Contains Autumn Lecture
to be printed in the half-yearly volume:
Journal of the Institute of Metals,
1935, Vol. LVII.

Vol. 2. Part 9

The Monthly Journal of the
INSTITUTE OF METALS

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METALLURGICAL ABSTRACTS

SEPTEMBER, 1935

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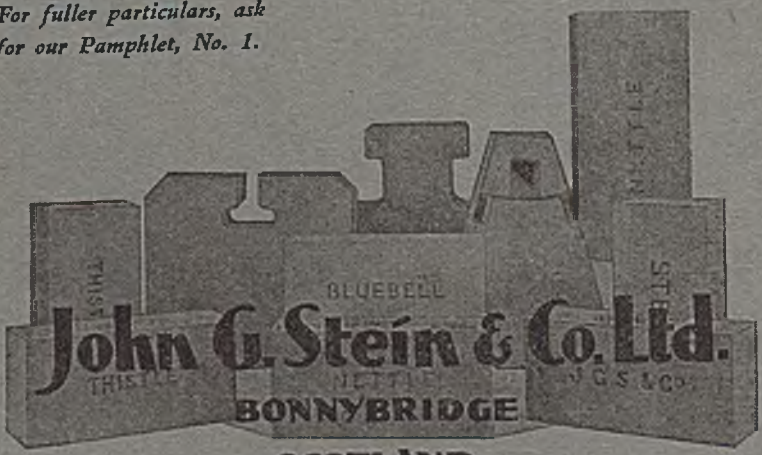

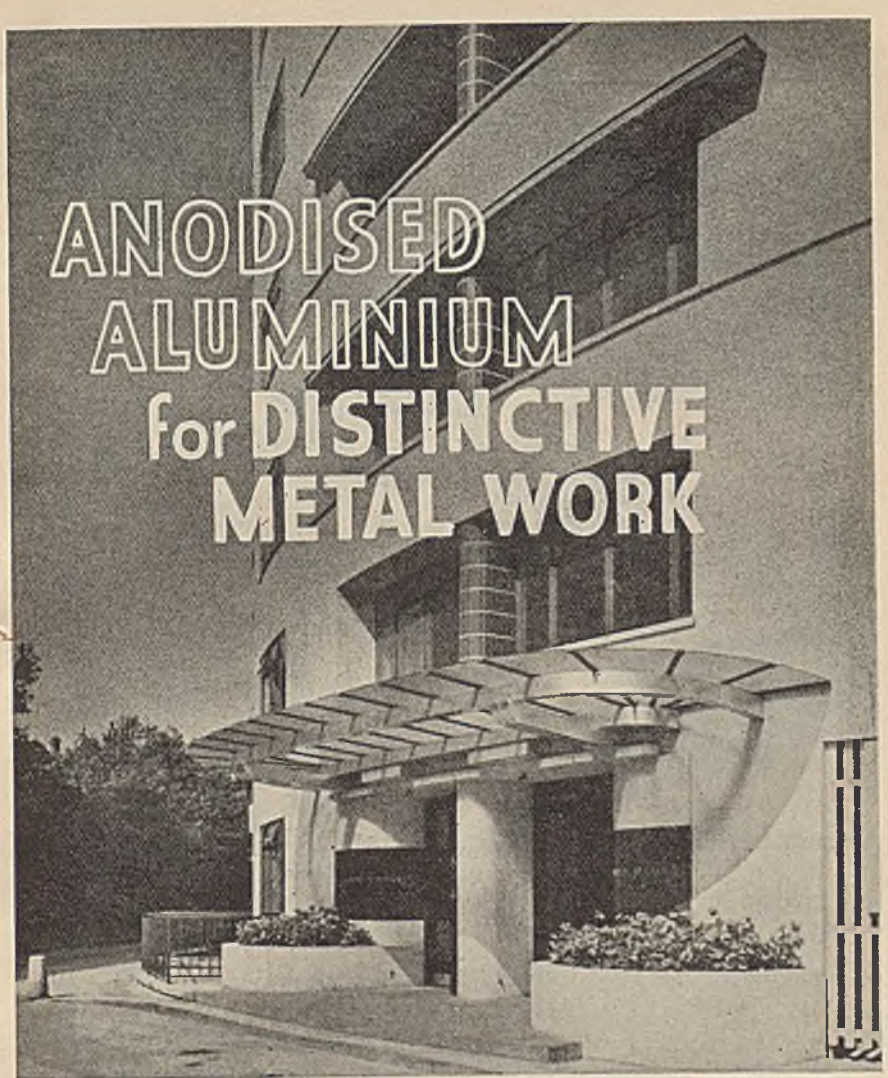

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CONTENTS
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This Contents List, issued in a stiff cover, with an Author Index, will facilitate reference to the papers published in the *Journal* since the Institute's foundation. It should be found most valuable pending the issue of the 10-year Index. Copies are obtainable from the Secretary. **Price 2s. 7d. each, post free.**

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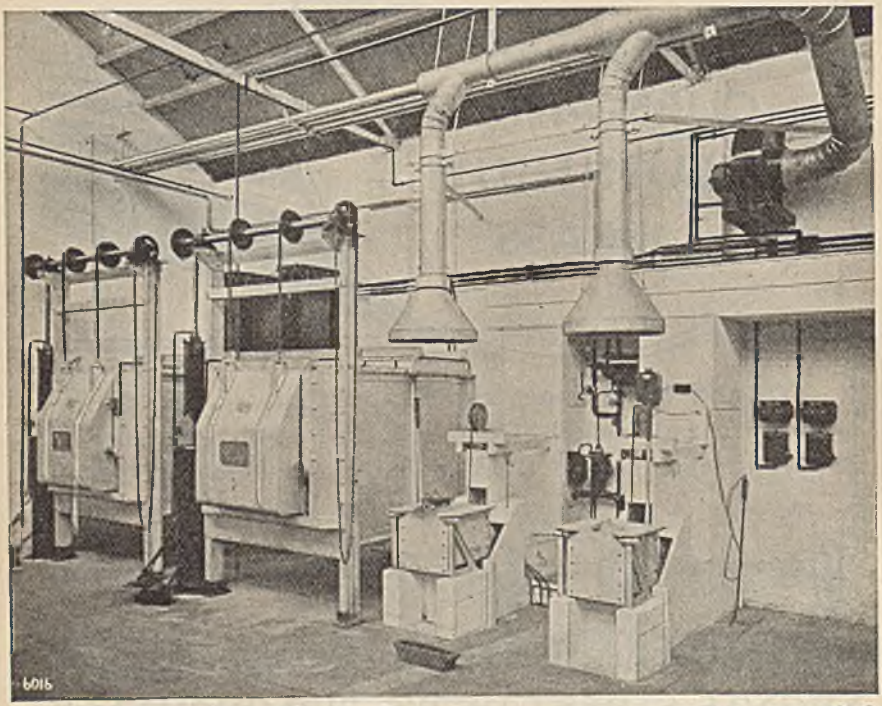

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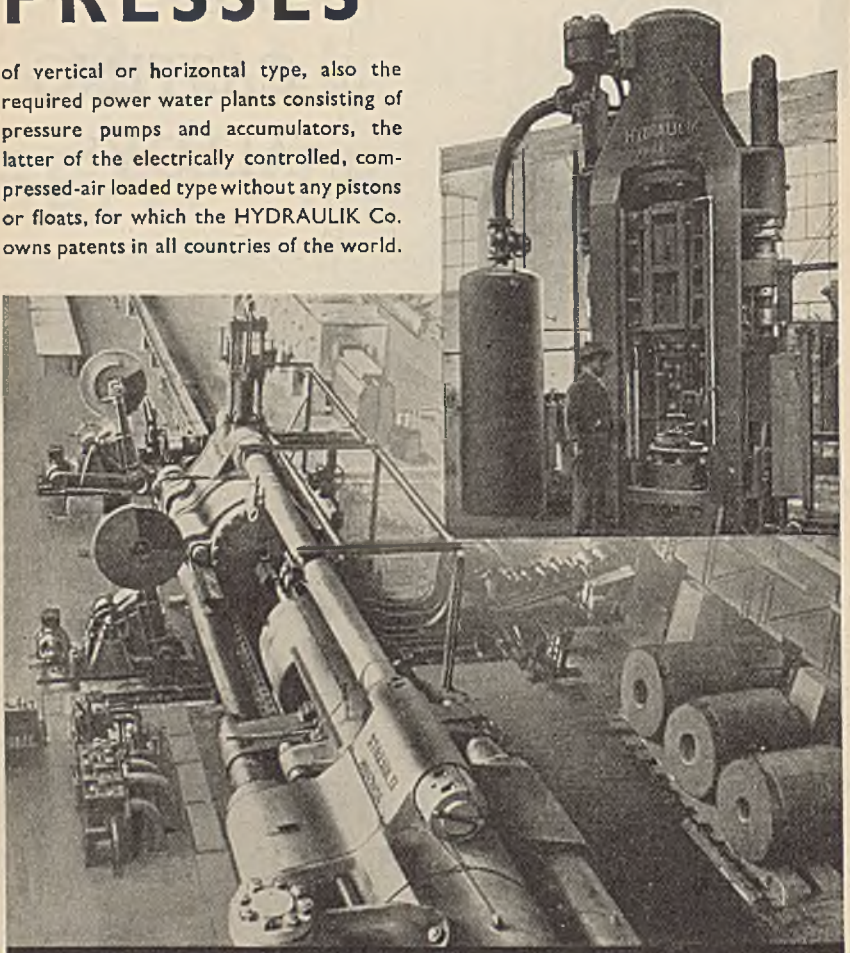

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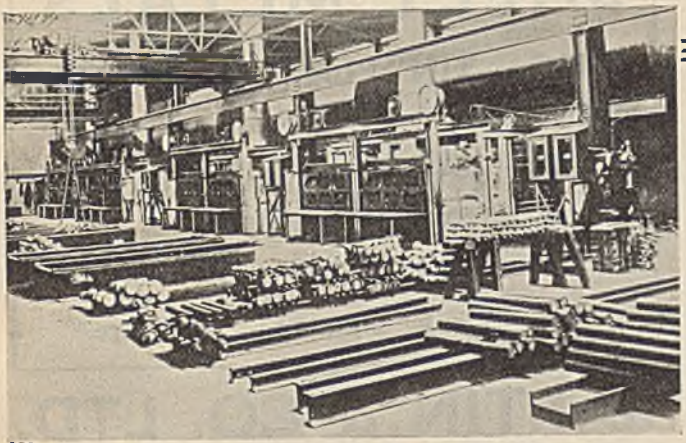

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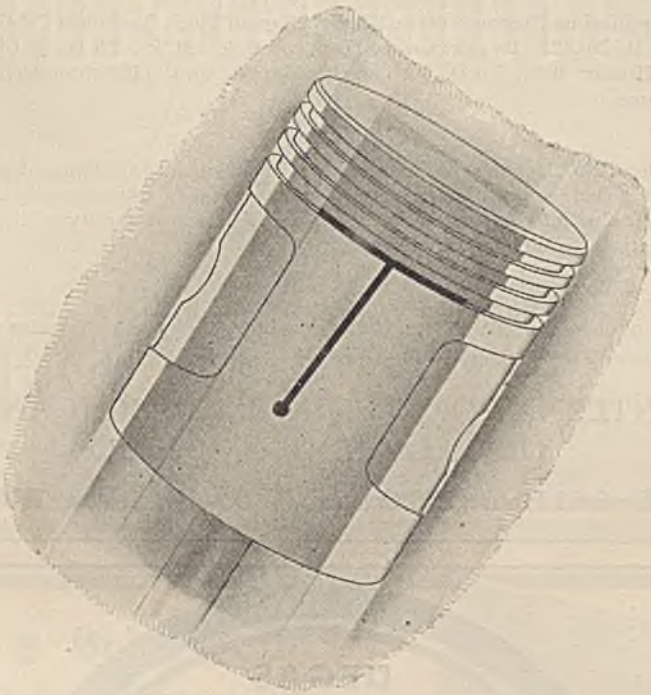

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"Equilibrium Diagrams of the Binary Alloys of Tin." Technical Publication, Series B, No. 2. By ERNEST S. HEDGES, D.Sc., M.Sc., Ph.D., A.I.C., and C. E. HOMER, B.Sc., Ph.D., with an Introduction on the interpretation of the diagrams.

Solder

Bulletin No. 2, of the International Tin Research and Development Council, describes the composition, properties, and methods of using tin-lead solders, and contains information on soldering machines and a variety of industrial applications; a bibliography is provided.

Pp. 52, illustrated.

The publications of the Council are issued free of charge to those interested. Copies may be obtained on application to the

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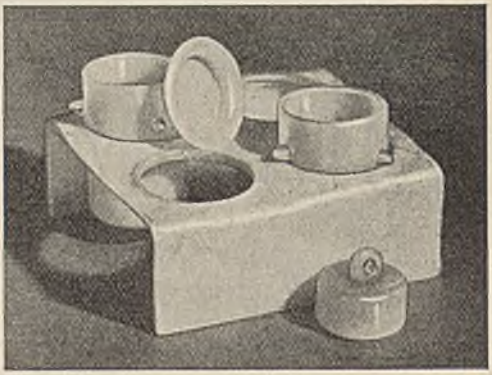

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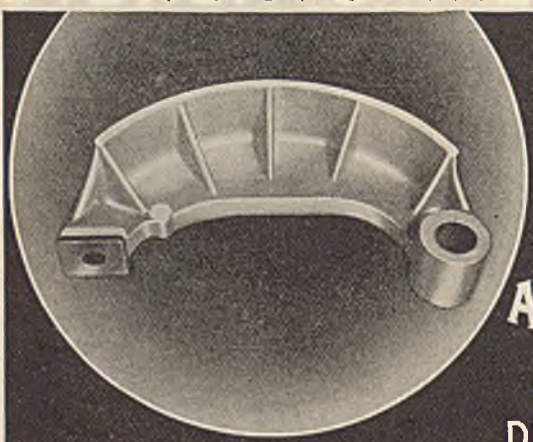

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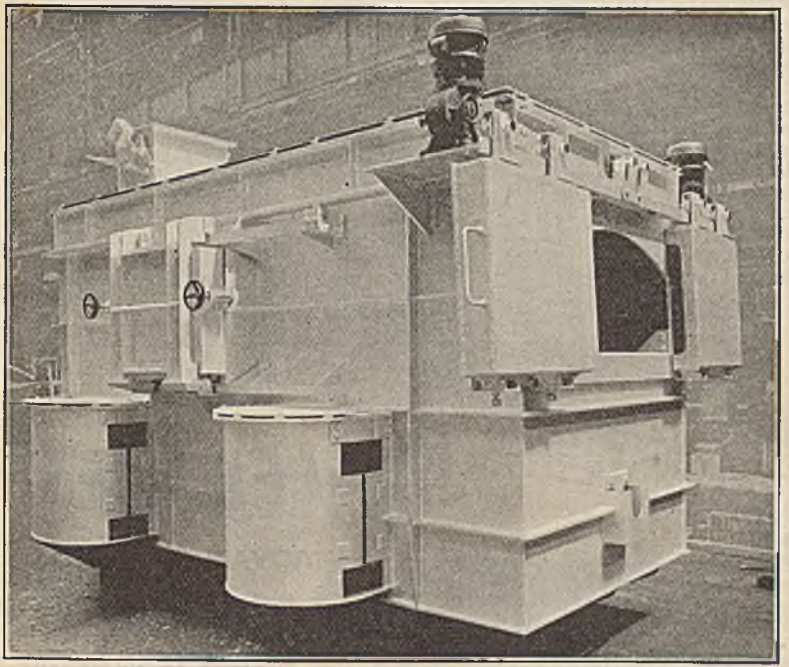

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INDEX TO ADVERTISERS

SEPTEMBER, 1935

	PAGE
Anglo-American Oil Co., Ltd.	—
Avery, Ltd., W. & T.	—
Birmingham Electric Furnaces, Ltd.	—
Bolton & Sons, Ltd., Thomas	—
Booth & Co. (1915), Ltd., James	v
British Aluminium Co., Ltd., The	iii
British Commercial Gas Assoc., The	—
British Metal Corporation, Ltd., The	xxi
British Oxygen Co., Ltd., The	x
Brookes (Oldbury), Ltd.	—
Carborundum Co., Ltd., The	xx
Consolidated Tin Smelters, Ltd.	—
Demag A.G.	—
Ebonestos Insulators, Ltd.	—
Electric Resistance Furnace Co., Ltd.	vi
Electroflo Meters Co., Ltd.	—
Elliott Bros. (London), Ltd.	—
Elton, Levy & Co., Ltd.	—
Fordath Engineering Co., Ltd.	—
Foster Instrument Co.	—
Foundry Services, Ltd.	xii
General Electric Co., Ltd.	—
High-Duty Alloys, Ltd.	xiii
Hilger, Ltd., Adam	—
Hydraulik G.m.b.H.	viii
I.C.I. Metals, Ltd.	—
Incandescent Heat Co., Ltd.	ix
International Tin Research Council	xii
Johnson Matthey & Co., Ltd.	xviii
Leitz (London), E.	—
McGraw-Hill Publishing Co., Ltd.	—
McKechnie Bros., Ltd.	xxi
Martin, W. E. & Co., Ltd.	x
Metropolitan-Vickers, Ltd.	—
Murex, Ltd.	—
National Alloys, Ltd.	vii
Northern Aluminium Co., Ltd.	xi
Oertling, Ltd., L.	xiii
Pearson, Ltd., E. J. & J.	—
Priestman, Ltd., T. J.	xxii
Ratcliff (Metals) Ltd., J. F.	xvi
Siemens-Schuckert (Gt. Britain) Ltd.	xv
Stein & Co., Ltd., John G.	ii
Sterling Metals, Ltd.	xiv
Stewarts and Lloyds, Ltd.	—
Thermal Syndicate, Ltd.	xiv
Wild-Barfield Electric Furnaces, Ltd.	xvii
Zeiss (London), Ltd., Carl	—

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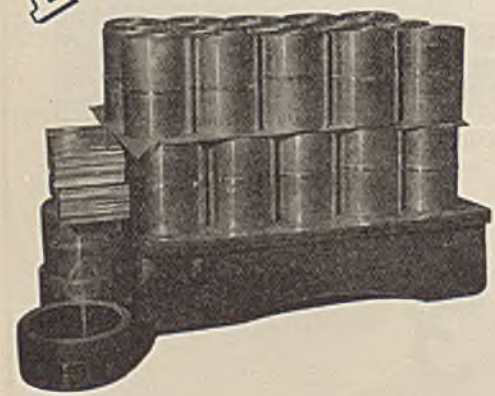

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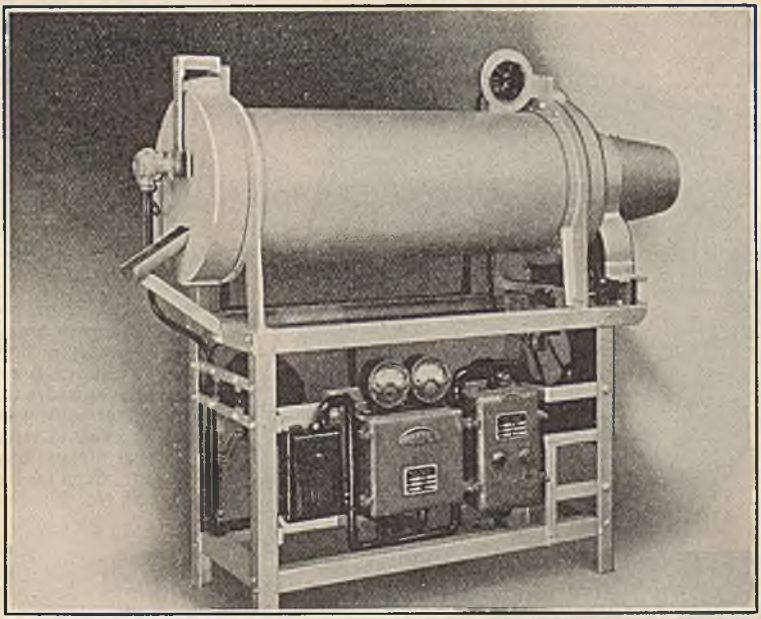

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Volume 2 SEPTEMBER, 1935 Part 9

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CONTENTS

PAGE

Institute News and Announcements 415

Personal Notes 416

Local Sections 417

714. Autumn Lecture: "Metal Melting—Its Effect on Quality." By H. W. Brownsdon, M.Sc., Ph.D. 419

Author Index to "Metallurgical Abstracts" 433

METALLURGICAL ABSTRACTS

I. Properties of Metals 413
II. Properties of Alloys 417
III. Structure (Metallography; Macrography; Crystal Structure) 423
IV. Corrosion 427
V. Protection (other than Electrodeposition) 430
VI. Electrodeposition 432
VII. Electrometallurgy and Electrochemistry (other than Electrodeposition) 435
VIII. Refining 435
IX. Analysis 435
X. Laboratory Apparatus, Instruments, &c. 437
XI. Physical and Mechanical Testing, Inspection, and Radiology 438
XII. Temperature Measurement and Control 440
XIII. Foundry Practice and Appliances 440
XIV. Secondary Metals: Scrap, Residues, &c. 441
XV. Furnaces and Fuels 442
XVI. Refractories and Furnace Materials 443
XVII. Heat-Treatment 445
XVIII. Working 445
XIX. Cleaning and Finishing 446
XX. Joining 447
XXI. Industrial Uses and Applications 448
XXII. Miscellaneous 452
XXIII. Bibliography . . . . . —
XXIV. Book Reviews . . . . . —

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Newcastle-upon-Tyne Meeting.

On Thursday, September 12, there was successfully concluded at Newcastle-upon-Tyne the Twenty-Seventh Annual Autumn Meeting of the Institute, which had begun in that city on the previous Monday. The admirable arrangements made for the entertainment and convenience of members by the Local Reception Committee were greatly appreciated. All the papers that were discussed at the meeting had been previously printed in the *Monthly Journal*. Written discussion on any of these papers should be sent to the Secretary not later than October 1, if intended for inclusion in the bound volume of the *Journal* which is due for issue in December, 1935. In this volume there will be reproduced all the papers that have already appeared in the *Monthly Journal*.

Publication of Papers.

The practice of presenting at a General Meeting every paper accepted was appropriate when the *Journal* was primarily a record of the proceedings of the Spring and Autumn Meetings, but has been less so since the Institute began to publish all papers in the *Monthly Journal*. The Council has now decided that, in future, papers will be accepted for publication in the *Journal of the Institute of Metals* and not necessarily for presentation at any meeting. Papers for presentation and oral discussion at a meeting will be selected, as at present, from those published in advance of the meeting, and written discussion will still be invited on all papers published.

Exhibition at Olympia.

Members are reminded of the official visit of the Institute that is being paid on Thursday, September 19, to the Shipping, Engineering, and Machinery Exhibition (incorporating the Foundry Trades Exhibition) to be held at Olympia (near Addison Road Station, London) from September 12 to 28.

By kind invitation of the Organizers of the Exhibition, members will meet at tea at Olympia at 4.45 p.m. on September 19. Admission to the Exhibition and to the tea-room is by presentation of one of the previously circulated invitation cards. If any member has mislaid his card, a duplicate can be obtained on application to the Secretary of the Institute.

Overdue Subscriptions.

Members who have not yet remitted their annual dues (the amount is £3 3*s*.) which became payable *on or before July 1 last*, are asked by the Finance Committee to be good enough now to send the necessary money, *thus enabling their names to be retained on the list of those entitled to receive this* Journal *month by month as issued*. Cheques should be made payable to the Institute of Metals and crossed "Lloyds Bank, Victoria Street." The Secretary will be glad to supply specially printed banker's order forms to those members who desire to pay their subscriptions by this simple and economical means. *Over 550 members are using Banker's Orders.*

Supper-Dance.

The Supper-Dance, arranged by the London Local Section with the co-operation of the Council, promises to become an annual function. Held for the first time in November, 1934, the Supper-Dance was so well attended by members and their friends that another function of the same type is being arranged to take place on **Wednesday, November 27** (not at a later date previously mentioned) at Thames House, Millbank, London, S.W.1. Several improvements suggested by last year's experience will be made in the arrangements; nevertheless the price of tickets will remain unaltered at 6*s*. Members are now invited to make a note of the date; or to apply for tickets which are already obtainable from members of the London Local Section Committee, Honorary Local Secretaries, or from the Secretary of the Institute.

International Congress of Mining, Metallurgy, and Applied Geology.

The seventh International Congress of Mining, Metallurgy, and Applied Geology will be held in Paris from October 20 to 26 next. Mem-

bers of the Institute of Metals are invited to take part in the Congress, which is being held under the patronage of the President of the French Republic and is being organized by the Société de l'Industrie Minérale, the Comité Central des Houillères de France, the Comité des Forges de France, the Société Géologique de France, and the *Revue de Métallurgie*.

The main committee of the Congress has as its President, Professor Henry Le Chatelier, D.Sc., and the metallurgy section is presided over by Professor A. M. Portevin, both distinguished members of the Institute of Metals. Dr. Harold Moore, C.B.E., President, and Dr. Richard Seligman, Past-President, have been appointed by the Council to represent the Institute at the Congress.

Already there are indications that the Congress will be a great success as 1200 applications for membership have been received, whilst 350 papers are included in the programme, and these numbers are increasing daily. Foreigners are joining in large numbers, 40 nations being represented in the registration list. Numerous delegations have been nominated to represent Governments, Academies, Institutes, Universities, and the leading engineering associations of the world.

The programme of the Congress includes, in addition to the formal opening ceremony and the business meetings, various works' visits, receptions by the Académie des Sciences au Château de Chantilly and by the Municipal Council of the Chamber of Commerce of Paris. An excursion to Versailles has been arranged, as well as a valedictory dinner at Claridge's and a gala evening at the Théâtre National de l'Opéra. Before the Congress formally begins, a series of technical visits will be paid to Morocco, Tunis, and to the south-east of France and Auvergne; after the Congress similar visits will be paid to the north-eastern centre of France. A special programme of excursions and visits is being arranged for ladies accompanying members of the Congress.

The technical sessions will be held in the Conservatoire National des Arts et Métiers and the École Centrale des Arts et Manufactures. In the latter there will be arranged an exhibition of scientific apparatus used in mining, metallurgy, and applied geology. Space for these exhibits will be available without charge. The Organization Committee appeals to makers of scientific apparatus coming within the purview of the Congress, and to Directors of Laboratories possessing novel or exceptionally interesting apparatus, to display their appliances at the exhibition. They should place their suggestions with regard to the exhibits before the Commissariat Général du Congrès, 1 rue Montgolfier, Paris (3e), who will be glad not only to receive these suggestions but also to send full particulars of the Congress to members of the Institute of Metals who may be able to participate in the coming great international gathering.

