected.

n.det. = presence not detected.

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the authors have been entirely unsuccessful, but in the course of their searches they have been fortunate enough to locate several specimens of chemically prepared aluminium, and it seems desirable to place on record the composition of these, as determined by modern methods.

The specimens, the results of the spectrographic examination of which, by Mr. D. M. Smith, are given in Table I, were :

III. A very small amount of metal obtained on loan from Mr. O. E. Sims, through the good offices of Mr. W. Murray Morrison. This metal had been in the possession of Mr. Sims's grandfather (1800-1857) and had, therefore, been made before 1857.

IV. A very small specimen, made over 50 years before, by Alexander Sutherland, probably from Antrim bauxite. This was obtained on loan from Mr. James Sutherland, through Mr. Murray Morrison.

V. A medal of aluminium made by the Aluminium Company, Ltd., by the Deville-Castner process, prior to 1889, and given by Professor F. Soddy, F.R.S.

VI. A small ingot of metal made in 1863 by Bell Brothers of Washington, Co. Durham, and given by Professor Alexander Scott, F.R.S. The manufacture of aluminium was commenced at Washington about 1860 by the firm of Bell Brothers, of which Sir Lowthian Bell was the moving spirit. J. W. Mellor² states that the Deville process was used. It is, perhaps, not without significance that Sir Lowthian Bell's son, Sir Hugh Bell, an original member of this Institute was, for a time, a pupil of H. St. Claire Deville.³

VII. A small ingot of metal, obtained by the good offices of Mr. C. E. Pearson, M.Met., which was made at Wallsend by the Netto process in which cryolite was reduced by sodium.⁴

Of No. VI a chemical analysis was made in Dr. A. G. C. Gwyer's laboratory, and of No. VII a partial analysis by Mr. G. B. Brook. Their results are given in Table I as Nos. VI*a* and VII*a*, respectively. Mr. Brook also made a partial analysis of the fragment of the statue which is recorded as No. II*a*.

Unfortunately the authors have no sample available of the earliest electrolytic metal for examination by modern methods, but in col. VIII are given H. Moissan's figures for metal produced electrolytically at Pittsburg in 1895, in col. IX for Neuhausen metal of the same year, and in col. X for another sample of electrolytically produced aluminium of 1896.⁵⁻¹¹

It will be noted that the composition of the samples taken from the statue is very similar to that of metal of known chemical origin, Nos. V,



Gilbert's "Eros," Piccadilly Circus, London.

VI, and VII. It differs rather more from that of metal produced by electrolysis at about the same time, to judge by Moissan's analyses. On the other hand, metal of composition very similar to that of the statue, as shown by col. II, is frequently produced electrolytically to-day.

It was hoped that a determination of the sodium content would throw light on the problem, since it has been generally assumed that chemically prepared aluminium contained much more sodium than that made by electrolysis. Analyses kindly made by Mr. G. B. Brook revealed, however, 0.002-0.004 per cent. of sodium in the sample of metal made by the Bell process (No. VI) whilst the small piece of the statue (No. IIa), gave 0.001 per cent. figures which are similar to those found in pure metal to-day (0.001-0.002 per cent.). Mr. Brook used a modification of Scheuer's method of analysis,¹² which he intends to describe shortly, and on which he places absolute reliance.* These figures suggest once more that the metal used for the statue was produced chemically, since Moissan found 0.1-0.42 per cent. sodium in metal from the three main electrolytic sources of his day (La Praz, Neuhausen, and Pittsburg). His determinations were made, however, by the nitrate method (according to a private communication from Mr. P. Williams, who was working in Moissan's laboratory at the time), and this process, though the best available then, is not held to be reliable to-day.

ACKNOWLEDGMENTS.

The writers wish to express their thanks to the many gentlemen who helped by making available and/or analyzing specimens of old chemically prepared aluminium, and especially to Mr. D. M. Smith, B.Sc., for his spectrographic work, which has once more illustrated the advantage to be derived from this method of examining minute quantities of metals.

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* The standard method in this country prior to Scheuer's communication was that described by Fairlie & Brook.¹³



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METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 3

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Part 12

I.—PROPERTIES OF METALS

(Continued from pp. 439-449.)

***Tensile Properties of Single Crystal and Polycrystalline Aluminium.** G. Welter and T. Mojmir (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, **3**, (3), 130-136).—[In Polish, with German summary.] In the preparation of large single crystals of aluminium from the polycrystalline metal by recrystallization the orientation and shape of the single crystals depend on the purity of the metal, e.g. with 99.8% aluminium the crystal boundaries are always perpendicular to the axis of the rod, whereas with 99.5% metal the crystal boundaries are practically always parallel to this axis. With rods consisting of two large crystals the relative elongation at the grain boundary is the smallest. The nature of the fracture of the specimen and the reduction in area depend on the crystal structure. Determinations of the elastic limits (0.001, 0.002, 0.01, and 0.2% permanent deformation) show that there is a sudden transition from purely elastic to plastic deformation so that the load-elongation curve bends sharply at right angles. The highest elastic modulus was obtained with single crystal 99.8% aluminium (7150 kg./mm.²), while the average value for polycrystalline aluminium is 6500 kg./mm.². The elastic limit (0.001% elongation) varies from 0.75 to 1.6 kg./mm.²; the tensile strength of single crystal aluminium is 4-5 kg./mm.² and the elongation 50-100%. With increasing grain-size the tensile strength of aluminium decreases rapidly at first, then more slowly—A. R. P.

***Contraction of Aluminium and Its Alloys During Solidification—II.** (Losana.) See p. 503.

***Temperature Coefficient of Electrical Resistance of Aluminium.** Maurice Henri (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, **2**, 165-166; and *Rev. Mét.*, 1936, **33**, (7), 420-421).—[In French.] The resistivities at 20° C., ρ_{20} , of aluminium 99.996, 99.56, 99.12, and 98.63% pure were determined as 2.620, 2.767, 2.780, and 2.835 microhms/cm., respectively. The corresponding values for the temperature coeff. of resistance, β_{20} , measured between 20° and 70° C., are 0.00433, 0.00400, 0.00413, and 0.00400; all ± 0.00008 . The product $\rho_{20}\beta_{20}$ is constant within the limits of experimental error, a result in agreement with Mathiessen's law.—J. C. C.

***K Spectrum and Conductibility Electrons of Solid and Liquid Aluminium.** Jules Farineau (*Compt. rend.*, 1936, **203**, (11), 540-541).—The work of Siegbahn and Karlsson (*Z. Physik*, 1934, **88**, 71) and Kunzl (*Z. Physik*, 1936, **99**, 481) has been extended to embrace both liquid and solid aluminium, and a special study of the β bands, which gives information of the electrons of conductivity.

—J. H. W.

***Investigation of Gases in Aluminium by the Complex Method.** I. F. Kolobnev (*Zvetnye Metalli (Non-Ferrous Metals)*, 1936, (5), 110-120; (6), 115-124).—[In Russian.] By means of a specially constructed vacuum furnace the gas content of aluminium was determined, separate values being obtained for the free and combined gases. Nitrogen is almost insoluble in aluminium, but at high temperatures forms nitrides. Carbon dioxide behaves similarly. Most of the gas found in aluminium, irrespective of the method of manufacture, is hydrogen (up to 70%); the remainder consists of methane

* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

(up to 20%), carbon monoxide, and nitrogen. Ingots cast in an argon atmosphere have the maximum and those cast in steam the minimum density. Castings made at 870° C. have a density about 8–9% below that of those made at 670° C. Aluminium melted *in vacuo* absorbs silicon from porcelain and fireclay crucibles, up to 0.8% being absorbed in 1 hr. Specimens cast in water vapour have an exceptionally fine-grained structure.—N. A.

***The Structure of Aluminium, Chromium, and Copper Films Evaporated on Glass.** R. Beeching (*Phil. Mag.*, 1936, [vii], 22, (150), 938–950).—Evaporated films of aluminium, chromium, and copper on glass when examined by electron diffraction have been shown, when very thin, to consist mainly of oxide. In the case of aluminium the oxide is related to $\gamma\text{-Al}_2\text{O}_3$. The effect of varying the conditions of evaporation were studied. The investigation includes a study of thicker films actually containing metal, the effects of low-temperature heating, and the mechanical properties.—W. D. J.

***On the Figuring and Correcting of Mirrors by Controlled Deposition of Aluminium.** John Strong and E. Gaviola (*J. Opt. Soc. Amer.*, 1936, 26, (4), 153–162).—The known method of deposition of metals evaporated in vacuum is controlled by using a screen or mask and rotating the mirror electromagnetically. The details of methods for changing the form of mirrors (e.g. spherical to parabolic) by this means are described.—R. G.

***Aluminizing of Large Telescope Mirrors.** J. Strong (*Astrophys. J.*, 1936, 83, 401–423).—A history of the evaporation process is given, including the contributions of Ritschl and others, and the present technique is described in detail. Formulae are developed which give the thickness of the film produced by a circular array of evaporation sources. Applications for the cases of 40 in. and the 108 in. tanks are discussed. Reference is made to the application of non-uniform films in the figuring of mirrors. Methods of cleaning the mirrors preparatory to coating are discussed. The technique of obtaining high vacuum in large tanks is treated. The reflectivities and other properties are given for evaporated films of aluminium and silver, as well as chromium, platinum, palladium, rhodium, tin, gold, and copper. Observations on aluminized astronomical mirrors in use for over 3 years are described. The results of a study of the oxidation (corrosion) of aluminium by means of measurements on transmissivity and reflectivity of partial films is reported. The different sets of equipment that have been developed in increasing size up to the 108-in. tank are described. The history of the application of the process to astronomical mirrors is given.—S. G.

***Studies on the Oxidation of Metals. IV.—The Oxide Film on Aluminium.** G. D. Preston and L. L. Bircumshaw (*Phil. Mag.*, 1936, [vii], 22, (148), 654–665).—The oxide film on aluminium at room temperature was isolated by removing the metal by treatment in dry HCl gas at 250° C. Electron diffraction photographs of the film show that it is amorphous. Heating the film at temperatures up to 650° C. does not induce crystallization, but at 680° C. crystallization begins slowly. The film becomes a random mass of small crystals of cubic $\gamma\text{-Al}_2\text{O}_3$, the form of alumina which is present on the surface of molten aluminium.—W. D. J.

***Alternating Current Investigations on Anodically Oxidized Aluminium.** Werner Baumann (*Z. Physik*, 1936, 103, (1/2), 59–66).—The dielectric properties of aluminium oxide films formed anodically are related to the voltage and frequency of the a.c. used for their measurement, and to temperature and humidity.—B. C.

***Different Behaviour of Single Crystals Grown from the Molten Metal and Obtained by Recrystallization using Aluminium of Varying Purity.** F. Gisen (*Light Metals Research*, 1936, 4, (22), 379–381).—Translated from *Z. Metallkunde*, 1935, 27, 256; see *Met. Abs.*, this vol., p. 29.—J. C. C.

Study of the Manufacture, Properties, and Uses of Refined Aluminium. R. Gadeau (*Chim. et Ind.*, 1935, **34**, (5), 1021–1026; also *Metallwirtschaft*, 1936, **15**, (30), 702–705; and (summaries) *Metallurgist* (Suppt. to *Engineer*), 1935, **10**, (Dec. 27), 94–96; *Light Metals Research*, 1936, **4**, (14), 220–224; and *Aluminium and Non-Ferrous Rev.*, 1936, **1**, (11), 499–501, (12), 535–536).—Read at the Congrès International des Mines, de la Métallurgie, et de la Géologie appliquée. See *Met. Abs.*, this vol., pp. 69, 237.—W. A. C. N.

***Recrystallization Diagram of Antimony.** J. Czochralski and E. Przyjemski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, **3**, (3), 113–115).—[In Polish, with German summary.] Cylinders of commercial antimony were cast inside copper rings 15 mm. high and 13 mm. internal diameter, the whole compressed to 1, 5, 10, 25, 50, and 70% reduction in height, and the grain-size measured after annealing for 30 minutes at 300°–610° C. Maximum grain-size was obtained after 1% reduction at all annealing temperatures; with increasing degree of reduction the grain-size decreases rapidly, being only about one-tenth of the maximum after 70% reduction. After annealing at 610° C. metal reduced 1% showed grains about 8 times the size of those obtained by annealing at 300°–400° C., and about 10 times the size of those in metal reduced 50%.—A. R. P.

***The Magnetic Properties of Antimony.** D. Shoenberg and M. Zaki Uddin (*Proc. Cambridge Phil. Soc.*, 1936, **32**, (3), 499–502).—The magnetic susceptibility of antimony both parallel and perpendicular to the trigonal axis is independent of field down to 4° K. The numerical value of the susceptibility parallel to the trigonal axis decreases with increasing temperature, similarly to that of bismuth, but perpendicular to the trigonal axis there is no temperature dependence. A comparison of the results at higher temperatures with earlier measurements, suggests that the susceptibility of antimony, like that of bismuth, is very sensitive to addition of foreign elements.—S. G.

***Photoelectric Properties of Barium and Calcium.** N. C. Jamison and R. J. Cashman (*Phys. Rev.*, 1936, [ii], **50**, (7), 624–631).—Using a photoelectric cell in which the barium was fractionated, and repeatedly distilled, the work-function of barium at room temperature was determined as 2.520 and 2.510 e.v., at the beginning and end of the experiments. In both conditions the cell showed extreme constancy of the work-function, and the differences are ascribed to difference in crystal structure or chemical purity, and not to gas contamination. A measurement at 397.2° K. gave a work-function of 2.512 e.v., and a positive temperature coeff. of $(2.2 \pm 0.7) \times 10^{-5}$ e.v./° K. The absolute photoelectric yield of the surface, and the optical reflection coeff. were also measured. After cooling to –77° C., or heating to 224° C., the data did not fit Fowler's curve accurately, suggesting that straining of the surface had occurred. The work-function of a calcium surface prepared by a single distillation was 2.706 e.v., but after heating to 100° C. the data suggested that the surface was not homogeneous, but consisted of two types of surface with work-functions differing by about 0.2 e.v.—W. H.-R.

***On the Thermal Expansion of Beryllium.** E. A. Owen and T. Ll. Richards (*Phil. Mag.*, 1936, [vii], **22**, (146), 304–311).—Results are given of measurements of the thermal expansion of beryllium by the X-ray method over the range 20°–550° C.—B. C.

***X-Ray Determination of the Coefficients of Thermal Expansion of Beryllium and Tin.** (Kossolapov and Trapeznikov.) See p. 528.

***Researches on Bismuth Crystals. I.—Heat and Electrical Conductivity in Transverse Magnetic Fields.** E. Grüneisen and J. Gielessen (*Ann. Physik*, 1936, [v], **26**, (5), 449–464).—The heat and electrical conductivities of 4 differently oriented bismuth crystals were measured between 0° and –195° C. and the effect of strong magnetic fields at low temperatures determined. In strong fields the heat conductivity is no longer a simple function of the electrical

conductivity in any one direction, but the mean of the values in all directions is a linear function of the mean electrical conductivity.—v. G.

***The Magnetic Properties of Bismuth. I.—Dependence of Susceptibility on Temperature and Addition of Other Elements.** D. Shoenberg and M. Zaki Uddin (*Proc. Roy. Soc.*, 1936, [A], **156**, (889), 687–701).—The susceptibility of small single crystals of bismuth was determined at temperatures from 14° to 400° K. The effect of small quantities of antimony, lead, tellurium, or tin on the temperature variation is also given. A theoretical discussion is included.

—B. C.

***The Magnetic Properties of Bismuth. II.—The de Haas-van Alphen Effect.** D. Shoenberg and M. Zaki Uddin (*Proc. Roy. Soc.*, 1936, [A], **156**, (889), 701–720).—Results are given of an investigation of the variation of the susceptibility of bismuth with field strength. The effects of small additions of various elements are included, and the results are discussed from the point of view of Peierl's theory.—B. C.

***The Thermal Expansion of the Crystal Lattices of Cadmium, Osmium, and Ruthenium.** E. A. Owen and E. W. Roberts (*Phil. Mag.*, 1936, [vii], **22**, (146), 290–304).—Details are given of measurements by an X-ray method previously described of the coeffs. of thermal expansion of the crystal lattices of cadmium, osmium, and ruthenium along and parallel to the hexagonal axis; for cadmium, the measurements were from 20° to 280° C., and for osmium and ruthenium from 20° to 600° C. No evidence was found for the doubtful allotropic change of cadmium at 60° C.—B. C.

***X-Ray Examination of the Oxidation of Cobalt at High Temperatures.** (Arharov and Voroshilova.) See p. 535.

***An Anomaly of Annealed Copper.** M. Cirou (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, **2**, 157–163; and *Rev. Mét.*, 1936, **33**, (7), 413–419).—[In French.] Ductility tests were carried out by the Persoz and K.W.I. methods on samples of sheet copper after annealing in air and also after close annealing in wood charcoal. It was found that electrodeposited copper, electrolytic copper melted in a reducing atmosphere, and copper deoxidized with phosphorus gave different results on account of their variations in copper oxide content. After annealing in air, the electrolytic copper was the most ductile. Close annealing in charcoal appeared preferable for the electrolytic and deoxidized copper, but ruined the remelted copper.—J. C. C.

***Failure of Copper Firebox Due to Deposit from the Feed Water.** — (*Brit. Engine Boiler and Elect. Insurance Co. Tech. Rep.*, 1935, 17–19).—The examination of the wrapper plate of a copper firebox of a locomotive boiler which cracked showed that the trouble was due to the accumulation of scale at the water side of the plate, which caused overheating of the copper, as a result of which considerable distortion and work-hardening of the material took place. Intergranular inclusions did not appear to contribute to the important cracking, although they may have assisted the formation of shallow intergranular cracks to a slight extent.—J. W. D.

Oxidation of Copper at High Temperatures. References to. See p. 535.

***An Experimental Investigation on the Influence of the Polished Surface on the Optical Constants of Copper as Determined by the Method of Drude.** H. Lowery, H. Wilkinson, and D. L. Smare (*Phil. Mag.*, 1936, [vii], **22**, (149), 769–790).—Dispersion curves for copper for the visible spectrum were obtained by Drude's method, using surfaces prepared by (i) evaporation; (ii) mechanical polishing; (iii) electrolytic polishing method of Jacquet. The optical constants were studied as increasing depths of the mechanically disturbed surface were removed. The disturbance is shown to exist at a depth of 0.0013–0.0029 cm. or more beyond the Beilby layer. The effect of exposing copper to the atmosphere was studied.—W. D. J.

***The Influence of Mechanical Deformation on the Properties of Copper Oxide Rectifiers.** J. Dunaev and D. Nasledov (*Tech. Physics U.S.S.R.*, 1936, **3**, (3), 268–278).—[In English.] The rectifying and photoelectric properties of copper sheets of various thicknesses with copper oxide coatings of various thicknesses were measured before and after bending to a definite curvature. The rectifying power decreases as the number of bends increases and the effect is shown by photomicrographs to be due to mechanical damage to the copper oxide layer.—B. C.

***The Electrocapillarity Curve of Gallium.—II.** A. Murtazajew and A. Gorodetzkaia (*Acta Physicochimica U.R.S.S.*, 1936, **4**, (1), 75–84).—[In German.] The electrocapillarity curve of liquid gallium against various materials was measured by determining the pressure required to expel a drop of gallium from the end of a capillary tube. The effects of phenol, isoamylalcohol, pyrogallol, thiourea, and potassium iodide on the positions and values of the maxima were determined. The effect of ageing on the results was also investigated.—B. C.

***The Influence of Impurities on the Properties of Lead.** (Russell; Greenwood and Worner.) See pp. 513–514.

***Investigation of the Tensile Properties of Solid Mercury and a Comparison with Those of Other Metals at Low Temperatures.** C. H. Lander and J. V. Howard (*Proc. Roy. Soc.*, [A], 1936, (888), 411–426).—A description is given of tensile tests carried out on solid mercury and on lead, zinc, nickel, Duralumin, mild steel, and nickel-steel at temperatures from -140°C . upwards to room temperatures. Solid mercury exhibits the usual tensile attributes of a metal, its tenacity increasing with reduction of temperature. It is shown that the other metals retain their usual tensile characteristics with only quantitative alterations at the temperatures reached.—B. C.

***The Surface and Interfacial Tension of Mercury by the Sessile Drop and Drop Weight Methods.** H. Brown (*J. Amer. Chem. Soc.*, 1934, **56**, (12), 2564–2568).—The results at 25° are: interfacial tension against water 374.3 dynes/cm.; surface tension in dry air and *in vacuo*, 473 dynes $\pm 0.3\%$. It was shown thermodynamically that the surface tension of mercury *in vacuo* cannot be less than 447 dynes at 25° ; this eliminates some of the values obtained by previous workers. On the basis that the surface oxidation of mercury in air takes place only in the presence of water vapour, some of the perplexing phenomena often observed with mercury can be explained, such as irreversible adsorption effects, and the difference in results sometimes obtained with a static and a dynamic method.—S. G.

***The Surface Tension of a Moving Mercury Sheet.** H. O. Puls (*Phil. Mag.*, 1936, [vii], **22**, (150), 970–982).—Bond's method of using the impact of two liquid jets for the determination of surface tensions is applied to mercury. The value of the surface tension of mercury in contact with air at 20°C . is given as 475.5 ± 2 dynes/cm. A survey is included of results of previous investigators.—W. D. J.

***The Atomic Weight of Molybdenum. Analysis of Molybdenum Pentachloride.** O. Hönigschmid and G. Wittmann (*Z. anorg. Chem.*, 1936, **229**, (1), 65–75).—The value obtained using fractionally sublimed material was 95.95.
—A. R. P.

***Molybdenum and Nitrogen.** A. Sieverts and G. Zopf (*Z. anorg. Chem.*, 1936, **229**, (2), 161–174).—Molybdenum sheet and wire which have been annealed at 1400°C . absorb only very small amounts of nitrogen when heated at 900° – 1200°C . in the gas; by this treatment the sheet metal recrystallizes and becomes brittle, but the wire shows no change in structure or bendability. Unannealed molybdenum wire absorbs considerably greater amounts of nitrogen under the same conditions, forming apparently a solid solution, which, on cooling in nitrogen, deposits a hitherto unknown nitride phase and becomes

brittle, giving a smooth fracture but not losing its original drawing structure. Various nitrides have been prepared by heating molybdenum powder in ammonia and then in nitrogen; their properties and structure are described.

—A. R. P.

***The Diffusion of Gases Through Metals. IV.—The Diffusion of Oxygen and of Hydrogen Through Nickel at Very High Pressures.** C. J. Smithells and C. E. Ransley (*Proc. Roy. Soc.*, 1936, [A], 157, (891), 292–302).—The rate of diffusion of hydrogen through nickel was measured at varying pressures up to 112 atm. at 248° and 400° C., and down to 3 mm. at 248° C. The rate of diffusion is proportional to the square root of the pressure, but shows the usual deviations below 4 atm. The rate of diffusion of oxygen through nickel at 900° C. was measured and found to be independent of the oxygen pressure above 0.25 mm. These results are discussed.—W. D. J.

***On the Localization of the Transition Points of Allotropic Metals under Varied Circumstances by Means of the Method of Saladin—Le Chatelier [Transition Points of Nickel and of the Compound AuSb₂].** E. Rosenbohm and F. M. Jaeger (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (3), 366–374).—[In English.] The twin galvanometer of Saladin and Le Chatelier may be used for the determination of transition points on heating or cooling curves. One galvanometer is connected with a thermocouple indicating the furnace temperature, whilst the second galvanometer is connected with a differential thermocouple indicating the difference in temperature between the substance under investigation, and a standard substance heated or cooled under identical conditions. A suitable vacuum apparatus is described. The transition point of nickel in a vacuum occurs at 369°–370° C. on heating, and about 6° lower on cooling. In the presence of traces of oxygen or hydrogen, the transition occurs at 363°–364° C. on both heating and cooling. The $\beta \rightleftharpoons \gamma$ transition of the compound AuSb₂ occurs at 355° C. on both heating and cooling; the $\beta \rightleftharpoons \alpha$ transformation, which occurs at 404° C. on heating, takes place much more slowly, and shows marked hysteresis on cooling.—W. H.-R.

***Measurement of the Electrical Resistance of Metals as Function of the Temperature by Means of a Twin Galvanometer with Photographic Recording [Resistance of Nickel Between 300° and 430° C.].** E. Rosenbohm and F. M. Jaeger (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (3), 374–383).—[In English.] The twin galvanometer of Saladin and Le Chatelier can be used to measure the change in resistance of a metal wire on heating or cooling. One galvanometer in connection with a Wheatstone bridge indicates the resistance, whilst the second galvanometer is connected to a thermocouple to record the change in temperature. A suitable vacuum apparatus is described. Results are given for the resistance of nickel wires when heated in a vacuum, and in the presence of hydrogen. On heating in a vacuum the temperature coeff. of resistance increases until the first transition point at 358° C., but then decreases rapidly to 380° C., when a constant value is reached. In the presence of hydrogen the resistance of nickel is higher than in a vacuum, but the difference becomes less marked at high temperatures, suggesting that absorbed hydrogen is gradually released. The transition points and the form of the curves in their neighbourhood are also affected by the presence of hydrogen.—W. H.-R.

***The Specific Resistance and Temperature Variation of Resistance of Nickel and Some of Its Alloys in the Annealed and Unannealed States.** (Thomas and Davies.) See p. 517.

***The Determination of the Thermoelectrical Force of Metals in a Vacuum by Means of the Photographically Recording Double Galvanometer [Thermoelectric Force of Iron and Nickel Against Copper].** E. Rosenbohm and F. M. Jaeger (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (4), 469–477).—[In English.] An apparatus is described for the measurement of the e.m.f. of a wire with respect to a standard metal. The thermoelectric force of iron and nickel

against copper was studied up to 950° and 390° C., respectively, and the electric resistance of iron was also measured. The thermoelectric force (E) of iron against copper is positive at low temperatures, reaches a maximum at 300° C., and becomes zero at 586° C., above which temperature E is negative. A slight change in direction of the E/T curve occurs at the A_2 point of iron, and a marked change in direction at the A_3 point. The e.m.f. of nickel against copper is positive between 300° and 400° C., and the E/T curve shows a slight irregularity at 343° C. Nickel and iron, in the region of their Curie points, behave in an analogous manner as regards electrical resistances and thermoelectric properties.—W. H.-R.

***The Specific Heat of Nickel.** Edmund C. Stoner (*Phil. Mag.*, 1936, [vii], 22, (145), 81–105).—An analysis is made of the specific heat of nickel, which is treated as the sum of four terms: $C_P = C_Q + (C_P - C_V) + C_E + C_M$, where C_Q is the term for lattice vibration, C_P is the experimental value, C_V is the specific heat at constant volume, C_E the electronic specific heat, and C_M the magnetic specific heat. The more reliable data for the observed value C_P are collected and discussed, and for each term in the above expression a figure is given with the discussion.—W. D. J.

***Some High-Temperature Properties of Niobium.** A. L. Reimann and C. Kerr Grant (*Phil. Mag.*, 1936, [vii], 22, (145), 34–48).—The properties of very pure niobium wire were examined in the range 1800°–2400° K. with extreme precautions to avoid contamination. (1) The relations between the colour-, brightness-, and true-temperatures of a niobium wire and also the total radiation were studied as a function of the heating current. (2) The relation between the specific resistance r in ohm.-cm., and the absolute temperature T is given by $\log_{10} r = 0.7354 \log_{10} T - 6.586$ in the range concerned. (3) The melting point is 2790° K. $\pm 20^\circ$. (4) The rate of evaporation was also studied as a function of temperature. The internal latent heat of evaporation (*i.e.* that part of the latent heat of evaporation not concerned with work of expansion or kinetic energy of the vapour) is 171,200 cal./gram.-mol. (5) The thermionic emission was also studied, and the constants of the empirical formula $i = AT^2 e^{-\psi/kT}$, are $\psi = 4.01_3$ e.v., and $A = 37.2/\rho$ amp. cm.⁻² deg.², where ρ is the effective roughness factor for the surface. (6) Niobium has a body-centred cubic structure, and the lattice constant at room temperature is 3.2935 ± 0.0005 Å.—W. H.-R.

Diffusion in Zeolitic Solids. Max H. Hey (*Phil. Mag.*, 1936, [vii], 22, (147), 492–497).—Theoretical treatment referring to the work of W. Jost and A. Widmann (*Z. physikal. Chem.*, 1935, [B], 29, 247) on diffusion of hydrogen in palladium.—W. D. J.

***Measurements of the Atomic Heats of Platinum and of Copper from 1.2 to 20° K.** J. A. Kok and W. H. Keesom (*Physica*, 1936, 3, (9), 1035–1045; and *Comm. K. Onnes Lab. Leiden* No. 245a).—The atomic heats can be represented by $C_v = D(233/T) + 0.001607T$ in the case of platinum and $C_v = D(335/T) + 0.0001777T$ in the case of copper. The density of the energy levels in the energy band corresponding to the $5d$ electrons for platinum must be several times the density corresponding to perfectly free electrons. Comparison with susceptibility data suggests the existence of an appreciable interaction effect between neighbouring electron spins. For copper the density of the energy levels (at the highest level) is only 1.5 times the density corresponding to perfectly free $4s$ electrons.—S. G.

***The Kinetics and Heat of Adsorption of Ethylene by Platinum.** E. B. Maxted and C. H. Moon (*Trans. Faraday Soc.*, 1936, 32, (9), 1375–1381).—The adsorption of ethylene by platinum black takes place in two stages, the greater part of the total adsorption taking place almost immediately on exposure of the metal to the gas and the remainder at such a rate that the ratio of the volume adsorbed to the square root of the time is a constant,

i.e. adsorption in the second stage follows Bangham and Burt's law (*Proc. Roy. Soc.*, 1924, [A], 105, 481). The molecular heat of adsorption is about 9 kg.-cal.—A. R. P.

***The Chemical State of the Photoelectrically Active Layer of Hydrogen on Platinum and Tantalum.** K. Reger (*Z. Physik*, 1936, 102, (3/4), 156-162).—The photoelectric effects of layers of hydrogen on platinum and palladium are investigated. The effect of purity and moisture content of the hydrogen is examined, and it is concluded that the effect is only large when the hydrogen is atomic and not molecular.—B. C.

***The Photo-Sensitization of Films of Potassium by Means of Hydrogen.** R. C. L. Bosworth (*Trans. Faraday Soc.*, 1936, 32, (9), 1369-1375).—Mon-atomic films of potassium on tungsten do not react with molecular hydrogen at temperatures below the volatilization point, but they react with atomic hydrogen to form a WHK surface which reacts with more potassium to give a sensitive WKHK surface. Still more sensitive surfaces may be prepared by depositing potassium on a filament which has been flashed with hydrogen to give a WH surface.—A. R. P.

***The Effect of Outgassing Potassium on the Photoelectric Effect.** F. Klauer (*Ann. Physik*, 1934, 20, 909-918).—S. G.

***The Electrical Conductivity of Thin Metallic Films. I.—Rubidium on Pyrex Glass Surfaces.** A. C. B. Lovell (*Proc. Roy. Soc.*, 1936, [A], 157, (891), 311-330).—A method for obtaining thin films of rubidium by means of a defined atomic beam is described, and the conditions required to give consistent resistivity measurements are defined. Films of thickness down to 1 Å. gave definite conductivities, but for films below about 25 Å. in thickness, the films were subject to a decay of conductivity with time. The thicker films are shown to obey Ohm's law, and have conductivities approaching that of the metal in bulk. A theoretical discussion is given of the variation of the resistivity with thickness and temperature.—B. C.

***Transmission and Reflecting Powers of Thin Silver Films from Infra-Red to Ultra-Violet.** F. Goos (*Z. Physik*, 1936, 100, (1/2), 95-112).—Details are given of measurements of the reflectivities and absorptions of silver films on quartz for monochromatic light from 265 to 1050 $m\mu$, the silver films having thicknesses of 0.8 to 142 $m\mu$. In addition to the experimental results, considerations relating to the structure of the films are given.—B. C.

***On the Knowledge of Fundamental Atomic Weights. Relation of Silver Nitrate to Silver Chloride.** O. Hönigschmid and R. Schlee (*Angew. Chem.*, 1936, 49, (28), 464-466).—From the experiments described the following fundamental atomic weights are derived ($0 = 16$): silver 107.881 \pm 0.002, chlorine 35.456 \pm 0.002, nitrogen 14.009 \pm 0.003.—A. R. P.

***Viscosity of Liquid Sodium and Potassium.** Y. S. Chiong (*Proc. Roy. Soc.*, 1936, [A], 157, (891), 264-277).—Measurements are given of the viscosities of liquid sodium and potassium by the method (previously described) of the damping of the oscillations of a sphere containing the liquid. The results are shown to agree closely with Andrade's viscosity theory except very close to the melting point.—B. C.

***The Photovoltaic Effect for Sodium.** Robert B. Gibney and Malcolm Dole (*J. Chem. Physics*, 1936, 4, (10), 653-657).—S. G.

***The Influence of Mechanical Deformation on the Transition Velocity of Polymorphic Metals. II.—The Influence of Metallic Impurities [on the Transition from White to Grey Tin].** Ernst Cohen and A. K. W. A. van Lieshout (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (3), 352-358).—[In German.] Cf. *Met. Abs.*, 1935, 2, 560. "Banka" tin of 99.95% purity was alloyed with 0.01-1.0% of different metals. The specimens were melted in evacuated glass tubes, and were then cooled in air, and drawn into wire at -80°C . Samples were then kept in sealed glass tubes at temperatures

between 0° and - 50° C. for periods up to 63 days, and the appearance of tin-pest noted at intervals. Bismuth, lead, antimony, cadmium, and silver retard the transformation from white to grey tin at - 50° C. Zinc and aluminium increase the velocity of the transformation enormously. Thus, with 0.05% of aluminium the appearance of tin-pest was noted after 4 days at 0° C., whilst the Banka tin showed no change after 62 days. All the specimens were prepared under identical conditions of melting and cold-working.—W. H.-R.

***An Electric Pressure Dilatometer [Effect of Pressure on the Allotropic Transformation Temperature of Tin].** Ernst Cohen and A. K. W. A. van Lieshout (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (5), 596-603).—[In German.] A dilatometer is described which is suitable for the study of the effect of pressure on polymorphic transformations. The design is one in which the changes of volume affect the level of a column of mercury in a tube containing a thin platinum wire, the resistance of the exposed portion of the wire being measured. The change from grey to white tin was studied at pressures up to 200 atm. With activated grey tin (Cohen and Lieshout, *Met. Abs.*, 1935, 2, 415), at 13.2° C. the transformation takes place spontaneously at 200 atm. pressure, and after 3½ hrs. about 25% of the grey tin has been transformed.—W. H.-R.

***The Exact Measurement of the Specific Heats of Metals at High Temperatures. XXIII.—The Calorimetric, Electrical, and Thermoelectrical Behaviour of Ductile Titanium.—I.-II.** F. M. Jaeger, E. Rosenbohm, and R. Fonteyne (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (4), 442-452, 453-461).—[In English.] (I.—) The specific heat of pure ductile titanium was measured in the range 200°-1200° C. In the range 200°-350° C. the specific heat increases comparatively rapidly with temperature, but between 350° and 600° C. the rate of increase is small, and the specific heat-temperature curve shows a point of inflection. The specific heat then increases with increase of temperature, and in the range 800°-905° C. reaches extremely high values (of the order 20-33 cal.). Above 905° C. the field of existence of stable β titanium is reached, and the specific heat is independent of temperature, and equals 7.525 cal. The results do not allow a theoretical interpretation, but suggest that a region of structural disturbance exists between 800° and 905° C. The specific heat-temperature curves also show certain minor irregularities, which are dealt with in later papers (cf. following abstracts). (II.—) Differential heat-capacity curves confirm the conclusion (cf. (I) above) that the specific heat-temperature curves for ductile titanium show a number of minor breaks or irregularities. More easily reproducible irregularities were found in the regions 250°-270°, 297°-300°, 508°, 631°, and 882° C. The curves show complicated hysteresis effects, and when an irregularity has occurred at a high temperature, its influence on successive "transitions" at lower temperatures is always partially preserved. The curves connecting the electrical resistance and temperature show similar irregularities. These "transition points" may be connected with the presence of traces of oxygen, since the resistance-temperature curve was greatly changed when air was admitted for a short time, and the wire became covered with a visible film of oxide.—H.-R.

***The Exact Measurement of the Specific Heats of Metals at High Temperatures. XXIV.—The Calorimetric, Electrical, and Thermoelectrical Behaviour of Ductile Titanium.—III.** F. M. Jaeger, E. Rosenbohm, and R. Fonteyne (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (4), 462-469).—[In English.] The thermoelectric force (E) of a titanium-gold thermocouple was measured at temperatures up to 1020° C.; a positive value of E means that at the hot junction the current flows from the gold wire to the titanium wire. On increasing the temperature, E is at first positive, and reaches a maximum at about 250° C., after which E decreases with increasing temperature, becomes zero at 490° C., and then has negative values; a deep minimum is reached at

860° C. followed by a very steep rise of the curve, which suggests that positive values will again be reached at a higher temperature. Apart from the above general trend of the curve, slight irregular maxima occur at about 620° and 720° C., respectively. The curves show marked hysteresis phenomena which are in a direction opposite to that observed in the electrical resistance measurements (cf. preceding abstract). These effects are probably due partly to the presence of traces of oxygen, and partly to the tardiness of the reversible allotropic change of $\alpha \rightleftharpoons \beta$ titanium at 882°–905° C.—W. H.-R.

***The Transition of Hexagonal α -Titanium into Regular β -Titanium at High Temperature.** (de Boer, Burgers, and Fast.) See p. 531.

***The Atomic Weight of Tungsten. Analysis of Tungsten Hexachloride.** O. Hönigschmid and W. Menn (*Z. anorg. Chem.*, 1936, **229**, (1), 49–64).—Analysis of the hexachloride purified by repeated fractional distillation gave a value of 183.92 for the atomic weight of tungsten.—A. R. P.

***An Investigation of Irregularities in Thermionic Emission from Tungsten.** Felix L. Yezley (*Phys. Rev.*, 1936, [ii], **50**, (7), 610–616).—A tube with a moving electrode was used to investigate variations in emission density over the length of a straight tungsten filament; both positive ion and electron emission were studied. After a critical temperature is exceeded, positive ion emission is limited to narrow regions near the lead wire connections, indicating that the central region can be thoroughly cleaned. In spite of this, electron emission is not uniform, but occurs in a stable though irregular pattern. The irregularity is ascribed to differences in work-function, or to differences in actual area covered by the slit, or to a combination of the two.—W. H.-R.

***The Production and Investigation of a New Source of Alkali Ions.** Jürgen Koch (*Z. Physik*, 1936, **100**, (11/12), 669–684).—A description is given of the preparation of an anode from tungsten powder and an alkali chloride. Details of the analysis of the ions produced from it are given.—B. C.

***Study of the Bombardment of a Previously Heated Tungsten Surface by Positive Cæsium Ions.** Jürgen Koch (*Z. Physik*, 1936, **100**, (11/12), 685–701).—Experiments are described on the reflection of cæsium ions and the emission of electrons when a tungsten surface is bombarded with cæsium ions. The state of the surface was standardized by heating to above 1300° C., and consistent results followed. It is shown that a thin layer of cæsium is adsorbed by the tungsten, and reaches a saturation value. It can be removed by heating the tungsten.—B. C.

***Surface Ionization of Cæsium on Tungsten.** M. J. Copley and Julian Glasser (*J. Amer. Chem. Soc.*, 1936, **58**, (6), 1057–1058).—S. G.

***The Influence of Ultrasonic Waves on the Process of Solidification of Molten Metal [Zinc].** S. Sokoloff (*Acta Physicochimica U.R.S.S.*, 1935, **3**, (6), 939–944).—[In French.] The influence of ultrasonic vibrations of frequencies 6×10^5 to 4.5×10^6 cycles on the cooling curves and structure of cast zinc is shown. The results indicate that the solidification takes place more quickly with ultrasonic vibration than without, and that the resulting structure is more dendritic.—B. C.

***The Elastic Constants and Specific Heats of the Alkali Metals.** K. Fuchs (*Proc. Roy. Soc.*, 1936, [A], **157**, (891), 444–450).—Corrections are made to calculations given in a previous paper on the elastic constants of the alkali metals. The corrected results are compared with recent experimental determinations. An attempt is made to explain the large deviations from the Debye theory of the specific heats of the alkali metals.—B. C.

***The Crystallization of Metals Free from the Influence of Gravitation.** A. Glazunov and N. Lazarev (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, **2**, 185–188; and *Rev. Mét.*, 1936, **33**, (7), 438–441).—[In French.] The solidification of a spherical drop of a pure metal when suspended in a liquid of the same density as that of the liquid metal at the melting point

was studied. For magnesium, a bath consisting of lithium chloride 85 and lithium fluoride 15%, having a density of 1.60 at 650° C., was used. For aluminium, the metal was suspended in a bath containing barium chloride 40, calcium chloride 45, and sodium chloride 15%. In these conditions, on slow cooling, crystallization begins at a number of centres distributed uniformly throughout the metal and proceeds uniformly in all directions. A compact ball of metal, free from cavities and blow-holes is thus obtained.—J. C. C.

***The Liquid State and the Theory of Fusion. I.—Continuity Between the Solid and Liquid States.** J. Frenkel (*Acta Physicochimica U.R.S.S.*, 1935, 3, (5), 633–649).—[In English.] F. discusses the transition between the solid and liquid when the solid is amorphous, with reference to the properties that are continuous in the two states; the transition between liquids and crystals, which is shown to be a quantitative rather than a qualitative change; and the influence of positive and negative pressures on fusion.—B. C.

***The Liquid State and the Theory of Fusion. II.—The Theory of Fusion and Crystallization.** J. Frenkel (*Acta Physicochimica U.R.S.S.*, 1935, 3, (6), 913–938).—[In English.] The analogy between the solid-liquid and the liquid-vapour transformations is discussed, and it is shown that the three states can be represented on a single isothermal on which there are two unstable regions corresponding to the two changes of state.—B. C.

***The Problem of Gases in Metals.** G. Chaudron (*Chim. et Ind.*, 1936, 35, (4), 759–767; also (abridged) *Rev. Fonderie moderne*, 1936, Feb. 1, 35–39; and (summary) *Usine*, 1936, 45, (5), 37).—Gases enclosed in metals may be classed as: (1) those retained by physical adsorption on the surface; (2) those occluded and held mechanically; and (3) those combined with the metal or the alloy. These divisions are explained and discussed, examples being quoted. The law for the solubility of a gas (e.g. hydrogen) in metal is given as $C_H = K\sqrt{P_H}$, where C is the concentration of hydrogen atoms and P_H is the pressure. With certain combinations of gas and metal—hydrogen in palladium, tantalum, cerium, and lanthanum, and nitrogen in manganese and chromium, the formation of hydrides and nitrides, respectively, has been demonstrated. Various aspects of diffusion of gases in metals are reviewed. In preparing metal containing a minimum quantity of gas it has been effective to maintain the former at an elevated temperature under low pressure. Methods for the extraction and examination of entrapped gases are described. A new method of degassing in a high vacuum discharge tube and at ordinary temperatures is given, and appears to yield results of gas content comparable with those obtained from an analysis of the original material.

—W. A. C. N.

Gaseous and Solid Impurities in Ingots. J. H. Andrews (*Aluminium and Non-Ferrous Rev.*, 1935, 1, (2), 59).—Summary of a paper read before the Midland Metallurgical Society.—J. C. C.

The Diffusion of Gases Through Metals. — (*Metallurgist* (Suppt. to *Engineer*), 1936, 10, 113–115).—A brief review of recent papers, referring particularly to the results of Smithells and Ransley, *Proc. Roy. Soc.*, 1935, [A], 152, 706; see *Met. Abs.*, 1935, 2, 553.—R. G.

A Survey of the Fundamental Principles of the Plasticity of Metals. H. Schlechtweg (*Techn. Mitt. Krupp*, 1936, 4, 29–34).—S. G.

†**A Review of Recent Research Work on Plasticity.** A. Nádaí (*J. Applied Mechanics*, 1936, 3, (3), 104–106).—A critical review of recent research work dealing with viscosity and plasticity in solids, plastic deformation of single crystals, and the creep of metals under combined stress.—J. W. D.

Notes on Nádaí's Theory of Plasticity (A Study on the Partial Yielding of a Hollow Cylinder under Pressure). Kikusaburō Nagashima (*J. Soc. Mech. Eng. Japan*, 1934, 37, (211), 805–806).—[In Japanese.] See *Met. Abs.*, this vol., p. 345.—S. G.

Reply to a Paper by Kuntze: "Relations Between Cohesion and Plasticity." N. Davidenkow and E. Shevandin (*Zhurnal Technicheskoy Fiziki (J. Tech. Physics)*, 1935, 5, (10), 1773-1775).—[In Russian.] Cf. *Met. Abs.*, 1935, 2, 175. Polemical. It is considered that extrapolation from a viscous to a brittle region cannot give an idea of the actual brittleness of a metal.

—N. A.

***The Effect of Stress on the Plasticity of Metallic Materials.** (Maier.) See p. 622.

***On the Temperature-Dependence of Crystal Plasticity.** W. Boas and E. Schmid (*Z. Physik*, 1936, 100, (7/8), 463-470).—Experiments on the rates of extension of single crystals of zinc, bismuth, tin, and cadmium under constant load at temperatures near room temperature and near 90° A. showed that the predictions of the Becker-Orowan theory are not correct. (See following abstract.)—B. C.

***On the Temperature-Dependence of Crystal Plasticity.** E. Orowan (*Z. Physik*, 1936, 101, (1/2), 112-118).—A discussion on a paper by Boas and Schmidt (preceding abstract), pointing out the differences to be expected between results on crystal plasticity and temperature at low and room temperatures. The results of Boas and Schmidt are discussed in terms of the Becker formula.—B. C.

***On the Rate of Creep of Metals under a Constant Load.** Anton Pomp and Walter Länge (*Mitt. K.-W. Inst. Eisenforsch. Düsseldorf*, 1936, 18, (6), 51-63).—The results of creep tests on copper at 30, 40, 55, and 70° C., on zinc at 25, 40, 55, and 70° C., and on lead at 30° C. are shown in a series of graphs. No periodicity in the elongation curves due to the conjunction of hardening and recrystallization phenomena was observed with any of the metals. Recommendations are made for standard conditions for short time creep tests on these metals.—A. R. P.

***The Creep of Metals.—II.** A. Náday and E. A. Davis (*J. Applied Mechanics*, 1936, 3, (1), A7-14).—Cf. *Met. Abs.*, this vol., p. 292. A number of cases of the slow flow of solids with particular reference to the creep of metals in the strain-hardening range are considered. Means are developed to include strain-hardening when discussing observations on the creep of metals. Creep tests with soft and strain-hardened copper at room temperature are included, which support the logarithmal speed law for copper at the high speeds of deformation occurring in the tests.—J. W. D.

†**Design Aspect of Creep.** R. W. Bailey (*J. Applied Mechanics*, 1936, 3, (1), A1-6).—Some of the more important factors concerned in the development of a rational treatment of creep for the purpose of engineering design are briefly dealt with, and consideration is given to the applications of creep to design problems with particular reference to hollow cylinders subjected to internal pressure, steam piping, and rotating discs. The determination of creep properties for design as regards permissible stresses, relation between creep rates, and the influence of prolonged heating on creep properties are also dealt with, and it is stated, that in spite of the complicated nature of creep phenomena, there is no reason why the treatment of creep for design should not be as satisfactory and reliable as the treatment used for materials under elastic conditions.—J. W. D.

Seizure of Metals at Elevated Temperatures and Methods of Testing for Propensity Toward Seizure. — (*Mech. Eng.*, 1936, 58, (10), 165-168; also *Mech. World*, 1936, 99, (2579), 569-570; and *Light Metals Rev.*, 1936, 2, (21), 372-373).—Abbreviated from a Progress Report by Sub-Group N on Wear and Seizure to the A.S.T.M.—A.S.M.E. Joint Research Committee on the Effect of Temperature on the Properties of Metals. The testing methods of Mochel, Spring, and Bolton are described; conditions contributing to seizure are analyzed and characteristic phenomena are illustrated.—P. M. C. R.

***Internal Dissipation in Solids for Small Cyclic Strains.** R. L. Wegel and H. Walther (*Physics*, 1935, 6, (4), 141-157; and *Bell Telephone System, Metallurgy, Monograph B864*, 1935, p. 17).—The internal dissipation or elastic hysteresis of various substances is determined by the resonant rod method. The strains are varied from 10^{-5} to 10^{-8} , and the frequency range is 10^{-2} to 10^5 cycles, and the hysteresis constant and its variation with frequency is given for a number of metals and alloys and a few non-metals. The effect of heat-treatment and of temperature on the hysteresis constants are also given, and it is shown that dissipation usually decreases as grain-size increases.

—B. C.

***On the Mechanical Properties and Crystalline Structure of Metals.** Yoichi Kidani (*Trans. Soc. Mech. Eng. Japan*, 1936, 2, (6), 61-67).—[In Japanese, with English summary in suppt., pp. 17-18.] The bending of a single crystal of aluminium shows that rotational slip occurs in the slip-plane by the uniform bending of crystal plates, that repeated bending of one side produces cold-work and alternate bending produces fatigue, and that the load corresponding with the yield-point obtained by gradual bending differs according to the orientation of each crystal. The damping vibration of a single crystal plate was studied and the logarithmic decrement on the crystallographical direction deduced. It is also shown that an external force applied on metal deforms each grain in an entirely arbitrary manner since metal is an aggregate of small grains which crystallographical axis direct in arbitrary directions. Change of internal friction tested by means of a torsional vibrating machine shows that the transitional point of the repetition curve is coincident with the beginning of fatigue of the grains, that the general trend of the curve and the form of fracture may be explained by the slip of the crystal grains, and that the rate of damping of the vibration of the specimens gives significant information as to the degree of fatigue.—J. W. D.

***On the Process and Mechanism of Failure of Metals.—II.** Motoichi Kodama (*J. Soc. Mech. Eng. Japan*, 1934, 37, (205), 282-289).—[In Japanese.] In a medium, energy propagates after the manner of wave motion. Stress induced in a material is a manifestation of energy which also propagates from one point in a medium to another by wave motion. Since from this point of view the mechanism of strain, which is caused by stress, is always slip, there can be no such thing as "tensile failure." K. shows strain waves chiefly by strain figures of mild steel and ordinary glass. As an illustration, the yield phenomena of mild steel are breaking states of equilibria, the so-called upper yield-point being their first breaking point. The equilibrium breaks in the "field" of slip when the wave motion of stress reaches that state where it causes a principal wave in the "field." Such "fields" of slip are classified into 2 types: the close and the open. The former are cases of compression and tension tests, and the latter of torsion and bending tests. In the field there are always one or more axes that divide the field into two or more divisions. Since the wave of breaking stress vibrates with intervals of + and - in these divisions, the contour of the "field" has two or more inflection points each at the ends of the axes. Thus, the breaking stress propagates by wave motion. From these observations K. concludes that no slip can occur in a simple "plane" as is usually believed. The evidence of wave motion may be traced in the phenomena of interference and symmetrical or antipodal properties of strain figures.—S. G.

The Practical Importance of the Damping Capacity of Metals, Especially Steels. O. Föppel. Appendix: A Note on the Terminology of Damping and Fatigue. F. Bacon (*Iron Steel Inst. Advance Copy*, 1936, Sept., 31 pp.; and (abridged) *Met. Ind. (Lond.)*, 1936, 49, (16), 383-388).—Under cyclic stresses well within the fatigue limits, many steels exhibit appreciable plastic strains. The "damping capacity" depends on the ratio of the plastic to the elastic

strain, and is best defined by the non-dimensional ratio ψ obtained by dividing the area of the hysteresis loop by the strain energy stored in the extreme positions of the cycle. Damping does not foretell impending fatigue failure, nor does it tend to disappear under prolonged cyclic stressing. On the contrary, it is capable of dissipating an unlimited amount of energy in heat without damage to the material. Ultimate damping, *i.e.* the steady value attained after some millions of cycles, is often considerably greater than initial damping. Unlike most other mechanical properties, the value of ψ is not affected by weak spots, and is independent of the form of the specimen. The value of ψ is of great importance as a criterion of suitability, (1) because a high value of ψ confers notch-toughness in fatigue, and (2) because it controls the amplitude of undesired and often dangerous vibrations at critical speeds. P. mentions 5 different methods of measuring ψ in use at the Wöhler Institut, and between which good agreement has been obtained. The method of free torsional vibrations receives preferential treatment, and the Föppl-Pertz apparatus is described in some detail. Damping curves are given for different materials. Damping in torsion is compared with damping in flexure. The limits within which damping is independent of frequency are also discussed. The great and increasing importance of the damping capacity of materials in many different fields of engineering is illustrated by reference to aerial cables, aeroplane wings and propellers, crankshafts of internal combustion engines, steam turbine blades, and welded *versus* riveted construction. Finally, attention is focussed on the need for finding a ductile steel which will give high damping at low stresses. 27 references are given. The symbols and terminology used in this and other German papers (which differ from English usage) is explained in an Appendix by B.—S. G.

***On the Change of Mechanical Properties of Metals under Repeated Stress and Recovery from Fatigue.** Ryōnosuké Yamada and Yōzo Matsuoka (*J. Soc. Mech. Eng. Japan*, 1934, **37**, (205), 273–281).—[In Japanese.] The changes in the mechanical properties of metals under repeated stress as well as those after annealing were measured. It was found that if the experiments are conducted under stresses exceeding a certain limit work-hardening takes place during the early stages of stress repetition which, to give one example, results in greater hardness; this is followed later by the growth of minute cracks, resulting in a decrease in hardness. A test-piece was heated above the recrystallization temperature *in vacuo* after being subjected to a number of stresses and again subjected to repeated stresses of a magnitude equal to that before heating. If the test-piece was heated in the early stages of the repetition, the number of repetitions required to fracture was almost equal to that of a test-piece that had undergone no heat-treatment, indicating recovery from fatigue. If, on the contrary, the number of repetitions before heating exceeded a certain limit, no recovery took place, *i.e.* the number of repetitions before fracture after heating was less than for a test-piece that had undergone no heat-treatment. From these results it may be said that there are two stages in the course of fatigue, one being the hardening stage and the other the crack-growing stage. By means of suitable annealing, metals may recover in the former but not in the latter stage.—S. G.

***The Rate of Growth of Fatigue Cracks.** A. V. de Forest (*J. Applied Mechanics*, 1936, **3**, (1), A23–25; discussion, (3), A114–117).—Tests carried out to determine the stress and number of reversals required to start a fatigue crack, and the resistance of the material to the effect of a fatigue crack once it is formed give data on the rate of progress of the cracks and on the size of the cracks. From these data the resistance of metal to the propagation of cracks is discussed, and it is pointed out that in the accepted method of fatigue testing the results are not conclusive, as there is no distinction between the load and the number of repeated stresses required to start cracks, and the

load and the number of reversals required to propagate the cracks to failure.—J. W. D.

***Fatigue Failure of Aircraft Materials and Their Endurance.** Kōji Takase (*J. Soc. Aeronaut. Sci. Nippon*, 1934, 1, (1), 79–174).—[In Japanese.] An investigation of the fatigue of metals used in aircraft (chiefly aero-engine) parts. As a result of an exhaustive study of fatigue failures of aircraft parts T. concludes that these failures are due to local cracks caused by an enormous stress equal to the so-called "cohesion strength." To ascertain the endurance of materials, the following are discussed: (1) relation between "cohesion strength" of materials and fatigue cracks; (2) the experimental determination of "cohesion strength"; (3) stress concentration of aero-engine parts and local maximum stress; (4) the effect of applied velocity of load on the strength of materials; (5) calculation of the fatigue limit by an empirical formula deduced from T.'s investigation.—S. G.

***Limits of Viscosity of Metals.** B. Tavecchi (*Ricerche di Ingegneria*, 1936, 4, (1), 16–23; *Sci. Abs.*, 1936, [A], 39, 808).—An investigation was made (omitting any particular hypothesis of the behaviour of materials) of the conditions, considered analytically and geometrically, which must satisfy the curves of shear obtained in the determination of the limits of viscosity of metals, so far as the load concerned is inferior to the said limit. Various limits are distinguished and the particular conditions studied for each one of them. The results obtained are then applied to experiments already carried out by other investigators, researches by which the limit was deduced on the basis of 20 actual tests. The deductions mentioned have been generally confirmed. By the same method an analysis was made of a theory of other authors that gives the viscosity of shear as a function of the shear itself, and of the value that this assumes after an infinite time. The consequences deduced from this theory tested in some of the experimental researches cited were not confirmed. It is considered that the theory itself is not of a general character.—S. G.

Internal Viscosity of Engineering Materials. Shun Hudita (*J. Soc. Mech. Eng. Japan*, 1934, 37, (211), 812–814).—[In Japanese.] According to H., who attempts to introduce a method for foretelling the residual lives of machinery parts, an erroneous idea prevails that the asymptotic value of the *S-N* curve (relation of the repeated stress to the number of times it is repeated) is the only safe stress at every loading condition. Even at a very low fatigue limit the impact figure of test-pieces gradually increases as the number of times the stress is repeated is increased, whence it follows that the impact figure of a test-piece is a measure of residual life. Since, however, with the impact testing machine, crank-shafts are broken in pieces and rendered unserviceable, H. proposes to measure the internal viscosity of fatigued materials by means of elastic vibrations. The sound caused by the elastic vibration of materials is caught by a microphone of ordinary type and the induced e.m.f., after being amplified by vacuum tubes, is lead to an oscillograph, an analysis of the oscillograms enabling measurement to be made of the internal viscosity. According to H., the internal viscosity is the only safe measure of the residual life of engineering materials.—S. G.

First Report of the Atomic Weights Committee of the International Chemical Union, 1936. F. W. Aston, N. Bohr, O. Hahn, W. D. Harkins, and G. Urbain (*Ber. deut. chem. Ges.*, 1936, 69, (10), 171–174).—The international Table of Stable Isotopes (1936) is reproduced in full; the proportion in which each isotope occurs is indicated in each case.—P. M. C. R.

***The Anomalous Specific Heat of Crystals, with Special Reference to the Contributions of Molecular Rotations.** R. H. Fowler (*Proc. Roy. Soc.*, 1935, [A], 151, (872), 1–22).—Bakerian Lecture. A discussion is given in terms of quantum mechanics of the theory of the specific heats of solids. The various

anomalies that have been observed are classified in three types: (1) in which the anomalous part of the specific heat has a maximum; (2) in which the extra specific heat increases with temperature and then decreases discontinuously to zero, and (3) in which the abnormality occurs at a single temperature. Particular reference is made to the specific heats of lithium and the ferromagnetic substances, the thermal characteristics of order-disorder points, transitions between rotational and librational motion, transition changes between one solid phase and another as in white to grey tin, and anomalous thermal expansions.—B. C.

***Studies on the Thermal Expansion of Solids at Low Temperatures.** Heinrich Adenstedt (*Ann. Physik*, 1936, [v], 26, (1), 69–96).—Very accurate measurements of the coeff. of expansion of iron, nickel, and copper between +20° and –195° C. failed to confirm the presence of the anomalies in the expansion curve reported by Simon and Bergmann.—v. G.

***The Optical Constants of Several Metals in Vacuum.** H. M. O'Bryan (*J. Opt. Soc. Amer.*, 1936, 26, (3), 122–127).—Describes measurements of optical properties made on mirrors, deposited by evaporation in vacuum, of beryllium, magnesium, calcium, strontium, barium, aluminium, germanium, lanthanum, cerium, and manganese.—R. G.

***Note on the Analysis of Photoelectric Data.** Robert J. Cashman and Noel C. Jamison (*Phys. Rev.*, 1936, [ii], 50, (6), 568–569).—Fowler's method (*ibid.*, 1931, [ii], 38, 45) for the determination of photoelectric work-functions is discussed with special reference to data for barium.—W. H.-R.

***An Industrial Apparatus for Determining the Thermal Conductivity of Metals up to 900° C.** Georges Ranque, Pierre Henry, and Marcel Chaussain (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 303–309; and *Rev. Mét.*, 1936, 33, (10), 602–608).—A method is described for determining, with an accuracy within 2%, the thermal conductivity of metals at various temperatures, and the sources of errors in its use are discussed. A hollow specimen is heated by an electric resistor at one end and is cooled at the other, and the temperature distribution along the central cavity is explored with a special thermocouple. A neutral atmosphere is maintained within the specimen to avoid oxidation. The thermal conductivity K , in cal./cm./sec./°C., is, for copper, constant at 0.90 up to at least 575° C.; for nickel constant at 0.129 up to the Curie point, increasing at higher temperatures to 0.221 at 880° C. The values of K for carbon and stainless steels and iron were also studied.—J. C. C.

***Energetic Theory of Thermoelectric Phenomena.** Félix Michaud (*J. chim. phys.*, 1936, 33, (2), 161–179).—The classical theory is criticized. Thermoelectric phenomena are partly irreversible in nature, and an appropriate equation has been deduced.—S. G.

***Measurements of the Volta Effect in Pure Metals.** F. Krüger and Gerhard Schulz (*Ann. Physik*, 1936, [v], 26, (4), 308–330).—If the adsorbed water film is removed by heating *in vacuo* the potential difference (so-called Volta effect) between the various metals disappears.—v. G.

***Magnetism and Cold-Working in Metals. I.—Polycrystals.** S. R. Rao (*Proc. Indian Acad. Sci.*, 1936, [A], 4, (1), 37–53).—The effect of cold-working on the susceptibilities of bismuth, zinc, cadmium, and tin is studied. The diamagnetic susceptibility of bismuth is decreased effectively while zinc and cadmium show a small decrease. The paramagnetic susceptibility of white tin shows a decrease as the density decreases owing to cold-working, and changes sign below a particular value. The nature of polycrystalline metals is examined, and attention is directed to the existence of a deformed boundary between the small crystals in the metal specimen. Natural explanations are offered for the observed susceptibility changes in the light of the existence of the distorted layer and of R.'s work on metallic colloidal powders (see *Met. Abs.*, 1934, 1, 552).—S. G.

The Magnetocaloric Effect According to the Honda-Okubo Theory of Ferromagnetism. Kotarō Honda and Tokutarō Hirone (*Z. Physik*, 1936, **102**, (1/2), 132-137).—It is shown that the experimental results of Okamura agree satisfactorily with the Honda-Okubo theory of ferromagnetism.—B. C.

Technical Problems in Ferromagnetism in Weak Fields. R. Goldschmidt (*Helv. Phys. Acta*, 1936, **9**, (1), 33-41; *Sci. Abs.*, 1936, [A], **39**, 429).—[In German.] The essential properties of a magnetic material for use in weak fields are outlined and, in illustration, a number of magnetization curves in low fields are given for several magnetic alloys of industrial importance. The hysteresis loops of all the alloys are similar in type, their characteristics being governed by the Rayleigh formula $B = (\mu_0 + 2\nu H_1)H \pm \nu(H^2 - H_1^2)$, where μ_0 is the initial permeability, ν the hysteresis factor, H_1 the maximum field strength, and H the field strength corresponding to an induction B . Measurements of permeability and hysteresis loss in weak alternating fields by Jordan, Gans, Becker, and others show a linear correspondence between permeability and loss and the amplitude; for finely divided materials the loss increases approximately with the frequency. These results may be derived from Rayleigh's formula. Measurements on magnetic losses near the Curie point are described and the results discussed theoretically. A description is given of a number of results obtained by G. with high silicon transformer sheet-iron.

—S. G.

On Ising's Model of Ferromagnetism. R. Peierls (*Proc. Cambridge Phil. Soc.*, 1936, **32**, (3), 477-481).—S. G.

***Distribution of Magnetic Field Around Simply and Multiply Connected Superconductors.** H. Grayson Smith and J. O. Wilhelm (*Proc. Roy. Soc.*, 1936, [A], **157**, (890), 132-146).—The magnetic field round parallel cylinders of cast tin joined by cross-bars of tin at the ends, at temperatures in the superconducting range, was investigated by means of search coils. By breaking the superconducting circuit magnetically, it is shown that the persistent current is a circulating current. A saturation value for the persistent current is determined.—B. C.

Magnetic After-Effect. H. Kindler and A. Thoma (*Arch. Elektrotech.*, 1936, **30**, 514-527).—A comprehensive review of theoretical and experimental work.—S. G.

II.—PROPERTIES OF ALLOYS

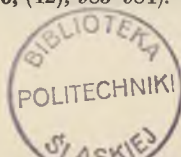
(Continued from pp. 450-457.)

***Contraction of Aluminium and Its Alloys During Solidification.—II.** L. Losana (*Alluminio*, 1935, **4**, (6), 325-331).—See also *Met. Abs.*, 1935, **2**, 279. Experiments were conducted to determine the volume contraction during solidification, and the influence on it of the various dissolved gases, for aluminium (99.998% pure) and binary alloys with copper, silicon, and iron. The gases were allowed to pass through the molten metal for 5 minutes at the rate of about 2 bubbles per second. It was found that the average volume contraction of the very pure aluminium is 6.38%. There is a relationship between the dissolved gases and contraction, in the sense that they tend to reduce the latter. Pure aluminium dissolves very small quantities of gas even at about 1000° C. The usual impurities, such as silicon and iron, increase solubility; iron is very active towards steam; copper strongly favours the fixing of oxygen. Alloys of aluminium, with silicon, iron, or copper, have a greater fixing power than pure aluminium. Nitrogen in every case is not very soluble.

