25 Q6/II
Cz

P.100/35

720 (Brownsdon) and 721 (Cook)
to be printed in the half-yearly volume:
*Journal of the Institute of Metals,*
1935, Vol. LVIII.

Vol. 2. Part 12.

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

*and*

# METALLURGICAL ABSTRACTS

BIBLIOTEKA
POLITECHNIKI
ŚLĄSKIEJ

DECEMBER, 1935

opyright] [*Entered at Stationers' Hall*

## High Grade Refractories

**From our wide range we are able to supply refractory materials of high quality suitable for most industrial purposes. In our various works, which are modern in design and equipment, care is taken in every stage of manufacture to ensure that our products are maintained at a uniformly high standard.**

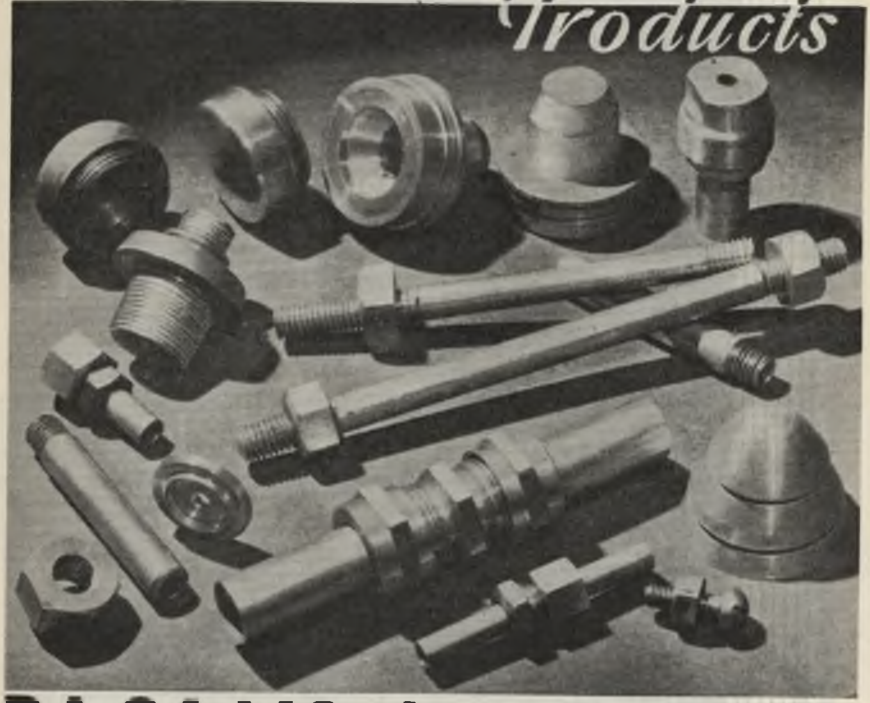
*For fuller particulars, ask for our Pamphlet, No. 1.*

**John G. Stein & Co. Ltd.**

**BONNYBRIDGE**

**SCOTLAND**

FOR ALL MACHINED *Products*



**BA 24 MS ALLOY ROD**

*Combines:-*

1. Excellent machining properties.
2. High Strength.
3. Light weight.
4. Exceptional resistance to corrosion.

*The* **BRITISH ALUMINIUM** *Co., Ltd.*
*Head Office:* ADELAIDE HOUSE, KING WILLIAM STREET, LONDON, E.C.4
*Telephone:* MANSION HOUSE 5561 & 8074 (5 LINES). *Telegrams:* CRYOLITE, BILGATE, LONDON

LONDON WAREHOUSE: 25–29, Pancras Rd., N.W.1.
MANCHESTER 3: Deansgate House, 274, Deansgate.
NEWCASTLE-ON-TYNE 1: Milburn House.

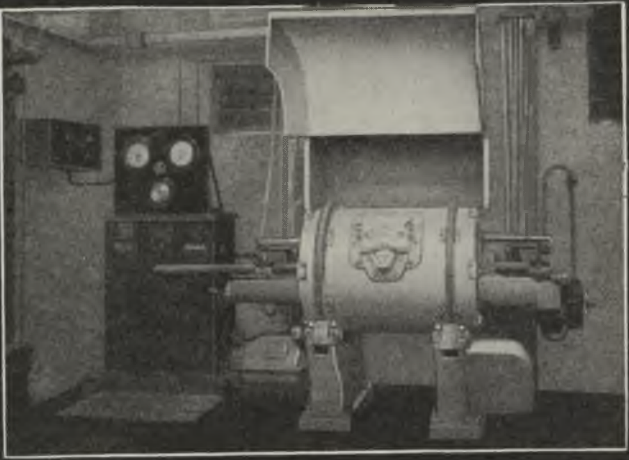
BIRMINGHAM 4: Lawley St.
LEEDS 3: 66, Kirkstall Rd.
GLASGOW C.2: 113, West Regent St.