PERSONAL NOTES

Mr. W. Coppen Bartley is now on Home leave from Calcutta, India. Correspondence may be forwarded to him at: Oakhurst, Crawley, Sussex.

Dr. H. D. H. Drane is discontinuing his practice as a technical consultant, and is closing his office at 66 Hanover Street, Liverpool, 1, preparatory to joining Messrs. High-Speed Steel Alloys, Ltd., in a new appointment on October 1.

Mr. J. H. Grant, J.P., A.R.S.M., has retired from the managership of The Rio Tinto Company's Works at Port Talbot, South Wales, and is succeeded by his son, Mr. Ivan S. Grant.

Mr. A. B. Winterbottom, who is now working in the Fysisk Institutt, Norges Tekniske Hoiskole, at Trondheim, has been awarded a Robert Blair Fellowship in Applied Science and Technology to carry out "a study, at the Technical University of Norway and elsewhere, of passivity and corrosion-fatigue . . ."

Death.

Dr. Arthur Dehon Little, Chairman of Arthur D. Little, Inc., Cambridge, Mass., U.S.A., died on August 1. He was elected a member of the Institute in 1912.

LOCAL SECTIONS

1935–1936 SESSION.

Before the next issue of the *Monthly Journal* appears, several of the Local Sections of the Institute will have held their opening meetings of the new session. As will be noted from the green folder-programmes that will be despatched at the end of the present month to all members resident in the British Isles, an attractive series of gatherings has been arranged for the coming session.

Members who desire to receive regular monthly "reminders" of the meetings of their Local Section should return to the Secretary the post-card that will accompany each copy of the programme.

For the first time the green folder will be found to include the programme of the Manchester Metallurgical Society. This Society is now in association with the Institute of Metals to the extent that all members of the Institute resident in Lancashire and Cheshire have the right to join the society (subject to the approval of its committee), the Institute paying the current subscription for each member so joining. Members of the Institute of Metals resident in Lancashire and Cheshire who desire to take advantage of this new facility should advise the Secretary, on the above-mentioned post-card, in order that his enrolment may be effected.

Beginning with our October issue it is proposed, during the coming session, to continue the practice of printing a short synopsis of each Local Section paper in the issue of the *Monthly Journal* appearing in the month previous to that in which the paper is due for presentation. It is hoped that, as a result, more members will be stimulated to attend the meetings and to take part in the discussions.

The opening meetings are as follows:

Birmingham:			
Professor J. H. Andrew, D.Sc., "Gaseous and Solid Impurities in Ingots."	October 3.	James Watt Memorial Institute.	7 p.m.
London:			
C. J. Smithells, M.C., D.Sc., Chairman's Address: "Gases and Metals."	October 10.	Society of Motor Manufacturers and Traders, 83 Pall Mall, S.W.1.	7.30 p.m.
Manchester Metallurgical Society:			
L. E. Benson, M.Sc., Presidential Address.	October 16.	Engineers' Club, Albert Square.	7 p.m.
Scottish:			
Works' Visit.	October 14.	Messrs. Henry Wiggin and Co., Ltd., Zenith Works, Thornliebank, Glasgow.	7.30 p.m.
Sheffield:			
L. B. Williams, "Lead Mining in Derbyshire."	October 11.	Non-Ferrous Section, Applied Science Department, The University, St. George's Square.	7.30 p.m.
Swansea:			
Roosevelt Griffiths, M.Sc., Chairman's Address.	November 12.	Y.M.C.A., Swansea.	6.30 p.m.

GENERAL INDEX

TO

THE JOURNAL

AND

METALLURGICAL ABSTRACTS

Vols. 26 (1921) to 55 (1934)

Members are requested to order their copies of the above at an early date, as the publication of this Index can only be proceeded with if a sufficient number of orders are secured in advance.

The Index will consist of Two Volumes—Names and Subjects—and is expected to contain 1100 pages, closely printed in double column.

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NOTE: If sufficient orders are secured it is hoped to publish the Names Index at the end of the present year.

AUTUMN LECTURE, 1935

METAL MELTING—ITS EFFECT ON QUALITY. 714

FOURTEENTH AUTUMN LECTURE TO THE INSTITUTE OF METALS, DELIVERED SEPTEMBER 9, 1935.

By H. W. BROWNSDON,* M.Sc., Ph.D., Member of Council.

In preparing this lecture I have been relieved of many of the anxieties usually associated with such a task. The subject is the choice of others, and my treatment of it is based on notes which Professor R. S. Hutton kindly placed at my disposal. All that was left for me to do was to link up the matter provided for me into presentable form, and in so doing I have introduced a few ideas of my own. As you are aware, this lecture breaks with precedent and, under the veil of an Autumn Lecture, serves as an introduction to a discussion on the subject.

Metal melting is carried out under such widely different conditions that some limitation of these becomes necessary if a concise review of the subject is to be made. Metal may be melted in 100 ton lots in a reverberatory furnace or drop by drop from a rod, as in welding. In both cases similar fundamental principles are involved, but under widely different conditions of melting, and it is with principles, rather than conditions, that I propose to deal.

When considering metal melting and its bearing on quality, it will be helpful to have some clear idea as to what is meant by quality. Quality implies the possession of desired distinctive properties, and the extent to which these are dependent on the process of melting is mainly determined by the degree to which the composition of the metal or alloy can be controlled during melting. So far as the melting process is concerned, quality and composition may be taken as synonymous, not forgetting, of course, that the ultimate quality of the finished product is also dependent on the many operations subsequent to melting.

Of the many factors which may come into play during the melting of a metal or alloy, some of the more important are diagrammatically indicated in Fig. 1.

It will be at once realised that metal melting, from a quality point

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of view, is not simply a matter of increasing the temperature so as to attain the liquid state, but involves the prevention or causation of a number of reactions which lead to changes in composition. The crucible becomes a reaction vessel, and the control of composition a complicated, difficult, but, at the same time, deeply interesting and important problem.

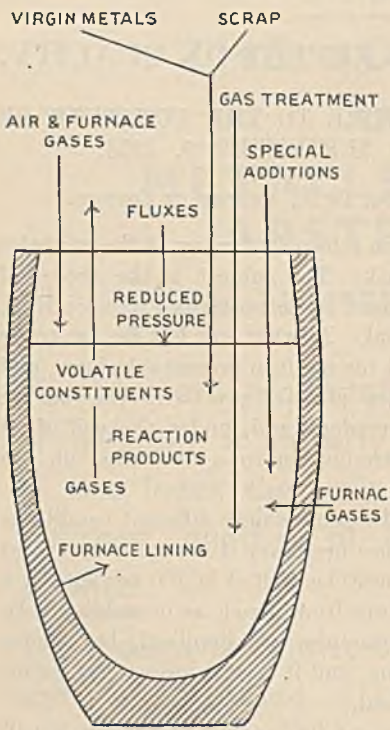

Fig. 1.

Taking a broad view of the control of composition, first consideration must be given to the choice of suitable raw materials. These may become contaminated during melting by oxidation, furnace gases, material from the melting vessel, and reaction products. There may be loss by volatilization, by gas removal, and through the skimmings. Special additions may be made, fluxes used, or treatment with gases, and melting under reduced pressure may be resorted to for the removal of undesirable constituents, introduced either through the raw materials or during the melting operation.

The factors influencing quality can be conveniently grouped under the headings of: raw material, contamination, and refining during melting.

Raw Materials.

Most of the commonly used virgin metals are available in a relatively pure condition, but danger from a quality point of view may easily be lurking in constituents present only in the smallest quantities. A purity of 99·99 per cent. is by no means a safeguard against trouble, unless it is known that the remaining 0·01 per cent. will not interfere with the quality of the metal or alloy. Instead of referring to the purity of a metal in terms of the major constituent, it would be much more instructive and helpful to know what the 0·01 per cent. consists of and to define the purity of a metal in terms relating to the im-

purities present. There are perhaps good reasons for the usually adopted method; an expression such as 99·99 per cent. impresses immediately with a sense of high purity, and is a figure more easily arrived at than details of the remaining 0·01 per cent., which in some cases may not be available.

The usual methods of stating the analysis of a metal never refer to gaseous constituents, which are known to be present and a frequent cause of serious trouble when molten metal solidifies. It will be an important advance when a fuller knowledge of gaseous constituents becomes available. A purity of 99·999 per cent. might suffice to remove all anxiety from metallic impurities, but if the remaining 0·001 per cent., or even 0·0001 per cent., consists of gaseous impurities, some reflection on quality may result. The problems associated with either free, combined, or reaction gases in metals are difficult, but we may hope that in time they will reveal their secrets to a wiser generation. Whilst some of the effects of gaseous impurities on metals are known, the position will not be clear until gas-free standards have been prepared to serve as bases for comparison.

The spectrograph which has served so nobly in the facile detection of solid impurities has already given promise of possibilities in the field of gaseous impurities.

As regards virgin metals, our knowledge of their true composition is incomplete. It is not possible to write down a complete analysis of a common metal such as copper. Although ultimate analysis goes a long way, it throws little light on the form in which the minor constituents, both metallic and non-metallic, are present. In attempting to get an insight into gaseous constituents by heating or melting in vacuum, the mere fact of increasing the temperature of the metal gives rise to a number of reactions, and the results obtained do not, therefore, represent the constituents as originally present in the metal.

Copper 100 per cent. pure and free from gaseous constituents is not yet available, and to speak of the effect of impurities without having a pure standard as a basis for reference may be misleading, and any conclusions drawn should, therefore, be considered as relative rather than absolute.

When dealing with the question of impurities as affecting quality, the purpose for which the metal or alloy is required must be kept clearly in mind, and an impurity which may be harmful for certain applications may be beneficial for others. Silver in copper is a case in point. For a certain electrical application a copper free from silver is required, and in such a case a copper prepared from a silver-free ore must be used. For the majority of applications small quan-

tities of silver are not detrimental, and there are some in which specific additions of silver are of advantage. Cuprous oxide, another common constituent in copper, whilst not harmful for many applications, may be distinctly so for others, hence the extended use of deoxidized copper and, in recent years, that of so-called oxygen-free copper. Whilst oxygen-free copper has valuable mechanical properties, complete freedom from oxygen decreases its electrical conductivity, which, however, is increased if small residual amounts of oxygen are left in the metal, and oxygen-free copper would be more truly designated, low-oxygen copper.

The effect of small quantities of impurities must not be judged solely from their individual behaviour, but also from their effect on the behaviour of other impurities. It is well known that small quantities of bismuth which may be harmful in a deoxidized or oxygen-free copper become much less so in the presence of oxygen, owing to a change over from the injurious metallic state in the absence of oxygen to the less harmful oxide condition.

When reviewing the effect of impurities in virgin metals on the quality of metal produced, it is evident from the above few examples that no general statements can be made as to what impurities are likely to be harmful without first knowing what other impurities are present and the special application for which the metal is required.

Melting for quality presents many difficulties even when virgin metals are the only raw materials used, but the use of scrap, an economic necessity, still further complicates the problems involved, which are similar but more intense than those associated with virgin metals. In addition to any undesirable constituents which may have been present in the original virgin metals, scrap may have suffered deterioration during the melting operations through which it has passed and, further, it may be contaminated by adherent as well as constitutional impurities. Owing to sampling and other difficulties, it is frequently impossible to assess its composition accurately, especially when in loose form, but much can be done to overcome some of these difficulties. Cleaning by washing, magnetting, hand-picking, and bundling, are helpful according to the nature of the scrap. If any serious doubt exists, the surest and in any case the safest procedure lies in refining so far as possible by melting and then casting into pigs, analyses of these providing the necessary safeguard as to their suitability for use.

The use of a limited percentage of scrap is sometimes stated to be beneficial to the quality of the metal melted, whilst, on the other hand, metal from remelted scrap is frequently considered inferior to that produced from virgin metals alone. Such general statements may

both be correct, and their truth dependent on the raw materials involved and methods of melting employed. The melting of virgin metals may be carefully carried out and become a refining operation, in which case scrap resulting from metal so melted may be purer than the original virgin metals from which it was made, and its use even up to 100 per cent., may lead to some improvement rather than deterioration in quality. On the other hand, virgin metals carelessly melted may suffer serious contamination, and resultant scrap may deserve all the condemnation it receives, not forgetting that the evil effects of careless melting are cumulative.

The word scrap implies something inferior; this is unfortunate, in spite of it being frequently the case, for by observing greater care during handling and melting many objections raised against its use would disappear.

Contamination During Melting.

The oxygen of the air and combustion products from fuels are common sources of contamination exterior to the metals being melted, and the materials of which melting vessels and stirring rods are made may also be attacked by the molten metal. No general statements can be made as to the extent to which these outside agents may react with the metal to the detriment of its quality. Whilst access of air may require vigorous exclusion in some instances, in others, oxidation by air may be advisable for the removal of undesirable constituents. Copper melting provides an example where both exclusion of air and oxidation by air may be usefully applied to one and the same metal for the production of either oxygen-free copper or refined tough-pitch copper. Exclusion of air during melting is generally advisable as it not only prevents the formation of oxides which may become admixed with and contaminate the molten metal, but losses due to oxidation are reduced, a matter of economic importance in the melting of some metals and alloys.

Furnace gases may be even more detrimental than air if allowed to contact freely with the molten metal, for, in addition to the oxidizing effect of excess air, they contain water vapour and sulphur dioxide which may lead, by interaction with metal or metallic oxides, to absorption of hydrogen or sulphur. Whilst the exposed surface of the metal may be more or less protected from contact with furnace gases, diffusion through the walls of melting vessels should not be overlooked as a possible source of contamination.

As regards the molten metal picking up undesirable impurities from the walls of the container in which it is melted, the wide range

of materials from which melting vessels can be made, of metals to be melted, and of temperatures involved, call for special consideration to be given to each particular case. In commercial melting operations, economy must play a part in the choice of materials to be used, and the use of refractories of high purity to prevent slight contamination of the molten metal is not usually necessary. One safeguard which may occur in practice against what might be a more serious trouble, lies in the early production of a protective slag or oxide coating on the surface of the refractory in contact with the molten metal. The building up of such a protective coating is very evident in the case of brass melting, and the fact that the first heat out of a new crucible or freshly-lined furnace is more contaminated than subsequent heats is due to this cause.

Stirring rods as a possible source of contamination come in the same category as materials for crucibles or furnace linings, except that the time of contact with the molten metal is comparatively short and the chance of pick up of undesirable impurities proportionately lessened. The old-fashioned bare iron stirring-rod has been responsible for many complaints of indifferent quality in high-melting point alloys, and brass, for example, that would not soften by normal annealing might easily have received an overdose of iron from the stirring-rod.

The use of mild steel melting pots is convenient and without danger for some metals of relatively low melting point, but with such metals as zinc and aluminium contamination by iron is unavoidable unless the pot be internally coated by a protective refractory wash, and even with such a precaution quality may easily be sacrificed on the altar of economy.

With all these possible sources of contamination to contend with, the production of high-quality molten metal presents many difficulties. The problems involved have much in parallel with those faced by the surgeon or physician when attempting to cure human ills and diseases. The melting pot is the operating table of the metallurgist, and it is there that he has to display his skill in curing the molten metals of their inherited or acquired diseases. Copper may suffer from chronic hydrogen, bismuth, or oxide contamination; nickel from gas, sulphur, and lead poisoning; aluminium from the ill effects of a humid climate. Besides these inherited diseases carried into the melting pot, they may become further infected during the melting process. Melting need not be an entirely surgical operation, for in some cases medicinal treatment may be preferable and the ill effects of contamination countered by suitably chosen antidotes. Once contracted the diseases may prove incurable, and then, as always, prevention is better than cure.

Just as the success of an operation or medical treatment depends on a correct diagnosis of the disease, the proper treatment of a metal during melting can only be carried out in the light of information provided by preliminary complete analysis and a knowledge of the special peculiarities of different metals and alloys.

In some respects the difficulties to be overcome by the metallurgist are greater than those which the surgeon or physician has to face. Diseases in molten metals more or less affect the whole mass, and there may be no visual evidence of their presence or of the success or otherwise of any operations performed. The fact that metals are opaque draws an impenetrable veil over what is happening in the melting pot. Perhaps it is well for our peace of mind that it should be so. All that we can do is to let our imaginations run riot and draw conclusions from the post-mortem examinations made on the cold frozen castings.

Removal of Undesirable Constituents During Melting.

If the metals to be melted are of known high quality, then the precautions to be taken may be limited to protection against possible external sources of infection, a charcoal or molten flux covering perhaps being all that is necessary. Much more frequently simple melting is insufficient to ensure the desired quality and definite steps must be taken to remove or lessen the ill effects of deleterious constituents by some suitable refining treatment.

Refining agents and methods are too numerous to consider individually, but the principles involved in their use may be considered conveniently under such headings as :

Special additions or deoxidizing agents,
Fluxes,
Gas treatment, and
Melting under reduced pressure or vacuum melting.

Deoxidizing agents find their widest application in the melting of copper and rich copper alloys. The solubility of cuprous oxide in molten copper leads directly or indirectly to many of the troubles associated with its own melting and that of its alloys. Fortunately, there are many other metals and non-metals which have a greater affinity for oxygen than copper itself, and the addition of one of these causes the oxygen to part company with the copper and attach itself to the added element. This is, however, only an exchange of oxygen from one element to another and not necessarily a removal from the bath of molten metal, which is the desired aim. The process is akin to pre-

cipitation as carried out in chemical analysis, and if looked at in this light, the complications and difficulties in the way of realising its full benefits may perhaps be more readily appreciated.

To begin with, excess of the deoxidizing agent or precipitant must be used, so in attempting to remove one impurity, oxygen, another constituent is introduced, and this residual deoxidant may be as objectionable (but for other reasons) as the original impurity it is desired to remove, in which case, further treatment for the removal or reduction to a minimum of the residual deoxidant may be desirable. Oxides lie in a rather vicious circle. Having got rid of the original oxide and transferred it into another, how is this latter to be removed and how do we know when it is completely removed? If insoluble and lower in density, it will tend to rise to the surface of the molten metal, but these assumptions may not always be true, or if true need not of necessity lead to a complete removal of the oxide. In chemical work the separation of a precipitate from a solution is by no means so rapid as might be anticipated from differences in density, and may require a long time for completion, and filtration is invariably resorted to. The metallurgist is severely handicapped as compared with the chemist when it comes to the separation of solid insoluble constituents from molten metals, and the results that he frequently obtains must be only partial instead of complete. How often is adequate time given for insolubles to rise to the surface, or how far is such separation hindered by agitation of the liquid metal? Vibration of the molten metal is stated to be helpful and such a process, known as the R.W.S. process, has been applied to the production of aluminium ingots free from admixed insolubles.

The full beneficial effects of a deoxidizing process are probably never realized by the use of solid deoxidants, and it is generally a case of a greater evil being displaced by a lesser one. There is again some analogy with surgical or medicinal treatments for the relief of disease, when the attempt to cure is not infrequently followed by some ill after-effects. The possibility of filtration would lead to a great step forward in the improvement of the quality of our metals by freeing them from insoluble constituents.

This question of removing reaction products due to the addition of deoxidizing agents to molten metal has probably never been given the attention it deserves. So many deoxidants are available that it is difficult to make the best choice. It is generally not difficult to find other metals or non-metals which will react with oxides in the melt, the trouble lying chiefly in the finding of a deoxidant which when used in a slight excess will have the minimum detrimental effect and

form a reaction product which will separate completely from the molten metal. In the case of copper some deoxidants, such as phosphorus, give a liquid reaction product in the form of cuprous phosphate which may not be so easily separated from the molten metal as a solid reaction product. Other deoxidants, such as lithium, for example, may have the disadvantage of reacting with the silica in refractories and lead to the contamination of the melt by silicon. A gaseous deoxidant such as carbon monoxide has many advantages over solid deoxidants, in so far as the reaction products are gaseous. Whilst referring to deoxidation by the addition of deoxidants to the molten metal in the furnace, it should be remembered that all the efforts to obtain a deoxidized metal in the furnace may be wasted if precautions are not taken to protect the metal from further oxidation during transference from the furnace to the mould, when the conditions may be very favourable to oxygen pick-up. A good clean deoxidized melt may therefore give a casting contaminated with oxide or oxide reaction gases unless special precautions against surface oxidation are taken during pouring.

Deoxidation, whilst generally beneficial, may sometimes be exactly the reverse, as in the case of copper containing small quantities of bismuth, the ill effects of which are appreciably less evident in the tough-pitch than in the deoxidized metal.

The electrical conductivity of copper is seriously reduced by even the smallest quantities of residual metallic deoxidant and deoxidized copper in spite of its many advantages cannot be used for applications calling for the highest electrical conductivity. Thermal conductivity suffers in a similar manner.

Special additions are not limited to the purpose of deoxidation, and in nickel and its alloys, for example, their use lies more in the direction of removing the ill effects of nickel sulphide. Small additions of manganese, silicon, magnesium, or lithium react with the nickel sulphide, forming sulphides which no longer separate at the crystal boundaries, and intercrystalline fracture on working gives place to malleability.

In the case of nickel and its alloys, residual small quantities of special additions are not so deleterious as in the case of H.C. copper, and the use of suitably chosen deoxidants or rather desulphurants is, therefore, everyday practice.

Whilst these special additions are frequently regarded as causing the removal of oxides or sulphides, it should be borne in mind that whilst some removal may take place, the primary benefit they confer on the metal is due to conversion of deleterious oxides or sulphides

into less harmful but chemically similar compounds. Complete removal would be preferable, but, for reasons already stated, the happy day when this can be accomplished has not yet arrived.

The treatment of molten metals by deoxidants is a phase of metal melting which cannot be fully developed until a closer knowledge is obtained of the equilibrium conditions which determine the reactions between the various constituents, and this fuller knowledge would lead to a much more scientific control of the melting process than is at present possible.

If the use of solid deoxidants be viewed as a precipitation method of purification, then the use of fluxes may be regarded as an extraction method, the impurities being dissolved in a suitably chosen molten salt. In some instances a flux may be used simply as a protective layer to prevent access of air or furnace gases to the molten metal. When it is required to choose a suitable flux for the removal of an impurity, the main properties to be taken into consideration are melting point, solubility of the impurity, and reaction with the material of the melting vessel. If the melting point is too high, this can be lowered by the addition of a second salt, and suitable mixtures are thus obtained within wide limits of melting point, although retaining the desired solvent properties.

The choice of a flux for the removal of any particular impurity is determined by chemical considerations. Removal of oxides and sulphides is perhaps the chief direction in which the use of fluxes is most beneficial, hence the common use of boric acid or borax, chlorides and fluorides or mixtures of these for the removal of oxides and of basic chemicals, such as lime or soda for the elimination of sulphides.

The cleansing of molten metals by fluxes is mainly confined to reactions at the contact surfaces of the molten metal and flux, hence the advantage of stirring metal and flux together or introducing the flux at the bottom of the melt, thus giving it an opportunity of reacting with impurities as it rises to the surface.

Whilst fluxes may generally be considered as solvents for undesirable constituents, their action may go further and cause definite changes in the composition of the melt. The removal of an undesirable constituent by means of a flux may alter equilibrium conditions and give rise to a secondary change of composition. In addition the flux may be decomposed and give rise to decomposition products which may go into solution, react with constituents, and again bring about a change in composition.

As compared with the completeness with which the chemist can purify his products by extraction methods, the metallurgist is at a

severe disadvantage. Why should we not purify our molten metals by shaking them up with solvent fluxes?

The wide use of charcoal as a covering in metal melting can conveniently be considered along with that of fluxes. It not only prevents access of air to the melt, but may also act as a very thorough reducing agent. Cuprous oxide is rapidly reduced when copper is melted under a layer of charcoal, and this fact is made use of in the production of oxygen-free copper.

As compared with the removal of cuprous oxide by deoxidants, removal by melting under charcoal has the great advantage of not leaving the copper contaminated with solid residual products from the reaction with the deoxidant. The active reducing behaviour of charcoal is probably not so much due to contact of carbon with the oxide at the surface of the melt, as to solution of carbon monoxide in the molten metal.

Copper completely deoxidized by melting under charcoal, if protected from oxygen pick-up during pouring into a mould, will solidify to a high density ingot without signs of gassing. Some precautions are necessary if the use of charcoal is to be fully effective; it should be dry and completely burnt, otherwise gassing on solidification may be evident.

Fluxes and charcoal coverings find their main application in preventing oxidation and aiding the removal of solid impurities. Gaseous impurities may be equally or even more detrimental to the soundness of the cast metal, and require other methods of treatment of the molten metal for their removal.

Several general principles are applied to the removal of gases from molten metals involving:

Reduced solubility of gases with decrease in temperature;
Slow solidification with rapid melting;
Reduction of partial pressure by treatment with an inert gas;
Treatment with reactive gases or volatile or decomposible chlorides;
Melting under reduced pressure.

The first method is based on gas evolution which occurs when molten metal cools, so that by melting and cooling slowly some removal of soluble gases takes place, but even if repeated several times such a process only leads to a partial removal of gas, and is of little practical interest.

Treatment by passing inert gases, such as nitrogen, through the molten metal provides a more efficient means of removing harmful

gases, amongst which hydrogen must be given pride of place. Even this method, although sound in principle, fails to yield entirely satisfactory results when applied to the removal of hydrogen from molten aluminium.

The removal of hydrogen from molten metals by treatment with chlorine or volatile and easily decomposible chlorides, such as those of titanium, boron, or carbon, has been successfully carried out, but such treatment does not appear to be of general application and, whilst successful in the case of aluminium and some of its alloys, is said to have little effect on the hydrogen content of other metals such as copper and magnesium.

The melting of metals under reduced pressure for the removal of gases is frequently at the same time a refining process involving the removal or decomposition of other constituents. As regards the evolved gases, some may result from liberation of dissolved or occluded gases present in the solid metal, whilst others, generally the larger volume, arise from reactions, even between solid constituents, which only take place when the metal is heated or melted. The volume and composition of the gases obtained by heating or melting under reduced pressure cannot, therefore, be taken as indicating their quantity or even existence in the solid metal. The possible reactions, though simple in themselves, become complicated by the varied equilibrium conditions that arise throughout the wide range of temperatures and pressures involved in a vacuum melting process. When reference is made to gases in metals, it is necessary, therefore, to distinguish between those which are free and " physically " liberated on melting under reduced pressure and others which result from reactions taking place at the high temperatures and low pressures involved in a vacuum melting process.