—J. K.

***Endurance of Aged Aluminium Alloys under Repeated Impact.** H. Bohner (*Metallwirtschaft*, 1936, **15**, (42), 983-984).—Periodic impact tests on notched

M M



bars of an aluminium alloy with copper 5.65 and manganese 0.7% showed that it has a higher endurance limit than iron under similar conditions. The rolled alloy is somewhat superior to the extruded alloy. The nature of the heat-treatment is without appreciable influence.—v. G.

Nickel in Copper-Aluminium Alloys. — (*Metallurgist* (Suppl. to *Engineer*), 1936, 10, 132-133).—A reference to former work and a brief summary of a paper by Gridnew and Kurdjumow in *Metallwirtschaft*, 1936, 15, 229, 256; see *Met. Abs.*, this vol., p. 298.—R. G.

***On the Composition of the Insoluble Residue Left after Dissolving Al-Cu-Ni Alloys in Potassium Hydroxide.** Otakar Quadrat and Jean Jiriste (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 211-215; and *Rev. Mét.*, 1936, 33, (8), 489-493).—[In French.] The residue left after dissolving the ternary aluminium-copper-nickel alloys in potassium hydroxide solution contains considerably more aluminium than the residues left after dissolving the binary aluminium-copper and aluminium-nickel alloys. Analyses of the residues from 28 (mostly unspecified) alloys are discussed at length, and it is concluded that the residue is mainly composed of the compound Cu_2NiAl_3 , with smaller amounts of NiAl_3 , CuAl_2 , and the free metals. Slowly cooled alloys and also water-quenched alloys yield residues containing less aluminium than if they are rapidly cooled in air.—J. C. C.

***A Study of the Effect of a Prolonged Overheating on the Mechanical, Macroscopical, and Microscopical Characteristics of an Aluminium[-Copper-Silicon] Alloy with or without Titanium.** A. Vivanti and R. Guastalla (*Alluminio*, 1935, 4, (5), 271-298).—An investigation of the effect of overheating for 1 or 2 hrs. at 800° C. on an aluminium alloy with copper 10, silicon 1, and iron 0.5%, with or without titanium (0.2%). Reproducing foundry conditions as faithfully as possible, 2 pouring temperatures were chosen—660° and 800° C.—so as to include all temperatures likely to occur in practice. 250 tensile test-bars were cast (100 of the specimens being for macrography) and various commercial castings were made. It is found that overheating generally has more effect on the first melt than on a remelt and has little effect on either if it contains titanium. Overheating for 1 hr. always acts favourably on the mechanical characteristics. Test-pieces of alloys overheated for 1 or 2 hrs. and cast at 800° C., give very similar results to those cast at 660° C. without overheating. The treatment tends to send the silicon as well as the iron into solid solution. Titanium refines the macroscopic structure and renders the alloy insensitive to overheating (in all test-pieces the CuAl_2 is present as a eutectic, and there is no ternary or quaternary eutectic). It improves the mechanical characteristics. The paper contains 100 photomicrographs, tables, and graphs.—J. K.

***The Physical Nature and Properties of Lantal-Type Alloys.** G. G. Urasow and G. M. Zamoruev (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Analyse Phys.-Chim.)*, 1936, 8, 255-267).—[In Russian.] The change in hardness was studied during artificial ageing of alloys with copper 4.0-4.86, silicon 1.4-2, and iron 0.44-0.70% at 100°, 125°, 145°, 165°, 175°, and 195° C. Maximum hardness was obtained on ageing at 145° C.—N. A.

***The Age-Hardening of Duralumin at Various Temperatures.** P. L. Teed (*Vickers (Aviation), Ltd.*, 1936, 44 pp. (mimeographed)).—[Note: The original of this paper may be consulted in the Library of the Institute of Metals.] The age-hardening of Duralumin after quenching was studied by tensile, shear, and hardness tests of material taken from 5 different sheets. When ageing occurs at atmospheric temperature there is a progressive increase at a diminishing rate in proof stress, ultimate stress, shear stress, and hardness, while the elongation value increases slightly. The proof stress value attained is less than that usually observed in "as received" material owing to a certain amount of cold-working of the latter subsequently to final heat-treatment, applied by manufacturers. When quenched material was aged at

0° C. the rate of increase in mechanical properties was much reduced, but the curves suggest that very long periods, e.g. 2500 hrs., of ageing at 0° C. would have given strength properties exceeding those obtained by ageing at atmospheric temperature. Ageing at -22° C. gave still slower rates of improvement in properties of quenched material. Age-hardening of quenched material stored at -22° C. and subsequently aged at atmospheric temperature is more rapid than normal. Age-hardening at 100° C. after quenching gave an increase in rate of initial improvement in mechanical properties. By ageing quenched material at 160° C. for a limited number of hours a very high proof stress (0.1%) was obtained, and this condition was found to be stable at atmospheric temperature over the period of 143 days covered by the tests. Ageing at 100° and 129° C. also gave higher values of 0.1% proof and ultimate stresses than ageing at atmospheric temperature.—H. S.

The Effect of Aluminium and Silicon on the Technological Properties of German Silver. — (*Metall-Woche*, 1936, (5), 82-83).—L. A. O.

***Systematic Studies of Heat-Resisting Aluminium Alloys.** Eiichiro Itami (*Tetsu-to-Hagane (J. Iron Steel Inst. Japan)*, 1934, 20, 358-386, 450-476).—[In Japanese.] In a previous research (*Met. Abs.*, 1935, 2, 371) I. was unable to find any good alloy that could be compared to "Y" alloy. A systematic study was therefore made of heat-resisting aluminium alloys. The specimens were chill-cast and tensile tests were carried out in the range room temperature to 500° C. on pure aluminium, and binary, ternary, and quaternary alloys and so on, adding the following elements: copper, zinc, nickel, chromium, manganese, iron, silicon, and magnesium. The results are discussed. The alloys containing copper 4, silicon 1, and magnesium 1% and copper 4, silicon 10, and magnesium 1% showed excellent mechanical properties after heat-treatment. The effects of nickel, chromium, manganese, and iron in improving these alloys were then studied. A remarkable improvement was noticed on adding titanium (as $TiCl_4$) to these alloys; for example, a specimen had a tensile strength of 46 kg./mm.² at ordinary temperature and 30 kg./mm.² at 300° C. These results are discussed from a theoretical point of view.—S. G.

Aluminium in Siderurgy. J. Bally (*Rev. Aluminium*, 1936, 13, (83), 307-316).—The physical and chemical properties of iron-rich iron-aluminium alloys are given, and the applications of these alloys are described.—J. H. W.

***X-Ray Examination of the Equilibrium Diagram of the Aluminium-Lithium Alloys and the Structure of the Compound AlLi.** G. Komovskiy and A. Maksimov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1935, 5, (8), 1343-1352).—[In Russian.] The system was examined by X-rays up to 20.5% (50 atonic-%) lithium. The β -phase is the compound AlLi with a cubic lattice, $a = 6.37 \text{ \AA}$, 16 atoms in the unit cell. The lattice parameter of aluminium remains unchanged by dissolution of lithium.—N. A.

***The Ternary System Aluminium-Magnesium-Zinc. II.—Region Aluminium-Al₃Mg₃-Al₄Mg₃Zn₃-Aluminium.** Werner Köster and Walter Dullenkopf (*Z. Metallkunde*, 1936, 28, (10), 309-312).—Cf. *Met. Abs.*, this vol., p. 347. In this portion of the ternary system the two compounds Al₃Mg₄ (δ) and Al₂Mg₃Zn₃ (T) form a pseudobinary system with a eutectic at 450° C. aluminium 36, magnesium 44, zinc 20% the two constituents of which are solid solutions containing, respectively, aluminium 41, magnesium 48, zinc 11%, and aluminium 22, magnesium 28, zinc 50%. In the range 35-55% magnesium the equilibria are (like those in the magnesium-aluminium system) difficult to determine since the melting range is only 15° C., but the existence of a ternary eutectic between the α , β , and T phases at 447° C., aluminium 57, magnesium 31, zinc 12% was established by micrographic examination. At 449° C. there is a point of 4-phase equilibrium: liquid + $\delta \rightleftharpoons \gamma + T$ (δ = aluminium 50, magnesium 45, zinc 5%; T = aluminium 44, magnesium 33, zinc 23%; and liquid = aluminium 51, magnesium 39, zinc 10%), and at 448° C. a second

point of 4-phase equilibrium: liquid + $\gamma \rightleftharpoons \beta + T$, the γ -phase containing aluminium 55, magnesium 40, and zinc 5%. Numerous characteristic structures are illustrated and a diagram of the equilibria in the system is included.

—A. R. P.

***System Aluminium-Magnesium-Zinc.** Karl Riederer (*Z. Metallkunde*, 1936, 28, (10), 312-317).—Cf. preceding abstract. An X-ray examination of the various phases of the aluminium system showed that the β -phase has a hexagonal lattice with $a = 11.38 \pm 0.02$ A. and $c/a = 1.57$ and the δ -phase a cubic body-centred lattice with $a = 10.45 - 10.56$ A., 58 atoms in the unit cell. The existence of the γ -phase of Kawakami (*Met. Abs.*, 1934, 1, 169), has been confirmed, but it can be obtained only by slow cooling from the liquid state, and not by annealing. In the ternary system the compound $Al_2Mg_3Zn_3$ (T) has a body-centred cubic lattice with 161 atoms in the unit cell; its parameter increases along the section T- β from 14.29 to 14.71 A. and along the section T- δ from 14.29 to 14.60 A., and its limits of homogeneity in these directions are, respectively, aluminium 44.6, magnesium 31.7, zinc 23.7%, and aluminium 27.5, magnesium 32.5, zinc 40%. The composition of alloys on the various quasi-binary sections of the ternary system are shown in a diagram, and the equilibria in the system are discussed from the point of view of the phase rule.—A. R. P.

***Ternary Diagram of the Aluminium-Magnesium-Zinc System.** Matsujiro Hamazumi (*Tetsu-to-Hagane (J. Iron Steel Inst. Japan)*, 1936, 22, (4), 258-271).—[In Japanese.] No English summary is given.—S. G.

***Investigation of Special Silumins.** G. G. Urasow and I. R. Nizheradze (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Analyse Phys.-Chim.)*, 1936, 8, 201-254).—[In Russian.] The mechanical properties of aluminium-silicon alloys (Silumins) increase on addition of up to 4% of copper. The mechanical properties of cast modified aluminium-silicon-copper alloys (Si 10-20% and Cu up to 4%) are higher than those of unmodified alloys. Heat-treatment at 500° C., quenching in water, and subsequent artificial ageing at 150° C. for 24 hrs. considerably improves their mechanical properties. These alloys age-harden only very slightly. Silumins containing copper have excellent casting properties, fill the mould well, and give dense, smooth and blister-free castings. The average sp. gr. of the alloys is 2.72, and they can be wrought.—N. A.

Castings in Silumin Gamma. G. Sachs and E. Scheuer (*Found. Trade J.*, 1936, 55, (1048), 218-220).—Abridged translation from *Metallwirtschaft*, 1935, 14, 937, 972; see *Met. Abs.*, this vol., p. 36.—J. E. N.

[“Lo-Ex”] **A Low-Expansion Nickel-Silicon-Aluminium Alloy.** — (*Inco*, 1936, 13, (4), 17).—The properties of “Lo-Ex,” an aluminium alloy containing silicon 14, nickel 2, copper 0.9, and magnesium 1.0%, used for pistons are dealt with. Carbide or diamond tools are recommended for machining this alloy.—R. G.

***Magnetic Investigation of the Zinc-Aluminium System.** Hermann Auer and Karl Ernst Mann (*Z. Metallkunde*, 1936, 28, (10), 323-326).—Measurements of the diamagnetic susceptibility of aluminium-zinc alloys show that the solid solubility of aluminium in zinc increases from 0.1% at 100° C. to 0.38% at 200° C. and 1.1% at 370° C. (eutectic temperature). The eutectoidal horizontal $\beta \rightleftharpoons \alpha + \gamma$ is at 270° C. and begins at 0.65% aluminium. The magnetic tests also showed that the iron impurity in zinc has a solid solubility which increases with increase in temperature.—A. R. P.

***Investigations of Zinc-Aluminium Alloys (German Electrolytic Zinc Basis Metal) with Additions of Copper, Magnesium, Nickel, Lithium, and Lead.** W. Guertler, F. Kleweta, W. Claus, and E. Rickertsen (*Light Metals Research*, 1936, 5, (5), 102-105).—Summary from *Z. Metallkunde*, 1936, 28, 107, 178; see *Met. Abs.*, this vol., p. 393.—L. A. O.

*Investigation of the Effect of Duration of Heat-Treatment on Aluminium Alloys. (Tutov.) See p. 584.

Variations in the Density of High-Strength Aluminium Alloys. — (*Metall-Woche*, 1936, (22), 429-430).—L. A. O.

Aluminium Foundry Alloys. R. Irmann (*Metallwirtschaft*, 1936, 15, (42), 984-989).—An extensive review of the properties of various aluminium alloys for the foundry.—v. G.

Composition and Properties of Light-Metal Piston Alloys. — (*Metall-Woche*, 1936, (16), 301-302; (17), 321-322; (18), 342-343).—The compositions of 55 alloys are tabulated, and a brief account is given of the properties of the most important of them.—A. R. P.

*On the Photoelectric Effect of Metallic Alloys.—II [Cadmium-Antimony, Copper-Antimony]. Luigi Belladen and Giulio Galliano (*Annali Chim. applicata*, 1936, 26, (6), 263-266).—See also *Met. Abs.*, this vol., p. 454. Photoelectric sensitivity curves were obtained for the systems cadmium-antimony and copper-antimony; in the former system the sensitivity reaches a pronounced maximum at CdSb and a much less marked minimum at the eutectic composition, whereas in the latter system there is no minimum but a sharp maximum at Cu_2Sb .—A. R. P.

*On Superposed Transparent Photo-Cathodes. P. Görlich (*Z. Physik*, 1936, 101, (5/6), 335-342).—The effects of alloying various metals with caesium on the photoelectric constants of transparent caesium alloy films on transparent films of supporting metals are given. The result of using oxygen as a sensitizer is discussed, and it is shown that this moves the emission maxima in the long-wave direction.—B. C.

*Alloys of Workable Chromium. Wilhelm Kroll (*Z. Metallkunde*, 1936, 28, (10), 317-319).—The structure and working properties of alloys of malleable chromium with 3-9% of iron, nickel, cobalt, aluminium, silicon, molybdenum, tungsten, vanadium, titanium, zirconium, and tantalum were examined. The alloys were made by sintering mixtures of the powdered metals first at 1200° C. *in vacuo*, then at 1500°-1700° C. in argon. All the alloys except those with a high nickel content were readily rolled hot to thin sheet, but were brittle at room temperature, especially those containing aluminium, silicon, and zirconium. The iron alloys were particularly good, especially that containing 4.7% iron. The presence of even a high content of oxide had little effect on the hot-rolling properties of the alloys. Most of the oxide-free alloys consisted of solid solutions the hardness of which varied considerably with the alloying element, nickel having the greatest and tantalum the least hardening effect. It is suggested that the lack of malleability of aluminothermic chromium is due to the presence of small amounts of sulphur, arsenic, phosphorus, and carbon.—A. R. P.

*X-Ray Investigation of the Iron-Chromium-Silicon Phase Diagram. A. G. H. Andersen and Eric R. Jette (*Trans. Amer. Soc. Metals*, 1936, 24, (2), 375-419).—The equilibrium diagram for solid iron-chromium-silicon alloys was determined by X-ray crystal structure methods for iron-rich alloys containing up to about 35% chromium and 20% silicon. The phase boundaries of the solid solution in α -iron were determined at 600°, 800°, and 1000° C. The α -phase boundary falls into three sections. In one it is in equilibrium with a phase of composition $(FeCr)_3Si_2$ which is isomorphic with Fe_3Si_2 . In the next section, which is very short, the α -phase is in equilibrium with a phase isomorphic with Cr_3Si . Over the longest section of the α -boundary, the second phase, denoted Σ , is probably a solid solution based on the compound FeCr, but containing silicon in solid solution. There is a range of composition in which precipitation-hardening is possible.—W. H.-R.

†A Review of Copper Alloys [—I]. M. G. Corson (*Iron Age*, 1936, 138, (16), 114-115, 117-118, 120, 122, 124, 126, 144).—C. classifies the copper alloys, both

those scarcely used and those in common use, describes their composition, properties, and applications, and discusses the use of heat-hardenable copper-base alloys for casting. He concludes that there is no hope of finding a new copper alloy with exceptional characteristics, although vanadium may still produce an alloy of sufficient strength and hardness to compete with others. [The review is to be continued.]—J. H. W.

***The Solid Solubilities of the Elements of the Periodic Sub-Group Vb in Copper [and the Lattice Spacings of the Primary Solid Solutions].** J. C. Mertz and C. H. Mathewson (*Metals Technology*, 1936, 3, (6), 20 pp.; *A.I.M.M.E. Tech. Publ. No. 747*).—The solid solutions of phosphorus, arsenic, and antimony in copper were investigated by the X-ray back reflection method, using specimens quenched from different temperatures. The lattice spacings are tabulated, and the following solubility limits determined: (1) *Phosphorus*. About 1.7% phosphorus by weight dissolves in solid copper at 700° C., and the solubility diminishes to 0.6% at 300° C. (2) *Arsenic*. The solubility diminishes gradually from about 8% by weight at 680° C. to 7.5% at 300° C. (3) *Antimony*. The solubility diminishes gradually from 11.3% antimony by weight at 630° C., to 10% at 450° C., and then much more rapidly to 2.1% at 211° C. The solid solubility curves give linear relations between $\frac{1}{T}$ and

$\log S$, where T is the temperature in degrees absolute, and S is the atomic percentage of solute at the solubility limit. The abrupt change in direction of the solubility curve for antimony is due to the transformation of the β -phase with which the α solid solution is in equilibrium.—W. H. R.

***Expansion Anomalies Due to External Forces in 7-16% Aluminium Copper-Aluminium Alloys.** André Boutillier (*Compt. rend.*, 1936, 203, (10), 572-574).—A study of the anomalies of expansion of the copper-aluminium alloys, observed in a great number of specimens under the most varied conditions using a Chevenard differential dilatometer, enabled these anomalies to be classified in 3 groups: (1) anomalies of change of state, which corresponds to a variation of density or of the law of expansion; (2) anomalies of plasticity, a function of the time and bound up with external forces; and (3) anomalies which cannot be attributed either to variations of density or to external forces. These anomalies may be more or less superposed. Those of (2) have been isolated and have been studied by assuming that when the sign of the applied force is changed, the anomalies change their sign without changing their magnitude. They are localized in the vicinity of certain transformations. In a specimen submitted to a compression of 20 gm./mm.² in the dilatometer, the anomaly of plasticity can compensate, for a rate of heating of 3°-4°/minute, the expansion which results from the increase of the specific volume in the course of the eutectoid- β solution transformation. A tension of the same value substitutes an expansion for the contraction, which must accompany the precipitation of the α -constituent during the cooling of the β -solutions containing at least 12% aluminium. With forging alloys rich in the α or δ constituents, the anomalies of plasticity at the first heating have an exceptional range, in particular that above 570° C. Microexamination showed a complete parallelism in this case between the phenomenon of plasticity and the progressive crystalline orientation of the elements of the different phases.—J. H. W.

***Transformations in Eutectoid Aluminium-Copper Alloys. II.—Dilatometric Investigation of the Transformations of the β -Solid Solution in the Metastable State.** V. Gridnev and G. Kurdjumov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1936, 6, (5), 775-780 (in Russian); and *Tech. Physics U.S.S.R.*, 1936, 3, (2), 135-141 (in German)).—Aluminium bronzes with 12% aluminium and with aluminium 12 and nickel 2% were investigated by means of the Chevenard dilatometer. The transformation of the disordered β -phase into

the ordered β_1 -phase is accompanied by a small contraction in volume. On rapid heating of quenched alloys, β' passes directly into β . For the $\beta' \rightarrow \beta_1$ transformation to take place diffusion must occur in the solid solution in the temperature range of existence of the β -phase. After annealing in this range the $\beta_1 \rightarrow \beta'$ transformation temperature is decreased. On subsequent heating the $\beta' \rightarrow \beta_1$ transformation proceeds without diffusion, and cannot be arrested even by rapid heating. Thus, the non-diffusion transformation of the space lattice of the metastable phases β_1 and β' , after annealing in a definite temperature region, becomes reversible. The cause of this phenomenon is not yet elucidated.—N. A.

***Research on the Hardness of Aluminium Bronzes after Ageing. I.—Binary Bronzes of the 90 : 10 Type.** C. Panseri (*Alluminio*, 1935, 4, (4), 213–218).—A study of the relations between ageing temperature, and hardness in aluminium bronzes. Two samples of the binary type were considered, containing (A) 10.85 and (B) 10.65% aluminium, respectively, but of very different purity; (A) contained iron 0.26 and silicon 0.07%; and (B) iron 0.02 and silicon 0.04%. The test-bars were die-cast in cast-iron dies. After treating for 2½ hrs. at 900° C. both bars were quenched in water at 15° C. For (A) the hardness was studied as a function of the quenching temperature, the transition points between the various regions of the diagram being thus deduced. The eutectic horizontal was found to occur at over 565° C., in agreement with Smith and Lindlieff. For the ageing temperatures the hardness of (A) increases to a maximum at about 400° C., decreases rapidly between 400° and 425° C., and then more slowly to 650° C., after which the hardness remains constant at a minimum. The curve for (B) is similar, except that there is a maximum at 350°, a first inflection at 390° and a second inflection at 725° C. All the specimens were aged for 2 hrs., and then cooled in the furnace at a rate of about 100° C. per hr. A few considerations on the measurement of the hardness of the aluminium bronzes are included in the paper.—J. K.

***Influence of Heat-Treatment on Fatigue and Corrosion-Resistance of [90 : 10] Aluminium Bronze.** I. Musatti and L. Dainelli (*Alluminio*, 1935, 4, (1), 51–63).—The fatigue limit of the material is considerably improved by heat-treatment, as compared with the material in the simply normalized condition. The highest resistance to fatigue was obtained with an ageing temperature of 500° C. The resistance of the alloy to nitric, hydrochloric, and sulphuric acids was greatly influenced by heat-treatment. With nitric acid in particular, the presence of eutectic makes the material very liable to attack; with a fully heat-treated structure it is approximately 20 times more resistant. With hydrochloric and sulphuric acids the difference is not so marked, but for these two acids samples containing the eutectic show a higher resistance than the fully heat-treated ones.—J. K.

***Investigation on the Precipitation-Hardening of Copper-Beryllium Alloys.** M. I. Zaharova (*Metallurg (Metallurgist)*, 1936, (7), 101–105).—[In Russian.] The rate of decomposition of the supersaturated solid solution in copper alloys with 1.4–2.1% beryllium, determined by X-ray analysis and hardness measurements, increases with increase in the beryllium content and ageing temperature, and is also accelerated by deformation especially when this is effected after the induction period rather than immediately after quenching. The hardening effects are attributed to the development of elastic stresses along the interfaces between the solid solution and the new phase.—N. A.

***Beryllium-Copper Alloys with High Electrical Conductivity and Hardness.** Werner Hessenbruch (*Z. Metallkunde*, 1936, 28, (10), 320–323).—The tensile properties and electrical conductivity of numerous alloys of copper with 0.15–2% beryllium and small quantities of chromium, cobalt, manganese,

silicon, iron, tin, silver, cadmium, nickel, aluminium, or zirconium are tabulated; the following range of properties may be obtained:

Alloying Elements, %.	Conductivity, %.	Tensile Strength, Kg./mm. ² .
Be 0.3, Zr 0.5	85-82	28-47
Be 0.15, Cr, 0.85	65-69	32-52
Be 0.4, Si 0.5, Co 2.6	55-58	about 70
Be 0.3, Mn 0.5, Co 0.5	40-37	73-83
Be 1.0, Ag 30-5	45-30	110-120
Be 2.0, Co, Fe, Mn, or Si 0.5	25-20	140-150

The actual values of these properties for any alloy can be varied considerably by heat and mechanical treatment. The alloys have proved useful for the manufacture of the electrodes of welding machines, springs for electric switches, and parts of electrical apparatus demanding high strength and conductivity.—A. R. P.

Beryllium-Copper-Cobalt Alloys. F. G. Benford (*Met. Ind. (N. Y.)*, 1936, **34**, (6), 226).—The addition of cobalt to the binary beryllium-copper alloys results in a decrease in the amount of beryllium necessary for heat-treating to obtain optimum physical properties, with consequent reduction in cost. Some physical properties are given for Trodaloy, an alloy with beryllium 0.4, cobalt 2.6, and copper 97%.—L. A. O.

High-Pressure and High-Speed Bearing Alloy "Kelmet." Iwao Iwasaki (*Kinzoku (J. of Metals)*, 1935, **5**, (8), 346-349 (in Japanese); and (abstract) *Japan Nickel Rev.*, 1936, **4**, (3), 523 (in English and Japanese)).—An account of a copper-lead bearing alloy containing small additions of tin, nickel, silicon, zirconium, and sulphur.—P. M. C. R.

***CA Alloy as Spring Material.** Sakae Onoe (*Furukawa Denko (J. Furukawa Elect. Ind. Co.)*, 1935, (July), 38-43 (in Japanese); and (abstract) *Japan Nickel Rev.*, 1936, **4**, (2), 366-368 (in English and Japanese)).—Describes tests on coil springs of a copper alloy containing nickel 3.5, silicon 1.0, and aluminium 4.75%. The alloy appears to be a suitable substitute for phosphor-bronze and for some applications in place of piano wire.—R. G.

***The Effects of Temperature and of Cold-Work on the Mechanical Properties of a Medal Bronze.** W. Broniewski and J. Szreniawski (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, **2**, 189-194; and *Rev. Mét.*, 1936, **33**, (7), 442-447).—[In French.] The mechanical properties were determined at 12 temperatures between -183° and 700° C. for an alloy of tin 5, copper 95%, the tests being carried out on wires 5 mm. in diameter both after a 50% reduction by cold-working and after annealing for 30 minutes at 600° C. Tensile strength, hardness, and impact strength decrease as the temperature is increased, but the curves show an inflection, the decrease in strength between 0° and 200° C. being very slight. The effects of cold-working are lost suddenly at 500° C. Samples of this alloy were also reduced by cold-work by amounts between 2.5 and 99%, and the mechanical properties at room temperature determined both after cold-working and after annealing for 2 hrs. between 100° and 800° C. After 20% reduction, the elongation decreases almost to zero, and after 72% reduction a rapid decrease in the reduction of area at fracture is observed. An increase in hardness occurs when alloys reduced more than 20% are annealed at low temperatures, the maximum effect occurring at about 200° C. The "true hardness" of the alloy, determined by making repeated Brinell impressions on the same spot, annealing at 600° C. between each impression, until the size of the impression remains constant, is 3.1.—J. C. C.

***Inverse Segregation and the "Tin Sweat" of Bronzes.** G. Somigli (*Industria meccanica*, 1936, 18, 347-355, 424-434; *C. Abs.*, 1936, 30, 7077).—According to new experiments, the cause of segregation in bronze must be ascribed to the action of enclosed gas. The Ludwig-Soret effect, although theoretically valid, has no practical importance as there is not sufficient thermal gradient during the casting period to establish itself. The contraction accompanying solidification has an indirect effect only, while the gases dissolved during melting, and escaping during solidification, determine but do not regulate the intensity of inverse segregation. Contraction due to shrinking is not sufficient to determine the causes for tin sweat because the latter does not take place when the dissolution of gases is prohibited. The method of presolidification, followed by remelting under a suitable cover, is practically sufficient to avoid inverse segregation even in bronzes with a high phosphorus content. 25 references are given.—S. G.

Influence of Iron on the Properties of Tin Bronze. L. I. Minkin (*Metallurg (Metallurgist)*, 1935, (6), 106-108).—[In Russian.] It is shown that 0.3% iron does not affect the mechanical properties of a bronze obtained by ordinary melting and may be allowed; this is confirmed by works' experience.—N. A.

On Lead-Bronzes. Willi Claus (*Z. Metallkunde*, 1936, 28, (6), 176).—The conclusion of an article in an earlier issue; see *Met. Abs.*, this vol., p. 199.

—L. A. O.

***Impurities in Silicon-Bronzes and -Brasses.** A. P. Smiriagin (*Zvetnyye Metalli (Non-Ferrous Metals)*, 1936, (6), 101-114).—[In Russian.] Since iron increases the friction and corrosion and adversely affects the mechanical properties of silicon-brasses, it should be considered an undesirable impurity. Nickel, antimony, arsenic, and phosphorus have a similar effect on the mechanical properties, increase porosity, film inclusions, and intercrystalline shrinkage. Aluminium improves the mechanical properties, but increases film formation and therefore should be considered harmful. Tin produces brittleness and should not exceed 1%. Lead reduces the mechanical, but improves the anti-friction properties. In manufacturing water- and steam-fittings from silicon-brasses, the alloys used should conform to the following specification: low-silicon bronzes should be free from lead; lead-tin bronzes should be free from aluminium. The influence of these impurities on the structure has been studied.—N. A.

***Improvement of Properties of German Silver, Phosphor-Bronze, and Tin-Zinc Bronzes.** G. F. Rauchenko (*Metallurg (Metallurgist)*, 1936, (9), 81-88).—[In Russian.] Types of phosphor-bronze and German silver suitable for springs have markedly different mechanical properties, particularly as regards modulus of elasticity and limit of proportionality in bending. The determination of the limit of proportionality in bending soon after rolling the metal and subsequent tests of the same material after storage, showed an increase of this factor on repeated tests. In phosphor-bronze there is a critical interval of work-hardening at 75-80%. Low-temperature annealing (200° C.) of the alloys examined produces a sharp increase in the limit of proportionality, somewhat increases the modulus of elasticity, tensile strength and elongation of German silver; sharply increases the relative elongation of the bronzes; decreases the residual stresses and removes the heterogeneity of the properties of the work-hardened material.—N. A.

***X-Ray Study of the Inter-Diffusion of Copper and Zinc.** (Owen and Pickup.) See p. 529.

***On the Non-Diffusion Transformation of the β -Phase in Copper-Zinc Alloys.** E. Kaminskiy and G. Kurdjumov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1936, 6, (6), 984-988).—[In Russian.] Non-diffusion transformations exist in solid solutions of β -copper-zinc alloys. The transformation temperature decreases rapidly with increase of zinc content. On quenching

the alloy in a 10% sodium hydroxide solution, a new face-centred tetragonal space lattice α' with $a = 3.755 \text{ \AA}$., $c = 3.586 \text{ \AA}$., and $a/c = 1.047$ appears. Appearance of the tetragonal space lattice may be explained by assuming that: (1) the heterogeneous β -phase before transformation into α' passes into a homogeneous β -phase; (2) the reconstruction of the space-centred β -lattice into a face-centred one takes place like the transformation of γ -iron into α -iron, and of β -brass into α -brass. The mechanism of the non-diffusion process and the distribution of atoms in the space lattices of homogeneous β and α' are indicated.—N. A.

***X-Ray Examination of Certain Copper-Zinc Alloys at Elevated Temperatures.** (Owen and Pickup.) See p. 530.

Calcium-Brass. Kenjo Ono (*Tetsu-to-Hagane (J. Iron Steel Inst. Japan)*, 1936, 22, (4), 272-276).—[In Japanese.] No English summary is given.—S. G.

***Magnesium Silicide in 85 : 15 Brass. Effect on the Properties.** H. S. Van Klooster and J. E. Harris, Jr. (*Metals and Alloys*, 1936, 7, (5), 135-139).—A series of alloy brasses was prepared by the addition of magnesium silicide up to 4.7% to a brass of approximately 85 : 15 composition. The effect of the added silicide was investigated by a study of the sp. gr., hardness, tensile strength, electrical conductivity, cooling curves, and microstructure. The alloy brasses are much harder than the pure brass and show an increase in hardness and electrical conductivity on annealing at successively higher temperatures. Maximum hardness is reached at 450°-550° C. While no age-hardening was observed, the temperature-hardening and the increase in conductivity on heating can be readily explained on the basis of the theory of Jeffries and Archer. The hard particles of silicide that remain scattered throughout the brass after prolonged annealing at high temperatures produce a brass that might possibly be used as a bearing metal, and in cases where strength, hardness, and machinability are required.—L. A. O.

***Contributions to the Systems Copper-Zinc-Sulphur and Cuprous Sulphide-Zinc Sulphide-Lead Sulphide.** Erwin Strohfeldd (*Metall u. Erz*, 1936, 33, (31), 561-572).—In the copper-zinc-sulphur system alloys with more than 1% sulphur separate into layers on cooling, the bottom consisting of a zinc-copper alloy and the upper of a mixture of cuprous and zinc sulphides. On addition of more sulphur, zinc sulphide alone is formed, the metal layer becoming poorer in zinc and the sulphide layer richer in zinc sulphide; no copper sulphide is produced until all the zinc has been removed from the metal. The sulphur in the metal layer exists as dendritic crystals of zinc sulphide.—A. R. P.

***Contribution to the Study of the Effect of Annealing on the Structure, Brinell Hardness (H_B), Tensile Strength (R_t), and Elongation (A_{10}) of Cold-Rolled 67 : 33 Brass.** L. Loskiewicz with G. Gouschbauer, M. Nosowicz, Z. Hayto, and B. Podczaski (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 195-210; and *Rev. Mét.*, 1936, 33, (8), 473-488).—[In French.] Cf. *Mét. Abs.*, 1935, 2, 574. Sheets of 67 : 33 brass were reduced between 1 and 65% by cold-rolling and samples were subsequently annealed for $\frac{1}{2}$, 6, and 200 hrs. at temperatures between 200° and 750° C. Determinations were made at each stage of the X-ray patterns, microstructure (grain-size), Brinell hardness, tensile strength, and elongation, and the results are presented in a series of tables, curves, and three-dimensional diagrams. The effect of very prolonged low-temperature annealing (up to 12,800 hrs.) at 300° C. on mechanical properties and microstructure was to produce recrystallization and grain-refinement in samples which, being reduced by only small amounts, were unaffected by anneals of shorter duration. Series of tests were also carried out on samples annealed at various temperatures before the start of cold-rolling, so as to relate the properties before and after reduction. The effects on the microstructure, X-ray patterns, and mechanical properties of sheet reduced by 40%, of a preliminary anneal for 6 hrs. at temperatures

between 200° and 750° C. before a second anneal over the same range of temperatures was also studied.—J. C. C.

Research on Tungum Alloy. J. E. Newson. B. C. Laws (*Shipbuilder*, 1936, 43, (322), 527).—Correspondence resulting from an article by L. (cf. *Met. Abs.*, this vol., p. 391). N. refers to the use of the alloy for propellers and asks for test data for Tungum in the "as cast" condition; L. supplies the data both for cast alloy and for test-pieces cut from a propeller.—J. W. D.

Remarks on the Paper by Le Blanc and Wehner on Gold-Copper Alloys. W. Broniewski and K. Wesolowski (*Ann. Physik*, 1936, [v], 25, (8), 757–758).—B. and W. reply to Le Blanc and Wehner's criticisms of their annealing conditions (see *Met. Abs.*, 1935, 2, 575).—v. G.

***On the Magnetic Stability of Ferro-Magnetic Iron Alloys.—I.** W. S. Messkin and J. M. Margolin (*Z. Physik*, 1936, 101, (7/8), 456–477).—The magnetic stability of iron alloys increases, in general, with increasing concentration of a solid solution and by homogenization of the structure. The decomposition of a super-saturated solid solution produces a corresponding large decrease in the stability. It is shown that the constancy of the permeability for small field strengths is always increased by precipitation-hardening. Nickel-free iron alloys may have a very small instability. A thorough investigation of a series of complex nickel-free iron alloys containing carbon, manganese, aluminium, chromium, copper, and silicon shows that these may have a lower instability in addition to a low hysteresis loss, a high electrical resistance, and satisfactory technical properties.—P. W. R.

***Influence of the Conditions of Test on the Shrinkage [of Antimonial-Lead and Aluminium Castings].—I–II.** O. Bauer and H. Sieglerschmidt (*Met. Material., Sonderheft* 28, 1936, 49–53, 99–104).—See *Met. Abs.*, 1935, 2, 576, and this vol., p. 352.—S. G.

***The Influence of Impurities on the Properties of Lead. IV.—Some Effects of Antimony on the Rate of Recrystallization of Distorted Lead.** R. S. Russell (*Proc. Australasian Inst. Min. Met.*, 1936, (101), 23–31).—The rate of recrystallization of electrolytic lead (99.9995%) alloyed with 0.05% antimony after distortion by rolling was determined by etching the distorted alloy and photographing the surface after storage at room temperature for various times. The pure lead recrystallized completely in 5 minutes, whereas the alloy took various periods up to 14 days and occasionally different areas recrystallized independently of others; this behaviour was found to be due to coring and could be completely eliminated by cold-rolling to 66% reduction and annealing for 10 days at 300° C. *in vacuo*. After this homogenization the cold-worked alloy recrystallized in 2 hrs. at 20° C. Addition of 0.05% antimony to pure lead did not affect the grain-size at any stage of the tests; hence, it is concluded that grain-size is no criterion of the purity of lead.—A. R. P.

***The Influence of Impurities on the Properties of Lead. V.—Creep Tests on Electrolytic Lead and Some of Its Alloys.** R. S. Russell (*Proc. Australasian Inst. Min. Met.*, 1936, (101), 33–56).—Creep curves are shown for 99.9995% electrolytic lead and for alloys thereof with 0.0001, 0.0005, and 0.005% silver, 0.005% bismuth, 0.05% antimony, 0.04% tellurium, and 0.05% zinc under stresses of 200–500 lb./in.². The life of the pure lead is 25 days with an elongation of 34% at 500 lb./in.², and this is considerably increased by addition of even minute amounts of impurities; at 350 lb./in.² the effect of alloying elements is relatively less marked. Bismuth has little effect at 500 lb./in.², but at 200–350 lb./in.² its strengthening effect is greater than that of any of the other additions. The homogenized antimony alloy does not recrystallize under creep conditions, whereas the cored alloy does. The tellurium alloy shows a gradually increasing rate of creep and cracks severely after 12% elongation. The rate of creep of the zinc alloy at 500 lb./in.² is slower than that of any of the other alloys tested. The results obtained with vacuum-cast

lead with and without atmospheric exposure suggest that atmospheric gases diffuse into lead at room temperature. The rate of creep of air-cast lead decreases with increasing casting temperature.—A. R. P.

***The Influence of Impurities on the Properties of Lead. VI.—The Influence of Tellurium on the Creep Rate of Commercial Lead.** J. Neill Greenwood and Howard K. Worner (*Proc. Australasian Inst. Min. Met.*, 1936, (101), 57–87).—Hard-rolled lead containing 0.01, 0.05, and 0.1% tellurium begins to soften 2 or 3 days after rolling, the hardness eventually reaching a constant value after about 100 days; in the case of the 0.05% tellurium alloy a further softening commences after 200 days and proceeds for a further 120 days. At 60° C. recrystallization, which takes several weeks at 20° C., is complete in less than 30 minutes. Creep tests under a load of 500 lb./in.² made 1 week after rolling showed that the rate of creep continuously increases as the test proceeds and is greater the higher the tellurium content, which indicates that addition of tellurium apparently softens lead despite its beneficial effect on the tensile strength and resistance to impression. Similar tests made 10 weeks after rolling showed that the rate of creep increases with ageing, and this difference is more pronounced the higher the tellurium content. After 26 weeks the rate of creep is still further increased, and fracture occurs in 79 days with 72% extension (0.05% tellurium) or in 32 days, 92.5% extension (0.1% tellurium), whereas with commercial lead the extension is only 4.5% after 250 days. Annealing at 120° C. has little effect on the creep rate of commercial lead and only slightly improves the behaviour of tellurium-lead which has been stored at room temperature. These and numerous other tests after various heat-treatments and times of storage indicate that even as little as 0.01% tellurium has a profound effect on the behaviour of lead under the influence of prolonged stress. In general, tellurium refines the grain-size after cold-working, prevents the development of work-hardening during creep under stresses of 500 lb./in.², produces an increased general elongation in creep tests, and decreases the reduction in area at the point of fracture.—A. R. P.

***The Arsenic-Lead Alloys.** O. Bauer and W. Tonn (*Mitt. Material., Sonderheft 28*, 1936, 61–65).—See *Met. Abs.*, 1935, 2, 507.—S. G.

***A Magnesium Alloy Capable of Heat-Treatment.** — Rockaert (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 173–176; and *Rev. Mét.*, 1936, 33, (7), 427–430).—[In French.] The solid solubility of aluminium in magnesium decreases from 12% at 436° C. to 3% at room temperature. Alloys in this range may thus be expected to show precipitation-hardening. Best results have been obtained with a magnesium alloy containing aluminium 8.5, zinc 0.5, and manganese 0.3%. This must be heated for at least 24 hrs. at 420° C. to obtain a uniform solid solution. In this condition, the alloy has a greater strength, higher ductility, and higher fatigue-strength than a cast alloy containing aluminium 6, zinc 3, manganese 0.3%. An increased strength, with decreased ductility, is obtained by reheating at 100°–200° C. to cause precipitation.—J. C. C.

***Rate of Transformation in Solid Solutions of Magnesium-Cadmium Alloys.** I. I. Korniloff (*Thesis: Acad. Sci. U.S.S.R., Moscow*, 1935, 1–55).—[In Russian.] Measurements of the change in electrical conductivity during the separation of Mg₂Cd (at 100° C.) and MgCd₃ (at 20° C.) from quenched solid solutions of cadmium in magnesium showed that the rate of transformation depends on the composition, the rate being a maximum at the exact compound composition, and decreasing sharply in the presence of excess of either component. The composition-rate of transformation curves consists of two branches intersecting at the compound compositions.—N. A.

***Investigation of the Properties of Magnesium Alloys with Increased Manganese Content.** V. O. Gagen-Torn and J. A. Zenter (*Metallurg (Metallurgist)*, 1936, (7), 85–91).—[In Russian.] Manganese is best introduced into mag-

nesium by the reaction $\text{MnCl}_2 + \text{Mg} = \text{MgCl}_2 + \text{Mn}$, in which up to 75% of the manganese passes into the magnesium with a loss of 15–18% of the latter. The mechanical properties of alloys containing aluminium 1–8, cadmium 1–5, and manganese up to 1.5% were determined; the best alloy contained aluminium 2, cadmium 0.5, and manganese 1%. Quenched alloys resist sea-water much better than annealed alloys. Addition of up to 4% aluminium and up to 3% zinc to alloys with 1–1.5% manganese increases the tensile strength. Elongation increases up to 2% aluminium or zinc, then decreases. Despite the rapid cooling the solid solution partly decomposes on quenching.—N. A.

Studies on the Manganese-Carbon System and on the Carburization of Manganese Alloys. R. Schenk, N. G. Schmahl, and O. Ruetz (*Z. Elektrochem.*, 1936, 42, (7b), 569).—A summarized account is given of the preparation of manganese carbide, of the increased cementation capacity of a 50:50 manganese-iron alloy over that of either constituent metal, and of the influence of a non-carburizing metal (copper) on the carburization of manganese. A brief discussion deals with the mechanism of the process.—P. M. C. R.

***†Alloys of Iron, Manganese, and Carbon. XV.—The Ternary Diagram and General Summary.** F. M. Walters, Jr., and Cyril Wells (*Trans. Amer. Soc. Metals*, 1936, 24, (2), 359–374).—A summary of work on alloys of iron, manganese, and carbon carried out in the Metals Research Laboratory of the Carnegie Institute of Technology (cf. *Met. Abs. (J. Inst. Metals)*, 1932, 50, 78, 79; and *Met. Abs.*, 1934, 1, 343, 344; 1935, 2, 578). The equilibrium diagram is discussed in detail, and numerous sections are shown graphically.—W. H. R.

***The Diffusion Constant and Valency of Silver in Liquid Silver Amalgam.** Karl Schwarz and Rüdiger Stockert (*Monatsh.*, 1936, 68, (5), 383–386).—The value determined at 16°C. is 1.11×10^{-5} cm.²/second compared with a theoretical value of 1.01×10^{-5} cm.²/second calculated from the transport number assuming that silver is divalent in amalgams.—A. R. P.

***On the Contact Potential Between Liquid Amalgams and Mercury in a Vacuum. I.—Contact Potential Between Dilute Sodium Amalgams and Mercury.** O. Chaltikian and M. Proskurnin (*Acta Physicochimica U.R.S.S.*, 1935, 4, (2), 263–274).—[In German.] The contact potential between the amalgam and pure mercury was determined by using the amalgam or mercury as anode and a hot filament as cathode, and measuring the current. The effect of concentration for low concentrations was investigated and it was found that the contact potential increased from zero at zero concentration to about 1.1 v. at 0.033% sodium, above which there was very little change up to 0.09%, the limit of the experiments.—B. C.

***The Viscosity of Sodium Amalgams.** Henry E. Bent and Norman B. Keevil (*J. Physical Chem.*, 1936, 40, (6), 709–714).—The viscosity of liquid sodium and silver amalgams is found to be independent of time. No scum forms on sodium amalgams when kept in glass containers which have been properly baked and evacuated. These experiments lessen the probability that sodium amalgams are colloidal.—S. G.

***The Solubility of Thorium in Mercury.** W. George Parks and George E. Prime (*J. Amer. Chem. Soc.*, 1936, 58, (8), 1413–1414).—Thorium is sparingly soluble in mercury, the solubility not being greater than 0.014 atomic-% at 25°C.—R. G.

Investigation of Nickel Alloys at the Kyoto Imperial University. Daikichi Saito (*Japan Nickel Rev.*, 1936, 4, (2), 253–260).—[In English and Japanese.] A brief *résumé* of some Japanese researches on non-ferrous metals. The rapid crumbling of 75:25 copper-nickel alloy coins whilst in transit was investigated and considered to be due to precipitation of Cu_2O -Cu eutectic at the grain boundaries. The effect of sulphur is similar (0.07%), while

arsenic is beneficial in the presence of oxygen. Comparative corrosion tests were carried out on a number of magnesium and aluminium alloys.—R. G.

***A Contribution to the Knowledge of the Magnetic Anisotropy of Polycrystalline [Ferro-Nickel] Materials.** Otto von Auwers (*Wiss. Veröff. Siemens-Werken*, 1936, 15, (2), 112-123).—The transverse magnetostriction in ferro-nickels is a function of the square of the intensity of magnetization, whereas the longitudinal magnetostriction varies directly with the intensity of magnetization. These facts have been used in interpreting the magnetization curves and constriction of the hysteresis loops of hard-worked and precipitation-hardened iron-nickel and copper-iron-nickel alloys. The characteristic shape of the hysteresis loops is shown to be due to a preferred position of the magnetization vector.—A. R. P.

The Velocities of Decarburization and Carburization of Iron, Nickel, and Cobalt in Mixtures of CO and CO₂. E. Doehlemann (*Z. Elektrochem.*, 1936, 42, (7b), 561-569).—The rates of carburization and decarburization of iron, cobalt, and nickel foil were measured by resistance methods at 920°-970° C. in mixtures of carbon monoxide and carbon dioxide of known initial composition. The rate of decarburization was found to be independent of the carbon content, and to vary directly as the total pressure for constant ratio of the partial pressures CO/CO₂. A general equation for the rate of both reactions is formulated.—P. M. C. R.

High-Temperature Properties of Nickel-Cobalt-Iron-Base Age-Hardening Alloys.—I. Charles R. Austin (*Trans. Amer. Soc. Metals*, 1936, 24, (2), 451-480).—Data for mechanical properties at room temperatures and 600° C. are given for nickel-cobalt-iron alloys made capable of precipitation-hardening by the addition of titanium, and further modified by addition of chromium. The precipitation-hardening at high temperatures, and the capability for cold work-hardening and temperature softening are also described, and the results tabulated. The results are correlated with the properties of two standard alloys, Konel (nickel 73, cobalt 17, ferro-titanium 10%, and K.42B (nickel 46, cobalt 25, chromium 19, ferro-titanium 10%); the ferro-titanium contained 25% titanium. Alloys containing tungsten, molybdenum, or silicon were also studied, and data for commercial 80 : 20 nickel-chromium, and 18 : 8 stainless steel are included. At high temperatures alloys of high iron content are strong, but show brittleness. Titanium is unique in imparting precipitation-hardening to the ternary or modified ternary alloys since silicon, zirconium, and vanadium have no such effect. The work-hardening capacity of the 18 : 8 stainless steel is outstanding, but temperature softening occurs more readily than with the K.42B type of alloy.—W. H.-R.

***High-Temperature Properties of Nickel-Cobalt-Iron-Base Age-Hardening Alloys.—II.** Charles R. Austin (*Trans. Amer. Soc. Metals*, 1936, 24, (3), 481-512; discussion, 512-518).—The nickel-cobalt-iron alloys (cf. preceding abstract) modified by the addition of titanium, molybdenum, chromium, aluminium, tungsten, and vanadium were studied with respect to corrosion in normal solutions of nitric and hydrochloric acids as shown by intermittent immersion tests. In general the alloys show a superior resistance to corrosion in the reducing (hydrochloric) acid, although the attack is progressive after 16 days' immersion. In nitric acid the alloys containing chromium are attacked during the first 24 hours, after which little loss in weight occurs. Atmospheric corrosion at 800°-1100° C. was investigated, and the scaling effect noted. Many of the alloys have a greater resistance to high-temperature oxidation than 18 : 8 steel, but at 1100° C. only the alloys containing aluminium are equal or superior to nickel-chromium alloys. The electrical resistances of the alloys were measured, and microstructures are illustrated and discussed.

—W. H.-R.

***The Specific Resistance and Temperature Variation of Resistance of Nickel and Some of Its Alloys in the Annealed and Unannealed States.** I. H. Thomas and R. M. Davies (*Phil. Mag.*, 1936, [vii], 22, (148), 681-717).—The following metals and alloys are examined in the annealed and unannealed conditions: (i) nickel 99.2%; (ii) Monel metal 67:28; (iii) nickel-iron, 48% nickel; (iv) Ferry metal, 44% nickel; (v) Brightray, 80% nickel; (vi) Glowray, nickel 65, chromium 15, iron 20%; (vii) Dullray, nickel 34, chromium 4, iron 62%; (viii) nickel-brass, copper 62, zinc 18, nickel 20%. The results are tabulated and are accurate to 0.5% in the case of the specific resistance, the temperature being measured to 0.1% in the case of the temperature variation of resistance. The results are discussed theoretically.—W. D. J.

***Optical Constant of Copper-Nickel Alloys.** N. F. Mott (*Phil. Mag.*, 1936, [vii], 22, (146), 287-290).—The variation of the absorption coefficient of copper-nickel alloys with composition is discussed theoretically from the point of view of the quantum theory, and is related to the magnetic properties of the alloys.—B. C.

***Relation Between Longitudinal Natural Frequency and a Geometrical Form of a Magnetostrictive Nichrome Rod.** Risaburō Torikai, Shigenori Hayashi, and Kazumi Kasuno (*Denki-hyōron*, 1934, 22, (4), 229-233).—[In Japanese.] An English abstract with diagram is given in *Jap. J. Eng. Abs.*, 1936, 14, 107.—S. G.

***Investigations on Iron-Nickel Alloys with a Cubic Texture.** Günter Wassermann (*Z. Metallkunde*, 1936, 28, (9), 262-265).—The anisotropy of the tensile properties of alloys of iron with 30-80% nickel after cold-rolling to 95% reduction and annealing at 1000° C. was investigated. The elongation shows a very pronounced maximum at 45° to the direction of rolling which decreases in magnitude with increasing nickel content. The tensile strength is at a minimum at 22.5° and 67.5° to the direction of rolling and shows maxima at 0°, 45°, and 90° thereto, those at 0° and 90° being more pronounced the higher the nickel content. Alloys with 60-80% nickel show the presence of spinel twins regularly distributed over the surface of the sheet; these grow in size and collect together with increasing annealing temperature or time and are oriented along octahedral planes. X-ray examination of sheet with a cubic texture indicates that the distortion of the lattice induced by severe cold-work produces, on annealing, a structure which deviates from purely cubic symmetry, and that this is the origin of the anisotropy of the mechanical properties.—A. R. P.

***The Electrical Properties of High Permeability [Nickel-Iron] Wires Carrying Alternating Currents.** E. P. Harrison, G. L. Turney, H. Rowe, and H. Gollop (*Proc. Roy. Soc.*, 1936, [A], 157, (891), 451-479).—Investigations are described on the variation of effective resistance and inductance of nickel-iron wires of high permeability with frequency and amplitude of the a.c. used for the measurement and with applied magnetic fields. It is shown that the effect of longitudinal fields is considerable, and an approximate theory of this effect is given. The influence of the heat-treatment of the nickel-iron wire is discussed, and the use of hydrogen as an atmosphere for annealing is recommended.—B. C.

***Relation Between Magneto-Elastic Effect, Initial Permeability, and Magnetostriction of Iron-Nickel Magnetic Alloy.** Kingo Mihara (*Furukawa Denko (J. Furukawa Elect. Ind. Co.)*, 1935, (July), 19-33 (in Japanese); and (summary) *Japan Nickel Rev.*, 1936, 4, (2), 351-358 (in English and Japanese)).—An investigation connected with the effect of external mechanical force on the magnetic properties of iron-nickel alloy when in use in forms such as the cores of transformers.—R. G.

Some New Nickel Alloys. A. B. Everest (*Coventry Eng. Soc. J.*, 1936, 17, (4), 100-116; discussion, 117-121).—A description of the character and

properties of recently introduced nickel alloys for permanent magnets, heat-treatable Monel metal, and alloy cast-irons.—R. G.

Nickel-Alloy Magnets. A. B. Everest (*Elect. Rev.*, 1936, 119, (3066), 273–274).—The addition of cobalt and aluminium to nickel-iron alloys imparts great magnetic hardness, yielding permanent magnets having greater magnetic energy per unit volume than hitherto available. Applications of these alloys are briefly reviewed. A typical alloy, "Alnico" contains cobalt 10, aluminium 10, and nickel 20%. The recent "Honda" alloys contain cobalt 15–36, nickel 10–25, and titanium 8–25%, and give a remanence of 7000 gauss with a coercive force of 840 gilbert.—J. C. C.

***Decomposition of the Solid Solution in Palladium-Copper Alloys.** P. S. Belonogov (*Metallurg (Metallurgist)*, 1936, (6), 92–95).—[In Russian.] Thermal analysis showed two critical points in the range 15–30 atomic-% palladium, the first, corresponding to the formation of Cu_3Pd , having a maximum at 610°C . and the second occurring at a constant temperature of about 300°C . In the range 35–50 atomic-% palladium there are critical points with a maximum at 48 atomic-%. Brinell and Shore hardness and electrical conductivity confirm the existence of Cu_3Pd and CuPd .—N. A.

***Contribution to the Systematic Theory of Affinity. LXX.—On the Combining Power of Palladium and Phosphorus.** Gerda Wiehage, Friedrich Weibke, and Wilhelm Biltz (with Karl Meisel and Friedel Wiechmann) (*Z. anorg. Chem.*, 1936, 228, (4), 357–371).—The system palladium-phosphorus was examined up to 35% phosphorus by thermal, micrographic, X-ray, and tensimetric methods. Pd_5P is formed by a peritectic reaction at 807°C . and Pd_5P_2 by a similar reaction at 860°C . The compounds Pd_3P (d 10.83) and PdP_2 (d 9.96) melt congruently at 1047° and 1150°C ., respectively. The system contains two eutectics: that between Pd_3P and Pd_5P (788°C ., 6.4% phosphorus), and that between Pd_5P_2 and PdP_2 (795°C ., 12.33% phosphorus). Up to 4% phosphorus the alloys are relatively tough and have a silvery colour; alloys with more than 7% phosphorus are very brittle and have a leady colour.—A. R. P.

***Ageing Phenomena in a Silver-Rich Copper [-Silver] Alloy.** Morris Cohen (*Metals Technology*, 1936, 3, (7), 20 pp.; *A.I.M.M.E. Tech. Publ. No. 751*).—A silver-copper alloy containing 8.72% copper was annealed at 765°C . for 2 hrs., and then quenched. Specimens were then aged at 100° , 125° , 150° , 175° , and 200°C ., and the ageing process was studied by measurements of hardness, lattice spacing, electrical resistance, and dilatation; the microstructures were also examined. Definite changes undoubtedly occur before actual precipitation takes place. The two types of ageing previously explained by the knot theory and the precipitation theory (cf. Merica, *Met. Abs. (J. Inst. Metals)*, 1932, 53, 74) are not in conflict with one another. The actual ageing mechanism involves both processes, knot formation being followed by precipitation. The process of hardening is more complicated, and depends on how far knot formation proceeds before precipitation sets in. With the present alloy double peaks occur in the hardness-time curves below 169° ; the first peak is due to knot formation, and the intermediate softening is due to relief of strain when precipitation first occurs, and is followed by further hardening when the precipitated particles grow to the critical size. Above 169°C . precipitation occurs so rapidly that the curves consist of the usual single peak.—W. H.-R.

Silver-Indium Alloys. Notes on the Ageing of Silver-Rich Ones. Tracy C. Jarrett (*Metals and Alloys*, 1936, 7, (9), 229–231).—Results of ageing tests on silver alloys with 1, 2, and 4% indium are shown graphically. The hardness of the quenched alloys increases slightly with the indium content to 2%, then decreases to below the value for pure silver with the 4% indium alloy. Heating of the cold-worked alloys removes work-hardness at 300°C ., and produces very

slow hardening at 400° C., maximum hardness being reached after 140–200 hrs.; the hardness of all three alloys increases by about 25 Rockwell E units during this treatment. Addition of indium to silver produces copious twinning in the annealed sheet.—A. R. P.

***The Hall Effect and Some Other Physical Constants of Alloys. V.—The Antimony–Silver Series.** W. G. John and E. J. Evans (*Phil. Mag.*, 1936, [vii], 22, (147), 417–435).—An account is given of an investigation of the antimony–silver system by measurements of the electrical resistivity, temperature coefficient of resistivity, thermoelectric power, density, and Hall coefficient of alloys of various compositions after careful annealing. The results are compared with the results of other investigations, and it is shown that discontinuities in some of the constants or in their rates of variation occur at the eutectic composition 55.03% silver, at the composition Ag₃Sb, and at the limit of solid solubility 94.47% silver.—B. C.

***The Magnetic Susceptibilities of the Silver–Lead, Silver–Antimony, and the Silver–Bismuth Series of Alloys.** G. O. Stephens and E. J. Evans (*Phil. Mag.*, 1936, [vii], 22, (147), 435–445).—Measurements are given of the susceptibilities of alloys of various compositions of the silver–lead, silver–antimony, and silver–bismuth series, by the Curie–Chéneveau magnetic balance method. The effects of annealing the alloys is indicated, and discontinuities in the susceptibility–composition curves are shown to correspond to known phase boundaries.—B. C.

The Effect of Small Quantities of Bismuth and Manganese on Tin. — (*Metall-Woche*, 1936, (2), 23–24).—L. A. O.

Bearing Metals. (Frhr.) F. K. von Göler and G. Sachs (*Mitt. Arbeitsbereich Metallgesellschaft, Frankfurt*, 1935, 1–8).—See *Met. Abs.*, 1935, 2, 451.—S. G.

***Notes on the Performance of Bearing Metal as Determined from the Results of Experiments.** Shinta Matsunawa and Matomu Ishida (*J. Soc. Mech. Eng. Japan*, 1934, 37, (203), 125–131).—[In Japanese.] Tests were carried out in the laboratory, and with rolling stock under service conditions, using test-pieces of improved design, to determine the friction between bearings and axle journals. It was found that a good bearing metal surface can be obtained easily and inexpensively by means of a new finishing device. The difference in frictional resistance according to the method of finishing the axle surface was determined quantitatively, and the relative merits of the finishing methods ascertained. It was found that the frictional resistance of the suspension bearing metal of an electric motor-car lined with a small piece of white metal is about $\frac{1}{2}$ of that of an ordinary bearing made of gun-metal.—S. G.

Tin-Base Bearing Metals. B. P. Haigh (*Metallurgist* (Suppt. to *Engineer*), 1936, 10, 147–148).—A review abstract and discussion of a paper by F. v. Göler and H. Pfister, *Metallwirtschaft*, 1936, 15, (15), 342–348; (16), 365–368; see *Met. Abs.*, this vol., p. 301.—L. A. O.

***Rubbing and Wear of Lead-Base Babbitts.** I. V. Pichugin (*Dizelestroenie* (*Diesel-Building*), 1936, (7), 11–21).—[In Russian.] Results are given of wear tests on tin- and lead-base bearing metals carried out on a specially constructed machine A1 and on Zaitzev's machine. The alloys tested on Zaitzev's machine were B-83 (tin 83.4, antimony 11.1, copper 5.30%), Bondrat (tin 10.6, antimony 10.3, copper 1.94, cadmium 1.07, arsenic 0.86, lead 75.1%), Termite (tin 5.74, antimony 14.5, copper 2.90, cadmium 1.94, arsenic 0.97, lead 73.8%), and Satco (tin 2.56, lead 95.9, calcium 0.62, sodium 0.54, magnesium 0.15%). The wear of the lead-base alloys was considerably higher than that of B-83 at all specific pressures, Bondrat having the greatest and Termite the least wear. The wear of steel rings was greatest with Satco bearings and least with Termite and Bondrat. With increasing load the coeff. of friction of all the alloys was decreased, being lower with Bondrat and Termite than with B-83 alloy. Termite gave the best results as regards running temperatures in

lubricated bearings. None of the alloys should be run at a greater specific pressure than 50 kg./cm.². On the Al machine the B-83 alloy showed the least loss of weight. The wear of the arsenic-cadmium-lead-base alloys does not differ substantially from that of B-83 under loads of 115-185 kg./cm.². The best results were obtained with alloys within the following composition range: tin 5.6-11.7, antimony 10.0-15.3, copper 1.7-2.8, arsenic 0.48-1.21, calcium 0.99-1.87, lead 72.7-75.3%. Bondrat and Termite but not Satco can be used for bearings in Diesel engines.—N. A.

What Do You Know About Babbitt? A. Hoyt Levy (*Machinist (Eur. Edn.)*, 1936, 80, (33), 696).—A plea for more study of the properties of Babbitt metal, particularly among engineers.—J. H. W.

***Contribution to the Knowledge of the System Iron-Tungsten.** Otto Landgraf (*Forschungsarbeiten über Metallkunde und Röntgenmetallographie*, 1934, (12), 46 pp.; *C. Abs.*, 1936, 30, 7081).—Previous work on the system is reviewed. Alloys were made by melting in a small indirect-arc furnace and studied by microscopic and X-ray methods. Microscopic examination indicated that the solid solubility line of tungsten in iron intersects the eutectic line at 23% tungsten and that the eutectic is at 33% tungsten. X-ray studies indicated that the solubility of tungsten in iron below 600° C. is small. In disagreement with Arnfelt (*J. Inst. Metals*, 1929, 42, 516) and Takeda, the compound Fe₃W₂ was found not to be trigonal but hexagonal with $a = 4.73$ Å. and $c = 7.70$ Å. X-ray studies also showed that Fe₃W₂ dissolves almost no iron or tungsten. The upper limit of existence of the compound was placed at 1675° C. In alloys from 55 to 68.3% tungsten two types of compound appeared to form, but X-ray diffraction patterns showed that they were crystallographically identical. Takeda's "X" phase could not be confirmed. Even at high temperatures tungsten dissolves almost no iron.—S. G.

***Notes on the Solidus Temperatures [and Solid Solubility Limits] in the Systems Iron-Tungsten and Iron-Molybdenum.** W. P. Sykes (*Trans. Amer. Soc. Metals*, 1936, 24, (3), 541-550).—The solidus curve and the solid solubility curve above 1100° C. were determined (by quenching methods and by observing the melting of wires) in the system iron-tungsten for alloys containing up to 35% tungsten. The solidus curve passes through a minimum at 1525° C. and 15% tungsten. The α solid solution is formed at 1540° C. by a peritectic reaction between the ϵ phase (Fe₃W₂), and iron-rich liquid. The α solid solubility limit diminishes from 32.5% tungsten at 1540° C. to 12% at 1100° C., whilst electrical resistance measurements indicate a further fall to between 6 and 7% tungsten at 700° C. A similar investigation of the iron-molybdenum system shows that the solidus passes through a minimum at 1440° C. and 36% molybdenum. The α solid solution is formed by a peritectic reaction at about 1455° C., between the ϵ phase (Fe₃Mo₂) and liquid, and the α solid solubility limit diminishes from 36% molybdenum at 1430° C. to between 3 and 5% at 700° C.—W. H.-R.