JIM.12.35

BIRLEC **Detroit**

# ROCKING ELECTRIC ARC FURNACE

## FOR BRASS MELTING



Messrs. SHANKS & CO. LTD. GLASGOW have installed the 350 lb. capacity BIRLEC-DETROIT ROCKING ARC FURNACE illustrated, for producing High Quality Castings for Sanitary and Water Fittings in various alloys, including BRASS, GUNMETAL AND NICKEL SILVER.

Features of the BIRLEC-DETROIT furnace are the uniform high quality of the metal produced, the short melting time, accurate control of analysis and thorough mixing of the molten baths. It would pay YOU to investigate these facts.

**BIRMINGHAM ELECTRIC FURNACES LTD.**
**ERDINGTON BIRMINGHAM**

**STRONG**

**DURALUMIN**
(REG. TRADE MARK)
**D 2 ALLOY**

MG
REGISTERED TRADE MARK

**ELEKTRON, etc.**
(REG. TRADE MARK)

**LIGHT**

**IN TUBES, ROLLED METALS, EXTRUDED BARS, WIRE, Etc.**

*For all purposes where strength with lightness is essential.*

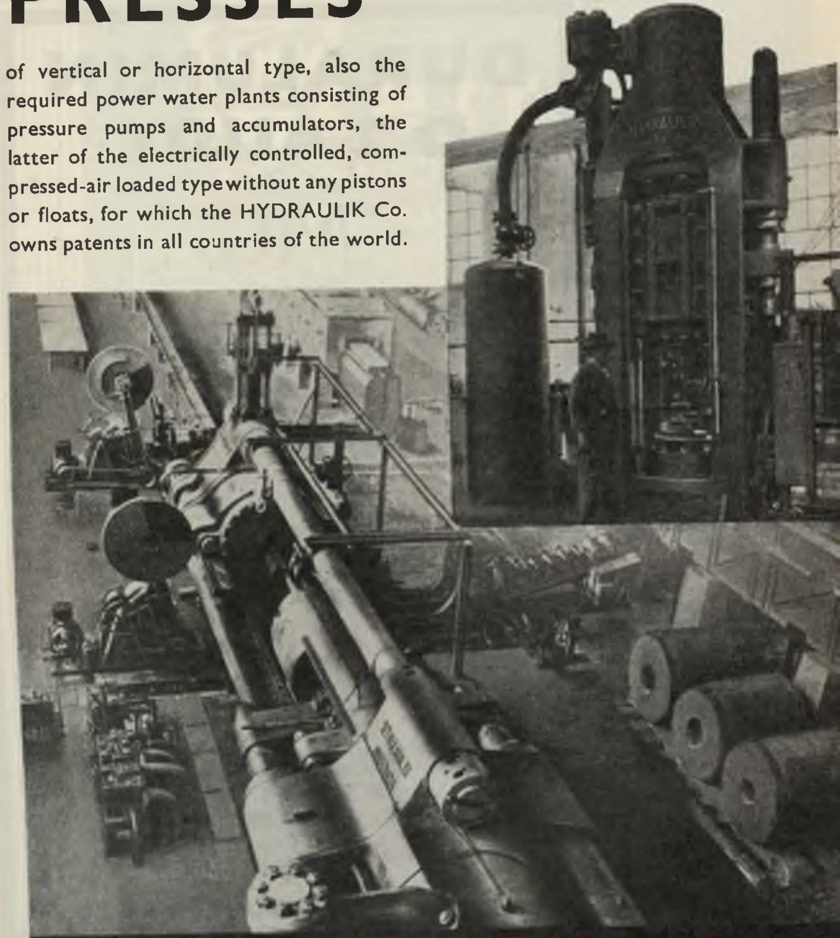
**JAMES BOOTH & COMPANY**
(1915) LIMITED.
**ARGYLE STREET WORKS, BIRMINGHAM, 7.**
*Telephone: EAST 1221 (Pte. Bch. Ex.). Telegrams: "Booth, Birmingham."*
*Codes: A.B.C. 5th & 6th Ed. Liebers 5 Letter, Bentley's Second Phrase.*
*Western Union*

**ALLOYS**

*For the economical production of tubes with absolutely uniform wall thickness we supply*