Oxides may be decomposed and thus removed from the melt, or they may be reduced by carbon giving rise to carbonaceous gases, and reactions which are incomplete at atmospheric pressure may run much nearer to completion under reduced pressure. Whilst complete removal of gases is not obtained, their concentration may be decreased to a point at which they are no longer harmful, and definite improvement of quality results. When gases arising from reactions with oxides are the main source of trouble, their formation may be prevented by removing the oxides by the addition of a deoxidant, an alternative which may render vacuum melting unnecessary. Metal melting under reduced pressure for the removal of gas is naturally limited to non-volatile metals and alloys. It can be applied to the purification of volatile metals by distillation or to the removal of certain volatile

impurities from non-volatile metals. Bismuth, for example, can be removed from copper, but whether this is a case of fractional distillation or whether the separation is facilitated by the presence of gases, especially hydrogen, in the copper, it is difficult to say.

Other Factors Bearing on Quality.

The advantages of a fine over a coarse crystal structure in either chill- or sand-castings are fully recognized, and whilst the macrostructure of the casting can to some extent be controlled by casting conditions, a similar, and in many cases more complete, grain-refinement can be obtained by suitable additions to the molten metal before casting. Zinc is an excellent example of a metal which tends to solidify in the form of large crystals and in which a fine macrostructure is encouraged by small additions of such metals as magnesium and lithium. In such cases the added elements are generally of very low solubility in the melt, or they form compounds of high melting point with either the metal or some of its minor constituents. The effect is not always fully developed in the casting, and may reveal itself to a more marked degree after cold-working and annealing. An explanation may be based on the assumption that small nuclei of insoluble compounds are formed in the molten metal before general solidification takes place. With some aluminium alloys, treatment with sodium or suitably chosen fluxes brings about a similar grain-refinement in the casting. As with all additions, some definite change in properties results, and in the case of zinc, for example, it would be more correct to attribute the refinement of grain to the formation of an alloy rather than to the production of a fine grain in pure zinc.

In the melting of certain metals and alloys stress is sometimes laid on the advisability of rapid melting, or of superheating the metal to a certain temperature. Whilst such procedures may be of some advantage, their importance is dependent on other considerations and they may have no marked intrinsic values in themselves. Rapid melting in fuel-fired furnaces reduces the time during which deleterious gases may be absorbed by or react with the metal, but with other conditions of melting, such as under reduced pressure, it may be better to bring the metal to the melting point more slowly. The degree of superheat to which a molten metal should be brought can only be considered in relation to the metal and the conditions of melting, keeping in mind the effect of temperature on gas absorption, viscosity, volatility and possible reactions.

With a clear understanding of the many factors which may influence

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the quality of metals and alloys due to the process of melting, it is not difficult to anticipate the relative advantages and disadvantages of the many types of melting furnaces and fuels. It is impossible to make any general statements as to the most suitable type of furnace and fuel without reference to the metal or alloy to be melted. Where products of fuel combustion are likely to be definitely detrimental, then the use of electrical energy as a source of heat offers great advantages, but this does not mean to say that if proper precautions be taken, metal of high quality cannot be produced in solid or gaseous fuel-fired furnaces. It is unlikely, however, that without the aid of electrical energy as a source of heat, melting under reduced pressure, for example, would have been commercially possible. The size of the melting vessel or furnace may not be without its effect on quality, as one of the requirements of quality is uniformity, and this is more easily attained in large melting units than in small ones. The melting of large masses of metal also facilitates the control of composition by analysis. The presence of volatile constituents, such as zinc in brass, may influence the choice of a suitable form of furnace, and furnaces of the reverberatory or vacuum melting type become unsuitable. This is not the place to discuss the merits and demerits of the many types of melting furnaces, but for any metal or alloy it should not be difficult to choose one which will meet the conditions of economic melting with high uniform quality.

In the light of this short survey of some of the problems met with in the melting of metals, a mixed feeling of satisfaction and disappointment may be justified. Satisfaction at knowing the causes of some of the troubles, disappointment at not yet having arrived at a technique which overcomes them. Continuous effort in the direction of improving quality is called for and if this introduction to the subject has outlined some of the problems involved and hinted at directions in which their solution may be sought, it has served its purpose.

AUTHOR INDEX TO ABSTRACTS

Adabidi, B., 445.
Ageenkov, V. G., 450.
Akimov, G. V., 427.
Alam, M. S., 414.
Alphen, P. M. van, 417.
Anderson, D. E., 451.
Anderson, E. A., 447.
Andreae, F. V., 442.
Arend, A. G., 446.
Aristov, V. M., 445.
Arzhanov, A. S., 440.

Bachmetew, E., 423.
Bärenfänger, C., 430.
Bastien, P., 413.
Bausch, K., 425.
Baxter, G. P., 416.
Becker, G., 419, 421.
Belknap, E. L., 452.
Benford, F. G., 420.
Benjamin, M., 414.
Berg, W. F., 425.
Bethe, H. A., 425.
Beynon, C. E., 430.
Bihlmaier, K., 434, 435.
Bloch-Sée, (Mlle.) L., 448.
Bloom, E., Jr., 434.
Bobovnikov, N. D., 428.
Bonomo, R. V., 442.
Boorse, H. A., 413.
Bor, J., 420.
Borelius, G., 422.
Bose, M. K., 437.
Bozhovskii, V. N., 440.
Brillie, J., 448.
Bulakh, A. A., 433, 441.
Burke, W. F., 417.
Burton, E. F., 417.

Cagliotî, V., 423.
Chalmers, B., 424.
Chatenet, J. du, 433.
Chizhikov, D. M., 435.
Cimerman, C., 437.
Clarke, S. G., 431.
Claus, W., 422.
Cohen, E., 415.
Cohen de Meester, W. A. T., 115.
Cole, S. S., 444.

Davis, E. C., 437.
Déribéré, M., 416, 452.
Dlougatch, L., 423.
Donaldson, J. W., 451.
Donau, J., 436.
Dreyer, K. L., 419.
Dunn, P. R., 448.

Easter, G. J., 413.
Ebert, H., 416.
Eddy, C. T., 437.
Ekstein, H., 426.
Elssner, G., 434.
Esch, W., 428, 429.
Etzrodt, A., 416.
Evans, B. S., 436.
Eve, L. L., 448.
Everest, A. B., 451.

Fahrenhorst, W., 426.
Faucett, P. H., 432.
Faust, C. L., 433.
Finck, J. L., 444.
Fink, C. G., 434.
Friedmann, W., 438.

Gaspar y Arnal, T., 435.
Geier, C., 440.
Geller, W., 418.
Gibbons, C. H., 439.
v. Göler, F. K., 451.
Gollnow, H., 437.
Gradusov, P. I., 418, 419.
Graham, A. K., 434.
Grayson, F., 447.
Grozin, B. D., 420.
Gründger, E., 452.
Guillery, R., 439.
Guillet, L., Jr., 439.
Guillon, —, 442.
Gupta, J., 436.

Haas, W. J. de, 417.
Haase, L. W., 430.
Hall, F. P., 444.
Hansen, M., 419.
Hartl, W., 449.
Harvey, F. A., 444.
Helling, W., 440.
Hengstenberg, J., 425.
Hepburn, W. M., 443.
Herb, C. O., 411.
Herr, A., 440.
Hiers, G. O., 450.
Hirone, T., 417.
Hoare, W. E., 430.
Holler, —, 447.
Hönigschmid, O., 416.
Horn, H. A., 447.
Huber, A., 423.
Hume-Rothery, W., 424.

Imhoff, W. G., 432.
Inglis, N. P., 420.
Insley, H., 444.
Isenburger, H. R., 439.

Jacquet, P. A., 446.
Jaeger, F. M., 415.
Jaffe, H., 414.
Johannsen, H., 421.

Kaischew, R., 423.
Karsten, A., 431.
Kasper, C., 432.
Keesom, W. H., 413.
Keller, J. D., 443.
Kibanov, V. P., 131.
Kihlgren, T. E., 440.
Kingsbury, P. C., 447.
Klement'ev, —, 447.
Kloster, A., 424.
Knapp, L. H., 442.
Knowles, A. V., 452.
Kornfeld, M., 413.
Köster, W., 418.
Kostylew, G. A., 127, 428.
Kozhina, N. K., 423.
Krebs, O., 442.
Kroenig, W. O., 427, 428.
Kroll, L., 447.

Lanza, A. J., 452.
Laszkiewicz, A., 423.
Leadbeater, C. J., 430.
Lebeau, P., 416.
Leland, H. R., 432.
Lépingle, M., 444.
Lewis, W. E., 422.
Lieshout, A. K. W. A. van, 415.
Louw, F. W., 436.
Lowery, H., 420.
Lukens, H. S., 435.
Lunde, G., 449.
Lundquist, E. L., 417.

McMullen, C., 443.
Macnaughtan, D. J., 431.
Mahle, E., 449.
Maier, —, 447.
Malgorn, G., 451.
Mark, H., 425.
Markarov, G. K., 411.
Matagrin, A., 430.
Mathiesen, E., 449.
Mendelssohn, K., 422.
Mesmer, G., 449.
Meyer, R. J., 416.
Meyer, T. F. W., 449.
Mitchell, R. W., 447.
Molder, J. W., 441.
Montillon, G. H., 433.
Moore, J. R., 422.
Moritz, G., 414.
Mott, N. F., 416.
Mouquin, H., 429.
Mueller, W., 441.
Müllenhoff, —, 448.
Müller, R. W., 451.
Mundt, H., 424.
Muratch, N. N., 440, 441.

Natta, G., 425.
Nekruitui, S. S., 420.
Neumann, F., 421.
Newbery, E., 430.
Niewodniczański, H., 413.
Nikonov, I. N., 450.

Okamoto, T., 450.
Ölander, A., 435.
Oleschko, A. S., 427.

Parvitzkii, V. I., 440.
Pendred, L. St. L., 452.
Perlitz, H., 426.
Pierce, R. H. H., 444.
Piersol, R. J., 433.
Popp, M., 429.
Précoul, M., 445.
Preisach, F., 421.
Preiswerk, M., 449.
Pridanzev, M. W., 446.
Prytherch, J. C., 431.

Quick, G. W., 429.

Rabbitt, J. A., 441.
Raistrick, A., 452.
Raub, E., 433, 434.
Rây, P., 436, 437.
Reddemann, H., 422.
Rice, C. W., Jr., 435.
Richards, E. T., 431, 444.
Richardson, H. K., 451.
Rjabinin, J. N., 422.
Robiette, A. G., 445.
Roehl, H., 419.
Rogers, R. R., 434.
Röntgen, P., 452.
Rueckel, W. C., 443.
Rukin, B. F., 446.
Ruprecht, B. C., 444.
Russ, E. F., 437.
Russell, H. W., 443.

Sachs, G., 451.
Sanfourche, A., 414.
Schilz, W. E., 436.
Schirm, E., 442.
v. Schmoller, F., 417.
Schneider, H., 436.
Scholes, S. R., 444.
Schüler, H., 437.
Schulze, A., 414.
Schürmann, E., 428, 429.
Schwinning, W., 422.
Seljakow, N. J., 426.
Shakhov, G. A., 441.
Shoenberg, D., 413.
Shubnikow, L. W., 422.
Silinskaya, V., 452.
Siluyanov, N. M., 452.
Smits, A., 422.
Snelling, R. J., 431.
Soderberg, C. R., 438.
Sokolov, M. N., 435.
Sosunov, S. L., 450.
Souder, W., 420.
Sovz, E. I., 426.
Stareck, J. E., 434.
v. Steinwehr, H., 414.
Steitz, W. A., 429.
Sterner-Rainer, —, 449.
Stevan, E., 441.
Stierstadt, O., 413.
Stranski, I. N., 423.
Straumanis, M., 424.
Stricker, P., 448.
Summa, O., 449.
Swale, W. E., 442.
Swanson, E. H., 420.

Taft, R., 434.
Tammann, G., 414, 419.
Tarr, F. G. A., 417.
Tartakovskii, V. Y., 436.
Taub, A., 451.
Taylor, A. H., 416.
Thews, E. R., 431.
Thomas, F., 447.
Thompson, M. de Kay, 435.
Thum, A., 439.
Titov, P. S., 450.
Tödt, F., 430.
Tonn, W., 421.
Trickett, J., 438.
Tupholme, C. H. S., 451.
Turner, A. A., 443.

Valentiner, S., 419, 421
Veber, V. F., 442.
Veenstra, W. A., 415.
Vegard, L., 424.
Vigelius, F. W., 437.

Waldram, J. M., 438.
Walter, E., 433.
Warren, A. G., 439.
Warren, B. E., 426.

Wassermann, —, 425.
Watts, O. P., 430.
Weinland, C. E., 443.
Weirs, O. T., 448.
Wenger, P., 437.
Wertheimer, E. G., 442.
Whitmore, W. F., 436.
Wilhelm, J. O., 417.
Wilkes, G. B., 443.
Wilkinson, H., 420.
Willard, H. H., 436.
Wolf, A. M., 449.
Woodall, A. J., 417.
Wrana, J., 448.
Wunderlich, F., 439.
Yakovleva, Y. A., 440.
Young, C. B F. 434.
Young, P., 436.
Zdralek, O., 448.
Zeelander, J., 431.
Zudin, M. D., 415, 416, 441.

METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 2 SEPTEMBER 1935 Part 9

I.—PROPERTIES OF METALS

(Continued from pp. 365-370.)

***The Softening of a Strained Metal [Aluminium] by Relaxation.** M. Kornfeld (*Physikal. Z. Sowjetunion*, 1934, **6**, 329-342).—[In German.] The dependence of the velocity of softening of an aluminium single crystal on the initial strain and temperature of relaxation is investigated. The nature of the dependence of the flow limit on the relaxation temperature, established by K. in previous work (*Met. Abs.*, 1934, **1**, 228, and this vol., p. 208) is now confirmed over a wide range of strains. Above 550° C. a second steady decrease of flow limit with decrease of relaxation temperature occurs, so that finally the original elastic characteristics of the crystal are recovered. A theory of relaxation is briefly discussed.—J. S. G. T.

***Electrical Resistance of Pure Aluminium at Liquid Helium Temperatures.** H. A. Boorse and H. Niewodniczański (*Nature*, 1935, **135**, 827-828).—Before becoming superconducting, the electrical resistance of very pure aluminium is constant between 4·2° and 2·2° abs.—E. S. H.

***On the Supraconductivity of Aluminium.** W. H. Keesom (*Proc. K. Akad. Wet. Amsterdam*, 1933, **36**, 381-383).—[In English.] See *Met. Abs.*, 1934, **1**, 545.—L. A. O.

***The Magnetostriction of Bismuth Single Crystals.** D. Shoenberg (*Proc. Roy. Soc.*, 1935, [A], **150**, 619-637).—The transverse magnetostriction effect exhibited by bismuth single crystals in magnetic fields of strength below 20,000 oerstedt is investigated experimentally. The change of length, of the order 5×10^{-7} cm., was measured by a special magnification method based on a hydraulic principle. The results confirm the general features of the phenomenon observed by Kapitza in intense longitudinal magnetic fields and are expressed in terms of 8 magnetostriction moduli, values of which are given. The anomalous temperature variation of diamagnetic susceptibility of bismuth is discussed in connection with the theoretical significance of these moduli.—J. S. G. T.

***Crystal Structure and Electrical Properties. V.—The [Electrical] Conductivity Surface of a Bismuth Crystal (Part 2).** O. Stierstadt (*Z. Physik*, 1935, **93**, 676).—In continuation of previous work (*Met. Abs.*, 1934, **1**, 77, 127, 484), the form of the electrical conductivity surface of a bismuth crystal in a transverse magnetic field is shown to be related, in general, to that characteristic of a longitudinal field. The surface, however, in the former case is not unique; characteristics of the surface are discussed.—J. S. G. T.

***Properties of Calcium Obtained by Sublimation.** Paul Bastien (*Rev. Mét.*, 1935, **32**, 120-136).—Very pure calcium (99·3%) is obtained by sublimation *in vacuo* and re-melting in argon. Observations on dilatation, differential thermoelectric properties, and hardness after quenching from various selected temperatures reveal 3 allotropic modifications of calcium. The transformation temperatures are 260° and 440° C. Dilatation curves of impure calcium show 2 supplementary anomalies which seem to be due to the action of atmospheric nitrogen on the warm metal. Sublimed calcium has a considerable capacity for deformation, which may be increased by hot-drawing at 420°–460° C. The impurities in industrial calcium reduce its capacity for

* Denotes a paper describing the results of original research.
† Denotes a first-class critical review.

deformation to a very moderate value. Sublimed calcium shows a lower rate of corrosion in alcoholic hydrochloric acid than commercial varieties, the corrosion-resistance of which is decreased by the impurities present.—H. S.

***Investigations Relating to Heat Changes Associated with Metallic Transformations. II.—[Cobalt]; III.—[Iron].** H. v. Steinwehr and A. Schulze (*Physikal. Z.*, 1935, **36**, 307–311, 419–423).—(II.—) The heat change associated with the α–β transformation of cobalt has been found to have the value $0{\cdot}1 \pm 0{\cdot}03$ cal./grm.; that associated with the magnetic transformation has the value $1{\cdot}2 \pm 0{\cdot}07$ cal./grm. (III.—) Values of the heat changes associated respectively with the magnetic (A_2) and the A_3 transformations of iron have been found to have the values (A_2) $4{\cdot}8 \pm 0{\cdot}2$ cal./grm.; (A_3) $6{\cdot}2 \pm 0{\cdot}08$ cal./grm.—J. S. G. T.

***The Electrical Resistance of Cobalt in a Longitudinal Magnetic Field.** Md. Sharf Alam (*Z. Physik*, 1935, **93**, 556–560).—The electrical resistance of a cobalt strip (purity 95%) in a longitudinal magnetic field is found to increase with increase of strength of field until a saturation value is attained, corresponding with a state of magnetic saturation of the metal, at a field-strength of about 1250 oerstedt. On subsequently decreasing and reversing the magnetic field the electrical resistance exhibits the phenomenon of hysteresis, the value of the resistance as the field is decreased being above that shown when the field is initially increased. The increase of resistance at saturation value is about 0·55–0·58% of the initial value of the resistance. A complete hysteresis cycle can be obtained by employing a cycle of values of the magnetizing field. In this cycle a field-strength of about 15 oerstedt is necessary to restore the resistance to its initial virginal value.—J. S. G. T.

***A Metallic Compound of Lithium and Ammonia. Electrical Conductivity and Galvanomagnetic Effects.** Hans Jaffe (*Z. Physik*, 1935, **93**, 741–761).—A saturated solution of lithium in liquid ammonia (containing about 4 mols. ammonia to 1 mol. lithium) freezes to form a solid compound at — 180° C.; the solid and liquid exhibit the phenomenon of metallic reflection, reflected light being copper-like in colour. The specific electric resistance of the saturated solution is about half that of mercury at room temperature and very nearly independent of temperature; the specific resistance of the solid compound at — 190° C. is reduced to about $\frac{1}{4}$ and has a positive temperature coeff. of about 2%. The saturated solution of lithium in ammonia, with a density of 0·48, is the lightest of all liquids at room temperature. The solid compound shows a normal negative Hall effect; at — 190° C. the Hall coeff. has the value $-1{\cdot}38 \times 10^{-3}$ cm.^{3}/amp. sec. It follows that exactly 1 free electron is present in the compound per atom of lithium. At — 200° C. a transformation of the compound occurs; this transformation is accompanied by a sudden fourfold increase in the value of the Hall coeff., and the marked dependence of the value of the electrical resistance of the compound on the strength of the magnetic field in which it is placed. The Hall coeff. for the saturated liquid is less than $-2{\cdot}5 \times 10^{-3}$ cm.^{3}/amp. sec.—J. S. G. T.

***On the Recovery of Iron and Nickel from Cold-Work.** G. Tammann and G. Moritz (*Ann. Physik*, 1933, [v], **16**, 667–679).—The changes produced in the electrical resistance and temperature coeff. of resistance of iron and nickel by rolling, drawing, and annealing have been measured.—v. G.

***The Influence of Impurities in the Core-Metal on the Thermionic Emission from Oxide-Coated Nickel.** M. Benjamin (*Phil. Mag.*, 1935, [vii], **20**, 1–24).—The commoner metallic impurities, added in turn to a pure nickel oxide-coated core-metal, are found to have a very considerable effect on the thermionic emission. This phenomenon is explained on the assumption that the amount of barium metal in the coating is dependent on the reducing power of the impurity.—J. S. G. T.

***Oxidation of Silicon.** A. Sanfourche (*Rev. Mét.*, 1935, **32**, 182–188).—Silicon oxidizes at low temperatures, even at normal air temperature. As

with other oxidizable metals, the action is the more intense the finer the state of subdivision. The product of the oxidation is either silica or a lower oxide. The oxide film usually protects against further oxidation when it consists of silica. The action of hydrofluoric acid on the oxide film led Moissan and Siemens to assume the existence of an allotropic form of silicon, soluble in hydrofluoric acid. The hydrogen liberation does not correspond to dissolution of silicon, but is much less in amount and is attributed by S. to the action of a sub-oxide. The modification of silicon–aluminium alloys by alkaline salts is attributed to elimination of the oxide film from silicon, thereby permitting intimate mixing of the constituents.—H. S.

***The Rate of Polymorphic Transformations. New Investigations on Tin Pest.** Ernst Cohen and A. K. W. A. van Lieshout (*Z. physikal. Chem.*, 1935, [A], **173**, 1–3).—The rate of transformation of white tin to grey and *vice versa*, is dependent on the number of transformations the metal has previously undergone, the medium (*e.g.* air or xylene) in which the transformation takes place, the previous thermal and mechanical history of the metal, and whether or not the metal is shaken during the change. Tin has been prepared in a form which is 7000 times as active as any previously known, so that it is possible to determine the rate of transformation at 1 atmosphere pressure in the neighbourhood of the transformation temperature; the rate is at 11·40° C. 6, 10·40° C. 12, and 9·40° C. 17·5 mm./hr. The observed phenomena are explained on the basis of the relation between the deformation and rate of transformation of enanteotropic metals.—B. Bl.

***Physico-Chemical Investigations on Tin.—The Temperature of Transformation White Tin ⇌ Grey Tin.** Ernst Cohen and A. K. W. A. van Lieshout (*Z. physikal. Chem.*, 1935, [A], **173**, 32–34).—Previous determinations of the transformation temperature of tin were made only within a temperature interval of 2·3° C. Using the highly active tin prepared as described in an earlier paper (see preceding abstract), the transformation temperature was found to be 13·2 ± 0·1° C.—B. Bl.

***The Rate of Polymorphic Transformations.—II.** Ernst Cohen and A. K. W. A. van Lieshout (*Z. physikal. Chem.*, 1935, [A], **173**, 67–70).—The "region of indifference" observed by Bridgman and others in the transformation of polymorphic substance is not a specific property of the substance but is to be ascribed to the previous history of the specimen; by suitable pre-treatment this region can be caused to disappear.—B. Bl.

***The Rate of Polymorphic Transformations. III.—The Influence of Mechanical Deformation on the Rate of Transformation [of Tin].** Ernst Cohen, W. A. T. Cohen de Meester, and A. K. W. A. van Lieshout (*Z. physikal. Chem.*, 1935, [A], **173**, 169–177).—Deformation of white tin by rolling, drawing, or bending accelerates very greatly the rate of transformation into grey tin, the rate being dependent on the severity of the cold-work applied. Tempering after deformation greatly reduces the rate again.—B. Bl.

***The Exact Measurement of the Specific Heats of Solid Substances at High Temperatures. VII.—The Calorimetric Behaviour of Zirconium.** F. M. Jaeger and W. A. Veenstra (*Rec. trav. chim.*, 1934, **53**, 917–932).—Hysteresis phenomena, already observed in the case of beryllium, are very marked with zirconium. A reversible transformation $\alpha \rightleftharpoons \beta$ is known to occur in zirconium at 870° C., but further unreproducible complications occur at about 620° C. The temperature varies with the previous treatment and grain-size of the metal. The values for heat content, &c., vary considerably. An attempt is made to explain the complex phenomena observed in the light of Smits' conception of dynamic allotropy, which assumes the existence of two "pseudo components" in movable equilibrium.—C. E. H.

***Mechanical Properties of Electrolytic Zinc.** M. D. Zudin (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (7), 116–126; *C. Abs.*, 1935, **29**, 4308).—[In Russian.] Soft pure electrolytic zinc assumes, in the process of rolling at

70°–80° C., a fine crystalline structure, which remains unchanged when heated up to 200° C. When it is heated from 200° to 250° C., the crystals grow larger, and a considerable reduction of mechanical properties results. 48 photomicrographs are given.—S. G.

Effect of Cadmium and of Rapid Cooling on the Structure of Cast Zinc. M. D. Zudin (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (3), 104–107; *C. Abs.*, 1935, **29**, 4305).—[In Russian.] Rapid cooling increased the hardness of pure zinc by 26% and of zinc containing 0·5 and 1% cadmium by 13 and 14%, respectively.—S. G.

Zirconium and Its Compounds. Maurice Déribéré (*Rev. mat. constr. trav. publ.*, **1935**, 61–63B).—A review.—S. G.

***Investigations at Pressures up to 5000 kg./cm.².** H. Ebert (*Physikal. Z.*, 1935, **36**, 385–392).—Fundamental data relating to the pressure apparatus are discussed, and the following empirical relations for the relative changes of length ($\Delta l/l$), expressed in mm./metre when the samples are subjected to pressures, p kg./cm.², are deduced for the respective metals at 20° C.; iron (single crystal), $\Delta l/l = 1{\cdot}97 \times 10^{-7}p - 0{\cdot}4 \times 10^{-12}p^2$; aluminium (single crystal), $\Delta l/l = 4{\cdot}48 \times 10^{-7}p - 0{\cdot}8 \times 10^{-12}p^2$; gold (single crystal), $\Delta l/l = 1{\cdot}96 \times 10^{-7}p - 2{\cdot}0 \times 10^{-12}p^2$; lead (single crystal), $\Delta l/l = 8{\cdot}00 \times 10^{-7}p - 4 \times 10^{-12}p^2$; silver (single crystal), $\Delta l/l = 3{\cdot}35 \times 10^{-7}p - 0{\cdot}5 \times 10^{-12}p^2$; magnesium (single crystal), $\Delta l/l = a \times 10^{-7}p - b \times 10^{-12}p^2$, the values of a ranging from 9·68 to 9·77, and of b from 7·0 to 9·0 according to the inclination of the pressure to the crystallographic axis; copper (polycrystal), $\Delta l/l = 2{\cdot}39 \times 10^{-7}p - 0{\cdot}79 \times 10^{-12}p^2$; Manganin (polycrystal), $\Delta l/l = 2{\cdot}75 \times 10^{-7}p - 2{\cdot}0 \times 10^{-12}p^2$; steel, $\Delta l/l = 2{\cdot}10 \times 10^{-7}p - 1{\cdot}0 \times 10^{-12}p^2$. Bridgman's results (where available) are also given. The following values of the cubic compressibilities of the metals ($K \times 10^7$) for $p = 0$ are deduced: silver, 10·05; aluminium, 13·44; gold, 5·88; copper, 7·17; iron, 5·91; magnesium, 29·09; lead, 24·00; Manganin, 8·25; steel, 6·30.—J. S. G. T.