***Zinc-Base Alloys as Substitutes [for Other Metals].** Arthur Burkhardt (*Z. Metallkunde*, 1936, 28, (10), 299-308; and (abridged) *Light Metals Research*, 1936, 5, (6), 140-141).—The equilibria at the zinc end of the binary systems aluminium-zinc and copper-zinc and in the ternary corner of the copper-aluminium-zinc system have been established by thermal, micrographic, and precision X-ray methods. The solid solubility of aluminium in zinc is 0.05% at room temperature and a maximum of 0.8% at 380° C., and that of copper in zinc 0.3% at room temperature and 2.7% at the peritectic temperature (424° C.). Separation of the aluminium- or copper-rich constituent from supersaturated solid solution results in an expansion which, however, is greater in the direction of the c axis than in that of the a axis in the copper alloys. In the ternary system the maximum solid solubility

(extrapolated) is copper 3.4, aluminium 1.6%, that at 300° C. is copper 2.6, aluminium 1.2% and that at 20° C. copper 0.6–0.8, aluminium 0.1–0.2%; hence ternary alloys with 4% aluminium and up to 0.7% copper behave similarly on ageing to copper-free alloys. The ternary eutectic point is 370° C., aluminium 7, copper 4% and the 4-phase reaction $\beta \rightleftharpoons \alpha + \beta' + \epsilon$ occurs at 270° C. Numerous curves are given showing the changes in length of test-pieces which occur during ageing of alloys with 4% aluminium, up to 2.7% copper and 0 or 0.04% magnesium. As a result of these studies three alloys of technical importance have been developed (a) with aluminium 4 and copper 2.7% which has a high tensile and impact strength and undergoes relatively small changes during prolonged storage, (b) the already well-known die-casting alloys of the Zamak type, and (c) the alloy ZL3 containing copper 0.4–0.7, aluminium 4, and magnesium 0.04%. By suitable heat-treatment of ZL3 the volume changes in this alloy can be reduced to 0.01–0.05% and the tensile strength raised to 41–43 kg./mm.². In this state the yield-point is 35–38 kg./mm.², elongation 10–15%, reduction in area 45–55%, Brinell hardness 95–105, impact strength 30–35 cm.-kg./mm.², and shear strength 25–35 kg./mm.², values which are superior to those of Lantal and as good as, or better than, those of 2:40:58 leaded screw brass. ZL3 can be used for extrusion or die-casting, is readily machined and drilled with suitably adjusted tools, and is easily polished to a high lustre.—A. R. P.

Failure of Small Electric Motors and Accessories [Zinc-Base Die-Castings].

—(Brit. Engine Boiler and Elect. Insurance Co. Tech. Rep., 1935, 93–96).—Among the failures discussed are those of die-castings made from a zinc-base alloy containing aluminium and used for the back of electrical instruments, such as ammeters and voltmeters. It is concluded that the cracks and disintegration which occur result from the unstable nature of the alloy, which is prone to intergranular corrosion, and that this susceptibility is increased by the presence of moisture.—J. W. D.

Effect of Small Traces of Tin and Lead on Zinc-Base Die-Cast Alloys.

—(Metalgram (Apex Smelting Co.), 1936, (16), (16A); Bull. B.N.F.M.R.A., 1936, (92)).—(16) deals with the effects of 0.002–0.020% tin on die-cast alloys No. 3 (zinc 99.99+ %) with aluminium 4.10, and magnesium 0.04%), and No. 5 (zinc with aluminium 4.10, copper 1.0, and magnesium 0.03%), in the as-cast state, on the tensile strength, elongation, and impact strength before and after exposure to water vapour at 95°, and dimensional stability on exposure to water vapour. (16A) deals similarly with the effects of 0.007–0.020% lead.—S. G.

Zinc-Base Die-Casting Alloys. E. T. Richards (*Metall-Woche*, 1936, (4), 62–63; (7), 123).—Preparation, properties, and uses are discussed.—A. R. P.

***The Mutual Solubility of Carbides of High Melting Metals.** L. P. Molkov and V. V. Vicker (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1936, 16, (8), 75–88).—[In Russian.] The mixed carbide powders were pressed into rods which were sintered at 1500°–2000° C. and examined by X-rays. The results showed that TiC forms solid solutions at 20° C. with up to 82.2% WC, 85% Mo₂C, and 40% Cr₃C₂, and a continuous series of solid solutions with VC. WC and Mo₂C dissolve only small amounts of TiC; Cr₃C₂ dissolves about 10% TiC; Mo₂C dissolves about 53% WC; VC dissolves about 76% Mo₂C or WC. Quaternary systems containing 50–58% TiC, 6–9% Mo₂C, 22–28% WC, and 22–5% VC are homogeneous and have the VC lattice. Melts containing 21–40% TaC, 40–0% Mo₂C, and 39–60% WC have the TaC lattice. In melts with a 1:1 or 1:2 molecular ratio of TaC and WC lattices of both constituent phases were found.—D. N. S.

***Mechanical Properties of Special Steels and Non-Ferrous Metals at Low Temperatures.** B. Smirnov and V. Chernjak (*Metallurg (Metallurgist)*, 1936, (8), 88–103).—[In Russian.] Results of tests are given for brasses (I):

copper 58.9, zinc 38.7, and lead 1.5%; (II): copper 57.14, zinc 40.75, lead 0.69, iron 0.90%, and traces of manganese, at room temperature and -185°C .; and also for Duralumin (copper 4.33, magnesium 0.12, iron 0.84, manganese 0.64%) at room temperature, -18° and -183°C . The results are summarized below:

Material.	Temperature, C.	Tensile Strength, Kg./mm. ² .	Elongation, %.	Shrinkage, %.	Brinell Hardness.	% Resistance, Kg./cm. ² .
Brass I.	{ 20	42.45	25.7	47.0	94	5.95
	{ -183	58.0	36	32.35	124	5.32
Brass II.	{ +20	36.5	22.3	19.9	94	5.23
	{ -183	50.8	26.9	19.2	113	5.18
Duralumin	{ +20	40.42	14.46	27.8	92	4.11
	{ -18	43.5	17.5	26.8	104	4.56
	{ -183	51.6	20.24	21.2	114	4.57

—N. A.

***Modulus of Elasticity of Certain Definite Intermetallic Compounds.** Albert Portevin and Léon Guillet (Fils) (*Compt. rend.*, 1936, 203, (3), 237-239).—The modulus of elasticity of certain homopolar alloys, having compositions representing or approximating to those of metallic compounds were investigated. The methods used were either Rolland and Sorin's sympathetic pendulum or fixed (*encastrée*) bending, the fixing being effected without lateral stress. The alloys studied were $\text{Cu}_{31}\text{Sn}_8$ (Cu = 68.00% by weight), Cu_5Al_4 (Cu = 84.25%), CuZn_6 (Cu = 18.16%), CuZn (Cu = 47.22%), Ag_3Sb (Ag = 68.00%), and MgZn_2 (Zn = 82.00%). The results showed that there appeared to be 2 classes of definite compounds: (1) those whose modulus follows approximately the rule of mixtures, such as CuZn , Ag_3Sb , and MgZn_2 , classed as homopolar by Bernal (*Met. Abs. (J. Inst. Metals)*, 1929, 42, 417), and SnMg_2 , classed as ionic by the same author; (2) those whose modulus considerably exceeds that given by the rule of mixtures, such as Cu_5Zn_6 , Cu_5Al_4 , which are homopolar. The compound CuZn_6 indicated by Broniewski, Jablonski, and Maj (*Met. Abs.*, this vol., p. 115) is in this category.—J. H. W.

†**The Flow of Alloys in Connection with Maxwell's Relaxation Theory.** (Gubkin.) See p. 585.

A Thermodynamic Extension of the Diffusion Equation. [Application of the Equations to the System Gold-Nickel.] U. Dehlinger (*Z. Physik*, 1936, 102, (9/10), 633-640).—It is shown that Fick's law $\frac{\partial n}{\partial t} = -D \frac{\partial^2 n}{\partial x^2}$ is a specialized form

of the general diffusion equation $\frac{\partial n}{\partial t} = -A \frac{\partial F}{\partial x}$, and may be obtained from it

by substituting for the free energy F , the appropriate value for an ideal mixture. The general equation can be used also in the calculation of diffusion in non-ideal mixtures when the dependence of F on concentration is taken into account by the introduction of activities or activity coefficients. The equations deduced are applied to the system gold-nickel.—P. W. R.

***Relation Between the Diffusion Rate of Metals and the Crystallographic Direction (Diffusion Anisotropy).** V. Bugakow and N. Bregneva (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1935, 5, (9), 1632-1637).—[In Russian.] The rate of diffusion of mercury into cadmium and zinc single crystals in the different crystallographic directions was studied; in both cases the rate is a maximum parallel to the basal plane, and minimum perpendicular thereto, but the difference between the two rates decreases as the temperature is increased up to 200°C . The diffusion of copper into zinc single crystals follows a similar course.—N. A.

***Dependence of the Diffusion Coefficient of Metals on Grain-Size.** V. Bugakow and F. Ribalko (*Zhurnal Tehnicheskoj Fiziki (J. Tech. Physics)*, 1935, 5, (10), 1729–1734).—[In Russian.] Measurements of the rate of evaporation of zinc at 700°–900° C. from α -brass single crystals and from polycrystalline specimens with average grain-sizes of 0.13 mm., 0.37 mm., and 0.48 mm., showed that the diffusion coefficient (D) of zinc increases sharply with decrease in grain-size especially in the transition from a mono- to a polycrystalline specimen; thus at 700° C. for a single-crystal $D = 0.06 \times 10^{-2}$ and for a specimen with 0.13 mm. grain-size $D = 2.3 \times 10^{-2}$. At higher temperatures this difference is reduced. An explanation of the observed phenomena and a comparison with results observed for the electrolytic conductivity are given.—N. A.

***Chemical Heterogeneity of Solid Solutions in Cast Alloys.** P. Chevenard and X. Waché (*Bull. Assoc. Tech. Fond.*, 1936, 10, (5), 152–165).—Many solid solutions are heterogeneous, but whilst certain properties are only slightly affected since the average properties are revealed, other properties, tenacity and corrodibility for example, give values representing the weakest portions. For a scientific study of problems of heterogeneity to be fruitful, quantitative methods must be applied, and the more usual methods of approach are all qualitative. Thermomagnetic transformations can be used in certain cases; e.g. ferro-nickels. The various degrees of segregation and their mechanism are described, and the influence of heat-treatment on them is discussed. By thermo-magnetic measurements, curves can be plotted which show the amplitude and extent of the lack of uniformity. Complex austenites were chosen for study, but the principles can be applied to all alloys of similar constitution, and its significance in relation to the hardening phenomenon of copper-beryllium and similar alloys, and to intercrystalline corrosion is mentioned. The practical importance of securing homogeneity to secure chemical and mechanical stability is obvious.—J. E. N.

***Properties of Metallic Solutions. I.—Theoretical.** V. K. Semenchenko (*Zhurnal Fizicheskoy Khimii (J. Phys. Chem.)*, 1936, 7, (4), 501–508).—[In Russian.] In cases of mutual solubility and surface phenomena, the behaviour of the solute is determined by the difference between two quantities, one referring to the solvent and the other the solute, which S. calls “generalized moments.” Liquid metal consists of ions, the potential energy of which is primarily determined by their relation to the surrounding electronic atmosphere, and $m = \frac{EZ}{r}$ may be taken as the “generalized moment,” where

$E = 4.774 \times 10^{-10}$, Z is the valency of the ion, and r the ionic radius. Expressions are derived for the surface tension and limiting surface activity. Determinations of the surface tension of different metal amalgams confirm the theory. Problems connected with the modification of alloys and the mutual solubility of metals are examined from the theoretical point of view.—N. A.

***Properties of Metallic Solutions. II.—Surface Tension of Amalgams.** B. P. Bering and N. L. Pokrovskiy (*Zhurnal Fizicheskoy Khimii (J. Phys. Chem.)*, 1936, 7, (4), 509–517).—[In Russian.] Measurements of the surface tension of mercury gave values of 410 dynes/cm. *in vacuo* and 465 dynes/cm. in hydrogen. Values were also obtained for the surface tension of amalgams containing up to 0.2% of the alkali metals, alkaline earth metals, and some of the heavy metals.—N. A.

Surface Phenomena and Properties of Alloys. V. K. Semenchenko (*Zvetnye Metalli (Non-Ferrous Metals)*, 1936, (6), 92–100).—[In Russian.] See abstract above (*Zhurnal Fizicheskoy Khimii*, 1936, 7, (4), 501–508).—N. A.

On Polymorphous and Magnetic Transformations. S. S. Scheinberg (*Metallurg (Metallurgist)*, 1936, (9), 6–10).—[In Russian.] It is pointed out that magnetic as opposed to polymorphous transformations, do not represent

structural phase transformations. Magnetic transformation takes place in a homogeneous phase, continuously throughout a wide temperature range and is subjected to the law of phase equilibria. Examples are given.—N. A.

***The Mechanism of Precipitations and Transformations [in Alloys].** Ulrich Dehlinger (*Arch. Eisenhüttenwesen*, 1936–1937, **10**, (3), 101–105; discussion, 105–107).—In transformations in solid alloys the equilibria only approximately conform to the phase rule; between the beginning and end of a reaction there are various intermediate stages. For example, in the hardening of supersaturated solid solution alloys precipitation may occur in three ways. In the hardening of copper–aluminium alloys at room temperature the increase in hardness takes place without any of the solute atoms leaving the lattice; they appear to form complexes within the structure of the basic lattice which are broken up only by heating at 130° C., at which temperature visible precipitation first occurs. On heating supersaturated beryllium–copper alloys precipitation may occur in either of two ways; in alloys which have been homogenized after cold-work precipitation starts along the grain boundaries and proceeds inwards at an increasing rate, *i.e.* the precipitation is auto-catalytically accelerated, whereas in alloys which have been quenched after casting precipitation takes place more slowly and is more uniform throughout the grain. A theoretical explanation of these different types of precipitation is advanced.—A. R. P.

The Application of the Quantum Theory of Metals to the Phase Equilibrium in Alloys. S. T. Konobejewski (*Ann. Physik*, 1936, [v], **26**, (2), 97–115).—From existing data on the structure and range of stability of phases of the Hume-Rothery type it is concluded that these phases cannot correctly be considered as chemical compounds with stoichiometric formulæ but only as true intermetallic phases of variable composition. The conditions of heterogeneous equilibrium of two solid solutions are determined on the basis of the quantum theory. The application of the theory to the calculation of the course of the solubility curve (α -phase) gives results which agree well qualitatively with the experimental results.—v. G.

Equilibrium Between Molten Metals and Slags. W. Krings (*Z. Metallkunde*, 1934, **26**, 247–249).—The applicability of the law of mass action is investigated in the case of a ferrous metal–slag system and of the systems copper–phosphorus–oxygen and manganese–phosphorus–oxygen. The stability of certain compounds in the liquid state is shown to diverge markedly from the expected values.—P. M. C. R.

†The Nature of Intermetallic Phases of Variable Composition. N. W. Ageew (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Analyse Phys.-Chim.)*, 1936, **8**, 175–200).—[In Russian.] Solid solutions, both atomic and molecular, are discussed. The existence of the latter in metallic systems is not confirmed by the available experimental data. Intermetallic phases can be divided into those with a congruent melting point (daltonides) and those without (bertollides). Daltonides can be metallic, metallo-homopolar, and metallo-ionic, according to the nature of the bonds. Bertollides generally belong to the metallo-homopolar type.—N. A.

The Topology of the Diagram of Chemical Equilibrium. N. S. Kurnakow (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Analyse Phys.-Chim.)*, 1936, **8**, 15–55).—[In Russian.] See *Met. Abs.*, this vol., p. 302.

—N. A.

***Topological Properties of Phase Diagrams.** A. B. Mlodzeevskiy (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Analyse Phys.-Chim.)*, 1936, **8**, 57–68).—[In Russian.] The investigation is a continuation of the work of N. S. Kurnakow (preceding abstract). An attempt is made to establish a relationship between the geometrical elements of the diagram and corresponding definite phase equilibria.—N. A.

The Melting Point Diagram of Poly-Component Systems.—I-IV. Yoshio Konishi (*Kogyo Kwagaku Zasshi (J. Soc. Chem. Ind. Japan)*, 1936, 39).—[In Japanese, with English abstract in supplemental binding, pp. 209-210b.] K. has devised a method whereby the change of a property (e.g. the melting point) with composition in systems of 2 or more components, under specified experimental conditions, may be represented by rectangular co-ordinates. The method is described and illustrated.—S. G.

***X-Ray Methods for Ternary Systems.** (Andersen and Jette.) See p. 531.

Complex Methods for the Study of Metallic Alloys. Léon Dlougatch (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 315-321 (in French); also *Rev. Mét.*, 1936, 33, (10), 612-618; and (in Russian) *Metallurg (Metallurgist)*, 1936, (1), 115-128).—The adoption, as a principle of research, of "complex methods," in which several properties of the same material are studied at the same time, is discussed. Reference is made to a number of examples of the successful use of "complex methods" in metallurgical research.—J. C. C.

On the Quantum Theory of the Dependence of the Magnetization Curve on Temperature. N. Akulov (*Z. Physik*, 1936, 100, (3/4), 197-204).—Mathematical.—P. W. R.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 457-459.)

***Grain Orientation and Growth in Rolled Sheet [Recrystallization Diagrams of Aluminium and Copper].** Otto Dahl and Franz Pawlek (*Z. Metallkunde*, 1936, 28, (9), 266-271).—Complete recrystallization diagrams for 99.6% aluminium and pure copper have been constructed. The aluminium diagram shows that a coarse grain is obtained by annealing at above 600° C. after a 3-6% reduction by cold-rolling, and an extraordinarily coarse grain on annealing at above 550° C. after more than 70% reduction. The recrystallization diagram of copper is more complex than that of aluminium, but very coarse grain growth is obtained on annealing at above 900° C. after more than 80% reduction and only relatively large grains after 3-6% reduction; minimum grain-size is obtained by annealing at 600° C. after 98% reduction. The 50 : 50 iron-nickel alloy also acquires a very large grain after annealing severely cold-worked material at high temperatures; in all three cases the grains exceed 100 cm.² in area, but only in the cases of copper and iron-nickel alloy is a regular orientation produced. With aluminium the large grains are formed irregularly from the [112] recrystallization texture. Brass does not show this coarse crystal growth. Alloying of even small amounts of other metals with copper changes the rolling and recrystallization texture and prevents the coarse crystallization.—A. R. P.

***The Crystallization of Ternary Eutectics.** A. A. Botchvar and K. V. Gorev (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Analyse Phys.-Chim.)*, 1936, 8, 283-290).—[In Russian.] The ternary eutectics lead-tin-cadmium, bismuth-lead-cadmium, and bismuth-tin-cadmium were studied. Formation of crystal nuclei in all three phases of a ternary eutectic does not take place simultaneously, but gradually. Metals entering into the composition of the eutectics may be placed in order of their separation as follows: cadmium, lead, tin, bismuth. Under given conditions cadmium apparently has the largest and bismuth the smallest number of crystal nuclei. Cadmium has the greatest and bismuth the lowest rate of linear crystal growth.

—N. A.

The Theory of Crystal Growth. R. Kaischew (*Z. Physik*, 1936, **102**, (9/10), 684-690).—Mathematical.—P. W. R.

On the Preparation of Sections for the Microscopic Examination of Aluminium and Its Alloys. E. Käpernick (*Aluminium*, 1936, **18**, (9), 433-435).—Mounting, polishing, and etching procedures are described.—A. R. P.

***Microscopical Metallography of Aluminium Bronzes.** C. Panseri (*Alluminio*, 1935, **4**, (1), 3-50).—P. describes the characteristics of the principal metallographic reagents used for the copper-rich alloys (bronzes, brasses), and the practical difficulties which prevent them from being generally used in the metallography of the aluminium bronzes. Although many of these reagents can give good results for a certain type of aluminium bronze, none can be used safely in every case. The phenomenon of passivity, exhibited by aluminium bronzes, is experimentally verified, and a reagent suggested to obviate it is a dilute aqueous solution of hydrofluoric and nitric acids (nitric acid 100 c.c., hydrofluoric acid 50 c.c., water 750 c.c.). The effect of this reagent is illustrated by many photomicrographs. The effect of various reagents was tested on many aluminium bronzes, binary or complex, and photomicrographs are given of typical examples. The 305 photomicrographs given by P. can therefore be used as a guide in the metallography of these alloys. A few peculiarities of binary bronzes of high purity and of commercial purity are discussed and illustrated. The influence of vanadium on the binary 90:10 aluminium bronzes is also mentioned.—J. K.

***Microscopical Study of Surface Modification Produced by Mechanical Polishing of Brass.** P. Jacquet (*J. chim. physique*, 1936, **33**, (3), 226-231).—Electrodeposition of copper on brass (66.7:33.3) which has been polished (1) mechanically with emery followed by alumina, or (2) by the same treatment followed by electrolytic polishing, previously described (see *Met. Abs.*, 1935, **2**, 446), shows that in (2) the deposited copper continues unchanged the structure of the brass, whilst in (1) the deposited copper is finely crystalline and does not continue the brass structure. This is taken as evidence that mechanical polishing produces a surface modification to a depth estimated visually at 4×10^{-3} mm. These results are discussed in connection with the work of Lees (*Met. Abs.*, this vol., pp. 288, 468) who studied the Beilby layer by electron diffraction technique.—W. D. J.

***Notes on Etching and Microscopical Identification of the Phases Present in the Copper-Zinc System.** J. L. Rodda (*Metals Technology*, 1936, **3**, (6), 5 pp.; *A.I.M.M.E. Tech. Publ. No. 746*).—The γ and ϵ phases in the copper-zinc system may be distinguished by anodic etching in a 17% aqueous solution of chromic oxide (CrO_3). At current densities above 1.5 amp./in.², the γ -phase is attacked, but not the ϵ -phase; at low current densities the order of attack is reversed. The η -phase is attacked under both conditions.

—W. H.-R.

***The Preparation of Tin and Tin Alloys for Microscopic Examination.** H. J. Taffs (*J. Roy. Microscop. Soc.*, 1936, [iii], **56**, (3), 300-306).—Characteristics of sealing wax, golasz, picein, sulphur, Spence metal, fusible alloys, and Bakelite as mounting materials are reviewed. Acid-hardened Bakelite has been found most satisfactory for mounting wires, plates, and similar sections, giving a hard moulding which adheres well and does not require the use of high temperatures or pressures. A mixture of Bakelite resin solution with 10% of special acid-hardening solution is poured in the mould with the specimen, heated for $\frac{1}{2}$ hr. at 40°-45° C. and then for 1-1 $\frac{1}{2}$ hrs. at 60° C. Preliminary polishing is done by machine with heavy magnesium oxide or by hand with "Silvo" on selvyt, and final polishing by hand on a stretched selvyt cloth soaked in benzene, impregnated with fine alumina made by calcining ammonium alum for 6-8 hrs. at 1000° C., and lubricated with water. The action of various etching reagents is briefly outlined.—J. C. C.

***Influence of a Third Element on the Structure of Zinc Alloys with Iron, Nickel, and Cobalt.** J. Czochralski and C. Niewiadomski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1936, 3, (3), 116–118).—[In Polish, with French summary.] Addition of sodium, lithium, copper, mercury, cadmium, antimony, lead, silver, manganese, chromium, tin, and calcium to alloys of zinc with up to 1% of iron, cobalt, or nickel has no effect on the structure. Addition of 3.5–8% aluminium, however, considerably modifies the structure and improves the properties. The best mechanical properties are obtained with 7.5–8% aluminium and about 0.5% of iron, cobalt, or nickel, the nickel alloy, for example, having a tensile strength of 23.6 kg./mm.², an elongation of 2.6%, and a Brinell hardness of 64.6.—A. R. P.

***Investigations of the Structure of Resistance Welds in Light Metals.** Hans Röhrig and Elfriede Kapernick (*Z. Metallkunde*, 1936, 28, (9), 281–289; discussion, 289).—The results obtained in a series of tests designed to elucidate the mechanism of the spot welding of aluminium alloys are shown in an instructive series of macro- and micrographs. Whether welding occurs by simple recrystallization or by joining of the two parts in the plastic range is determined by the pressure applied, by the resistance of oxide films, and by the current density used. In welds made in Duralumin the line of the weld was brighter than the surrounding metal, indicating that a temperature in the solid solution range had been obtained; etching tests showed a higher concentration of copper in the weld than in the basis metal, and the presence of broken particles of CuAl₂ in the regions adjacent to the weld indicated that the temperature had not exceeded 550° C. The oxide films on the metal surfaces first assume an undulating form and then break down, allowing the metal to unite; at the same time the oxide and the more fusible constituents tend under certain conditions to be forced out of the weld forming a eutectiferous ring round the joint. It is concluded that the welding temperature is in the region of 525°–548° C.—A. R. P.

The Structure of Thin Evaporated Metal Films on Rock-Salt. L. Brück (*Ann. Physik*, 1936, [v], 26, (3), 233–257).—Films of metal evaporated on to rock-salt *in vacuo* acquire a preferred crystal orientation at a certain temperature characteristic of the metal. This orientation is determined by the nature of the metal and the substrate.—v. G.

Method for Determining Crystal Orientations in Metallic Thin Films. M. M. Umanskiy and V. A. Krilov (*Zhurnal Eksperimentalnoy i Teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (7), 684–690).—[In Russian.] The quantitative characteristic of the degree of orientation is the curve of distribution of the section of the three-dimensional polar figure by a plane. A method is given for constructing the distribution curve by comparing the relative intensities of the Debye lines. A calculation is given and a curve constructed for the distribution of crystals in a cadmium film obtained by vaporization in a high vacuum.—N. A.

***Electron Diffraction Investigation of the Structure of Thin Metal Films.** M. M. Umanskiy and V. A. Krilov (*Zhurnal Eksperimentalnoy i Teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (7), 691–699).—[In Russian.] Examination of the structure of thin films showed that copper, nickel, molybdenum, and tungsten (obtained by evaporation in a high vacuum) have the normal lattice, whereas with similar films of magnesium, iron, zinc, and cadmium an oriented crystallization was observed: The crystal size (10^{-6} – 10^{-7} cm.) appears to be related to the melting point of the metal. The structure and size of the crystals do not change with lapse of time.—N. A.

***A Study of Oxide Films on Metal Surface with Cathode Ray Diffraction. I.—Cu and Its Alloys.** Shizuo Miyake (*Sci. Papers. Phys. Chem. Res. Tokyo*, 1936, 29, (636), 167–178).—[In English.] See also *Met. Abs.*, this vol., p. 148. Electron diffraction methods were used to study the surface films formed on

copper and its alloys when heated (a) in an electric furnace at 200°–900° C., and (b) in the oxidizing flame of a gas burner. The alloys investigated included 70:30 brass, aluminium bronzes (2–10% Al), beryllium bronzes (1–15% Be), and binary copper alloys containing 7% of tin, manganese, nickel, and magnesium, respectively. On pure copper, and the alloys with tin, manganese, magnesium, and nickel, a film of cuprous oxide Cu_2O is formed at low temperatures (200° C), and a cupric oxide film at higher temperatures. Below 550° C. the cupric oxide film gives the CuO "three rings" pattern described by Thompson (*J. Inst. Metals*, 1930, 44, 480) and Murison (*Met. Abs.*, 1934, 1, 114), but above 600° C. the normal pattern of tenorite is obtained. In all these alloys scaling or flaking of the surface film occurs. In the alloys with zinc, aluminium, and beryllium the surface layer consists of oxides of the alloying element, which prevent further action; in such cases cupric oxide is not observed, and scaling is prevented or diminished.

—W. H. R.

***Calculation of the Compressibility Coefficients of Crystals.** V. Shdanov (*Z. Physik*, 1936, 101, (1/2), 86–92).—Assuming the Morse function applicable to crystals of any type, the compressibility coefficients of metallic, ionic, and homopolar crystals are calculated and found in satisfactory agreement with experiment. The other elastic constants of a crystal may be calculated in a similar manner.—P. W. R.

***The Lattice Constants of Very Pure Aluminium.** A. Ievins and M. Straumanis (*Z. physikal. Chem.*, 1936, [B], 33, (4), 265–274).—Aluminium containing only 0.0014% impurity has $a = 4.04143 \pm 0.00002$ A. at 25° C. The calculated coeff. of expansion between 25° and 47° C. is 23.13×10^{-6} .—V. G.

***X-Ray Determination of Coefficients of Thermal Expansion of Beryllium and Tin.** G. F. Kosolapov and A. K. Trapeznikov (*Zhurnal Eksperimentalnoy i Teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (6), 577–583).—[In Russian.] c and a for beryllium and tin were determined by X-rays at different temperatures. The calculated coeffs. of expansion are: beryllium, $\alpha_{11} = 1.04 \times 10^{-5}$, 1.10×10^{-5} , and 1.31×10^{-5} ; $\alpha_{\perp} = 1.50 \times 10^{-5}$, 1.54×10^{-5} , and 1.57×10^{-5} ; for the temperature ranges 18°–220°, 18°–320°, and 18°–454° C., respectively; tin, in the range 23°–150° C., $\alpha_{11} = 2.2 \times 10^{-5}$, and $\alpha_{\perp} = 4.66 \times 10^{-5}$.—N. A.

***Structure of Plastically Deformed Crystals According to the Laue Patterns. II.—Plastically Stretched Magnesium Single Crystals.** A. Komar and M. Mochalov (*Zhurnal Eksperimentalnoy i Teoreticheskoy Fiziki (J. Exper. Theoret. Physics)*, 1936, 6, (7), 700–704).—[In Russian.] Cf. *Met. Abs.*, this vol., p. 255. The presence of the diapason of the K_{α} reflections of Mo radiation from the (0001) plane of single crystal magnesium stretched 10%, and of "tails" on the Laue diagrams, is due to the heterogeneity caused by the regular distribution of distorted areas which may be represented as a mosaic bending of slip-planes around an axis perpendicular to them.—N. A.

***X-Ray Examination of the Equilibrium Diagram of the Aluminium–Lithium Alloys and the Structure of the Compound AlLi .** (Komovskiy and Maksimov.) See p. 505.

***System Aluminium–Magnesium–Zinc.** (Riederer.) See p. 506.

***Superlattice Phenomena in Nickel–Arsenic Alloys.** F. Laves (*Fortschr. Min. Krist. Petr.*, 1935, 19, 33–37; *C. Abs.*, 1936, 30, 7499).—Cf. *Met. Abs.*, 1935, 2, 378. Rotation photographs obtained with tetragonal Ni_3As_2 (maucherite) give $a = 3.45$, $c = 21.7$ A., with a superposed two-dimensional superlattice having $a = 6.9$ A.—S. G.

***X-Ray Examination of the Thermal Treatment of Magnetic Aluminium–Nickel–Iron Alloys.** L. Vereshagin and G. Kurdjumov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1935, 5, (9), 1629–1631).—[In Russian.] The structures of two iron alloys containing aluminium 11.23 and 10.23, nickel

24-36 and 26-68, silicon 0-18 and 0-02, and carbon 0-2 and 0-055%, respectively, were examined after annealing for 1 hr. at 1200° C. and quenching and after a subsequent precipitation heat-treatment at 300°–1000° C. The alloys have a body-centred cubic lattice with regular atomic distribution. The changes in coercive force produced by heat-treatment are not related to the separation of the disperse phase since the lattice parameter is unchanged by the precipitation treatment, but are caused by internal changes in the solid solution itself during precipitation.—N. A.

Calcium. A. Schubert (*Russko-Germanskiy Vestnik Nauki i Tehniki (Deut.-Russ. Z. Wiss. Tech.)*, 1936, (6), 8–15).—[In Russian.] X-ray examination at high temperature shows that calcium exists in three modifications: α , stable below 300° C., has a face-centred lattice, $a = 5.56$ A.; β , stable from 300° to 450° C., an unknown lattice; and γ , stable above 450° C., a close-packed hexagonal lattice, $a = 3.94$ A., $c = 6.46$ A., $c/a = 1.64$. In the presence of small amounts of impurities γ has a body-centred cubic lattice, $a = 4.434$ A. The α - β transformation is accompanied by changes in the coeff. of linear expansion, electrical resistance, and contour of the cooling curves.—N. A.

***X-Ray Investigation of the Iron-Chromium-Silicon Phase Diagram.** (Andersen and Jette.) See p. 507.

***The Atomic Rearrangement Process in the Copper-Gold Alloy Cu₃Au.** C. Sykes and F. W. Jones (*Proc. Roy. Soc.*, 1936, [A], 157, (890), 213–233).—Results are given of an investigation, by a method previously described, of the thermal constants relating to the order-disorder change in Cu₃Au. X-ray and electrical resistance data are also given, and the results are compared with those predicted by the theories of Bragg and Williams and of Bethe and Peierls.—B. C.

***The Solid Solubilities of the Elements of the Periodic Sub-Group Vb in Bronze.** (Mertz and Mathewson.) See p. 508.

***On the Internal Structure of Dendrites in Bronze.** Gunji Shinoda (*Tetsu-to-Hagane*, 1936, 22, (9), 727–730).—[In Japanese.] The structures of dendrites in bronze were studied by means of X-ray back-reflection photographs, with the following results: In the case of alloys solidified very slowly the compositions of the stems of the dendrites are nearly uniform and differ little from those of annealed alloys. The distribution of composition in dendrites of chill-cast alloys is very nearly the same, but the crystal arrangements differ greatly. When the rate of solidification is not so rapid nor slow, as in a sand mould, the X-ray photographs show Debye-Scherrer rings corresponding to the stems of dendrites and broad bands corresponding to the fillings of dendrites. The compositions of these stems, calculated from lattice constants, suggest the degrees of supercooling; the edges of the bands correspond to the solubility limit of tin in the α solid solution. The non-uniformity of composition almost disappears on annealing for 1 hr. at 800° C. Fracture surfaces of these cast alloys consist of the tin-rich side of the fillings of the dendrites.—S. G.

***X-Ray Study of the Inter-Diffusion of Copper and Zinc.** E. A. Owen and Llewelyn Pickup (*Proc. Roy. Soc.*, 1936, [A], 149, (867), 282–298).—The inter-diffusion of copper and zinc filings was studied by means of X-rays, observations being made on the effect of time, temperature, particle size, pre-annealing, and pre-exposure to the atmosphere. Inter-diffusion takes place in reasonable time only when the temperature is above the melting point of zinc. The α - and β -phases were detected but not the γ -phase. The relation between the α -phase composition and time of inter-diffusion at constant temperature is given by $M - C = K_1 e^{-m_1 t} + K_2 e^{-m_2 t}$, where M is the composition of the undiffused mixture, and K_1 , K_2 , m_1 , and m_2 are constants depending on the diffusing conditions.—W. D. J.

***X-Ray Examination of Certain Copper-Zinc Alloys at Elevated Temperatures.** E. A. Owen and Llewelyn Pickup (*Proc. Roy. Soc.*, 1934, [A], 145, 258-267).—Cf. *Met. Abs.*, 1935, 2, 592. A method is briefly described by which accurate values of crystal parameters are obtained from X-ray photographs taken when the material examined is maintained at high temperature *in vacuo*. The thermal expansions of the β -constituent in the $(\alpha + \beta)$, β , and $(\beta + \gamma)$ regions of the copper-zinc system are found up to 600° C. The β -phase in the three regions was found to expand at the same rate up to the transformation temperature. The rate of expansion is slower above this temperature, but is again the same in each region. These change points noted in the expansion are shown distinctly, and are at about 450°, 470°, and 485° C. in the $(\alpha + \beta)$, β , and $(\beta + \gamma)$ regions, respectively, and correspond to the transformation temperatures recorded by previous workers by other methods. The explanation of the abrupt change found in the expansion curves is to be sought in the behaviour of the atoms within the lattice. The possibility of a change in orientation of the atoms *in situ* was considered improbable. It is concluded that the β -transformation is more likely to be due to a change in the distribution of copper and zinc atoms within the lattice.—S. G.

***On the Non-Diffusion Transformation of the β -Phase in Copper-Zinc Alloys.** (Kaminskiy and Kurdjumow.) See p. 511.

***Crystal Structure of the Intermetallic Phases MgAu and MgHg.** G. Brauer and W. Haucke (*Z. physikal. Chem.*, 1936, [B], 33, (4), 304-310).—Both compounds have the cubic body-centred, β -brass lattice, with $a = 3.259$ for MgAu and $a = 3.442$ A. for MgHg.—v. G.

***The Crystal Structure of Polonium by Electron Diffraction.** M. A. Rollier, S. B. Hendricks, and Louis R. Maxwell (*J. Chem. Physics*, 1936, 4, (10), 648-652).—Electron diffraction photographs ($\lambda = 0.062$ Å.) were obtained from about 10^{-7} gm. of polonium that had been volatilized in a stream of hydrogen and condensed over an area of about 3 mm.² on a thin collodion film. Diffraction patterns were also obtained from bismuth and tellurium, since it was expected that polonium would have a similar crystal structure. Analysis of these patterns shows that the structure of polonium closely resembles that of tellurium, the lattice being pseudo-hexagonal, with $a = 4.25$ Å., $c = 7.06$ Å., or 14.12 Å., and $d_{\text{calc.}} = 9.39$, assuming 3 Po in the pseudo unit of structure. The true lattice is probably monoclinic with $a = 7.42$ Å., $b = 4.29$ Å., $c = 14.10$ Å. and β quite close to 90°, a suggested value being $\beta = 92^\circ$; $d_{\text{calc.}}$ for 12 Po in the unit of structure is 9.24. A structure, based on the space group $C_2^3-C_2$, in which each polonium atom has 4 nearest neighbours gives moderate agreement between observed and calculated intensities of reflection.—S. G.

***X-Ray Studies on Electrodeposited Silver.** Sudhendu Basu and M. Hussain (*Indian J. Physics*, 1936, 10, (4), 267-274).—The work of W. A. Wood (*Met. Abs.*, 1935, 2, 590) with nickel is extended to silver, confirming, in a general way, his conclusions as regards correlation between current density and selective orientation and between hardness and breadth of diffracted lines. Intensity measurement is extended to lines of planes 111, 200, 220, 311, and 222 of silver for different current densities. The brightness of the electrically-deposited surfaces is estimated photographically, giving a better estimate of the lustre than the visual estimate of Wood.—S. G.

***X-Ray Study of the Structure of the β -Phase of Ag-Cd [Alloys] at High Temperatures.** G. F. Kosolapov and A. K. Trapeznikov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1936, 6, (7), 1131-1134).—[In Russian.] Cf. *J. Inst. Metals*, 1928, 39, 537, 538; 1928, 40, 573; 1929, 41, 511. The β' -phase existing at room temperatures has a cube-centred cubic lattice with $a = 3.32$ Å. The structure of the β' -phase at 270° C. is similar to β' . The β -phase at 500° C. has a hexagonal space lattice with $a = 3.16$ Å. and

$c = 4.95$ A. The phase with a hexagonal structure fixed by quenching remains stable at high temperatures.—N. A.

***The Lattice Spacings of Certain Primary Solid Solutions in Silver and Copper.** William Hume-Rothery, George Farley Lewin, and Peter William Reynolds (*Proc. Roy. Soc.*, 1936, [A], 157, (890), 167-183).—The modifications of the lattice parameters of silver and copper by the addition of certain metals which form solid solutions were studied. It is shown that the lattice spacing varies linearly with the product of the atomic-% of solute and a factor specific to the solute, for a given solvent. The multiplying factors are generally expressible in whole numbers.—B. C.

***The Transition of Hexagonal α -Titanium into Regular β -Titanium at a High Temperature.** J. H. de Boer, W. G. Burgers, and J. D. Fast (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (4), 515-519).—[In English.] The α -modification of titanium which is stable at room temperatures has a close-packed hexagonal structure, and is stable up to $882^\circ (\pm 20^\circ)$ C. at which temperature a transition to the β -modification takes place. With pure titanium the electrical resistance-temperature curve shows a sharp break at the transition temperature, but in the presence of oxygen the transition takes place over a range of temperature. β -titanium has a body-centred cubic structure, and at 900° C. the lattice constant $a = 3.32$ A. The allotropy of titanium closely resembles that of zirconium, for which the transition temperature is $862^\circ \pm 5^\circ$ C.—W. H.-R.

***Contribution to the Knowledge of the System Iron-Tungsten.** (Landgraf.) See p. 520.

Errata: Precision Lattice Constants from X-Ray Powder Photographs. M. U. Cohen (*Rev. Sci. Instruments*, 1936, [N.S.], 7, (3), 155).—A correction of errata in a previous paper (*Met. Abs.*, this vol., p. 306) includes a reference to the Debye camera, which becomes an absolute instrument only if the angle measured is that between the incident and reflected beams. Modifications in construction are suggested.—P. M. C. R.

Contact Potential Differences Between Single Crystal Surfaces of Various Orientations.—I. H. Kurzke and J. Rottgardt (*Z. Physik*, 1936, 100, (11/12), 718-725).—The photoelectric method was used to give the contact potential between the (111) and (11 $\bar{1}$) faces of bismuth crystals. The value obtained was 0.36 v.—B. C.

***X-Ray Methods for Ternary Systems.** A. G. H. Andersen and Eric R. Jette (*Trans. Amer. Soc. Metals*, 1936, 24, (3), 519-540).—The theory of the application of X-ray methods to the determination of phase boundaries in ternary alloys is discussed in detail. The method is similar in principle to that used in binary alloys, except that the lattice spacings of a given phase in a two-phase region at a given temperature are no longer constant for a series of two-phase alloys, since the composition of the two phases may vary, in contrast to a binary system where at a given temperature the composition of two phases in equilibrium are fixed. Possible variations are discussed, and the way in which isoparametric lines (*i.e.* lines joining alloys with the same lattice spacing) can be drawn is described. The method enables the tie-lines to be determined.—W. H.-R.

Metals: Their Structure, Characteristics, and Idiosyncrasies. V. N. Krivobok (*Canad. Chem. Met.*, 1936, 20, (2), 48, 50).—A review of crystal structure and the effect of deformation thereon.—A. R. P.

The Theory of Alloy Structures. W. L. Bragg (*J. Roy. Aeronaut. Soc.*, 1936, 40, (306), 409-413; discussion, 414-419).—Recent advances in the elucidation of structures of alloys by X-ray analysis are discussed. The powder method is recommended for the examination of alloys. Reference is made to the properties of phases on which information is gained by X-ray structural analysis. Recent theoretical treatment of the theory of structure in alloys is mentioned briefly.—H. S.

On Our Knowledge of the States of Metals in Alloys. Wilhelm Biltz (*Forschungen u. Fortschritte*, 1935, **11**, (23/24), 306-309).—Consists of a summary of information about the state of metals in alloys, and is mainly about volumes, heats of formation, and compressibilities of alloys.—B. C.

***The Special State of Matter in Known Alloys. Stereochemical Considerations.** Wilhelm Biltz and Friedrich Weibke (*Z. anorg. Chem.*, 1935, **223**, (4), 321-361).—The volume effects of metallic atoms on each other in both compounds and solid solutions are tabulated and discussed. The results are not suitable for abstracting.—B. C.

***Magnetic and Electronic State of Metallic Alloy Crystals and Elements.** U. Dehlinger (*Z. Elektrochem.*, 1935, **41**, (9), 657-659).—The small difference between the observed and calculated values of the magnetic saturation moments of cobalt, nickel, and copper, and mixtures of these elements, are discussed from the point of view of the quantum theory. The ferromagnetism of iron and the iron-rich alloys is also considered.—B. C.

***The Transition from Metallic to Heteropolar Linkage.** U. Dehlinger (*Z. Elektrochem.*, 1935, **41**, (6), 344-346).—The lattice types of the phases of simple atomic ratios that form between aluminium and various other metals are related to the electronic structures of the metals. The existence of heteropolar linkages between metals, and the consequent existence of inter-metallic compounds having non-metallic properties, is also considered.—B. C.

***On the Theory of Metallic Linking.—II.** Paul Gombás (*Z. Physik*, 1936, **100**, (9/10), 599-614).—See *Met. Abs.*, this vol., p. 245. A further contribution to the mathematical theory of inter-atomic forces in metals: the calculation of heats of sublimation. The formulæ deduced are applied to the calculation of the lattice constants, the lattice energies, and the heats of sublimation of potassium, rubidium, and caesium. The results are in satisfactory agreement with the experimental values.—P. W. R.

Problems of the Internal Physics of Materials. Georges-A. Homès (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, **2**, 323-327; and *Rev. Mét.*, 1936, **33**, (11), 641-645).—The uses of X-rays for studying the internal structure of metals and also for detecting flaws are briefly reviewed. Examples of X-ray diffraction photographs showing the effects of deforming and annealing a single crystal of zinc and a polycrystalline sample of copper are included.

—J. C. C.

***On the Atomic Forces of Solid States [—I—II].** Weng Wen-Po (*Phil. Mag.*, 1936, [vii], **22**, (145), 49-68).—Theoretical. The relations between the elastic constants and the atomic forces in solids are discussed, and the theory is developed. The compressibilities, coeffs. of thermal expansion, melting points, and specific heats are dealt with, and the experimental constants for metals and salts are compared with those expected from the theory.

—W. H. R.

***On the Atomic Forces of Solid States.—III.** Weng Wen-Po (*Phil. Mag.*, 1936, [vii], **22**, (146), 281-286).—Cf. preceding abstract. The theory is developed with reference to the repulsive forces between atoms in solids, and melting point phenomena.—W. H. R.

†**Zeitschrift für Kristallographie. Ergänzungsband II. Strukturbericht Band II. 1928-1932.** C. Hermann, O. Lohrmann, and H. Philipp (*Z. Krist.*, 1936).—The second volume of the *Strukturbericht* (S.B. II) covers the great majority of the papers on X-ray crystal structure analysis published in the period 1928-1932. For completeness it must, however, be used in conjunction with the first volume (S.B. I), since, in general, if papers in the period 1928-1930 were included in S.B. I, they are not repeated in S.B. II, whilst the latter contains references to some early papers accidentally omitted from the first volume. The volume S.B. II is divided into three main parts, dealing with inorganic compounds, alloys, and organic compounds, respectively. The

distinction between the inorganic compounds and alloys is inevitably not a sharp one, and substances such as selenides, tellurides, arsenides, antimonides, and bismuthides are included in the inorganic part, although many are constituents of well-known alloy systems. The general arrangement follows that of S.B. I. Types of structure not illustrated in S.B. I are illustrated clearly at the beginning of S.B. II, the general nature of each structure being explained with special reference to one or two examples. The substances are then classified, and a complete summary given of all X-ray work bearing directly on crystal structure in the period concerned; results from the electron diffraction method are also included when these bear directly on crystal structure. The discussion is critical, and in some cases mistakes in original calculations have been noted and corrected. The whole work is of the greatest value, and when the index is available, it should become the standard work of reference. *Heft I*, pp. vii-xxiv and 1-96. This number contains illustrations, and discussions of types of structure not described in S.B. I. These include the structures of gallium, α - and β -manganese, and β -tungsten, of several carbides, sulphides, arsenides, borides, and phosphides, as well as that of the compound AuCd. *Heft II*, pp. 97-256. The remaining types of structure are illustrated, but do not refer to alloys. Pp. 162-206 refer to work on the crystal structure of the elements, including many of the metals. Pp. 207-242 refer to the structures of compounds of formula AB , and include many sulphides, selenides, tellurides, nitrides, phosphides, carbides, silicides, and borides which are of metallurgical interest. The remaining pages deal with halides and hydroxides of formula AB_2 . *Heft III*, pp. 257-416. Pp. 257-286 deal with compounds of formula AB_2 , and pp. 287-328 with compounds of the more general type A_mB_n . These include many compounds of metals with metalloids (carbides, antimonides, &c.) which are of direct metallurgical interest. The remaining pages deal first with compounds which contain more than two kinds of atoms but no complex radicals (some double sulphides are included), and then with more general compounds of inorganic chemistry. *Heft IV*, pp. 417-598. These pages deal with the more complicated compounds of inorganic chemistry.—W. H.-R.

IV.—CORROSION

(Continued from pp. 459-460.)

*On Corrosion Tests on Pure Aluminium and Aluminium Alloys. E. Zurbrugg (*Korrosion V. Bericht über die Korrosionstagung 1935, 1936*, 100-108; discussion, 108-110).—Cf. *Met. Abs.*, this vol., p. 459. The results obtained in corrosion tests in distilled water, tap-water, and artificial sea-water in the presence of small amounts of copper salt, on 99.3% aluminium, Duralumin, and three alloys containing manganese, magnesium, and silicon are shown graphically and in photographs of the specimens. Aeration of the corrosive medium with carbon dioxide results in severe corrosion starting from the cut edges and later in the development of blisters and flaking of the sheet. This behaviour is shown even by the sea-water resistant manganese-magnesium-aluminium alloy. The presence of even as little as 0.5 mg./litre of copper produces severe local corrosion irrespective of the p_H of the solution between 5 and 8; lead in solution is almost as deleterious.—A. R. P.

*On the Influence of the Purity of Aluminium on the Corrosion in Hydrochloric Acid of Different Concentrations. W. J. Müller and E. Löw (*Aluminium*, 1936, 18, (10), 478-486).—The rate of dissolution of aluminium of purity varying from 99.355 to 99.998% in 0.1-6*N*-hydrochloric acid was determined in the Palmær apparatus and the results are recorded in numerous tables and graphs and discussed from a theoretical point of view. The purest

grade of aluminium is not attacked by acid more dilute than 4N; with lower grades of aluminium there is always a period of induction before dissolution commences. The course of the dissolution curves is not in accord with the simple theory of local elements, which also does not explain the induction period.—A. R. P.

Non-Metallic Inclusions in Aluminium and Their Influence on Its Corrodibility. L. Tronstad (*Kongelige Norske Videnskabernes Selskabs*, 1935, 1, (19), 1-30).—[In English.] See *Met. Abs.*, this vol., p. 203.—L. A. O.

***Study of the Corrosion in Nitric Acid of Welded and Riveted Aluminium Seams.** S. M. Gelman and I. O. Kazen (*Khimicheskoe Mashinostroenie (Chem. Machine Building)*, 1936, (4), 26-30).—[In Russian.] The results are recorded of corrosion tests on gas-welded and electrically welded joints in 3 mm. sheets of a 0.93% copper-aluminium alloy in 95, 75, 55, 40, and 20% nitric acid at room temperature, 25° and 60° C., with and without stirring, elongation before and after the test being measured. Gas-welded joints corroded least under all conditions. With riveted joints holes formed by corrosion round the rivets. Aluminium apparatus can be used for 95, 75, and 55% nitric acid up to 60° C. provided that the joints are gas-welded, but corrosion is higher in 55 than in 95 and 75% acid.—N. A.

***Aluminium Alloys in the Manufacture of Kitchen Utensils.** M. N. Rozov (*Legkie Metalli (Light Metals)*, 1936, (4), 43).—[In Russian.] The corrosion in 3% brine and 1% oxalic acid of Alclad and of aluminium alloys containing (a) copper 1.58, (b) manganese 1.37, or (c) manganese 1.42 and magnesium 0.20% was investigated. The corrosion-resistance of (b) is about equal to that of pure aluminium, but the mechanical properties are inferior; the alloy, however, is suitable for the manufacture of kitchen utensils by stamping.

—D. N. S.

On the Corrosion-Resistance of Hydronalium Especially Towards Sea-Water. G. Siebel (*Korrosion V. Bericht über die Korrosionstagung 1935*, 1936, 110-113; discussion, 114-116).—See *Met. Abs.*, this vol., p. 8.—A. R. P.

***Resistance of Hydronalium Castings to Corrosion.** G. Siebel (*Aluminium*, 1936, 18, (10), 511-518).—Corrosion tests in alkaline solutions and in sea-water show that Hydronalium alloys have an extraordinarily good resistance to corrosion by sea-water owing to the small potential difference between the various phases: in consequence of this the heterogeneous alloy whether in the cast or heat-treated condition behaves just as satisfactorily as the homogenized alloy. The presence of micro-pores, due to the phenomena of crystallization, may produce local corrosion, but their formation may be prevented by addition of 1% of silicon to the alloy.—A. R. P.

***Relation Between Corrosion-Resistance of Magnesium-Aluminium Alloys and the Properties of Their Surface Films.** B. I. Rimmer (*Izvestia Akademii Nauk S.S.S.R. (Bull. Acad. Sci. U.B.S.S.)*, 1935, [vii], (10), 1399-1410).—[In Russian.] The densities were determined of aluminium alloys with 5.0, 24.8, 33.6, 48.0, 74.0, and 95.7% magnesium, and of the oxide mixtures obtained by heating the powdered alloys at 800°-1000° C. In all cases except pure magnesium the volume of the oxides is greater than that of the alloy. Oxides with a small magnesium content are only slightly hygroscopic, the hygroscopicity increasing to a maximum with the oxides given by alloys with 70-95% magnesium. Corrosion tests in 3% salt solution and in air of 75, 84, and 95% R.H. showed that the resistance of the alloys to corrosion depends chiefly on the hygroscopicity of the surface oxide film.—N. A.

***On the Question of the Stability of Manganese-Aluminium Alloys Against Chemical and Atmospheric Influences.** W. Helling (*Aluminium*, 1936, 18, (10), 473-477).—The loss in weight of alloys of aluminium with manganese 1-3, iron 0.12-0.3, and silicon 0.17-0.4% was determined in the following media: 0.05 and 0.5% sodium hydroxide solution at 20° C.; 40% acetic acid at 50° C.;

2% sulphur dioxide solution, 2% sulphuric acid, and a 4:4:1 mixture of nitric acid, water, and hydrochloric acid at 20° C.; flue gases containing sulphur dioxide at 100° C.; water vapour in a cooling tower at 40° C.; M.B.V. solution at 95° C.; and 3% salt solution containing 1% of hydrogen peroxide at 20° C. The results, given in tables and graphs, show that with increase in the manganese content the resistance to corrosion by caustic alkalis increases, whereas that by sulphurous and sulphuric acid decreases; in all acid solutions alloys annealed at 600° C. behave better than those annealed at 400° C. In the oxidizing salt test by far the most resistant alloy is that containing manganese 3, iron 0.18, and silicon 0.32%, especially after annealing at 400° C.—A. R. P.

†**Corrosion-Resistant Aluminium Casting Alloys.** R. Sterner-Rainer (*Aluminium*, 1936, 18, (9), 408-415).—The composition and properties of commercial corrosion-resistant casting alloys of aluminium are tabulated and the effect of various alloying constituents on the behaviour of aluminium alloys is discussed.—A. R. P.

***X-Ray Examination of the Oxidation of Cobalt at High Temperatures.** V. I. Arharov and Z. A. Voroshilova (*Zhurnal Tehnicheskoj Fiziki (J. Tech. Physics)*, 1936, 6, (5), 781-782).—[In Russian.] Scale on metallic cobalt during oxidation at 385°-800° C. consists primarily of cobaltous oxide as an inner layer adhering to the metal and covered with a film of Co_3O_4 . It is possible that this is covered with a film of Co_2O_3 , which is too thin to be detected by X-rays. The rate of growth of the CoO layer increases with increase of temperature; at relatively low temperatures the proportion of Co_3O_4 in the film is greater.—N. A.

***On the Oxidation of Copper at High Temperatures.** V. I. Arharov and Z. A. Voroshilova (*Zhurnal Tehnicheskoj Fiziki (J. Tech. Physics)*, 1935, 5, (9), 1625-1628).—[In Russian.] Copper oxide is stable below 375° C. Between 290° and 490° C. the rate of oxidation of copper increases regularly with the temperature, the oxide film formed being almost entirely cuprous oxide. The black film of cupric oxide formed on the surface of a 4-hr.-old scale is so thin that it gives no lines of its own in the X-ray diagram. Oxidation of copper apparently always begins with the formation of a cupric oxide film, below which a cuprous oxide is then formed.—N. A.

***Phenomena Accompanying the Atmospheric Oxidation of Copper at 500°-800° C.** S. P. Gvozdoz (*Metallurg (Metallurgist)*, 1936, (5), 57-60).—[In Russian.] On heating copper at 500°-750° C. in air on a film of cuprous oxide a needle-shaped crystal perpendicular to the surface is formed having a velvety black appearance; at above 750° C. the points of the crystals sinter into a grey crust in which, on cooling to 700°-800° C., crystallization centres appear followed by spreading of the needle crystals irregularly over the surface. The black colour of the velvety film is an optical illusion since the individual crystals are transparent and have a reddish tint. Abnormal oxidation of copper at certain temperatures is connected with the above-mentioned phenomena.—N. A.

***Influence of Impurities on Oxidation of Copper at High Temperatures.** S. P. Gvozdoz and N. N. Nagornov (*Metallurg (Metallurgist)*, 1936, (6), 78-82).—[In Russian.] The rate of oxidation at 950°, 900°, and 840° C. follows a parabolic law, the law of chemical reaction rates ($\log K = \frac{Q}{RT} + \text{const.}$)

being inapplicable. The growth of the oxide film has a sharply defined lateral effect. The orientation of the cuprous oxide crystals does not follow that of the original copper.—N. A.

***The Rate of Oxidation of Metals at High Temperatures.** Nickel, Copper, Iron, Brass. Alexandre Krupkowski and Jean Jaszczurowski (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 329-336; and *Rev. Mét.*, 1936, 33, (11), 646-653).—The rate of oxidation of metal plates

3.5 cm. long by 2.1 cm. wide has been followed by observing their increase in weight when surrounded by a furnace and suspended from one arm of a balance. At each temperature studied, the parabolic formula $w^2 = kt$, where w is the increase in weight in time t and k is a constant, was followed exactly, indicating that oxidation is determined by the resistance of the oxide film to

diffusion. Taking $k = ce^{-\frac{A}{RT}}$, the values found for c and A , respectively, were 0.95 grm.cm.⁻² minute⁻¹ and 43,420 cal.mol.⁻¹ for nickel between 900° and 1200° C., 6.96 and 40,560 for copper between 750° and 1070° C., and 1.77 and 49,990 for brass (29.2% zinc) between 530° and 800° C. Below 700° C., the rate of oxidation of copper departs from the above relation, probably owing to the formation of CuO in place of the Cu₂O produced at higher temperatures. Similarly, brass shows deviations in its rate of oxidation above 800° C., probably on account of an increase in the vapour pressure of the zinc. The oxidation of iron was also studied. A bibliography is appended.—J. C. C.

***The Rate of Solution of Copper in Dilute Aqueous Reagents.** Cecil V. King and Lillian Weidenhammer (*J. Amer. Chem. Soc.*, 1936, 58, (4), 602-607).—The rate of solution of polycrystalline copper from a rotating cylinder was measured in solutions of acetic acid and various oxidizing agents, especially hydrogen peroxide and quinone, and also in solutions of ferric chloride and nitrate, with the addition of hydrochloric acid. From the temperature coeff., variation in rate with rotational speed, effect of changed viscosity, and a comparison of the rate with that for other metals dissolving in acid solutions, it is concluded that the rate in the ferric salt solutions is largely diffusion-controlled. In the acetic acid solutions the rate may be entirely or partly controlled by the rate of the chemical reaction; in some of these solutions surface coatings may mechanically prevent access of reagent to the copper surface or otherwise change the character of the reaction.—S. G.

***Influence of Heat-Treatment on Fatigue and Corrosion-Resistance of Aluminium Bronze.** (Musatti and Dainelli.) See p. 509.

***Cause of Intensive Corrosion of Equipment [Bronze Valves, &c.] of the Soviet Tube Still in the Pyatakov Refinery.** V. F. Negreev and M. S. Arutyunov (*Novosti Neftepererabotki*, 1936, 3, (4), 4-5; *C. Abs.*, 1936, 30, 7086).—[In Russian.] The precipitates found in different sections of the tube still contained sodium chloride 93.02, calcium sulphate 0.94, calcium chloride 0.36, magnesium chloride 0.39, water 3.44, and mud, coke, &c., 1.22%. This precipitate when taken up with water showed a strictly acid reaction. The chemical analysis of condensed water yielded Fe⁺⁺ 0.1676 and Cl⁻ 0.1955 per litre. A brownish precipitate found in the upper plate section of the bubble tower was composed of 27.39-28.94% Fe⁺⁺, 0.152% S, and 30.4-33.0% Cl⁻. The bronze valves of the hot oil pumps were destroyed through the high content of active sulphur in the oil forming a sediment with copper 55.94 and sulphur 16.71%. Hydrogen sulphide separated during the distillation combines with iron forming ferrous sulphide. Hydrochloric acid present in the vapours acts with ferrous sulphide forming ferrous chloride and water; the separated hydrogen sulphide reacts again with a fresh surface of iron facilitating the formation of ferrous chloride in the presence of hydrochloric acid. These difficulties can be overcome by proper dehydration and treatment of the crude oil with ammonia, which should be admitted into the bubble tower.—S. G.

***Studies on the Corrosion of Condenser Tubes (Second Report).** Tomojiro Tanabe and Goro Koiso (*J. Soc. Mech. Eng. Japan*, 1934, 37, (208), 506-516; *Jap. J. Eng. Abs.*, 1936, 14, 29).—[In Japanese.] Gives (1) the results of corrosion tests on condenser tubes of various materials inserted in a specially constructed model condenser; (2) an examination and consideration of some condenser tubes used in Japan and abroad; (3) results obtained by the jet

test on the copper-zinc system and some other copper alloys; and (4) studies on the forms of corrosion, and corrosion phenomena in general.—S. G.

***A Study of the Phenomena of Abnormal Corrosion in Condenser Tubes.** Kurazo Fukagawa and Ken-ichiro Kameyama (*Rikwagaku-Kenkyu-jo Iho* (*Bull. Inst. Phys. Chem. Res. Tokyo*), 1935, 14, (12), 1246-1261).—[In Japanese.] Briefly reports the results of an investigation carried out at various electricity plants and on steamboats.—S. G.

Cleaning [Brass Tubes of] Colliery Condensers. P. A. Redford (*Colliery Eng.*, 1936, 13, (148), 207).—Mechanical methods for removing deposits from brass condenser tubes usually result in scoring. The loss of material in ordinary solvent cleaning with dilute hydrochloric acid is considerable, and a graph illustrates the beneficial effect of introducing small amounts of colloidal material into the acid.—P. M. C. R.

Recent Development in Condenser Tubes. — (*Mech. Eng.*, 1935, 57, (10), 628-630).—Abstract of Progress Report No. 8 of the A.S.M.E. Special Research Committee on Condenser Tubes, presented Dec. 1934. The experimental condenser tests carried out by the U.S. Naval Engineering Experiment Station at Annapolis are described, as are a series of impingement tests in a modified type of apparatus. A report on pitting from an industrial research laboratory is summarized. The performance of several recently-developed alloys is reviewed.—P. M. C. R.

Brass Tubes in the Java Cane Sugar Industry. P. Honig (*Korrosion u. Metallschutz*, 1936, 12, (11), 310-312).—Corrosion of the brass tubes of preheaters and evaporators in sugar factories may be caused by acid gases (carbon dioxide and sulphur dioxide) in the presence of traces of oxygen which cause dezincification, by traces of hydrogen sulphide which sulphidizes the copper, and by the presence of ferric oxide particles which attack the zinc and render the tubes brittle. Rapid movement of the sugar syrup or the presence therein of air bubbles or suspended matter may cause serious erosion of the tubes. The most satisfactory tube material is 70 : 30 brass free from antimony, lead, arsenic, and iron, and having a uniform fine-grained structure (grains 0.03-0.04 mm.).—A. R. P.

***Tube Corrosion [Copper, Bronze, Brass] in the Sugar Industry.** W. Köhler (*Korrosion u. Metallschutz*, 1936, 12, (11), 312-331).—The behaviour of copper, bronze, and various brass tubes in acid and alkaline solutions and in various syrups obtained in sugar refining was investigated. Tables and graphs are given showing the relative and absolute rates of corrosion in 0.1N-hydrochloric acid and 0.1N-potassium hydroxide solution and the potentials of the various alloys in these solutions and in sugar syrups after various times of immersion. The appearance of tubes exposed to these liquids is illustrated by numerous photographs in colour, and characteristic corrosion phenomena are also illustrated by cross-sections of the tubes and micrographs of the corroded parts. The results indicate that corrosion of preheater tubes is chiefly of an electrochemical or chemical nature and is rarely caused by erosion due to suspended matter in the syrups. Copper and fine-grained 70 : 30 brass showed an excellent resistance to attack. Special brasses appeared to have no advantage since the walls of the tubes rapidly became coated with a protective layer of non-sugars. For use with dilute syrups containing sulphur dioxide or carbon dioxide 60 : 40 brass with 0.4% chromium and 70 : 29 : 1 nickel-brass gave the best results since these alloys quickly developed a protective film.—A. R. P.

***Summary of Memoranda and Other Information Submitted to the [Corrosion] Committee [of the Iron and Steel Institute] [Corrosion in a Sugar Beet Plant].** — (*Iron Steel Inst. Special Rep. No. 13* (4th Rep. Corrosion Cttee.), 1936, 235-240).—Corrosion of baffle plates (steel) and internal fittings of drying drums through which combustion gases are passed is attributed to con-

densation. In conveyors for wet pulp copper coatings on spindles, rubber coatings on the screws, and linings of phosphor-bronze or copper in the channel overcame corrosion troubles. In pumps, phosphor-bronze impellers gave the best results. Results of immersion tests of various metals and alloys in the process water are given.—H. S.