Light and Ultraviolet Reflection by Various Materials. A. H. Taylor (*Trans. Illuminating Eng. Soc.*, 1935, **30**, 563–567).—Reflection factors for visible light and ultraviolet radiations at 2967 A., as measured with the Taylor reflectometer, are tabulated for a number of materials, including aluminium foil and sheet with various finishes, nickel- and silver-plated surfaces, rhodium, and tinned metal.—J. C. C.

Fifth Report of the Atomic Weights Committee of the International Union for Chemistry. G. P. Baxter, O. Hönigschmid, P. Lebeau, and R. J. Meyer (*Ber. deut. chem. Ges.*, 1935, [A], **68**, (6), 73–85).—The atomic weight of 92·91 is adopted for niobium. Investigations on the atomic weights of carbon, nitrogen, sodium, calcium, krypton, niobium, molybdenum, iodine, and cæsium are described, together with Aston's investigations on the rare earth metals and some recent work on tantalum, lead, radium, and protactinium. A complete list of international atomic weights is appended.—P. M. C. R.

***A Discussion of the Transition Metals on the Basis of Quantum Mechanics.** N. F. Mott (*Proc. Phys. Soc.* (*Lond.*), 1935, **47**, 571–588).—The magnetic susceptibilities and electrical conductivities of cobalt, nickel, palladium, and of their alloys with copper, silver, and gold are discussed in accordance with the quantum theory of metals. The number of electrons in the outermost s state must be 0·6 per atom in the transition metals, and 1 in the noble metals; magnetic properties of the alloys are explained on this basis. A quantum-mechanical explanation of the relatively high resistance of the transition metals is given; the theory is supported by values of the electrical resistances of the alloys.—J. S. G. T.

***Direct Effect of Light on the Electrical Resistance of Metals.** A. Etzrodt (*Physikal. Z.*, 1935, **36**, 433–441).—Majorana (*Physikal. Z.*, 1932, **33**, 947) has claimed to have established the fact that the incidence of light on certain

metals causes the electrical resistance of these metals to be increased, apart from the purely thermal effect produced. E. now shows that the phenomenon observed by M. is purely thermal in character.—J. S. G. T.

***A Simple Theory on the Anomaly of Electrical Resistance of Ferromagnetic Substances.** Tokutarô Hirone (*Sci. Rep. Tôhoku Imp. Univ.*, 1935, [i], **24**, 122–127).—[In English.] The anomaly is explained by the fact that the mean path of the conduction electron is affected by the rotational vibration of the molecular magnets in the Honda–Ôkubo model of a ferromagnetic substance. It is to be noted that the equation of corresponding state exists between the reduced resistance and the reduced temperature of the ferromagnetic substance. This conjecture has been confirmed by results of measurements on iron, cobalt, and nickel.—S. G.

***Change of the Resistance of Metals in a Magnetic Field at Low Temperature.** W. J. de Haas and P. M. van Alphen (*Comm. K. Onnes Lab. Leiden*, 1933, (225a), 1–15).—[In English.] See *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 489.—L. A. O.

Investigations Relating to the Matteucci Effect. F. v. Schmoller (*Z. Physik*, 1935, **93**, 35–51).—The Matteucci effect—the production of an e.m.f. between the ends of a twisted ferromagnetic wire subjected to a change of magnetization—is investigated in considerable detail. The phenomenon is characterized by two phases of opposite sign corresponding to the direction of change of magnetization; characteristics of these phases are discussed.

—J. S. G. T.

***The Direct Measurement of the Peltier Coefficient.** A. J. Woodall (*Proc. Phys. Soc.* (*Lond.*), 1935, **47**, 615–625).—A new apparatus, including all-metal calorimeters separate from the specimens being tested, and employing a differential platinum resistance thermometer, for the measurement of Peltier coeffs. is described. Employing a sufficiently good thermostatic device, the apparatus is capable of just detecting a steady heating effect of the order of 10^{7} cal./sec. The Peltier coeff. for copper against Constantan is found to be constant for values of the current between 0·1 and 0·012 amp.—J. S. G. T.

Thermo-Electric Effect and the Supra-Conducting State. E. F. Burton, F. G. A. Tarr, and J. O. Wilhelm (*Nature*, 1935, **136**, 140).—No thermoelectric effect exists between tin and lead when both metals are in the superconducting state (*i.e.* below 3·7° abs.), but the effect is observed when either one of the junctions is raised above the superconducting point of one of the metals.—E. S. H.

Asymmetric Rectangular [Hysteresis] Loops Associated with Circular Magnetization. F. v. Schmoller (*Z. Physik*, 1935, **93**, 52–54).—The magnetization curves of a twisted cold-drawn nickel wire subjected to circular magnetization by passage of a direct current show asymmetry about the magnetization axis of the curve which is displaced parallel to the axis of field-strengths. The Barkhausen magnetic effect is also found to be influenced by the torsion.—J. S. G. T.

***Magnetic Properties of Metals at Low Temperatures.** W. J. de Haas and P. M. van Alphen (*Comm. K. Onnes Lab. Univ. Leiden*, 1933, (225b), 16–26).—[In English.] See *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 489.—L. A. O.

II.—PROPERTIES OF ALLOYS

(Continued from pp. 370–377.)

***Strength Tests of Thin-Walled Duralumin Cylinders of Elliptic Section.** Eugene E. Lundquist and Walter F. Burke (*Nat. Advis. Cttee. Aeronautics, Tech. Notes* No. 527, 1935, 23 pp.).—The shearing stress at failure in torsion for thin-walled elliptical cylinders is equal to that for circumscribed circular

cylinders of the same wall-thickness and length. Since buckling of the walls occurs at the ends of the mirror axis prior to failure, the calculated shearing stress for the elliptical cylinder is analogous to the modulus of rupture. For pure bending in the place of the major axis the calculated stress on the extreme fibre at failure is greater than the corresponding stress for similar circumscribed circular cylinders. Since small imperfections produce wide scattering of the test results the bending strength determinations are somewhat indefinite and the probable value must be estimated after consideration of all the data for both types of cylinders before choosing a design. For combined transverse shear and bending in the plane of the major axis the strength is dependent on the value of $M/r'V$ (representing the loading and stress conditions). At low values of $M/r'V$ failure occurs in shear and as the value approaches zero (a condition of pure transverse shear) the shearing stress on the neutral axis at failure is about 1·25 times the shearing stress at failure in torsion. At large values of $M/r'V$ failure occurs in bending and the strength developed is equal to the lowest strengths developed for similar cylinders in pure bending. At intermediate values of $M/r'V$ there is a transition from shear to bending failure. The experimental results are shown in numerous tables and graphs, and a short *bibliography* is appended.—A. R. P.

***An Electrochemical Investigation of Solid Cadmium–Antimony Alloys.** (Ölander.) See p. 435.

***The System Iron–Cobalt–Tin.** Werner Köster and Werner Geller (*Arch. Eisenhüttenwesen*, 1934–1935, 8, 557–560).—The system has been examined by thermal and micrographic methods up to 40% tin. The two compounds Fe_2Sn and Co_2Sn form a continuous series of solid solutions. Addition of cobalt increases the temperature of the equilibrium α + liquid = Fe_2Sn to meet the equilibria α + liquid = γ of the cobalt–iron system and liquid = γ + Co_2Sn of the cobalt–tin system in the 4-phase equilibrium liquid + $\gamma = \alpha$ + Co_2Sn–Fe_2Sn solid solution. The solubility of the compounds in the α and γ phases decreases with decrease in temperature, hence certain alloys are subject to precipitation-hardening, the reheating temperature being 700° C. for α, 600° for α + γ, and 750° C. for γ-alloys. The magnetic properties, hardness, and microstructure of certain of the alloys are discussed.—A. R. P.

***The System Iron–Cobalt–Titanium.** Werner Köster (*Arch. Eisenhüttenwesen*, 1934–1935, 8, 471–472).—The system has been studied by thermal and micrographic methods up to 22% titanium; only the two binary compounds Fe_3Ti and Co_3Ti exist, and these form a continuous series of solid solutions, the solubility of which in the α- and γ-phases increases with increase in temperature from about 2% at room temperature so that alloys containing these can be precipitation-hardened by suitable heat-treatment. Thus, after quenching from 1100° C., the alloy with 55% cobalt and 7·6% titanium has a Brinell hardness of 420 which is increased to 600 by tempering at 600° C.; the corresponding values for the alloy with 75% cobalt and 4·5% titanium are 205 and 305. The eutectic equilibrium of the iron–titanium system and the peritectic equilibrium of the iron–cobalt system are displaced to lower temperatures by the addition of the third metal and terminate at 1150° C. in the 4-phase reaction liquid + α-solid solution = γ solid solution + Fe_3Ti–Co_3Ti solid solution. From this point the equilibrium liquid = α + Fe_3Ti–Co_3Ti extends to the eutectic equilibrium of the Co–Ti system, and the equilibrium $\alpha = \gamma$ + Co_3Ti–Fe_3Ti to room temperature.

—A. R. P.

***α-Aluminium–Bronze and Its Mechanical Properties.** P. I. Gradusov (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (7), 126–137; *C. Abs.*, 1935, 29, 4315).—[In Russian.] α-Aluminium–"bronze," containing 6·5 ± 0·5% aluminium and the remainder copper, is a good substitute for bronzes con-

taining (1) tin 4, zinc 3, copper 93%, or (2) tin 6·5, phosphorus 0·4, copper 93·1%. The α-aluminium–"bronze" was melted in an oil-fired furnace. The alloy contained 6·62% aluminium and was used in a series of mechanical tests. Its mechanical strength at temperatures up to 500° C. was 1·5 times that of phosphor–bronze. The α-aluminium–"bronze" was free from defects. It was rolled, first hot and then cold, into plate, rod, and wire. It has good plastic qualities and is suitable for the production of springs. It is not inferior to phosphor–bronze in corrosion-resistance to air or in solutions, and is also resistant to abrasion. It is recommended as a substitute for ordinary bronze in machine construction, but not in the form of fine wire (*e.g.* in screens) of 0·30–0·07 mm. diameter.—S. G.

***Heusler Alloys.** S. Valentiner and G. Becker (*Z. Physik*, 1935, **93**, 629–633).—Polemic with Heusler (*Met. Abs.*, 1934, **1**, 579). New measurements of the magnetic and electric properties of the alloy containing manganese 25, aluminium 25, and copper 50% confirm the stability of the crystal $MnAlCu_2$ at about 300° C. and support the authors' contention (*Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 620) that the magnetic properties of Heusler alloys are associated with the presence of crystals of $MnAlCu_2$.—J. S. G. T.

***Standard Manganin Containing Aluminium, and Its Properties.** P. I. Gradusov (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (6), 101–105; *C. Abs.*, 1935, **29**, 4315).—[In Russian.] Manganin (copper 85, manganese 12, nickel 3%), in which aluminium replaces nickel, behaves during melting, pouring, and heat-treatment like the ordinary alloy. Its mechanical properties are indistinguishable from those of the standard alloy when its tempering temperature is not above 700° C. The specific resistance of the aluminium–Manganin increases with increase of tempering temperature. In practice it can be used up to 400° C.—S. G.

***Mechanical Properties of Double Manganin.** P. I. Gradusov (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (6), 105–111; *C. Abs.*, 1935, **29**, 4315).—[In Russian.] Samples of double Manganin containing copper 71·49, manganese 20·79, and aluminium 6·11% were tempered at 550°, 600°, 650°, 700°, 750° and 800° C., and their mechanical properties were then studied. Heating to 800° C. followed by slow cooling gives the best results.—S. G.

***The Recovery of the Electrical Resistance of Binary Solid Solution Alloys of Copper, Silver, and Gold from the Consequences of Cold-Work.** G. Tammann and K. L. Dreyer (*Ann. Physik*, 1933, [v], **16**, 657–666).—Cf. *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 177. The increase in the electrical resistance produced by cold-work and the subsequent reduction by annealing have been measured for solid solution alloys of copper with zinc, tin, nickel, manganese, and aluminium, of silver with zinc, cadmium, and gold, and of gold with silver and copper. The increase is greater the greater the difference between the lattices of the two alloying metals and the greater the atomic radius of the solute metal.—v. G.

***The Elastic Properties of Gold–Silver Single Crystals.** H. Roehl (*Ann. Physik*, 1933, [v], **16**, 887–906).—The elastic constants in 10^{-13} cm.^{2}/dyne and the anisotropy of single crystals of gold and silver alloys are:

Atomic-% Gold.	Δ_{11}.	Δ_{44}.	Δ_{12}.	E_{111}/E_{100}.	G_{100}/G_{111}.
0	23·2	22·9	— 9·93	2·72	2·26
25	20·7	20·5	— 8·91	2·66	2·26
50	19·7	19·7	— 8·52	2·65	2·25
75	20·5	20·6	— 9·09	2·68	2·24
100	22·7	22·9	— 10·35	2·72	2·26

—v. G.

Nickel in the Precious Metal Field. Eric H. Swanson (*Metals and Alloys*, 1935, 6, 194).—Letter to the Editor. The statement that addition of about 2% of nickel to precious metal alloys containing less than 75% (gold + platinum) seriously impairs the tarnish-resistance is incorrect. Alloys containing about 45% (gold + platinum + palladium) and 4·25% nickel have a high resistance to tarnishing and give excellent castings.—A. R. P.

Nickel in Dental Alloys. Wilmer Souder (*Metals and Alloys*, 1935, 6, 194).—Letter to the Editor. Small quantities of nickel in casting alloys for dental restorations appear to reduce their elasticity and resilience; the nickel has a tendency also to produce irritation of the tissues. At least 65% of precious metals is the minimum necessary to obtain tarnish-resistance. (Cf. preceding abstract.)—A. R. P.

†**Beryllium–Copper Alloy.** F. G. Benford (*Gen. Elect. Rev.*, 1935, 38, 297–299).—The heat-treated 2·5% beryllium–copper alloy, whilst possessing excellent mechanical properties has two disadvantages: it is expensive and has a low electrical conductivity (25% that of copper). The addition of a small quantity of cobalt reduces the amount of beryllium necessary for hardening by precipitation. The addition of cobalt not only reduces the cost of the alloy, but also increases the electrical conductivity to about 50% that of pure copper. With the ternary alloys the precipitation-hardening temperature is increased from 275° to about 500° C. Certain compositions have been standardized and the cost of one of these is about ⅓ that of the binary beryllium–copper alloy. It is available in all forms and has been applied to a variety of uses. [*Note by abstractor:* No actual compositions are given.]—S. V. W.

***Effect of Low Temperatures on the Structure and Mechanical Properties of Antifriction Alloys.** S. S. Nekruitui and B. D. Grozin (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (3), 91–104; *C. Abs.*, 1935, 29, 4314).—[In Russian.] The behaviour at low temperatures of antifriction alloys used in railway cars and locomotives was studied. The alloys tested were Sharpe Babbitts B–1, B–2, B–3, B–4, and B–5 and a lead-base calcium–Babbitt containing calcium 0·75–1·1, sodium 0·7–1·0, antimony less than 1%, and other elements. Samples, first cooled to − 53° or − 75° C., then heated in oil or air to + 12°, + 70°, or + 75° C., were tested for hardness, impact, compression, and abrasion, and were also examined microscopically. Low temperatures down to − 50° C. have no harmful effect on the tin or calcium–Babbitts, but below this temperature a softening effect is produced, owing to the decomposition of Sn–Sb and Pb_3Ca crystals in the Sharpe or calcium–Babbitts, respectively. Calcium–Babbitt compares well with the Sharpe standard Babbitt B–1.

—S. G.

Notes on Heat-Resisting Metals. N. P. Inglis (*J. Soc. Glass Tech.*, 1933, 17, 366–377).—Deals with developments and improvements in various metals to improve their heat-resistance. The extreme susceptibility of the Nichrome type alloys to gases containing sulphur is shown, and the effect of an addition of aluminium to these alloys is dealt with. I. quotes experimental results showing the great increase in resistance to sulphur-containing gases which is obtained by an addition of aluminium to the Nichrome alloys.—S. G.

***The Optical Constants of the Copper–Nickel Alloys.** H. Lowery, J. Bor, and H. Wilkinson (*Phil. Mag.*, 1935, [vii], 20, 390–409).—The optical const. of 12 copper–nickel alloys containing, respectively, 0, 8·8, 18·4, 24·7, 35·2, 45·1, 53·2, 64·9, 76·0, 85·5, 91·8, and 100% (atomic) of nickel were measured, using a polarimetric method, for wave-lengths 5780, 5461, and 5348 A. Stress is laid on the method of polishing adopted, the object of which is the production of a very thin flowed layer. The significance of the results is briefly discussed.

—J. S. G. T.

"K" Monel Metal. —— (*Mech. World*, 1935, **97**, 632).—By the addition of aluminium and careful adjustment of composition, "K" Monel metal is obtained, the properties of which may be widely varied by suitable heat-treatment. Examples of the variation in properties obtainable by specified heat-treatment, &c., are given.—F. J.

***Magnetic Investigations Relating to Precipitable Iron–Nickel Alloys.** F. Preisach (*Z. Physik*, 1935, **93**, 245–268).—The changes of magnetic properties of 2 iron–nickel alloys of respective compositions nickel 55, iron 45% with 1% of beryllium added to the melt, and nickel 38, iron 46, copper 15, manganese 1% (Isoperm) during the process of precipitation-hardening, are investigated. The results are interpreted on the assumption that in addition to the amount and distribution of the precipitated material, the recovery of the crystal lattice is of extreme importance in the discussion of the development of magnetic hardening. Observations referring to the inter-relationship of the precipitation process and crystal lattice recovery are discussed in considerable detail.
—J. S. G. T.

Wear of Iron[–Nickel] Alloys on Emery Paper and Their Hardness. Willi Tonn (*Arch. Eisenhüttenwesen*, 1934–1935, **8**, 467–470).—The comparative rates of wear of metals or alloys may be determined by holding specimens under a load of 1 kg. on the surface of a rotating disc covered with emery paper and moving the specimen slowly along a diameter so that it continuously meets fresh emery. The loss in weight is roughly proportional to the scratch hardness, and is not affected by heat or mechanical treatment. The wear of iron–nickel alloys decreases rapidly with increasing nickel content to 30%, then remains constant to 70% nickel after which it increases slightly; the Brinell hardness curve shows a well-marked maximum at 17% nickel, and is practically a horizontal line between 35 and 100% nickel.—A. R. P.

***The Causes of the Change in Length of Invar Wires.** F. Neumann and H. Johannsen (*Z. Instrumentenkunde*, 1934, **54**, 173–190).—The behaviour of carefully treated and well-aged Invar Jäderin wires depends on (1) changes in structure which lead to slight expansion, and (2) accidental strains in the wires. The paper deals principally with the latter, and describes investigations on the effects of artificially produced kinks on the dimensions of the wire. The dimensional changes are related to the geometrical form of the kinks. In a wire under tension there is an initial shortening when a kink is formed, but this is followed by a lengthening. Recommendations are made for the handling and usage of Invar wires to give the most accurate results from experiments in which they are used.—C. E. H.

***The System Nickel–Manganese.** Siegfried Valentiner and Gotthold Becker (*Z. Physik*, 1935, **93**, 795–803).—Nickel–manganese alloys, quenched from a high temperature, are found to consist of a solid solution of manganese in nickel, or, in the case of alloys containing over 80% manganese, of a solid solution of nickel in β-manganese. A tetragonal phase is present in annealed alloys containing from 40 to 70% manganese. The electrical conductivities of alloys containing, respectively, 25 and 50% manganese increase considerably when the alloys are annealed at about 450° C.; the temperature coeff. of electrical conductivity of these alloys increase under the same condition. The effect is attributed to the replacement of Ni_3Mn in the quenched alloys by NiMn in the annealed alloys. The effect of the two component metals is clearly brought into evidence in the magnetic properties of the alloys. Alloys containing about 25% manganese are very strongly paramagnetic; this phenomenon is attributable to the presence of the superstructural alloy Ni_3Mn. Ferromagnetism is not exhibited by the superstructural alloy containing about 50% manganese; this is attributable to the presence of a tetragonal crystal lattice. Further, these latter alloys are

characterized by increased values of electrical conductivity. The presence in them of NiMn is confirmed by X-ray analysis.—J. S. G. T.

†**Alloys with a Zinc Base.** Willi Claus (*Z.V.d.I.*, 1935, **79**, 385–386).—Advances made in recent years in zinc-base alloys have resulted in greatly increasing their sphere of usefulness in engineering technique. The tensile properties of zinc-base die-castings and the effect of impurities thereon are discussed.—K. S.

***The Mechanical Properties of Metals at Low Temperatures.** W. Schwinning (*Z.V.d.I.*, 1935, **79**, 35–40).—The notched-bar impact strength and endurance properties of numerous metals and alloys at low temperatures are tabulated, and the effects of temperature changes are shown graphically. The tensile properties and endurance bending strength of light alloys, especially of hardened Duralumin and Aldrey, are affected only slightly by cooling to − 40° C. The tensile strength and yield-point of copper and steel are considerably increased and the endurance bending strength is raised by double as much as the tensile strength on cooling to − 40° C.—K. S.

†**Brittleness in Ductile Engineering Materials.** W. E. Lewis (*Trans. Inst. Eng. Ship. Scotland*, 1934–1935, **78**, 444–484).—L. deals with the embrittlement occurring in various ductile materials, including the "season-cracking" of cold-worked brass, failure of mild steel in contact with brazing solder, embrittlement occurring when molten tin or tin–lead solders are applied to copper or brass when stressed in tension, and electrochemical disintegration in brass or manganese–brass propellers. In the discussion considerable space is devoted to the Izod impact test as a means of determining brittleness in materials.—J. W. D.

***The Norbury Relation in the Thermal Resistance of Metals.** H. Reddemann (*Ann. Physik*, 1934, [v], **20**, 502–512).—The increase in electrical resistance of alloys is proportional to the increase in thermal resistance up to a high content of alloying metal. This rule has been confirmed by data taken from the literature on alloys of copper, aluminium, gold, silver, platinum, and palladium. The thermal resistance of alloys can, therefore, be calculated in most cases from their electrical resistance.—v. G.

***Supra-Conducting Alloys.** K. Mendelssohn and Judith R. Moore (*Nature*, 1935, **135**, 826–827).—Differences in the behaviour of superconducting alloys in comparison with pure metals have been examined in the case of a lead–bismuth alloy. As an explanation, it is suggested that the temperature at which superconductivity is observed is high in some parts of the alloy while the main part has the same value as pure metals.—E. S. H.

***Magnetic Properties and Critical Currents of Supraconducting Alloys.** J. N. Rjabinin and L. W. Shubnikow (*Nature*, 1935, **135**, 581–582).—The relation between the intensity of the field applied and the magnetic induction produced in alloys of lead–thallium ($PbTl_2$) and lead–bismuth (lead 65%) at very low temperatures is described. Above a certain critical field-strength these alloys lose their superconductivity.—E. S. H.

***On the Theory of Transformation of Metallic Solid Solutions.** G. Borelius (*Ann. Physik*, 1934, [v], **20**, 57–74).—Equations have been developed on thermodynamic principles for expressing the course of transformations which take place over a temperature range and are subject to hysteresis. The results are applied to the transformation of AuCu and $AuCu_3$.—v. G.

***Internal Equilibria in Solid Phases.** A. Smits (*Physikal. Z.*, 1935, **36**, 367–371).—S. directs attention to the priority of his work on equilibria and heterogeneous transformations in solid phases (*Physikal. Z.*, 1930, **31**, 376; and *Met. Abs.*, this vol., p. 155), and discusses subsequent work by Juste and von Laue (*Met. Abs.*, this vol., p. 155) and by Eucken (*Met. Abs.*, this vol., p. 219).—J. S. G. T.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 378–380.)

†**Questionnaire on Dendrites, the Monocrystalline State, Metal Grains, and the Mechanism of Grain-Growth.—I,—II.** Léon Dlougatch (*Rev. Mét.*, 1935, **32**, 23–31, 85–99).—(I—) The views of 24 authorities are given and are followed by a brief *résumé* of the replies received on the subject of dendrites (see also abstract from Russian, *Met. Abs.*, 1934, **1**, 578). (II.—) The replies received on the subject of the monocrystalline state are reviewed. On the subject of twinned crystals there is some divergence of opinion. While many of the authorities regard twinned crystals as something different from monocrystalline, several point out that it is a matter which may be considered from various aspects and with different results. The various views on grain in alloys and on grain-growth are also reviewed.—H. S.

The Kinetics of Crystallization Processes. A. Huber (*Z. Physik*, 1935, **93**, 227–231).—A mathematical theory of crystallization is presented, which is a development of that due to v. Göler and Sachs (*J. Inst. Metals*, 1932, **50**, 671) and which enables the theoretical conclusions of the latter to be compared with experimental results.—J. S. G. T.

***Crystal Growth and the Production of Crystal Nuclei.** I. N. Stranski and R. Kaischew (*Physikal. Z.*, 1935, **36**, 393–403).—A mathematical theory of cubical crystal growth based on considerations of energy is developed. —J. S. G. T.

***The Orientation of Crystals in Metals and [its Effect on] Solubility.** Vincenzo Caglioti (*Atti IV Congr. naz. chim. pura applicata* (*1932*), 1933, 442–446; *C. Abs.*, 1935, **29**, 4239).—Out of 99·95% aluminium, repeatedly forged and reheated, 2 small cubes were cut in a direction parallel to that of forging, and were then rolled down to 99%, one being rolled in all directions and the other in one direction only. X-ray examination showed random orientation of the crystals in the first, while, in the second, one (335) axis was substantially parallel and one (135) axis substantially normal to the direction of rolling. The two sheets, 10 cm.^{2} in area, were polished and then cleaned by dipping for 10 minutes in 4-*N* hydrochloric acid. They were then immersed each in 3 litres of 2·5-*N* hydrochloric acid at 19·8° C., and the hydrogen evolved was measured every 15 minutes up to 4 hrs. The second sheet (uniform orientation of crystals) showed a longer period of induction and a slightly lower rate of solution than the first (random orientation). This may be owing either to a difference of potential of solution for the various faces, or to a regular distribution of an impurity in some of the crystal faces.—S. G.

***X-Ray Tests of the Recrystallization of Duralumin.** N. K. Kozhina (*Trans. Research Inst. Aircraft Materials* (*U.S.S.R.*), 1934, (17), 3–16).—[In Russian, with German summary.] See *Met. Abs.*, this vol., p. 221.—S. G.

***X-Ray Determination of the [Crystal] Structure of $FeAl_3$.** E. Bachmetew (*Z. Krist.*, 1934, **89**, 575–586).—Cf. *Met. Abs.*, this vol., p. 99. The alloy $FeAl_3$ is shown to possess rhombic crystal symmetry. The crystal lattice constants have the respective values: $a = 47{\cdot}43$ A., $b = 15{\cdot}46$ A., $c = 8{\cdot}08$ A. The number of atoms per cell (N_A) is 400; the calculated density is 3·811 [temperature not specified]. The crystals belong to the translation group $\Gamma_v^{''}$ (general face-centred) and to space group V_h^{23}.—J. S. G. T.

Native Copper. Antoni Laszkiewicz (*Arch. Mineral. Tow. Nauk. Warszaw.*, 1933, **9**, 1–17).—Crystallographic.—S. G.

*Growing Magnesium Crystals. M. Straumanis (*Z. Krist.*, 1934, 89, 487–493).—Cf. *Met. Abs.*, this vol., p. 15. The growth of magnesium crystals deposited from the vapour phase in hydrogen at a pressure of 0·001–360 mm. of mercury is described and illustrated. During such deposition, in addition to crystals having the equilibrium form bounded by the planes 0001, $10\bar{1}0$, and $10\bar{1}1$, others bounded by some of these planes and a curved surface, having a bright and molten appearance are found to occur. Microscopic investigations show that during the initial process of crystal growth, more especially when the vapour is highly supersaturated, crystal nuclei having no external planes can be produced. With increasing size of the nuclei the equilibrium plane surfaces begin to appear, with so-called "Vizinal" surfaces appearing during the intermediate stage. These last surfaces occur only in rapidly growing crystals. As conditions of growth approach equilibrium conditions the "Vizinal" surfaces disappear. In addition to these surfaces and the plane $10\bar{1}3$ which appears sporadically, no other surfaces were found to characterize non-equilibrium conditions of growth.—J. S. G. T.

*Gold–Copper Alloys, more Especially at High Temperatures. L. Vegard and Arne Kloster (*Z. Krist.*, 1934, 89, 560–573).—The crystal structures of gold–copper alloys containing respectively the pure components and 75, 50, and 25% (atomic) of the components were determined by X-ray analysis. At 475° C. the alloys are characterized by random atomic distribution; in accordance with previous work, compounds such as CuAu and $CuAu_3$ cannot be present at this temperature. Although the system copper–gold at 475° C. forms a complete series of true solid solutions (Mischkristalle) the additive law of lattice dimensions is not very closely obeyed. At room temperature the system of alloys shows no lines associated with the presence of metallic compounds, but exhibits the character of solid solutions with random atomic distribution; alloys containing about 50% (atomic) of the constituent metals are characterized by such a conspicuous absence of micro-structure that the X-ray lines, even at large dispersion, almost disappear altogether. Lattice dimensions, so far as they could be determined at room temperature, exhibit the same kinds of departure, as regards magnitude and direction, from the additive law, as at high temperature.—J. S. G. T.

*X-Ray Investigation of Palladium–Gold Alloys Saturated with Hydrogen. H. Mundt (*Ann. Physik*, 1934, [v], 19, 721–732).—X-ray examination of palladium–gold alloys saturated with hydrogen showed that they are similar to the corresponding silver alloys (see *Met. Abs.* (*J. Inst. Metals*), 1933, 53, 190).—v. G.

*Lattice Parameters of Solid Solutions in Silver. William Hume-Rothery (*Nature*, 1935, 135, 1038).—The addition of cadmium, indium, tin, and antimony to silver changes its lattice structure to an extent which is proportional to the valency of the added element.—E. S. H.

*The Twinning of Single Crystals of Tin. Bruce Chalmers (*Proc. Phys. Soc.* (*Lond.*), 1935, 47, 733–746).—Methods for preparing single crystals of tin are described, and the crystallographic orientation of the crystals determined optically, the method employed being based on the character of the etched crystal surface. Conditions in which parts of the crystal can be caused to twin either by impact or tension are investigated, and the determination of the energy relations for controlled cases of twinning is described. When twinning occurs, energy equal to 8×10^5 ergs is transformed into heat per cm.^{3} of crystal twinned. The mechanism of twinning in tin is discussed. The twinning plane is of the 301 type, of which there are 4 sets in the crystal lattice. A sufficient component of sheer stress in the right direction in a set of 301 planes is essential before twinning can occur. When tension is applied in a direction nearly parallel to the 001 axis the result may be either twinning or glide. When there is a component of shear stress in the appropriate

direction in two or more of the twinning planes, twinning occurs on the plane in which the component stress is greatest.—J. S. G. T.

***Investigation of Slip under Shear in Single Crystals of Tin.** K. Bausch (*Z. Physik*, 1935, **93**, 479–506).—Single crystals of tin were so mounted by soldering in a Polanyi extensometer that thrusts in the slip-planes and slip directions were operative. In the slip-planes (110) and (100) slip occurred in the direction [001] whatever the direction of application of the tensile stress in the planes. The initial parts of the hardening curves followed the cosine law of thrust stress; in subsequent parts intensified hardening was present. In the plane (110) slip also occurred in the direction [$\bar{1}$11]; in the plane (100) slip also occurred in the direction [010]. The mechanism of plastic deformation of crystals is discussed in considerable detail.—J. S. G. T.

***A Special Type of Unstable Solid Solutions With Anomalous Lattice Constants.** G. Natta (*Naturwiss.*, 1935, **23**, 527–528).—Very thin films of platinum alloys are obtained by immersing silver or copper plates in a very dilute solution of platinum tetrachloride and then treating the deposit with nitric acid. Films 10^{-6} cm. thick afford good electron diffraction patterns which show that they consist of alloys the nature of which depends on whether the ratio of the atomic radii of the deposited and depositing metals is or is not smaller than 1. When platinum, palladium, or silver are deposited on copper the diffraction patterns are those of a cubic face-centred solid solution. When platinum is deposited on silver, however, the freshly-formed film has the same lattice parameter as silver, but this becomes smaller on keeping at room temperature for some days or on heating at 700° C. for a few seconds, indicating that unstable silver solid solutions with up to 50% platinum can exist having the same lattice parameter as pure silver. The change from the unstable loose lattice into the stable compact lattice is often accompanied by a change in colour.—B. Bl.

***Statistical Theory of Superlattices.** H. A. Bethe (*Proc. Roy. Soc.*, 1935, [A], **150**, 552–575).—The degree of order in an alloy crystal containing two sorts of atoms in equal proportion is calculated statistically, assuming interaction between nearest neighbouring atoms only. At high temperatures the state of the crystal as regards order is similar to that of a liquid. At low temperatures the crystal as a whole is ordered; the structure is "solid-like." The order at long distances is restricted to two or more dimensions. The long-distance order vanishes at a critical temperature, 0. All the physical quantities, plotted as functions of T, exhibit a kink at $T = 0$, but no jump. This is owing to the fact that at 0, two "symmetrical" states exist, having the same energy. The derivatives of physical quantities, *e.g.* specific heat, exhibit jumps at the critical temperature. The extra specific heat due to the destruction of order is rather large on the low-temperature side of 0; it is 70% of the ordinary specific heat due to thermal motion of the atoms (provided all atoms of the crystal take part in the transition. On the high-temperature side of 0 it decreases to about 10% of this value.—J. S. G. T.

***Intensity Measurements on Deformed Crystals and Solid Solutions.** J. Hengstenberg (with H. Mark, and —— Wassermann) (*Ergebnisse tech. Röntgenkunde*, 1931, **2**, 139–150; *Brit. Chem. Abs.*, 1934, [A], 1161).—The change in intensity of X-ray reflection for deformed crystals of tantalum, tungsten, molybdenum, or potassium chloride is proportional to the degree of deformation. In gold–silver solid solutions (4, 8, and 10 wt.-% gold) an increase in the diffuse scattered radiation was observed, the Laue intensity distribution being confirmed. Duralumin showed characteristic effects for both solid solution and deformed crystals.—S. G.

***Laue Diagrams of Deformed Crystals.** W. F. Berg (*Z. Krist.*, 1934, **89**, 587).—[In English.] The following facts relating to Laue X-ray diagrams of deformed crystals are explained: (1) Laue spots of a deformed crystal

are radially elongated if the Laue diagram is taken by transmitted X-rays, (2) the spots are smeared out in all directions in a diagram taken by reflected X-rays, (3) the Laue spots on a diagram of a crystal deformed by bending round an axis normal to the incident beam of X-rays, are elongated in a direction perpendicular to the axis of deformation, (4) a Laue diagram taken by reflected X-rays is comparatively insensitive to errors in setting of the crystal.—J. S. G. T.

The Laws of Valence-Electron Concentration in Binary Metallic Alloys [Hume-Rothery Rule]. Harald Perlitz (*Acta et Comm. Univ. Tartuensis*, 1933, [A], **24**, (2), 16 pp.; *C. Abs.*, 1935, **29**, 4719).—Cf. *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 629 and *Met. Abs.*, 1934, **1**, 297. The rule proposed by Hume-Rothery and by Westgren that the valence-electron concentration, or ratio of the number of valence electrons to the number of atoms, is a definite constant characteristic of each lattice type, is shown to apply to β-, γ-, and ε-alloys. The values of the constants are 3 : 2, 21 : 13, and 7 : 4, respectively. Since the constant is always greater than 1, a necessary condition for the existence of these structures is that one of the metals contributes at least 2 valence electrons and the other component contributes not more than 1 valence electron to the lattice structure. From the actual existence and non-existence of the alloys that can possibly be formed on the basis of this requirement, it is further concluded that one of the components must be a transition metal with the electron effect, or else either copper, silver, or gold; and that the other component must be a metal of the B-subgroup, or else either beryllium or magnesium. If it be assumed that the intermediary phase with the β-, γ-, or ε-structure has a stoichiometric formula, and further, on the basis of its magnetic susceptibility, that the valence-electron concentration of silver in its alloys is one, then the valence-electron concentration of the metals having the electron effects, *viz.* manganese, iron, cobalt, nickel, rhodium, palladium, and platinum, is zero, and that of copper, silver, gold, beryllium, magnesium, zinc, cadmium, aluminium, germanium, tin, and antimony is equal to the salt valence, while that of mercury and indium is 4.—S. G.

Identification of Crystalline Substances by Means of X-Rays. B. E. Warren (*J. Amer. Ceram. Soc.*, 1934, **17**, 73–77).—Methods for the preparation of X-ray diffraction patterns of crystalline materials, the significance of an X-ray diffraction pattern, and its relation to the sample material are discussed. Methods are also given for identification by (*a*) direct analysis of pattern, and (*b*) comparison with diffraction patterns of known materials. Difficulties in classifying and cataloguing diffraction patterns are dealt with.—S. G.

***A Simple Determination of the Space-Orientation of Crystals.** H. Ekstein and W. Fahrenhorst (*Z. Krist.*, 1934, **89**, 525–528).—A graphical method is described for determining crystal orientation from results of X-ray analysis by the rotating crystal method and an optional Laue diagram. The case of a cylindrical crystal is more particularly discussed, but the method is applicable generally. Results relating to cadmium crystals are illustrated.

—J. S. G. T.

***A Graphical Method for Indexing [X-Ray] Spectra Taken by the Rotating Crystal Method.** N. J. Seljakow and E. I. Sovz (*Z. Krist.*, 1934, **89**, 601–606).—See also *Met. Abs.*, this vol., p. 101. A graphic method is discussed for indexing lines in X-ray spectra taken by the rotating crystal method, rotation taking place about an arbitrary axis. The method is illustrated by reference to lines in the spectrum of a single-crystal of aluminium.

—J. S. G. T.

IV.—CORROSION

(Continued from pp. 381–384.)

***Structural Corrosion of Aluminium Alloys. I.—Electrode Potentials. II.—Structural Corrosion.** G. V. Akimov and A. S. Oleschko (*Trans. Research Inst. Aircraft Materials* (*U.S.S.R.*), 1934, (18), 3–30).—[In Russian, with English summary.] See *Met. Abs.*, 1934, **1**, 582, and this vol., p. 58.—S. G.

Behaviour of Copper on Exposure to the Elements. —— (*Roy. Inst. Brit. Architects Advance Copy*, **1934**, Apr., 4 pp.).—Brief notes are given on the formation of natural and artificial patina, on heat bronzing, and on the action of various natural waters, on copper.—A. R. P.

***Corrosion of Magnesium Alloys. II.—Corrosion of Cast Magnesium Alloys.** W. O. Kroenig and G. A. Kostylew (*Trans. Research Inst. Aircraft Materials* (*U.S.S.R.*), 1933, (4), 5–58; *C. Abs.*, 1935, **29**, 4724).—[In Russian, with English summary.] Cf. *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 195. Samples of cast magnesium containing up to aluminium 12·21, manganese 1·16, zinc 3·99, copper 2, cadmium 4·95, nickel 3·10, silicon 0·69, and lead 0·82% were tested for corrosion in solutions of chloride salts (including sea-water), in distilled and tap-water and in air in atmospheric conditions. The method of measuring corrosion was the same as that used in the previous work. In sea-water magnesium containing manganese is more resistant than when pure, the optimum amount of manganese being 0·3–0·4%; in distilled and tap-water manganese has no effect. Addition of aluminium increases the resistance of magnesium to sea-water and particularly to distilled and tap-water; the optimum aluminium content in the latter case being 6–8%. Addition of manganese to magnesium–aluminium alloys increases their resistance to sea-water, the optimum manganese content being 0·3–0·4% for all magnesium–aluminium alloys; in distilled and tap-water manganese has no effect on these alloys. Cadmium has a beneficial effect on binary magnesium alloys in distilled water, when its content is 5%, but no effect on ternary alloys. Zinc has no effect on the corrosion of magnesium alloys, but its use is desirable because it improves the mechanical properties of ternary magnesium alloys. Lead and nickel are definitely harmful. Copper in amounts greater than 1% is harmful to binary alloys, but when only 0·1% of copper is added to magnesium alloys with aluminium, zinc, and manganese it is somewhat beneficial, particularly in the first period of attack. Beryllium (0·25–0·75%) has no advantage over the other additions to magnesium. Calcium has no effect on magnesium or its alloys. Commercial magnesium, as well as its manganese, cadmium, and zinc alloys, when etched in acid solutions containing dichromates did not become more resistant in water or sea-water, but with magnesium–aluminium alloy the resistance increased 600–700 times. It is concluded that none of the magnesium alloys investigated is sufficiently resistant to corrosion by sea-water. In distilled and tap water the best composition is aluminium 6–8, zinc 1–1·5, and manganese 0·3–0·4%. Etched cast Elektron is very resistant in air in atmospheric conditions. A *bibliography* of 49 references is given.—S. G.

***Corrosion of Magnesium Alloys. III.—Influence of Heat-Treatment on the Corrosion of Cast Magnesium Alloys.** W. O. Kroenig and G. A. Kostylew (*Trans. Research Inst. Aircraft Materials* (*U.S.S.R.*), 1933, (5), 5–30; *C. Abs.*, 1935, **29**, 4724).—[In Russian, with English summary.] Magnesium alloy castings containing up to aluminium 8·38, manganese 1·16, zinc 3·99, copper 0·51, cadmium 4·95, iron 0·11, nickel 3·10, and silicon 0·69% were heat-treated in an electric muffle furnace. The samples were heated to 300°, 400°, and 500° C. and kept at these temperatures for 24–32 hrs. Some of the samples were then quenched in water and some were annealed for 15 hrs. at 150° C. Corrosion tests on these samples were carried out in a 3% sodium

chloride solution. Heat-treatment decreased corrosion-resistance in nearly all cases. Microscopic analysis of the heat-treated samples revealed that, unlike aluminium alloys, the magnesium alloys become, in the hardening process, less homogeneous in structure because of the formation of small inclusions distributed through the solid solutions of the alloys.—S. G.

***Corrosion of Magnesium Alloys. IV.—The Corrosion of Magnesium and Elektron in Contact with Other Metals.** W. O. Kroenig and G. A. Kostylew (*Trans. Research Inst. Aircraft Materials* (*U.S.S.R.*), 1933, (7), 5–24; *C. Abs.*, 1935, **29**, 4724).—[In Russian, with English summary.] Samples of magnesium containing aluminium 0·03, iron 0·04, and silicon 0·02% and of Elektron containing aluminium 8·4, iron 0·06, silicon 0·02, copper 0·12, zinc 1·02, and manganese 0·36% were placed together with samples of other metals in a 3% solution of sodium chloride, the circuit between the two dissimilar metals was then closed and corrosion measured by the amount of hydrogen liberated at the magnesium or Elektron cathode. Similar experiments were carried out in 0·5% solutions of potassium chloride, sodium chloride, magnesium chloride, potassium nitrate, magnesium sulphate, potassium sulphate, and sodium sulphate. In all cases the corrosion of magnesium or Elektron was greater than when placed alone in the solutions. Regarding the promotion of corrosion in 3% sodium chloride solution, the elements, arranged in order of decreasing effect, are: platinum, aluminium, iron, nickel, copper, lead, manganese, zinc, and mercury. Intensity of corrosion was directly proportional to the size of the magnesium or Elektron sample, up to a certain ratio between its size and that of the other metal after which the intensity decreases somewhat; it is also directly proportional to the distance between the electrodes.—S. G.

***Corrosion of Wrought Aluminium Alloys.** W. O. Kroenig and N. D. Bobovnikov (*Trans. Research Inst. Aircraft Materials* (*U.S.S.R.*), 1934, (16), 4–39; *C. Abs.*, 1935, **29**, 4723).—[In Russian, with English summary.] A study was made of the effect of heat-treatment on mechanical properties and resistance to corrosion of (1) alloys of the Duralumin type containing varying amounts of copper, manganese, magnesium, and silicon; (2) magnesium–cadmium–aluminium and magnesium–cadmium–silicon–aluminium alloys, and (3) alloys of the Magnalium type (magnesium up to 8 and manganese up to 2%). Samples were heated to 500° C. in a bath of molten salt and then either quenched in water or aged artificially at 150° C. for 3, 6, 12, or 24 hrs. or naturally at room temperature for 7 days. It is concluded that when the copper content in Duralumin exceeds 5–5·2%, heat-treatment results in a decrease in mechanical properties. Alloys of the Duralumin type containing 0·5–0·7% silicon are improved mechanically by artificial ageing and to a lesser degree by ageing at room temperature. The same alloys acquire a greater resistance to corrosion after natural ageing, but artificial ageing has an opposite effect because of separation of CuAl or MgSi at the grain boundaries. It is possible to regulate the separation of these compounds by changing the ageing temperature and the duration, but this will lead to a decrease in mechanical properties. The addition of cadmium to aluminium–magnesium alloys does not improve their mechanical properties or increase their resistance to corrosion either before or after heat-treatment. Alloys containing up to 8% magnesium and 1% manganese possess high mechanical properties and good resistance to corrosion, either before or after heat-treatment; the best composition, however, is 6% magnesium at 0·5–1·0% manganese.

—S. G.

***On Corrosion Phenomena of [Chromium–Nickel] Wire-Wound Radio Resistances on Steatite Insulators.** E. Schürmann and W. Esch (*Elektrotech. Z.*, 1934, **55**, 1003–1005); and *Mitt. Material., Sonderheft* **26**, 1935, 149–151).—Corrosion phenomena have been frequently observed on the chromium–

nickel alloy wires wound on steatite insulators for radio resistances. The cause of these phenomena has been traced to the presence of pyrite crystals in the steatite; comparative tests on the reaction between powdered pyrite and nickel sheet and the electrochemical nature of the corrosion have confirmed this conclusion.—B. Bl.

***The Causes of the Corrosion of the [Nickel and Constantan] Wires in Heating Pads.** M. Popp (*Kautschuk*, 1935, **11**, 60–61; *C. Abs.*, 1935, **29**, 4725).—Experiments by P. indicate that the explanation advanced by Schürmann and Esch (*Met. Abs.*, 1934, **1**, 583) for the corrosion of nickel by asbestos is erroneous. No iron sulphide could be detected, either chemically or microscopically, in any asbestos at the disposal of P., nor does the literature mention this impurity, and oxidation with hydrogen peroxide, nitric acid, and potassium chlorate–hydrochloric acid did not give any evidence of sulphuric acid. The green oxidation products on nickel and Constantan wires in contact with asbestos are chiefly nickel chloride and cupric chloride with smaller proportions of nickel carbonate and copper carbonate. Various commercial grades of asbestos contain chlorine, part of which is soluble in water, and more of which is soluble in aqueous sodium hydroxide. The water exts. also contain magnesium, calcium, sodium, potassium, and silicon and are in some cases alkaline, in others acid, to turmeric. The samples which contain the most soluble magnesium are alkaline. Some of the chlorine of asbestos can be extracted only with acids. Accordingly, asbestos probably contains alkali chlorides, magnesium chloride, and magnesium oxychloride. Magnesium chloride is the agent responsible for the attack on the metal, by virtue of the solution of the hydrochloric acid in the moisture present, and its electrolysis to hydrochloric acid by the electric element formed with the magnetite present as an impurity. (See also following abstract.)—S. G.

The Causes of the Corrosion of the Wires in Heating Pads. E. Schürmann and W. Esch (*Kautschuk*, 1935, **11**, 78–79; *C. Abs.*, 1935, **29**, 4725).—Cf. preceding abstract. Iron sulphide in asbestos was reported by Dammer and Tietze (*Die nutzbaren Mineralien*, 1914, **2**, 246, 249). Popp offers no evidence to invalidate the conclusions of S. and E., and the part played by magnesium chloride should be substantiated by experiments with asbestos containing no magnetite.—S. G.

***Solution Rates of Zinc Electrodes in Acid Solutions.** H. Mouquin and W. A. Steitz (*Trans. Electrochem. Soc.*, 1935, **67**, 339–344; discussion, 344–345).—See *Met. Abs.*, this vol., p. 162.—S. G.

***Atmospheric Exposure Tests on Non-Ferrous Screen Wire Cloth.** G. Willard Quick (*J. Res. Nat. Bur. Stand.*, 1935, **14**, 775–793; and *Nat. Bur. Stand. Research Paper* No. **803**).—Atmospheric corrosion tests on 7 compositions (90 : 10 and 80 : 20 copper–zinc; 75 : 20 : 5 copper–nickel–zinc; 70 : 30 nickel–copper; unalloyed copper; 98 : 2 copper–tin, and 95 : 5 copper–aluminium) of non-ferrous screen wire cloth were carried out by the (U.S.) National Bureau of Standards in co-operation with the American Society for Testing Materials over a period of about 9 years. The specimens were exposed at Pittsburgh, Pa., in a heavy-industrial atmosphere; at Portsmouth, Va., and Cristobal, C.Z., which have temperate and tropical sea-coast atmospheres, respectively, with some industrial contamination, and at Washington, D.C., having a normal inland atmosphere. At the end of the tests at least one failure had occurred in each of the materials exposed at Pittsburgh; one of the materials (80 : 20 copper–zinc) had failed at both Portsmouth and Cristobal; whilst at Washington none of the materials had failed. The tensile strengths of the materials before and after exposure are compared. There was no consistent relation between the results of laboratory accelerated-corrosion tests and the atmospheric exposure tests at any of the locations.—S. G.

Corrosion in Sea-Water in Which the Action of the Lower Forms of Life Play a Part. C. Bärenfänger (*Wasser*, 1934, **8**, (II), 44–48; *C. Abs.*, 1935, **29**, 4496).—The action of the lower sea plants and animals on metal and wood in sea-water is briefly discussed. A lacquer having a benzylcellulose base is reported to be particularly effective protection against both biological and chemical action. Tests show that this lacquer protects iron from the action of sea-water saturated with air and carbon dioxide.—S. G.

Corrosion by Warm Water and Its Prevention. L. W. Haase (*Wasser*, 1934, **8**, (II), 111–123; *C. Abs.*, 1935, **29**, 4496).—The action of warm water (50°–85° C.) on metals and protective coatings used for pipes, various types of warm-water plants, and methods of treatment to prevent corrosion are discussed.—S. G.

***Motor-Electrolytic Current as a Factor in Corrosion.** E. Newbery (*Trans. Electrochem. Soc.*, 1935, **67**, 223–231; discussion, 231–233).—See *Met. Abs.*, this vol., p. 163.—S. G.

***Voltaic Couples and Corrosion.** Oliver P. Watts (*Trans. Electrochem. Soc.*, 1935, **67**, 235–251; discussion, 251–257).—See *Met. Abs.*, this vol., p. 163.—S. G.

On the Possibility of a Standardization of Corrosion Results. F. Tödt (*Aluminium*, 1935, **17**, 392–393).—In the present state of knowledge on corrosion problems the only safe criterion of the relative corrodibility of metals is considered to be the loss in weight expressed as grm./m.^{2}/day.—A. R. P.

The Chemist as Professional Corrosion Expert. Fritz Tödt (*Wasser*, 1934, **8**, (II), 124–133; *C. Abs.*, 1935, **29**, 4316).—Discusses the chemical properties of metals (as solubility of their oxides, &c.) which are important in the matter of corrosion.—S. G.

V.—PROTECTION

(Other than Electrodeposition.)

(Continued from pp. 385–386.)

Ferrous Metals and High Temperatures. Protected Cast Irons and Steels. Am. Matagrin (*Industrie chimique*, 1935, **22**, 333–337).—This final part of a serial article discusses the value of aluminium, nickel, and chromium as protective coatings for iron and steel destined for use at high temperatures. The various methods of applying these coatings are described.—C. E. H.

†**Tinplate: Some Fundamental Considerations.** W. E. Hoare (*Proc. Swansea Tech. Coll. Met. Soc.*, **1934**; and *Tech. Publ. Internat. Tin Res. Develop. Council*, 1935, [A], No. **14**, 1–16).—A discussion of recent work on the reaction between iron and tin, the iron–tin compound in tinplate, and its influence on the mechanical properties of tinplate, the influence of annealing temperature on the alloy layer, the mechanism of the coating of steel with tin, and the porosity of tinplate.—E. S. H.