Corrosion Damage in Beet Sugar Works. H. Claassen (*Korrosion u. Metallschutz*, 1936, 12, (11), 305-307).—Causes of corrosion of steel and brass plant in beet sugar factories are briefly discussed. Attention is directed to the corrosive effects of ammonia, sulphur dioxide, and carbon dioxide in the syrups and vapours therefrom and means for avoiding these difficulties are indicated.—A. R. P.

The Importance of p_H Measurements with Reference to Their Practical Use in the Sugar Industry. G. Gollnow and F. Tödt (*Korrosion u. Metallschutz*, 1936, 12, (11), 307-310).—The importance of p_H control in restraining the corrosion of metal parts of sugar evaporators is emphasized.—A. R. P.

***Corrosion of Water Pipes of Lead and of a New Lead Alloy.** E. Sorrentino and R. Intonti (*Annali Chim. applicata*, 1936, 26, (9), 385-398).—The corrosive action of various potable waters on common lead and on an alloy of lead with cadmium 0.75 and arsenic 0.1% was investigated. The alloy has a greater strength and more resistance to corrosion than ordinary lead, and pipes made of it can therefore have thinner walls. Dissolved silica and carbon dioxide produce the greatest corrosive action whereas some dissolved salts have an inhibiting effect. The mechanism of the action of the various constituents of waters on lead is discussed at some length.—A. R. P.

***The Corrosion of Lead and Iron by Solutions of Potassium Chloride Containing Sodium Chloride, Potassium Chlorate, and Sodium Hydroxide.** S. S. Shaibman and A. V. Baleev (*Kalib*, 1936, (5), 43; *C. Abs.*, 1936, 30, 7087).—[In Russian.] Lead and iron were tested in a solution of potassium chloride 300-350, sodium chloride 80-120, potassium chlorate 50-70, and sodium hydroxide 0.3 gm./litre, at 95°-105°. The corrosion of iron in solution without sodium hydroxide after 3 days was 349 gm./m.² and with sodium hydroxide none. The corrosion of lead in solution without sodium hydroxide after 9 days was 16 gm./m.² and with sodium hydroxide 31 gm./m.².

—S. G.

***Anodic Corrosion of Lead Cable-Sheaths in Manhole Water.** Mosaku Iwasa (*Rev. Electrotech. Lab. Japan*, 1934, (361), 1-17).—[In Japanese, with English summary.]—S. G.

***On Cable-Sheaths Subjected to Solutions of Various Salts.** Koei Sasaki (*J. Inst. Teleg. Teleph. Eng. Japan*, 1934, (139), 702-710).—[In Japanese.] The corrosion of cable-sheath depends on the density of the out-going cable-sheath current, and is also connected with the nature and chemical constituents of the water surrounding the buried cable. S. describes the state of corrosion of cable-sheaths in solutions of various salts and in natural and pure water. The specimens used were pieces of lead cable-sheath, 10 × 10 × 0.1 cm., of the composition lead 97 and tin 3%. The solutions were sulphuric, nitric, hydrochloric, and oxalic acids, sodium chloride, and calcium and sodium hydroxides, each solution being of 6 different densities of 0.1, 0.3, 0.5, 1, 3, and 5% by weight. The sheaths were submerged for from 1580 to 1640 hrs. Sulphuric acid had the least and nitric acid the greatest corrosion effect. The extent of corrosion is smaller in the horizontal than in the vertical submergence test.—S. G.

***On a Method for Producing a Good Protective Film on Magnesium Alloys.** S. Goto and H. Asada (*Tetsu-to-Hagane*, 1936, 22, (10), 798-800).—[In Japanese.] Cadmium-zinc-magnesium alloys containing a large amount of manganese, e.g. AZG and AZE, have considerable resistance to corrosion by a 3% salt solution. If, however, these alloys are heated in air at about 200° C.

after machining, their surfaces are covered with a film which is much more resistant. The average loss in weight of a tension test-piece (35 grm.) of the magnesium alloy containing cadmium 4, zinc 3, and manganese 1.8%, heated at about 200° C. was 0.9% of its initial weight on immersion in a 3% salt solution for 28 days, and there was a decrease in strength from 23 to 19 kg./mm.². The corrosion, which took place at 2 or 3 pits, is ascribed to defects in the film, *i.e.* pitting corrosion. An unheated specimen, however, had a loss in weight of 1.3% and a reduction in strength of 7 kg./mm.²; it was generally corroded over the surface. Cadmium-manganese-magnesium and zinc-manganese-magnesium alloys of numerous compositions were prepared to study the effects of cadmium and zinc on the film. The alloys were heated at 150°, 200°, 250°, and 300° C. and their corrosion-resistance compared qualitatively with unheated ones by immersion in a 3% salt solution. It was found that zinc up to 2% has no harmful effect, while cadmium up to 6% aids the formation of the film and the greater the manganese content the more effective is the film. The best heating temperature for the production of the film is 200° C.—S. G.

***On the New Non-Corrosible Magnesium Alloys.** Isamu Igarashi and Hyoji Nakata (*Tetsu-to-Hagane*, 1936, 22, (10), 800-813).—[In Japanese.] The corrosion of manganese-magnesium alloys can be almost entirely overcome by solution treatment and quenching. Addition of lithium improves the corrosion-resistance, but other elements are injurious—zinc, cadmium, and bismuth having the least ill effect. The corrosion of these alloys and of AZM in the quenched and annealed states is studied.—S. G.

***Influence of Light on Corrosion of Elektron "AZM," Immersed in Sea-Water from the Black Sea.** V. M. Fakeev (*Vestnik Inzhenerov i Tehnikov (Messenger Eng. and Tech.)*, 1936, (5), 302-303).—[In Russian.] The alloy which contains aluminium 7.15, zinc 0.73, and manganese 0.48% was tested for corrosion in daylight, in the dark, and in electric light by the hydrogen evolution method. In the dark the rate of corrosion is considerably greater than in light and remains constant, whereas in light it decreases, tending towards a limit.—N. A.

†(1) **Passivity of Metals.** *(2) **Experimental Study of Passivity of Nickel.** Louis Colombier (*Publ. Sci. Tech. Min. Air (Paris)*, No. 82, 1935, 95 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—(1) A survey (33 pp.) is given of the present knowledge of the passivity of metals: historical review; passivity of iron; passivity of other metals—nickel, chromium, aluminium, manganese, tin, lead, silver, thallium, zinc, copper, molybdenum, tungsten—and alloys; theories of passivity. (2) C.'s own investigation of the passivity of nickel is described (61 pp.); this included a careful study of its normal potential and its passivation by oxidizing agents and by electrochemical methods. A bibliography of approx. 200 references is given.—S. G.

***High-Temperature Properties of Nickel-Cobalt-Iron-Base Age-Hardening Alloys.—II.** (Austin.) See p. 516.

***Corrosion of Milk Tins in Ocean Transit.** W. F. Seyer and R. J. Donald (*Canad. Chem. and Met.*, 1936, 20, (7), 227-228).—Rusting of tinsplate milk containers in ocean transit is shown to be due to condensation of moisture from salt-laden air caused by rapid temperature changes; it can be prevented by packing the tins in air-tight packages made of moisture-resistant material, *e.g.* cardboard impregnated with asphalt.—A. R. P.

***Roofing Paper and Zinc.** H. Mallison (*Vedag-Buch*, 1935, 111-118; *Build. Sci. Abs.*, 1936, 9, 125).—A study was made of the behaviour of zinc when used in juxtaposition with roofing paper saturated with tar or with asphaltic-bitumin. Products of the latter type do not contain any chemically active phenols known to have a corrosive action on zinc, while those embodying tar may contain a small % of phenols, although the relevant German standard

specifications are severely restrictive in this respect. Specimens of each type of paper were applied to one-half of one surface of zinc sheets, similar to those used in roof construction, the tar-saturated paper being fixed by means of a hot-tar coating, and a hot asphaltic-bitumin coating being used for the paper of that type. After exposure to the weather for 4 weeks the exposed surfaces of neither set showed any deterioration. On removal of the paper coatings, by means of an organic solvent, the surface of the metal beneath showed no harmful effect in either case. A similar series of experiments was carried out in which the coatings were attached only to the edges of the zinc sheets, thus forming a sort of pocket. These were exposed to the weather for some weeks and it was found that whereas water had collected in the pockets, the sheets exhibited a typical white corrosion product, a result of reaction between zinc oxide, carbon dioxide and water, while the uncoated parts of the surfaces were unaffected. It is concluded, therefore, that where zinc is used in juxtaposition with roofing papers precautions should be taken to prevent the accumulation of standing water or places in which condensed moisture might collect. An instance is described of corrosion of this type in a building.—S. G.

***Injury to Zinc Gutting by Bituminous Roofing Felt.** E. Deiss (*Vedag-Buch*, 1936, 123-135; *Build. Sci. Abs.*, 1936, 9, 266).—Cf. *Met. Abs.*, this vol., p. 362. Owing to its marked durability on exposure to weather, zinc is widely used for roofings, gutting, rainwater down-pipes, and the clothing of structural elements. Its useful life when used for gutting is commonly reckoned at 15 years, although there are cases where it has behaved well for twice as long, while roofing has been known to last for 50 years without replacement. Recently, however, there have been cases in Germany in which zinc gutting or the like, when used in conjunction with bituminous roofing materials, has shown marked deterioration after 2 or 3 years' service. Several instances are described in detail, and it is established that the severe corrosion is not attributable to poor quality of the metal or to air-borne combustion products, but occurred in those situations on the buildings which received the greatest amount of sunlight. It is shown that the combined action of sunlight, moisture, and atmospheric carbon dioxide results in the formation of an acid decomposition product of the bitumin which when washed into the gutting, &c., has a markedly corrosive action on zinc. In this connection reference is made to Walther's investigations (*Oel u. Kohle Erdol u. Teer*, 1936, 12, 191).—S. G.

Corrosion Tests on Galvanized Sheet. Franz Schreiber (*Illust. Zeit. Blech-industrie*, 1936, 65, (38), 1130-1131).—A criticism of the review of testing methods by Radecker and Haarmann (see *Met. Abs.*, this vol., p. 459).

—P. M. C. R.

Corrosion of Bearing Surfaces. Christopher H. Bierbaum (*Mech. Eng.*, 1935, 57, (4), 239-240).—The acid constituents produced in lubricating oils by oxidation exert a slight but definite corrosive effect on bearing alloys. This, if selective, may be beneficial, but the general corrosion due to certain sulphur compounds and fatty acids is usually simply destructive.

—P. M. C. R.

***Research on Thin Layers of Tin and Other Metals. II.—The Corrosion of Metals [Tin, Copper, and Lead] by Technical Insulating Oils.** P. J. Haringhuizen and D. A. Was (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (2), 201-214; and *Tech. Publ. Internat. Tin Res. Develop. Council, Series A*, 1936, (35), 16 pp.).—[In English.] By evaporation in a high vacuum, metallic films were prepared sufficiently thin for them to show appreciable transmission of light. The films were then exposed to technical insulating oils at 20° and 60° C., and the corrosion was estimated by the increase in the transmission. With tin, lead, and copper, the initial rate of corrosion at first diminishes rapidly, indicating that a surface film is being built up. With tin and lead, the film

is durable, and the rate of corrosion diminishes continually. With copper the film appears to break down or to be continuously destroyed, and the corrosion continues with a fluctuating velocity. The velocities of corrosion were not related to the concentrations of the acid formed on the deterioration of the oil. A diffusion theory is developed on the assumption that the concentration of the agent producing the actual corrosion is small in comparison with that of the available acid.—W. H.-R.

***Investigation of the Corrosion of Metals by Non-Electrolytes. I.—The Action of Light Hydrocarbon Fuels on Metals and Alloys.** L. G. Gindin and R. S. Ambarzumjan (*Izvestia Akademii Nauk S.S.S.R. (Bull. Acad. Sci. U.R.S.S.)*, 1935, [vii], (10), 1385–1397).—[In Russian.] The action of petrol was investigated on aluminium (Si 0.23, Fe 0.32%), Duralumin (Cu 3.74, Si 0.2, Fe 0.43, Mg 0.94%), alloy No. 11 (Mg 3.15, Mn 1.0, Fe 0.29, Si 0.17%, remainder Al), American alloy (Cu 7.41, Si 0.08, Fe 0.27%, remainder Al), magnesium (traces Si; 0.12% Fe), zinc (Fe 0.19, Cu 0.09, Pb 1.0%), copper (traces of Bi and Sb), brass (38.88% Zn), bronze (10% Sn), carbon steel, and stainless steel. It may be assumed that aviation petrol does not affect the above metals and alloys, even after being saturated with water at 14° C.

—N. A.

***Investigation of the Corrosion of Metals by Non-Electrolytes. II.—Action of Light Hydrocarbon Fuels on Metals and Alloys.** L. G. Gindin, I. I. Torsuev, and R. S. Ambarzumjan (*Izvestia Akademii Nauk S.S.S.R. (Bull. Acad. Sci. U.R.S.S.)*, 1936, [vii], (1), 75–89).—[In Russian.] Cf. preceding abstract. The vigorous attack on metals by cracked petrols is due to their auto-oxidation; this is proved experimentally in the case of zinc. It was established that the attack of zinc is a function of acid concentration as also of resin-forming substances in the petrols in contact with this metal. It was shown that a peculiar film may form on the zinc, protecting it from attack.—N. A.

***Methods of Testing Materials for Use as Salt-Water Pipe-Lines in the Naval Service.** W. C. Stewart (*Proc. 9th Ann. Conf. Maryland-Delaware Water Sewerage Assoc.*, 1935, 28–62; discussion, 62–66).—For comparing the behaviour of materials under conditions of high water velocity short pipe sections are rotated vertically about their own axes in the corroding medium, the pipe being arranged off centre as regards the axes of the jar containing the medium. For heating materials under conditions simulating low water velocities the specimens are rigidly suspended from hard rubber holders attached to cross-arms extending across and above 4 glass jars mounted in an electrically heated and thermostatically controlled oil-bath, and provided with pipes passing through the oil-bath to supply water and air to the cells at the appropriate temperature; in this apparatus the specimens are moved through a circular path in the vertical plane and can be totally immersed for a part or the whole of a test with or without electrical contact, so that loss in weight and potential variations can be determined under various conditions. In the impingement apparatus a controlled jet of water is discharged against a flat disc of the metal in a glass vessel mounted in an oil-bath. Some preliminary results obtained on pipe materials and soldered joints are recorded with photographs of the corrosion produced. Silver-soldered joints appear from these tests to be stronger and less liable to corrosion than joints made with ordinary brazing solders.—A. R. P.

***Corrosion of Alloys under Conditions of Fibre Manufacture.** M. M. Romanov and O. I. Vehr (*Khimicheskoe Mashinostroenie (Chem. Machine Building)*, 1936, (3), 36–42).—[In Russian.] The resistance of aluminium, iron, cadmium, copper, zinc, and various steels and cast irons to corrosion in zinc chloride solutions at 20° and at 100° C. depends on the p_H ; acid solutions being highly corrosive. Most of the materials tested lost less than 0.1 gm./m.²/hr. at room temperature. In boiling concentrated zinc chloride solution the most

resistant non-ferrous materials are: electrolytic copper, lead-bronze, and manganese-bronze. Since copper in solution is less objectionable in fibre manufacture than iron, copper alloys are recommended for the necessary apparatus.—N. A.

Use of Corrosion-Resistant Metals and Alloys in Cider Mills. G. Warcollier and J. Tavernier (*IV. Congr. internat. tech. chim. ind. agr., Bruxelles, 1935*, 3, 448-454; *C. Abs.*, 1936, 30, 7086).—The metals considered are classified in the following order as regards resistance to corrosion by cider: special steels A.R.C. 2702 and Uranus 10, pure aluminium (99.9%), Monel metal. Aluminium metals are classified as pure aluminium, 99.5% aluminium, and Almasilium, aluminium-manganese. Aluminium and its alloys are to be rejected for strongly sulphited (0.1%) worts; there is a strong attack at the liquid-air-metal contact and the non-submerged metal is corroded more than the submerged portion. These metals have little effect on the taste of apple juice, but the taste of cider is depreciated; they should all be given a protective coat.—S. G.

***On the Reaction of Sulphur Dioxide on Metals and Alloys of Soviet Manufacture.** I. J. Klinov and V. V. Andreeva (*Khimicheskoe Mashinostroenie (Chem. Machinebuilding)*, 1936, (4), 31-34).—[In Russian.] The investigation dealt mainly with steels and pig irons. Of the non-ferrous metals various bronzes were tested—all of them proved unstable to sulphur dioxide. Lead containing 8% antimony was particularly resistant.—N. A.

***Corrosion of Metals by Water and Carbon Dioxide under Pressure.** F. H. Rhodes and John M. Clark, Jr. (*Indust. and Eng. Chem.*, 1936, 28, 1078-1079).—The rate of corrosion of metals in quiescent solutions of carbon dioxide under pressure was studied, and the experimental procedure is described. The rates of penetration (in./month) for various non-ferrous metals, with carbon dioxide under a gauge pressure of 450 lb./in.² are as follows: brass (copper 61, zinc 39%) 2.7×10^{-5} , Monel metal 1.4×10^{-5} , malleable nickel 1.4×10^{-5} , electrolytic copper 2.0×10^{-5} , Duralumin 1.5×10^{-4} , aluminium 2.5×10^{-4} , chemical lead 1.4×10^{-4} , zinc 5.2×10^{-4} . The only metal which showed any pitting was zinc.—F. J.

Corrosion of Metals in Waterworks Practice. G. Wiegand (*Korrosion V. Bericht über die Korrosionstagung 1935*, 1936, 35-40; discussion, 40-41); and *Illust. Zeit. Blechindustrie*, 1936, 65, (2), 36-37).—Copper and bronze filter sieves are frequently destroyed by the small hydrogen sulphide content of some well waters; bitumen-coated aluminium wire sieves have proved satisfactory substitutes. An example of corrosion of 63:37 brass tubes connected to a cast-iron purification vessel is described; considerable dezincification had taken place by the action of the water which contained 30 mg./litre of carbon dioxide and 10 mg./litre of oxygen. The brass tubes lasted 6 years whereas phosphor-bronze replacements have shown no corrosion after 15 years. Other similar examples of corrosion when two dissimilar metals were in contact are described.—A. R. P.

Corrosion by Industrial Waste Waters and Its Prevention. H. Stooff (*Korrosion V. Bericht über die Korrosionstagung 1935*, 1936, 41-47; discussion, 47-48).—Brief notes are given of the action of various chemicals in industrial waste waters on pipes, sumps, &c., of lead, copper, aluminium, iron, and various non-metallic materials.—A. R. P.

The Handling and Storage of Acids. Thomas J. Dixon and Frank Roffey (*Proc. Chem. Eng. Group (Soc. Chem. Ind.)*, 1935, 17, 108-113; discussion, 113-117).—Non-ferrous metals and alloys used in the handling and storage of sulphuric, nitric, hydrochloric, acetic, formic, and oxalic acids include aluminium, lead, silver, copper, and a number of bronzes. The most widely used of the foregoing are lead, either pure or alloyed with antimony or tellurium,

and aluminium; the former mainly for sulphuric and formic acids, the latter for nitric and acetic acids.—P. M. C. R.

***Organic Inhibitors of Corrosion. Aromatic Amines.** Charles A. Mann, Byron E. Lauer, and Clifford T. Hultin (*Indust. and Eng. Chem.*, 1936, 28, 1048-1051).—Tests showing the effect of various organic inhibitors on the rate of corrosion of mild steel in sulphuric acid are described. The aromatic amines form salts with corroding acids that ionize to give positive inhibitor ions, which form a protecting layer by being adsorbed by the cathodic areas of the metal surface. The varying effect of different inhibitors is explained.

—F. J.

***Studies on Corrosion.** Ernst Cohen and W. A. T. Cohen de Meester (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (3), 361-365).—[In German.] The corrosion of sheets of tin immersed in 0.1N-hydrochloric acid was studied. Individual results for the loss of weight showed such great divergence from the mean values that a mere duplication of tests might give completely misleading results. Experiments with rotating cylinders or rods of tin gave much more consistent results; the apparatus used is described.—W. H. R.

Cavitation Research: A Progress Report on Work at the Massachusetts Institute of Technology. J. C. Hunsaker (*Mech. Eng.*, 1935, 57, (4), 211-216).—This investigation of the mechanism of hydraulic cavitation was carried out in an apparatus permitting control of velocity, pressure, temperature, and air content; kinematographic, phonographic, and dynamometric methods were combined in the investigations, which demonstrated the mechanical nature of the phenomenon, its dependence on the shape of the boundary walls and on air content, and its probable association with the periodical formation and collapse of water-vapour.—P. M. C. R.

***Cavitation and Surface Tension.—I-II.** F. K. Th. van Iterson (*Proc. K. Akad. Wet. Amsterdam*, 1936, 39, (2), 138-149; (3), 330-339).—[In French.] The phenomenon of cavitation is described with special reference to the blades of centrifugal pumps. Similar effects sometimes arise with ships' propeller blades, and are accompanied by marked erosion. The phenomenon is due to local reduction of pressure causing the formation of bubbles of water vapour or air. van I. describes the effects of surface tension, the presence of dissolved or suspended impurities, and other factors on the formation of bubbles.—W. H. R.

The Principles of the Theory of Metal Corrosion. W. J. Müller (*Korrosion V. Bericht über die Korrosionstagung 1935*, 1936, 6-9).—It is shown that the behaviour of a metal under corrosive conditions depends principally on the nature or attackability of the covering film; if this is unattacked by the corrosive medium no attack on the metal occurs when the area of the pores is about 10^{-4} cm.²/cm.² and attack always occurs when this area is greater than 10^{-3} cm.²/cm.². With a pore area intermediate between these values the nature of the medium, the metal, and the film determines whether attack or passivation will occur.—A. R. P.

The Corrosion of Metals. I.—Mechanism of Corrosion Processes. R. M. Burns (*Bell System Tech. J.*, 1936, 15, (1), 20-38; and *Bell Telephone System Tech. Publ., Chemistry, Monograph B-912*, 1936, 19 pp.)—B. outlines the application of electrochemical methods to corrosion investigations, and discusses the position of the potential of a metal against its environment and the trend of this potential with time, pointing out that it is thereby possible to determine whether the corrosion process is controlled by reactions occurring in the anodic areas, the cathodic areas, or both; i.e. whether there is a tendency to passivation, inhibition, or progressive attack. Measurements of film stability whether in terms of the leakage current which may be passed through the film or in terms of the amount of film-forming material required to produce passivity or the amount of film-destroying material required to render a metal

active, furnish information as to the quality of corrosion-resistant films. Measurements of the rate at which a film forms on a metal when placed in a film-forming environment throws light on its relative surface reactivity, and such information is of assistance in determining the rate of corrosion in homogeneous corrosive environments or the rate of passivation in the film-forming environments. On the basis of such measurements, and with a chemical knowledge of the environments in which the metals are used, as well as the composition and physical state or structure of the metals, it is possible to predict corrosion behaviour and to obtain an understanding of corrosion problems usually not possible by ordinary empirical corrosion tests.—S. G.

The Corrosion of Metals. G. D. Bengough, W. H. J. Vernon, and F. Wormwell. T. P. Hoar (*Met. Ind. (Lond.)*, 1936, **49**, (16), 394–395; (19), 470–471).—B., V., and W. criticize H.'s interpretation of their results (*Met. Abs.*, this vol., p. 400), and state their views of the film distribution theory as opposed to the differential aeration theory. They believe that air-formed films are of negligible importance on subsequent corrosion under immersed conditions (a view not shared by Evans and Hoar), and stress the value of time-oxidation curves for studying the rates of growth of oxide films. In his reply, H. discusses principles of corrosion rather than the specific metals quoted by B., V., and W. in their work, and points out that in essentials the two schools of thought have much in common, and concludes by suggesting that lengthy mass-volume-time observations be supplemented by electron diffraction and other modern research methods.—J. E. N.

***The Design, Interpretation, and Uses of Standard Corrosion Tests in Salt Solutions and Industrial Waters.—II.** G. D. Bengough and F. Wormwell (*Iron Steel Inst. Special Rep. No. 13* (4th Rep. Corrosion Cttee.), 1936, 213–232).—Standard corrosion tests in stagnant or slowly moving neutral salt solutions under atmospheric and higher pressures of oxygen and air are described. The specimens are tested under total immersion conditions, and consist of disks. These are supported in a horizontal position by glass points. Typical corrosion-time curves are given and the results are reasonably reproducible. Corrosion rates can be increased by slowly rotating the specimens in the corroding medium under atmospheric pressure or by the use of high oxygen pressure and stagnant corroding medium.—H. S.

Two Methods of Investigation of the Corrosion Behaviour of Metals. M. Prot and N. Goldowski (*Publ. Sci. Tech. Min. Air (Paris)*, No. **91**, 1936, 47 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—Describes (1) the "coloroscopic" method, using p_H indicators, which is stated to reveal zones prone to corrosion, and (2) the thin test-piece method. Both are claimed to be speedy.—S. G.

A Rapid Method for Testing Corrosion. W. Palmær (*Korrosion V. Bericht über die Korrosionstagung 1935*, 1936, 10–16; and (in greater detail) *Korrosion und Metallschutz*, 1936, **12**, (5/6), 139–148).—An apparatus is described for determining the rate of rusting of iron by measuring the oxygen absorbed when the metal is immersed in calcium or sodium chloride solutions.—A. R. P.

The Standardization of Corrosion Results and Corrosion Tests. Fritz Tödt (*Korrosion V. Bericht über die Korrosionstagung 1935*, 1936, 26–30; discussion, 31–33).—It is recommended that loss in weight figures in corrosion tests be expressed as grm./m.²/day and loss in thickness figures as mm./day.—A. R. P.

The Evaluation of Reports on Corrosion. F. Tödt (*Listy Cukrovar*, 1936, **54**, 171; *C. Abs.*, 1936, **30**, 7085).—See also preceding abstract. T. advocates a standard method for reporting corrosion and suggests that it be reported as the weight loss per square metre per 24 hrs. with additional comments as to the nature of the reaction, presence of gases in solution, dynamics of the fluids, appearance of the metallic surface, penetration of the liquid, &c.—S. G.

On the Methods of Physico-Chemical Analysis [in the Study of Corrosion]. V. A. Kistiakovskiy (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Anal. Phys.-Chim.)*, 1936, **8**, 5–13).—[In Russian.] K. discusses the

application of physico-chemical analysis to the electrochemistry of colloids for the purpose of studying the corrosion of alloys.—N. A.

Conversion Factors in Determining Corrosion Rates. — (Inco, 1936, 14, (1), 26–28).—A suitable expression for corrosion rate in terms of weight loss should cover the relationship between weight loss, area of exposed surface, and time. A comparison is shown for various materials, of the corrosion rate in mg./dm.²/day and depth of penetration in cm. per year.—K. G.

V.—PROTECTION

(Continued from pp. 460–462.)

***On the Protective Action of Sodium Chromate in the Dissolution of Aluminium in Caustic Soda.** J. Fischer and W. Geller (*Korrosion u. Metallschutz*, 1936, 12, (9), 297–299).—Addition of sodium chromate to 0.5% sodium hydroxide solution reduces considerably the rate of dissolution therein of 99.99% aluminium; with 3% sodium chromate only 0.24 gm./m.²/24 hrs. is dissolved. With 99.5% aluminium the inhibiting effect of chromate is appreciable only with solutions containing more than 1%. With very small amounts of chromate dissolution is actually accelerated owing to reduction of the chromate to chromic hydroxide.—A. R. P.

The Elytal Process [of Plating Aluminium]. H. Ginsberg (*Aluminium*, 1936, 18, (9), 441–442).—The process consists in producing an oxide film by anodic oxidation, then partly dissolving this in suitable solvents and plating over the remainder which acts as an anchor for the plate. No details are given, but it is claimed that the plated metal may be mechanically worked without detaching the plate.—A. R. P.

A Chemical for the Protection of Light Alloys. The Protal Process. — (Rev. *Aluminium*, 1936, 13, (80), 172–173).—See also *Met. Abs.*, 1934, 1, 18. The process is briefly described.—J. H. W.

On the Production of Oxidic Protective Films on Aluminium and Aluminium Alloys. Robert J. Snelling (*Metall-Woche*, 1936, (12), 221–223).—A review of American patent literature.—A. R. P.

***Electrolytic Colouring of Anodic Layers of Aluminium Oxide.** G. M. Sella (*Aluminio*, 1935, 4, (2), 89–92).—S. found that no colouring could be obtained by direct introduction of the dye in the electrolytic bath used for anodic treatment. Irregular results are obtained by immersion in the colouring solution. A greater penetration of the pigment is possible using a different disposition of the electrodes. The addition of a small percentage of ferrous hydrate to an acid colouring solution increases the stability of the colour obtained. S. mentions that the layer of oxide formed, which permits a deeper penetration of the dye, favourably influences the resistance of the colour to light radiations.—J. K.

On Blisters on Alplate [Aluminium-Coated Duralumin] Sheets. I. T. Kolenov (*Metallurg (Metallurgist)*, 1936, (5), 91–94).—[In Russian.] Both surface and internal blisters are observed; the former have no effect on the mechanical properties, whereas the latter tend to produce peeling of the plate. Surface blisters occur in sheet plated by the welding-on method, and internal blisters on sheets produced by the casting process. The development of surface blisters can be prevented by using a high degree of compression in the first rolling.—N. A.

†Aluminium Coatings on Iron. A. von Zeerleder (*Korrosion u. Metallschutz*, 1936, 12, (10), 275–283).—A brief account is given of the following processes of coating iron with aluminium: calorizing, “alutieren,” treatment with aluminium chloride vapour, “alumetieren,” aluminium painting, electrolytic deposition, dipping processes, and rolling-on processes. A bibliography is appended.—A. R. P.

***Copper-Plating of Boiler Hatches.** N. M. Galuzin and S. A. Nesterov (*Autogennoe Delo (Autogenous Practice)*, 1935, (10), 25-27).—[In Russian.] The following methods were investigated: copper-plating with a gas burner, carbon arc, metal arc; brass-plating with gas burner; bronze-plating with carbon arc. The best microstructure as regards the number of cavities and oxides was obtained with brass and the worst with bronze. The best results for copper were obtained by the gas-burner method.—N. A.

Protection of Telephone Cables Against Corrosion Due to Electrolysis and Chemical Action. Comité Consultatif International Téléphonique (*Proc. 10th Plenary Meeting, Comité Consult. Internat. Téléph.*, 1934, Sept.; *English Translation*, 1936, 133-156; *Bull. B.N.F.M.R.A.*, 1936, (91)).—This English translation of the Proceedings of the 1934 Budapest meeting, includes extensive recommendations on various electrical protective measures, as well as notes on protection against chemical corrosion and on methods for distinguishing between electrolytic and chemical corrosion.—S. G.

Contribution to the Electrolytic Tinning of Wires. (Snelling.) See p. 553.

Porosity Tests for Tinplate. R. Gire (*Rev. trav. Office Pêches Maritimes*, 1935, 8, (4), 423-429; *Bull. B.N.F.M.R.A.*, 1936, (91)).—G. reviews the ferricyanide and hot-water tests and then describes his own test (first announced *ibid.*, 1934, 7, (2), 223), which consists of anodic treatment in a sodium monosulphide solution. The technique of cleaning the specimen and carrying out the test is described. The test is claimed to be rapid, and pores are stated to be shown up very clearly.—S. G.

A Test for Porosity in the Coating of Tinplate. J. C. Andrews and R. T. D'Anvers (*Analyst*, 1936, 61, (723), 402).—Sheets of Cellophane paper are soaked in 750 c.c. of a 7% solution of potassium ferricyanide containing 10 drops of sulphuric acid (d 1.84). A sheet is withdrawn from the solution, drained, and laid on the tinplate, good contact being effected by drawing a squeegee over the paper. After 45-60 minutes the sheet is removed, washed, and dried, when the imperfections in the plate are revealed by the development of blue spots and stains on the paper. It is essential that all grease be removed from the plate before making the test; this is effected by washing first with carbon tetrachloride, then with acetone.—A. R. P.

A Rapid Method for Testing Tinplate and Tinned Containers. R. Legendre (*Recherches et Inventions*, 1936, 17, (259), 96-98; *Bull. B.N.F.M.R.A.*, 1936, (91)).—A method is discussed based on that of Prot and Goldowski (cf. *Met. Abs.*, 1934, 1, 502); it consists of the application to tinplate, &c., of a jelly containing any desired corrosive agent and a p_H indicator. Practical details of the test are given.—S. G.

Zinc Coating [Hot-Galvanizing]; A Bibliography. Victor S. Polansky (*Carnegie Library of Pittsburgh*, 1936, 110 pp.).—Covers the period from the year 1910.—S. G.

Hot-Galvanizing in Connection with Sheets. Nelson E. Cook (*Iron Steel Eng.*, 1934, 11, 135-141; *C. Abs.*, 1934, 28, 3700).—A brief description of zinc coatings with emphasis on hot-galvanizing. The uses and limitations of different kinds of zinc coatings are pointed out.—S. G.

The Development and Control of Spangles on Galvanized Iron.—VIII. Wallace G. Imhoff (*Metal Cleaning and Finishing*, 1936, 8, (2), 89-93).—The effect of addition of tin to the galvanizing bath is discussed. Tin additions open up the coating, develop a flower spangle, and tend to give the finish a bright tin brilliancy.—S. G.

How Thick Should the Sides of the Galvanizing Pot Be? Wallace G. Imhoff (*Amer. Metal Market*, 1934, 41, (72), 4-5).—An attempt to provide a systematic basis for using a definite thickness for each size of pot.—S. G.

New Wire Galvanizing Process Applies Dense Coatings at High Current Densities. (Lyons.) See p. 553.

The Basic Theory of the New "Bethanizing" Process [for Galvanizing Wire]. (Tainton.) See p. 553.

Methods for Determining the Thickness of Zinc Coatings. Walter R. Meyer (*Met. Ind. (N. Y.)*, 1936, 34, (5), 173-175).—The various methods are compared, for electrodeposited, Sherardized, and hot-galvanized coatings. For electrodeposited coatings the Hull-Strausser drop test, antimony chloride-hydrochloric acid strip measurement, microscopic measurement, and analytical measurement give reliable and correlated results. The stripping-analytical method is most reliable for Sherardized coatings. For determining the amount of zinc on hot-galvanized coatings the stripping-analytical method is considered to be the most reliable; the Preece test and microscopic measurement are valuable in determining the distribution of the coating.—S. G.

Corrosion Prevention on the North-Sea Coast. W. Wittneben (*Bauverwaltung*, 1935, 55, (50), 1000-1001; *Build. Sci. Abs.*, 1936, 9, 87).—Effective protection of iron and steel structures is afforded by dense coatings of zinc, to which aluminium has been added, applied by the Sherardizing process. Painting is also necessary.—S. G.

Specifications for Corrugated [Galvanized] Metal Pipe. — (*Bull. Amer. Railway Eng. Assoc.*, 1935, 37, (381), 128-132).—Appendix F to Report of Committee I.—Roadway of the American Railway Engineering Association. —S. G.

***The Cementation of Grey Cast Iron with Beryllium.** Joseph Laissus (*Congrès Internat. Mines Mét., Géol., Section de Métallurgie*, 1936, 2, 219-222; and *Rev. Mét.*, 1936, 33, (8), 494-497).—[In French.] Cf. *Met. Abs.*, 1935, 2, 697. The cementation of grey cast iron with beryllium has been studied by heating small polished cubes at 800°-1150° C. for 2½-10 hrs. in a powdered mixture of either 98% beryllium or 80% ferro-beryllium with 25% by volume of beryllia. Diffusion occurs in a manner similar to that observed in the cementation of iron and steels with beryllium. The layers produced are extremely hard, the maximum Vickers diamond hardness number occurring on samples cemented at 1000° C. in ferro-beryllium and reaching a value of 1561, the highest so far recorded on any metallic body. Rusting is retarded, but no appreciable protection is given against corrosion in acids.—J. C. C.

***Cementation of Ferrous Alloys by Beryllium.** Joseph Laissus (*Compt. rend.*, 1934, 199, 1408-1410).—See *Met. Abs.*, 1935, 2, 697.—S. G.

Metallic Coatings as Protective Media. S. Robson and P. S. Lewis (*Proc. Chem. Eng. Group (Soc. Chem. Ind.)*, 1935, 17, 23-35; discussion, 35-37).—A review of the principal types of corrosion (atmospheric, or due to water, soil, or foodstuffs) which includes suggestions regarding suitable protective media. The advantages, limitations, and chief applications of the various types of zinc, aluminium, tin, lead, cadmium, and nickel coating are considered, special attention being devoted to Sherardizing, calorizing, and metal spraying. In the discussion, reference was made to some characteristics of electrodeposits, and to the electrochemical properties desirable in a covering metal.—P. M. C. R.

Metal Coatings for Aircraft Structures. R. M. Wick (*Automotive Ind.*, 1936, 74, (12), 423, 430).—Abstract of an address delivered in Philadelphia on European and British practice in electroplating. Special emphasis was laid on the protection of magnesium alloys for aircraft work, on the use of copper-oxide rectifiers, and on the repair of worn parts by electrodeposition. —P. M. C. R.

Protection Against Corrosion of Metals. H. Kalpers (*Umschau*, 1935, 39, 794-796).—General information is given on protection against corrosion and on corrosion-resistant alloys.—L. A. O.

Preventing Corrosion [by Electroplating]. William Swallow (*Automobile Eng.*, 1936, 26, (350), 409-410).—Serviceable processes for preventing corrosion

in motor-car steel bodywork are dealt with, and the use of electroplating by means of chromium, nickel, cadmium, zinc, and copper is considered. Chromium and nickel plating besides being protective is also ornamental, but copper plating is unsatisfactory and causes serious electrolytic corrosion of the steel, if the coating is damaged or if moisture is present.—J. W. D.

†**Prevention of Corrosion by Additions to the Corroding Medium** [—II]. Erich Rabald (*Chem. Fabrik*, 1936, 9, (43/44), 473-479).—See also *Met. Abs.*, this vol., p. 400. Continuation of a review of the uses of inhibitors and a discussion of the mechanism of their action with especial reference to silicate and chromate additions. Numerous tables and graphs are included together with a *bibliography* of 70 references.—A. R. P.

Influence of Protective Layers on the Life of Metals. Frank N. Speller (*Mech. Eng.*, 1935, 57, (5), 355-360).—A classification of the principal types of corrosive attack is followed by a summary of the factors associated with corrosion in the presence of water. Methods of protection include improvements in the inherent resistance of the metals and the modification or exclusion of the environment. Individual methods are discussed, and results obtained by the U.S. Bureau of Standards in connection with soil corrosion are reproduced with a summary of the essential requirements of underground coatings.—P. M. C. R.

Fundamentals of Metal Spraying. G. Schenk (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, (9/10), 259-262).—The process of metal spraying and the technological characteristics of metal films so formed are discussed. Since metallization of combustible surfaces is possible it is concluded by some that the temperature of the spray on reaching these surfaces is below its melting point; but microscopical examination of the droplets formed on a glass surface appears to indicate that this conclusion is wrong and that, indeed, the metal is still molten at the time of impact. The chemical and physical properties which are commonly found in sprayed films and the harmful effects of foreign matter are briefly reviewed.—W. A. C. N.

New Method of Spraying Aluminium and Other Metals. C. F. Lumb (*Aluminium and Non-Ferrous Rev.*, 1936, 2, (1), 45-47).—An account of the Schori metal-spraying process, which consists in drawing powdered metal from a container into a stream of compressed air. The present type of pistol will spray zinc, which for some purposes is preferred to cadmium and aluminium. The process is used in marine and railway work, both for ferrous materials and for light-alloy parts which must be protected from sea-water. The coating is said to form a satisfactory basis for paint.—P. M. C. R.

Improvement of the Properties of Sprayed Metal Coatings by Non-Metallic Intermediate Layers and Adhesive Bases. H. Reininger (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, 34, (2), 29-31; (3), 51-53).—L. A. O.

Application of Metallization in Automobile Construction. S. P. Kurkin (*Mashinostroitel (Mechanician)*, 1936, (4), 37).—[In Russian.] A brief survey.—N. A.

A Method for Blackening Brass. David W. Mann (*Rev. Sci. Instruments*, 1936, [N.S.], 7, (4), 192).—The preparation of a dipping solution is described.—P. M. C. R.

A Simply-Made Fire Bronze for Brass. A. H. Cox (*Rev. Sci. Instruments*, 1936, [N.S.], 7, (4), 192).—Lacquering may be obviated by dipping brass parts into a copper nitrate solution, with subsequent heating and brushing.—P. M. C. R.

The Problem of Efficient Enamelling of Light Alloy. Components of the Magnesium-Base Type. E. E. Halls (*Metallurgia*, 1936, 14, (84), 157-161).—Practical details are given of various finishing schemes for magnesium-base alloys, and test results are given to show how far the normal finishing media used in the average enamelling shop of a general engineering factory can be

utilized for miscellaneous magnesium alloy components. Rapid and slow chromate treatments are considered, and various finishes with and without chromate treatment are investigated and submitted to a humidity test, outside atmospheric exposure, and to a salt-spray test. From the results obtained, it is concluded that the inclusion of both an aqueous chromate treatment and a zinc chromate type of priming is highly desirable if the best finishes are to be obtained.—J. W. D.

The Surface Protection of Zinc Articles. S. W. K. Morgan and L. A. J. Lodder (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (7), 133-134).—Summary of a paper read at the February meeting of the James Watt Memorial Institute, Birmingham.—L. A. O.

Lithoform, an Aid in Painting Zinc and Metal Surfaces Coated with Zinc. J. J. Raaff (*Verfkroneik*, 1936, **9**, 161-162; *C. Abs.*, 1936, **30**, 7877).—Adhesion difficulties in painting metal surfaces are discussed, and the utility of Lithoform (apparently an acidic product) in preparing zinc surfaces for painting is pointed out.—S. G.

Bonderite "Z" Process for Treating Zinc Surfaces. — (*Amer. Metal Market*, 1936, **43**, (186), 3; also *Met. Ind. (N.Y.)*, 1936, **34**, (9), 353; and *Metal Cleaning and Finishing*, 1936, **8**, (9), 577-580).—Brief notes of a new process for stabilizing paint finishes on zinc die-castings and other zinc surfaces. An insoluble crystalline coating is produced which provides an excellent basis for the finish. The process is particularly effective for parts having deep recesses as the solution flows into, and reacts on, all surfaces, assuming a uniform coating on all areas. The temperature of the processing bath is 170°-180° F. (77°-82° C.) and will not distort or change the shape of flat work.—L. A. O.

Protective Coating for Zinc [the Cronak Process]. — (*Met. Ind. (N.Y.)*, 1936, **34**, (7), 273).—A brief description of the Cronak process.—L. A. O.

Paint and Varnish Problems in Aeronautics. E. W. J. Mardles (*Oil Colour Trades J.*, 1935, **86**, 1683-1687; and *Paint Manuf.*, 1935, **5**, (1), 8-13; (2), 46; discussion, 46-49).—Deals with: adhesion of films; paints for cadmium-plated steels; adhesion of cellulose finishes; adhesion on stainless steel; undercoats for synthetic resin enamels; abrasion tests; anti-rust preparations; weathering and artificial ageing; anti-fouling preparations; methods of testing; consistency and viscosity.—L. A. O.

Properties and Uses of Aluminium-Bronze Paints. H. Jensch (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (18), 349-352).—L. A. O.

***Some Results Obtained with Aluminium-Bronze Paints.** — Fritz-Jürgen (*Farbe u. Lack Cent.*, 1936, (1), 4; (2), 15; and (abstract) *Light Metals Rev.*, 1936, **2**, (22), 398).—80 specimens of sheet iron painted with aluminium-bronze paint were exposed for 7 years to outdoor conditions. 40 specimens were painted using various varnishes for the paint vehicle; the remaining 40 were designed to test the effect of a number of priming paints on aluminium-bronze paints. Results obtained were as follows: After 8 years only those specimens were destroyed in which nitro-varnish was the paint vehicle and in which white-lead paint was the primer. The specimens with 2 coatings of aluminium-bronze paint were unattacked except 4 with a copal-linseed oil-wood oil vehicle. These showed incipient rusting. Specimens with one coating of aluminium paint darkened owing to slight rusting of the metal surface which penetrated the paint layer; there was, however, no tendency to rusting beyond a certain stage. Some observations were made on the effect of particle size on porosity, permeability to water and oxygen, and on the oil-paint priming.—L. A. O.

An Important Innovation in the Treatment of Metal Surfaces. The Deposition of Rubber. — (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (9), 172-174).—L. A. O.

VI.—ELECTRODEPOSITION

(Continued from pp. 462-464.)

Two Important New Processes in the Surface Treatment of Metals. I.—Deposition of Aluminium by Fink's Process. II.—Seofoto Process. — (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, 34, (4), 72-73).—L. A. O.

Helpful Calculations for Barrel Plating with Cadmium. Austin Fletcher (*Metal Cleaning and Finishing*, 1936, 8, (9), 559-560, 591-592).—The bath recommended for barrel plating contains cadmium 1.5 and free sodium cyanide 9 oz./U.S. gall. Methods of calculating the thickness of deposit and time of plating are given.—A. R. P.

The Production and Properties of Cadmium Plating. — (*Metall-Woche*, 1936, (10), 181-182).—L. A. O.

*Investigation of the Structure and Properties of Electrolytic Deposits. III.—Investigation of the Porosity of Chromium Deposits. V. I. Arharov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1935, 5, (9), 1618-1624).—[In Russian.] Cf. *Met. Abs.*, 1935, 2, 235, 700. In determining the porosity of chromium plate on brass by measuring the rate of evaporation of the zinc through the plate on heating, results with an accuracy of $\pm 3-4\%$ are obtained by heating the metal under reduced pressure provided that the thickness of the plate does not exceed 20 μ . Traces of nitric acid in the chromium bath considerably affect the porosity of the plate.—N. A.

On the Detection and Removal of Faulty Chromium Plate. Ralph W. Harbison (*Metall-Woche*, 1936, (20), 381-382).—The copper sulphate dip, ferroxyl, and electrodeposition of copper methods for detecting porosity in chromium plate are described and their relative merits discussed. Chromium plate is best stripped by anodic dissolution in caustic soda solutions; stripping with hydrochloric acid should be used only when nickel is the basis metal. —A. R. P.

*On the Theory of Electrolytic Chromium-Plating: An Attempt at a New Explanation, with Particular Reference to the More Electro-Negative Metals. R. Weiner (*Light Metals Research*, 1936, 5, (6), 123-130).—Abridged from *Z. Elektrochem.*, 1936, 42, 377, 585; see *Met. Abs.*, this vol., pp. 366, 462. —L. A. O.

Chromium Plating of Metallic Reflectors. N. Biriukov and S. Makarieva (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1936, 18, (3), 81-94).—[In Russian.] The chromium plating of motor-car headlamps is dealt with. —D. N. S.

Chromium Plating of Sections. I. S. Tutin (*Vodnii Transport (Water Transport)*, 1936, (6), 19-22).—[In Russian.] A survey.—N. A.

Progress in Liner Wear Reduction [Chromium Plating]. — (*Marine Eng.*, 1936, 59, (710), 297-298; and *J. Commerce (Ship. and Eng. Edn.)*, 1936, (Oct. 8), 11).—A new process (Listard) of chrome hardening of cast-iron cylinders and liners to reduce wear to a minimum is discussed. The chromium is deposited by electrochemical means and gives a very hard surface which is said to resist both chemical and mechanical wear to a greater extent than before. Results are given of tests on cylinders hardened by this process and nitrogen hardened.—J. W. D.

*On the Problem of the Investigation of the Formation of Layers in Cathode Deposits of Copper. A. T. Vagramjan and E. S. Sarkisov (*Izvestia Akademii Nauk S.S.S.R. (Bull. Acad. Sci. U.R.S.S.)*, 1935, [vii], (10), 1411-1417).—[In Russian.] It is shown that it is possible to obtain streaks on copper deposits in an acid medium, wherein hydrolysis of copper sulphate actually takes place; this is in disagreement with Taft's results. The streaked deposit is formed both with and without gelatine, and whether the electrolyte is stirred or not. The formation of the streaky deposits is considered to be

produced by the varying rates of growth of the deposit on different parts of the cathode, depending in their turn on the distribution of the lines of force on the cathode surface and on the thickness of the diffusion layer there.—N. A.

Electrolytic Deposition of Divalent Europium. Alfred Brukl (*Angew. Chem.*, 1936, 49, (9), 159-161).—The sulphate solution of the most soluble cerium group earths is electrolyzed with a mercury cathode; when the europium constitutes more than 2% of the total earths it is almost completely deposited as EuSO_4 . Only a few repetitions of the process are required to obtain pure europium. When less than 2% of the total earths is europium, strontium chloride is added drop by drop to the electrolyte during electrolysis and the resulting precipitate of $(\text{Sr},\text{Eu})\text{SO}_4$ is roasted and leached with dilute hydrochloric acid to extract the europium which is purified by repeated electrolysis.

—A. R. P.

Lead Coating of Aluminium. O. Scarpa (*Alluminio*, 1936, 5, (1), 1-5).—A study of the problem of lead coating of aluminium, and a description of the galvanic methods.—J. K.

***Corrosion Prevention of Steel Structures by Electrodeposition of Lead.** R. Bernhard (*Bautechnik*, 1935, 13, (20), 251-255; *Build. Sci. Abs.*, 1936, 9, 49).—A research on the electrodeposition of lead on steel for the protection of steel structures exposed to smoke and acid-containing gases is being carried out by the Deutsche Reichsbahn Gesellschaft. A brief account is given of the plant and process developed, of the elimination of certain difficulties in the process, and of its cost compared with painting. For the maximum degree of protection a coating 0.3 mm. thick has been found necessary; the time required to obtain the coating has been reduced to 6 hrs. The electrodeposition of lead coatings on welded joints can be carried out satisfactorily, but difficulties have been encountered with riveted joints. Attention is directed to the importance of applying a rust-preventive paint to all contact surfaces before assembling lead-coated parts, including bolts and nuts in existing structures.—S. G.

***On the Simultaneous Electrodeposition of Lead and Copper.** P. P. Beljaev, S. P. Markova, and S. P. Gelman (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1936, 16, (4), 90-94).—[In Russian.] From benzenedisulphonate solutions containing lead 0.7, copper 0.2, and nickel 0.2 gm.-equiv. with 0.2 gm.-equiv. of free acid per litre and 1% of gelatin, an alloy containing 11% lead is obtained without stirring, and one with 5% lead with stirring using current at 1 amp./dm.². With 3 amp./dm.² the corresponding deposits contain 90 and 50% lead, respectively.—D. N. S.

Electrolytic Manganese. J. Koster and S. M. Shelton (*Eng. & Min. J.*, 1936, 137, (10), 510-512, 514).—Outlines the methods of deposition and states that the degree of purity obtainable is 99.6%.—R. Gr.

New Bright Nickel Process. — (*Met. Ind. (N.Y.)*, 1936, 34, (1), 27).—A new process for bright nickel plating is described in which the deposit contains some cobalt; this is supplied from special cobalt-nickel anodes. A special brightening agent is also required. A brief account is given of the process, the properties of the deposit obtained, and its uses.—L. A. O.

The Production of Nickel Sheets by Deposition. A. I. Wynne-Williams (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 143-153; and *Met. Ind., (Lond.)*, 1936, 49, (9), 215-219).—Considers the production of nickel sheets by deposition on rotating cathodes from the point of view of purity of product (high), size (12 ft. × 4 ft. is quite practical), and cost. The present limitations of the method are the inability to produce modified compositions, and the lack of a bright finish on both sides of the sheet. The theory of the process and constructional and operating data are considered in some detail.—W. D. J.

Alloy Plating Bath and Process. — (*Automotive Ind.*, 1936, 74, (18), 640).—A description of a (patented) process for the electrodeposition of a

hard, bright, and non-pitting nickel-cobalt alloy, which can be deposited directly on steel.—P. M. C. R.

***Influence of the Addition of Cadmium Salts to Nickel Baths on the Properties of Nickel Deposits.** N. P. Lapin and G. P. Matveev (*Zhurnal Prikladnoy Khimii* (*J. Applied Chem.*), 1936, 9, (7), 1260–1268).—[In Russian.] Addition of a cadmium salt to a nickel bath assists in the production of a bright deposit, the effect depending on the bath composition and operating conditions. The best results are obtained with baths containing boric acid and ammonium chloride. With increasing thickness of deposit the brightening effect of cadmium diminishes; it is a maximum when the nickel is deposited on copper or a copper undercoat. To maintain the cadmium content of the electrolyte, small cadmium anodes may be used together with the ordinary nickel anodes. Test results are tabulated.—N. A.

Nickel and Chromium Plating of Zinc and Die-Cast Zinc. V. P. Sacchi (*Industria meccanica*, 1936, 18, 334–339; *C. Abs.*, 1936, 30, 7047).—A very exhaustive review of the literature on procedures for obtaining good deposits, defects most common in the deposits, properties of the deposits from acid and basic baths, and stresses occurring in the deposits. A bibliography of 67 references is given.—S. G.

Analysis of Nickel Salts for Plating Baths. (Malý.) See p. 563.

Some Remarks on Platinum, Palladium, and Rhodium Baths. A. Wogrinz (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, 34, (9), 174–177).—A brief review, with particular reference to the patent literature.—L. A. O.

Plating Rhenium and Rhenium-Nickel Alloys. C. B. F. Young (*Met. Ind.* (*N. Y.*), 1936, 34, (5), 176–177).—A brief historical review and description of present methods, with references to the literature.—L. A. O.

Rhodium Plating: A New Protective Process. F. Kűch (*Metallwirtschaft*, 1936, 15, (25), 569–570).—The increased production of rhodium has rendered possible its use as a protective coating, and developments in deposition processes are briefly outlined. The high reflecting power, mechanical strength, and resistance to oxidation of the metal have led to its increasing use in ornamental work, clock making, radio construction, and in surfacing mirrors and optical projector systems.—P. M. C. R.

Rhodanizing. — (*Jeweller and Metalworker*, 1936, 62, (1503), 550).—A brief account of a new process for the rhodium-plating of silver, and its possible influence on the precious metal industry.—L. A. O.

Control of Silver-Plating Solutions. E. J. Dobbs (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 104–108).—An account of the determination of free cyanide, metal, and carbonate content of silver-plating solutions, together with some recommended analyses.—W. D. J.

Historical Development and Practice of Silver-Plating. R. E. Close (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 101–103).—A very brief historical account of silver-plating, together with some recommendations for practice.—W. D. J.

Silver and Gold Plating of Aluminium, Duralumin, &c. G. Huth (*Deut. Goldschmiedezeit.*, 1934, 37, 31–32).—The surface of the base metal is first oxidized either chemically or electrolytically. As the natural oxide layer on aluminium is unsuitable for plating with gold or silver this is produced artificially by electrolysis in either 10% chromic acid or 3% oxalic acid solutions, or by chemical treatment in an aqueous solution containing 3% ammonium chloride and 1% ammonia, at 100° C. The silver plating is carried out by dipping in a solution of silver nitrate at 160° C. A similar method is used for gold plating.—L. A. O.

Plating Silver to Specifications. C. B. F. Young (*Metal Cleaning and Finishing*, 1936, 8, (5), 227–231).—Describes a method of control.—S. G.

***X-Ray Studies on Electrodeposited Silver.** (Basu and Hussain.) See p. 530.

Electroplating in the Service of Metallurgy. Electrolytic Tinning as Protection Against Nitride Hardening. A. Barattini (*Industria meccanica*, 1934, 16, 94-95; *C. Abs.*, 1936, 30, 7460).—Parts or areas not to be hardened are protected by an electrodeposit of tin. Details are given, but the composition of the bath is not stated.—S. G.

Contribution to the Electrolytic Tinning of Wires. Robert G. Snelling (*Metall-Woche*, 1936, (21), 409-411).—A discussion of the relative merits of acid sulphate and stannate-acetate plating baths.—A. R. P.

Electro-Galvanizing Round Wire. Arnold Weisselberg (*Met. Ind. (N.Y.)*, 1936, 34, (5), 168-172).—See *Met. Abs.*, this vol., p. 260.—S. G.

New Wire Galvanizing Process Applies Dense Coatings at High Current Densities. Ernest H. Lyons, Jr. (*Metal Cleaning and Finishing*, 1936, 8, (9), 541-542).—A process recently introduced in America is claimed to produce dense, bright, smooth and non-porous zinc deposits on steel which require no wiping, burnishing, or other mechanical treatment. No details are given.

—A. R. P.

The Basic Theory of the New "Bethanizing" Process [for Galvanizing Wire]. U. C. Tainton (*Wire and Wire Products*, 1936, 11, (5), 225-227, 243; and *Draht-Welt*, 1936, 29, (29), 431-433).—The method, which is based on the non-reactivity of pure zinc towards acids, consists in the purification of zinc concentrates and in the subsequent direct deposition of metallic zinc on the steel wire, which is prevented from adsorbing either hydrogen or oxygen by immersion in fused sodium hydroxide. An account is given of the necessary adjustments of current density, and a large commercial Bethanizing plant is described.—P. M. C. R.

Improved Method for Electrodepositing Alloys. H. Kersten and Wm. T. Young (*Indust. and Eng. Chem.*, 1936, 28, (10), 1176-1177).—A method for the electrodeposition of nickel-iron alloys of a required composition is illustrated and described. The bath is kept saturated with respect to a salt of one of the metals (in this case, nickel formate) and the salt of the other (ferrous sulphate) is added continuously or at frequent intervals. An insoluble anode is used, and the p_H of the solution is kept constant by frequent additions of a neutralizing substance or by passing the electrolyte continuously over a solid neutralizing substance. Crystal structure of the electrodeposit, made by the Hull-Debye-Scherrer method, showed that it had the same structure as that of nickel and was probably a solid solution of iron in nickel.—F. J.

Castings for Electrodeposition. B. Caplan (*Found. Trade J.*, 1936, 54, (4), 83-84; discussion, 134-136).—Read before the Midland Branch of the Electrodepositors' Technical Society and the Coventry and West Midland Branch of the Institute of British Foundrymen, entitled: "Troubles Experienced in Electrodeposition due to Unsuitable Castings."—J. H. W.

***Some Characteristics of Electrolytically Deposited Metals [Cr, Ni, Cu, Fe].** Ladislav Jenicek (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 131-138; and *Rev. Mét.*, 1936, 33, (6), 371-378).—[In French.] The effects of annealing thick electrodeposits of chromium, nickel, copper, and iron on their hardness, microstructure, and density were studied, and a Chevenard differential dilatometer was used to determine changes in length on heating. The unetched polished surface of a chromium deposit shows numerous cavities, but after annealing fewer are found. They are probably formed as a result of particles of the brittle deposit being torn out during polishing. An etched surface also shows numerous fine fissures. These appear unaffected by annealing or recrystallization and may represent small channels which have not been filled up during deposition. The hardness, originally 800-1000 Brinell, starts to decrease after annealing at about 300° C. and decreases to 230-250 Brinell after annealing at 1000° C. Dilatometric curves show a contraction, commencing at a lower temperature, and reaching

nearly 1% after annealing at 1000° C. For a given annealing temperature, contraction and loss of hardness are a function of annealing time, approaching a constant value after several hours. Deposited iron, like chromium, shows a dilatometric contraction, accompanied by an increase in density, after annealing. Deposited nickel, on the other hand, shows practically no increase in density, and no increase has been detected in deposited copper.—J. C. C.

Plating Motor-Car Headlights. A Modern Installation in Paris. — (*Met. Ind. (Lond.)*, 1936, **49**, (18), 443-445).—A brief description of the polishing and automatic plating equipment of the Société des Phares Marchal à Pantin (Paris).—J. E. N.

Electroplating on Aluminium. R. Vogt (*Aluminium and Non-Ferrous Rev.*, 1936, **1**, (10), 481; **2**, (1), 43-44).—A review of the principal difficulties in electroplating aluminium and its alloys.—P. M. C. R.

Aluminium Pickle "C" a Means for the Ready Electrodeposition on Light Metals with Aluminium Base. — (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (18), 352).—L. A. O.

Observations on the Plating of Non-Ferrous Metals for Outdoor Exposure Tests. P. W. C. Strausser (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, **23**, (10), 23-33).—Methods and baths for producing standard plates of nickel, copper, and chromium on iron, steel, copper, brass, and zinc-base die-castings are described.—A. R. P.

The Commercial and Practical Aspects of Throwing Power as a Factor in the Character of Deposits. Donald Wood (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, **23**, (10), 7-11; discussion, 11-22).—The importance of throwing power in silver-plating solutions is discussed.—A. R. P.

Plating Economy Demands Control of "Drag-Out" Losses from Plating Solutions. George B. Hogaboom (*Metal Cleaning and Finishing*, 1936, **8**, (10), 677-682).—The loss of plating solution by drag-out has been calculated for a number of commercial plating baths and is shown to increase with decreasing size of the articles plated, with increasing viscosity of the solution, with decrease in draining time and with increase in the size of the bottom edge.—A. R. P.

***The Significance of the p_H Number of Alkaline Baths in Electrodeposition.** Richard Springer (*Z. Elektrochem.*, 1936, **42**, (10), 732-736; and *Metallwaren Ind. u. Galvano-Tech.*, 1936, **34**, (14), 269-270).—An investigation of the quality and colour of brass plated from a solution containing 37 gm./litre NaCN (? NaCN), 18 CuCN, 11 ZnCl₂, 22 Na₂CO₃, 2 NH₄Cl, and 10 Na₂SO₃ (cryst.), and having p_H values of from 9.8 to 13.5. From p_H 9.8 to 10.3 the coating was brass yellow; from 10.4 to 12.5 it was increasingly mottled and non-uniform; above 12.5, it became uniform again and was of a yellow-red (Tombak) colour. Dilution down to 50 gm./litre of salt had little effect on the deposit. The effect of NH₄ ions, the deposition of Tombak from brass baths, the significance of the p_H value in cadmium baths, the p_H value of alkaline cyanide copper baths and of silver baths, and the use of LPW-Peha paper (similar to litmus paper, but more sensitive) for the determination of the p_H value are discussed.—J. H. W.

The Influence of New Advances in p_H Determination in the Metal and Electroplating Industries. A. Karsten (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (1), 10-12; and *Met. Ind. (Lond.)*, 1936, **49**, (22), 541-542).

—J. E. N.

p_H Determination in Electroplating Baths. R. Springer (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (11), 211-212).—L. A. O.

A Rapid Method of Determining Boric Acid in Nickel Plating Solutions. M. H. Longfield (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, **23**, (5), 23-24).

—S. G.

Modern Filtration Practice in Electroplating. F. D. Pace (*Metal Cleaning and Finishing*, 1936, 8, (5), 233-238, 260).—See *Met. Abs.*, this vol., p. 163.

—S. G.

Process Control and Finishing Costs. H. L. Farber (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (9), 5-17).—Examples from a typical American works producing domestic electrical apparatus with nickel- or chromium-plated finish are discussed.—A. R. P.

Pickling and Plating Brittleness of Steel. H. Sutton (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 117-130).—Comprises an account of the causes of pickling and plating brittleness of steel, the effect of pickling or plating on the mechanical properties, the influence of composition and condition of the steel, and the modifications which may be obtained by varying the pickling conditions. Recommendations are given, e.g. for acid electrolytic pickling, low or moderate temperature and high initial current density, or alternatively, passivation treatment, in chromate-sulphuric baths.—W. D. J.

Determination of Some Metal Contents [in Plating Baths]. — (*Metallurgical-Ind. u. Galvano-Tech.*, 1936, 34, (8), 154-156).—L. A. O.

Plating by the Ampère-Hour Meter Method. Robert W. Wilson (*Met. Ind. (N.Y.)*, 1936, 34, (10), 387-388).—The method provides accurate knowledge of thickness and assures economy by obviating overplating.—S. G.

The Growth of the Electroplating Industry. D. J. Macnoughtan (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 155-181).—Comprises an account of the development of the electroplating industry in some detail. The article is illustrated with some interesting date charts.—W. D. J.

Electroplating. Present Position of Industry. H. J. T. Ellingham (*Canad. Chem. and Met.*, 1936, 20, (9), 282-283).—A review of recent advances.

—A. R. P.

Observations on Electroplating in Europe. William Blum (*Monthly Rev. Amer. Electroplaters' Soc.*, 1936, 23, (4), 38-46).—S. G.

Recent Developments in Electroplating.—I-II. M. de Kay Thompson (*Metal Cleaning and Finishing*, 1936, 8, (1), 13-16; (2), 65-66, 70).—A brief summary of the more important developments during the past 3 years.—S. G.

Progress in the Electrodeposition of Metals. C. B. F. Young (*Metal Cleaning and Finishing*, 1936, 8, (2), 61-64).—S. G.

The Relative Commercial Values of Various Methods of Heating, Together with Some Notes on Heat Transmission. J. Binns (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 131-142).—Discusses the heating of plating baths by (i) coal-fired steam heating; (ii) fuel-oil fired steam heating; (iii) fuel-oil direct fired; (iv) paraffin direct fired; (v) gas direct fired; and (vi) electric heating, mainly from the point of view of cost. Some useful costing data are cited. An introduction to the practical study of heat transfer in connection with plating is included.—W. D. J.