***A Study of the Yellow Stain on Tinplates.** C. E. Beynon and C. J. Leadbeater (*Tech. Publ. Internat. Tin. Res. Develop. Council*, 1935, [D], No. **1**, 1–11).—The yellow stain which sometimes forms on tinplate during storage is due to surface oxidation of the tin in accordance with the differential aeration principle; it can be produced artificially by anodic oxidation. Difficulties in lithographing yellow-stained sheets cannot be attributed to the stain, as such sheets print satisfactorily when stoved at 140° C. or washed in methylated spirits—treatments which remove the film of grease which is believed to be responsible for the printing difficulty. Yellow stain can be removed by cathodic treatment of the sheet in dilute sodium carbonate solution. Since this treatment also removes the grease, the sheets can then be printed without difficulty. (See also following abstract.)—E. S. H.

Causes of Yellow Stains on Tinplate, and Methods of Prevention. E. T. Richards and R. J. Snelling (*Illust. Z. Blechindustrie*, 1935, **64**, 887–888).—See also preceding abstract. An analysis is given of the conditions in which yellow stains are produced; the principal contributory factors are moisture, ventilation, temperature, and the quality of the tin employed. Storage in piles should be avoided. The staining is attributed to electrolytic oxidation, and it has been shown that it can be removed by appropriate electrical treatment. Preventive methods are summarized.—P. M. C. R.

***The Determination of the Porosity of Tin Coatings on Steel.** D. J. Macnaughtan, S. G. Clarke, and J. C. Prytherch (*Tech. Publ. Internat. Tin Res. Develop. Council*, 1935, [A], No. 7, 1–9).—Practical details are given of the determination of the porosity of tin coatings on steel by the hot-water method and the modified potassium ferrocyanide paper test. Improved methods for degreasing the specimens before applying the tests are described. The specimen is immersed in boiling 1% water-glass solution for 1 minute and then washed in water. Alternatively, the specimen is made a cathode in 0·5% sodium carbonate solution, using a sheet of nickel on each side as anodes. An e.m.f. of 4 v. is applied for about 1 minute, until gas bubbles form freely on the surface. Exceptionally resistant grease films may be removed by washing with carbon tetrachloride, applying a thin coating of a cellulose-base varnish, and then degreasing by the cathodic method, whereupon the varnish film is detached and removes all the grease with it.—E. S. H.

***A Rapid Test of Thickness of Tin Coatings on Steel.** S. G. Clarke (*Analyst*, 1934, **59**, 525–528; and *Tech. Publ. Internat. Tin Res. Develop. Council*, 1934, [A], No. 12, 4 pp.).—The loss of weight of the specimen on stripping the tin coating in a solution of antimony chloride in hydrochloric acid is determined. The attack on the basis steel is negligible. With hot-dipped tin coatings the underlying layer of tin–iron alloy is almost completely dissolved, and a correction for the iron constituent amounting to one-third of the alloyed tin is necessary. The determination may be carried out on a selected area by protecting the rest of the coating with varnish.—E. S. H.

The Surface Testing of Tinplate. A. Karsten (*Illust. Zeit. Blechindustrie*, 1935, **64**, 820–822).—An apparatus is described and illustrated for the optical testing of tinplate. The apparatus may be used with or without a camera attachment, and a modification, adopted for the examination of the internal surfaces of cylinders, is stated to have proved valuable in investigating cases of corrosion of tinned containers by foodstuffs.—P. M. C. R.

Tinplate Manufacture. J. Zeelander (*Mech. World*, 1935, **97**, 637).—A flowsheet, which gives in condensed form the whole process of tinplate manufacture.—F. J.

Possibility of Substituting Zinc for Tin in Coating Copper Wire. V. P. Kibanov (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (4), 74–81; *C. Abs.*, 1935, **29**, 4316).—[In Russian.] The process of covering copper wire with zinc is similar to tinning, except that the temperature in the first case is 450° C. while in the second it is 290°–310° C. The zinc coating is plastic and does not crack or peel on twisting the wire. It increases resistance 2·6–4·2%, depending on the size of wire, the increase being smaller for heavier wires. The zinc-covered wire, on vulcanizing, becomes coated with a thin layer of zinc sulphide, which, however, has no harmful effect on the wire or the rubber. The difficulties involved in the zinc coating process are oxidation of the liquid metal, in spite of the carbon protection, rapid cooling which does not permit the excess zinc to run off the wire, and the high temperature of the operation. The latter might be overcome by the addition of other metals.—S. G.

Zinc Galvanizing. Effect of Impurities and Factors Governing Results with Various Types of Zinc. Edmund R. Thews (*Canad. Chem. and Met.*, 1935, **19**, 137–138, 142).—The most detrimental impurity in zinc for galvaniz-

ing is arsenic, since it reduces the fluidity of the bath, results in the heavy formation of ashes, and decreases the ductility of the coating; addition of aluminium eliminates to a greater extent the evil effects of arsenic, but in no case should the arsenic content exceed 0·01%, an amount which requires 0·03% of aluminium. Antimony in amounts not exceeding 0·01% produces a brown coloration on the coating, but about 1 oz. of aluminium per ton of zinc prevents this action. Copper should not exceed 0·05%, and iron should be kept to a minimum; lead is really beneficial and up to 1·5% may be tolerated, any excess above this figure settling to the bottom of the pot.

—A. R. P.

How Far Below the Top of the Galvanizing Pot Should the Surface of the Galvanizing Bath Be? Wallace G. Imhoff (*Amer. Metal Market*, 1935, **42**, (134), 3, 6).—The best operating conditions as regards depth of metal and flux in the galvanizing pot are discussed with reference to the type of articles being galvanized. Heavy articles require a thick flux layer and small or light articles only a very thin layer or none at all; in both cases it is advisable to have the pot as full as possible to avoid crust formation and to assist in the maintenance of an equable temperature.—A. R. P.

Flux on Hot-Dip Galvanizing Baths. Wallace G. Imhoff (*Amer. Metal Market*, 1935, **42**, (125), 6, 8).—A general discussion of the types of fluxes used on galvanizing baths, their functions and properties.—A. R. P.

Bend Tests on the Hot-Dipped Zinc Coatings Measured with Micrometer Calipers. Wallace G. Imhoff (*Amer. Metal Market*, 1930, **37**, (247), 5, 9, 10).—The operating conditions of 4 American galvanizing plants are critically analyzed. Tabulation of the results shows that the amount of zinc deposited is a function of the time of immersion in and speed of withdrawal from the bath. When adherence is the important factor a light coating is best; ductile coatings are obtained by keeping the zinc as pure as possible, the bath well dressed and a steady production through the bath to maintain an even temperature therein.—A. R. P.

Metallizing an Important Factor in Prevention of Corrosion in Refineries. H. R. Leland (*Oil and Gas J.*, 1935, **33**, (45), 99, 168).—S. G.

The Leafing of Aluminium Paint. P. H. Faucett (*Paint Varnish Production Mgr.*, 1935, **12**, (May), 12; *C. Abs.*, 1935, **29**, 4605).—Microscopic observation of the drying of the aluminium paint indicates that a circular cyclonic movement is set up in the film because of the escape of the volatile solvents. This causes the flat aluminium particles to align themselves parallel to the direction of movement of the liquid and in a position to offer the least resistance to the flow of the liquid past them. A viscous aluminium paint containing the optimum content of aluminium-bronze was taken and thinned with equivalent amounts of petroleum ether, petroleum benzine, V M and P naphtha, No. 1 distillate, and No. 2 distillate. The sample thinned with equal parts of these 4 liquids showed excellent leafing properties with resultant increase in hiding power of the product.—S. G.

VI.—ELECTRODEPOSITION

(Continued from pp. 387–388.)

***Mechanism of Chromium Deposition from the Chromic Acid Bath.** Charles Kasper (*J. Res. Nat. Bur. Stand.*, 1935, **14**, 693–709; and *Research Paper* No. **797**).—In commercial electroplating chromium is deposited from baths composed principally of chromic acid in which the chromium is sexivalent. After use, such baths always contain some trivalent chromium, and many of the theories which have been proposed for this process postulate that the chromium is deposited from the trivalent (or possibly bivalent) state, for

which the chromic acid serves as a reservoir. K. presents evidence that the electrolytic deposition of chromium occurs directly from the sexivalent state. The principal evidence is the fact that relatively large additions of compounds of metals such as zinc, nickel, cadmium, iron, and copper have no such effect on the behaviour of the chromic acid bath as would be expected if deposition occurred from the trivalent state. It is shown by cryoscopic and spectrophotometric data that the dichromates of these metals are strongly ionized. The low efficiency and high polarization in chromium deposition are accounted for, and certain paradoxes are explained. The possible directions for improvement are pointed out, but none appears practicable with existing knowledge. A *bibliography* of 40 references is appended.—S. G.

***Influence of Bath Temperature on Chromium Hardness.** R. J. Piersol (*Metal Cleaning and Finishing*, 1935, **7**, 169–172; *C. Abs.*, 1935, **29**, 4677).—With a bath containing 2·50 grm. chromium trioxide and 2·5 grm. sulphuric acid per litre and operated at a current density of 1 amp./in.^{2}, it was impossible to obtain a hard chromium plate at temperatures above 38° C. At lower temperatures the hardness increased gradually to the lowest limit investigated (21° C.). At a current density of 2 amp./in.^{2} the hardest plate was obtained at 43° C. and the effect of the temperature was exceedingly critical between 49° and 52° C., with a decrease in hardness of from 100 to 5 units. A bath containing 250 grm. chromium trioxide, 2 grm. sulphuric acid, and 3 grm. Cr^{III} per litre, operated at 68° C., produced hard deposits which were also very satisfactory as regards texture and smoothness. At this temperature the range of current density which produced very hard plates was extremely wide and was of importance for the plating of articles of irregular shape. The present results suggest future plating based on high current density and bath temperature and extremely rapid rates of deposition of chromium for wear-resistance.

—S. G.

Industrial Applications of Chromium Plating. Jacques du Chatenet (*Métaux et Machines*, 1935, **19**, 270–273).—Comparative tests on special steels, nitrided steel, and steel protected by chromium plating showed that the chromium-plated specimen possessed a very high resistance to wear and corrosion. It is suggested that more extended use should be made of thick chromium deposits, as ordinary steels so protected can advantageously be substituted for the more costly special steels. Optimum adhesion and texture of the protective layer are obtained by its deposition in the cold.

—P. M. C. R.

***Direct Electrolytic Production of Copper Sheets.** A. A. Bulakh (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (7), 101–115; *C. Abs.*, 1935, **29**, 4268).—[In Russian.] A study was made of the optimum conditions for the electrolytic production of copper plate on a rotating drum. It was found that successful deposits can be obtained at a cathode current density of 500–5000 amp./m.^{2} from a copper sulphate solution containing 150–200 grm. sulphuric acid per litre. Addition of colloids is not desirable. Interruptions of the current for periods of 0·5 minute had no harmful effect on the quality of the product. Plates up to 0·25 mm. thick can be produced without the use of special compression rollers; for a thickness of 0·25–0·50 mm. compression is desirable, and for thicker plates compression is necessary. (Cf. U.S. patent No. 1,952,762.)—S. G.

The Electrodeposition of Copper, Nickel, and Zinc Alloys from Cyanide Solutions. II.—Discussion of the Results of Part I. Charles L. Faust and Geo. H. Montillon (*Trans. Electrochem. Soc.*, 1935, **67**, 281–297; discussion, 297–298).—See *Met. Abs.*, this vol., p. 300.—S. G.

***Electrodeposits of Nickel-Iron Alloys.** E. Raub and E. Walter (*Mitt. Forschungsinst. Edelmetalle*, 1935, **9**, 17–21).—Cf. *Met. Abs.*, this vol., p. 237. Bright deposits of iron–nickel alloys containing 40–60% iron can be obtained

from solutions containing nickel sulphate or chloride, ferrous sulphate, magnesium sulphate, and citric acid at a p_H of 3–3·6. The higher the temperature the lower is the iron content of the deposits, and at 100° C. the iron decreases to 12–14%. High temperatures reduce pitting, as also does addition of "Nekal," a mixture of alkali alkylnaphthalenesulphonates used as a wetting agent in the textile industry. Deposits with a high iron content tend to develop hair-cracks and have little protective power against rusting when applied to an iron surface.—A. R. P.

Faulty Silver Deposits. Influence of Weighting Cements and Sulphur on Silver Plating. E. Raub and K. Bihlmaier (*Mitt. Forschungsinst. Edelmetalle*, 1935, **9**, 29–35).—Hollow articles of thin metal are often weighted with organic cements containing resins, asphalt, and oils with an inorganic filler, usually calcium carbonate; this type of cement is attacked by the ordinary silver-plating bath and organic compounds pass into the solution and produce rough, dark, and usually porous deposits. Since there is no method of removing the objectionable constituents from the bath, it is recommended that such articles be plated before the cement filling is inserted. Particles of suspended silver sulphide in the plating bath produce nodular deposits; in this case the bath may be heated and allowed to rest for a day or two to allow the sulphide particles to coagulate and settle.—A. R. P.

***Cadmium–Zinc Alloy Plating from Acid Sulphate Solutions.** Colin G. Fink and C. B. F. Young (*Trans. Electrochem. Soc.*, 1935, **67**, 311–336; discussion, 336–338).—See *Met. Abs.*, this vol., p. 299.—S. G.

***Studies in Zinc Electrodeposition: Deposition from Ammonium Sulphate Zinc Baths.** Raymond R. Rogers and Edgar Bloom, Jr. (*Trans. Electrochem. Soc.*, 1935, **67**, 299–309).—See *Met. Abs.*, this vol., p. 167.—S. G.

***A Further Study of Cyanide Zinc Plating Baths Using Al–Hg–Zn Anodes.** A. Kenneth Graham (*Trans. Electrochem. Soc.*, 1935, **67**, 269–279; discussion, 279).—See *Met. Abs.*, this vol., p. 167.—S. G.

New Plating Anode of Zinc, Aluminium, and Mercury. —— (*Amer. Metal Market*, 1935, **42**, (91), 6).—A brief description is given of the advantages of using zinc containing small amounts of aluminium and mercury as an anode in zinc cyanide plating baths (cf. preceding abstract).—A. R. P.

Electrodeposits on Aluminium. G. Elssner (*Aluminium*, 1935, **17**, 376–378).—A brief account is given of methods of preparing the metal for plating, of the application of anchoring undercoats, and of the final plating process.—A. R. P.

Technological Developments in the Plating Industry. C. B. F. Young (*Metal Cleaning and Finishing*, 1935, **7**, 165–168; *C. Abs.*, 1935, **29**, 4269).—A discussion of the electrodeposition of zinc on steel wires, the electrolytic treatment of zinc or zinc-coated articles which greatly increases the resistance to corrosion and imparts a deep black colour to the zinc, and the allowance to be made in the thickness of copper deposits on zinc to compensate for the diffusion of zinc and copper during the plating. The electrodeposition of tin and indium are also briefly described.—S. G.

***The Use of a Modified Haring Cell in Detecting Electrode Reactions.** Jesse E. Stareck and Robert Taft (*Trans. Electrochem. Soc.*, 1935, **67**, 357–374).—With the aid of a modified Haring cell, the deposition of silver from silver nitrate and from cyanide solutions was carefully studied. Starting with extremely low current densities and voltages, these were gradually increased and every slight break in the volt–ampère curves repeatedly checked. Finally, these breaks in the curves are interpreted and assigned to certain physical and/or chemical reactions. The cathode products detected were crystalline silver, silver hydride, and hydrogen; the anode products were silver peroxide and oxygen. The characteristics and properties of silver hydride formed at the cathode are discussed at length.—S. G.

VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from p. 388.)

***An Electrochemical Investigation of Solid Cadmium–Antimony Alloys.** Arne Ölander (*Z. physikal. Chem.*, 1935, [A], **173**, 284–294).—The electrode potential of cadmium–antimony alloys was determined at 240°–290° C.; the results indicate that the stable intermediate phase CdSb has a range of homogeneity of 50–50·5 atomic-% cadmium. The thermodynamic relations and the degree of lattice disorder of the phase have been calculated. A table is given showing the statistical term of the temperature coeff. of the potentials with different degrees of lattice disorder.—B. Bl.

***The Hydrogen Overvoltage and the Anodic Behaviour of Tungsten in Aqueous Solutions of Potassium Hydroxide.** M. de Kay Thompson and C. W. Rice, Jr. (*Trans. Electrochem. Soc.*, 1935, **67**, 71–78; discussion, 79).—See *Met. Abs.*, this vol., p. 169.—S. G.

***The Mechanism of Conductance.** Hiram S. Lukens (*Trans. Electrochem. Soc.*, 1935, **67**, 29–36).—Presidential Address. See *Met. Abs.*, this vol., p. 351. —S. G.

VIII.—REFINING

(Continued from p. 388.)

***Use of Pure Oxygen in Lead Refining.** D. M. Chizhikov and M. N. Sokolov (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (7), 59–73; *C. Abs.*, 1935, **29**, 4303).—[In Russian.] Oxygen was blown through molten impure lead, contained in an iron crucible at lower temperatures and in a clay crucible at higher temperatures, by means of a porcelain tube. At 350°–500° C. a considerable time is required to remove all the zinc, arsenic, antimony, and tin, which leads to the formation of litharge (40–47% by weight of charge). At 860°–900° C. the removal of the impurities is almost complete in 5–10 minutes, and litharge formation is only 4·0–5·5%. As compared with air, oxygen speeds up the reaction and, therefore, results in a saving of fuel.—S. G.

IX.—ANALYSIS

(Continued from pp. 388–391.)

Determination of the Fineness of Silver Alloys by Streak Tests. Karl Bihlmaier (*Mitt. Forschungsinst. Edelmetalle*, 1935, **9**, 22–24).—Details are given of the tests using standard needles and a special HNO_3–H_2CrO_4 acid mixture. The method is applicable only to Cu–Ag alloys, and with practice is accurate to ± 2% for alloys containing 60–100% Ag.—A. R. P.

A Very Sensitive Reagent for Aluminium. Separation of Aluminium and Beryllium. T. Gaspar y Arnal (*Anal. Soc. espan. Fis. Quim.*, 1934, **32**, 866–871).—The reagent consists of a solution of 20 grm. of $Ca_2Fe(CN)_6.12H_2O$ in 670 c.c. of water to which is added 400 c.c. of 96% C_2H_5OH. As little as 0·02 mg. of Al in 1 c.c. produces an opalescence. For gravimetric work the precipitation is carried out in a boiling solution, and the precipitate is dried at 85°–90° C. for weighing; alternatively a known amount of reagent may be added and the excess determined by titration with $KMnO_4$ after removing the precipitate. Be gives a precipitate under the same conditions as Al but the Be compound dissolves on addition of water whereas the Al compound remains insoluble.—A. R. P.

The Microscopic Identification of the Elements of the Platinum Group and Gold. Willet F. Whitmore and Herman Schneider (*Mikrochemie*, 1935, **17**, 279–319).—[In English.] Au is extracted from the solution by shaking with $CH_3{\cdot}CO_2{\cdot}C_2H_5$; treatment of the extract (after evaporation of the solvent) with caffeine affords golden hair-like crystals. The aqueous layer from the extraction is distilled with HNO_3 in a micro-distillation apparatus to remove the Os, and the residual solution is divided into several portions. Pd is tested for by addition of HCl and dimethylglyoxime in the usual way. A second portion is treated with solid methylamine hydrochloride; a deep green ring round the circumference of the drop and the formation of green crystals as the solution evaporates indicates Ru, while an immediate red crystalline precipitate (octahedra) indicates Ir. To a third portion is added *m*-toluidine hydrochloride; sheaves of yellow crystals indicate Pt. There is no known specific reaction for Rh. Tables are given showing the behaviour of the Pt group of metals and Au towards a large number of organic reagents.—A. R. P.

***The Determination of Trivalent Chromium in Chromic Acid and in Chromium Plating Baths.** Hobart H. Willard and Philena Young (*Trans. Electrochem. Soc.*, 1935, **67**, 347–356; discussion, 356).—See *Met. Abs.*, this vol., p. 171. —S. G.

Quinaldinic Acid as a Microchemical Reagent. II.—Estimation of Copper and Its Separation from Cadmium and Manganese. Priyadaranjan Rây and Jagannath Gupta (*Mikrochemie*, 1935, **17**, 14–16).—The method previously described (*Met. Abs.*, 1934, **1**, 194) is modified slightly for microchemical work. —A. R. P.

***Microchemical Determination of Gold in the Presence of Palladium and Tin.** J. Donau (*Mikrochemie*, 1935, **18**, 11–17).—Alloys containing Pd and Sn should be given a double inquartation with the Zn–Cd eutectic alloy, the beads being parted first in 1 : 1 then in concentrated HNO_3. Decantation and washing of the (SnO_2 + Au) residue are effected in a centrifuge and the SnO_2 is removed by heating with NH_4Cl prior to weighing the Au.—A. R. P.

***The Determination of Metallic Magnesium, Magnesia, and Magnesium Fluoride in the Products of Electrolytic Recovery of Metallic Magnesium.** V. Ya. Tartakovskii (*Trans. Inst. Econ. Mineral.* (*U.S.S.R.*), 1934, (64), 16 pp.; *C. Abs.*, 1935, **29**, 4692).—[In Russian.] Two methods were developed for the analysis of crude electrolytic Mg containing MgO and MgF_2. These methods are based on the fact that, in the presence of $K_2Cr_2O_7$ or HF, Mg becomes passive and insoluble in acids. In the first method the sample is treated with a mixture of AcOH and $K_2Cr_2O_7$; MgO dissolves, and Mg and MgF_2 are filtered off. The residue is then treated with dilute AcOH, which dissolves the Mg. In the second method, MgO is first converted into MgF_2 by means of HF; the Mg is then dissolved from the mixture of Mg and MgF_2 with AcOH. MgO and MgF_2 are determined by the first method.—S. G.

Volumetric Determination of Tin Using Various Reducing Agents and Various Concentrations of Acid. F. W. Louw and W. E. Schilz (*J. S. African Chem. Inst.*, 1934, **17**, 3–7; *Chim. et Ind.*, 1934, **32**, 791).—Fuse with Na_2O_2, dissolve in 200 c.c. hot water, and neutralize with HCl. Add 400 c.c. HCl, and then 1–2 grm. aluminium bromide. Pass a current of CO_2 through the flask, and when the evolution of H_2 ceases heat until ebullition just commences. On cooling, syphon over some Na_2CO_3 solution, and titrate with I_2 as usual. Other reducing agents used are: powdered Al (gives variable results), powdered Zn (good results), Ni foil, Pb foil (gives good but consistently low results). Mg cannot be used but Sb is satisfactory. Acid concentrations of 35–50% are the most satisfactory.—W. A. C. N.

***A Method for the Determination of Small Amounts of Zinc in Commercial Nickel.** B. S. Evans (*Analyst*, 1935, **60**, 464–467).—The metal (10 grm.) is dissolved in HNO_3 and the Fe removed by double precipitation with NH_4OH.

The filtrate is treated with KCN until it assumes a clear orange colour, then with $CH_2 \cdot CO_2H$ until acid to litmus, saturated with H_2S at above 60° C. under pressure, cooled and filtered. The precipitate of ZnS, CuS, and PbS is dissolved in HNO_3 and H_2SO_4, the Cu removed with H_2S, and the Pb with Na_2S after addition of citric acid, NH_4OH, and KCN, and finally pure ZnS is precipitated by acidifying with formic acid and passing H_2S as before. The ZnS is converted into $ZnSO_4$ for weighing.—A. R. P.

Quinaldinic Acid as a Microchemical Reagent. I.—Estimation of Zinc and Its Separation from Manganese. Priyadaranjan Rây and Mukul Kumar Bose (*Mikrochemie*, 1935, **17**, 11–13).—The method previously described (*Met. Abs.*, 1934, **1**, 194) is adapted to micro-analysis.—A. R. P.

Quinaldinic Acid as a Microchemical Reagent. III.—Estimation of Zinc in the Presence of Iron, Aluminium, Uranium, Beryllium, and Titanium. Priyadaranjan Rây and Mukul Kumar Bose (*Mikrochemie*, 1935, **18**, 89–91).—The precipitation is made in slightly ammoniacal tartrate solution and the excess of NH_3 is removed by blowing a current of air over the surface of the solution at 60° C. before filtering.—A. R. P.

On the Microchemical Determination of Zinc by Means of Anthranilic Acid. Ch. Cimerman and P. Wenger (*Mikrochemie*, 1935, **18**, 53–57).—[In French.] The method of Funk and Ditt (*Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 453) is modified for microchemical work.—A. R. P.

X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from pp. 391–392.)

***An Induction Furnace in which Motion of the Bath is Eliminated, *e.g.* for the Melting of Light Metals.** E. Fr. Russ (*Z. Physik*, 1935, **93**, 220–226).—Devices for reducing or eliminating motion of the liquid metal bath in induction furnaces are suggested. Motion of the bath liquid is attributed to divergence of the current stream lines from parallelism and the devices proposed eliminate this divergence. The elimination of motion of the bath in the case of aluminium results in castings being produced which are gas free, and very little metal is lost by burning.—J. S. G. T.

***Furnace Temperature and Heating-Rate Control by Dilating Wire.** C. T. Eddy, F. W. Vigelius, and E. C. Davis (*Instruments*, 1935, **8**, 174–176).—Typical current and temperature curves are given to show that the temperature of a small laboratory resistance furnace can be varied at any desired constant rate by choosing a suitable starting current and increasing this uniformly. An arrangement for reproducing current (and thus temperature) runs consists of a control wire, mounted under tension in a glass tube, and connected in series with the furnace. The dilation of this wire controls a power-driven rheostat. Normally, the wire is kept at constant length, but by rotating a commutator the length of the wire, and thus the current passing, can be uniformly varied. Fluctuations in room temperature have no appreciable effect on performance.—J. C. C.

An Intense Glow-Discharge Tube for the Spectroscopic Investigation of Very Small Masses of Material. H. Schüler and H. Gollnow (*Z. Physik*, 1935, **93**, 611–619).—A glow-discharge tube, suitable for the spectroscopic investigation of extremely minute samples, is described. The apparatus has already been applied to the detection of protactinium, cassiopeium (lutecium), terbium, samarium, scandium, thulium, yttrium, rhodium, holmium, and europium.—J. S. G. T.

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

(Continued from p. 392.)