Power Supply for Electro-Plating with Particular Reference to Rectification. A. Smart (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 109-116; and (summaries) *Met. Ind. (Lond.)*, 1936, 48, (13), 391-394; *Met. Ind. (N.Y.)*, 1936, 34, (7), 261-264).—An elementary descriptive and explanatory account of electric supply equipment necessary for plating. Some approximate figures for capital cost are cited.—W. D. J.

Use of Korolac as a Protective Coating on Electroplating Racks. H. E. Fritz (*Met. Ind. (N.Y.)*, 1936, 34, (1), 26-27).—Korolac is a solution of koroseal, a new synthetic rubber-like material, which at normal temperatures is a jelly-like substance but when heated becomes liquid. In the latter form it has been successfully applied as a protective coating for electroplating racks. The method of application of Korolac to the racks is described.—L. A. O.

Coating Procedure for Plating Racks. H. E. Fritz and M. H. Longenecker (*Metal Cleaning and Finishing*, 1936, 8, (5), 287-288).—Briefly describes a

satisfactory coating procedure for plating racks, which can be applied to individual plants and which gives good protection when used in various plating and cleaning solutions.—S. G.

Rubber-Lined Equipment Finds Extensive Use in Modern Pickling Rooms. J. R. Hoover (*Metal Cleaning and Finishing*, 1936, 8, (10), 687-692).—Some types of modern rubber-lined pickling vats and other equipment are described and illustrated.—A. R. P.

Developments in Plating Machinery.—I-II. John Vander Voort (*Metal Cleaning and Finishing*, 1936, 8, (1), 17-20; (2), 67-69).—Briefly discusses developments in generators, lathes for polishing and buffing, conveyor systems, plating barrels, burnishing barrels, and centrifugal dryers and cleaning equipment.—S. G.

Maintenance of Generators and Rheostats. M. M. Rose (*Metal Cleaning and Finishing*, 1936, 8, (5), 249-250, 276).—S. G.

"Trouble Shooting" on Plating Generators. L. L. Stoffel (*Metal Cleaning and Finishing*, 1936, 8, (8), 479-482; (9), 565-570, 590; and *Met. Ind. (N. Y.)*, 1936, 34, (9), 339-341).—The cures for the common troubles which occur in routine practice are discussed.—S. G.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from pp. 464-465.)

Electrolytic Production of Calcium. V. M. Guskov and M. T. Kovalenko (*Metallurg (Metallurgist)*, 1936, (8), 73-76).—[In Russian.] A description and the results of tests of a bath designed for the production of calcium.—N. A.

***Contributions to the Chemistry of Germanium. On the Electrochemical Behaviour of Germanium.** Robert Schwarz, Fritz Heinrich, and Erika Hollstein (*Z. anorg. Chem.*, 1936, 229, (2), 146-159).—On account of its ready oxidizability in the presence of oxygen electrolytic germanium gives neither a constant nor a reproducible e.m.f. in the cell: $\text{Ge} | \text{N-ZnSO}_4 | \text{N-KCl, Hg}_2\text{Cl}_2 | \text{Hg}$. Attempts to determine the normal dissolution potential Ge-Ge^{IV} by potential measurements in aqueous solutions failed, but c.d.-potential curves for various germanium-containing electrolytes have been constructed. Germanium cannot be electrolytically deposited quantitatively except from alkaline oxalate solutions containing tin, when both metals are deposited quantitatively; examples are given.—A. R. P.

***The Influence of a Small Quantity of Agar-Agar and Gelatin on the Rate of Crystallization of Cathodic Silver Deposits.** A. Glazunov, J. Teindl, and J. Halik (*Chem. Listy*, 1935, 29, (9), 117-118, 131-133).—The influence of colloids and organic substances on the nature of cathodic deposits is reviewed. The apparatus used is similar to that described previously (*Met. Abs. (J. Inst. Metals)*, 1932, 50, 636). Using a slightly acidified 1% solution of silver nitrate and varying the current density and the additions of agar-agar and gelatin, the rate of crystallization KG_T was measured. Results are given in the form of tables and diagrams. KG_T decreases with increase in the amount of gelatin or agar-agar added, the influence of gelatin being more effective. An increase of the viscosity of the electrolyte has practically no influence. The colloids are present as insignificant residues of the electrolyte, between the crystallites, or they are placed in the space-lattice endocraptically.—O. Q.

***The Influence of a Small Quantity of Agar-Agar and Gelatin on the Rate of Crystallization of the Anodic Deposit of Silver Peroxide (Electrolysis under the Microscope.—XII).** A. Glazunov and K. Valečka (*Chem. Listy*, 1935, 29, (23), 359-361).—The fact that the colloids have a certain influence on the anodic deposit is an argument against the view that the variation in form and rate of

crystallization of the cathodic deposit is due to a migration of the colloids in the direction of the cathode during the process of electrolysis. The colloid particles seem to be bipolar or to "envelop" the ions.—O. Q.

***Insulating Gas Film on Aluminium Electrodes.** O. Jansch (*Aluminium*, 1936, 18, (10), 486-487).—When an alternating current is passed between two aluminium electrodes in dilute ammonia, the metal becomes coated with a film which is conductive when dry and prevents the formation of the Eloxal type of film when the metal is anodically treated in sulphuric acid. The ammonia film becomes coated with a luminescent gas film when immersed in water or sulphuric acid. Addition of ammonium carbonate to the ammonia solution accelerates the formation of this peculiar film, whereas addition of ammonium bichromate has the opposite effect.—A. R. P.

***Studies in Antimony Electrode.** D. N. Mehta and S. K. Kulkarni Jatkar (*J. Indian Inst. Sci.*, 1935, 18A, 85-100; *C. Abs.*, 1935, 29, 7824).—The e.m.f. of polished cast antimony against platinum, hydrogen at 685 mm. in a solution at p_H 6.0 is 0.2774 v. at 25° and 0.2279 v. at 40°. Against saturated calomel at 25° E_0 for cast antimony is -0.0293 v. over the p_H range 2.5-8.5, with an accuracy of 0.01 p_H unit. The calculated ΔH of the cell reaction, hydrogen + polished cast antimony, is 197,290 cal. at 25°-40°, in agreement with Simon and Thaler (*Z. anorg. Chem.*, 1927, 162, 253) for the reaction of hydrogen with Sb_2O_3 . The hydrogen electrode function of cast antimony is attributed to Sb_2O_3 dissolved in the metal. Unpolished cast antimony develops a film which does not exhibit the simple hydrogen electrode function.—S. G.

***The Behaviour of the Cadmium Electrode in the Alkaline Nickel-Cadmium Accumulator.** G. Grube and E. Doetsch (*Z. Elektrochem.*, 1936, 42, (5), 247-253).—Observations on the total voltage and the electrode potentials of nickel-cadmium cells were undertaken with the primary object of elucidating the function of the hammer-slag (Fe_3O_4) contained in the negative mass. The iron oxide was shown to play an important part in the cycle. Further investigations on the nature of the discharge product of the cadmium electrode, the equilibrium potential of cadmium electrodes prepared by different methods, the ionic behaviour of the iron oxide at various stages in the cycle, and the function of the water content of the electrolyte are described and summarized.—P. M. C. R.

***On the Platinum Electrode. I.—Capacity of Platinized Platinum in Various Electrolytes and the Electrolytic Behaviour of Adsorbed Hydrogen.** A. Šlygin and A. Frumkin (*Acta Physicochimica U.R.S.S.*, 1935, 3, (6), 791-818).—[In German.] An account is given of experiments on the relation between the quantity of electricity passing through a platinized platinum electrode and the potential difference between the electrode and the neighbouring solution, using various electrolytes. The results are discussed in relation to adsorption of hydrogen and the formation of a double layer.—B. C.

***Simultaneous Cathodic and Anodic Polarization of the Electrodes, Using Direct Current. II.—Platinum, Palladium, and Gold Electrodes.** Panta S. Tutundžić (*Z. Elektrochem.*, 1936, 42, (1), 21-27).—A study of the influence of a steady superimposed direct current of different direction, strength, and voltage on the potential and the decomposition potential measured at platinum, palladium, and gold anodes in 2 N-sulphuric acid at room temperature.—P. M. C. R.

VIII.—REFINING

(Continued from p. 408.)

***Studies on the Electrolytic Refining of Aluminium in a Mixture of Fused Chlorides.** J. Czochoński and W. Gawlikowski (*Wiadomości Instytutu Metalurgji i Metaloznawstwa (Warszawa)*, 1935, 2, (1), 31-33).—[In Polish, with

German summary.] Electrolytic refining of commercial aluminium in a fused mixture of sodium, potassium, and aluminium chlorides at 150° C. is considerably affected by the presence of a small quantity of water in the electrolyte; dense uniform deposits several tenths of a millimetre thick may thus be obtained on iron or other metal cathodes.—A. R. P.

IX.—ANALYSIS

(Continued from pp. 465–468.)

On Physical Methods in Chemical Laboratories. XXXII.—A New Method of Quantitative Emission Spectrographic Analysis for Micro-Analysis. G. Scheibe and A. Rivas (*Angew. Chem.*, 1936, **49**, (28), 443–446).—The substance is dissolved in an appropriate solution and a minute drop placed on each electrode of a carbon arc, across which a constant current is passed for 30 seconds during which time the spectrum is photographed. The proportion present of the element sought is then calculated from the relative intensities of certain of its lines and lines of the major constituent. The method is particularly valuable for determining traces of one metal in another; examples described are the determination of Mg in Al and the determination of Al and Cr in Fe.—A. R. P.

Analysis of Materials by the X-Ray Diffraction Method. Herbert R. Isenburger (*Product Eng.*, 1936, **7**, 177–179, 264–266; *C. Abs.*, 1936, **30**, 7479).—The principles of X-ray analysis are reviewed, with a description of the apparatus used, drawings, and photographs. Photographs of typical diffraction patterns are shown.—S. G.

A New X-Ray Method for the Chemical Analysis of Sections. L. v. Hámos (*Metallwirtschaft*, 1936, **15**, (19), 433–436).—The secondary radiations from the prepared surface of a metallic section exposed to X-rays vary in wave-length according to the chemical composition of the material at the point of incidence, and are capable of forming a series of monochromatic images after dispersion by a cylindrical crystal reflector of suitable structure. The methods of standardizing the crystal and of obtaining and interpreting comparable images are described, with practical examples.—P. M. C. R.

The Air-Carbon Arc in High Vacuum [Application to Spectroscopic Analysis of Volatile Metals]. F. H. Newman (*Phil. Mag.*, 1936, [vii], **22**, (147), 463–465).—Describes the conditions for the operation of an air-carbon arc with gas pressures between 1.0 and 0.01 mm. mercury and voltages and currents of the order of 100 and 1.5, respectively. The arc has certain advantages in the spectroscopic examination of volatile metals.—W. D. J.

The Importance and Use of X-Ray Methods in Works' Laboratories. G. I. Aksenov, V. I. Arharov, and V. I. Khristiani (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, **5**, (1), 70–88).—[In Russian.] A comprehensive survey.—D. N. S.

***Quantitative Chemical Spectrum Analysis of Aluminium Alloys.** G. Scheibe and A. Schöntag (*Light Metals Research*, 1936, **5**, (5), 106–108).—Summary from *Metallwirtschaft*, 1936, **15**, 139; see *Met. Abs.*, this vol., p. 312.

—L. A. O.

Method for Spectrographic Analysis of Silumin. A. R. Stroganov (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, **5**, (5), 614–620).—[In Russian.] The method described allows of the determination of 0.1–1.0% of Mg, Fe, Co, and Cu, and up to 8–10% of Si with an accuracy of 7–10%. Bi, Zn, Sb, Ti, and Ca can be detected qualitatively.—D. N. S.

Analysis of Magnesium. Katsumi Inouye (*Kyushu Teikoku-Daigaku Kokaku Iho (Tech. Rep. Kyushu Imp. Univ.)*, 1934, **9**, (6), 253–260).—[In Japanese.] No summary is given in a European language.—S. G.

*Study of the Method of Alkalimetry. I.—The Volumetric Analysis of Magnesium. Sannoji Mukai (*Kyushu Teikoku-Daigaku Kokaku Iho (Tech. Rep. Kyushu Imp. Univ.)*, 1935, 10, (1), 31–36).—[In Japanese.] No summary is given in a European language.—S. G.

*On a Systematic Procedure of Analysis without the Use of Hydrogen Sulphide. W. J. Petraschenj (*Z. anal. Chem.*, 1936, 106, (9/10), 330–342).—A detailed scheme is described for the detection of the common metals without using H_2S .—A. R. P.

*Sodium Diethyldithiocarbamate as a Reagent for Certain Microcrystal Reactions. Julius Grant and F. A. Meggy (*Analyst*, 1936, 61, (723), 401–402).—When a few drops of the solution to be tested are shaken with a saturated solution of the reagent and a little C_6H_6 , and the C_6H_6 layer is evaporated on a microscope slide, characteristic crystals are formed as follows: *cadmium*: large hexagons with well-defined facets (sensitivity 0.01 mg. Cd); *mercury*: brown plates (sensitivity 0.1 mg.); *manganese*: elongated hexagonal crystals (sensitivity 0.01 mg.); *lead, zinc, strontium*: elongated rectangular plates and groups of radiating crystals; *cobalt*: rectangular, brownish-green plates; *nickel*: tiny, green hexagons formed with difficulty.—A. R. P.

*Electrolytic Application of the Hydrobromic Acid Test for Copper. Gerard W. Baker (*Analyst*, 1936, 61, (726), 603–604).—A piece of Pt wire tipped with cotton wool soaked in a saturated solution of KBr in H_3PO_4 is placed on the metal suspected to be Cu and a current of 1 amp. at 6 v. is passed from metal to wire; in the presence of Cu a purple-red colour develops on the Cu. The method detects as little as 0.0002 mg. of Cu and has been employed to detect the presence of Cu on shears used to cut telephone wires.—A. R. P.

*Microchemical Detection of Gallium with Morin. Gottfried Beck (*Mikrochemie*, 1936, 20, (2/3), 194–197).—The reaction of Ga with morin is more intense than that of Al and is not inhibited by the presence of NaF; hence the development of a greenish fluorescence when the test is made in solutions containing NaF is a specific test for Ga.—A. R. P.

*On the Micro-Reactions of Lead. I. I. Korenmann and Sh. Sh. Mesongenik (*Mikrochemie*, 1936, 20, (2/3), 189–193).—See *Met. Abs.*, this vol., p. 467.—A. R. P.

*Detection of Manganese by Catalysis. L. Szebellédy and M. Bartfay (*Z. anal. Chem.*, 1936, 106, (11/12), 408–416).—The solution is treated with saturated KIO_4 solution and a few drops of 0.1% *p*-phenetidine solution; in the presence of as little as 0.001 γ Mn a violet-red colour appears in 2–3 minutes.—A. R. P.

*On the Detection of Small Quantities of Platinum in Minerals, Alloys, Residues, &c. Separation and Concentration of Platinum by Coprecipitation with Tellurium. S. Kühnel Hagen (*Mikrochemie*, 1936, 20, (2/3), 180–188).—The *aqua regia* solution of the material is evaporated with HCl to expel HNO_3 and, after addition of Na_2TeO_3 and adjustment of the acidity to 2–2.5N-HCl, is saturated with SO_2 . The Te precipitate which contains all the Pt, Au, and Hg present is ignited in air, the residue dissolved in *aqua regia*, the solution evaporated to dryness, the residue dissolved in H_2O , and the solution boiled, filtered, neutralized with NaOH, treated with KI, and acidified with CH_3CO_2H ; a rose colour indicates the presence of Pt.—A. R. P.

*Detection of Rhenium in the Sodium Carbonate Bead. Herman Yagoda (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1936, 8, (2), 133–134).—Re gives a transitory yellow colour in the Na_2CO_3 bead test in either an oxidizing or a reducing flame; Mn does not interfere in the latter case.—A. R. P.

*Detection of Zinc with Potassium Ferricyanide and *para*-Phenetidine. L. Szebellédy and St. Tanay (*Z. anal. Chem.*, 1936, 106, (9/10), 342–348).—The solution to be tested (1 drop) is added to a mixture of 6 drops of 2% $K_3Fe(CN)_6$, 2 drops of 2N- H_2SO_4 , and 12 drops of 1% *p*-phenetidine hydro-

chloride solution; in the presence of Zn a blue colour or precipitate forms immediately. Fe, Co, Ni, and Cu interfere by giving colour reactions.—A. R. P.

***Separation of Iron, Aluminium, and Chromium from Manganese, Cobalt, and Nickel by Means of Pyridine.** E. A. Ostroumov (*Z. anal. Chem.*, 1936, 106, (4/6), 170–176).—Addition of C_5H_5N to dilute chloride or nitrate solutions containing the corresponding NH_4^+ salt affords a quantitative separation of Fe, Al, and Cr from Mn, Co, and Ni in one operation, provided that excessive amounts of sulphate are absent.—A. R. P.

***On a Method of Separating Iron, Titanium, and Aluminium by Means of 8-Hydroxyquinoline.** A. M. Zanko and G. A. Butenko (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, 5, (4), 415–418).—[In Russian.] The solution is treated with tartaric acid and 80% CH_3CO_2H , the Fe removed by addition of a 2% CH_3CO_2H solution of the precipitant, the filtrate neutralized with NH_4OH after addition of $H_2C_2O_4$, the Ti precipitated with an alcoholic solution of 8-hydroxyquinoline, and the Al in the filtrate precipitated similarly after addition of NH_4OH .—D. N. S.

Separation of Lead from Copper, Nickel, Cobalt, and Cadmium by Carbonic Acid in Pyridine Medium. A. Jilek, J. Kota, and J. Vřestál (*Chem. Listy*, 1935, 29, (19), 299–304).—The separation can be easily effected if the respective metals are in the form of nitrates and if the contents of each does not exceed 0.2 grm. Pb and Cu are separated by precipitation with CO_2 in presence of ammonia. The $PbCO_3$ is dried, ignited, and weighed, Cu is determined by electrolysis. The presence of alkaline nitrates has no influence. Ni and Co are separated similarly but without addition of NH_4OH . When separating Pb from Cd CH_3COONH_4 is added; the results obtained in this case are not quite accurate.—O. Q.

***On the Separation of Small Quantities of Tin from Antimony and Arsenic.** N. I. Cherviakov and E. A. Ostroumov (*Ann. chim. analyt.*, 1936, [iii], 18, (8), 201–207).—The metals are precipitated in the usual way with H_2S , the As, Sb, and Sn extracted from the precipitate by digestion with Na_2S solution, and the mixed sulphides reprecipitated by addition of CH_3CO_2H to the filtrate. The washed precipitate is dissolved in *N*-HCl and the ice-cold solution is treated with cupferron which precipitates only the Sn.—A. R. P.

***A New Method for the Precipitation of Uranium and Its Separation from Alkaline Earths with Pyridine.** E. A. Ostroumov (*Z. anal. Chem.*, 1936, 106, (7/8), 244–248).—From neutral nitrate solutions C_5H_5N precipitates U completely as $H_2U_2O_7$, ignition of which affords U_3O_8 free from alkalis and alkaline earths.—A. R. P.

***Use of Formaldehyde for Eliminating Ammonia and Ammonium Salts.**
III.—Decomposition of Ammine Complexes by Formaldehyde. Determination of Metals by Precipitation with Alkali Carbonates or Hydroxides in Solutions Containing Ammonia or Ammonium Salts. Antonio Hemmeler (*Annali chim. applicata*, 1936, 26, (6), 240–248).—To precipitate Ag, Cu, Zn, Cd, Mn, Co, or Ni from ammoniacal solutions containing NH_4 salts CH_2O is added to convert the NH_3 to $(CH_2)_6N_4$, and the metal is then precipitated with $NaOH$ or Na_2CO_3 .—A. R. P.

***Determination of Gases in Aluminium by the Hot-Extraction Method in Vacuo.** J. A. Kliachko (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, 5, (5), 572–579).—[In Russian.] The apparatus described differs from that of Oberhoffer and Hessenbruch by the use of a Nichrome wire-wound resistance furnace, and by modifications of some of the glass parts, flat-ground glass joints being used instead of socket joints. The gas is expelled by heating the specimen to 800° C.; no gas can be obtained from specimens tested immediately after annealing, but the gas content increases with time of storage. Unannealed specimens contain most gases, the gas content of all the most important aluminium alloys being approximately the same and less than that of pure Al,

tending to increase with an increase in the Si content (e.g. in Silumin) and with the Cu content (in Duralumin). Mg has only a slight influence. Wrought metal contained more gas than cast metal.—D. N. S.

Methods of Analysis for Impurities in Copper and Brass. F. T. Longman (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (6), 238–240).—Read before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, &c.).—J. C. C.

***The Colorimetric Determination of Aluminium with the Aid of Alizarin (Red) S.** A. P. Mussakin (*Zhurnal Prikladnoy Khimii (J. Applied Chem.)*, 1936, 9, (7), 1340–1346).—[In Russian.] See *Met. Abs.*, this vol., p. 369.—N. A.

Spectrographic Methods for the Quantitative Determination of Al, Zn, and Mn in the Alloy Elektron. L. W. Wedjenski and S. Mandelstam (*Tech. Physics U.S.S.R.*, 1936, 3, (7), 662–681).—[In German.] (1) A rapid visual method is described for the estimation of Al from 4 to 8%, Zn from 0.5 to 1.5%, and Mn from 0.15 to 0.5%. The results are compared with the results of chemical analysis, both being applied to samples of Elektron. (2) A new photometric interpolation method of quantitative spectrographic analysis is described.—B. C.

***Direct Determination of Aluminium in Aluminium-Iron-Manganese Bronze.** M. I. Shubin (*Zavodskaya Laboratoria (Works' Lab.)*, 1936, 5, (4), 407–411).—[In Russian.] The alloy is dissolved in HNO_3 and H_2SO_4 , the solution is evaporated to fumes, the sulphates are dissolved in H_2O , and the solution electrolyzed with a Hg cathode for 20 minutes with 1.2–1.5 amp., then, after neutralizing with NH_4OH for $1\frac{1}{2}$ hrs. at 2 amp. whereby all the Cu, Fe, Zn, Ni, Pb are deposited in the Hg. The Al in the solution is then recovered by double precipitation with NH_4OH .—D. N. S.

***Determination of Arsenic in Ferrous and Non-Ferrous Metals by Means of Calcium Hypophosphite.** E. I. Fogelson and N. V. Kalmykova (*Zavodskaya Laboratoria (Works' Lab.)*, 1936, 5, (5), 584–586).—[In Russian.] Sn and Sn-base alloys are dissolved in 1:1 HCl with the aid of a little KClO_3 , the solution is diluted to 150 c.c. with the same acid, treated with 0.3–0.5 gm. of CaCl_2 , and boiled with 5–7 gm. of CaHPO_2 , and the As precipitate collected, washed first with HCl containing CaHPO_2 , then with 5% NH_4Cl solution and determined iodometrically. With Pb and Pb-base alloys the PbCl_2 must be removed before precipitating the As. Cu and bronze are dissolved in *aqua regia*, and the As concentrated by precipitation with $\text{Fe}(\text{OH})_3$; the precipitate is dissolved in HCl and the analysis continued as above.—D. N. S.

***A New Volumetric Method for the Determination of Beryllium.** B. S. Evans (*Analyst*, 1935, 60, (710), 291–293).—The $\text{Be}(\text{OH})_2$ obtained after separation of other metals giving insoluble hydroxides is dissolved in HCl, 1 c.c. of 0.04% thymolphthalein added, followed by 2% NaOH solution until the liquid is blue, 1:1 HCl until colourless and, after boiling for 10 minutes, NaOH until a dark blue colour is obtained. The boiling solution is then neutralized exactly with 0.1N-HCl until colourless above the $\text{Be}(\text{OH})_2$ precipitate, a measured volume of the same acid sufficient to dissolve the precipitate added (volume of solution not less than 200 c.c.), the solution cooled, and a mixture of 20 c.c. of saturated KIO_3 solution and 20 c.c. of 4% KI added, followed, after 2–3 seconds, by 4 gm. of solid NaHCO_3 and immediate titration of the liberated I_2 with 0.1N- As_2O_3 solution containing NaHCO_3 . The HCl is standardized against the As_2O_3 solution by the KI- KIO_3 method and the difference between the acid added in the test and that corresponding to the I_2 liberated in the last stage is calculated to Be (1 c.c. of 0.1N-HCl = 0.00045 gm. Be).—A. R. P.

***Studies in Internal Electrolysis. I.—The Determination of Small Quantities of Cadmium and Nickel in Zinc.** James G. Fife (*Analyst*, 1936, 61, (727), 681–684).—The anolyte consists of a solution of ZnCl_2 (\approx 5 gm. of Zn) and NH_4Cl 10 gm./100 c.c. and the catholyte of the solution (300 c.c.) of the metal

in HCl, 5 c.c. of 5% $\text{CH}_3\cdot\text{CO}_2\text{Na}$ solution, 2 drops of 2% HCl, and 0.25 gm. of $\text{NH}_2\text{OH}\cdot\text{HCl}$. The apparatus and technique are similar to those of Collin (*Analyst*, 1930, **55**, 495). For the deposition of Ni the same anolyte is used with the addition of 17 c.c. of NH_4OH (*d* 0.88) while the catholyte consists of ZnCl_2 and NH_4Cl with 2 gm. of $\text{Na}_2\text{SO}_3\cdot 7\text{H}_2\text{O}$; electrolysis is conducted at $65^\circ\text{--}70^\circ\text{C}$.—A. R. P.

***New Rapid Method for the Determination of Copper.** L. Jolson (*Z. anal. Chem.*, 1936, **106**, (4/6), 157–167).—The ammoniacal solution is reduced with NH_2OH or N_2H_4 and the Cu converted into Cu_2C_2 by passing C_2H_2 through the liquid after addition of gelatin as a protective colloid. The suspension is then titrated with standard KCN solution until completely decolorized. Addition of $\text{Na}_4\text{P}_2\text{O}_7$ prevents interference of Fe. Some applications of the method are described.—A. R. P.

***The Determination of Small Amounts of Copper in Tin by Controlled Potential.** Sydney Torrance (*Analyst*, 1936, **61**, (727), 688–689).—The Sn (10 gm.) is dissolved in HCl with the aid of a little HNO_3 , the solution is evaporated to fumes with 30 c.c. of H_2SO_4 , 50 c.c. of H_2O are added, and the mixture boiled to dissolve $\text{Sn}(\text{SO}_4)_2$, cooled and filtered. The filtrate is diluted to 150 c.c., treated with 10 c.c. of 2% $\text{N}_2\text{H}_4\cdot\text{H}_2\text{SO}_4$ and electrolyzed in the Lindsey and Sand apparatus (*Met. Abs.*, 1934, **1**, 390, 607).—A. R. P.

***Gravimetric Determination of Copper with Hexamethylenetetramine.** Antonio Hemmeler (*Annali chim. applicata*, 1936, **26**, (6), 237–240).—Addition of $(\text{CH}_2)_6\text{N}_4$ to a boiling neutral Cu salt solution effects complete precipitation of the Cu; the precipitate is ignited to CuO for weighing. Zn and Ag interfere.—A. R. P.

Colorimetric Method of Determining Germanium. I. P. Alimarin and B. N. Ivanov-Emin (*Zhurnal Prikladnoy Khimii* (*J. Applied Chem.*), 1936, **9**, (7), 1334–1339).—[In Russian.] The HCl solution obtained by distillation in a current of Cl_2 is decolorized with NaHSO_3 , treated with Br water until pale yellow, again bleached as before and, if much Se is present, treated with $\text{NH}_2\text{OH}\cdot\text{HCl}$. The filtrate from the Se is adjusted to 6N-HCl, treated with H_2S for $\frac{1}{2}$ hr., and filtered next day. The GeS_2 precipitate is dissolved in 10 c.c. of 1% NaOH free from SiO_2 and P_2O_5 , the solution oxidized with H_2O_2 and boiled to decompose excess, and an aliquot portion treated with 20–40 c.c. of 5% $(\text{NH}_4)_2\text{MoO}_4$ and HNO_3 to 0.15–0.35N. The resulting yellow colour is compared with that of a standard solution of K_2CrO_4 or picric acid (10 mg./litre of picric acid corresponds to 74.8 mg./litre of GeO_2).—N. A.

***On the Determination of Small Quantities of Germanium.** N. S. Poluektov (*Zavodskaya Laboratoria* (*Works' Lab.*), 1936, **5**, (1), 27–28).—[In Russian.] See abstract from German source, *Met. Abs.*, this vol., p. 369.—D. N. S.

***On the Detection and Determination of Gold by Means of Hydrogen Phosphide and Filter Paper.** N. D. Costeanu (*Bull. Soc. chim. France*, 1936, [v], **3**, (8/9), 1527–1530).—The Au alloy (*e.g.* 25 mg. of material filed from an article) is boiled with HNO_3 to remove Cu and Ag, and the residual Au dissolved in *aqua regia*. After diluting the solution to 25 c.c. a standard strip of filter paper is soaked in the liquid and placed in a tube through which PH_3 (from the action of KOH on PH_4I) is passed. The dark blue colour produced is compared with that of a series of standards produced similarly from solutions containing known amounts of Au.—A. R. P.

***A New Method for the Qualitative and Quantitative Determination of Traces of Gold in Presence of Copper.** L. M. Kulberg (*Zavodskaya Laboratoria* (*Works' Lab.*), 1936, **5**, (2), 170–175).—[In Russian.] The $\text{CH}_3\cdot\text{CO}_2\text{H}$ solution (*p_H* 3.6) is treated with 0.2 gm. KF and 5–6 drops of a 2.5% solution of the leuco-base of malachite or brilliant green in 20% $\text{CH}_3\cdot\text{CO}_2\text{H}$, boiled for 2–3 minutes and, after cooling, shaken with CHCl_3 . A pale green to indigo-blue colour in the CHCl_3 layer indicates Au (sensitivity 0.003–0.1 mg. of Au

in 10 c.c.). The method can be used quantitatively, the colour being compared with that given by a HAuCl_4 solution of known Au content—D. N. S.

***Quantitative Determination of Iridium by Titration with Potassium Ferrocyanide.** A. A. Grinberg and U. L. Mihelis (*Dokladi Akademii Nauk S.S.S.R. (Rep. Acad. Sci. U.R.S.S.)*, 1936, 2, (5), 177-178 (in Russian); and *Compt. rend. Acad. Sci. U.R.S.S.*, 1936, [N.S.], 2, (5), 179-181 (in German)).—Ir can be determined potentiometrically by titration of H_2IrCl_6 with $\text{K}_4\text{Fe}(\text{CN})_6$ in dilute H_2SO_4 solution.—N. A.

***Formation of Hydrogen Peroxide in the Silver Reductor. A Micro-Analytical Method for Iron.** Charles F. Fryling and Fay V. Tooley (*J. Amer. Chem. Soc.*, 1936, 58, (5), 826-831).—Determination of small quantities of Fe by reduction in HCl solution with a metallic Ag reductor and final titration with ceric sulphate is affected by an error due to H_2O_2 formed in the reductor. The method, which has practical advantages, is made accurate by use of a H_2 atmosphere during reduction and application of a correction for the indicator (ortho-phenanthroline-ferrous complex).—R. G.

***Volumetric Determination of Lead and Molybdate with Absorption Indicators.** C. Candea and I. G. Murgulescu (*Ann. chim. analyt.*, 1936, [iii], 18, (2), 33-36).—The titration of Pb with $(\text{NH}_4)_2\text{MoO}_4$ in a neutral acetate solution can be accurately made with eosin as internal indicator, the precipitate being rose-coloured during titration and becoming yellow at the end-point. The method can also be used for determining Mo by titration of a neutral molybdate solution with $(\text{CH}_3\text{CO}_2)_2\text{Pb}$, the original yellow precipitate becoming rose at the end-point.—A. R. P.

A Method for the Estimation of Lead Volumetrically by Fajan's Method. Sachindra Nath Roy (*J. Indian Chem. Soc.*, 1936, 13, (1), 40-41).—A method of estimation by titrating $\text{Pb}(\text{NO}_3)_2$ against standard Na_2CO_3 using fluorescein as adsorption indicator. Results are accurate within 1%.—R. G.

***Quantitative Spectrographic Method for the Determination of Alkali and Alkaline Earth Metals in Aluminium and Lead.** B. I. Bodnakow (*Z. anal. Chem.*, 1936, 106, (11/12), 419-427).—Li, Na, Ca, and Sr may be determined by visual photometry of their flame spectra under standardized conditions.—A. R. P.

***On a Rapid and Accurate Method for the Quantitative Determination of Mercury.** Selim Augusti (*Gazz. chim. ital.*, 1935, 65, (7), 689-693).—The method takes only 40-50 minutes for the complete determination, and is accurate. The average difference is only 0.3% from the theoretical figure.—J. K.

Analysis of Nickel Salts for Plating Baths. J. Malý (*Chem. Listy*, 1935, 29, (2), 24-26).—In addition to Ni, NH_4^+ , Na^+ , SO_4^{2-} , Cl^- , H_3BO_3 , and water are determined. Instead of separating H_3BO_3 as methyl borate it is extracted (including free H_2SO_4) with ether. The remainder is determined by the usual methods. An example is given of the calculation of an economical composition of nickel salts for plating baths, taking in account the results of the analysis.—O. Q.

***On the Titration of Divalent Platinum and Trivalent Iridium at Different Temperatures.** A. A. Grinberg and B. V. Ptizin (*Dokladi Akademii Nauk S.S.S.R. (Rep. Acad. Sci. U.S.S.R.)*, 1936, 2, (1), 17-18; (in Russian), and *Compt. rend. Acad. Sci. U.R.S.S.*, 1936, [N.S.], 2, (1), 17-19 (in German)).—At 80°-90° C. titration of a solution containing H_2PtCl_6 and H_3IrCl_6 with KMnO_4 gives a well-defined potential jump when the former is completely oxidized to H_2PtCl_6 , but no second jump occurs on completion of the oxidation of the Ir acid.—N. A.

New System of Analytical Chemistry for the Platinum Metals. Raleigh Gilchrist and Edward Wishers (*IX Congr. internat. quim. pura applicada (Madrid)*, 1934, 6, 32-49 (published in 1936); *C. Abs.*, 1936, 30, 7062).—The

chemistry of Os, Ru, Pt, Rh, and Ir is discussed, and the procedure worked out at the Bureau of Standards (U.S.A.) is outlined (cf. *Met. Abs.*, this vol., p. 48).—S. G.

***The Determination of Rhenium. II.—The Geilmann Reaction.** Loren C. Hurd and Bernard J. Babler (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1936, 8, (2), 112–114).—See also *Met. Abs.*, this vol., p. 167. The solution should contain less than 500 γ Re, 2% HCl, 0.4% KCNS, and 0.2% SnCl₂. The coloured complex is extracted with butyl acetate, cyclohexanol, or ethyl acetate 7 minutes after adding the reagents, and the colour of the solvent layer compared immediately with that of the standard solution (freshly prepared).—A. R. P.

***On the Determination of Silver by Means of Acetylene.** I. I. Strigevski (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, 5, (5), 590–591).—[In Russian.] The AgNO₃ solution containing not less than 0.01 gm. of Ag is treated at 60° C. with 5 c.c. of 50% tartaric acid solution and 10 c.c. of NH₄OH, then with a current of C₂H₂, freed from H₂S and PH₃ by passage through Na₂PbO₂ and Na₂CrO₄ solutions, for 15 minutes. The precipitate is collected, washed with H₂O—saturated with C₂H₂, and dissolved in HNO₃; the Ag is then titrated with KCNS.—D. N. S.

Determination of Small Amounts of Sodium and Potassium in Metallic Magnesium. K. M. Popov (*Kališ*, 1936, (5), 39–43; *C. Abs.*, 1936, 30, 7063).—[In Russian.] Cf. *J. Inst. Metals*, 1924, 31, 481; 1930, 44, 585; *Met. Abs.*, 1935, 2, 65. The Na is determined as “triple acetate” and the K as cobaltinitrite.—S. G.

***Investigations into the Analytical Chemistry of Tantalum, Niobium, and Their Mineral Associates. XXXII.—Observations on Phosphorus, Vanadium, and a Tannin Precipitation Series.** W. R. Schoeller and H. W. Webb (*Analyst*, 1936, 61, (726), 585–590).—In the hydrolytic precipitation of Ta and Nb from tartaric acid solutions the precipitate is contaminated with P₂O₅ if the solution contains H₃PO₄. The P may be removed by fusing the ignited precipitate with NaOH and extracting the melt with H₂O, Na₃PO₄ alone dissolving. In the tannin precipitation process in oxalate solutions half saturated with NH₄Cl Ta and Ti can be separated from V in one operation, but the Nb precipitate is always contaminated with the black V-tannin complex. V can be removed either by reprecipitation or in the same way as P. The use of tannin in the analytical chemistry of the earth acids and earth oxides (Ti, Zr, Hf, U, Th) is discussed.—A. R. P.

***Application of Gravimetric Methods to the Separation and Determination of Small Quantities of Thorium.** L. E. Kaufman (*Zhurnal Prikladnoi Khimii (J. Applied Chem.)*, 1936, 9, (5), 918–923).—[In Russian.] The following modification of the KIO₃ method gives the best results: the Th solution (which may contain much Ce) in 1:3 HNO₃ is treated with an equal volume of 1:2 HNO₃ containing 10% KIO₃ at 60°–80° C. and after 15 minutes twice the volume 1:9 HNO₃ containing 0.8% KIO₃ is added. After cooling, the precipitate is collected, washed, dissolved in HNO₃, and reprecipitated. The second precipitate and the filter paper are boiled with 2–3 gm. of H₂C₂O₄ in 50 c.c. of water, and the resulting Th(C₂O₄)₂ is collected, washed, and ignited to ThO₂.—N. A.

***Determination of Tin in Minerals and Metallurgical Products [e.g., White Metals] by Means of 0.1N-Potassium Bromate.** Léopold Deutsch (*Ann. chim. analyt.*, 1936, [iii], 18, 10).—The metal is dissolved by heating with 20 c.c. of H₂SO₄ and 5 gm. of Na₂SO₄, the cold solution is treated with 100 c.c. of H₂O and 30 c.c. of HCl, boiled and titrated with 0.1N-KBrO₃ for Sb, and the Sn is then determined by reducing the solution with Fe wire and again titrating with the KBrO₃ using ZnI₂-starch solution as indicator.—A. R. P.

***Separation and Determination of Tungsten and Molybdenum.** Herman Yagoda and Harold A. Fales (*J. Amer. Chem. Soc.*, 1936, 58, (8), 1494–1501).— MoS_3 can be precipitated quantitatively in formic acid media by initiating the reaction at a low temperature with saturated H_2S in water at 0° in excess. For separation from tungsten the p_{H} is adjusted to 2.9 by a buffer mixture of ammonium formate, tartaric and formic acids. A simple electric crucible furnace for igniting precipitates at constant temperature is described.—R. G.

Notes on the Volumetric Determination of Uranium. M. Axt (*Ingénieur Chimiste*, 1936, 20, (115), 23–29).—(a) A gravimetric method, the U being precipitated with oxyquinoline and weighed dry or estimated bromometrically or as oxide; (b) a more convenient volumetric method by reduction with Zn and titration with permanganate.—R. G.

***The Determination of Zinc in Metallic Cadmium.** J. J. Lurie and V. F. Neklutina (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, 5, (5), 587–589).—[In Russian.] The metal is dissolved in HCl with the aid of a little HNO_3 , the greater part of the Cd removed by precipitation on Al foil, and the remainder by H_2S in 5% H_2SO_4 solution containing citric or tartaric acid, and, finally, the Zn is precipitated with H_2S from an acetic or formic acid solution. Re-precipitation of the ZnS is advisable.—D. N. S.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from p. 468.)

A Self-Recording Apparatus for Thermal Analysis. R. L. Wilcox and J. R. Bossard (*Metals and Alloys*, 1936, 7, (9), 221–224).—A Nichrome-wound heating furnace is wound in such a way as to maintain a constant temperature area in the working zone. The operation of the furnace is regulated by three rheostats, one of which is a motor-driven spiral rheostat which controls the rate of heating and cooling. The temperature is measured with an iron-Constantan couple recording on a Micromax chart with an accuracy of $\pm 1^\circ \text{C}$.—A. R. P.

Apparatus for Studying the Deterioration [Vieillessement] of Alloys and Metals. F. Combettes (*Documentation sci.*, 1935, 4, 262–264; *Chim. et Ind.*, 1936, 36, 319; *C. Abs.*, 1936, 30, 7514).—The apparatus consists essentially of a Pyrex crystallizing dish containing an electric heating element connected to the lighting circuit through a rheostat. A Pyrex bell-jar is supported in the dish on pieces of glass which raise it slightly above the bottom of the dish. A thermometer passes through a slotted stopper into the jar. Water is fed into the dish through a glass constant-level device which supplies water only as it evaporates. The test-pieces are supported on glass above the level of the water. The vapour condenses on the wall of the jar which it follows, and cannot fall on the test-pieces. The advantage of the apparatus is that, being all of glass, the test-pieces can be observed throughout the test.—S. G.

Table-Type Metallographic Microscope. H. Freund (*Eng. Progress*, 1936, 17, (9), 212).—A table-type metallographic microscope with a built-in mirror reflex camera is described. The instrument is of the upright type, with a side tube for visual observation. Above the bellows is a focussing mirror, which is removable from the path of the rays after the focussed image has been obtained. The low-voltage lamp is adapted for photography as well as for visual examination.—P. M. C. R.

Panphot, a New Photo-Metal-Microscope. Hugo Freund (*Autogene Metallbearbeitung*, 1936, 29, (5), 69–72).—See *Met. Abs.*, 1935, 2, 245, 617.

—S. G.

***An Arc Support for Making a Series of Spectrographic Analyses.** R. Breckpot (*Bull. Soc. chim. Belg.*, 1936, 45, (6), 375-378).—The construction of a stand for holding the arc and for exhausting the fumes derived from a test is described with reference to detailed diagrams.—A. R. P.

Spectroscopy and the Non-Ferrous Metals. Thomas L. Tippell (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (10), 459-461).—An illustrated description of a simple spectroscope for works' use on non-ferrous materials.—P. M. C. R.

A New Method of Testing Surface Finish in the Wire Industry. A. Karsten (*Draht-Welt*, 1936, 29, (21), 327-328; (22), 343-344).—See *Met. Abs.*, this vol., p. 86.—P. M. C. R.

Determination of the Thickness of Coatings on Wire. — (*Draht-Welt*, 1936, 29, (20), 314).—A brief description is given of the principle and applications of the Culometer, an apparatus for determining the weight of a metallic coating by the measurement of its hydrogen equivalent.—P. M. C. R.

Optical Instruments in the Testing of Diamond and Hard-Metal Drawing Dies. A. Metz (*Draht-Welt*, 1936, 29, (27), 403-404).—Illustrated descriptions are given of a measuring microscope, which permits the use of both reflected and transmitted light and magnifies 15-200 diameters, and a micro-projection assembly, adaptable for micrometric work and for photography.—P. M. C. R.

Industrial Optical Testing and Gauging Instruments. H. Alquist (*Eng. Progress*, 1936, 17, (5), 111-116).—The optical processes and apparatus used in modern metal-working plant are discussed and illustrated. The main classes of apparatus are: instruments for the examination of surfaces; apparatus for measuring form and contour, e.g. thread-contour tests; comparative length gauges for high-precision mass-produced parts; direct length gauges for larger work; instruments for checking alignment, angles, and directions.—P. M. C. R.

Apparatus and Measuring Methods for the Mechanics of Solids, Liquids, and Gases.—I. H. Ebert (*Die Physik*, 1936, 4, (3), 93-106; *Sci. Abs.*, 1936, [A], 39, 1051).—Essentially a survey of the subject; it has a very extensive bibliography of the papers relating to the measurements discussed. The topics dealt with include elastic deformation, density, and "quantity," and also pressure, including the measurement of high and low pressures, pressure and vacuum pumps, and vacuum apparatus.—S. G.

***The Design of Eddy-Current Heating Apparatus for Outgassing Electrodes in a Vacuum.** C. W. Oatley and J. B. Smith (*Phil. Mag.*, 1936, [vii], 22, (147), 453-462).—The conditions of operation of eddy-current heating apparatus are investigated experimentally, particular attention being paid to the heating of tubes and discs constructed of thin sheet metal. The design of the heating coil is considered and a method of determining the optimum frequency is described.—W. D. J.

The Hydrocal. A Hydrodynamic Calculating Machine for Solving Unsteady-State Problems in Heat Transfer and Other Types of Diffusion. A. D. Moore (*Indust. and Eng. Chem.*, 1936, 28, (6), 704-708).—The Hydrocal, a calculating instrument operating on hydrodynamic principles, is illustrated and described. Transient problems in diffusion of heat, chemical diffusion, or other fields where diffusion laws prevail, can be set upon the Hydrocal and worked. Explanation can be made in terms of a transient heat situation in a simple solid—a slab being heated from one side. The slab is divided into a suitable number of incremental slices and the Hydrocal is then set up to imitate all of the heat characteristics of the slab.—F. J.

XI.—PHYSICAL AND MECHANICAL TESTING, INSPECTION AND RADIOLOGY

(Continued from pp. 469-471.)

Modern Methods of Testing Metals. Robert L'Hermite (*Bull. Soc. Ing. Soudeurs*, 1936, 7, (40), 2195-2216).—The atomic structure of metals is discussed with particular reference to its elucidation by X-ray methods of investigation, and the mechanisms of failure by static stress, fatigue, impact, and creep are considered. Testing appliances, in use at the Laboratoires du Bâtiment et des Travaux Publics, are described, and a detailed account is given of the design of a special compression testing machine, recently installed, which has a capacity of 10,000 tonnes. Some remarks are added on the effect of great hydrostatic pressure on the properties of metals.—H. W. G. H.

Mechanical Testing of Aluminium and Aluminium Alloys. R. Irmann (*Aluminium*, 1936, 18, (5), 192-202).—The shape and dimensions of standard test-pieces for determining the tensile properties, the hardness, the bending, shear, impact (notched bar), and torsion strengths, the Erichsen value, and the resistance to alternate bending are illustrated and a brief description is given of appropriate machines for making the tests.—A. R. P.

***Comparative Study of Different Methods of Testing Brass-Ware (Tubes) for Season-Cracking.** L. A. Glikman and S. P. Goncharov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1935, 5, (9), 1598-1612).—[In Russian.] A study of the methods (mercury, ammonia, cutting of ring sections), for detecting the tendency of brass tubes to season-crack showed that, for factory control tests, the last-named method is best, and affords a satisfactory explanation of the mechanism of cracking.—N. A.

New Method for Testing Antifriction Alloys for Wear. N. A. Andreevskiy and I. V. Pichugin (*Dizelstroenie (Diesel-Building)*, 1936, (5), 9-13).—[In Russian.] Describes a machine for testing flat specimens by wearing with a standard cylindrical axle on the Conolly principle.—N. A.

Quality Control of Hard Alloys, Subjected to Friction. S. B. Kocharov (*Mashinostroitel (Mechanician)*, 1936, (7), 33-34).—[In Russian.] Description of a machine for testing hard alloys for frictional wear. Results of tests on several hard alloys are given.—N. A.

Gloss Investigations Using Reflected Images of a Target Pattern. Richard S. Hunter (*J. Opt. Soc. Amer.*, 1936, 26, (4), 190-196).—For the study of the characteristics of reflective surfaces of various kinds, a lamp is used giving a beam of concentric light and dark rings. The image reflected from the metal or paint surface is photographed.—R. G.

Measuring Surface Finishes. Willis G. Meyers (*Machinist (Eur. Edn.)*, 1936, 80, (6), 96-97E).—The use of the Profilograph for measuring and recording the character of finished surfaces is described. A ray of light is focussed on a hinged mirror and reflected on to a sensitized photographic paper mounted on a drum. The specimen is passed under a diamond tracer point attached to the mirror, so that a curve of the profile is made photographically with readings measurable in millionths of an inch.—J. H. W.

***A New Method for Testing the Resistance to Cracking of Metallic Materials.** P. Brenner (*Luftfahrtforschung*, 1935, 12, 107-115).—Tests on the corrosion of various light metal alloys under bending stresses are described. It is shown that cracking sets in earlier with larger tensions, and the effect of temperature is discussed.—B. C.

***Two- and Three-Dimensional Cases of Stress Concentration and Comparison with Fatigue Tests.** R. E. Peterson and A. M. Wahl (*J. Applied Mechanics*, 1936, 3, (1), 23-25).—A comparison of values obtained for the stress-concentration factor in the study of two- and three-dimensional cases of stress concentration in shafts having fillets or transverse holes with data from

fatigue tests leads to the following conclusions: (1) in some cases fatigue results are quite close to the theoretical stress-concentration values; (2) fatigue results for alloy steels and quenched carbon steels are usually closer to the theoretical values than are corresponding results for unquenched carbon steels; (3) with decrease in size of specimen, the reduction in fatigue-strength due to a fillet or hole becomes somewhat less and for very small fillets or holes the reduction is comparatively small; (4) sensitivity factors determined for small specimens should not be applied to the design of machined parts regardless of size.—J. W. D.

Endurance Tests on Metals. DIN DVM4001. — (*Z. Metallkunde*, 1936, 28, (4), 103–104).—Terms are defined, standard tests are specified, and a uniform method of reporting results suggested.—A. R. P.

***An Application of the Interferometer Strain-Gauge in Photoelasticity.** R. W. Vose (*J. Applied Mechanics*, 1935, 2, (3), 199–202).—The difference of the principal stresses and their direction at any point in a suitable loaded specimen are determined by means of the usual photoelastic methods, and through a knowledge of Poisson's ratio their sum is obtained and a solution made possible by a measurement of the lateral deformation of the specimen by means of an interferometer strain gauge. The instrument used together with its accessories and their use is described, and examples of problems solved by means of the instrument are given, which show its accuracy and the consistency of the results obtained.—J. W. D.

Technique of Studying Deformations by Means of Varnish Coatings. I. P. Prokofiev (*Vestnik Inzenerov i Technikov (Messenger Eng. and Tech.)*, 1936, (7), 411–417).—[In Russian.] A description is given of the method for determining the presence and distribution of stresses by coating the surfaces of the articles with different varnishes.—N. A.

The Notched-Bar Test Applied to Steel and Weld Metal, with Special Reference to the Izod Test. L. W. Schuster (*Brit. Engine Boiler and Elect. Insurance Co. Tech. Rep.*, 1935, 114–172).—In a discussion of the notched-bar test and its applications, consideration is given to the value of the Izod test in the normal testing of materials, to some causes of so-called inconsistencies in the results obtained, to the use of round and square Izod specimens in the testing of welded joints, to the influence of the depth of the notch and the height of the specimen in an Izod test, to slow notch-bend tests on beam-type specimens, and to Izod tests on fusion-welded boiler drums. The results of experiments carried out for the purpose of illustrating the various points under consideration are given, and are used in the discussion to amplify the various points dealt with.—J. W. D.

The Bend Test and Its Value as a Guide to Ductility. L. W. Schuster (*Proc. Inst. Mech. Eng.*, 1935, 129, 251–350; discussion, 351–398; and (summaries) *Engineer*, 1935, 149, 354–356; *Mech. World*, 1935, 97, 445–447, 470–472).—Mainly ferrous.—L. A. O.

***Elastic Limits and Microdeformations under Dynamic Bending Stresses of Constructional Materials at High Temperatures.** Georg Welter (*Z. Metallkunde*, 1936, 28, (9), 257–261).—An apparatus for determining the dynamic bending strength of metals and alloys is described. It consists of a pendulum giving an impact force of 30 cm.-kg. and a divided electric furnace which can be pushed over each end of the bar and moved aside to expose the notch just before the pendulum is dropped; the specimen is connected with an arrangement of mirrors which records the first permanent deformation. Results obtained on a low nickel-chromium steel, a mild steel, and an aged Duralumin alloy (shown in tables and graphs) indicate that the alloy steel is much superior to the mild steel, which is about as good as the Duralumin. Conclusions can also be reached as to the behaviour of metals under alternating stresses at high temperatures.—A. R. P.

***Photoelectric Extensometer for Very Small Gauge-Lengths.** E. Lehr and H. Granacher (*Forsch. Ingenieurwesens*, 1936, 7, 66-74; *Sci. Abs.*, 1936, [B], 39, 284).—A new type of extensometer, 40 mm. long and weighing about 15 gm., is described with the aid of sectional views. The gauge points are 2 mm. apart and the extension is magnified mechanically about 50 times by levers which cause a slit to vary its width. A ray of light from a lamp within the extensometer passing through the slit falls on a small plane photoelectric cell at the end of the instrument, and the current produced is magnified until a total extensometer magnification over 30,000 times is obtained. Methods of calibrating the instrument and attaching it to a specimen are described, together with an automatic punch for marking off the specimen. The accuracy of the instrument is compared with a Huggenberger extensometer by a series of tests on a flat disc spring, and the experimental results are given in graphical form together with calculated values.—S. G.

Determination of the Elongation without Destroying the Specimen. A. Šahnazarov (*Maschinenbau*, 1936, 15, (15/16), 443-444).—Two holes 7 mm. in diameter are drilled in the metal with centres 8 mm. apart and the thin partition wall is pressed in with a suitable tool until it begins to fracture. The resulting bending is a measure of the elongation.—v. G.

Note on the Torsion Impact Test. N. Davidenkow (*Tech. Physics U.S.S.R.*, 1936, 3, (6), 577-580).—[In English.] The discrepancies between the results of torsion and bending impact tests in steel are explained by consideration of the different effects of normal and shear stresses, and the different ratios between them in the two kinds of test.—B. C.

***Similarity Between the Stress-Strain Diagrams Obtained from Impact, Tensile, and Torsional Tests.** Mititosi Itihara (*J. Soc. Mech. Eng. Japan*, 1934, 37, (212), 869 (in Japanese); *Trans. Soc. Mech. Eng. Japan*, 1936, 2, (6), 197-202 (in Japanese, with English summary in suppt., pp. 55-58)).—See *Met. Abs.*, this vol., p. 268.—S. G.

Impact Torsion Tests. Mititosi Itihara (*Metallurgist* (Suppt. to *Engineer*), 1936, 60, 141-143).—A summary and discussion of papers by I., *Tech. Rep. Tōhoku Imp. Univ.*, 1933, 11, 16; 1935, 11, 489, 512; 1936, 12, 63, 105; see *Met. Abs.*, 1934, 1, 615; 1935, 2, 356; and this vol., p. 268.—R. G.

The Microcharacter [Hardness Testing Machine] as a Research Tool. W. J. Conley, W. E. Conley, H. J. King, and L. E. Unger (*Trans. Amer. Soc. Metals*, 1936, 24, (3), 721-734).—The Microcharacter (C. H. Bierbaum, *Met. Abs.* (*J. Inst. Metals*), 1931, 47, 491) is essentially a sclerometer in which the cutting tool is a diamond ground to the shape of the corner of a cube. The micro-hardness, K , is defined by $K = \frac{10,000}{\lambda^2}$, where λ is the width of the cut in microns, and a standard load of 3 gm. is used. Applications of the instrument are described with special reference to its use for determining the relative hardness of the different constituents of an alloy.—W. H.-R.

German Hardness-Testing Machines and Appliances. G. Richter (*Eng. Progress*, 1936, 17, (4), 81-86).—Developments in works' hardness-testing equipment have been directed towards eliminating the personal equation of the observer, standardizing conditions by holding the work under pressure, supplying an electro-automatic drive or other types of drive likely to facilitate the testing process, and providing reliable methods of testing cumbersome or irregularly shaped pieces. Stationary and portable machines for different types of hardness test are described and illustrated.—P. M. C. R.

A New Hardness Tester. Otto Welz (*Eng. Progress*, 1936, 17, (7), 157).—The instrument described may be used either for the Vickers or Brinell test; an optical system projects an image of the impression at a standard magnification on a ground-glass screen. The hardness may either be read direct from

the screen by means of "involutes," or calculated from measurements of the image.—P. M. C. R.

RADIOLOGY.

Some Applications of X-Rays. J. R. Townsend and L. E. Abbott (*Metal Progress*, 1936, 29, (2), 64-70, 86).—An illustrated description is given of the Coolidge tube and of its use in the examination in particular of welds and shrinkage cracks.—P. M. C. R.

***A New Method for the Detection of Internal Strains in Solids by Radiograph.** Shinsuke Tanaka and Chūjirō Matano (*J. Soc. Mech. Eng. Japan*, 1934, 37, (212), 860-863).—[In Japanese.] See also *Met. Abs.*, 1935, 2, 248.—S. G.

The Use of X-Rays for Examining Weld Seams and Testing Welders. Erich Wegerhoff (*Elektroschweissung*, 1936, 7, (10), 192-195).—Typical faults in welds are described and illustrated by radiographs. It is pointed out that X-rays provide an excellent method of supervising workmanship, and it is emphasized that they disclose faults which are insufficient to justify rejection.

—H. W. G. H.

X-Rays and Arc-Welding. F. Grèbert (*Arts et Métiers*, 1936, 89, (188), 107-110).—A method of determining by X-ray examination not only the position of a defect, but the depth at which it occurs, is described and illustrated: the limits of accuracy are discussed. An apparatus suitable for works' routine is illustrated, and the thicknesses of copper, bronze, brass, and aluminium up to which it can be employed are stated.—P. M. C. R.

Radiographic Inspection of Welded Refinery Equipment. Herbert R. Isenburger (*Mech. Eng.*, 1936, 58, (7), 442-446).—The radiographic examination of welded oil-refining equipment is described. A semi-portable X-ray installation for workshop use, and a portable apparatus for field examination, are described and illustrated, and the limitations of gamma-ray examination are discussed. Methods of locating defects are described, and several illustrated examples are given.—P. M. C. R.

The X-Ray Investigation of Fine Structure in the Foundry. A. Karsten (*Giesserei*, 1936, 23, (3), 57-59).—Some modern portable apparatus is described.

—L. A. O.

Stereometric Measurements of X-Ray Photographs. A. Matting (*Giesserei*, 1936, 23, (1), 7-11).—X-ray stereoscopy can be applied to the testing of materials. Various instruments are described with the principles underlying their use.—L. A. O.

The X-Ray Examination of Wire-Bars. M. S. Beletski (*Legkie Metalli (Light Metals)*, 1936, (4), 40-42).—[In Russian.] X-ray methods for examining the homogeneity of aluminium wire-bars, as used at the Dnieper Aluminium Plant, are described.—D. N. S.

Industrial X-Rays: An Introduction to the Physics of the Science. Robert C. Woods (*Metals and Alloys*, 1936, 7, (2), 45-50).—L. A. O.

X-Rays and Atoms: An Industrial Review. Robert C. Woods (*Metals and Alloys*, 1936, 7, (7), 181-184).—An elementary review.—L. A. O.

Practical Applications for X-Rays for the Examination of Materials.—I-III. W. G. Burgers (*Philips Tech. Rev.*, 1936, 1, (1), 29-31; (2), 60-61; (3), 95).—S. G.

XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from p. 471.)

Pyrometry in Foundries and Smelting Works. Edmund T. Richards (*Feuerungstechnik*, 1936, 24, (8), 141-143).—Pyrometers may be dispensed with in certain foundry and smelting operations where special stages in the process are accompanied by unmistakable indications (e.g. the evolution of fumes,

colour changes, &c.). Elsewhere pyrometric control must be effected by instruments of the immersion type, thermocouples with exposed junctions, or optical pyrometers. The advantages, limitations, and special applications of each type are described.—P. M. C. R.

Methods and Instruments of Industrial Temperature Measurement and Control. R. Boye (*Eng. Progress*, 1936, 17, (5), 117–121; (6), 135–139).—A short discussion of the principles of temperature measurement is followed by a classification of the instruments employed: the four main classes—expansion thermometers, electrical resistance thermometers, thermocouples, and radiation pyrometers—are then considered, and recent types of each are illustrated and described.—P. M. C. R.

***A Gas-Tight Furnace for Thermocouple Standardization.** C. D. Niven (*Canad. J. Research*, 1936, [A], 14, (9), 177–180).—A detailed description of a furnace for calibrating platinum/platinum-rhodium thermocouples in molten metals. The essential part is a water-cooled gas-tight lid designed in such a way as to maintain a reducing atmosphere over the surface of the crucible. A device is also described for removing the crucible from the furnace without having to turn the furnace upside down.—J. W. D.

Temperature Measurements with a New Colour Pyrometer. Gerhard Naeser (*Giesserei*, 1936, 23, (15), 363–368).—See *Met. Abs.*, this vol., p. 269.

—A. R. P.

Thermoelectric Pyrometers for Very High Temperatures (1500°–2000° C.). A. A. Borzdyka (*Zavodskaja Laboratoria (Works' Lab.)*, 1936, 5, (2), 204–207).—[In Russian.] Characteristics of the thermocouples: Rh/Pt + 8% Re; Rh/Rh + 8% Re; Ir/Ir + 60% Rh; W-Mo and C-SiC are discussed.

—D. N. S.

A Spindle for Insulating [Thermocouple] Wires. Julian M. Sturtevant (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1936, 8, (5), 341).—In the construction of thermocouples it is sometimes desirable to wrap a small bundle of wires with cotton or silk insulating thread. This is a tedious procedure when done by hand. A simple and easily constructed spindle, which is illustrated and briefly described, enables 1 ft. of wire to be wrapped with one layer of thread in 1 minute.—S. G.

***The Platinum Resistance Thermometer.** W. H. Keesom (*7e. Congr. internat. froid, 1e. Comm. internat., Rapports et Communiqués*, 1936, 12–15; *C. Abs.*, 1936, 30, 6999).—Cf. *Met. Abs.*, this vol., pp. 87, 270, 413. Five platinum resistance thermometers were compared with a helium thermometer at 10° intervals from 0° to –180°. All the thermometers were calibrated at 0° and at –182.985° (the boiling point of oxygen). From 0° to about –110° the international (platinum) scale is low; maximum errors of 0.0375° to 0.0455° occurred at –80° and at –90°. From about –110° to –183° the international scale is high; maximum errors of 4 of the platinum thermometers were 0.0135–0.0235° at –130° and –140°; the fifth thermometer had a maximum error of 0.0495° at –140°. Four of the platinum thermometers had maximum differences (among themselves) of 0.012°; including all 5, the maximum difference was 0.038°.—S. G.

***Thermometry at Low Temperatures.** W. H. Keesom (*7e. Congr. internat. froid, 1e. Comm. internat., Rapports et Communiqués*, 1936, 27–44; *C. Abs.*, 1936, 30, 6999).—As a result of a redetermination of the fundamental pressure coeff. of helium, a table of corrections from 0° to –270° is given for the Celsius-Avogadro scale. The revision is termed the “1936 scale.” Platinum resistance thermometers were found to have a maximum unreliability of 0.05° and 0.15° in the ranges 0° to 190° and –190° to –259°, respectively. The two formulæ used to determine temperatures at liquid helium temperatures have a discontinuity of about 0.01° at 2.19° K. Phosphor-bronze resistance thermometers gave excellent results for the range 0.7°–7.3° K. The effects of

current intensity (0.025–1.36 ma.), lead content (0.0257–0.0010), and external magnetic field (0–6500 gauss) on temperature determinations made with phosphor-bronze wires are shown graphically. Resistances of cerium and magnesium from 1° to 4° K. are shown. Thermoelectric couples of the gold alloy–silver alloy type are discussed; e.m.f.s of the couple Au + 2.11 atom-% Co–Ag + 0.37 atom-% Cu are given from 2.5 to 17.5° K. All these methods become unreliable at 0.7 to 0.8° K. to the extent of perhaps 1%. The determination of temperatures below 1° K. obtained by adiabatic demagnetization and the measurement of temperatures by adiabatic expansion are discussed briefly. 25 references are given.—S. G.

The Measurement of the Temperature of Hot Moving Objects. A. E. Krogh (*Iron and Steel Eng.*, 1936, 13, (4), 11–12).—The pyrometric system described (Optimatic) is based on the differential reactions of two photocells included in a bridge circuit containing an amplifying tube. The system indicates temperatures with a lag of only 0.5 second, and may operate automatic recorders. Any number of galvanometers may be connected with a single system, or one galvanometer may be used with several systems in turn. The rapidity and scope of the observations thus made possible ensure complete control and uniformity of treatment, especially in the case of continuous processes.—P. M. C. R.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 471–473.)

***Second Report of the Steel Castings Research Committee [of the Iron and Steel Institute and British Iron and Steel Federation].** — (*Iron Steel Inst. Special Rep. No. 15*, 1936, 117 pp.; and *Found. Trade J.*, 1936, 55, (1051), 267–270; (1052), 291–293, 296; (1053), 314–318; (1055), 354–355; (1056), 377–379; (1057), 389–390, 392).—This systematic investigation of the difficulties associated with steel castings should prove invaluable in similar studies of allied problems relating to non-ferrous castings where many of the same principles are involved and have not been subjected to such scientific treatment. The report is divided into 6 sections: I.—Introduction; II.—(1) Review of existing information on dimensional changes and on the strength and ductility of steel at high temperature; (2) review of existing information on fluidity or castability, on cast iron and non-ferrous metals, a study of the problem applied to steel and experiments; III.—Description of a standard method evolved to measure fluidity for the study of the effect of various elements; IV.—Research on the strength and ductility of steel while cooling down from the cast condition; V.—Outlines the work of Moulding Materials Sub-Committee. Findings to be embodied in a later report; VI.—Radiological examination of steel castings.—J. E. N.

Cooling of Castings in Moulds. I. E. Gorshkov (*Metallurg (Metallurgist)*, 1936, (8), 104–110).—[In Russian.] Attention is directed to the marked effect, on the crystallization of castings, of the deformation of the mould due to its unequal heating. In the first stage of heating, when the outer surfaces of the mould remain cold, its inner parts are in closer contact with the casting and conduct heat away more vigorously. As the mould becomes hotter, a reversal of the deformation of its walls occurs, *i.e.* separation of its inner parts from the casting. G.'s conclusions are supported by some examples.—N. A.

Wall Thickness Sensitivity of Metals and Alloys. E. Söhnchen and E. Piowarsky (*Z.V.d.I.*, 1936, 80, (31), 933–936).—A review of the literature on the moulding of alloys. —v. G.

***A Centrifugal Purifier for Molten Metals.** E. Vroonen (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 227–234; and *Rev. Mét.*, 1936, 33, (8), 502–509).—[In French.] A description is given of a refractory-

lined centrifuge for separating slag and metal, and details given of its use for purifying cast iron and also treating it with sodium carbonate for removal of sulphur. The centrifuge, a conical tube inclined at 35° to the horizontal, is rotated at 350–450 r.p.m. and handles $2\frac{1}{2}$ tons per minute. The possibility of using such a device for other metals is briefly discussed.—J. C. C.

Note on a New Casting Process. A. Courtecuisse (*Arts et Métiers*, 1936, 89, (184), 13; and *Rev. Fonderie moderne*, 1936, Mar. 10, 81).—It is claimed that sound castings of good surface finish are produced by vibrating the table carrying the moulds. The method is said to be especially applicable to aluminium.—P. M. C. R.

A New Process for the Production of Thick Castings in Non-Ferrous Metals. — (*Giesserei-Praxis*, 1936, 57, (29/30), 313–314).—Describes the methods to be adopted to prevent porous non-ferrous metal castings, owing to slag and oxide inclusions, which are liable to occur on account of the ease with which the metals oxidize.—J. H. W.

†**Recent Progress in the Founding of Light Alloys.** M. L. Montupet (*Bull. Assoc. Tech. Fond.*, 1936, 10, (7), 269–271).—A review of progress in light aluminium casting alloys. Two distinct tendencies are developing: (1) improvement in mechanical properties; (2) improvement in corrosion-resistance. The melting, moulding and casting, and heat-treatment of alloys containing copper 4.5 and titanium 0.3% are described, and these are claimed to be the best and strongest cast aluminium alloys. Other alloys described are aluminium-magnesium and heat-treated Alpac.—J. E. N.

Recent Developments in the Manufacture of Light Metal Castings. W. Linicus (*Aluminium*, 1936, 18, (9), 401–408).—A review of recent researches on aluminium casting alloys to improve their structure, castability, strength, and resistance to corrosion. Some examples of complicated aero-engine castings are illustrated.—A. R. P.

Principles of the Development of the Casting of Light Metal Alloys. Willi Claus (*Maschinenbau*, 1936, 15, (17/18), 505–509).—A review of the most important properties of light metal casting alloys and their effect on casting technique.—v. G.

New Ideas in the Casting of Light Metal Alloys. — (*Giesserei-Praxis*, 1936, 57, (39/40), 437–438).—Gives a brief review of patents (two English, one American, and one French) which have for their object the production of sound light metal alloy castings, having regard especially to the great tendency of these alloys to oxidize.—J. H. W.

The Melting of Aluminium and Its Alloys. — (*Giesserei-Praxis*, 1936, 57, (15/16), 169–173).—Discusses temperature control, casting temperature, crucible material, cover, the use of scrap metal, and the melting operations for aluminium and aluminium alloys in coke, oil and, more particularly, electric furnaces.—J. H. W.

Technical and Economic Points of View in the Preparation of Aluminium Sand and Chill Castings. A. von Zeerleder (*Aluminium*, 1936, 18, (5), 203–208).—Practical hints are given on moulding and casting, together with curves and tables showing the properties of the castings, and cost data.—A. R. P.

***Non-Metallic Inclusions in Commercial Aluminium.** B. Grashchenko, V. Darovski, and A. Khangian (*Legkie Metalli (Light Metals)*, 1936, (4), 26–40).—[In Russian.] By blowing oxygen, water vapour, carbon monoxide, or carbon dioxide through molten aluminium and by the addition of powdered oxide the alumina content of the metal may be increased from 0.012–0.02 to 0.08–0.12%, the oxide occurring as films along the grain boundaries in the first case and as point-like inclusions in the second. By addition of scrap or oxide films a still further increase in oxide content can be obtained, but the oxide inclusions are irregularly distributed throughout the ingot, sometimes

as thick films covering crystals of the metal, and sometimes as long inclusions which are not connected with the crystals. Oxidation by blowing gases or addition of alumina has little effect on the mechanical properties or electrical conductivity, because if casting is carried out correctly, the oxide is not retained in the aluminium to any great extent. Addition of oxide films may cause deterioration of the mechanical properties and electrical conductivity.

—D. N. S.

The Blowing of Nitrogen Through Aluminium Alloys. — (*Vestnick Metallopromishlennosti (Messenger Metal Ind.)*, 1936, **16**, (7), 46).—[In Russian.] The number of faulty pistons cast from an alloy of aluminium with copper 9–12, nickel 1.3–1.5, and iron 0.3–0.5% was reduced considerably by treating the metal with nitrogen for 8–10 minutes before casting.—D. N. S.

***A Study of the Effect of a Prolonged Overheating on the Mechanical, Macroscopical, and Microscopical Characteristics of an Aluminium-Copper-Silicon Alloy with and without Titanium.** (Vivanti and Guastalla.) See p. 504.

Gating Practice in the Aluminium Foundry. — (*Giesserei-Praxis*, 1936, **57**, (15/16), 167–169).—Describes the differences in gating practice in the aluminium and the brass foundries.—J. H. W.

***Contraction of Aluminium and Its Alloys During Solidification.** (Losana.) See p. 503.

The Rational Dressing of Aluminium Castings. — (*Giesserei-Praxis*, 1936, **57**, (15/16), 173–175).—Describes the various methods of trimming and cleaning aluminium castings.—J. H. W.

Sources of Faults in the Casting and Forging of Ingots of Aluminium and Aluminium Alloys. W. Schnorrenberg (*Aluminium*, 1936, **18**, (9), 422–427).—The following faults, the appropriate remedies and precautions to avoid them are discussed: porosity, coarse crystal structure, segregation and inverse segregation, piping, oxide inclusions, casting stresses, hot shortness.

—A. R. P.

Points of View in the Use of Scrap in the Aluminium Foundry. R. Irmann (*Aluminium*, 1936, **18**, (9), 416–421).—Practical hints for the correct utilization of foundry and machine-shop scrap.—A. R. P.

Composition, Physical Properties, and Range of Application of Common Light Metal Casting Alloys. — (*Giesserei-Praxis*, 1936, **57**, (15/16), 160–162).—Tabulates data relating to 22 aluminium alloys in the sand- and chill-cast conditions, and classifies them in 9 groups.—J. H. W.

Be Careful in the Use of Old Material. Test It First. — (*Giesserei-Praxis*, 1936, **57**, (15/16), 163–165).—Since most defects in metals arise in the foundry, care is required in melting light alloys from scrap metal. According to DIN 1713, the aluminium alloys can be classified in 9 groups (see preceding abstract), and for these old metal can be remelted. The resistance to attack by 20% caustic soda solution and, in the case of Elektron, of 30% hydrochloric acid required by castings of magnesium alloys and aluminium alloys containing copper, zinc, magnesium, or silicon is discussed.—J. H. W.

Light [Magnesium and Aluminium] Alloys. H. G. Warrington (*Aluminium and Non-Ferrous Rev.*, 1936, **1**, (4), 125–132; discussion, 132–134).—See *Met. Abs.*, this vol., p. 88.—J. C. C.

How Do I Cast Thick-Walled Discs and Plates in Aluminium or Silumin? — (*Giesserei-Praxis*, 1936, **57**, (23/24), 253–255).—Describes the moulding, melting, and casting of thick-walled plates in these metals. The temperature during the melting of aluminium must not exceed 740° C., and of Silumin 780° or 800° C. at the most. The casting temperature of aluminium is 690°–700° C. and of Silumin 700° C., the mould being inclined.—J. H. W.

Difficulties in the Production of a Pantal Grating. — (*Giesserei-Praxis*, 1936, **57**, (29/30), 312–313).—Considerable care is required in the manu-

facture of a grating in Pantal; the precautions to be observed in moulding, melting, and casting are given.—J. H. W.

All in a Day's Work—1800 Aluminium Pistons. — (*Machinist (Eur. Edn.)*, 1936, 80, (21), 444-445).—Briefly describes the use of permanent moulds and fully automatic melting and annealing in the mass production of aluminium pistons.—J. H. W.

Sand-Castings of Copper-Silicon Alloys. H. A. Bedworth and V. P. Weaver (*Trans. Amer. Found. Assoc.*, 1936, 44, 193-204; discussion, 205-210; also *Foundry*, 1936, 64, (7), 24-26, 59; and (summaries) *Met. Ind. (Lond.)*, 1936, 49, (6), 139-141; *Found. Trade J.*, 1936, 55, (1057), 391-392; *Aluminium and Non-Ferrous Rev.*, 1936, 2, (1), 31-32).—Copper-silicon alloys containing small quantities of other elements have been developed as substitutes for the older and more expensive tin bronzes. The melting, casting, and foundry technique of an alloy containing copper 95, silicon 4, and manganese 1% is described. A neutral or slightly oxidizing furnace atmosphere is recommended, and glass is preferred to charcoal as a cover. Shrinkage is rather high, and well-placed feeder heads are necessary; chills may be used with advantage on heavy sections. Properties and uses of the alloy are given. In a lengthy discussion, information was sought on several points of foundry practice, comparative values of the various proprietary alloys, corrosion-resistance, and suitability of the alloys for welding and soldering.—J. E. N.

Casts Bronze Parts for Pumps. Pat Dwyer (*Foundry*, 1936, 64, (6), 32-33, 90).—After describing the general lay-out of a foundry and core shop specializing in castings for pump parts in 88-10-2 gun-metal, the moulding of a four-lobe rotor is outlined. The gates are designed to give non-turbulent entry of the metal, and the risers are off-set but have sloping bases. It is claimed that these give perfect feeding and are readily removed.—J. E. N.

Castings of Lead-Bronze in a Reducing Atmosphere of Carbon Monoxide. N. A. Andreevskiy (*Dizelstroenie (Diesel-Building)*, 1936, (6), 10-13).—[In Russian.] The reducing processes occurring during heating of the core in a closed chamber in the presence of carbon and air are discussed and a casting process is described. The operation of a Diesel engine with bearings cast by this method is discussed.—N. A.

An Interesting Case of a Defect Caused by the Use of Phosphor-Copper. — (*Giesserei-Praxis*, 1936, 57, (15/16), 213-214).—Small irregularities which sometimes occur in bronze and red brass castings are shown to be due not, as might at first be supposed, to errors in moulding or to the gas permeability of the moulding sand, but to the incorrect use of phosphor-copper as a deoxidizer.—J. H. W.

Porosity in Bronze Castings and Means to Avoid It. D. S. Veronin (*Liteinoe Delo (Foundry Practice)*, 1936, (7), 14-15).—[In Russian.] To eliminate porosity in bronze castings subjected to hydraulic or air tests, the internal pores of the sections are plugged with molten lead under pressure. Sections earmarked for plugging are coated, before charging, with chalk dissolved in water to prevent the lead from freezing to them. The sections heated to 150°-200° C. are placed in a tank with molten lead, at a temperature of 420°-450° C., where they are kept for 7-10 minutes under a pressure of 6-6.5 atm. They are then withdrawn and the chalk and adhering lead is scraped off.—N. A.

***Inverse Segregation and the "Tin Sweat" of Bronzes.** (Somigli.) See p. 511.

Making a Propeller by Snap-Flask Methods. J. J. McClelland (*Found. Trade J.*, 1936, 54, (1032), 415).—S. G.

Nickel in Brass Foundry Practice. D. M. Curry (*Met. Ind. (N.Y.)*, 1936, 34, (9), 330-332).—An address to the St. Louis Chapter of the American

Foundrymen's Association. Briefly discusses developments in the addition of nickel to brasses and bronzes, nickel-brasses, and foundry practice.—S. G.

Melting of Magnesium Alloys under a Gaseous Medium. K. V. Peredelskiy (*Liteinoe Delo (Foundry Practice)*, 1936, (5), 33-36).—[In Russian.] Magnesium alloys can be melted satisfactorily if protected by oxygen-free gases which do not dissociate at the melting temperatures. Inert gases and sulphur-containing gases which dissociate can be employed, if the products do not react with the molten metal, but the gas should be dry and pure. Hydrogen gives the best results, thus after melting the 8% aluminium-magnesium alloy under hydrogen the tensile strength was 16-17 kg./mm.², and the elongation 2-4%; while after melting under hydrogen sulphide the corresponding values were 13.6-14.4 kg./mm.² and 2.2%.—N. A.

Production of White Metal Linings. Edmund R. Thews (*Canad. Chem. and Met.*, 1936, 20, (4), 111-112).—The following points are briefly discussed: white metal adhesion, cleaning and etching, tinning the bearing, temperature of lining, effect of rate of cooling, core conditions.—A. R. P.

The Lining of Bearing Shells with Tin-Rich White Metals. E. T. Richards (*Metall-Woche*, 1936, (15), 281-283).—The following points are discussed: effect of the nature of the shell and the degree of working on the adhesion of the lining, the tinning of the shell, influence of temperature conditions during casting.—A. R. P.

The Present Position of Casting Under Pressure. Paul Bastien (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (12), 543-546; 2, (1), 32-34, 37-38, 40-41).—The composition and properties of the principal groups of die-casting alloys are reviewed: graphs illustrate the influence of magnesium admixtures on the strength of a zinc-copper-aluminium alloy, the shrinkage of 4 zinc casting alloys at atmospheric temperature, and the influence of injection pressure on the resilience of zinc and of aluminium alloys. The mechanical properties of ordinary and pressure castings of brass, Alpax, and zinc alloy are tabulated. The applications of piston and compressed-air injection are discussed, and common types of casting machine are briefly described. A discussion of the general principles of the design of pressure castings and of moulds is followed by a summary of the causes of porosity. A bibliography is appended.

—P. M. C. R.

On the Porosity of Die-Cast Sections. B. Sachs (*Liteinoe Delo (Foundry Practice)*, 1936, (7), 5-10).—[In Russian.] Pores in die-cast sections fall into two groups: (1) those due to the difference in specific volume of the metal in the liquid and solid states and to irregular crystallization from the outer to the inner portions, and (2) those due to the difference in the capacity of the metal to absorb gases in the liquid and solid states, as well as to irregular crystallization. Most detrimental are the clearly defined shrinkage cavities; most favourable is a regular distribution of microscopic pores spread over the casting. Die-casting provides favourable conditions for reducing porosity.

—N. A.

Porosity of Die-Cast Sections. K. V. Peredelskiy (*Liteinoe Delo (Foundry Practice)*, 1936, (7), 10-13).—[In Russian.] Porosity increases with the wall-thickness of the casting. In sections with thick and thin parts, pores are concentrated mainly in the thick parts. Both gas and shrinkage porosity is observed. To obtain a dense casting strict technical control is essential, depending on the type of section cast, the nature of the alloy, and design of the apparatus. Castings with the highest density are obtained in plant operating on the press principle (with a cold pressure chamber), piston machines come next, and compressors are least suitable. It is essential to select alloys with a minimum shrinkage.—N. A.

Means of Eliminating Porosity in Die-Casting. A. S. Lugaskov (*Liteinoe Delo (Foundry Practice)*, 1936, (7), 13).—[In Russian.] The process of casting

under pressure is accompanied by reduction of porosity and increase in density and mechanical properties. In the casting of alloys the latest methods of degasification must be employed. The type of machine selected must be adapted to the nature of the alloy; compressor plant is not recommended for aluminium alloys.—N. A.

Copper Alloy Die-Castings. Allen F. Clark (*Machine Design*, 1934, 6, (11), 24-26; *Mech. Eng.*, 1935, 57, 256).—In specifying copper alloy die-castings undercuts and sharp corners should be avoided. Generous fillets and webs add strength to the part and assist in producing a better casting. The use of inserts should be confined to those applications where special qualities are required. Minimum wall stocks in a cylindrical portion or the main part of a casting should be $\frac{3}{32}$ in., although portions of a casting may have a $\frac{1}{16}$ in. wall. Variations from drawing dimensions must be ± 0.003 in. Desirable draft for side walls and cores is 0.020 in. per in. On the outside walls draft, as is sometimes desirable, may be 0.005 in. per in. of length. The wall intersections should be liberally filleted as also should be the area around the base of bosses. Minimum size of cored holes is $\frac{1}{4}$ in. diam. In general, holes from $\frac{1}{8}$ to $\frac{1}{4}$ in. diam. can be cast $1\frac{1}{2}$ times their diameter in depth; larger holes than this can be cast deeper. External threads, if of coarse pitch, may be cast but have to be chased, while internal threads cannot be cast. Spur-gear teeth of 24-pitch or larger can be cast and then shaved to size.—S. G.

Dies for Brass Die-Castings. Charles O. Herb (*Machine moderne*, 1936, 30, (334), 438-450).—See *Met. Abs.*, this vol., p. 320.—P. M. C. R.

Production Die-Castings. Herbert Chase (*Machinist (Eur. Edn.)*, 1936, 80, (37), 767-768).—Describes production work in zinc and aluminium die-casting alloys by a large American firm.—J. H. W.

Pressure Casting. Ladislav Jenicek (*Bull. Assoc. Tech. Fond.*, 1935, 9, (6), 190-197; (9), 294-301).—See *Met. Abs.*, 1935, 2, 717.—J. E. N.

Die-Casting Properties of Zinc-Base Die-Casting Alloy No. 5. — (*Metalgram* (Apex Smelting Co.), 1936, (15), 4 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—A summary of the behaviour of an alloy, consisting of zinc (99.99 + %) alloyed with aluminium 4.1, copper 1, and magnesium 0.03%, when cast at various metal and die temperatures and various pressures. It is claimed that, considering every major physical property, as well as casting and machining qualities, surface finish, &c., this alloy has proved superior to any of the present commercial zinc-base die-casting alloys.—S. G.

Die-Cast Radiator Grilles. — (*Automotive Ind.*, 1936, 74, (2), 44-47).—An illustrated description is given of the zinc-alloy die-cast grilles now in use on 12 types of American automobile. The weights of the various types and of die-cast hood louvres are tabulated.—P. M. C. R.

Recent Developments in the Casting of High-Strength Zinc-Base Alloys. A. H. Munday (*J. B'ham. Met. Soc.*, 1936, 16, (3), 118-128; discussion, 128-133; and *Aluminium and Non-Ferrous Rev.*, 1936, 1, (7), 296-298).—See *Met. Abs.*, this vol., p. 172.—J. C. C.

Defects Caused by Improper Gates. N. K. B. Patch (*Foundry*, 1936, 64, (8), 26).—Defects in non-ferrous castings are frequently produced by turbulent entry of the metal into the mould, and are not always attributed to this cause. Attention to detail of size and design will eliminate the harmful nozzle effect.—J. E. N.

Some Notes on the Gating of Castings. J. E. Garside (*Found. Trade J.*, 1936, 54, (1027), 326-327; discussion, 327).—Read before the Lancashire Branch of the Institute of British Foundrymen.—S. G.

The Use and Care of Crucibles. H. N. Bassett (*Found. Trade J.*, 1936, 55, (1054), 339-340).—Crucibles, particularly the larger sizes, are expensive and considerable improvement in performance may be expected by care in storage,

and early life in use. Crucibles should be stored under cover in heated, properly ventilated chambers, preferably on shelves. The first heating should be gradual, and for subsequent heats the crucible should be preheated before charging any metal; rapid changes of temperature are harmful, and the use of fluxes should be avoided as far as possible. The setting of crucibles in tilting furnaces must allow for shrinkage, and the condition of the lining plays an important part in ensuring uniform heating of the crucible.—J. E. N.

50 Rules for the Care of Graphite Crucibles. E. R. Thews (*Rev. Fonderie moderne*, 1936, Oct. 25, 285-287).—A commentary and translation from *Giesserei-Praxis*, 1936, 57, 211-213, 230-231; see *Met. Abs.*, this vol., pp. 215, 272).—J. E. N.

The Reduction of Core-Shop Costs. N. P. Newman (*Met. Ind.*, (Lond.), 1936, 48, (14), 417-420).—Abridged from a paper presented before the London Branch of the Institute of British Foundrymen. Cost reduction is considered under the headings of material, labour, and overhead charges. The selection and storage of sand, the quality of binder and the blending of fresh sand with old or unused material are discussed, and methods of mixing and transport are described. Core-box repairs and maintenance may be reduced by the use of a filter-table fitted with grips and a vibrator. Core-blowing practice is briefly described, and an account is given of 3 types of conveyor and of continuous drying and batch drying ovens. Details regarding fuel consumption and output are given for the "continuous" system.—P. M. C. R.

***The Influence of Atmospheric Humidity on Dried Moulds, and on Cores without Artificial Bonds.** M. B. Holman (*Bull. Assoc. Tech. Fond.*, 1936, 10, (6) 213-221).—Exchange paper of Czechoslov Assoc. Tech. Fond. to the French Foundry Congress. After examining the relative humidity of the air in foundries under varying conditions, the hygrosopic qualities of a number of sands were determined. The influence of the moisture pick-up on the cohesion and strength was studied, and it was found that the strength of the sand was seriously impaired when the dried moulds were exposed to air of a relatively high humidity, reaching a maximum decrease of 50%, 48 hrs. after drying. Similar effects were noted on cores.—J. E. N.

Can Oil-Sand Cores Be Used in the Non-Ferrous Metal Foundry? — (*Giesserei-Praxis*, 1936, 57, (13/14), 147-148).—The use of oil-sand cores in the iron foundry gives clean castings, but they are not yet extensively used in the non-ferrous metal foundry. The reasons for this are either: (1) an unrefined core oil is used; (2) the core is dried at the wrong temperature; (3) an oil core is used where it is quite inapplicable, or (4) a poor core-sand, not properly prepared, is used. It is shown how, by attention to these points, oil-sand cores can be used with advantage in the non-ferrous metal foundry.

—J. H. W.

†Present Status of Foundry Sand Investigation and Control in America. William G. Reichert (*Congrès internat. Mines Mét. Géol., Section de Métallurgie*, 1935, 2, 239-252; also *Rev. Mét.*, 1936, 33, (9), 529-542; and (partly abridged) *Bull. Assoc. Tech. Fond.*, 1936, 10, (8), 297-315).—A complete review of all the physical, chemical, and mechanical tests on moulding sands, and their correlation with the behaviour of the sands in use.

—J. E. N.

Contribution to the Standardization of Sand Testing Methods. F. Boussard (*Fonderie Belge*, 1936, 450; *Bull. B.C.I.R.A.*, 1936, 4, 412).—B. compares the various methods employed for obtaining a mechanical analysis of moulding sand. Of the elutriators, the "Crook" and "Boswell" are the most convenient, and can be arranged to give full and accurate results, but elutriation is slow and the time required for the analysis is excessive. Sieving methods are useless unless the clay is first removed from the sand, when they can be used to obtain results of sufficient accuracy in a short time.

Shaking the sand in alkaline water in the cold is insufficient to remove the clay from the sand grains in less than 2 hrs., and the mixture of water and sand should be boiled. Separation of the clay emulsion by siphon is tedious and necessitates the continued attention of the operator for 2 hrs. B. finally decides that the most convenient procedure is: (1) to separate clay from sand by boiling with slightly alkaline water; (2) to remove clay in a simplified form of elutriator, which he describes, and which is easy to make, requires little attention, and is sufficiently accurate for practical purposes; (3) to grade the sand by sieving. The method is claimed to combine rapidity, convenience, and accuracy.—S. G.

The Application of Science to the Control of Foundry Sands. H. H. Shepherd (*Found. Trade J.*, 1936, 55, (1054), 333-337).—Read at a Joint Meeting of the London and Birmingham Branches of the Institute of British Foundrymen. The need for maintaining scientific control of moulding sands, particularly in mechanized foundries, is stressed. Acceptance and control tests are briefly described, and the results of a number of screening tests are compared. The suitability of the various sands for specific purposes is indicated, and the influence of silt on permeability and mechanical properties is shown to be important. Synthetic sands require very strict control to yield the best results.—J. E. N.

Reclaim and Prepare Sand. Lester B. Knight, Jr. (*Bull. Assoc. Tech. Fond.*, 1936, 10, (5), 183-194; and *Foundry*, 1936, 64, (10), 26-27, 80).—A.F.A. Exchange Paper. The paper describes the equipment necessary for reclaiming and reconditioning foundry sands, which should provide for cleaning and screening to remove metallic and other refuse, re-bonding the used sand with the minimum of new sand or bond and moisture, and properly aerating the sand after milling.—J. E. N.

Applying Technical Control to Foundry Sand. Fred L. Weaver (*Iron Age*, 1936, 138, (14), 36-37).—Discusses the various ways in which sound technical advice can assist both large and small foundries.—J. H. W.

***The Constitution of Bond Clays and Its Influence on Bonding Properties.** R. E. Grim, R. H. Bray, and W. F. Bradley (*Trans. Amer. Found. Assoc.*, 1936, 44, 211-227; discussion, 228).—An investigation of the fundamental causes for the difference in bonding properties possessed by different clays shows that it is possible to predict with considerable accuracy the bonding properties of a given clay from its mineral composition as determined by a petrographic analysis. Considerable importance is attributed to "base-exchange" capacity, which has a marked influence on bonding strength. The physical properties of clay vary depending on whether sodium, calcium, hydrogen, or some other cation is present as the exchangeable cation. The two clay minerals having highest base-exchange are Beidellite ($\text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2 \cdot x\text{H}_2\text{O}$) and Montmorillonite ($\text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O}$), whilst Kaolinite ($\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$) and the other clay minerals have low or no base exchange capacity. The minerals examined included one natural bonded moulding sand, 3 bond clays widely used in preparing synthetic moulding sands, and 5 clays not used as moulding sand bonds. Petrographic and chemical analyses, green compression strength, permeability and base exchange capacity were determined for all.—J. E. N.

Sand Research. — (*Found. Trade J.*, 1936, 55, (1041), 87-88; (1043), 123).—Discussion on a paper by F. Hudson on "Composition and Its Effect on the Properties of Mould and Core-Sand Mixtures at Elevated Temperatures" (see *Met. Abs.*, this vol., p. 319).—J. E. N.

Moulding Sand in the Aluminium Foundry. — (*Giesserei-Praxis*, 1936, 57, (15/16), 165-166).—Describes the qualities required by moulding sand for aluminium castings, and tabulates the constitution, grain-size and

distribution, gas permeability, and shear strength of commonly used German moulding sands.—J. H. W.

†**Important Causes of Waste in the Heavy Metal Industry.** M. Schied (*Giesserei-Praxis*, 1936, 57, 41/42), 457-464).—Read before the Gesamtverbandes deutsche Metallgiessereien. Discusses the properties of various sands used in moulds for the casting of the heavy metals, the make-up of foundry sands, the right and wrong way of using deoxidizers, the design of crucibles to hold back slag, and overheating the metal.—J. H. W.

Modern Moulding Machines and Their Use. H. Kalpers (*Giesserei-Praxis*, 1936, 57, (9/10), 89-114; (13/14), 140-143).—A general and comprehensive survey of the development of moulding machines, both hand- and mechanically-operated. It is claimed that although the review may not be complete, it indicates the lines on which further development of existing machines may take place.—J. H. W.

A New Type of Jar-Ramming Moulding Machine. — (*Found. Trade J.*, 1936, 55, (1040), 61).—Describes and illustrates a new machine introduced by J. R. Molineux.—S. G.

Foundry Machines. U. Lohse (*Eng. Progress*, 1936, 17, (1), 19-23).—An illustrated description of new foundry machinery includes dressing machines for moulding material, sand mills, moulding machines, core moulding machinery, and cleaning drums.—P. M. C. R.

Foundry Mechanization. George E. France (*Found. Trade J.*, 1936, 54, (1012), 33).—A brief review of developments during the past 5 years.—S. G.

Accidents in the Non-Ferrous Metal and Iron Foundry Are Avoidable. A. Schulze (*Giesserei-Praxis*, 1936, 57, (11/12), 124-128; (13/14), 148-150).—Describes commonly occurring and possible accidents in the foundry and the precautions to be taken to prevent them.—J. H. W.

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

(Continued from p. 473.)

***Researches on the Recovery of Zinc from the Flue Dust of Iron Blast Furnaces.** Otto Johannsen (*Angew. Chem.*, 1936, 49, (29), 478-480).—The dust is leached with water to remove potash, then with ammoniacal ammonium carbonate solution to extract the zinc. The filtered solution is boiled to recover the solvent and precipitate zinc carbonate, which is roasted to oxide from which the metal is recovered by carbon reduction or electrolysis after dissolution in sulphuric acid.—A. R. P.

On the Working-Up of Nickel Scrap. R. Thews (*Metall-Woche*, 1936, (24), 469-471).—Practical hints on preliminary cleaning, melting, refining, deoxidizing, and casting.—A. R. P.

A Suggested Method for Preparing Deliquescent Tin Dross Samples. J. B. Kasey (*Met. Ind. (N. Y.)*, 1936, 34, (9), 338).—S. G.

XV.—FURNACES AND FUELS

(Continued from pp. 473-474.)

Controlled Furnace Atmospheres. E. O. Mattocks (*Metal Progress*, 1936, 30, (4), 27-34, 46).—An illustrated summary of recent developments in the production and control of furnace atmospheres. Special emphasis is laid on sampling, and a water-cooled quartz sampling tube is described.

—P. M. C. R.

Radiation Reaction at Any Point in a Furnace Cavity. W. J. Wohlenberg (*Indust. and Eng. Chem.*, 1936, 28, (6), 698-703).—A solution of the dynamical processes occurring in the furnace cavity requires evaluation of the radiation

reaction with respect to its net effect at each of several classes of local, or point, zones within the cavity. This involves an extension of the idea of the radiant mean value with respect to the point under observation, of conditions affecting the net radiant exchange between the point and the enclosure, including its contents. The classes of required local reference zones are defined, and expressions representing the net exchange by radiation between each of these zones and its surroundings are included. General forms of the expressions apply to any cavity whatever for conditions stated. Special forms are included which apply to gas, grate, or pulverized-coal fired cavities.—F. J.

Temperature in Industrial Furnaces. Interpretation and Use to Measure Radiant Heat Flux. H. C. Hottel, F. W. Meyer, and I. Stewart (*Indust. and Eng. Chem.*, 1936, 28, (6), 708–710).—The significance of temperature measurements in industrial furnaces is discussed. Except in making heat balances, the true gas temperature has less utility than the uncorrected reading ordinarily obtained with a protected couple; the latter measures the rate at which heat would be transferred if the couple were replaced by a surface at the temperature of the "heat sink" (surface of charge). An instrument consisting of a pair of oriented thermocouples is shown to be capable of measuring the actual rate of heat-flow across any plane in a furnace. Under the testing conditions the average error in 8 tests was 4%. Its application to a study of uniformity of heat distribution in furnaces is discussed.—F. J.

An Economical Crucible Furnace for Metal Melting. E. Fr. Russ (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, (7/8), 199–201).—A furnace in which the contents can be heated to 1000° C. in the crucible, and which is said to have a long life. The crucible rests on a platform that can be raised by means of a foot pedal when ready for pouring. The temperature may be automatically regulated. Data from various trials are given.—W. A. C. N.

Second Thoughts About [Brass] Foundry Furnaces. M. G. Corson (*Met. Ind. (N.Y.)*, 1936, 34, (4), 131–132).—Briefly discusses the advantages and disadvantages of the various types of brass foundry furnaces.—S. G.

Views on the Construction of Smelting Furnaces for White Metal and White Metal Residues. Edmund R. Thews (*Metall-Woche*, 1936, (11), 201–203).—
—L. A. O.

Tendencies in Development of Resistance Furnace Construction. K. Scherzer (*Congrès Internat. Appl. Électrocalorifiques (Preprint)*, 1936, 12 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—[In German.] Changes in furnace design are discussed, and applications to melting and heat-treatment of light metals are referred to.—S. G.

High-Frequency Induction Furnaces. N. A. Halbertsma (*Congrès Internat. Appl. Électrocalorifiques (Preprint)*, 1936, 7 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—[In English.] In addition to a general discussion, H. gives a description of the high-frequency melting plant at the Philips Lamp Works, Eindhoven, Holland, in which high-frequency energy is supplied by a 250 kw. transmitting valve.—S. G.

Applications of the Electric Radiation Furnace. — Etienne (*Congrès Internat. Appl. Électrocalorifiques (Preprint)*, 1936, 12 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—[In French.] Describes a radiation furnace consisting of a cylindrical furnace space in the long axis of which a radiating element of graphite is placed. Various advantages are claimed. It is possible to work in special atmospheres or *in vacuo*. Applications include melting of copper alloys, aluminium alloys, and low melting point metals, e.g. zinc, magnesium, &c. For a description in English, see H. George, *Met. Abs.*, 1935, 2, 482.—S. G.

Recent Improvements in Electric Furnaces with Cross Channels. Jean Kuntziger (*Congrès Internat. Mines Mét. Géol., Section de Métallurgie*, 1936, 2, 15–17; and *Rev. Mét.*, 1936, 33, (4), 244–246).—[In French.] The construc-

tion of molten tin heat-treatment baths, heated by the passage of an electric current supplied from carbon electrodes, and utilizing thermo-siphon effects to secure uniformity of temperature, is outlined.—J. C. C.

Electrically Heated Industrial Furnaces. R. Boye (*Drop Forger*, 1936, 15, (4), 299-316, 318, 320).—From *Eng. Progress*, 1935, 16, (11), 265-272; see *Met. Abs.*, this vol., p. 416.—S. G.

Electric Furnaces with Protecting Atmospheres. G. Tamele (*Congrès Internat. Appl. Electrocalorifiques (Preprint)*, 1936, 14 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—[In German.] A general survey of present knowledge, with an account of the protective gases used; the references are to the treatment of ferrous materials.—S. G.

Improvement (Equalization) of Heating in Electric Furnaces. G. Simon (*Congrès Internat. Appl. Electrocalorifiques (Preprint)*, 1936, 13 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—[In German.] A discussion of furnaces with air circulation, salt-bath furnaces, and furnaces with moving load, band and chain furnaces, puller and pusher gear furnaces, &c.—S. G.

Electric Furnace for the Continuous Bright-Annealing of Copper Strip. O. Junker (*Metallwirtschaft*, 1936, 15, (3), 71-72).—Uniform annealing conditions are secured by passing copper strip through a bright-annealing furnace with a water-seal at each end: the furnace atmosphere is saturated with steam under somewhat increased pressure, and any traces of oxygen are reduced by the traces of lubricant on the sheet. Two strips are treated simultaneously, with separate control gear. The complete installation and some structural details are illustrated.—P. M. C. R.

Electric Furnace Fans. G. B. Lamb (*Elect. Rev.*, 1936, 119, (3070), 403-404).—The design of fans for low-temperature heat-treatment furnaces which employ forced-air circulation is briefly discussed. In large horizontal furnaces, the number and diameter of fans should, generally speaking, be chosen so that maximum driving power is required, and alternate fans should be rotated in opposite directions.—J. C. C.

The Use of Liquid Fuels in Industrial Furnaces. Heinr. Mantel (*Metall-Woche*, 1936, (13), 241-242).—L. A. O.

Pulverized Fuel in the Metallurgical Industry. J. H. Mahler (*Proc. S. Wales Inst. Eng.*, 1935, 51, 79-104, 127-138; and (summary) *Mech. World*, 1935, 97, 585-586).—S. G.

XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 474-475.)

Foundry Refractories. John D. Sullivan (*Canad. Chem. and Met.*, 1936, 20, (9), 285-286, 288).—Discusses modern refractories for lining steel furnaces of various types and for use in indirect arc, high-frequency induction, and heat-treatment furnaces. High-alumina fireclay bricks or rammed mullite hearths are recommended for melting copper and its alloys.—A. R. P.

Acid and Basic Bottoms of Copper-Refining Furnaces. E. R. Thews (*J. Four élect.*, 1936, 45, (3), 99).—See *Met. Abs.*, 1935, 2, 309.—J. E. N.

Refractories: Recent Types, Uses, and Unit Costs. O. L. Day (*Metal Progress*, 1936, 30, (4), 59-63, 72, 82).—The preparation, properties, and special applications of fireclay, high alumina, silica, and basic refractories (magnesite, chrome, and dolomite) are reviewed.—P. M. C. R.

Modern Furnace Applications of Refractories and Insulation.—III. J. L. Spence and J. W. Craig (*Iron Steel Canada*, 1936, 19, (3), 12-16).—See also *Met. Abs.*, this vol., pp. 274, 321. Describes applications of insulation to modern metallurgical furnaces, both ferrous and non-ferrous, and compares cost of installation with savings in fuel economy and improved working efficiency.—J. E. N.

Refractories and Their Applications. W. F. Rochow (*Trans. Amer. Inst. Chem. Eng.*, 1934–1935, 31, 228–248).—S. G.

The Destruction of Refractory Furnace Bricks by Softening and Fusion. E. T. Richards (*Feuerungstechnik*, 1936, 24, (5), 73–77).—The natural softening and fusion temperatures of a number of furnace refractories are tabulated. In practice, failure may occur at considerably lower temperatures on account either of mechanical stresses due to furnace design, especially of the arch, or of exposure to furnace gases, metallic vapours, or dust of a type capable of fluxing with the material of the bricks. Damage can be minimized by: modification in design; careful construction and finish; or provision of a protective coating on the bricks, e.g. by immersion in an emulsion of alumina.—P. R.

***Determination of Mechanical Properties of Refractory Materials at High Temperatures.** B. J. Pines and E. I. Ter-Mikaeljanz (*Ogneupori (Refractories)*, 1936, (4), 181–187).—[In Russian.] A simple method and apparatus are described for measuring the mechanical properties of highly refractory materials at temperatures up to 1700° C. using a Carborundum-carbon thermocouple. Even in such a heterogeneous material as Dinas brick, the mechanical characteristics are regular when small specimens (1 cm. cubes) are used. Data obtained for Magnesite, Dinas, Dunite, and Carborundum indicate that usually the softening temperature under load corresponds not to the beginning of, but to a far advanced "flow" of the material. The plasticity characteristics of refractory materials at high temperatures show that Dunite suffers a reduction of relative plasticity with increase of temperature in contrast to Dinas brick.—N. A.

***Young's Modulus of Elasticity, Strength, and Extensibility of Refractories in Tension.** R. A. Heindl and L. E. Mong (*J. Research Nat. Bur. Stand.*, 1936, 17, (3), 463–482; and *Research Paper No. 923*).—Young's modulus of elasticity, strength, and extensibility were determined at ordinary temperatures on the following materials in tension: 16 brands of fire-clay brick with a wide range of silica content, representing the stiff mud, dry-press, and hand-made methods of forming; one brand each of silica brick, chrome, forsterite, 60% alumina, 80% alumina, and of mullite. A comparison is made of the tensile properties of specimens obtained parallel to the 9 in. dimension with those parallel to the 4½ in. dimension. The effects of methods in the manufacture by the dry-press process were briefly studied.—S. G.

Heat-Resistant Magnesite. Z. J. Tabakov and V. V. Belovodskiy (*Ogneupori (Refractories)*, 1936, (5), 295–297).—[In Russian.] Magnesite brick manufactured by the "Magnesite Works" softens at 2000° C., deforms under load at 1460°–1520° C., and has a mechanical strength of 450–500 kg./cm.², with a mean thermal stability of 25–30.—N. A.

Heat Insulation for Furnaces and Kilns. — (*Fuel Economist*, 1936, 11, (130), 394–396).—An account is given of Insulite and Amberlite, two proprietary refractories consisting largely of diatomaceous earth (a natural deposit of porous silica having a cellular structure).—P. M. C. R.

Diatoms and Insulating Materials.—I–II. A. B. Cummings (*Heat-Treat. and Forging*, 1936, 22, (3), 141–143; (4), 199–201).—(I.—) The origin and occurrence of diatomaceous earths are discussed. (II.—) Some of the applications of diatomaceous earths in the engineering industries are briefly described.—J. E. N.

XVII.—HEAT-TREATMENT

(Continued from pp. 321–322.)

Salt-Baths. C. Albrecht (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, (5/6), 140–144).—The method of heating these baths must be chosen in relation to the temperature to be maintained, the nature of the bath and, to a

certain extent, the character of the material to be heated. Baths for the following 3 ranges of temperature are considered: (1) 140°–580° C.; (2) 600°–950° C., for annealing, hardening, &c.; (3) 1000°–1350° C. for hardening.

—W. A. C. N.

***Investigation of the Effect of Duration of Heat-Treatment on Aluminium Alloys.** I. E. Tutov (*Metallurg (Metallurgist)*, 1936, (6), 83–91).—[In Russian.] The effects of annealing cast alloys was studied on specimens of "Y" alloy cast at (I) 720°, (II) 760°, and (III) 820° C. The specimens, which had a grain-size of 2.5 mm., 5 mm., and 7.5 mm., respectively, were annealed for 0, 25, 50, 70, 100, 140, and 300 minutes at 500° C., quenched in oil, and normalized at 225° C. Determinations of the tensile strength, elongation, and Brinell hardness showed that specimens (I) required no annealing to obtain maximum mechanical properties, whereas (II) required 25 minutes and (III) 50 minutes, the annealing time being, therefore, directly proportional to the grain-size. Similar tests on Duralumin showed that annealing the castings for 1 hr. at 500° C. prior to quenching produces a satisfactory metal for forging. Two series of Duralumin rods forged at 460°–360° C. to 28.5 and 60% reduction, respectively, were quenched at 500° C. after annealing for 0–120 minutes, and their tensile strengths determined; the best mechanical properties were obtained after a 15 minutes' anneal. Ageing tests on "Y" alloys at 150°, 210°, 225°, and 250° C. showed that maximum mechanical properties were obtained in 1 hr. at 250° C., but for practical purposes 2–3 hrs. at 225°–230° C. is recommended. The results obtained were verified in practice in the manufacture of pistons.—N. A.

Annealing Aluminium and Its Alloys. — (*Rev. Aluminium*, 1936, 13, (80), 174–177).—The function and the different phases of annealing and the factors influencing it are discussed. The annealing of stacked sheet and rolled strip, of brazed and of stamped and embossed aluminium articles and the annealing of aluminium alloys are briefly described.—J. H. W.

The Heat-Treatment of Light Metal Castings. — (*Giesserei-Praxis*, 1936, 57, (15/16), 175–178).—Describes furnaces suitable for the heat-treatment of light metal castings and the methods of carrying out these operations.—J. H. W.

***Influence of the Process Temperature Regime in Tempering Duralumin-Type Alloys.** A. I. Gornostaeva (*Metallurg (Metallurgist)*, 1936, (5), 95–104).—[In Russian.] The best mechanical properties of Duralumin with copper 4.4–4.8, magnesium 0.81–0.98, and manganese 0.72–0.90% are obtained after quenching from 500° to 506° C. Ageing in oil or hot water reduces the mechanical properties slightly compared with annealing in cold water, but considerably reduces the resistance to corrosion. The time which elapses between withdrawal from the furnace and immersion in the quenching medium strongly affects the increase in mechanical properties in ageing. The results are given in graphs and tables.—N. A.

***The Age-Hardening of Duralumin at Various Temperatures.** (Teed.) See p. 504.

Bright-Annealing of Copper and Brass Wires. W. Metzdorf (*Metall-Woche*, 1936, (7), 121–122).—A brief description of modern methods.—A. R. P.

***Influence of Heat-Treatment on Fatigue and Corrosion-Resistance of Aluminium Bronze.** (Musatti and Dainelli.) See p. 509.

***Research on the Hardness of Aluminium Bronzes after Ageing. I.—Binary Bronzes of the 90 : 10 Type.** (Panseri.) See p. 509.

***Bi-Metal Annealing in Ammonia Gas.** A. V. Smirnov and L. V. Beloruchev (*Metallurg (Metallurgist)*, 1936, (9), 79–80).—[In Russian.] Annealing of Tombak bimetal in moist ammonia at 600° C. gave a perfectly satisfactory surface appearance and degree of softness without producing hydrogen embrittlement.—N. A.

*Contribution to the Study of the Effect of Annealing on the Structure, Brinell Hardness (H_B), Tensile Strength (R_t), and Elongation (A_{10}) of Cold-Rolled 67 : 33 Brass. (Loskiewicz, *et al.*) See p. 512.

XVIII.—WORKING

(Continued from pp. 475-477.)

Advances in the Knowledge and Practice of Plastic Forming Processes. E. Siebel (*Metallwirtschaft*, 1936, 15, (12), 277-279).—An illustrated summary is given of recent processes and plant for oblique rolling, radial rolling, and "needle" rolling (involving the use of hyperbolic rolls), and for the production of thin-walled pieces; in this connection a method of gauging the action of eccentric rolls is briefly described.—P. M. C. R.

The Plastic Working of Metals. Developments in Theory and Practice. [E. Siebel] (*Met. Ind. (Lond.)*, 1936, 49, (19), 458-460).—Abridged translation of a series of articles in *Metallwirtschaft*; see *Met. Abs.*, 1935, 2, 629, 723; this vol., p. 322.—J. E. N.

†**The Flow of Alloys in Connection with Maxwell's Relaxation Theory.** S. I. Gubkin (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Anal. Phys.-Chim.)*, 1936, 8, 291-304).—[In Russian.] It has been shown experimentally that alloys and metals (aluminium and its alloys, copper and its alloys) can vary their resistance to a change of shape during the process of deformation. If an alloy is subjected to a stress beyond the elastic range, the stress will decrease with time, finally reaching a limit. Only in certain cases (*e.g.* Duralumin at 500° C.) can the rate of decrease of stress be represented exponentially according to Maxwell's law of relaxation. In order to be able to study the mechanism of deformation and the conditions determining the brittle or plastic condition of a material, it is necessary to establish a law governing the decrease of stress with time and also to determine the relation between all the factors governing the decrease of stress in the solid material. The flow method suggested by N. S. Kurnakow for studying the relaxation of a solid material may be used as a method of physico-chemical analysis. The method is, however, not entirely free from sources of error (*e.g.* friction). For a detailed study of the relaxation phenomenon the method of investigation suggested by Karmann in 1913 should be adopted. As a first approximation a model is suggested as an explanation of the mechanism of relaxation, which involves only the rate of inter- and intro-crystalline slip. In addition to the rate of slipping, the resistance to deformation is also influenced by phenomena connected with the thermal agitation of atoms (recovery), as well as by a change, during deformation, of the orientation of the grains and of their size, owing to recrystallization.—N. A.

The Importance of Friction in Rolling, and Its Influence on the Design of Machinery for Rolling Sheet and Strip. Theodor Dahl (*Kalt-Walz-Welt*, 1936, (5), 33-38; (6), 41-46).—A theoretical study of rolling conditions shows that the frictional resistance between rolls and material is essential to the process, which is contrasted with that of drawing. Further analyses show the influence of varying degrees of friction under stated conditions on resistance to flow and thus on the work done in effecting deformation; excessive friction prevents uniform distribution of stresses, and the product is irregular in thickness and has a poor surface finish. Diagrams show the influence of surface roughness of the rolls on the form and dimensions of the pieces. In practice, there is an increasing tendency to use a succession of light rolls, as in the Rohn and the Steckel assemblies, diagrams of which are reproduced.

—P. M. C. R.

***On the Determination of the Principal Stresses of Malleable Materials under the Plane-Rolling Process.** Hiroshi Yamanouti (*J. Soc. Mech. Eng. Japan*, 1934, 37, (211), 783-793).—[In Japanese.] In an experiment with very pure malleable metals on a plane rolling-mill, the plastic deformation at the extremity of the blank at each position on passing through the rolls was observed and, regarding the contact surface of the material and the rolls as the principal plane, the principal equations were determined. The change in width of the blank after rolling being very small, Y. investigated the plane stresses on the vertical section of the blank through the rolls. With the data thus obtained the stress equations were solved and the distribution of the principal stresses in the extremity of the blank at the moment of passing through the rolls determined. The vertical pressure was measured by means of quartz disks used for piezo-electricity and a string electrometer. The deflection of the electrometer was photographed on a film rotating at constant speed. The test-specimens were of lead, and were machine finished to about $5 \times 20 \times 800$ mm. The stress intensity of the contact surface is not uniformly constant and does not maintain minimum plastic stress intensity. Although the maximum stress intensity is sometimes about twice the mean stress intensity, the distribution on the other principal plane, which is normal to the contact surface, is nearly equal. Y. theoretically determined the nett work necessary for the rolling deformation of a material—a fundamental feature in determining the rolling power—and then calculated the power necessary for the rolling process. These results are claimed to be nearly equal to the actually measured values.—AUTHOR.

***Influence of Specific Pressure in Rolling on the Friction Coefficient.** Ig. M. Pavlov and N. N. Get (*Metallurg (Metallurgist)*, 1936, (7), 47-54).—[In Russian.] From determinations of the vertical pressure of the metal on the roll and the corresponding frictional force the coeff. of friction and its relation to the specific pressure can be calculated. In cold-rolling with dry or lubricated quenched cast-iron rolls this relation is similar for aluminium, copper, brass, and iron; in all cases an increase in the specific pressure (and Brinell hardness) being accompanied by a decrease in the coeff. of friction which is at first very rapid and then gradually decreases. With an increase in the specific pressure from 2 to 40 kg./mm.², the coeff. of friction is reduced by 40-50%, most of this reduction taking place within the pressure range 2-10 kg./mm.².—N. A.

***Pitting Due to Rolling Contact.** Stewart Way (*J. Applied Mechanics*, 1935, 2, (2), A49-58; discussion, (3), A110-114).—Tests carried out with rolls of different materials, with different lubricants, and with various loads, show that (1) a lubricant must be present if pitting is to take place; (2) if the lubricant is of a viscosity above a certain critical value which depends on the load, pitting can be prevented; (3) the nature of the surface finish on the rolls greatly influences the tendency to pit, pitting being prevented on a highly polished surface and accelerated on a rough machine surface; (4) nitrided rolls will not pit under conditions that would result in severe pitting of quenched and tempered mild steel rolls; and (5) pits are smaller on harder surfaces in general. It is also suggested that oil penetration of very small surface cracks with a certain initial direction is the reason for the growth of these cracks until a particle is separated from the main body of material leaving a pit.

—J. W. D.

Direct Rolled Aluminium. T. W. Lippert (*Iron Age*, 1936, 138, (16), 26-30, 33, 46).—A direct rolling mill consists essentially of two horizontal rolls, one of which is equipped with a flange, so that a shallow pool of molten metal can be supported between them. Some metal is constantly frozen on each roll, and, as the rolls rotate, this frozen metal is pressed together and emerges as a homogeneous and smooth strip. For direct rolling aluminium,

it is necessary to coat the steel rolls with aluminium. As the metal leaves the mill, it has a tensile strength of 13,000–15,000 lb./in.², as compared with 7000 lb./in.² for ordinary cast aluminium, and 9000–10,000 lb./in.² for ordinary full-annealed hot-rolled aluminium. Aluminium is used for coating steel by hot-dipping, and effects a great saving in cost over tinplate.—J. H. W.

Working of Light Metals to Semi-Finished Products. P. Scherber (*Metall-Woche*, 1936, (9), 161–163).—A review of modern methods of rolling aluminium alloys to sheet, drawing them into wires and tubes, and forming them into screws and rivets.—A. K. P.

***The Rolling and Stamping of Silumin-Type Alloys (Iron up to 2%).** V. O. Gagen-Torn and N. N. Ivanov-Skoblikov (*Metallurg (Metallurgist)*, 1936, (9), 73–78).—[In Russian.] Aluminium alloys with up to 8% silicon and 2% iron present no difficulties in hot- or cold-rolling to sheet and require no vital modifications in the normal technique adopted for commercial aluminium. The best annealing temperature is 300° C. The tensile strength, elongation, and Erichsen value (diagrams given) show that the alloys should deep-draw well. Satisfactory domestic utensils have been produced in the alloys without difficulty. Addition of magnesium is objectionable, and a high iron content increases the tendency to corrosion, but considerably improves the durability.—N. A.

Influence of High Degree of Deformation and Annealing Temperature, Preceding Deformation, on the Mechanical Properties of Copper Strip. S. A. Kushakevich (*Metallurg (Metallurgist)*, 1936, (8), 53–62).—[In Russian.] The great ease of deformation of copper by cold-working affords a means of obtaining anisotropic (*i.e.* single-crystal) metal. Maximum anisotropy is obtained by an intermediate anneal at 300°–500° C., and minimum at 700° C. or over. The final annealing temperature has a greater or smaller effect, but never masks the effect of the intermediate treatment. The results obtained are illustrated by diagrams of the changes in mechanical properties.—N. A.

Control of Motor Acceleration in Rolling Mills. H. Strudthoff (*V.D.E. Fachberichte*, 1935, 117–119).—S. G.

A Precision Sheet-Straightening Machine. L. Reichert (*Eng. Progress*, 1936, 17, (3), 58–60).—Hand straightening is a slow process, and fails to achieve the surface finish demanded in high-class work. The simpler straightening machinery, without backing rolls, require great experience in operation, and often produce surface markings, whilst the rolls are of large diameter. In machines provided with backing rolls, the diameters are greatly reduced, and the distribution of material is hence much more uniform. Recently developed machinery is described.—P. M. C. R.

Bending of Sheet and Strip of Aluminium and Its Alloys. — (*Rev. Aluminium*, 1936, 13, (79), 129–144).—Describes the effect of the thickness of the piece, the rate of bending, the nature of the machine, rolling, and the nature of the metal on the bending of sheet and strip of pure aluminium and the principal aluminium forging alloys.—J. H. W.

The Manufacture of Apparatus from Medium and Heavy Nickel-Plated Steel Sheet. B. Trautmann (*Werkstatt u. Betrieb*, 1936, 69, (19/20), 253–256).—The material recommended is steel sheet on to which thinner nickel sheet has been hot-rolled. The advantages and special applications of this material are described, and an account is given of the production of rectangular vessels.—P. M. C. R.

Interesting and Important [Information] on Nickel and Copper-Clad Sheets. J. F. Kesper (*Apparatebau*, 1935, 47, 247).—Describes the properties and uses of sheets clad with nickel and copper by rolling.—L. A. O.

***On the Characteristics of Extension in Hot-Pressing of Non-Ferrous Metals.** V. V. Zholobov (*Zvoinye Metally (Non-Ferrous Metals)*, 1936, (4), 96–106).—[In Russian.] The irregularities in the longitudinal stretching of ingots

when extruded into a rod is shown by the co-ordinate net method. The difference in the behaviour of copper and brass is explained as follows: brass, which has a lower heat conductivity, cools by contact with the cold sides of the mould and acquires different plastic properties in the inside and the outside of the ingot resulting in a non-uniform longitudinal microstructure of the rods. —N. A.

Non-Ferrous Metal Tubes. W. L. Govier (*Met. Ind. (Lond.)*, 1936, **49**, (18), 431-436; (19), 461-465; discussion, 465-466; and (summary) *Metallurgia*, 1936, **15**, (85), 23-24).—Read before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, &c.). The manufacturing processes for seamless tubes of copper-rich alloys are described. Casting, hot-punching, rotary piercing, extrusion, tube reducing, cold-drawing, and annealing are discussed in detail, from the point of view of the product rather than of the plant, and the effects of the various forms of work on the microstructure are compared. Tube reducing is dealt with at some length and the advantages of this process are detailed. After describing some applications of tubes, G. suggests that future developments will be along the lines of improving and extending the use of rotary piercers, and tube reducing plant, with the declining use of the drawbench. The discussion raised questions relating to the steels used for mandrels, the limits of accuracy of the processes described, die lubricants, and comparison with steel tube practice.—J. E. N.

***Investigation of Thin-Walled Duralumin Tubes.** I. G. Shulgin (*Vestnik Inzhenerov i Technikov (Messenger of Engineers and Technologists)*, 1936, (5), 305-308).—[In Russian.] The tubes had a wall-thickness: diameter ratio of over 1:40. Tensile tests showed that high mechanical properties (tensile strength 43 kg./mm.² and elongation 20%) are obtained in the absence of surface defects. Longitudinal bending tests showed that thin-walled tubes were more economical than thick-walled. Transverse bending tests showed the disadvantage of using short tube lengths. The data are given in tabular and diagram form.—N. A.

Removing Dents from Non-Ferrous Tubing. A. E. Peters (*Machinist (Eur. Edn.)*, 1936, **80**, (10), 170E).—For removing dents in aluminium, brass, copper, and Duralumin tubing of small diameter the damaged part is annealed and a number of highly polished steel balls, equal in diameter to the undamaged bore, are driven through the tube. For fairly large diameter tubing, an iron or steel plug is inserted to serve as an anvil for hammering out the bulge. For bad bulges, a little metal is cut away from the centre of the bulge and the remainder hammered back to shape, the cut being welded with an oxy-acetylene flame.—J. H. W.

Bending Tubes and Profiles of Aluminium and Its Alloys. — (*Rev. Aluminium*, 1936, **13**, (78), 81-84).—An article founded on a book by Hermann and Zurbrugg, "Die Bearbeitung des Aluminiums" (see *Met. Abs.*, 1935, **2**, 194).—J. H. W.

The Manufacture of Tubular Aluminium Articles by Extrusion. O. Kühner (*Eng. Progress*, 1935, **16**, (11), 285-287; and *Met. Ind. (Lond.)*, 1935, **47**, 535-536, 539).—The types of presses used for the extrusion of aluminium tubes, and the advantages of the method compared with drawing processes are briefly discussed. Extrusion may be employed with satisfactory results for collapsible tubes, when the length of the part is a multiple of the diameter and when the bottom is required to be considerably thicker than the wall, particularly when bulges and depressions must be formed in the bottom. —L. A. O.

Manufacture of Tubes from High-Strength Light Alloys. M. I. Kovarskiy (*Metallurg (Metallurgist)*, 1936, (6), 96-101).—[In Russian.] For the manufacture of tubes an alloy of aluminium with copper 4.6-6.0, manganese

0.8-1.2, magnesium 0.65-1.5, silicon up to 0.7, iron up to 0.5, and titanium up to 0.2% is recommended. The alloy is extruded at 440°-460° C. and quenched at 505° ± 3° C. When the copper exceeds 5.2% and the magnesium 1% the quenching temperature must be 502° ± 2° C.—N. A.

Manufacture of Copper Tubing. Otto Z. Klopsch (*Iron Age*, 1935, 136, (25), 24-27, 86).—See also *Met. Abs.*, this vol., pp. 280, 418. Paper read before the Non-Ferrous Section of the Detroit Chapter of the American Society for Metals. Describes the manufacture of copper tubing from cast billets extruded in a vertical press, and then drawn to specified size and annealed. The copper, of 99.9% purity, is cast in tilting furnaces having carefully controlled oxidation, and phosphor-copper is added as a deoxidizer in such a quantity that approximately 0.02% phosphorus remains in the metal. The details of extrusion are fully described.—J. H. W.

The Manufacture of Condenser Tubes. — (*Met. Ind. (Lond.)*, 1936, 49, (1), 3-5, 18).—An account of a modern plant for the production of condenser tubes. Special descriptions are given of a vertical extrusion press designed for both the direct and indirect processes, the reheating furnace, and the cutting and sharpening machinery.—P. M. C. R.

Extrusion of Nickel and Its Alloys. W. R. Barclay (*Met. Ind. (Lond.)*, 1935, 47, 494-495).—Abstract of an article published by the Centre d'Information du Nickel; see *Met. Abs.*, this vol., p. 322.—J. H. W.

†**Determination of Specific Pressure During the Extrusion of Metals, as a Method of Physico-Chemical Analysis.** V. A. Bobrov (*Izvestia Sektora Fiziko-Khimicheskogo Analiza (Ann. Sect. Anal. Phys.-Chim.)*, 1936, 8, 305-329).—[In Russian.] The curves connecting the variation of specific pressure with composition have different shapes at different temperatures and different specific extrusion pressures. The variation of the curve specific pressure-composition becomes sudden and discontinuous at the temperatures of phase- or allotropic changes. In constructing the specific pressure-composition curves, it is necessary to use the highest possible degrees of deformation in view of the more pronounced changes in the specific pressure under those conditions. The straight line portions of the specific pressure-composition curves correspond to the presence of mechanical mixtures or eutectics, while the curved portions are caused by solid solutions. The specific pressure-degree of deformation curves constitute valuable nomograms in establishing and rationalizing the technology of the process of treatment under pressure.

—N. A.

New Types of Hydraulic Metal-Extrusion Presses. P. Wieghardt (*Eng. Progress*, 1936, 17, (2), 30-31).—A large horizontal metal rod and tube press is illustrated and briefly described. The single-piece frame construction gives simplicity of design and ready accessibility. The die-holder is placed in a frame which can be moved sideways at right angles to the direction of extrusion, and a hydraulic device at one side of the main frame forces out the die and die-holder from their holding frame when the latter has been moved out. A new type of hydraulic drive for a small extrusion press is also described.

—L. A. O.

The More Recent Developments of Hydraulic Extrusion Presses. F. Pachtner (*Metall-Woche*, 1936, (18), 341-342; (19), 361-362).—L. A. O.

The Stripping and Ejection of Drawn Pieces. Ernst Göhre (*Werkstatt u. Betrieb*, 1936, 69, (15/16), 210-213; (19/20), 273-278).—The influence of the form of the mandrel, drawing-ring, and die on the ease of ejection of the pieces, and consequently on their finish, is illustrated by a series of diagrams; improved stripping and ejection gear are briefly described.—P. M. C. R.

Power for Cascade Drawing of Copper. P. M. Mueller (*Met. Ind. (Lond.)*, 1936, 49, (18), 437-438).—Read before the Wire Association (U.S.A.). This paper is an attempt to show how published theoretical data on the wire-

drawing of copper can be applied in practice. Lee Vaughn's equation states that the die-pull is proportional to the area reduced and the average tensile strength, modified by an experience factor F , which covers die friction and the ratio between "resistance to compression" and the more easily determined "tensile strength." The value of the factor F has been determined empirically from test records over several years' shop practice, and curves derived which allow of the calculation of horse power required for any given series of drafts in cascade drawing within an error of 5%.—J. E. N.

The Production and Treatment of Copper Alloy Wire. — (*Canad. Chem. and Met.*, 1936, 20, (6), 200–202).—A review of modern methods of drawing, annealing, pickling, and colouring brass, bronze, and nickel-brass wire.—A. R. P.

How Can the Output of Multiple Fine Wire Drawing Machines of the Earlier Types be Increased? Heinrich Meyer auf der Heyde (*Draht-Welt*, 1936, 29, (18), 279–282; (19), 295–297).—Numerical examples illustrate the increase in output consequent on a decrease in the number of stages and on annealing only once during the drawing process.—P. M. C. R.

Extending the Scope of Wire-Drawing Machinery. Ernst Schröder (*Draht-Welt*, 1936, 29, (8), 115–120; (9), 133–139).—An illustrated survey of recent types of wire-drawing and wire-working machinery includes descriptions of multiple drawing machines, in which the immersion system, incorporating a cooling coil, is increasingly adopted. Gear ratios are high, and both the drawing tension and the number of stages have increased. In one instance the output per 10-hr. day is tabulated for a variety of materials and gauges. Wire fabrics can be produced up to 6.5 ft. in width. Descriptions are given of fabric looms, continuous hot-galvanizing plant, welding machinery, and machines for the stranding and laying of wire rope, and for the production of small parts and of chain.—P. M. C. R.

Novelties in the Wire Industry. Ernst Schröder (*Draht-Welt*, 1936, 29, (30), 443–446).—An illustrated review of recent machinery for the drawing of wire and for the production of small wire parts.—P. M. C. R.

Machine for the Production of Wire Fabric. — (*Draht-Welt*, 1936, 29, (31), 456–459).—An account of a machine which permits direct control of the width of the fabric by means of adjustable cams, and thus obviates stoppages for the interchange of parts. The method of operation is fully described and illustrated.—P. M. C. R.

Stress Reduction in Cast Silumin by Mechanical Working. — (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, 34, (19), 379–381; (20), 399–401; (21), 420–421).—L. A. O.