Examination of Polished Surfaces. J. M. Waldram (*Illuminating Engineer (Lond.)*, 1934, **27**, 163–164; *Sci. Abs.*, 1934, [B], **37**, 427).—The examination of a polished surface for the detection of minute flaws is generally carried out by observing the reflection of a luminous object in the surface. The flaws cause local distortion of the image, but in order that this may be noticeable the source must have a "structure," *i.e.* it must be of some extent but not uniformly bright. W. describes a specially designed source consisting of an extended bright surface crossed by a number of dark strips. The effect of flaws in causing deformation of the image of such a source is shown by means of photography.—S. G.

Working Stresses. C. Richard Soderberg (*Amer. Soc. Mech. Eng. Advance Copy*, **1932**, Dec., 9 pp.).—The fundamental aspects of the problem of the strength and safety of machine parts is reviewed mathematically with especial reference to the behaviour of stainless and other special steels at high temperatures and under torsional, tensile, and shear stresses.—A. R. P.

Open Discussion on the Metallurgical Inspection of Engineering Materials. —— (*Proc. Staff. Iron. Steel Inst.*, 1933–1934, **49**, 66–72).—See *Met. Abs.*, 1934, **1**, 254.—L. A. O.

Commercial Testing of Engineering Materials. I.—[Tensile, Compression, and Transverse Tests]. II.—Ductility Tests on Sheet Metals. III.—Impact Tests. IV.—Torsion Tests. V.—Hardness Tests. J. Trickett (*Mech. World*, 1935, **97**, 603–606, 631; 1935, **98**, 3–4, 29–30, 55–60).—Describes and illustrates: (I.—) The tensile test-piece, the tensile testing-machine, making the tensile test, compression and transverse tests. (II.—) The Erichsen cupping test and the Olsen ductility test. (III.—) The Izod and Charpy impact tests (of notched bars). (IV.—) Typical methods and machines for making torsion tests on metals. (V.—) The Brinell ball hardness test.—F. J.

***Determination of the Alternating Bending Strength of Wires. Construction of a Suitable Testing Machine.** Werner Friedmann (*Mitt. Wöhler-Inst.*, 1934, (22), 91 pp.).—See also *Met. Abs.*, this vol., p. 174. To avoid fracture of the specimens in the holders in the Föppl–Heydekampf alternating bending machine the use of lead supports in the grips is recommended; even with this modification hard-drawn aluminium specimens frequently fracture in the holders. A modification of the machine for testing wires up to 3 mm. in diameter is described and the results obtained with it in steel, aluminium, Aldrey, copper, and various bronze wires in the annealed and hard-drawn states are tabulated. A selection of the results is given below for wires of 2·1–2·8 mm. diameter:

	Tensile Strength (*A*), kg./cm.².	Modulus of Elasticity, kg./cm.².	Alternating Bending Strength (*B*) (2×10^8 reversals), kg./cm.².	Ratio: *B*/*A*.
Soft copper	2300–2400	$1{\cdot}3 \times 10^6$	1235–1300	0·54
Hard copper	4500	$1{\cdot}3 \times 10^6$	1295	0·29
Hard aluminium (99·5%)	1500–2000	$0{\cdot}7 \times 10^6$	590–920	0·34–0·53
Aldrey	3000–3300	$0{\cdot}65 \times 10^6$	1060–1250	0·34–0·40
Cadmium-bronze	6100–6300	$1{\cdot}34 \times 10^6$	1656–2020	0·27–0·33
Tin-bronze	5800–6600	$1{\cdot}3 \times 10^6$	1370–2120	0·23–0·32

—A. R. P.

†**Materials Testing Machines.** C. H. Gibbons (*Baldwin Locomotives*, 1935, **13**, (3), 31–38; **14**, (1), 31–39; and *Instruments*, 1935, **8**, 48–49, 76–78, 99–102, 130–132, 156–159).—See *Met. Abs.*, this vol., pp. 28, 111. This very comprehensive review of tension-compression-transverse testing machines is concluded. A *bibliography* of 79 references is contained in foot-notes. A tabulated comparison of the design features, accuracy, and sensitivity of the principal modern types of testing machines concludes the series as printed in *Baldwin Locomotives*, but is omitted from the reprint in *Instruments*.—J. C. C.

***Endurance Bending Strength of Constructional Parts at Sockets, Boss-Heads, and Similar Joined Parts.** A. Thum and F. Wunderlich (*Mitt. Materialprüfungsanst. Tech. Hochschule Darmstadt*, 1934, (5), 82 pp.).—Endurance tests on flat and round rods of various metals with one end inserted in various shaped sockets and bosses have been made under vibrational stresses to ascertain the effect of such joints on the strength of complex structures. The endurance strength decreases with the pressure in the socket and tends to reach a limiting value depending on the nature of the 2 metals in contact, which is lower the more sensitive is the rod to notch effects, and higher the softer the metal of the socket. Oil in the junction raises the endurance strength, but graphite has no effect and water tends to reduce it. The effects of surface condition, case-hardening, fractional wear, &c., are considered chiefly with reference to ferrous metals. Numerous practical examples are discussed in detail.—A. R. P.

***Modulus of Elasticity.** Léon Guillet, Jr. (*Rev. Mét.*, 1935, **32**, 61–68).—A study of the modulus of elasticity in tension and bending. Methods of determination are discussed. Attention is directed to the important effect of temperature, a variation of 5° C. resulting in an error of the order of 5%. The practical advantages and theoretical disadvantages of the "bending" method of determining Young's modulus are detailed. The dynamic method of Rolland and Sorin is simple, rapid, and gives results in good agreement with direct observations obtained from careful extensometer tests, results of both types of tests being given. The influence of graphite on the modulus of cast iron is considered. Modulus values for the different elements plotted against melting temperature divided by the square of the atomic volume results in fair alignment of the points. G. discusses the influence of chemical composition and treatments on modulus value and gives a short *bibliography*.—H. S.

Tensile Testing Machine, 2·75 kg. for Small Test-Pieces. R. Guillery (*Rev. Mét.*, 1935, **32**, 58–60).—A small hydraulic machine of the bench type.—H. S.

***New Machine for Hardness Tests of Metals.** R. Guillery (*Rev. Mét.*, 1935, **32**, 49–53).—The preliminary load on the ball is $\frac{1}{10}$ of the main load subsequently applied. A steel ball is used for tests of soft metals and tungsten carbide for tests of hard steels.—H. S.

RADIOLOGY

***Radiography of Fine Flaws in Metals.** A. G. Warren (*Brit. J. Radiology*, 1935, **8**, 235–247).—Cracks and crack-like voids present the most difficult problem in the radiographic examination of metal structures. In order to determine the practical limits of examination artificial cracks in steel have been examined. Examples of typical cracks found in practice are given and a method of radiography applicable to cylindrical objects is mentioned.—S. V. W.

Inspection of Welds—With Particular Reference to Radiography. Herbert R. Isenburger (*Welding Eng.*, 1935, **20**, (6), 26–27).—The advantages of radiographic inspection are pointed out, some hints on the choice of suitable equipment are given, and the importance of exact technique and correct interpretation is emphasized.—H. W. G. H.

†**The Application of Very Hard X-Rays to the Testing of Materials.** A. Herr (*Elektrotech. Z.*, 1935, **56**, 425–428).—Reasons are given for the use of very hard X-rays in the testing of metals and some of their technical applications are discussed with reference to examples. A description of the necessary apparatus and of the precautions to be taken in its use is also given.

—B. Bl.

XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from p. 393.)

Temperature Indicator Methods in Aluminium Switchgear. C. Geier, W. von Zwehl, and W. Helling (*Aluminium*, 1935, **17**, 375–376).—The various coloured compounds, chiefly derivatives of mercuric and other iodides, usually employed for indicating dangerous increases in temperature by a colour change can be employed on aluminium switchgear if the metal is first protected by a lacquer coat.—A. R. P.

Realization of the International Temperature Scale by Means of Thermocouples of Platinum and Platinum–Rhodium. V. N. Bozhovskii and A. S. Arzhanov (*Vsesoyuznuii Nauch.-Issledovatel. Inst. Metrol. i Standartizatzii*, 1933, (132), 3–11 (in French), 29–33 (in Russian); *C. Abs.*, 1935, **29**, 4641).—A comparison over the range 300°–1300° C. of the International Temperature Scale as determined by the melting points of gold, silver, and antimony, with a scale determined by the melting points of zinc, antimony, and copper.

—S. G.

Realization of the International Temperature Scale in the Interval 0° to 600° C. by Means of the Platinum Resistance Thermometer. V. A. Yakovleva (*Vsesoyuznuii Nauch.-Issledovatel. Inst. Metrol. i Standartizatzii*, 1933, (132), 22–28 (in French), 41–44 (in Russian); *C. Abs.*, 1935, **29**, 4642).—A determination of the melting point of antimony is included.—S. G.

Realization of the Fundamental Reference Point of Optical Pyrometry. V. N. Bozhovskii and V. I. Parvitzkii (*Vsesoyuznuii Nauch.-Issledovatel. Inst. Metrol. i Standartizatzii*, 1933, (132), 12–21 (in French), 34–40 (in Russian); *C. Abs.*, 1935, **29**, 4641).—Apparatus and method are described.

—S. G.

XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 393–395.)

Removal of Zinc from High-Tin Bronze. N. N. Muratch (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (4), 69–74; *C. Abs.*, 1935, **29**, 4316).—[In Russian.] By blowing air through molten bronze scrap the zinc in it was reduced to the permissible limit. With molten scrap containing zinc 1·09, tin 18·27, copper 79·19, iron 0·03, lead 0·92, and nickel 0·10%, the final product, after blowing with air for 6 hrs. 20 minutes and subsequent addition of cupric oxide to the slag, contained: zinc 0·08, tin 12·78, copper 85·70, iron 0·04, lead 0·92, and nickel 0·15%.—S. G.

Foundry Production of Nickel Silver.—II. T. E. Kihlgren (*Metals and Alloys*, 1935, **6**, 175–180).—The choice of a suitable deoxidizer for nickel–brass castings is discussed. Silicon in the alloy tends to produce porous brittle castings, hence deoxidizers, such as lithium, boron, and titanium which reduce silica from the melting crucible, should not be used. The best results are obtained by the use of phosphorus, manganese, and magnesium as described in section I (*Met. Abs.*, this vol., p. 394). Numerous examples and illustrations showing the effects of various deoxidizers and correct methods of moulding and casting are given.—A. R. P.

Foundry Practice for Nickel Silver (Including Some Other Nickel-Containing Non-Ferrous Alloys). James A. Rabbitt (*Japan Nickel Information Bureau Working Instructions*, **C-16**, 1935, 106 pp.).—[In English and Japanese.] The quality of raw materials, melting equipment and practice, and moulding technique are discussed. Several alternative procedures for melting nickel–brass are described, but the recommended method is that specified by the Japanese Navy, in which a 50 : 50 copper–nickel alloy is first made and ingotted. Particulars of permissible impurities in nickel–brass castings, and typical charge sheets for nickel–bronzes, nickel–aluminium–bronzes, and light alloys are given. A list of typical nickel–brasses, with their trade names and compositions forms an appendix.—H. W. G. H.

***Removal of Sulphur from Tin and Its Alloys.** A. A. Bulakh (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (8), 115–116; *C. Abs.*, 1935, **29**, 4721).—[In Russian.] Tin (285 kg.) containing sulphur 0·2 and iron 0·61% was heated to 530° C. and sodium hydroxide was added in the following manner: first, 5 kg. was added, after 25 minutes the slag was removed, 5 minutes later 3 kg. sodium hydroxide was added and after 25 minutes the slag was removed. The resulting metal contained a trace of sulphur and 0·11% iron.—S. G.

***Melting Zinc Dust under Fluxes.** N. N. Muratch and G. K. Markarov (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (2), 107–108; *C. Abs.*, 1935, **29**, 4304).—[In Russian.] NH_4Cl and $MCl_2 + NaHSO_4$, where M is alkali or alkaline earth, were tested as fluxes for zinc dust. The reactions are: $ZnO + 2NH_4Cl = ZnCl_2 + 2NH_3 + H_2O$ and $ZnO + MCl_2 + 2NaHSO_4 = ZnCl_2 + Na_2SO_4 + MSO_4 + H_2O$. Both fluxes proved successful.—S. G.

Effect of Rapid Cooling on the Distribution of Lead in Cast Zinc. M. D. Zudin (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (5), 115–120; *C. Abs.*, 1935, **29**, 4303).—[In Russian.] Rapid cooling of zinc ingots results in a finer crystal grain and more uniform distribution of lead.—S. G.

Joint Plates and Joint Grids. J. W. Molder (*Iron Steel Ind.*, 1935, **8**, 421–422).—The use of joint plates and joint grids in the making of large castings for which special boxes are not available are discussed, and the making of both plates and grids and their operation are described in detail.—J. W. D.

Die-Casting with Machines of Simple Design. Charles O. Herb (*Machinery* (*N.Y.*), 1935, **41**, 669–672).—Hand-actuated semi-automatic die-casting machines can be used economically for making small parts up to 1 lb. in weight at a rate of 4 to 10 "shots" per minute. Descriptions are given of 2 dies for use with such machines, one casting 8 lead battery bushings and the other a zinc bowl-shaped part.—J. C. C.

Die-Cast Wheel Hubs and Caps. E. Stevan (*Mech. World*, 1935, **97**, 5–6).—An example is given of economics effected by substituting die-cast hubs and caps for parts previously made from pressings (hubs) and brass sand-castings (caps). The details of the mould used are illustrated and described, but the composition of the die-casting alloy is not given.—F. J.

†America Appreciates Zinc Die-Castings! And Germany? W. Mueller (*Maschinenbau*, 1935, **14**, 67–72).—The present position of the die-casting industry is discussed and the use of zinc die-castings in place of more expensive metals is reviewed in the light of modern metallurgical knowledge.—K. S.

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

(Continued from p. 395.)

***Treatment of Brass Scrap and Crude (80–90%) Copper at the Moscow Molotov Plant.** G. A. Shakhov (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (5), 100–114; *C. Abs.*, 1935, **29**, 4301).—[In Russian.] Cf. *Met. Abs.*, 1934, **1**, 457. A study of the operation of tilting open-hearth furnaces and Bes-

semer converters for the refining of copper from brass scrap and crude copper, at the Moscow Molotov plant, led to the following conclusions: (1) the cost of refining in the converters is only ½ of that in the open-hearth; (2) one converter can produce as much as 3 open-hearth furnaces; (3) removal of antimony is complete in the converter and zero in the open-hearth; (4) consumption of coke in the converter is 10% by weight of that in the open-hearth; crude oil 30% by weight; (5) recovery of zinc in the converter is greater than in the open-hearth; (6) conditions of work at the converters are much better than at the open-hearth.—S. G.

Extraction of Zinc from Waste Materials at the Belovo Zinc Plant. V. F. Veber (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (9), 14–22; *C. Abs.*, 1935, **29**, 4711).—[In Russian.] A description of methods used in the recovery of zinc scrap, dust, and other waste materials.—S. G.

Industrial Non-Ferrous Metal Scrap. Its Classification and Preparation. E. G. Wertheimer (*Amer. Metal Market*, 1935, **42**, (98), 5; (99), 4).—Practical hints are given for sorting and classifying scrap metal from foundries and workshops with the object of accumulating uniform parcels which are more readily saleable and fetch better prices than do mixed parcels.—A. R. P.

Avoiding Evils in Scrap Transactions. Richard V. Bonomo (*Amer. Metal Market*, 1935, **42**, (99), 9).—A brief discussion of the best methods for disposing of scrap metals in the U.S.A.—A. R. P.

XV.—FURNACES AND FUELS

(Continued from p. 395.)

Heat-Treating Aluminium Alloys. L. H. Knapp (*Elect. World*, 1935, **105**, 1712, 1715).—A brief, illustrated account of a sodium nitrate bath, employing 19,000 lb. of the salt, heated by twenty-four 7-kw. cast-in immersion heaters, operating at 940° ± 3° F., having a container made of 1½ in. welded boiler plate, and used for heat-treating aluminium alloy aircraft parts.—J. C. C.

Heating of Furnaces. —— Guillon (*Usine*, 1935, **44**, (18), 31; *C. Abs.*, 1935, **29**, 4638).—The generation of heat in the furnace and its transmission to the material to be heated is discussed as dependent on construction, type of fuel and material.—S. G.

†**Air-Heating Blowers.** E. Schirm (*Feuerungstechnik*, 1935, **23**, 61–64).—Blowers, incorporating a form of heat-exchanging device for heating gases, more especially air, are described.—J. S. G. T.

Technical Considerations Relating to Heat Conservation Concerned in the Construction of an Electric Furnace. Otto Krebs (*Feuerungstechnik*, 1935, **23**, 54–55).—Thermal data relating to heat distribution, losses, &c., in an electric furnace are discussed.—J. S. G. T.

Electric Heat for the Printer. W. E. Swale (*Elect. Rev.*, 1935, **117**, 80).—Electric melting, with thermostatic control, is ideal for type metal in a printing works. Tests on an electrically heated monotype caster showed it to consume 1·693 kWh/hr. A 3 kw. remelting pot consumed 25·2 Wh. per lb. of metal. —J. C. C.

The Reactance of Large Rectangular Three-Phase Electric Furnaces. F. V. Andreae (*Trans. Electrochem. Soc.*, 1935, **67**, 151–167; discussion, 167–168).—See *Met. Abs.*, this vol., p. 359.—S. G.

XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from p. 395.)

***Effect of Variations in the Alumina–Silica Ratio in Fused Refractory Materials upon Resistance to Metal Oxides [of Iron and Brass].** Charles McMullen, A. A. Turner, and G. J. Easter (*J. Amer. Ceram. Soc.*, 1935, 18, 30–33).—Solid pieces of electrically-fused material, varying in composition from alumina 63, silica 37% to 100% alumina, of the ordinary abrasive grade, were heated in contact with cast iron and brass which were allowed to oxidize and attack the refractory. The least attack was found in the case of iron with alumina 80 and silica 20%, and in the case of brass with straight alumina, although alumina 80 : silica 20% was not greatly inferior. Bonds were developed for the materials thus selected and confirmatory tests were carried out on crucible fusions. Arc and powdered-coal fired furnaces lined with the bonded materials have proved successful.—S. G.

Insulating Refractories. W. M. Hepburn (*J. Amer. Ceram. Soc.*, 1935, 18, 13–17).—Insulating materials of various types are discussed, and their installation in industrial furnaces, &c. (including some metallurgical examples) is described. Data are given of savings involved in the use of insulating refractories. The characteristics of the materials are uniformity of product, shrinkage and spalling properties, physical strength, insulating value, and thermal capacity.—S. G.

***Physical Properties of Some Insulating Brick.** Walter C. Rueckel (*J. Amer. Ceram. Soc.*, 1935, 18, 18–22).—A study was made of 11 types of insulating brick. The physical properties determined included bulk density, porosity, transverse and crushing strength, pyrometric cone equivalent, volume shrinkage at 2300°, 2500°, and 2700° F., load deformation at elevated temperatures, and resistance to spalling. A study of the relation between permeability and pressure differential through the various insulating bricks is also reported. Suggestions are made for classifying the various types of insulating bricks into groups, and a discussion is given of formulæ for permeability.—S. G.

The Application of Insulating Materials to Industrial Furnaces. J. D. Keller (*J. Amer. Ceram. Soc.*, 1934, 17, 77–87).—Deals with the classification of insulating materials, insulation applied outside refractory walls, the use of refractory insulators for the entire furnace wall, economics, and obstacles to the wider use of insulation.—S. G.

Principles of Heat-Flow in Porous Insulators. H. W. Russell (*J. Amer. Ceram. Soc.*, 1935, 18, 1–4; discussion, 4–5).—Gives an approximate theory of the thermal conductivity of porous materials. The effect of pore size and shape is discussed.—S. G.

***The Thermal Conductivity of Refractories.** Gordon B. Wilkes (*J. Amer. Ceram. Soc.*, 1934, 17, 173–177).—The thermal conductivity of recrystallized silicon carbide, clay-bonded silicon carbide, and silica and fireclay bricks was determined from 200° to 2600° F. (93°–1409° C.). The results are compared with those of previous investigators and a possible explanation is given of the peculiar variation of the coeff. of thermal conductivity with temperature for certain bricks.—S. G.

***A Method of Measuring Thermal Conductivity [of Refractory Materials] at Furnace Temperatures.** Clarence E. Weinland (*J. Amer. Ceram. Soc.*, 1934, 17, 194–202).—An apparatus of original design for the measurement of the thermal conductivities of insulating and refractory materials at temperatures up to 2600° F. (1409° C.) was constructed. The primary heat is supplied by Globar resistors, and the rate of heat-flow measured by a calibrated "heat-meter," means for the calibration of which were incorporated in the apparatus itself. The test-specimen consisted of 8 standard-size bricks form-

ing a section 18 × 18 × 2½ in. in size. Results are given of 6 complete tests: one of a high-temperature insulating brick, one of a fireclay brick, and 4 tests of refractory insulating bricks. In two cases comparative results from tests in a different kind of apparatus are shown. The accuracy of the results obtained in testing insulating and refractory insulating bricks are considered to be fully equal to the requirements of engineering use.—S. G.

***An Apparatus for Measuring the Thermal Conductivity of Refractories at High Temperatures.** J. L. Finck (*J. Amer. Ceram. Soc.*, 1935, **18**, 6–12).—An apparatus is described for measuring the thermal conductivity of refractories up to about 2000° F. (1093° C.). The theory and method of test are discussed in detail and results are given for light refractory insulating brick and for a silica fire-brick and dense fire-brick.—S. G.

***A Study of the Effect of Natural Gas and of Hydrogen upon Various Refractories.** Bertram C. Ruprecht, R. H. H. Pierce, and Fred A. Harvey (*J. Amer. Ceram. Soc.*, 1934, **17**, 185–193).—Natural gas was passed through an electric tube furnace where it was partially cracked and then through a second furnace containing the sample of a refractory. The refractories tested were fireclay bricks of various types and fired in various ways, and bricks made of magnesite, high alumina material, and silica. The action on the refractory was similar to that of carbon monoxide. Carbon was deposited in some of the refractory bodies within a critical temperature range. Some of the fireclay bodies were almost completely disintegrated by the growth of the carbon deposits, although others were scarcely affected. Hydrogen gas had no disintegrating action at any temperature in the range studied.

—S. G.

The Destruction of Refractory Melting Furnace Brick-Work by Splintering. E. T. Richards (*Feuerungstechnik*, 1935, **23**, 49–52).—The splintering of refractory furnace materials due to mechanical and thermal effects and owing to textural changes in the material is discussed and illustrated.—J. S. G. T.

***A Rapid Method for the Analysis of Siliceous Refractories.** Sandford S. Cole and S. R. Scholes (*J. Amer. Ceram. Soc.*, 1934, **17**, 134–136).—Evaporation with hydrofluoric and sulphuric acids removes silica. Ignition of the residue at 800°–900° C. yields a mixture of R_2O_3 and sulphates, which is weighed. The residue is brought into solution and R_2O_3, calcium oxide, and magnesium oxide are determined by standard methods. Calcium and magnesium oxides are calculated back to sulphates and alkali is calculated from weight of ignited residue. Silica is found by difference. A summary is given of previous investigations on the behaviour of sulphates at elevated temperatures, as well as the results of similar experiments by C. and S.—S. G.

A Compilation of Phase-Rule Diagrams of Interest to the Ceramist and Silicate Technologist. F. P. Hall and Herbert Insley (*J. Amer. Ceram. Soc.*, 1933, **16**, 463–567).—Gives a compilation of equilibrium diagrams, principally of silicates and refractory oxides. The text of the paper includes definitions of terms used in discussion of the Phase Rule, a description of methods used in the study of the systems at high temperatures, and an interpretation of Phase Rule diagrams for systems of one or more components.—S. G.

The Physico-Chemical Study of the Manufacture of Refractory Materials. M. Lépingle (*Métaux et Machines*, 1935, **19**, 117–120, 257–262).—The Phase Rule is applied to the equilibrium diagrams of the principal types of refractories; the properties on which the refractory character of the material depends are thence deduced. Details of permissible variations in composition, working temperature range and reversible and irreversible thermal changes are given in each case. A table shows the influence of 26 catalysts on the transformation speed of quartz at 1300° C., and further tables show the effect of repeated heating.—P. M. C. R.

XVII.—HEAT-TREATMENT

(Continued from p. 396.)

†**Bright-Annealing of Non-Ferrous Metals.** A. G. Robiette (*Metal Treatment*, 1935, **1**, 63–69).—It is not sufficient to exclude oxygen to obtain a bright-anneal; water vapour, carbon dioxide, and gases evolved from the metal may all cause oxidation. The gas–metal equilibria, both at the annealing temperature and during cooling, must be taken into account, as well as such factors as the effect of a continuous gas stream in disturbing equilibria. Zinc alloys present troubles due to volatilization, and in addition will be oxidized if more than 0·2% of water vapour, carbon dioxide, or oxygen be present. By adding hydrocarbons to the gas mixture, however, oxide formation can be largely prevented. This action is apparently connected with the catalytic breakdown of the hydrocarbons. Nickel can be bright-annealed in the presence of water vapour and carbon dioxide provided sufficient reducing gases are present. Copper can be annealed in steam (wet annealing) or carbon dioxide, but traces of oxygen attack the metal above 80° C. Dry annealing is necessary for fine wires, and can be carried out without fear of "gassing" the copper if the atmosphere is only very slightly reducing. Lubricants on the surface may give trouble through carbon deposition or the liberation of free oxygen. The costs and applications of commercial atmospheres are reviewed, and the principal features of the main types of continuous and batch bright-annealing furnaces described.
—J. C. C.

Practical Data Regarding the Heat-Treatment and Workability of Light Metals [Duralumin]. B. Adaridi (*Tek. Tids. Uppl. C., Bergsvetenskap.*, 1935, **65**, 21–24, 31–32; *C. Abs.*, 1935, **29**, 4307).—The effect of various heat-treatments on the tensile strength, elasticity, and elongation of rolled and drawn Duralumin is described, together with practical information on the working of Duralumin by hand-forming, cold-pressing after quenching in water, pressing in the annealed condition, and hot-pressing.—S. G.

XVIII.—WORKING

(Continued from p. 396.)

Note on the Treatment of Light Alloys in U.S.S.R. The Forging, Drop Forging, and Heat-Treatment of Elektron. Michel Préceul (*Chaleur et Industrie*, 1935, **16**, 241–242).—Elektron, used for propeller blades in the U.S.S.R., should be heated to 380° C. for 12 hrs. before forging and worked with frequent turnings between 330° and 380° C., reheating as required. Working increases the strength, especially in the longitudinal direction, but reduces elongation. Heat-treatment for 8 hrs. at 350° C. equalizes the strength in different directions at 24–25 kg./mm.^{2}, and increases the elongation to 9–15%.—J. C. C.

Stamping Monel Metal. V. M. Aristov (*Zvetnye Metally* (*The Non-Ferrous Metals*), **1934**, (4), 81–86).—[In Russian.] A review.—S. G.

The Henley Lead-Extrusion Machine. —— (*Electrician*, 1935, **115**, 148; also *Elect. Times*, 1935, **88**, 103; and *Elect. Rev.*, 1935, **117**, 118).—A continuous cable-sheath extrusion press has been perfected by W. T. Henley, Ltd., using the principle of a screw extruder. The machine is illustrated and briefly described. Its length from back to front is only about 12 in., and on account of the rigid construction, extremely close dimensional limits can be maintained in the extruded sheath. The usual oxide inclusions and seams are eliminated by the continuous nature of the extrusion.—J. C. C.

Copper Wire Rope. A. G. Arend (*Mech. World*, 1935, **97**, 273–274).—Copper wire rope, although made in a smaller class of machine, with different number of strands, and in smaller quantity than steel rope, is used for haulage and transport in chemical factories and in the operation of all classes of tank plungers where corrosive fluids are used. Brass and iron wire ropes are too readily attacked in such conditions. Copper wire rope is not suited to withstand considerable abrasion, but when this property, together with the usual flexibility, is required, the wires in the outer layer are large, being laid on a layer of wires of small diameter. Details of the manufacture of copper wire rope are described. The progress recently made in radio and certain electrical pursuits has been responsible for an increased production.—F. J.

Nichrome Wire. M. W. Pridanzev (*Katschestvennaja Stalj*, **1934**, 44–47; *Korrosion u. Metallschutz*, 1935, **11**, 163).—Nichrome is made most readily by adding pieces of low-carbon nickel–chromium steel to molten 98% nickel and deoxidizing with ferrosilicon. The Russian alloy made in this way contains nickel 61·4, chromium 16·3, iron 19·5, carbon 0·12, silicon 0·5, manganese 2·4, phosphorus 0·012, and sulphur 0·007%. Wire made from this alloy is descaled after annealing by pickling at 40°–80° C. in a solution containing hydrochloric 5–20, nitric 5–20, and sulphuric acid 5–35%; it is then usually copper-plated.—A. R. P.

***Processes for the Production of Nichrome Wire.** B. F. Rukin (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (6), 81–100; *C. Abs.*, 1935, **29**, 4307).—[In Russian.] A description of experiments for the production of Nichrome wire from Russian raw materials.—S. G.

Free-Cutting Aluminium for Screw Machine Work. —— (*Amer. Metal Market*, 1935, **42**, (131), 5, 6).—The free-cutting properties of aluminium are considerably improved by addition of lead and bismuth together with copper and magnesium. A special technique is required in the melting, casting, and working operations to obtain homogeneous distribution of the lead and bismuth which are insoluble in solid aluminium but soluble to a limited extent in the liquid metal at a high temperature. Age-hardening alloys of the Duralumin type may also be given free-cutting properties by the same process. The semi-hardened alloys work best in automatic lathes, but modifications in the shape of the tools are necessary; subsequently the screws may be hardened by heat-treatment. A general account of the development and properties of these alloys is given without any details of the composition or methods of working.—A. R. P.

Working Aluminium and Its Alloys. —— (*Mech. World*, 1935, **97**, 615, 619).—Technical details are given of the tools used for drilling, turning, milling, and sawing of aluminium and its alloys. On the whole, fine to medium feeds combined with high speeds, give the best results. It is preferable to use a cutting compound. A soluble cutting oil, or a mixture of lard oil and kerosene oil, the relative proportions varying according to the type of work and the speed and feed, will be found quite suitable. Pure lard oil is excellent for the heavier work.—F. J.

The Need for Zinc Cutters. —— (*Mech. World*, 1935, **97**, 517).—Letter to the Editor. The need for a method of cutting zinc sheets and cathode slabs by welding methods and the practical difficulties thereby involved are described.—F. J.

XIX.—CLEANING AND FINISHING

(Continued from p. 397.)

Electrolytic Method for Obtaining Bright Copper Surfaces. P. A. Jacquot (*Nature*, 1935, **135**, 1076).—The specimen is treated with emery paper, then cleaned cathodically in an alkaline solution, and finally treated anodically for

2 or 3 minutes in aqueous orthophosphoric acid (50 vol.-% of the commercial product, sp. gr. 1·71), using a high current density (about 60 amp. per sq. dm.). The solution tends to increase in temperature and should be cooled. A rotating anode is an advantage in securing uniformity.—E. S. H.

Recent Advances in Metal Cleaning Technology. R. W. Mitchell (*Metal Cleaning and Finishing*, 1935, **7**, 133–135; *C. Abs.*, 1935, **29**, 4307).—See also *Met. Abs.*, this vol., p. 360. A discussion of alkaline cleaners and new developments in cleaning equipment.—S. G.

Chemical Stoneware in the [Cleaning] Finishing Industries. Percy C. Kingsbury (*Metal Cleaning and Finishing*, 1935, **7**, 239–242).—S. G.

Tested Cleansers for Dairy Plants. Forrest Grayson (*Food Industries (N.Y.)*, 1935, **7**, 231–232, 281–282).—Sodium metasilicate is considered the best alkaline cleanser, as it has little action on tin, aluminium, and other metals, and a strong emulsifying and solvent action for milk fat. It is further improved by the addition of 5–10% of soap. Recommended concentrations for different pieces of plant are given.—C. E. H.

Blackening Metals. —— Klement'ev (*Novosti Tekhniki, Seriya Gornorudnayna Promishlennosti*, 1935, (7), 9–10; *C. Abs.*, 1935, **29**, 4307).—[In Russian.] The articles to be blackened are immersed in a saturated nitric acid solution of copper at 50°–60° C., removed, and heated until the liquid on the plate is evaporated and the greenish residue becomes black. The surface is then carefully brushed and the above operation repeated a number of times.—S. G.

***Atmospheres for Annealing High Brass in Relation to Buffing.** L. Kroll and E. A. Anderson (*Metals and Alloys*, 1935, **6**, 192–193).—Experiments have been carried out on the loss in weight on buffing brass containing copper 65·75, lead 0·01, and iron 0·025%, and balance zinc. When the alloy is pickled in 7–15% sulphuric acid after annealing and then buffed the loss in weight increases with increase in annealing temperature, being about twice as great after annealing at 700° C. as after annealing at 440° C. At constant annealing temperature, increase in the time of annealing increases the buffing loss. Annealing in hydrogen produces smaller losses than annealing in air, but nitrogen atmosphere is not so good as air. Annealing in coal-gas is definitely unsatisfactory owing to the discoloration produced by the sulphur content of the gas and by carbon deposits derived from the cracking of the hydrocarbons.—A. R. P.

XX.—JOINING

(Continued from pp. 397–401.)

Contribution to the Investigation of Fusion Joints Between Aluminium and Other Metals. —— Holler and —— Maier (*Autogene Metallbearbeitung*, 1935, **28**, 177–187).—Joints with iron, copper, brass, nickel, Monel metal, stainless steel, lead, and zinc are described and illustrated by photomicrographs. Details of the technique used and physical properties obtained are given. In most cases, the heavy metal is "tinned" before welding. Corrosion tests in tap-water and 3% brine show that the joints have about the same resistance to corrosion as soft-soldered joints in aluminium.—H. W. G. H.

Welded Light Metal Wagons of the French Northern Railway. F. Thomas (*Aluminium*, 1935, **17**, 378–380).—The welding technique is explained with reference to illustrations.—A. R. P.

***Welding of Zinc Sheets.** Hans A. Horn (*Autogene Metallbearbeitung*, 1935, **28**, 169–171).—Samples up to 2·5 mm. thick were welded by oxy-acetylene, with a flame having about 10% excess oxygen. Flux-cored filler-rods, and also strips cut from the sheet with the flux in powder form, were

used: the latter gave slightly the better results. The flux in each case was an ammonium chloride–zinc chloride mixture. The most suitable nozzle size was found to be that passing 50–60 litres/hr. per mm. thickness of material. A brick backing-plate was used. Photomicrographs and radiographs show that the results obtained were excellent.—H. W. G. H.

***Welding of Wires by Condenser Discharge.** O. Zdralek and J. Wrana (*Elektrotech. Z.*, 1935, **56**, 579–580).—Wires can be welded by a non-oscillating condenser discharge. Welding takes place in 2 steps, first the ends of the wires fuse to small globules and these then coalesce, producing a larger globule at the joint. The electrical conditions for welding copper, iron, aluminium, Constantan, and Nickelin by this method are given.—B. Bl.

†**The Eleventh International Congress [Rome] on Acetylene and Autogenous Welding and Related Industries.** J. Brillie and (Mlle.) L. Bloch-Sée (*Rev. Mét.*, 1935, **32**, 106–119).—A *résumé* of papers presented at the Congress, mainly dealing with ferrous materials. Papers by A. Boutté on the unweldability of nickel and by A. B. Kinzel and A. R. Lytle on brazing with the oxy-acetylene torch are reviewed briefly.—H. S.

An Early History of Oxy-Acetylene Welding and Cutting in the United States. Orn T. Weirs (*Welding Eng.*, 1935, **20**, (6), 22–24).—An interesting account of the introduction, by Eugene Bournonville, of oxy-acetylene welding and cutting into the U.S.A.—H. W. G. H.

Internal Stresses in Weld Seams. —— Müllenhoff (*Elektroschweissung*, 1935, **6**, 103–108).—The advantages of Mathar's method for measuring internal stress (by boring holes and measuring the deformation round them) are pointed out, and a series of investigations on mild steel welds is described. Special attention is directed to the effect of stressing specimens, beyond the proportional limit, longitudinally to the weld. In a gas-welded specimen, stresses along and across the seam of about 38 and 12½ tons/in.², respectively, decreased to about 6½ tons/in.²; in a bare-wire arc-welded piece, a stress of about 28½ tons./in.² parallel to the seam decreased to about 16 tons/in.²; and, in a sample welded with coated electrodes, stresses of about 25 parallel to, and 19 across the seam, were reduced by half, the stress applied to the specimens being 6½ tons/in.².—H. W. G. H.

Applications of Resistance Welding. P. R. Dunn (*Elect. Rev.*, 1935, **117**, 177–178).—A general survey.—J. C. C.

Arc Welding in the Chemical Industry. P. Stricker (*Arcos, Z. Lichtbogenschweissung*, 1934, **11**, 1127–1129).—The use of electric arc welding in the construction of chemical apparatus is discussed, with examples.—S. G.

XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 401–405.)

Effect of Vibration on Steel-Cored Aluminium Conductors. L. L. Eve (*World Power*, 1934, **21**, 247–249; and *Electrician*, 1934, **112**, 565; discussion, 565–566; *Sci. Abs.*, 1934, [B], **37**, 417).—Vibration is most prevalent with wind velocity of about 5 m.p.h. and where the line is unobstructed. The fatigue breaks have occurred mostly on the 37/0·102 s.c.a. conductor and at entrance to suspension clamps (and sometimes to tension clamps). When the temperature decreases below the erecting temperature the proportion of stress taken by the aluminium of the s.c.a. conductor increases considerably. E. advises overstressing the conductor before sagging the line to ensure against the calculated proportion being severely encroached upon at the lower temperatures. He suggests, as a precaution against fatigue breaks, erecting (1) at a safe tension, or (2) at a tension taking full advantage of the strength of the conductor and equipping the line with dampers.—S. G.

Method of Damping the Vibrations of Overhead Cables. M. Preiswerk (*Bull. Assoc. Suisse Élect.*, 1934, **25**, 252–253).—See *Met. Abs.*, 1934, **1**, 637. —S. G.

Lightness in Truck Design. Austin M. Wolf (*Soc. Automotive Eng. Preprint*, **1934**, 19 pp.).—The advantages of using light aluminium in the construction of the chassis of trade motor vans, &c., are discussed with reference to numerous examples. Tables of the mechanical properties and applications of aluminium alloys for trucks and truck bodies are included. —A. R. P.

Aluminium Castings and Their Uses in Modern Vehicle Construction. Oskar Summa (*Automobiltech. Z.*, 1935, **38**, (12), 297–301).—A tabulated comparison of important physical and mechanical properties of aluminium with those of magnesium, copper, tin, iron, and steel, is followed by a summarized account of aluminium alloys containing silicon, magnesium, copper, and/or zinc. Their properties in the cast condition are tabulated. Their freedom from thermal distortion makes them especially suitable for use in motor engines. Defects resulting from faulty preparation are described and classified, with special emphasis on the technique of remelting. Compositions and properties of Nŭral, 142, copper–Silumin, and Silumin–Beta are given, and the thermal changes of the last-named are described.—P. M. C. R.

Cast Aluminium, a German Material. W. Hartl (*Automobiltech. Z.*, 1935, **38**, (12), 301–307).—An account is given of the physical and mechanical properties of certain light alloys—Pantal, Silumin, Copper–Silumin, and Silumin–gamma—all of which are said to be especially suited for use in the cast condition. Cleaning, finishing, and protection methods are described, and data are given regarding the corrosion of Silumin and of pure aluminium in liquid fuels, including some proprietary mixtures. Detailed instructions are given for the substitution of light alloy for copper and nickel parts. —P. M. C. R.

Twenty-Five Years of Light Metal Pistons. E. Mahle (*Aluminium*, 1935, **17**, 355–369).—A review of the development of the design of light metal alloy pistons during the past 25 years.—A. R. P.

***Airscrew Oscillations.** M. Hansen and G. Mesmer (*Z. Flug. u. Motor.*, **1933**, (11); and (translation) *Aircraft Eng.*, 1935, **7**, 65–69).—Theoretical considerations on natural frequency and torsional oscillations are supplemented by experimental data on models. The results suggest that there is considerable danger of serious resonance effects between overtone oscillations due to blade bending and the pulsations of the engine particularly with thin metal airscrews having low natural frequencies.—H. S.

Aluminium in Shipbuilding. —— Sterner-Rainer (*Aluminium*, 1935, **17**, 370–374).—The advantages of magnesium–aluminium alloys in shipbuilding are discussed, and the technique of melting, casting, and working them is described. Surface protection of aluminium alloys by plating with pure aluminium and by coating them with oxide by the Eloxal process is briefly considered.—A. R. P.

***Formaldehyde in Canned Marine Products [in Aluminium and Tinplate Cans].** Gulbrand Lunde and Erling Mathiesen (*Indust. and Eng. Chem.*, 1934, **26**, 974–976; and (abstract) *Light Metals Rev.*, 1934, **1**, (12), 242).—Formaldehyde can be detected in the distillate from fresh or canned marine products, and tests show that there is no difference between the amounts formed in tinplate or in aluminium vessels after various periods of storage. The formation of formaldehyde, which was thought to be caused by reaction between the fish and the containers, does not increase during long storage. —R. B. D.

Recent Developments in Metallurgy and Design of [Bronze] High-Speed Motor-Boat Propellers. T. F. W. Meyer (*Soc. Automotive Eng. Preprint*, **1933**, 17 pp.).—A description is given of the development, construction, and per-

formance of Federalite bronze propellers used in the American competitor for the motor-boat trophy.—A. R. P.

The Use of Lead in the Oil Industry. G. O. Hiers (*Amer. Metal Market*, 1935, **42**, (133), 3, 5).—Lead-lined tanks and pipes are used widely in the oil industry in refining processes involving the use of sulphuric acid. The properties of chemical lead, antimonial lead, and tellurium-lead are reviewed and the suitability of these 3 grades of lead for various purposes in the oil refinery is indicated.—A. R. P.

***Stability of Lead Alloy Anodes in the Electrolytic Production of Zinc.** P. S. Titov and I. N. Nikonov (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (6), 53–62; *C. Abs.*, 1935, **29**, 4269).—[In Russian.] A study was made of the stability of anodes made of binary lead alloys containing various amounts of bismuth, antimony, arsenic, and silver, in the electrolysis of zinc, in ordinary conditions of operation, and the results were compared with those obtained from experiments with pure lead anodes. Lead–bismuth anodes containing 0·5–10% bismuth were less stable than pure lead anodes. Alloys containing 0·5–10% antimony were somewhat more stable than pure lead at 400 and less stable at 1000 and 1200 amp./m.^{2}. The amount of arsenic added to the lead varied from 0·5 to 3·0%. At 400 amp./m.^{2} the stability increased for the 0·5 and 1·0% arsenic alloys, decreased for the 2·0% and increased again for the 3·0% alloy. At 1000 and 1200 amp./m.^{2} the stability of all the arsenic alloys was less than that for pure lead. Addition of silver, 0·5–3·0%, to the lead anodes increased the stability considerably (cf. Ageenkov and Sosunov, following abstract). The stability curve reaches a maximum at 2·5% silver, where the anodes last 20–25 times as long as in the case of pure lead. Small additions of antimony up to 0·5%, of arsenic up to 0·5%, of bismuth up to 0·2%, or of bismuth and arsenic together, 0·1 and 0·4%, respectively, produced no deleterious effect on the lead–silver anodes. The presence in the sulphuric acid bath of zinc sulphate, manganese sulphate and glue had no appreciable effect on the stability of the anodes.—S. G.

***Effect of Anode Composition on Zinc Electrolysis.** V. G. Ageenkov and S. L. Sosunov (*Zvetnye Metally* (*Non-Ferrous Metals*), **1934**, (5), 61–74; *C. Abs.*, 1935, **29**, 4269).—[In Russian.] Cf. preceding abstract. Lead anodes containing small amounts of silver or calcium, or both, were compared with pure lead anodes in the electrolysis of zinc ore from a sulphuric acid bath. The composition of the lead used was: arsenic, trace; antimony, 0·00107–0·00910; bismuth, 0–0·002; copper, trace–0·00130; iron, 0·00192–0·00143; lead, 99·994–99·996%. The amount of silver in the silver–lead anodes or silver–lead–calcium anodes varied from 0·462 to 1·987% and of calcium, from 0·28 to 1·06%. The electrolyte contained on the average 60 grm. zinc, 100 grm. sulphuric acid, 0·174–0·36 grm. manganese, and 0·007 grm. iron per litre; the temperature varied from 21·0° to 29·8° C., voltage 3·25–3·75, and anode density 400 amp./m.^{2}. The presence of silver improves the chemical resistance of the anode, lowers the voltage, and reduces the amount of lead in the zinc deposit. The presence of calcium in addition to silver intensifies the effects due to silver. The mechanical strength of the lead anode is increased by the addition of silver and particularly calcium.—S. G.

Plumbers' Metal. —— (*Mech. World*, 1935, **97**, 177).—Notes prepared and communicated by British Insulated Cables, Ltd., for the information and assistance of those using plumbers' metal (tin 33·3, lead 66·7%)—F. J.

[Molybdenum] Crucibles for High-Temperature Work. —— (*Mech. World*, 1935, **97**, 237, 286, 383–384, 433, 518, 569).—The *pros* and *cons* of the application of molybdenum to large-scale work in the form of crucibles are discussed by correspondence.—F. J.

Properties of Nickel and Nickel Alloys in Caustic Processing Equipment. Takashi Okamoto (*Japan Nickel Information Bureau, Tech. Information* B–19, 1935, 50 pp.).—[In English and Japanese.] From a paper read before

the Society of Chemical Industry, Japan. The behaviour of materials in dilute and concentrated caustic solutions and in fused caustic soda is reviewed, and the advantages of nickel and its alloys are pointed out. The selection of the most suitable materials for various parts of caustic processing plant is discussed, and the properties of those recommended are given in detail.

—H. W. G. H.

Nickel Alloys in the Paper-Making Industry. A. B. Everest (*World's Paper Trade Rev.*, 1935, **103**, 831–836, 876, 878, 996–1000, 1034, 1036).—The applications of nickel alloys in the paper-making industry are described.

—S. G.

Nickel and Nickel Alloys in the Refining of Crude Oil. R. W. Müller (*Oel u. Kohle*, 1935, **11**, 504–507).—Alloys containing a high proportion of nickel, especially Monel metal, are much used in chlorination plant and in coolers and condensers where sea-water is used. Monel metal is used for bolts, piston-rods, tubing, sheet and valve and pump parts. The 70–30 copper–nickel alloy is employed in condensing and heating plant, as is Inconel, which combines high resistance to corrosion with unusual freedom from surface carbonization. Some steel parts are nickel-plated as a protection against attack by acids, alkalis, or petrol.—P. M. C. R.

Alkaline Accumulators. Guy Malgorn (*Électricien*, 1934, **45**, 126–132).—A description of the manufacture, characteristics, and applications of nickel–iron and nickel–cadmium accumulators, and a discussion of their advantages and disadvantages as compared with lead accumulators.—C. E. H.

Correlation of Viscosity Measurements with Flow of Glass. A.—Development of the Platinum Alloy-Lined Die: the Die of Unvarying Diameter. H. K. Richardson (*J. Amer. Ceram. Soc.*, 1934, **17**, 236–239).—S. G.

Silver for Chemical Equipment. C. H. S. Tupholme (*Chem. Industries*, 1935, **36**, 527–528).—The action of various chemicals on silver is described and the use of silver in chemical plant for handling foodstuffs, acetic acid, and hydrofluoric acid is briefly discussed.—A. R. P.

Bearing Metals. F. K. von Göler and G. Sachs (*Metallgesellschaft Periodic Review*, 1935, (**10**), 3–10).—[In English.] The structure and most important physical and mechanical properties of tin-, lead-, and cadmium-base bearing metals, of lead-base alloys containing alkali and alkaline earths, of lead bronzes and of zinc- and aluminium-base bearing metals are reviewed, and the selection of suitable alloys for specific purposes is discussed.—v. G.

Engine Bearings from the Designer's View-Point. Alex Taub (*J. Soc. Automotive Eng.*, 1934, **31**, 385).—Curves are given and discussed showing the relation between loading, shaft speed, and life of various bearing metals.

—A. R. P.

The Bearing Manufacturer's View-Point on Engine Bearings. D. E. Anderson (*Soc. Automotive Eng. Preprint*, **1932**, 15 pp.).—The max. bearing pressure and oil temperature permissible in bearings are determined by the properties of the Babbitt metal and the lubricating oil. The best grade of Babbitt has a compressive resistance of about 2000 lb./in.^{2} at 175° C. and a bearing having a load of 1000 lb./in.^{2} produces a hydrostatic pressure of nearly 2000 lb./in.^{2} at its centre; since tests have shown that the metal temperature in the bearing is about 55° C. above that of the oil supplied to it the Babbitt temperature will be within the range at which the metal becomes plastic and fails when the oil temperature is 120° C. The P–V factor of the bearing must, therefore, be such that the mean unit pressure is less than 1000 lb./in.^{2} and the oil temperature must be below 120° C. Thus at 4000 r.p.m. the P–V factor must not exceed 40,000. At higher engine speeds the bearings must be made of lead–copper or silver alloys to withstand the pressure and heat.—A. R. P.

Modern Alloys in Marine Engineering and Shipbuilding. J. W. Donaldson (*Metal Treatment*, 1935, **1**, 59–62).—A general review. The non-ferrous

alloys mentioned include modified aluminium–silicon alloys for hull work; Monel metal for interior construction, linings for trawler fish-holds, and valves; 70 : 30 copper–nickel alloys and aluminium–brass for condenser tubes; and high-duty copper alloys.—J. C. C.

Motor Manufacture in the Light of Available Unrestricted Materials. Erich Gründger (*Automobiltech. Z.*, 1935, 38, (12), 294–298).—The use for certain industrial purposes of copper, nickel, lead, and tin, as well as of chromium, nickel, or cobalt plating, is now forbidden in Germany. A list is given of important automobile parts affected by these restrictions, and alternative possibilities are considered. Where possible, ferrous materials should be avoided in view of their liability to corrosion, though zinc coatings are recommended for some purposes. Where synthetic resins are unsuitable, there is a wide field of light metals and alloys, and a summary is given of the available range of mechanical properties, of anti-corrosive measures, and of special means of protecting magnesium alloys.—P. M. C. R.

The Piping Installation. A. V. Knowles (*Motor Boat*, 1935, 63, 125).—Materials and lay-out for the water-circulating system of a motor-boat are discussed. Copper is considered to be the best material for all water, fuel, and oil pipes, and where some filling is necessary with such pipes lead is recommended. Flanges and unions on copper pipes should be of brass and should be brazed or hard (silver) soldered on. Soft soldering is not recommended for marine work.—J. W. D.

XXII.—MISCELLANEOUS

(Continued from pp. 405–406.)

The Science of Metallurgy in Technology and Research. Paul Röntgen (*Aachener Akad. Reden I*, 1934, 16 pp.).—A review of recent developments in non-ferrous metallurgy, with especial reference to the production of electrolytic zinc, aluminium, and beryllium, and to progress in the heat-treatment of non-ferrous metals.—A. R. P.

State of Non-Ferrous Metallurgy in Foreign Countries. V. Silinskaya (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (4), 92–100).—[In Russian.] —S. G.

Cadmium and Its Outlook in the U.S.S.R. N. M. Siluyanov (*Zvetnye Metally* (*Non-Ferrous Metals*), 1934, (10), 148–154).—[In Russian.]—S. G.

The Order Book of the New Wire Company, Cheadle, 1788–1831. L. St. L. Pendred (*Newcomen Soc. Advance Copy*, 1935, Mar., 18 pp.).—The activities of an old English company making copper and brass wire are surveyed between 1788 and 1831 by extracts from the order and minute books.—A. R. P.

The London Lead Company, 1692–1905. A. Raistrick (*Newcomen Soc. Advance Copy*, 1934, Apr., 38 pp.).—The development and activities of the company in the production of lead and silver from mines in the north of England are reviewed, and a brief account is given of the contribution of the company to the technique of mining and smelting lead ores.—A. R. P.

Epidemology of Lead Poisoning. A. J. Lanza (*J. Amer. Med. Assoc.*, 1935, 104, 85–87; *C. Abs.*, 1935, 29, 4852).—A daily dose of from 1·5 to 2 mg. is dangerous. Lead in the form of vapour is more dangerous than as dust. —S. G.

Control of Lead Poisoning in the Worker. Elston L. Belknap (*J. Amer. Med. Assoc.*, 1935, 104, 205–211; *C. Abs.*, 1935, 29, 4852).—A successful working technique is outlined for the medical control of poisoning in industrial occupations.—S. G.

Manganese : Its Minerals and Industry. Maurice Déribéré (*Bull. anc. Eleves École Bréguet*, 1933, (86), 1–20).—A general review.—S. G.

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