***Investigations on the Mechanism of Forging.** Anton Pomp and Horst Houben (*Mitt. K.-W. Inst. Eisenforschung*, 1936, 18, (7), 65–87).—Experiments on the forging of lead cylinders of different r/h ratios with a drop hammer of 20–40 kg. in weight gave curves of the type $k_{\text{avg}} = c \cdot f^n$, where k_{avg} is the mean resistance to deformation, f is the degree of reduction, and c and n are constants equal to 4.16 and 0.33, respectively. From this expression the true resistance to deformation k_w is $(n + 1)c \cdot f^n$. Further mathematical relations between the energy losses, distance of drop, and rate of deformation of copper, aluminium, and lead for various r/h ratios have also been deduced from experimental results which are shown in a series of graphs. The energy loss by elastic compression is shown to be approximately a parabolic function of the energy of the hammer blow.—A. R. P.

***Model Experiment Concerning the Mechanism of Forging.** Otowo Hara (*Tetsu-to-Hagane (J. Iron Steel Inst. Japan)*, 1936, 22, (9), 677–688).—[In Japanese.] The mechanism of hydraulic forging and upsetting was investigated by the use of clay ingots. It was found that (1) in general, the inner deformation of the ingot varies according to the width of the anvil and its

penetration, the deformation of centre (Δd) being represented by $\Delta d = a \log L/D + bh/D + c$, where D is the diameter of the ingot, L the width of the anvil, h the depth of penetration, and a , b , and c are constants. (2) In upsetting the inner deformation of the ingot has a transition point at the ratio $D/H = 0.7$, where D and H are diameter and height of the ingot to be upset, respectively.—S. G.

Recent Advances in Pressure-Forming Processes. H. Haake (*Eng. Progress*, 1936, 17, (1), 1-5).—Recent investigations of the mechanism of hot and cold deforming processes in relation to metallic structure have rendered possible marked improvements in plant and practice. An illustrated account, with *bibliography*, is given of developments in the rolling and testing of thin strip, rolling-mill design, the constitution and design of forging hammers, drop-forging methods, cold-pressing, deep-drawing, and the serial manufacture of press tools.—P. M. C. R.

Manufacture of Alloy Stampings. — (*Aircraft Eng.*, 1936, 8, (88), 175).—A brief note, with two illustrations of plant.—H. S.

The Press-Forging of Copper and Brass.—I-II. E. T. Richards (*Metall-Woche*, 1936, (1), 3-4; (2), 21-22).—L. A. O.

The Forging of Brass. Charles M. Rose (*Heat-Treat. and Forging*, 1936, 22, (8), 381-382).—Short account of "hammer forging" and "pressing" of brass as practised in the U.S.A. Small typical pressings are illustrated. —J. E. N.

Magnesium and the Ultra-Light Alloys. Henri Portier (*Technique moderne*, 1936, 28, (9), 313-320).—The article is in two parts: (1) the working of magnesium and its alloys in the solid state, and (2) the strength of the alloys compared with other materials. The first part reviews published information on forging, stamping, rolling, extrusion, pressing, riveting, and machining; and the second explains the principles on which designs should be altered when ultra-light alloys are substituted for other materials. The work of P. and de Fleury is mainly considered in the latter connection and two nomograms are given to illustrate the replacement of a Duralumin construction by one of magnesium alloy. The need for extreme care in the design of joints, particularly between dissimilar materials, is emphasized.—H. W. G. H.

The Manufacture of Food Tins. J. Jacobi (*Eng. Progress*, 1936, 17, (10), 235-238).—The depth of tin coatings for various sizes of container is tabulated. A plan shows the lay-out of a modern manufacturing plant for food tins, and the various processes and certain machine assemblies are described in detail.—P. M. C. R.

Presses for Metallic Materials. Otto Kühner (*Eng. Progress*, 1936, 17, (1), 10-15).—An illustrated review of recent advances in the design and construction of presses. The rigidity of an assembly cannot be judged solely on a basis of weight, and a typical graph illustrates the correlation of the longitudinal spring of the frame and the obliquity of the ways. The "surface expansion" of the blank during drawing is shown graphically in relation to specific plate-holder pressure: the use of rigid blank holders reduces surface expansion and facilitates the advantageous adjustment of drawing stages. New types of eccentric and high-speed presses and toggle drawing presses are described.—P. M. C. R.

Introduction of Pure Nickel Coinage in Japan. Tsuguo Hirose (*Japan Nickel Rev.*, 1936, 4, (2), 291-299).—[In English and Japanese.] The history of nickel is reviewed. Japan circulated its first pure nickel coins in 1933. The melting, casting, and working in the production of these coins are described. A cold-rolling mill was adapted for hot-rolling the ingots of 100 lb. weight, cast from an Ajax-Northrup induction furnace and taken from the mould while hot without any reheating before rolling. The strips were finished by cold-rolling. There was a total of 70% scrap.—R. G.

Powdered Metals. A. B. Everest (*Found. Trade J.*, 1936, **54**, (1027), 329).—Cf. Chaston, *Met. Abs.*, 1935, **2**, 258. Submitted for a short-paper competition of the Institute of British Foundrymen. A very brief review.—S. G.

Spinning Stamped and Embossed Aluminium Articles. J. Bally (*Rev. Aluminium*, 1936, **13**, (80), 164-171).—Discusses the advantages of aluminium for making spun articles, and describes the machines and operations used in spinning the metal.—J. H. W.

Filing Aluminium and Its Alloys. — (*Rev. Aluminium*, 1936, **13**, (80), 228-231).—Aluminium and aluminium alloys are resistant to ordinary filing, as the filings fill up the interstices of the file. Milling files are therefore used, in which the teeth are well spaced and the bottoms rounded. Thus shavings rather than filings are formed by the reamering action of the file and can be easily removed. For finishing, ordinary files can be used. Mechanical filing is done with small tools rotating at up to 22,000 r.p.m. when special steel files of small diameter are used.—J. H. W.

***Metal Cutting. The Formation and Functions of the "Built-Up Edge."** Hans Ernst and M. Martellotti (*Mech. Eng.*, 1935, **57**, (8), 487-498).—S. G.

Sawing Aluminium and Its Alloys. — (*Rev. Aluminium*, 1936, **13**, (83), 331-333).—Describes hand- and mechanical-sawing of aluminium and aluminium alloys, the construction of band and circular saws, and the necessity of good lubrication during sawing.—J. H. W.

The Machining and Grinding of Monel Metal. — (*Aluminium and Non-Ferrous Rev.*, 1936, **1**, (12), 557-560).—From working instructions issued by Henry Wiggin and Co., Ltd., Birmingham. Covers lubricants, turning, drilling, threading, screwing, tapping, milling, grinding, and suitable wheels.—S. G.

Lathe Cutting of Monel Metal. Melvin Matsen (*Iron Age*, 1936, **138**, (11), 34-39).—Discusses the relations, on an experimental basis, between the cutting speed, tool life, and shape and depth of cut and feed in the machining of Monel metal. These tests were part of a larger investigation in the field of metal cutting, and were carried out in co-operation with the American Society of Mechanical Engineers.—J. H. W.

XIX.—CLEANING AND FINISHING

(Continued from pp. 477-478.)

Principles of Solvent Degreasing. M. Marean (*Metal Cleaning and Finishing*, 1936, **8**, (9), 553-558, 590).—The economic and technical aspects of solvent degreasing are discussed.—A. R. P.

Metal Cleaning. F. E. P. Griggs (*Canad. Chem. and Met.*, 1936, **20**, (8), 258, 260).—The operation of alkali cleaners, electrolytic degreasers, and solvent degreasers is outlined.—A. R. P.

Colloidal and Surface Aspects of Metal Cleaning and Finishing. Albert L. Kaye (*Metal Cleaning and Finishing*, 1936, **8**, (1), 9-12, 40; (2), 71-72, 93; (3), 179-182; (6), 311-312).—S. G.

Cleaning and Priming Galvanized Iron and Zinc-Coated Metals. Geo. A. Endom (*Indust. Finishing (U.S.A.)*, 1936, **12**, (12), 14-16).—After thorough cleaning in a suitable alkali cleaner, followed by brushing, rinsing, and drying at 80° C. in clean, dry air, the metal is given a priming coat of zinc chromate thinned with toluene, followed by an outer coat of any of the good commercial synthetic enamels.—A. R. P.

Pickling in Galvanizing Works. Otto Schliephake (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (4), 73-74).—L. A. O.

Monel Metal in Pickling Installations. R. W. Müller (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, **34**, (20), 391-392).—L. A. O.

Sand- and Shot-Blasting. J. H. D. Bradshaw (*Found. Trade J.*, 1936, 54, (1021), 205–208).—Read before the Sheffield Branch of the Institute of British Foundrymen. Discusses applications of the process, systems in general use, sand-blasting without compressed air, output of machines, hardness of abrasives, effect of moisture, wear of nozzles, Norbide nozzles, and metallic *v.* non-metallic abrasives.—S. G.

Airless Sand Blasting. An Interesting New Process. — (*Found. Trade J.*, 1936, 55, (1039), 43).—S. G.

Chevrolet Methods of Finishing Bumpers. An Example of Modern Efficiency. John M. Bonbright (*Metal Cleaning and Finishing*, 1936, 8, (9), 543–547).—Details are given of pickling, cleaning, polishing, and nickel- and chromium-plating processes adopted.—A. R. P.

The Production of Artificial Patina [on Copper]. — (*Metall-Woche*, 1936, (6), 103–104).—L. A. O.

Chemical Colouring of Zinc Goods. H. Krause (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, (7/8), 213–217).—A solution containing 50 grm. of copper sulphate per litre, to which sufficient ammonia has been added to give a clear blue solution, is used for giving a copper finish. A light copper colour is given by adding 80 grm. per litre of acetic acid to the simple copper sulphate solution and then sufficient ammonia to make alkaline. A brown colour is obtained by adding ammonium chloride to the above solutions, dipping the articles, drying, and finally brushing with liquor containing 250 grm. of ammonium chloride and carbonate per litre. A good bath for coloration of zinc is said to be—nickel ammonium sulphate 60 grm. in a litre of water containing ammonium chloride. The polished pieces are dipped, and assume the following colours according to the period of immersion—yellow, brown, purple, blue, blue black. Lustre colours are given with a bath containing copper sulphate 36 grm., tartar 30 grm. in a litre of water to which is added 150 grm. of nitre. The ultimate effect is brown. The deposition of black copper oxide or of molybdenum sesquioxide gives a black colour.—W. A. C. N.

Chemical Colouring of Metals. J. W. Perring (*J. Electrodepositors' Tech. Soc.*, 1936, 11, 75–86).—A simple account of the principles and methods employed in colouring metals. Only the more common finishes are considered.—W. D. J.

Aluminium Name Plates. H. K. Work (*Met. Ind. (N.Y.)*, 1936, 34, (9), 327–329).—Various types of name plates are described together with methods of etching, colouring, and finishing them and colouring them by the Alumilite process.—L. A. O.

Tin Decorating Finishes. H. F. Frank (*Metal Cleaning and Finishing*, 1936, 8, (9), 585–586).—Varnishes, lacquers, and other coatings for decorating tinned containers are described briefly.—A. R. P.

Testing of Organic Metal Finishes. E. A. Zahn (*Metal Cleaning and Finishing*, 1936, 8, (10), 706–709).—Brief descriptions are given of the following tests: heat and light discoloration, resistance to humidity, grease and fruit juice, flexibility and impact tests.—A. R. P.

Measuring Surface Finishes. (Meyers.) See p. 567.

Gloss Investigations Using Reflected Images of a Target Pattern. (Hunter.) See p. 567.

Applications of Mechanical Finishes to Aluminium. R. T. Griebing (*Metal Cleaning and Finishing*, 1936, 8, (9), 615–620, 646).—Methods of producing high lustre, scratch brush, satin, hammered, sand-blast, and burnished finishes on aluminium articles are described.—A. R. P.

Faulty Use of a Band Polisher [on Aluminium]. H. Röhrig and E. Käpernick (*Aluminium*, 1936, 18, (10), 488–489).—In polishing aluminium on an emery band portions of the metal 1–2 mm. in diameter were dragged out and embedded in the band subsequently causing scoring of the metal.

Microscopic examination showed that the surface of the metal had been locally severely overheated with consequent reduction in strength, thus allowing particles of the metal to be torn away. This danger may be avoided by polishing a number of articles alternately in stages.—A. R. P.

The Polishing of Metals. E. J. Dobbs (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (5), 184-186).—See also *Met. Abs.*, this vol., p. 131. Read before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, &c.). Includes report of the discussion.—J. C. C.

Progress in Polishing Room Practice. Fred B. Jacobs (*Metal Cleaning and Finishing*, 1936, 8, (1), 29-30, 44).—S. G.

Buffing and Polishing of Architectural Ornamental Fixtures. R. A. Huhn (*Metal Cleaning and Finishing*, 1936, 8, (6), 347-348).—S. G.

Principles Governing the Selection of Polishing Wheels. Robert T. Kent (*Metal Cleaning and Finishing*, 1936, 8, (10), 713-718).—Practical hints on the selection and use of grinding wheels.—A. R. P.

Polishing Wheel Development. Henry R. Power (*Metal Cleaning and Finishing*, 1936, 8, (1), 31-32).—Briefly describes the construction and uses of a new fibre polishing wheel.—S. G.

Abrasive Sleeve Polishing Wheels. Fred B. Jacobs (*Metal Cleaning and Finishing*, 1936, 8, (3), 121-127, 156).—Describes the equipment and examples of its application.—S. G.

Polishing Wheel Adhesives and Abrasives. Fred B. Jacobs (*Metal Cleaning and Finishing*, 1936, 8, (2), 73-75).—S. G.

Abrasives. V. L. Eardley-Wilmot (*Mineral Ind.*, 1935, 44, 1-12).—The sources and production of abrasives are discussed, together with progress in abrasive engineering.—S. G.

Burnishing Procedure. J. F. Coneen (*Met. Ind. (N.Y.)*, 1936, 34, (8), 301).—Recommended equipment, materials, and procedure for the burnishing of aluminium screw-machine products are briefly described.—L. A. O.

Barrel Burnishing. Walter R. Meyer (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (7), 318-319).—See *Met. Abs.*, this vol., p. 176.—J. C. C.

XX.—JOINING

(Continued from pp. 478-480.)

Modern Production of Soft Solder Rods. Edmund T. Richards (*Metall-Woche*, 1936, (25), 491-492; (26), 511-512).—A short review of modern practice in melting, refining, and casting soft solders.—A. R. P.

Hard Soldering of Aluminium Beer Pipes. Karl Heinemann (*Aluminium*, 1936, 18, (3), 103).—For joining two aluminium beer pipes, one end is flared out and the other end inserted in the flared portion; the gap is then filled with a suitable aluminium solder.—A. R. P.

Hard Solders for Aluminium. E. L. Werner (*Metall-Woche*, 1936, (14), 261-262).—Practical soldering hints with notes on the use of fluxes.—A. R. P.

Fundamentals on the Improvement of Aluminium Castings by Soldering and Welding. H. Reininger (*Metallwaren-Ind. u. Galvano-Tech.*, 1936, 34, (15), 298-300; (16), 318-321; (17), 339-340; (18), 361).—L. A. O.

Methods for Joining Very Fine Wires. G. L. Pearson (*Rev. Sci. Instruments*, 1936, [N.S.], 7, (2), 108).—The methods described consist in (a) fusion by means of a pin-point gas flame; (b) the use of silver solder with a borax flux. The former method is recommended for uncoated wires of widely different melting-point, and the latter for wires coated with enamel or oxide.

—P. M. C. R.

***Contribution to the Testing of Tin-Lead Soldered Joints.** Willi Tonn and Heinrich Günther (*Mitt. Material., Sonderheft* 28, 1936, 117-119).—See *Met. Abs.*, this vol., p. 478.—S. G.

Practical Soldering and Welding of Monel Metal. R. Müller (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, (9/10), 252-258).—It is now possible to obtain welds in Monel metal equal in strength to the original material, and also with similar corrosion-resistance. When soldering is attempted only those solders should be used that have physical properties akin to those of the base metal. They should also be selected according to the medium with which the joint is in immediate contact. Silver solder is recommended. General rules for the proper selection of welding and soldering materials and for their proper application are given. It should be specially remembered that in the range 785°-895° C. Monel metal tends to be hot-short. Choice of welding methods is discussed and examples of practice are quoted.—W. A. C. N.

***Faulty Monel Metal Rivets.** — (*Brit. Engine Boiler and Elect. Insurance Co. Tech. Rep.*, 1935, 16-17).—Examination of rivets broken during the hydrostatic test of a Monel metal pressure vessel and of an unused rivet show that the material had been slightly damaged during manufacture, with the formation of cracks. There was also a tendency for the material to be overheated when the original heads were formed, and even in the absence of overheating there was a tendency for existing cracks to develop when the heads were formed.—J. W. D.

Influence of Cutting and Subsequent Brazing of Pobedit with Cast-Iron Solder on the Structure of the Bit, when Carried Out with Natural Gas. V. I. Timofeev (*Novosti Tekhniki Burenya*, 1936, 4, (5), 8-9; *C. Abs.*, 1936, 30, 7088).—[In Russian.] It is stated that a preliminary heat-treatment of the bit before forging causes the formation of a coarse-grain overheated structure which is but little corrected by subsequent forging. The cutting of grooves, for the purpose of reducing the profile of the bit, with an oxygen burner and by means of an electric arc causes only small structural changes. The sand-blasting of the bit prior to brazing ensures good adhesion of the cast-iron solder to the metal of the bit. The brazing process causes the structure to become non-homogeneous, while a proper preliminary heat-treatment may improve the structure. Brazing with a preliminary heat-treatment is recommended, although to ensure good adhesion of the cast-iron solder the bit must be cleaned after heat-treatment or the latter should be carried out in a reducing atmosphere.—S. G.

Automatic Soldering Conveyor. Chas. W. Hardy (*Met. Ind. (N.Y.)*, 1936, 34, (8), 293-294).—A description and illustration of the automatic equipment, and its advantages over hand soldering for certain small articles.—S. G.

Welding of Aircraft Structures. J. B. Johnson (*J. Amer. Weld. Soc.*, 1936, 15, (9), 2-11).—This is a contribution for the proposed Welding Handbook of the A.W.S., and constructive criticism is invited. The non-ferrous materials mentioned are: aluminium and magnesium alloys, Alclad, copper-silicon, Monel metal, and Inconel. The various welding processes used are briefly discussed. Spot-welding is recommended for the heat-treated aluminium alloys, a machine with 6 in. gap and 30 in. throat depth requiring a transformer capacity of 300 k.v.a. to weld two thicknesses of 0.093 in. The nickel alloys and copper-silicon are usually welded by oxy-acetylene.—H. W. G. H.

Aluminium Welding in England and Germany. L. Rostosky (*Aluminium*, 1936, 18, (4), 143-145).—A review.—A. R. P.

***Investigations on the Spot-Welding of Aluminium Alloys.** K. Schraivogel (*Aluminium*, 1936, 18, (5), 177-183).—Laboratory tests, the results of which are shown in tables and micrographs, indicate that aluminium alloys can be satisfactorily spot-welded. Improvements in the apparatus and technique for large-scale operations are suggested.—A. R. P.

Repair Welding of Aluminium Castings. W. Froelich (*Metall-Woche*, 1936, (23), 449-451).—A brief description of modern practice.—A. R. P.

Gas Welding Aluminium and Its Alloys. G. O. Hoglund (*Internat. Acet. Assoc. Proc.*, 1935, 36, 104-110; discussion, 110-121; and (abstract) *Aluminium and Non-Ferrous Rev.*, 1936, 1, (6), 265).—See *Met. Abs.*, this vol., pp. 220, 278).—S. G.

Arc Welding of Aluminium. E. P. Rogozhkin and V. V. Kostin (*Tekhnika Vozdushnogo Flota (Technology of Air Navy)*, 1936, (5), 45-60).—[In Russian.] Arc welding for joining aluminium alloys and eliminating flaws gives as good results as oxy-acetylene welding, the seam having a high mechanical strength, the output being rapid, and the operation simple. The weld metal has a tensile strength of 19 kg./mm.² and a bending angle of 16°, the corresponding figures for the base metal being 13 kg./mm.² and 8.5°. Corrosion-resistance is satisfactory. D.c. must be used, the parts must first be heated to 300°-350° C.; with intricate shapes moulds must be used and cooling must be slow, the parts and the electrodes must be thoroughly cleaned and degreased, and drawn wire electrodes of a similar composition to the work should be used with as small an arc as possible.—N. A.

Joining of Aluminium-Cored Cables. K. Tonnemacher (*V.D.E. Fachberichte*, 1935, 57-59; discussion, 59-61; *Sci. Abs.*, 1936, [B], 39, 238).—Describes and illustrates methods of joining aluminium cables. Soldering and welding methods are discussed, and their effect on mechanical and electrical resistance is considered.—S. G.

Telephone Wires of Aldrey. M. Preiswerk and W. Müller (*Aluminium*, 1936, 18, (5), 184-191; and (abstract) *Light Metals Rev.*, 1936, 2, (24), 453-454).—The mechanical and electrical properties of the wires are discussed, and various methods of fixing the wires to the insulators and of joining wire ends are described, with reference to numerous photographs.—A. R. P.

***Fracture of Wire in a High Tension Conductor of Pure Aluminium.** W. Geller (*Aluminium*, 1936, 18, (10), 487-488).—Micrographic examination of a fracture which occurred in a high-tension cable (110 kv., 3.8 mm. diam.) showed it to be due to lapping of the wire in the neighbourhood of a welded joint. It is essential therefore to ensure that the ends to be joined by welding are perfectly clean and that the metal is thoroughly welded throughout its cross-section.—A. R. P.

***Investigations of the Structure of Resistance Welds in Light Metals.** (Röhrig and Käpernick.) See p. 527.

The New Coated Electrode for the Arc Welding of Copper. A. Matting and W. Lessel (*Maschinenbau*, 1936, 15, (17/18), 501-503).—Cf. *Met. Abs.*, this vol., p. 479. A copper electrode with a special 4-fold coating has been developed for use in the arc welding of copper. The electrodes have been used successfully for some time for joining locomotive stay-bolts.—v. G.

Welding of Sheets for Copper Pressure Vessels. (*Brit. Engine Boiler and Elect. Insurance Co. Tech. Rep.*, 1935, 20-21).—Tests carried out on treated and untreated copper sheet welded by oxy-acetylene show that the treated weld behaves almost as well as the solid sheet except for the bend test. Heat-treatment of hammered welds at 650° and 700° C. does not refine the weld metal, and in the case of the treatment at 700° C. the parent metal away from the weld is coarsened. The hammered sample was found to represent good-quality welding by oxy-acetylene.—J. W. D.

Joining of E.H.V. Cables. A. L. Sanders (*Trans. S. African Inst. Elect. Eng.*, 1935, 26, 290-302).—Details the important points in the design of a satisfactory joint, and discusses the jointing of paper-insulated, lead-covered solid cable. In joint design the drawn lead sleeve is best.—S. G.

The Welding of Magnesium Light Alloys. Fr. Eggesmann (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, (7/8), 205-210).—The use of an aluminium-alloy welding rod (silicon 0.9, manganese 0.5, magnesium 1.0%) and the mechanical properties of various types of welds are discussed.—W. A. C. N.

Gas Welding of Technically Pure Nickel. I. L. Tukazinskiy (*Avto-gennoe Delo (Autogenous Practice)*, 1936, (6), 17-18).—[In Russian.] The need for protection from oxidation and sulphur absorption is indicated. As a protective flux: boric acid 50, borax 30, salt 10, and barium carbonate 10% may be used. Annealing at 870°-930° C. after welding is necessary, air being excluded.—N. A.

Welding Galvanized Iron. V. L. Sage (*Industry and Welding*, 1935, 7, (6), 20-21).—The carbon-arc and oxy-acetylene processes are described. S. considers the carbon-arc process the quickest and most satisfactory.—S. G.

Composite Bushings. — (*Oxy-Acetylene Tips*, 1936, 15, (10), 231-233).—Connecting-rod bearings for lumber locomotives, formerly of solid cast bronze, are now made from a steel shell, coated with bronze by the oxy-acetylene process, shoulders being built up to hold a bearing surface of Babbitt metal. The costs of renewal have been very much reduced by the new design.

—H. W. G. H.

Selecting the Hard-Facing Alloy. — (*Oxy-Acetylene Tips*, 1936, 15, (10), 226-227).—Hard-facing materials are of three types: iron-base alloys; non-ferrous alloys of cobalt, chromium, and tungsten; and tungsten carbide in various forms. The characteristics of each type are explained and typical applications suggested.—H. W. G. H.

The Oxwelding of Non-Ferrous Metals and Stainless Steel. W. A. Duncan (*Iron Steel Canada*, 1936, 19, (3), 5-11).—Read before the Montreal Chapter, American Society for Metals. Describes the procedure for oxy-acetylene welding of pure aluminium and its alloys, copper, brass and bronze, Everdur and Tempaloy, Monel metal and nickel, and the 18:8 stainless steels. For aluminium and its alloys a good flux is required, with a soft, slightly reducing flame, and a filler rod of aluminium or aluminium-silicon alloy. For copper, a neutral or slightly reducing flame issued with deoxidized copper filler rod and no flux. For brasses and bronzes, a slightly oxidizing flame is the best with suitable flux, and, as in the case of Everdur, contraction stresses are to be avoided. A flux is always used for Monel metal, but seldom with pure nickel, rods of the same composition as the parent metal, and slightly reducing flame. Stainless steels require a filler rod containing a stabilizer such as titanium or columbium to eliminate weld decay.—J. E. N.

Ignition Velocity and Flame Capacity of Industrial Gases in Combustion with Oxygen. H. Brückner, W. Becher, and E. Manthey (*Autogene Metallbearbeitung*, 1936, 29, (17), 257-259).—The flame capacity of a gas is said to be a measure of its suitability for use in welding, and is defined as the heat developed in unit time by a Bunsen flame having a standard size of cone. It is determined for hydrogen, carbon monoxide, methane, acetylene, propane, water-gas, and towns' gas. Acetylene is shown to have by far the highest flame capacity—three times that of hydrogen.—H. W. G. H.

The Handling, Storage, and Proper Control of Compressed-Gas Cylinders. F. R. Fetherston (*Internat. Acet. Assoc. Proc.*, 1935, 36, 58-63).—S. G.

Prevention of Welding and Cutting Fires. C. D. Abbott (*Internat. Acet. Assoc. Proc.*, 1935, 36, 50-57).—S. G.

Contributions to the History of Seams in the Metal Fabric Industry. Franz Hassmann (*Draht-Welt*, 1936, 29, (25), 380-381).—Methods of joining metal fabric are reviewed, with brief reference to the relevant group of German patents. The production of seams by the use of wire of special composition is now declining in favour of soldering or welding processes.—P. M. C. R.

The Calculation of the Energy Consumed in Resistance Welding. M. Mathieu (*Arts et Métiers*, 1936, 89, (191), 164-166).—A summary of the conclusions reached in a previous article (see *Met. Abs.*, 1935, 2, 636).—P. M. C. R.

The Developments in Arc Welding. E. Steinert and W. W. Reddie (*Iron and Steel Eng.*, 1936, 13, (1), 9-12).—Read at the American Iron and Steel Electrical Engineers' Convention, 1935.—S. G.

Alternating Current Arc Welders. Iwane Shigyo (*Shibaura Review*, 1934, 13, (2), 85-90).—[In Japanese.] After a discussion of the advantages of electric welding, and especially of a.c. welding, S. describes a new type of a.c. welder that operates on the moving coil principle without any taps on the secondary winding of the transformer. The welding current can be adjusted continuously for a very wide range by means of a single operating handle, and the welder may be designed for remote control. There is no objectionable noise from core vibration, and little danger from electric shock. The principle of operation, construction, and characteristics of the welder are discussed and test results are given.—S. G.

The Jointing of Materials by Welding. R. H. Dobson and R. F. Taylor (*J. Roy. Aeronaut. Soc.*, 1936, 40, (309), 647-657; discussion, 657-662).—See *Met. Abs.*, this vol., p. 420.—L. A. O.

Modern Developments in Welding. C. G. Bainbridge (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (12), 567-570; discussion, 570-572).—Read before the Institute of Engineers-in-Charge. A list of metals and alloys which can be oxy-acetylene welded is followed by an account of the application of this method to repairing broken parts, reclaiming worn parts, replacing obsolete or faulty parts, and pipe-welding. The discussion dealt with the comfort of tank welders, the welding of sheet and of galvanized pipe, the filling of pit holes, repairs to copper firebox plates, the strength of welded joints, and the tipping of tools.—P. M. C. R.

The Influence of Research on Welding Standardization. ——— (*Welder*, 1936, [N.S.], 8, (27), 840-842; and *Aluminium and Non-Ferrous Rev.*, 1936, 1, (6), 268-270).—A review of the scope of the present British Standard Specifications relating to the materials, procedure, and workmanship used in making welds for constructional purposes.—J. C. C.

Welding Research and Projects. F. C. Lea (*Mech. World*, 1936, 99, 299-301).—Abstract of a lecture entitled "Some Researches in Connection with Welding" given at a Conference on Welding at University College, Swansea.—F. J.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 480-483.)

***A Quantitative Study of the Improvement of Speculum Gratings by the Application of Aluminium.** Alfred B. Focke (*J. Opt. Soc. Amer.*, 1936, 26, (6), 235-237).—Read before the American Physical Society. Tests made on a clean concave speculum metal grating show that if the surface is coated with aluminium by evaporation, the time required to obtain a photograph of a spectrum is reduced by a factor which is the ratio of the reflection coeff. of aluminium to that of the speculum metal. The speed of the original grating was increased by the following amounts: 4077 Å., 45%; 3341 Å., 80%; 2536 Å., 170%. In preliminary tests, the observed increase in speed was very much greater than is indicated by these values, since the initial tests were made before the grating had been sufficiently cleaned.—S. G.

Aluminium for Packing Joints in Tubes. Joh. Reiprich (*Aluminium*, 1936, 18, (10), 519-522).—Soft aluminium wool has proved satisfactory for packing pipe joints instead of lead. The metal surfaces are first coated with bitumen, the gaps then filled with aluminium wool which is tightly rammed in, and finally a layer of bitumen is applied over the aluminium.—A. R. P.

Aluminium and Rubber. R. T. Griebing (*Rubber Age (N.Y.)*, 1936, 39, 273-275; *C. Abs.*, 1936, 30, 7382).—A review of present developments in the use of aluminium and rubber in combination in fabricated articles, and of aluminium in processing equipment in the rubber industry.—S. G.

Screws and Threads of Light Metal. F. Pachtner (*Maschinenbau*, 1936, 15, (15/16), 441).—Light metal wood-screws should be given an oxide coating by the M.B.V. process and then coated with Lanolin before use. The thread should be free from sharp edges; it can be rolled in.—V. G.

Aluminium Standards for the Electrical Industry. — (*Aluminium*, 1936, 18, (9), 438–440).—DIN specifications are given for aluminium wires, rods, tubes, and other products used in the electrical industry.—A. R. P.

Aluminium in the Construction of Rotors for Alternating Current Motors. — Mullner (*Aluminium*, 1936, 18, (7), 305–306).—Several types of aluminium rotor are illustrated and briefly described.—A. R. P.

Arrangement of Aluminium Bus-Bars for Heavy Currents. H. H. Johann (*V.D.E. Fachberichte*, 1935, 71–73; discussion, 73–74).—S. G.

Electric Interrupters. J. Bally (*Rev. Aluminium*, 1936, 13, (82), 251–256).—Describes the use of Duralumin and Alpac in the construction of electrical high-tension interrupters and short circuits.—J. H. W.

Aluminium in Tool Manufacture. — (*Machine moderne*, 1936, 30, (335), 469–471).—On account of its strength and lightness, aluminium is increasingly used in the mounting of tools, especially those which are overhung or which have a rapid forward and backward stroke. Other applications are described. —P. M. C. R.

Shops and Stores: Presentation and Aluminium. J. Dumontet (*Rev. Aluminium*, 1936, 13, (78), 65–80).—Describes the use of aluminium alloys, notably Studal (aluminium–manganese–magnesium), Almasilium (magnesium 1, silica 1–2%), and Duralinox (7% magnesium), in shop fronts and fittings. —J. H. W.

Aluminium in Ornamental Metal Work. — (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (12), 561–562).—Aluminium and Duralumin are much used in ornamental work, the former mainly as sheet and the latter in railings and frames. Design is influenced by the desirability of avoiding soldering and by the “drag” of the material. Anodic treatment renders a pleasing range of colours available.—P. M. C. R.

Precision Instruments. Calculating, Adding, and Registering Machines. (*Rev. Aluminium*, 1936, 13, (83), 325–330).—Describes the action of calculating machines and the use of aluminium and magnesium and their alloys in their construction.—J. H. W.

Rod and Line Fishing Gear. J. Bally (*Rev. Aluminium*, 1936, 13, (79), 111–117).—Describes the use of aluminium for fishing rods and accessories. —J. H. W.

New Antifriction Alloys Containing Al–Zn–Pb. V. Biroli (*Alluminio*, 1936, 5, (4), 144–145).—Describes new types of antifriction alloys, containing aluminium, zinc, and lead, which can be substituted for tin-base alloys and even bronzes.—J. K.

Materials and Methods of Joining Used in Strong Light Structures (Aircraft). R. H. Hobrook (*Daniel Guggenheim Airship Inst., Report on Airship Forum*, 1935, 64–88; and (summary) *Light Metals Research*, 1936, 5, (7), 154–157. *Bull. B.N.F.M.R.A.*, 1936, (91)).—A general discussion, referring to types of structure of aeroplane spars; value of endurance, creep, damping capacity, &c., data for the prediction of the behaviour of materials in service; and fatigue behaviour. Some notes are given on the effect of heat-treatment on aluminium alloys. Electric spot- and seam-welding are discussed; H. favours the latter for aircraft structures.—S. G.

Metallurgy in Aircraft Engine Construction. R. C. Moore (*Canad. Chem. and Met.*, 1936, 20, (3), 81–82).—The properties of steels and light alloys used in aero-engine construction are briefly described.—A. R. P.

Spread and Results of Light Metal Applications in Railway Travel. F. Reidemeister (*Aluminium*, 1936, 18, (10), 495–498).—A list is given of all the

regular trains built of light metal alloys and now running throughout the world with particulars of their construction and performance.—A. R. P.

Successive Stages in the Use of Aluminium Alloys in Rolling-Stock Construction. [J.] Lancrenon (*Monthly Bull. Internat. Railway Congress Assoc.*, 1936, 18, (10), 1067-1071).—The increase in the weight of rolling stock necessitated by modern requirements for comfort and safety has been reduced by the use of aluminium and light alloys in coach construction. L. traces developments in France, Germany, Great Britain, and the U.S.A. in the use of light metal sheet, castings, and forgings, and finally refers to the welded construction made possible by the use of an alloy containing 7% of magnesium.
—P. M. C. R.

Modern Railway Trains in the United States, 1936. E. Isdahl (*Aluminium*, 1936, 18, (10), 489-494).—Modern American streamlined trains constructed either wholly or partly of aluminium alloys are described. All-aluminium construction saves 30-40% in the weight of the train. The "New Haven Comet" has a deadweight of only 720 kg. per passenger. Numerous illustrations are included.—A. R. P.

New Light Metal Passenger Vehicles of the Milan Tramway System. Industrieabteilung des Lautawerks (*Aluminium*, 1936, 18, (10), 499-500).—Construction and performance details are given.—A. R. P.

The Articulated Train of the Compagnie du Chemin de Fer du Nord. J. Lancrenon (*Rev. Aluminium*, 1936, 13, (83), 301-306).—Describes the use of an aluminium alloy, M.G.7 (Duralinox H734), containing 7% magnesium, in the construction of articulated railway coaches. The breaking strength of this alloy ≥ 36 kg./mm.², the yield-point ≥ 18 kg./mm.², and the elongation $> 18-22\%$. Bending and deep-drawing are carried out at 375°-425° C. The use of other light alloys for different parts of the train are described.—J. H. W.

The Capacity of Rope Railways for Passenger Transport. Ad.-M. Hug (*Rev. Aluminium*, 1936, 13, (78), 61-64).—The capacity of rope railways depends on the weight that can be carried, the speed at which the cars can run, and the facilities for clearing the terminal stations. The use of aluminium alloys and reduction of the deadweight increase the capacity in the first two respects, the extra initial cost being justified by the lower running costs per passenger carried.—J. H. W.

The Light Metals for Trucks, Trains, Ships. — (*Metal Progress*, 1936, 29, (4), 33-34).—A survey of the increasing applications of aluminium and magnesium in the transport services.—P. M. C. R.

Aluminium Connecting Rods. R. L. Templin (*Mech. Eng.*, 1936, 58, (3), 169-170; discussion, (7), 458-459; and (summary) *Light Metals Rev.*, 1936, 2, (20), 343-346).—The mechanical properties of an aluminium alloy containing copper 4.4, silicon 0.8, manganese 0.75% are tabulated in the forged condition for various orientations, and stress-distribution diagrams covering 3 conditions of loading are reproduced for models of connecting rods of 2 designs used in locomotive work. In discussion, W. F. Kiesel writes that the small space generally available for counterbalance favours the use of light members, and refers to the encouraging results obtained in service tests with light alloy rods of suitably modified design.—P. M. C. R.

Increasing the Heat Stability of Piston Heads. Otto Steinitz (*Maschinenbau*, 1936, 15, (17/18), 509-510).—The stability of pistons is improved by making the head of "Y" alloy and the shaft of E.C.124 alloy. Both alloys are cast one after the other under such conditions that a narrow strongly welded joint is obtained.—v. G.

Light Metal Motor Lorries and Trailers. M. Koenig (*Aluminium*, 1936, 18, (10), 500-510).—An illustrated article showing the construction of the vehicles and their components.—A. R. P.

The Grégoire Motor-Car with Alpac Bodywork. A. Charneil (*Rev. Aluminium*, 1936, 13, (82), 257-260).—Describes the use and advantages of Alpac in the manufacture of French automobile bodywork.—J. H. W.

Motor Omnibuses of the 1936 Type of the Société des Transports en Commun de la Région Parisienne. — (*Rev. Aluminium*, 1936, 13, (83), 317-324).—The use of light alloys in the construction of motor omnibuses in Paris and the saving in weight thereby effected are discussed.—J. H. W.

On a Few Recent Applications of Light Alloys in Motor-Cycle Construction. G. Piantanida (*Alluminio*, 1935, 4, (2), 92-95).—A brief review of recent development of light alloy parts in motor-cycle construction in Italy and abroad. Special mention is made of a British cylinder barrel cast in "Y" alloy, for use without liner.—J. K.

Removal of Radio Interference with Aluminium Foil. B. Unger (*Aluminium*, 1936, 13, (9), 446).—Aluminium foil treated to prevent moisture condensation makes an excellent insulator for the various components of radio sets; examples are given.—A. R. P.

Paints Containing Aluminium Powder. H. Rabaté (*Rev. industrielle*, 1936, [N.S.], (174), 177-180; (176), 277-279; (179), 373-376).—An account of the various methods of producing aluminium powder, and the preparation and properties of paints containing suspensions of the powder in various media. The calorific, optical, and corrosion-resisting values of the several classes of paints are discussed at length.—J. E. N.

Cr-Fe-Al-Co Alloys as Resistance Elements in Electric Heating. H. von Kantzow (*Congrès Internat. Appl. Électrocalorifiques (Preprint)*, 1936, 9 pp.; *Bull. B.N.F.M.R.A.*, 1936, (91)).—[In German.] An account of the properties and uses of alloys of the Kanthal type.—S. G.

Utilization of Copper and Copper Alloys. Wm. G. Schneider (*Mineral Ind.*, 1935, 44, 149-155).—A review. Tables are given for shipment of brass and bronze ingots (U.S.A.); prices (all New York) of brass ingots, copper products, brass products, seamless tube, and seamless pipe; estimated use of copper in U.S.A.; refined copper statistics (N. and S. America); deliveries of copper by refineries; and per capita consumption of copper of various nations.—S. G.

The Control of the Use of Copper by Building Authorities. Prussian Ministry of Finance (*Bauverwaltung*, 1935, 55, (40), 800; *Buuld. Sci. Abs.*, 1936, 9, 11).—A ministerial decree of Sept. 19, 1935, requires building authorities to notify cases of non-observance of the regulations of 1934 and 1935 relating to restrictions of the use of certain metals for building purposes. An extract is given referring to copper and its alloys and to nickel and its alloys. These metals may be used for surface coatings and light platings. Purposes for which they are forbidden are enumerated.—S. G.

Electricity Supply and the Problem of Copper Shortage. W. Bolling (*V.D.E. Fachberichte*, 1935, 53-55; discussion, 55-56; *Sci. Abs.*, 1936, [B], 39, 238).—B. discusses the possibility of adopting various methods, such as the more intense loading of existing networks, in order to cope with the situation created by the decrees restricting the use of copper.—S. G.

Unsuspected Copper in Domestic Water Supplies.—II. David W. Horn (*Amer. J. Pharm.*, 1936, 108, 320-323; *C. Abs.*, 1936, 30, 7737).—*Cf. Met. Abs.*, 1934, 1, 638. The finding of unsuspected copper in domestic supplies that make use of combined air and water pumps along with copper pipes is reiterated. A simple test for such domestic supplies is given.—S. G.

Specifications for Locomotive Firebox Copper. — Chan (*Monthly Bull. Internat. Railway Congr. Assoc. (English Edn.)*, 1936, 18, (10), 1091-1097).—From *Rev. gén. Chemins de Fer*, 1936, 55, (5), 331-338. See *Met. Abs.*, this vol., p. 280.—S. G.

Proposed Revision QQ-B-691 Federal Specification for Bronze Castings. — (*Met. Ind. (N.Y.)*, 1936, 34, (8), 288-290).—L. A. O.

The Manufacture of Alloys for High Water Pressure. — (*Giesserei-Praxis*, 1936, 57, (37/38), 407-409).—The following alloys are recommended as high pressure bronzes: (1) copper 84, tin 7, zinc 8, phosphor-copper 1%, for fittings up to 150 atm. water pressure; (2) copper 83, tin 6.5, zinc 8, nickel 1.5, phosphor-copper 1%; this alloy is superior to (1), being finer grained; it can be used for up to 200 atm. water pressure or 100 atm. oxygen pressure; (3) copper 84, tin 10, zinc 2, nickel 3, phosphor-copper 1%, for up to 300 atm. water pressure and 200 atm. oxygen pressure. The purest metals must be used in making up these alloys, the nickel being added as a 50:50 copper-nickel alloy. Details of melting and pouring the alloys are given.—J. H. W.

Bronzes in Machine Construction. John D. Watson (*Metallurgia*, 1936, 14, 173-174).—Various grades of bronzes including straight copper-tin bronzes, phosphor-bronze, silicon-bronze, and nickel-bronzes are discussed in relation to their value for various forms of machine construction. Consideration is also given to their resistance to corrosion, when used for chemical plant and oil machinery, and to their strength at high temperatures when used for valve parts.—J. W. D.

Spindle Bearings for High-Speed Machine Tools. G. Schlesinger (*Machine moderne*, 1936, 30, (334), 433-436; (335), 481-490).—Numerous designs for friction and ball-bearings are illustrated and described. The function of bearing metals is discussed, and (in the second part) an account is given of Caro bronze (copper 91.2, tin 8.5, phosphorus 0.3%), the mechanical properties of which are summarized. A graph correlates the coeff. of friction, pressure per unit area, total load, and surface temperature of the journal in Caro bronze bearings with different speeds of working.—P. M. C. R.

Bearings That Need Not Be Oiled. — (*Machinist (Eur. Edn.)*, 1936, 80, (22), 490-493).—Oilite bearings have either a graphite bronze or a sponge iron basis with 35% of oil. The operations in the manufacture are: (1) mixing in a tumbling barrel, (2) forming or briquetting in both mechanical and hydraulic presses, (3) heat-treatment, a sintering operation, in which the briquette is made just hot enough to melt the tin and form bronze, (4) impregnating with oil by soaking in oil for about 10 minutes at 225° F. (110° C.), (5) finish sizing on mechanical presses. It is claimed that these bearings have a relatively low coeff. of friction, low wear factor, and permit of high unit pressures.—J. H. W.

Nickel in American Bronze Alloys. — (*Met. Ind. (Lond.)*, 1936, 49, (17), 407-409).—Bronzes containing nickel additions are increasingly employed in the U.S.A., especially for cast and pressure-cast pieces, examples of which are illustrated. Compositions and mechanical properties are given for several alloys of both types.—P. M. C. R.

British Standard Specification for Cold-Rolled Brass Sheets, Strip, and Foil, Copper Content 61.5 Per Cent. Minimum and Under 64 Per Cent. Maximum (Up to and Including 3 S.W.G. (0.252 in.) Thick). — (*Brit. Stand. Inst.*, No. 265, 1936, 15 pp.).—Revision of a specification issued in 1926 under the title of "Brass Sheet and Strip for Engineering Purposes" and in 1928 (revised) as "61/39 Brass Sheet and Strip."—S. G.

British Standard Specification for Cold-Rolled Brass Sheets, Strip, and Foil, Copper Content 64 Per Cent. Minimum; 67 Per Cent. Maximum (Up to and Including 3 S.W.G. (0.252 in.) Thick). — (*Brit. Stand. Inst.*, No. 263, 1936, 15 pp.).—Revision of a specification issued in 1926 under the title "Best Brass Sheet and Strip" and in 1928 (revised) as "65/35 Brass Sheet and Strip."—S. G.

British Standard Specification for Cold-Rolled Brass Sheets, Strip, and Foil, Copper Content Within Range 68 Per Cent. Minimum and 72 Per Cent. Maximum (Up to and Including 3 S.W.G. (0.252 in.) Thick). — (*Brit. Stand. Inst.*, No. 267, 1936, 15 pp.).—Revision of a specification first issued in

1926 under the title "Cartridge Brass Sheet and Strip" and in 1928 (revised) as "Soft Cartridge Brass Sheet and Strip."—S. G.

British Standard Specification for Cold-Rolled Brass Sheets, Strip, and Foil, Copper Content Respectively: 80 Per Cent. (B.S.S. No. 711), 85 Per Cent. (B.S.S. No. 712), 90 Per Cent. (B.S.S. No. 713) (Up to and Including 3 S.W.G. (0.252 in.) Thick). — (*Brit. Stand. Inst.*, Nos. 711-713, 1936, 15 pp.).—S. G.

Characteristics of Nickel Silver Alloys. — (*Met. Ind. (Lond.)*, 1936, 48, (1), 3-4).—A brief account is given of the properties of the commercial nickel silver alloys, and of their preparation, heat-treatment, soldering, and principal applications.—P. M. C. R.

On Standards for Alloys for Printing Machines and Methods of Testing Type Metals. A. Semionov (*Poligraficheskoe Proizvodstvo (Polygraphic Ind.)*, 1936, (1), 45-52).—[In Russian.] Standard type metals are tentatively proposed with the following compositions (%): (antimony first, tin second, remainder lead): Linotype I, 11.5 ± 0.2 , 4.5 ± 0.2 ; Linotype II, 11.75 ± 0.25 , 2.0 ± 0.2 ; Typograph, 12.0 ± 0.2 , 3.0 ± 0.2 ; Monotype I, 16.5 ± 0.3 , 7.0 ± 0.3 ; Monotype II, 15.0 ± 0.5 , 5.0 ± 0.3 . Impurities should not exceed 0.2% in the first three and 0.5% in the last two alloys.—N. A.

Lead Pipes as a Source of Lead in Drinking Water. G. N. Quam and Arthur Klein (*Amer. J. Public Health*, 1936, 26, 778-780; *C. Abs.*, 1936, 30, 7737).—Gives tabulated results of the analysis of water remaining in pipes over a definite length of time.—S. G.

Specification of Plumbing and Glazing. — (*Manchester Architects' and Builders' Consultative Board, Report No. 7*, 1936, 28 pp., *Build. Sci. Abs.*, 1936, 9, 244).—The nature, properties, and uses of various materials used in plumbing are described and recommendations made relating to the formulation of accurate and clear specifications for plumbing work. After some general observations on modern trends in technique, detailed consideration is given to sheet lead, the ternary alloys of lead, tellurium-lead, Monel metal, cast-iron gutters, rainwater pipes, water supply systems, and various pipes and fittings for sanitary purposes, &c.—S. G.

Tellurium Lead: Its Performance under Service Conditions. — (*Dutch Boy Quarterly*, 1936, 14, (2), 9-11).—The superior mechanical properties and corrosion-resistance of tellurium-lead are illustrated by a number of short accounts of its successful use, especially in chemical plant.—P. M. C. R.

Use of Calcium Babbitt for Merchant Mill Bearings. P. Alexandrov and M. Igonkin (*Stal (Steel)*, 1934, 4, (6), 11-21; *C. Abs.*, 1935, 29, 1042).—[In Russian.] Good results are obtained with a lead-base alloy containing copper 0.75-1.10, sodium 0.70-1.10, and antimony < 0.5% if the alloy is protected from oxidation while melting and is cast at 550°-580° C.—S. G.

Satco Lined Bearings. — (*Dutch Boy Quarterly*, 1936, 14, (1), 1-2).—Bearings and lateral plates of Satco, a lead-base white metal, are said to be increasingly used in railway work in the U.S.A. The metal is said to have an unusually high melting point and to be stable on remelting.—P. M. C. R.

The New Copper-Lead Anti-Friction Alloys. Alfred Ricard (*J. Soc. Ing. Automobile*, 1936, 9, (1), 3-7; discussion, 7-9).—See *Met. Abs.*, this vol., p. 423.—S. G.

Recent Developments in the Metallurgy and Application of Nickel Alloys. Robert C. Stanley (*Sheet Metal Ind.*, 1936, 10, (108), 293-295).—S. G.

Nickel Alloys in Diesel Locomotives and in Railcars. Kango Takemura (*Japan Nickel Rev.*, 1936, 4, (3), 449-471).—[In English and Japanese.] Nickel is employed in Diesel railway engines as an alloying element in steel and cast iron, and also as one of the main constituents in the copper-nickel alloys used for valves and cooling tubes; light alloys of the R.R. Hiduminium, Lo-Ex, and "Y" type are used in pistons, and bed-frame bolts are of an R.R. alloy. The compositions of the alloys used, with the numbers of the

existing official specifications, are tabulated, as are the various parts of the engine and the materials employed. An illustrated account of Diesel and railcar units and material is appended.—P. M. C. R.

Electric Heat-Resisting Alloys in Japan. Yonosuke Matsunaga (*Japan Nickel Rev.*, 1936, 4, (2) 300-310).—[In English and Japanese.] A review of the properties and uses of the alloys used for resistance heating in Japan.

—R. G.

Nickel-Iron Alloys. Their Application in Electrical Engineering. N. W. McLachlan (*Electrician*, 1936, 117, (3039), 249-252).—Methods of measuring the magnetic characteristics of high permeability alloys are discussed and typical curves given for Permalloy C and Mumetal under conditions of d.c. and a.c. magnetization. The application of these alloys in submarine cable manufacture, as magnetic screens and for the cores of intervalve and current transformers, is discussed.—J. C. C.

Precision of Length Comparisons with Invar Wires. C. Oltav (*Bull. géodésique*, 1936, 50, 167-172).—S. G.

The Occurrence of Platinum and the Platinum Metals and Their Uses. P. Krusch (*Metall u. Erz*, 1936, 33, (18), 481-487; (19), 510-515).—The most important platinum deposits of the world are described and a brief account is given of the uses of the metals and their alloys.—A. R. P.

On the Industrial Applications of the Platinum Metals. — (*Metall-Woche*, 1936, (19), 362-364).—L. A. O.

Note on a Seventeenth-Century Discourse on Tin as a National Asset. S. W. Smith (*Bull. Inst. Min. Met.*, 1936, (384), 3 pp.).—The use of tin for coining farthings and halfpennies between 1684 and 1692 is briefly discussed. The discourse is an attempt to obtain a continuance of this policy.—A. R. P.

A New Piping for Drawing Beer [Use of Tin]. R. Laneau (*Petit J. Brasseur*, 1936, 44, 551; *J. Inst. Brewing*, 1936, 42, 398).—Mainly concerned with a description of the evils attendant on the use of tin piping in beer cellars (tin has largely replaced lead, the use of which for this purpose is prohibited in Belgium). Tin is appreciably soluble in beer, and imparts an unpleasant metallic flavour besides causing the well-known haze. These defects are naturally accentuated in beer which has been standing in pipes overnight, so that the publican has no alternative to the risk of displeasing his customers in the morning but to empty his pipes back into the cask at the end of the day. This procedure is objectionable since any dirt in the pipes will then infect the cask. The appearance on the market of a new alloy which is unaffected by beer promises to be a welcome solution of the problem of drawing beer from cask.—S. G.

Contemporary Pewter in the Netherlands. — (*Bull. Internat. Tin Research Develop. Council*, No. 3, 1936, 64 pp.).—The uses of pewter for making decorative and useful domestic articles are illustrated by numerous beautiful photographs, and brief notes are given of the history of the pewter art in Holland and of the methods of manufacture.—A. R. P.

White Metals for Gliding Bearings and Gliding Planes. DIN 1703. — (*Z. Metallkunde*, 1936, 28, (2), 47).—Standard specifications for numerous alloys are tabulated giving composition, permissible deviations and impurities, and sp. gr.—A. R. P.

Tin-Poor and Tin-Free White Bearing Metals. DIN 1703. — (*Z. Metallkunde*, 1936, 28, (2), 47).—The composition and properties of lead-base bearing metals containing tin and antimony with small amounts of numerous hardening metals are tabulated. Specifications for zinc-base bearings are also included.—A. R. P.

Anti-Friction White Metals in Germany. L. J. Gouffier (*Rev. Fonderie moderne*, 1936, June 10, 194-195).—Attention is directed to efforts in Germany to replace white anti-friction metals containing tin by alloys containing little

or no tin—a metal which is dear and must be imported. The respective compositions and properties are compared in specifications DIN 1703 and 1703 U (cf. preceding abstracts).—J. E. N.

Present Position and Basic Problems of Development of Zinc-Base Alloys for General Machine Construction. W. Claus (*Russko-Germanskiy Vestnik Nauki i Tehniki (Deut.-Russ. Z. Wiss. u. Tech.)*, 1936, (4), 7-10; (5), 7-11)—[In Russian.] Methods of improving the chemical properties, eliminating ageing, and increasing the mechanical properties of zinc-base die-castings are discussed.—N. A.

The Rarer Metals and Their Technical Applications. — (*Giesserei-Praxis*, 1936, 57, (35/36), 372-374).—Briefly describes some of the applications of beryllium, lithium, barium, calcium, rhenium, tungsten, sodium, cadmium, titanium, tantalum, bismuth, mercury, gallium, thallium, and molybdenum.—J. H. W.

Technological Properties of Large Clad Sheets. Wilhelm Rädcker and Edgar Schöne (*Z.V.d.I.*, 1936, 80, (38), 1163-1165).—The tensile properties of steel sheets clad with nickel, copper, stainless steel, or Monel metal are given together with hints for working them and some possible uses.—v. G.

Non-Ferrous Alloys in Railway Engineering. Kinichiro Kawada (*Japan Nickel Rev.*, 1936, 4, (3), 475-492).—[In English and Japanese.] A review of the applications of nickel and its non-ferrous alloys in railway practice in Europe and the U.S.A. Pure nickel is used in batteries and nickel-clad sheet for tank containers. Nickel-copper alloys include: high-copper materials (compositions and strengths as received, after heating tests, and after use are tabulated) for firebox stays; cupro-nickel tubing; Monel metal rods, tubes, pump parts, valves, and floats; Platnam facings for parts exposed to hard wear; and a 55:45 casting alloy for power control grids. Nickel silver is used for folding or swinging appliances in passenger cars; "Cronite" for parts exposed to sulphur corrosion; Inconel as a spring material and in meter rotors; and Y alloy and Hiduminium in pistons and cylinder heads. Nickel is also used to harden bearing metals, and the properties of Bagra and Asarcoalloy are described, the latter being tabulated in comparison with Babbitt.—P. M. C. R.

Locomotive Pipe and Pipe Fittings. P. L. Falconer (*J. Inst. Locomotive Eng.*, 1936, 26, (132), 438-485; discussion, 485-509).—In a general discussion of the arrangement and design of piping in a modern locomotive, consideration is given to the principal materials used for such parts. These include copper, brass, and bronze, which are dealt with in detail as regards their composition, physical properties, resistance to high temperatures and pressures, resistance to corrosion, influence of impurities, and other properties.—J. W. D.

The Application of Metals in Chemical Engineering. H. W. Cremer (*Met. Ind. (Lond.)*, 1936, 48, (7), 214-218; (8), 237-241; also *Chem. Age*, 1936, 34, (871), 214-216; (872), 238-239; (873), 257-258; and (summary) *Light Metals Rev.*, 1936, 2, (19), 326-328).—Read before the London Local Section of the Institute of Metals. A brief outline of the extensive field covered by the chemical and allied industries. The following points are considered: the service which metals are required to perform in these industries; the need for close co-operation between the process metallurgist, the designer, and the chemist in the production of chemical plant; the growing tendency to employ high temperatures and pressures and the bearing of this on the development of new alloys to withstand severe service conditions; metal problems of the future; and some of the more recent developments in metals and alloys as they affect chemical engineering.—L. A. O.

Present-Day Problems of Working Materials in the Chemical Industry. E. Rabald (*Chem. Fabrik*, 1935, 8, 441-446; *C. Abs.*, 1936, 30, 533).—A review of: imports and exports of copper, lead, zinc, tin, and aluminium; German

production from domestic and imported ores; methods of economizing in construction and of combating corrosion by coating and alloying; the recovery of scrap metal and the substitution of other materials for metals. Thirty-five references are given.—S. G.

Materials for the Construction of Dye Kettles. H. L. Burke (*Amer. Dye-stuff Rep.*, 1935, 24, 415-417).—Copper and Monel metal have been successfully used in the dyeing of silk and wool; cast-iron is suitable for alkaline baths.—L. A. O.

***Selection of Materials for Equipment for [Parchmentized] Fibre Production.** D. M. Flyate (*Zentral. Nauch.-Issledovatel. Inst. Bumazhnoi Prom. Materialui*, 1935, (3/4), 200-239; *C. Abs.*, 1936, 30, 7329).—[In Russian.] The recommendations for the use of materials, capable of resisting the corrosive action of zinc chloride solutions, in the construction of equipment for the production of parchmentized fibre paper are based on the literature, American practice, and preliminary experiments. Zinc chloride solutions free from even small amounts of free acids and iron should be used. The use of copper should be confined to electrolytic 99-95% copper for the evaporating apparatus and other equipment.—S. G.

Economics of the Use of Various Materials Resistant to the Action of Zinc Chloride Solutions in the Construction of Apparatus for the Production of [Parchmentized] Fibre. M. Ya. Marschak (*Zentral. Nauch.-Issledovatel. Inst. Bumazhnoi Prom. Materialui*, 1935, (3/4), 239-252; *C. Abs.*, 1936, 30, 7329).—[In Russian.] The economic discussion is based on the results of Flyate's (preceding abstract) experimental study.—S. G.

Tea Preparing Machinery. Douglas James Dalgarno (*J. Inst. Eng. (India)*, 1936, 16, 43-75; discussion, 76-82).—The uses of non-ferrous materials in tea preparation are mentioned.—S. G.

Ceramic Materials and Their Use in Fine Mechanical Work. P. Goerz (*Maschinenbau*, 1936, 15, (15/16), 445-447).—Metals can be joined to ceramic bodies if the latter are first covered with a silver solution and fired to produce a thin silver film, which is then thickened by plating and used as a basis on which to solder the metal.—v. G.

Metallic High-Temperature Resistors. R. Gautheret (*Electricité*, 1934, 18, 107-113; *C. Abs.*, 1936, 30, 7045).—Data are given for the selection of resistor materials and the design of the heating elements. For greater temperatures than 950° C. molybdenum, tungsten, or chromium-iron-aluminium alloys are recommended.—S. G.

Failures in Overhead Lines. ——— (*Met. Ind. (Lond.)*, 1936, 48, (17), 490).—A brief summary of the causes of failure of metallic aerial conductors.—P. R.

The Heavier Non-Ferrous Metals in Transportation. C. H. Mathewson (*Metals Technology*, 1936, 3, (7), 9-20).—A general review of the uses of non-ferrous metals in the transport industry with special reference to steamers, bearing metals, railway locomotives and rolling stock.—W. H.-R.

Light-Weight Metals in New Transportation [Properties of Aluminium and Magnesium Alloys]. Zay Jeffries (*Metals Technology*, 1936, 3, (7), 21-39).—The use of light alloys in the transport industry is described with special reference to magnesium and aluminium alloys. Tables are given summarizing the mechanical properties of many commercial alloys.—W. H.-R.

Structural Steels and Light-Weight Metals in the Transportation Industry. Horace C. Knerr (*Metals Technology*, 1936, 3, (7), 62-65).—Where strength is required, the practical value of a "light" alloy depends on two factors, the sp. gr. and the strength. From the structural point of view, some of the special steels, particularly chrome-molybdenum steels, are still the "lightest" alloys, since their high strength compared with that of an aluminium alloy outweighs the greater density of the steel.—W. H.-R.

Proposed Use of Alloys in Merchant Shipbuilding. Edgar P. Trask (*Metals Technology*, 1936, 3, (7), 66-83).—Tables are given showing the effects of substituting high elastic steel and aluminium for the conventional materials in ships of different classes. It is only in large ships that the saving in annual costs is sufficient to balance the increased cost of construction. Safety requirements and the benefits derived from the use of lighter metals are also discussed.—W. H.-R.

Mutual Effects of Metallurgy and Speed in the Automotive Industry. Merrill C. Horine (*Metals Technology*, 1936, 3, (7), 84-92).—The requirements of special alloys in motor transport are discussed with special reference to alloys which must retain their strength at high temperatures (e.g. engines and brakes). The majority of the alloys referred to are special steels.—W. H.-R.

The Railroads and Light-Weight Equipment. W. W. Colpitts (*Metals Technology*, 1936, 3, (7), 92-102).—The economics of high-speed railway passenger trains are discussed. Some of the rolling stock on new American high-speed trains is built of Duralumin.—W. H.-R.

XXII.—MISCELLANEOUS

(Continued from p. 483.)

An Experiment in Metallurgical Training. N. P. Allen (*J. B'ham. Met. Soc.*, 1936, 16, (1), 2-15).—A description of the lines of the 4-year course at Birmingham University.—R. G.

New Methods in the Technical Training of the Rising Generation. Joh. Mehrrens (*Giesserei-Praxis*, 1936, 57, (5/5), 62-64).—An account of the training of foundry apprentices in Germany since the War.—J. H. W.

The Institute of Material Research of the D.V.L. P. Brenner (*Luftwissen*, 1936, 3, (3), 7 pp.).—See *Met. Abs.*, this vol., p. 483.—S. G.

Some Installations of the Metal-Chemical Division (Laboratory M) of the Institut für anorganische Chemie of the Technische Hochschule, Hannover. Friedrich Weibke (*Chem. Fabrik*, 1935, 8, 123-126).—L. A. O.

Recent Developments in Metallurgy and Their Influence on Engineering. Charles-Eugène Schneider (*J. Inst. Civil Eng.*, 1936, 3, (8), 657-676; and (abstract) *Mech. World*, 1936, 100, (2583), 4).—A review of recent developments in metallurgical engineering deals principally with the production and applications of steels, but reference is also made to methods of testing, including microscopic examination, micro-analysis, and X-ray examination, and to the use of the light alloys of aluminium and magnesium in the aircraft and motor-car industries.—J. W. D.

On Keeping Abreast of Technical Developments. T. R. Cave-Brown-Cave (*Proc. Inst. Mech. Eng.*, 1935, 131, 619-624).—S. G.

Recent Advances in Metallurgy. D. Hanson (*Aluminium and Non-Ferrous Rev.*, 1936, 1, (7), 292-295).—See *Met. Abs.*, this vol., p. 182.—J. C. C.

Treatment of Metals Through the Ages. S. Neil Greenwood (*Heat-Treat. and Forging*, 1936, 22, (7), 335-339).—Presented to Metals Treatment Society of Victoria. A historical review of the development of the uses of metals by man from prehistoric to modern times.—J. E. N.

Statistical Correlation and Metallurgical Problems. T. P. Hoar (*Metallogrist* (Suppt. to *Engineer*), 1936, 10, 134-137).—A discussion of the utility of application of statistical methods to the consideration of experimental data.—R. G.

Japan's Advance in Non-Ferrous Metals. Masaharu Goto (*Japan Nickel Rev.*, 1936, 4, (2), 311-318).—[In English and Japanese.] A review.—R. G.

Powder Metallurgy—a Warning ; a Promise. Gregory J. Comstock (*Metal Progress*, 1936, 30, (1), 49–50).—The limitations and possibilities of the sintering of metallic powders are briefly indicated.—P. M. C. R.

Engineering Materials and Production Methods. — (*Mct. Ind. (Lond.)*, 1936, 49, (18), 439–440).—This review of recently developed materials and processes contains an account of Asarco, a cadmium–nickel bearing metal for automobile big-end bearings; of a new high-tensile alloy of the Hiduminium class (Hiduminium R. R. 53C); of standard copper alloys developed in Germany for centrifugally cast bearings; of a surface treatment for zinc-base die-castings which are subsequently to be enamelled or painted; and of light alloy lorry bodies, flexible hose of Monel metal, and lead–antimony loading-coil cases for use in telephone work.—P. M. C. R.

American Metal-Working Practice. — (*Mct. Ind. (Lond.)*, 1936, 49, (17), 417–418).—This review of recent methods includes accounts of a silver-soldering equipment, electric immersion heaters, automatic conveyor-type soldering plant, a rotating-barrel degreasing unit, a method of controlling tension in cold-rolling, and the Bonderizing process as applied to zinc-base die-castings and galvanized coatings.—P. M. C. R.

†**Safety in the Metal Industry.** E. A. Bolton (*J. B'ham. Met. Soc.*, 1936, 16, (3), 102–117).—Presidential Address. See *Met. Abs.*, this vol., p. 483.—S. G.

Contributions of Aluminium to Metallurgical Progress. Junius D. Edwards (*Metal Progress*, 1936, 29, (2), 34–39).—An account of the development of the electrolytic production of aluminium is followed by brief descriptions of the "Thermit" process, the age-hardening of Duralumin, and the introduction of the aluminium cable.—P. M. C. R.

Aluminium and Bauxite. C. L. Mantell (*Mineral Ind.*, 1935, 44, 13–30).—Mainly statistical. Developments in the production of aluminium in various countries are dealt with.—S. G.

Po-Shan Bauxite as a Possible Raw Material for the Production of Aluminium in China. Shoo-Tze Leo and Wie-Cheng Wei (*J. Chem. Eng. (China)*, 1936, 3, 113–123; *C. Abs.*, 1936, 30, 7720).—Experiments carried out on alumina from the Po-Shan bauxite show that the purity of aluminium obtained is closely proportional to the purity of the oxide used, and the metal obtained in laboratory experiments is always less pure than that obtained on a commercial scale. The aluminium produced from Po-Shan bauxite for an estimated commercial scale would satisfy the requirements of British Standard Specification for aircraft material, 99% aluminium notched-bars and pigs.—S. G.

Antimony. — (*Mineral Ind.*, 1935, 44, 31–37).—World production, prices, imports and exports are discussed.—S. G.

Arsenic. — (*Mineral Ind.*, 1935, 44, 38–40).—Statistical.—S. G.

Barium and Strontium. — (*Mineral Ind.*, 1935, 44, 54–57).—Mainly statistical.—S. G.

Chromium. — (*Mineral Ind.*, 1935, 44, 58–65).—Statistics of production and prices are given, with notes on mine developments.—S. G.

Cobalt. C. W. Drury (*Mineral Ind.*, 1935, 44, 105–110).—Production, trade, and prices are dealt with, with a brief note on new uses of the metal. A bibliography is appended.—S. G.

Copper. Percy E. Barbour (*Mineral Ind.*, 1935, 44, 111–148).—A review of the industry. The international copper restriction scheme, world copper outlook, production, consumption and stocks, prices, and developments of the producers are dealt with. Among the tables of statistics, a table is given of the amount of secondary copper recovered in the U.S.A. from 1929 to 1935.—S. G.

Metallurgy of Copper in 1935. Carle R. Hayward (*Mineral Ind.*, 1935, 44, 156–169).—A review. Deals with properties of copper, and progress in

smelting, fire-refining, electrolytic refining, and properties and manufacture of copper alloys.—S. G.

Gold and Silver. H. N. Lawrie (*Mineral Ind.*, 1935, 44, 183-302).—Developments in mining, production, and metallurgy are reviewed. Gold reserves, economics, stocks of silver, and government acts are discussed. Numerous tables of statistics are given. A full bibliography is given, devoted to mining, process metallurgy, and economics.—S. G.

Lead. Allison Butts (*Mineral Ind.*, 1935, 44, 361-389).—A review of production, with statistics.—S. G.

Metallurgy of Lead in 1935. Carle R. Hayward (*Mineral Ind.*, 1935, 44, 390-395).—A brief review, covering smelting, refining, alloys, and the production of solder by direct electrolysis.—S. G.

Magnesite. Samuel H. Dolbear (*Mineral Ind.*, 1935, 44, 396-401).—A review of production for magnesite and metallic magnesium. Statistics include sales or use of new ingot metal and manufactured products by producers in U.S.A., and imports for consumption in U.S.A.—S. G.

Manganese. — (*Mineral Ind.*, 1935, 44, 402-415).—A review of production, prices, imports, exports, and consumption.—S. G.

Quicksilver. — (*Mineral Ind.*, 1935, 44, 513-519).—A review of production, prices, imports and exports, with a brief note on developments in technology. Statistics are given.—S. G.

Molybdenum. Alan Kissock (*Mineral Ind.*, 1935, 44, 422-425).—Briefly reviews uses, market, and production, with statistics of world production from 1927 to 1935.—S. G.

Canada's Nickel Industry. E. A. Collins (*Canad. Geographical J.*, 1936, 13, (5), 257-276; *Bull. B.N.F.M.R.A.*, 1936, (92)).—A popular account of the history of the industry, production, and uses of nickel, with excellent illustrations.—S. G.

The Research and Development Laboratory of the Mond Nickel Company, Ltd. — (*Found. Trade J.*, 1936, 55, (1053), 307-309; also *Met. Ind. (Lond.)*, 1936, 49, (17), 414-416; *Metallurgia*, 1936, 15, (85), 1-3; *Engineering*, 1936, 142, (3694), 472-474; *Elect. Rev.*, 1936, 119, (3075), 597; *Machinery (Lond.)*, 1936, 49, (1255), 145-146; *Machinist (Eur. Edn.)*, 1936, 80, (40), 588-591E).—P. M. C. R.

Nickel. Thomas W. Gibson (*Mineral Ind.*, 1935, 44, 426-432).—Sources, production, and uses are briefly discussed, with statistics.—S. G.

Platinum Group Metals. G. A. Roush (*Mineral Ind.*, 1935, 44, 467-482).—A review of the industry, with statistics.—S. G.

World Radium Industry. G. A. Nikitin (*Redkie Metalli (Rare Metals)*, 1936, (4), 41-46).—[In Russian.] Statistics.—D. N. S.

Rhodium and Uranium. Hugh S. Spence (*Mineral Ind.*, 1935, 44, 520-531).—A review of developments, with statistics.—S. G.

World Production of Tantalum and Niobium. L. A. Bronstein (*Redkie Metalli (Rare Metals)*, 1936, (2), 42-45).—[In Russian.] Statistics.—D. N. S.

Tin. E. Baliol Scott (*Mineral Ind.*, 1935, 44, 566-585).—Discusses production, prices, consumption, restriction, and smelting, with statistics.—S. G.

Tungsten. Colin G. Fink (*Mineral Ind.*, 1935, 44, 586-599).—Discusses production, with statistics. Developments in technology are briefly reviewed. A short bibliography is given.—S. G.

Vanadium. B. D. Saklatwalla (*Mineral Ind.*, 1935, 44, 532-534).—Discusses world production, with statistics.—S. G.

Zinc. S. D. Strauss (*Mineral Ind.*, 1935, 44, 600-621).—A review of the industry, production, consumption, imports and exports, with statistics.—S. G.

Metallurgy of Zinc in 1935. W. R. Ingalls (*Mineral Ind.*, 1935, 44, 622-627).—Developments in process metallurgy are reviewed.—S. G.

Minor Metals. — (*Mineral Ind.*, 1935, 44, 628-641).—Production, imports, exports, and prices are reviewed.—S. G.

World Markets for Non-Ferrous Metals. W. R. Ingalls (*Met. Ind. (Lond.)*, 1936, 49, (17), 409-411).—Paper presented at American Mining Congress.

—J. E. N.

Avoiding Waste. — (*Giesserei-Praxis*, 1936, 57, (33/34), 343-345).—The causes and distribution of waste in the various branches of metal manufacture are analyzed, and the means of avoiding or minimizing them are discussed.—J. H. W.

Toxic Dusts: Their Origin and Sources in Various Industries. Reuel C. Stratton (*Mech. Eng.*, 1935, 57, (2), 95-98).—S. G.

Prevention of Occupational Diseases Other Than Those That are Caused by Toxic Dust. R. R. Sayers and J. M. Dallavalle (*Mech. Eng.*, 1935, 57, (4), 230-234).—S. G.

Propeller Crankshaft-Vibration Problems. H. H. Couch (*Mech. Eng.*, 1936, 58, (4), 215-221).—A summary of results of investigations carried out by the U.S.A. Air Force. An account of the standard method of determining the type of vibration is followed by a description of failures in crankshaft, crank-case, gearing, and propeller blades. Typical cases are illustrated in the case of blading. The "magnetic pick-up" used in determining the type, frequency, and amplitude of vibrations under service conditions is described; oscillograph records are reproduced, and methods of protecting propellers from damage by vibration are suggested.—P. M. C. R.

***The Inductance of Iron-Cored Coils Having an Air Gap.** G. F. Partridge (*Phil. Mag.*, 1936, [vii], 22, (148), 665-678).—Curves are given showing the variation of inductance of an iron-cored coil with length of air gap. A method of estimating the effect of leakage is given sufficient to enable the inductance to be calculated to within a few per cent.—W. D. J.

General Summary of the Plan of Work for 1936 in the Physical Institutes of the People's Commissariat of Heavy Industry [U.S.S.R.]. B. Hochberg (*Tech. Physics U.S.S.R.*, 1936, 3, (3), 287-291).—[In English.] An outline is given of the subjects of investigation for 1936; these come under the headings: nuclear physics; electrical properties of solid bodies (semiconductors and rectifiers); photoelectric, liquid, and amorphous states; mechanical properties of solid bodies (includes methods of testing); phase transformation; X-ray analysis; magnetic properties at low temperatures; and optics.—B. C.

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***American Institute of Mining and Metallurgical Engineers.** *General Alphabetical and Analytical Index [to] Publications of the American Institute of Mining and Metallurgical Engineers (1926-1935).* Med. 8vo. Pp. 431. 1936. New York: The Institute, 29 W. 39th St.

American Society for Testing Materials. *Methods of Chemical Analysis of Metals.* Pp. 275. Philadelphia, Pa.: The Society, 260 S. Broad St. (Paper, \$2; cloth, \$2.50.)

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[Contains the following papers, with discussions: E. F. Cone, "Carbon and Low-Alloy Steels"; E. E. Thum, "Corrosion-Resisting Steels"; C. H. Davis, "Alloys of Copper"; G. F. Geiger, "Alloys of Nickel"; E. H. Dix, Jr., and J. J. Bowman, "Alloys of Aluminium and Magnesium."]
- Arkadjew, W. K.** *Elektromagnetische Prozesse in Metallen.* Teil II.—*Das elektromagnetische Feld. Die Anwendung der Theorie von Maxwell zur rationellen Verwendung der Metalle in der Elektrotechnik.* [In Russian.] Pp. 304. 1936. Moscow and Leningrad: Onti. (Rbl. 6.60.)
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[Contains most useful reports on failures of ferrous and non-ferrous materials as well as a paper by L. W. Schuster on "The Notched-Bar Test Applied to Steel and Weld Metal, with Special Reference to the Izod Test" (pp. 114-172). All items of non-ferrous interest are abstracted in the present issue of *Met. Abs.*]
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- ***Copper Development Association.** *Copper for Bus-Bar Purposes.* (C.D.A. Publication, No. 22.) $6\frac{1}{2} \times 8\frac{1}{2}$ in. Pp. vi + 161, with frontispiece and 29 illustrations in the text. 1936. London: The Association, Thames House, Millbank, S.W.1. (Limited free issue.)
- ***Damerow, E., and A. Herr.** *Hilfsbuch für die praktische Werkstoffabnahme in der Metallindustrie.* 17×25 cm. Pp. iv + 80, with 38 illustrations. 1936. Berlin: Julius Springer. (R.M. 9.60.)
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- Doczekal, R., and H. Pitsch.** *Absolute Thermische Daten und Gleichgewichtskonstante.* Med. 8vo. Pp. 69, illustrated. 1935. Wien: Julius Springer. (R.M. 6.60.)
- Drinker, Philip, and Theodore Hatch.** *Industrial Dust. Hygienic Significance, Measurement and Control.* Med. 8vo. Pp. 316, with 104 illustrations. 1936. New York: McGraw Hill Book Co., Inc. (\$4.00); London: McGraw-Hill Publishing Co., Ltd. (24s. net).
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- ***Edwards, Junius David.** *Aluminium Paint and Powder.* Second Edition, Revised and Enlarged. Med. 8vo. Pp. 216, with 78 illustrations. 1936. New York: Reinhold Publishing Corp.; London: Chapman and Hall, Ltd. (22s. 6d. net.)
- ***Eggert, John.** *Einführung in die Röntgenphotographie.* Sechste Auflage. Pp. vii + 217, with 90 illustrations in the text. Leipzig: S. Hirzel. (Geh., M. 5; geb., M. 6.)

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- [Contents: D. MacDonald, "The Metallurgy of the Alloys of Gold and Silver"; R. S. Hutton, "Working the Metals: Rolling Sheet and Forming Articles Therefrom"; W. A. C. Newman, "The Heat-Treatment of Gold and Silver Alloys"; H. A. P. Littledale, "A New Process of Hard Soldering and its Possible Connection with the Methods Used by the Ancient Greeks and Etruscans"; R. S. Hutton, "Polishing: Methods and Results of Finishing Processes"; S. Field, "The Process of Plating and Colouring in Relation to the Gold and Silver Trades."]
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- ***Hanemann, —, and — Schrader.** *Atlas Metallographicus.* Band II, Lieferung 1, 2, 3 u. 4. Tafel 1-32; Abbildungen 1-229. 1936. Berlin: Gebrüder Borntraeger, Koester Ufer 17. (R.M. 30.)
- ***Hays, Jos. W.** *How to Build Up Furnace Efficiency.* Eighteenth Edition, Revised and Enlarged. Pp. xvi + 559, illustrated. 1936. Michigan City, Ind.: Dunes Publishing Co. (\$3.00.)
- ***Hebberling, Hans.** *Das Wichtigste vom Korrosionsschutz.* Ein Merkbüchlein für Baufachleute und alle an der Sachwerterhaltung interessierten Kreise. 13 × 20 cm. Pp. 45, with 18 illustrations. 1936. Mün- chen: Geo. Callwey. (M. 2.)
- ***Hermann, E., and E. Zurbrügg.** *Die Bearbeitung des Aluminiums.* Zweite vermehrte und verbesserte Auflage. Demy 8vo. Pp. viii + 117, with 70 illustrations. 1936. Leipzig: Akademische Verlagsgesell- schaft m.b.H. (M. 4.)
- ***Hodgman, Charles D.** Editor-in-Chief. *Handbook of Chemistry and Physics.* A Ready-Reference Book of Chemical and Physical Data. Twenty- First Edition. Fcap. 8vo. Pp. xix + 2023. 1936. Cleveland, O.: Chemical Rubber Publishing Co. (\$6.00.) Obtainable in England from A. Harvey, 17 Market St., London, S.E.1, or A. Bird, 22 Bedford St., W.C.2.
- ***Holler, Hermann.** *Der Kupfer-, Messing-, Nickel-, Blei-Schweisser.* 15 × 21 cm. Pp. 71, with 71 illustrations. 1936. Halle a. S.: Carl Marhold. (R.M. 1.50.)
- ***Holler, Hermann.** *Der Leichtmetall-Schweisser.* 15 × 21 cm. Pp. 102, with 92 illustrations. 1936. Halle a. S.: Carl Marhold. (R.M. 2.)
- ***Home Office.** *The Use of Abrasive Wheels.* (Home Office Safety Pamphlet No. 7.) Fifth Edition. Med. 8vo. Pp. 51, with 38 illustrations. 1936. London: H.M. Stationery Office. (9d. net.)
[Covers: abrasives used for wheels; manufacture of abrasive wheels; prevention of dust inhalation; with a summary of the main precautions recommended. An appendix gives the statutory requirements applying to abrasive wheels.]
- ***Horner, J. G.** *Mechanical Engineering Terms.* Comprising approximately 8000 Definitions. Sixth Edition, revised and enlarged by E. H. Sprague. Large Cr. 8vo. Pp. 512. London: The Technical Press, Ltd. (12s. 6d.)
- ***Imperial Institute.** *The Mineral Industry of the British Empire and Foreign Countries. Statistical Summary (Production, Imports and Exports), 1933-1935.* Med. 8vo. Pp. 438. 1936. London: H.M. Stationery Office. (7s. 6d. net.)
[Covers: abrasives, aluminium, antimony, arsenic, asbestos, barium minerals, bismuth, borates, cadmium, china clay, chrome ore and chromium, coal, coke and by- products, cobalt, copper, diamonds, diatomaceous earth, felspar, fluorspar, Fuller's earth, gold, graphite, gypsum, iron and steel, lead, magnesite, manganese, mercury, molybdenum, monazite, nickel, nitrogen compounds, petroleum and allied products, phosphates, platinum, potash minerals, pyrites, salt, silver, strontium minerals, sulphur, talc, tin, titanium minerals, tungsten, uranium minerals, vanadium, and zinc. A list of statistical publications completes the volume.]
- ***Institute of Chemistry of Great Britain and Ireland.** *Register of Fellows, Associates, and Students, 1936.* Demy 8vo. Pp. 433. 1936. London: The Institute, 30 Russell Sq., W.C.1.

- ***Institution of Petroleum Technologists.** *List of Members.* Demy 8vo. Pp. 85. 1936. London: The Institution, Aldine House, Bedford St., Strand, W.C.2.
- ***International Tin Research and Development Council.** *Tinplate and Tin Cans in the United States.* (Bulletin of the International Tin Research and Development Council, No. 4.) Demy 4to. Pp. 142, with 159 illustrations. 1936. London: The Council, 378 Strand, W.C.2. (Gratis.)
- ***Iron and Steel Institute.** *Fourth Report of the Corrosion Committee.* Being a Report by a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council. (Special Report No. 13.) Demy 8vo. Pp. xv + 240, with 52 illustrations. 1936. London: The Institute, 28 Victoria St., S.W.1. (16s.; Members, 10s.)
- Jerochin, A. A.** *Das Schweissen mit Elektroden von grossem Durchmesser.* [In Russian.] Pp. iii + 73. 1936. Moscow: Orgametall. (Rbl. 8.75.)
- Jørgensen, Holger.** Die Bestimmung der Wasserstoffionenkonzentration (p_H) und deren Bedeutung für Technik und Landwirtschaft. 15.5 × 22.5 cm. Pp. xv + 264, with 49 illustrations. 1935. Dresden-Blasewitz: Theodor Steinkopff. (Geh., R.M. 15; geb., R.M. 16.)
- Kaschtschenko, G. A.** *Lehrbuch der allgemeinen Metallographie.* 2. Auflage. Teil 1.—*Die Grundlagen der Metallographie. Die Theorie der Kristallisation von Metallen und Legierungen und über die metallographischen Methoden ihre Untersuchung.* [In Russian.] Pp. 236. 1936. Moscow and Leningrad: Onti. (Rbl. 3.)
- Kaschtschenko, G. A.** *Lehrbuch der allgemeinen Metallographie.* 3. Auflage, Teil 2: *Untersuchung der wichtigsten technischen Legierungen in verschiedenen Zuständen.* Pp. v + 315. 1936. Moscow and Leningrad: Onti. (Rbl. 4.25.)
- ***Kelly's Directory of Merchants, Manufacturers, and Shippers of the World.** *A Guide to the Export and Import, Shipping and Manufacturing Industries.* Fiftieth Edition. In two volumes. Volume I. Pp. cccxlii + 1950. Volume II. Pp. cvii + 2166. 1936. London: Kelly's Directories, Ltd. (64s.)
- Konobejewski, S., G. Kurdjumov, und W. Turianski.** *Die Röntgenographie in ihre Anwendung zur Materialprüfung.* Pp. xv + 568. 1936. Moscow and Leningrad. Onti. (Rbl. 12.)
- ***Krupp (Fried.) A.G.** *Widia-Handbuch.* 15 × 21 cm. Pp. 230, with 213 illustrations. 1936. Essen: Fried. Krupp A.G.
- Landolt, Hans, und Richard Börnstein.** *Physikalische-chemische Tabellen.* 5. umgearb. u. verm. Auflage. Erg.-Band 3, Teil 3. Pp. xvi + 1815-3039. Berlin: Julius Springer. (M. 188.)
- Lessel, W.** *Die Schlauchelektrode zur Lichtbogenschweissung von Kupfer. Neuartiges Verfahren zur Metall-Lichtbogenschweissung von Kupfer und kupferreichen Legierungen unter Verwendung u. "Schlauch"-Kupferelektrode.* Pp. iv + 57. Berlin: V.D.I. Verlag. (M. 3.80.)
- ***Lincoln Electric Company.** *Procedure Handbook of Arc-Welding Design and Practice.* Fourth Edition. Demy 8vo. Pp. xii + 819, with 990 illustrations. 1936. Cleveland, O.: The Company (\$1.50 in U.S.A., \$2.00 elsewhere, post paid); Toronto: Lincoln Electric Co. of Canada, Ltd.; Welwyn Garden City, Herts.: Lincoln Electric Co., Ltd.

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[Reprinted from *Met. Ind. (Lond.)*, 1936, 48, 705; see *Met. Abs.*, this vol., p. 328.]
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[Reprinted from *Met. Ind. (Lond.)*, 1936, 49, 201, 229; see *Met. Abs.*, this vol., p. 391.]
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[Reprinted from *Metals and Alloys*, 1936, 7, 204-206; see *Met. Abs.*, this vol., p. 410.]
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- Standardization.** *A Survey of the Present Organization of Standardization, National and International.* Pp. viii + 55. 1936. London: Central Office of the World Power Conference, 36 Kingsway, W.C.2. (3s. 6d. net.)
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- ***Thorneycroft, W. E.** *Antimony and Bismuth.* (A Text-Book of Inorganic Chemistry. Edited by J. Newton Friend. Volume VI, Part V.) Med. 8vo. Pp. xxviii + 249, with 12 illustrations. 1936. London: Charles Griffin and Co., Ltd. (18s. net.)
- Timoshenko, S., and G. H. MacCullough.** *Elements of Strength of Materials.* London: Macmillan & Co., Ltd. (14s. net.)
- Turner, Francis.** *Turner's Metal Plate Workers' Workshop Companion.* Seventh Edition. London: Sheet Metal Industries, 49 Wellington St., W.C.2. (6s. 6d., post free.)
- Tustison, F. E., and Ray F. Kranzusch.** *Metalwork Essentials.* 8vo. Pp. xii + 176, illustrated. 1936. New York: Bruce Publishing Co. (\$1.50.)
- ***U.S. Department of Commerce, National Bureau of Standards.** *X-Ray Protection.* (National Bureau of Standards Handbook, HB20.) Cr. 8vo. Pp. 28, with 3 plates. 1936. Washington, D.C.: Superintendent of Documents. (5 cents.)
- ***Wegel, R. L., and H. Walther.** *Internal Dissipation in Solids for Small Cyclic Strains.* (Bell Telephone System Technical Publications, Metallurgy, Monograph B-864.) Med 8vo. Pp. 17, with 9 illustrations. 1936. New York: Bell Telephone Laboratories, Inc., 463 West St.
[Reprinted from *Physics*, 1935, 6, 141-157; see *Met. Abs.*, this vol., p. 499.]
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- ***Wendt, R. E.** *Foundry Work.* A Text on Moulding, Dry-Sand Coremaking, Melting and Mixing of Metals and Problems in Foundry Management. Third Edition. Demy 8vo. Pp. xii + 240, with 208 illustrations. 1936. New York: McGraw-Hill Book Co., Inc. (\$2.00); London: McGraw-Hill Publishing Co., Ltd. (12s.)
- Witman, F. F., L. I. Kukanow, P. S. Ssacharow, N. A. Schaposchnikow, und Je. M. Schewandin.** *Leitfaden für Laboratoriumsarbeiten für die Metallprüfung.* [In Russian.] Pp. iii + 205. 1936. Leningrad and Moscow: Onti. (Rbl. 2.25.)

XXIV.—BOOK REVIEWS

(Continued from pp. 485-486.)

Engineering Alloys. Names—Properties—Uses. By Norman E. Woldman and Albert J. Dornblatt. Med. 8vo. Pp. xv + 622. 1936. Cleveland, O.: American Society for Metals, 7016 Euclid Ave. (\$10.00.)

In the opinion of the authors there has been a great demand for a practical and technical reference book on engineering alloys, and they have undertaken the formidable task of collecting all available data on the composition, properties, uses, and manufacturers of over 8200 ferrous and non-ferrous alloys. All the information is cross-indexed in such a way that knowing only

the name of an alloy, or the name of a manufacturer, or the application and uses of an alloy the remainder of the facts can be readily traced.

The first section lists the alloy names in alphabetical order with corresponding serial numbers. The second section lists the alloys in these consecutive serial numbers and gives trade names, composition (where known), properties, uses, and key numbers indicating the manufacturer and source from which data were obtained. The third section classifies the alloys represented by their serial numbers according to special characteristics and typical uses. In further sections the manufacturers are listed in alphabetical order, and again in numerical order of the key numbers of Section 2.

Information was supplied direct by about 650 manufacturers and obtained from about 100 other listed sources of reference. The final section consists of three Appendices; (1) a classification of the ferrous corrosion- and heat-resistant alloys according to composition; (2) terms of metallurgical interest; and (3) useful tables and information.

The authors point out that blank spaces appear in the text because of the manufacturers' feeling that certain information is either confidential or of no practical interest, and it is emphasized that the reader requiring more specific information as to properties, composition, or uses should communicate direct with the manufacturer.

The greatest credit is due to the authors for the thoroughness and care devoted to the presentation of all these facts, and the book should prove invaluable as a standard work of reference to metallurgists and engineers. In the majority of cases, actual compositions are quoted, but where these are omitted the remaining values are generally sufficient to indicate the general properties of the alloys. The range is very extensive, covering the products of most of the important manufacturers in Europe and the United States, but one cannot help feeling there are too many alloys. A careful study of the book shows that many alloys of similar composition appear under a wide variety of trade names, and this book represents the most ambitious attempt made up to the present to collate these alloys.—J. E. NEWSON.

Corrosion-Resistance of Metals and Alloys. By Robert J. McKay and Robert Worthington. (American Chemical Society Monograph Series.) Med. 8vo. Pp. 492, with 66 illustrations. 1936. New York: Reinhold Publishing Corp. (\$7.00); London: Chapman and Hall, Ltd. (35s. net).

This worthy addition to the distinguished series of monographs published by the American Chemical Society classifies the phenomena of corrosion under five headings: (1) The properties of the media causing corrosion; (2) the form of corrosion; (3) factors affecting corrosion rate; (4) the properties of metals affecting their corrosion; and (5) the specific corrosion-resistance of metals and alloys to different media. Part 1, the first fifth of the book, deals with considerations (1) to (4), and the remainder, Part 2, is devoted to (5). In this latter section, the corrosion-resistance of the following materials is reviewed; magnesium and its alloys, aluminium and its alloys, zinc and zinc coatings, cadmium plate, tin and tinfoil, lead, iron and steel, molybdenum alloys, chromium alloys, chromium plate, nickel-iron alloys, nickel, nickel-copper alloys, copper, brass, bronze, and nickel silver.

It will be realized that Part 1 is too short to be satisfactory as a review of corrosion theory. Too drastic condensation of this section detracts from the merits of the work as a text-book; it is, however, an adequate introduction to Part 2, in which lies the main value of the book. Here are collected the known *facts* of corrosion in a concise and accessible form which will be welcomed by all whose task it is to choose "the right alloy in the right place." Not only have the authors scoured the literature for data concerning the materials mentioned above, but they have also converted all the figures to a common unit—mg./dm.² per day loss in weight—thus making it an easy matter to compare directly the results of different workers. In a task of such magnitude, it is only to be expected that some small omissions can be found—the M.B.V. process for the protection of aluminium (as distinct from its use to provide a "key" for paint) and the selenium process for magnesium are not mentioned—but their number is certainly small. The chapter on chromium alloys describes the foibles of the protective film more clearly than we have seen done elsewhere and sheds a vivid light on the difficulty of forecasting service behaviour from small-scale tests.

A comprehensive bibliography is given at the end of each chapter and the indexing is good. Every technologist who has to consider the problem of corrosion should have such classical works as "Evans" and "Speller" on his bookshelf. He will keep "McKay and Worthington" on his desk.—H. W. G. HIGNETT.

The Technology of Aluminium and Its Light Alloys. By Alfred v. Zeerleder. Translated from the Second German Edition by A. J. Field. Roy. 8vo. Pp. vi + 301, with 219 illustrations. 1936. Amsterdam: Nordemann Publishing Co.; London: Crosby Lockwood & Son, Ltd. (21s. net.)

The usefulness of Dr. von Zeerleder's book can be gauged from the fact that a second German edition was called for in little more than a year after publication, and thus an English

translation will be widely welcomed. The German editions have already been favourably reviewed in *Met. Abs.* (1934, 1, 282 and 1935, 2, 493) and the subject-matter needs no further comment.

Mr. Field has attempted to make a translation which is equally acceptable to English and to American readers, and so far as English readers are concerned we have no hesitation in saying that he has succeeded. He has accomplished the difficult task of making an accurate translation which reads like an original work. The book is very well printed and the illustrations are excellent.—H. W. L. PHILLIPS.

Das Antimon, Geschichte, Gewinnung und Verwendung des Antimons in Industrie und Heilwesen sowie seine Giftwirkung. Von Joachim Habeck. 16 × 23 cm. Pp. 55. 1936. Berlin: Richard Schoetz, Wilhelmstrasse 10. (R.M. 2.40.)

After a brief account of the history, occurrence, metallurgy, and properties of antimony, short accounts are given of the properties and uses of the most important compounds with special reference to those used in medicine. The remainder of the book deals entirely with medical and forensic aspects and includes interesting accounts of the use of antimony compounds as poisons, the more recent use of complex organic antimony compounds in the treatment of tropical diseases, and methods of detecting antimony in organs in cases of suspected antimonial poisoning.—A. R. POWELL.

Die Korrosion Metallischer Werkstoffe. Herausgegeben von O. Bauer, O. Kröhnke, und G. Masing. Band I.—**Die Korrosion des Eisens und seiner Legierungen.** Von G. Masing, E. H. Schulz, C. Carius, K. Daeves, E. Houdremont, und H. Schottky. 7 × 10 in. Pp. xxiii + 560, with 219 illustrations. 1936. Leipzig: S. Hirzel. (Geh., R.M. 37.50; geb., R.M. 39.)

The scientific and technical literature dealing with all the diverse aspects of the corrosion of metals is so extensive and so widely scattered that it has become exceedingly difficult to follow the development of the subject as a whole. In the present treatise, which will eventually comprise four volumes, the general editors and their team of expert collaborators have set themselves the stupendous task of gathering together all the essential facts into an ordered system and of interpreting them so far as possible in terms of clearly defined principles. So far they have achieved considerable success, and if the standard of this first volume is maintained the complete work should be of immense value to everyone who is concerned with any aspect of corrosion, whether from the theoretical point of view or in relation to technical problems of corrosion prevention.

The first 126 pages contain an informative survey of the physico-chemical principles governing the corrosion of metals by electrolyte solutions and by gases, and thus afford a general introduction to the whole treatise. The electrochemical theory is clearly set out and its application under various conditions indicated; experimental methods of investigation are outlined and the main conclusions correlated.

The remainder of this volume is devoted to the corrosion of iron and steel, including stainless steel and other alloys. The general principles set forth in the previous section are extended to cover the special features of the corrosion of ferrous materials. Technical aspects are considered in detail, and separate chapters are devoted to the corrosion of iron and steel as an industrial problem, the effects of special corrosive agents, and the relation between mechanical strain and corrosion.

The book is well illustrated with numerous diagrams, especially graphs, and a number of photographs. Many tables of data are included, and full reference is made to the original literature of all countries which have contributed to the investigation of the problems of corrosion.—H. J. T. ELLINGHAM.

Physical Constants of Pure Metals. National Physical Laboratory. Med. 8vo. Pp. 27. 1936. London: H.M. Stationery Office. (6d.)

This pamphlet contains a valuable collection of data on the physical properties of pure metals, mostly determined within recent years at the National Physical Laboratory. Information given includes melting points, critical points, density, electrical resistivity, surface tension of molten metals, lattice parameters, latent heats of fusion, specific heats, thermal conductivities, and coefficients of expansion at various temperatures. No metallurgist can afford to do without this handy reference book.—A. R. POWELL.

Progrès dans la Technique de la Métallographie microscopique. Par R. Castro. (Actualités scientifiques et Industrielles, 301. Exposés publiés sous la direction d'Albert Portevin.) 16 × 25 cm. Pp. 56, with 14 illustrations. 1935. Paris: Hermann et Cie, 6 Rue de la Sorbonne. (12 francs.)

This booklet is a very compact review of metallurgical microscopy. The essential fundamental information is given without unnecessary detail. The preparation of the specimen for microscopic examination and photography is thoroughly dealt with in about 7 pages, the reader being referred to other works for details of some of the newer methods. The microscope itself is then considered under two headings, the optical system and the mechanical system, and the book ends with a chapter on the future in which such things as cinephotomicrography, photomicrography in three dimensions, and the electron microscope are discussed.

Two words, new to the reviewer, may also be of interest to readers. The first is "un glazebrook" for a polarizing nicol prism; the other is the phrase "au moyen de bowdens"—by means of Bowden cables.—J. L. HAUGHTON.

Atlas Metallographicus. Von H. Hanemann und A. Schrader. Band II. Lieferung 1: Tafel 1–8; Lieferung 2: Tafel 9–16; Lieferung 3: Tafel 17–24; Lieferung 4: Tafel 25–32. 1936. Berlin: Gebrüder Borntraeger. (R.M. 30.)

The four parts with which volume 2 of the "Atlas" begins deal with grey cast iron. In a 32 pp. introduction, the equilibrium diagrams of the Fe–C–Si, Fe–C–P, and Fe–Mn–FeS–MnS systems are described and their effect on the properties and constitution of cast iron are discussed. The method adopted for preparing cylindrical castings of different diameters, polishing and etching the specimens, and the various structural constituents to be sought are also described. Although the 229 photomicrographs illustrate structures relating to cast iron of interest primarily to metallurgists in iron and steel, even the purely non-ferrous metallurgist can find facts and items of interest and instruction, as, for instance, the effect of insufficient polishing and etching on the structure revealed, shown in Plate I.

The high standard of production that the authors have set in preparing this "Atlas" is fully maintained in the parts under review.—J. H. WATSON.

The Theory of the Properties of Metals and Alloys. By N. F. Mott and H. Jones. (The International Series of Monographs on Physics. General Editors: R. H. Fowler and P. Kapitza.) 8vo. Pp. xiii + 326, with 108 illustrations. 1936. Oxford: at the Clarendon Press. (25s. net.)

Since the formulation of the Fermi–Dirac statistics in 1926, the application of quantum mechanics to the general theory of the metallic state has proceeded rapidly and although of such recent origin has met with considerable success. The authors have made outstanding contributions to this branch of physics and their book forms a first-class summary of our present knowledge of certain aspects of the wave theory of metals.

The main problem of the mathematical treatment of the behaviour of electrons in the crystal lattice is considered and the various approximate solutions are obtained. These are then used to develop theories of optical properties, cohesion, crystal structure, magnetic and electrical properties. The various theoretical results are compared with experimental results wherever possible and the agreement discussed. The peculiarities of certain metals such as, for example, bismuth are explained in terms of their individual atomic structure.

Perhaps the most remarkable achievement of quantum mechanics has been to provide a theoretical basis for the occurrence of different electron–atom ratios corresponding to certain definite phases in alloy systems. This subject, which is of great interest to metallurgists, is fully examined in the chapter on "The Crystal Structure of Metals and Alloys."

The book is intended primarily for the mathematical physicist, consequently the metallurgist will find it difficult to follow unless his mathematical technique is well above the average.

—C. SYKES.

An Introduction to Physical Metallurgy. By Leland Russell van Wert. Med. 8vo. Pp. xi + 272, with 177 illustrations. 1936. New York: McGraw-Hill Book Co., Inc. (\$3.00); London: McGraw-Hill Publishing Co., Ltd. (18s. net).

There are already several good "Introductions" to physical metallurgy, and in a new book of this kind we may reasonably expect accuracy and clearness, together with a reliable account of the ideas underlying modern views on alloy structures. We have read this book with every sympathy for the attempt to include new developments of the subject, and it is therefore with regret that we must report that the reader will obtain better value elsewhere. In so far as the

book deals with the older branches of the subject, such as the interpretation of equilibrium diagrams, the description is adequate, but the sections dealing with more recent developments are often very inferior. We have noted more than 40 mistakes in one reading of the book, and some of these are of such an elementary character that either the subject-matter has not been understood, or there has been great carelessness in correcting the proofs.—W. HUME-ROTHERY.

Hilfsbuch für die praktische Werkstoffabnahme in der Metallindustrie. Von E. Damerow und A. Herr. 17 × 25 cm. Pp. iv + 80, with 38 illustrations. 1936. Berlin: Julius Springer. (R.M. 9.60.)

This little book is a manual for the test room and inspection departments, compiled by two technologists of a metal firm. Nine pages are devoted to the marking out and handling of tensile test-pieces according to German standards, together with particulars of useful calculating dodges with the slide rule. Methods of hardness testing are summarized in 5 pages, whilst bending and impact tests, and weld tests, receive two pages each. Then follow 42 tables in metric units for calculating stress, elongation, reduction of area, &c., from the dimensions of test-pieces of various sizes. Bend and hardness tables are included, together with approximate conversions for results obtained from the various different hardness tests. The book concludes with a few physical constants and English-metric conversion factors.

Absolute accuracy is essential in such a manual, and it is, therefore, a pity that a misprint on p. 79 reports that one English ton = 3240 lb.—HUGH O'NEILL.

Einfluss des Spannungszustandes auf das Formänderungsvermögen der metallischen Werkstoffe. Von Albert F. Maier. (Mittelungen aus der Materialprüfungsanstalt an der Technischen Hochschule, Stuttgart.) Demy 8vo. Pp. iv + 47 + 11 tables. 1935. Berlin: V.D.I.-Verlag, G.m.b.H. (Br., R.M. 5; V.D.I.-Mitgl., R.M. 4.50.)

This book is in the nature of a record of an extensive research. The author examines the behaviour of steel, cast iron, and bronze test-pieces when subjected to the simultaneous action of two applied loads. Tubular test-pieces are subjected to internal pressure and to simultaneous longitudinal tensile stress, and to simultaneous internal pressure and longitudinal compressive stress, respectively. The mechanical properties, flow characteristics, and fracture are compared to those of similar test-pieces subjected to normal tensile or compressive stresses.

Similarly, cylindrical bodies are subjected to uniform radial compressive stresses and simultaneous longitudinal tensile or compressive stresses.

The latter portion of the book is devoted to fatigue tests on mild steel and cast-iron tubular test-pieces subjected at the same time to internal pressure or to longitudinal tensile stress. A useful tabular summary of mechanical tests results is appended.

The photographs of characteristic fractures are well reproduced. The letterpress appears to be photographed from typescript and some may find it trying to read.—W. D. JONES.

La Métallurgie en Belgique et au Congo Belge. Historique—Situation actuelle. Par Eugène Prost. Cr. 8vo. Pp. 340, with 21 figures and 2 maps. 1936. Paris: Dunod. (40.60 francs.)

This book gives an historical survey of the growth of the Belgian metallurgical industries and a description of present-day practice. Since the iron and zinc industries are by far the most important to Belgium, it is only natural that the greater part of the book (250 pp.) is devoted to them; lead and silver are dismissed in 20 pages, and cadmium, copper, nickel, and antimony have only 10 pages between them. A large part of the zinc section deals with the *Vielle-Montaigne* practice, which is described in fair detail with plans and illustrations of the various types of furnaces used. Modern practice in the production of electrolytic zinc and the continuous retort-fractional distillation process of the New Jersey Zinc Company are only briefly and very incompletely described. The section closes with statistics of production and consumption in the principal countries of the world. The last 53 pages of the book contain a relatively brief account of the ore deposits of the Belgian Congo and of the methods used in recovering therefrom copper, cobalt, tin, gold, and radium, but the metallurgical side is dealt with in quite a superficial manner.—A. R. POWELL.

Dechema Werkstoffblätter, Kurzreferate über Werkstoff-Fragen in der Chemischen Technik aus dem Schrifttum des In- und Auslandes. Bearbeitet von E. Rabald. 23 × 30 cm. Pp. viii + 105. 1935. Berlin: Verlag Chemie, G.m.b.H. (R.M. 10.00; Ausl. Preis., R.M. 7.50.)

This is a bound volume of the abstract section of "Die Chemische Fabrik," and contains a classified collection of abstracts usually very brief of the world's literature for 1935 in so far as

it relates to the properties of metals and alloys, corrosion problems, physical testing, non-metallic constructional materials and non-metallic protective coatings and cements for use in chemical works. Its main purpose is to direct the works' chemist to the current literature of the subject in which he is interested and, taken as a whole, it seems to fulfil this purpose satisfactorily.

—A. R. POWELL.

75 Jahre Verein Deutscher Eisenhüttenleute 1860-1935. 21 × 30 cm. Pp. 200, illustrated. 1935. Düsseldorf: Verlag Stahl Eisen m.b.H.

This handsome volume has been prepared to celebrate the 75th anniversary of the foundation of the German equivalent of our Iron and Steel Institute. It contains an account of the growth of the Society and the extraordinarily great developments which have taken place in the metallurgy of iron and steel and in methods of control and testing. Brief biographies of all the most important German steel metallurgists and ironmasters are also included, as well as numerous photographs showing the growth which has taken place in some important steel-works. A bibliography of over 600 references, chiefly to articles in *Stahl und Eisen* is appended.

The book will repay study by all who are interested in the history and progress of the iron and steel industry.—A. R. POWELL.

Cumulative Index of Metallurgical Abstracts Published in Vols. III-V of *Metals and Alloys*, January 1932-December 1934. Pp. v + 272. 1935. New York: Reinhold Publishing Company. (\$10.00.)

Subscribers to the American periodical *Metals and Alloys* will welcome this general index to the contents of the three volumes issued in the years 1932-1934. *Metals and Alloys* contains, in addition to original articles and critical summaries and translations of important articles published in the well-known European scientific and technical journals, extensive abstracts which cover in addition to the fields of ferrous and non-ferrous metallurgy, the literature of "process" metallurgy. The volume, as its title implies, covers the abstracts section only.

The index is divided into four parts: (1) subject index for 1932 and 1933; (2) author index for 1932 and 1933; (3) subject index for 1934; and (4) author index for 1934. It is, we feel, unfortunate that in one volume two entirely separate subject and two names indexes should be published, as this necessitates a double search for every entry to be consulted.

The indexing, in general, appears to have been carefully carried out, but the book often needs careful use if all references are to be found to the subject sought; for example, under the heading "Extrusion" (p. 27) there are only two entries, but under "Metals" (p. 45) we find—"Metals, extrusion, V. 3, p. MA 137 L/7," an entry which is not to be found under "Extrusion." We have noticed that in other cases the same applies. The numerous entries which are to be found under "Metals" are unnecessary in a metallurgical index: the user of the index would naturally refer, for instance, to entries under "Casting," "Deformation," "Fluidity," "Melting," &c., and not—to give another example—to find under "Melting" 4 entries with another and different 6 entries under "Metals."

Metal Castings. By Harry L. Campbell. Med. 8vo. Pp. ix + 318, with 174 illustrations. 1936. New York: John Wiley & Sons, Inc. (\$3.00); London: Chapman & Hall, Ltd. (15s. net).

In spite of the increasing competition from fabricated and wrought products, castings still occupy a very important place in the engineering world, and this volume offers a well-planned and clearly written survey of the materials, processes, and equipment employed in the metal casting industry in the United States of America. These differ somewhat in detail from British practice, and it is instructive to contrast the lines of development in the two countries. The bias is naturally mainly ferrous, and in this respect the title suggests a larger scope than the subject-matter actually covers, as most of the book is devoted to sand-castings of iron and steel. The one short chapter devoted to non-ferrous alloys is quite inadequate, and an undue proportion of this small space is given to anti-friction white metals, which are not normally regarded as castings. The alloys forming the bulk of the output of non-ferrous foundries are each dismissed in a few lines, whilst light alloys of aluminium and magnesium, and die-casting alloys are treated only a little more generously. Two useful chapters are devoted, respectively, to the design of metal castings and the comparative properties of cast metals.

The value of the book for reference purposes is enhanced by the appendix, in which are collected the principal A.S.T.M. specifications for cast metals and the A.F.A. methods for sand testing. A volume planned on the lines of this work, but devoted exclusively to non-ferrous metal castings, would be welcome.

The book is excellently illustrated, well printed and bound. A short bibliography is to be found at the end of each chapter, but refers principally to American publications. The price is reasonable for a text-book of this description.—J. E. NEWSON.

Foundry Work. By R. E. Wendt. Third Edition. Demy 8vo. Pp. xii + 240, with 208 illustrations. 1936. New York: McGraw-Hill Book Co., Inc. (\$2.00); London: McGraw-Hill Publishing Co., Ltd. (12s. net).

The third edition of this well-prepared little book has been brought up to date by the inclusion of recent developments in such matters as standard pattern colours, alloy iron and alloy steel castings, and mass-production foundries. The object of the book is to provide an elementary text-book for schools and colleges and apprentices in commercial shops, and the author, an instructor in foundry practice in an American University, has produced a volume suitable for this purpose. The text is amplified by numerous illustrations, and each chapter concludes with a series of test questions. The book is divided into four sections; the first, *Fundamental Principles*, covers lay-out, equipment, and sands; the second, *Melting and Mixing of Cast Irons*; the third, *Exercises in Bench and Floor Moulding and Foundry Control*; and the last, *Non-Ferrous Metal Founding and Glossary*.

The non-ferrous section is quite subsidiary and the information given is so vague as to be worthless, and in future editions this section should either be re-written or entirely omitted. Admiralty gun-metal and aluminium bronze are not even mentioned.

The printing and binding are good, but for students and apprentices the price appears high.—J. E. NEWSON.

Practical Design of Exhaust and Blower Systems. A Handbook on the Designing and Engineering of Blower Systems in which the Subject is Treated in a Way that the Man of Limited Education Can Comprehend and Understand Both Its Meaning and Application. By E. W. Favalora. Demy 8vo. Pp. ix + 274, with 91 illustrations. 1935. New York: Ed. A. Scott Publishing Co., Inc. (\$5.00.)

The object of this book is amply explained in the sub-title and the author must be complimented on the admirable way in which he has fulfilled his mission. In many industries the menace of dust to the health of the workers is very serious, and in all industrial countries there are very stringent regulations covering its control. Again, many dusts and fumes contain constituents of commercial value the recovery of which is of importance to the economical running of the works. In this book the numerous types of exhaust and blower systems for dealing with dust and fume problems are admirably explained and their operation described in clear and simple language with many examples from practice. The book is profusely illustrated and contains numerous charts of value even to skilled engineers; the publishers have carried out their part of the work in a praiseworthy manner and the book can be thoroughly recommended to works' managers especially those controlling small works. The price is very reasonable.—A. R. POWELL.

Sonderheft : Schweisstechnik II. 21 × 30 cm. Pp. 67, with 275 illustrations. 1936. Berlin: V.D.I.-Verlag G.m.b.H. (M. 4.50.)

The first of these "Special Numbers" devoted to welding, was published in 1926. The present issue reviews the progress made since that date. It contains four groups of papers (for a list of which see *Met Abs.*, this vol., p. 433), of which the second and third contain matters of non-ferrous interest—viz. (in German) "Soldering and Welding of Light Metals," by L. Rostovsky; "Welding and Soldering of Light Metals," by E. Lüder; "Surface Treatment by Welding Technique for Corrosion-Resistance," by A. Matting; and "Welding Technique in the Production of Metallic Coatings," by A. Matting.

These are concise statements of experience up to date and, as such, will be found valuable by all who are interested in the subjects.—H. W. G. HIGNETT.

Cours de Soudure Electrique à l'Arc. [Mimeographed.] In 5 volumes. Pp. 522, with 436 illustrations. 1936. Paris: École Supérieure de Soudure Autogène, 32 Boulevard de la Chapelle, XVIIIe. (250 francs.)

This is the first of the welding courses of the École Supérieure de Soudure Autogène to be made accessible to those who are unable to attend the school. Although, as M. Granjon points out in a short preface, the text has been made as complete as possible, full benefit cannot possibly be obtained from it without systematic laboratory work and practical training in manipulation. If the practical training given at the École Supérieure is of the same standard as this text-book shows the lectures to be, the students there are indeed fortunate.

Volume I treats the fundamentals of electricity from the point of view of arc-welding—from the constitution of the atom to magnetic stabilization of the welding arc. Volume II deals with electrodes and their coatings—manufacture, properties, and testing. Volume III is devoted to practical considerations, such as preparation for welding, manipulative technique, and the calculation of welding costs. Volume IV reverts to theory, the characteristics of d.c. and a.c.

generators being considered in detail. The first chapter of Volume V deals with problems of installation, multi-operator lay-outs, and welding accessories; and, in the remaining chapters, automatic arc welding, atomic hydrogen, and shielded arc processes are described.

Throughout the work, emphasis is laid on the importance of first principles. An example of the careful treatment is the application of Gauss' law to the analysis of test results.

These five volumes can be highly recommended to all interested in arc welding, and, in particular, to all welding instructors. Although no complaint can reasonably be made of the high price, one feels that it should include a binding of greater durability. One looks forward with great interest to the publication of all the other welding courses under the direction of the Institut de Soudure Autogène.—H. W. G. HIGNETT.

Oxy-Acetylene Welding and Cutting. By Robert H. Harcourt. Demy 8vo. Pp. xi + 131, with 34 illustrations. 1935. Stanford University, Cal.: Stanford Bookstore. (\$1.60.)

This book is intended for use in schools and colleges, and contains the usual descriptions of blowpipes and accessories, instructions in manipulation, and advice on technique. In addition to mild steel and cast-iron, the welding of stainless steels, copper, bronze, brass, Monel metal, aluminium, and lead is briefly considered.

The responsibility of the author of an elementary text-book is far greater than that of the writer of an advanced monograph, the readers of which are expected to exercise critical discrimination. It is very disturbing, therefore, to find in this primer no carefully considered exposition, but many misleading statements and important omissions. For example, the relative advantages of high- and low-pressure blowpipes are not stated; the important features of the rightward method are missed; an excess of acetylene is recommended for welding stainless steels, and a neutral or slightly oxidizing flame for brass. \$1.60 is too much to pay for information of this kind.—H. W. G. HIGNETT.

Spectrum Analysis with the Carbon Arc Cathode Layer ("Glimmschicht"). By Lester W. Strock, with a Preface by V. M. Goldschmidt. Med. 8vo. Pp. 54, with 20 illustrations. [1936.] London: Adam Hilger, Ltd., 98 King's Rd., N.W.1. (5s. 8d., post free.)

This book contains a description of the methods developed by Professor Goldschmidt and his co-workers at Göttingen for the spectrographic analysis of non-conducting solids and powders and of the application of these methods to the analyses of rocks. The necessary apparatus is illustrated and described in detail, and a full account is given of the experimental procedure with reference to numerous examples. The book, which is beautifully printed and illustrated, should be of great service to those interested in geochemical problems.

—A. R. POWELL.

Glances at Industrial Research During Walks and Talks in Mellon Institute. By Edward R. Weidlein and William A. Hamor. Cr. 8vo. Pp. x + 238, with 26 illustrations. 1936. New York: Reinhold Publishing Co.; London: Chapman and Hall, Ltd. (13s. net.)

This book is a collection of essays, particularly in relation to the Mellon Institute and the industrial fellowship system which it originated. The success of the Institute has been great; over two million sterling have been subscribed by Industry since its foundation, and last year as much as £200,000 was subscribed. The magnificent new buildings of the Institute, endowed by the Mellon Brothers, have recently been opened.

Whilst mainly devoted to an account of American experience, this book should not fail to be interesting and stimulating to European readers. The main sections are: (1) the industrial research procedure of the Mellon Institute; (2) industrial research successes and opportunities; (3) professional aspects of industrial research; (4) questions in industrial research management, and (5) literary activities in industrial research, including methods for the introduction of new industrial products. Another outstanding feature of the book is a list of the main achievements of American chemistry since 1914.

The authors, who have been mainly concerned with industrial research of a physical and chemical nature, emphasize the growing urgency of employing scientific workers to study the human factors in production, and point out that only a trivial amount has been expended in this direction compared with what has been accorded to the design and care of machinery.

Chemical Synonyms and Trade Names. A Dictionary and Commercial Handbook. By William Gardner. Fourth Edition, much enlarged. Med. 8vo. Pp. 495. 1936. London: Technical Press, Ltd. (31s. 6d.)

Instead of resetting the type with each new edition, the subject-matter of the first edition has been left practically intact and the new terms added in an appendix which in this edition

has extended to 139 pages or more than a third of the original book so that in effect we have two dictionaries in one, necessitating for some references a double search. The subject-matter in the appendix appears to live up to the high standard of the main portion of the work and covers recently introduced materials as well as those omitted from the first edition.

The reviewer has only one minor criticism to make and that is that names of minerals can scarcely be termed "trade names," especially as many of those included are scarcely more than curiosities with little or no commercial value. The definitions of a few of these are also misleading; thus, ferrotantalite is said to be columbite, and a few are given a wrong formula, thus psilomelane is said to be RO_2MnO_2 , where $\text{R} = \text{Mn, Ba, or K}_2$. Taken as a whole, however, the book is a useful work of reference for the commercial man.—A. R. POWELL.

Annual Reports on the Progress of Chemistry for 1935. Issued by the Chemical Society. Volume XXXII. Demy 8vo. Pp. 527, illustrated. 1936. London: The Chemical Society, Burlington House, W.1. (10s. 6d.; 11s. post free.)

The ramifications of chemistry have become so extensive and intricate that it is no longer possible to survey the whole field of progress from year to year. In recent volumes of the Chemical Society's Annual Reports the policy appears to have been to cover the major branches of the science, but to restrict the report on each branch to a few broad subjects of research. The result is a more readable type of report, which still contains something of interest for investigators in every branch of physical science.

The metallurgist will find in the volume for 1935 much that he should read, partly because it describes progress in the knowledge of the fundamental properties of matter, and partly because certain sections have a direct interest. H. J. J. Braddick has contributed a chapter on radioactivity and sub-atomic phenomena, some metallic salts are discussed by S. R. Carter and W. Wardlaw, a section on non-ferrous alloy systems has been written by E. S. Hedges, and J. D. Bernal has contributed a section on crystal physics, in which special attention is given to metals and alloys.—E. S. HEDGES.

Reports of Progress of Applied Chemistry. Volume XX.—1935. Demy 8vo. Pp. 814. 1935. London: Society of Chemical Industry, 46-47 Finsbury Sq., E.C.2. (12s. 6d.)

The volume for 1935 maintains the high standard that has come to be expected of the Annual Reports of the Society of Chemical Industry. Metallurgists will find much to interest them, particularly in the reviews on General Plant and Machinery, by H. W. Richards and J. N. Fowler; Fuel, by L. E. Winterbottom and A. H. Raine; Refractories, Ceramics, and Cements, by J. H. Chesters and W. J. Rees; Iron and Steel, by C. O. Bannister; Non-Ferrous Metals, by A. R. Powell; and Electro-Chemical and Electro-Metallurgical Industries, by J. W. Cuthbertson.—E. S. HEDGES.

Annual Survey of American Chemistry. Volume X. 1935. Edited by Clarence J. West. Pp. 487. 1936. New York: Reinhold Publishing Corp. (\$5.00); London: Chapman and Hall, Ltd. (\$5.00.)

This volume contains only two sections of direct non-ferrous metals interest, namely those on the application of X-rays in metallurgy (by Eric R. Jette) and on the platinum metals (by Raleigh Gilchrist); the former consists of only 5 pages with 69 references, but the latter extends over 11 pages with 162 references and covers the chemistry, physics, and industrial uses of the metals in an interesting although brief manner. Of less direct interest to the members of the Institute of Metals are the sections on analytical chemistry (15 pp.) and ferrous metallurgy (14 pp.).—A. R. POWELL.

Libraries for Scientific Research in Europe and America. By H. Philip Spratt. Pp. 227. 1936. London: Grafton & Co., 51 Great Russell St. (10s. 6d. net.)

As a result of extensive travel and personal enquiry, the author here provides a most useful review of many of the public libraries in this country, in Europe, and in America dealing with the increasingly difficult problem of assisting Science and Industry with information. The Science Library, South Kensington, and its loan system, which the Institute of Metals finds so useful, is first described. The recent development in Paris of the "Maison de la Chimie"—the Institute's meeting place for the recent Autumn Meeting—is another of the numerous Institutions embraced in this volume. Mention should also be made of the chapter on the Libraries of Soviet Russia, and the large section giving an account of the more important libraries in the U.S.A.

The treatment of the subject is particularly useful, for the author has approached it in the dual capacity of a librarian and a scientific worker.

Kelly's Directory of the Engineering, Hardware, Metal, and Motor Trades. Twenty-Second Edition. $6\frac{3}{4}$ in. \times $10\frac{1}{4}$ in. Pp. lvi + 2716 + 154. 1936. London: Kelly's Directories, Ltd. (50s. post free.)

This edition is ninety pages larger than the previous edition (which was reviewed in *Met. Abs.*, 1934, 1, 650) and includes for the first time particulars of electric lighting, power and traction undertakings.

The Directory embraces England, Scotland, and Wales. It contains the names and addresses of those engaged in the various trades indicated by its title, both the manufacturing and selling branches being adequately dealt with.

The following headings (selected from a total of over 2000) give an indication of the wide scope of the information supplied:—Aerial Ropeway Contractors; Aircraft Manufacturers; Boiler Makers; Colliery Proprietors; Cycle Agents and Dealers; Electrical Instrument Manufacturers; Electric Lighting, Power and Traction Undertakings; Gas Works; Iron-mongers (both wholesale and retail); Motor-Car Manufacturers; Motor Engineers and Garages; Railway Plant Contractors, and Tool Dealers. The metal industries are well represented; thus the names of individuals and firms connected with aluminium fill five columns, brass ten, copper and zinc three each, the latter including "zinc nail makers, rolling mills, smelters and workers." A detailed classification with necessary modifications for each metal, is followed throughout a valuable section of the Directory.

The book comprises the following information: (1) the names for each county, arranged alphabetically under the towns and villages; (2) an alphabetical classification of trades for the London postal district, with the names arranged under each trade heading in alphabetical order; (3) a similar classification of trades for the rest of England, Scotland, and Wales.

Among the special sections is an alphabetical list, covering 118 pages, of the names of some 10,000 branded articles and specialities used in the engineering and allied trades, together with the names and addresses of the manufacturers.

Kelly's Directory of Merchants, Manufacturers, and Shippers of the World. Fiftieth Edition. $8\frac{1}{2}$ \times $10\frac{1}{4}$ in. In two volumes, Volume I.—Pp. 1950. Volume II.—Pp. 2166. London: Kelly's Directories, Ltd. (64s. post free.)

The Directory consists of two volumes, the first containing information concerning all the countries of the world except the British Empire, with which the second volumes deals. Volume I is divided by continents as follows: (a) Europe, (b) Asia, (c) Africa, (d) America (Central, North, and South) and the West Indies. The division for each continent contains in alphabetical order sections for the countries which form part of that continent. The section for each country contains in alphabetical order sub-sections for the towns in that country. The sub-section for each town is divided in its turn into trade headings arranged in alphabetical order, and under the trade headings are given in clear fashion the names and addresses. For the United States of America there is a general trade classification, where the names of those engaged in any trade throughout the country appear in one alphabetical list under the heading referring to their trade.

The second volume, devoted to the British Empire, is divided as follows: (a) Great Britain and Ireland; (b) the British Dominions, Colonies, Possessions, Protectorates, and Territories under British Mandate (1) in Europe, (2) in Asia, (3) in Africa, (4) in America, (5) in Australia, and (6) in New Zealand. The section for Great Britain and Ireland is divided into three parts: England, Scotland, and Wales (except London); London; Ireland. Each part contains an alphabetical list of firms, a classification of the firms under the trade headings, a list of telegraphic addresses, and separate lists of the exporters and importers arranged alphabetically under the headings of goods in which they deal. The pages coloured green at the end of the section for Great Britain and Ireland contain reproductions of trade marks. The indexing, which is in four languages, is very complete, and makes reference of any kind a very easy matter.

Planes Directory of the Aviation and Allied Industries. Demy 8vo. Pp. xxviii + 333. 1935. London: Planes Publishers, Ltd., 4 Johnson's Court, Fleet St., E.C.4. (12s. 6d.)

This book—the first edition to be issued—is set out in six sections: (i) commercial (names, addresses, and descriptions of firms); (ii) brand and trade names (the names of makers are given); (iii) general (names of commercial and private aircraft owners, flying clubs, flying schools, airports, and aerodromes in Great Britain); (iv) classified trades; (v) overseas and foreign (air transport companies, aerodromes, constructors, suppliers of materials, &c., by countries); (vi) general information. Each section is printed on a differently coloured paper.

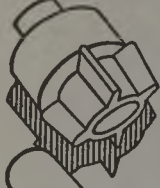
The book should prove most useful for reference purposes to all concerned with the aircraft industry.

SYMBOLS AND ABBREVIATIONS USED IN TEXT.

A.	Ångström units.	km. ²	square kilometre.
abs.	absolute.	kv.	kilovolt(s).
a.c.	alternating current(s).	kva.	kilovolt-ampère(s).
amp.	ampère(s).	kw.	kilowatt(s).
amp.-hr.	ampère-hour(s).	kw.-hr.	kilowatt-hour(s).
A.W.G.	American wire-gauge.	lb.	pound(s).
Bé.	Baumé.	L.-F.	low-frequency.
B. & S.	Brown & Sharpe (gauge).	m.	metre(s).
B.H.P.	brake horse-power.	m. ²	square metre(s).
B.O.T.	Board of Trade.	m. ³	cubic metre(s).
B.th.u.	British thermal units.	m.amp.	milliampère(s).
B.T.U.	Board of Trade unit.	max.	maximum.
B.W.G.	Birmingham wire-gauge.	mg.	milligramme(s).
C.	centigrade.	mm.	millimetre(s).
cal.	calorie(s).	mm. ²	square millimetre(s).
c.c.	cubic centimetre(s).	mm. ³	cubic millimetre(s).
cg.	centigramme(s).	m.m.f.	magnetomotive force(s).
c.g.s.	centimetre-gramme-second.	m μ	millimicron.
cm.	centimetre(s).	m.v.	millivolt(s).
cm. ²	square centimetre(s).	N.	normal.
cm. ³	cubic centimetre(s).	N.T.P.	normal temperature and pressure.
coeff.	coefficient(s).	oz.	ounce(s).
const.	constant(s).	P.C.E.	pyrometric cone equivalent.
c.p.	candle-power.	p.d.	potential difference.
C.T.U.	centigrade thermal units.	p.p.m.	parts per million.
cwt.	hundredweight(s).	R.	Réaumur.
d	density.	r.p.m.	revolutions per minute.
d.c.	direct current(s).	sp. gr.	specific gravity.
dg.	decigramme(s).	sq.	square.
diam.	diameter(s).	v.	volt(s).
dm.	decimetre(s).	va.	volt-ampère(s).
dm. ²	square decimetre(s).	w.	watt(s).
dm. ³	cubic decimetre(s).	w.-hr.	watt-hour(s).
e.m.f.	electromotive force(s)	w.p.c.	watts per candle.
F.	Fahrenheit.	°	degree(s) (arc or temperature).
ft.	foot; feet.	%	per cent.
ft. ²	square foot.	λ	wave-length.
ft. ³	cubic foot.	μ	micron.
ft.-lb.	foot-pound(s).	$\mu\mu$	1 millionth micron = 0.1 A.
gall.	gallon(s).	Ω	ohm.
gm.	gramme(s).	"	minute of the arc.
H.-F.	high-frequency.	<	second of the arc.
H-ion.	hydrogen ion.	A < B	denotes that A is less than B.
H.P.	horse-power.	>	A > B denotes that A is greater than B.
H.P.-hr.	horse-power hour(s).	*	negative of <; A * B denotes that A is not less than B.
hr.	hour.	∩	combination of < and =; A ∩ B denotes that A is equal to or less than B.
hrs.	hours.	≠	is not equal to.
in.	inch; inches.	≡	identically equal to.
in. ²	square inch.	≈	approximately (or essentially) equal to.
in. ³	cubic inch.		
in.-lb.	inch-pound(s).		
I.S.W.G.	Imperial standard wire-gauge.		
K.	absolute temperature (scale).		
K.C.U.	kilogramme-degree-centigrade heat unit (= 3.97 B.th.u.).		
kg.	kilogramme(s).		
kg.m.	kilogramme-metre(s).		
km.	kilometre(s).		



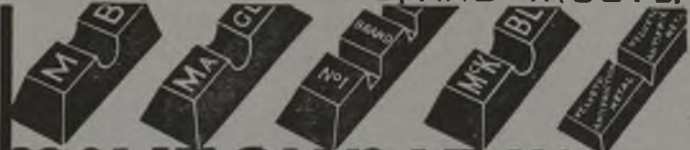
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