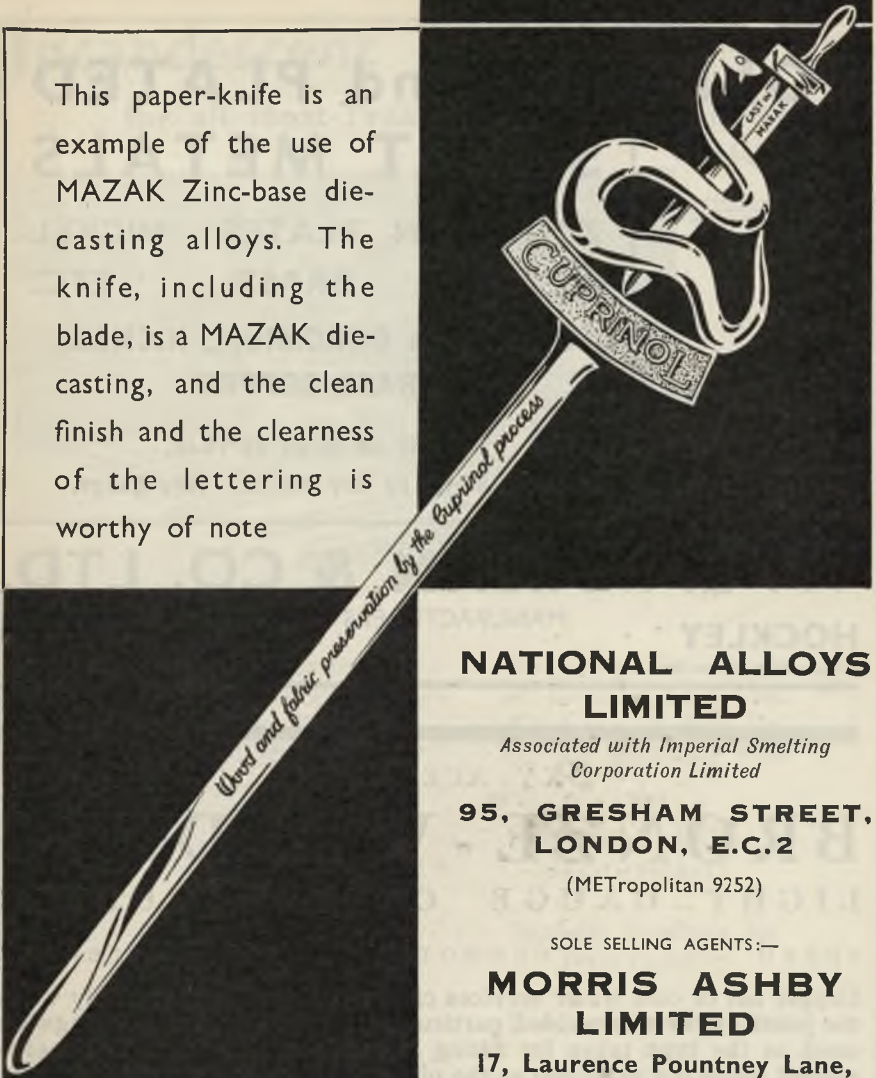
TUBE EXTRUSION PRESSES

of vertical or horizontal type, also the required power water plants consisting of pressure pumps and accumulators, the latter of the electrically controlled, compressed-air loaded type without any pistons or floats, for which the HYDRAULIK Co. owns patents in all countries of the world.



HYDRAULIK
G·M·B·H·
DUISBURG

British Agents: Aabacas Engineering Co., Ltd., 10 Canning Place, Liverpool,



This paper-knife is an example of the use of MAZAK Zinc-base die-casting alloys. The knife, including the blade, is a MAZAK die-casting, and the clean finish and the clearness of the lettering is worthy of note

**NATIONAL ALLOYS LIMITED**

*Associated with Imperial Smelting Corporation Limited*

**95, GRESHAM STREET,**
**LONDON, E.C.2**
(METropolitan 9252)

SOLE SELLING AGENTS:—

**MORRIS ASHBY LIMITED**

**17, Laurence Pountney Lane,**
**London, E.C.4**
(MANsion House 8383 'Grams: ASHBY, LONDON)

# 'MAZAK'

**REG. TRADE MARK** **FORMULÆ PATENTED**

**POLISHED and PLATED SHEET METALS**

**ZINC, TIN PLATES, NICKEL SILVER, BRASS, ETC.**

**Plated with CHROMIUM, NICKEL, BRASS, COPPER**

**Sheets up to 84 by 18 in.**
**Strips 84 in. by any width. Any gauge.**

*Please send us your enquiries:*

**W. E. MARTIN & CO. LTD.**
MANUFACTURERS
**HOCKLEY** **BIRMINGHAM, 19**
Telephone: Northern 2961-2. Telegrams: BEEZEDD, B'HAM.

OXY-ACETYLENE

BRONZE-WELDING

LIGHT GAUGE COPPER TUBING

speed . . . . economy . . . . strength

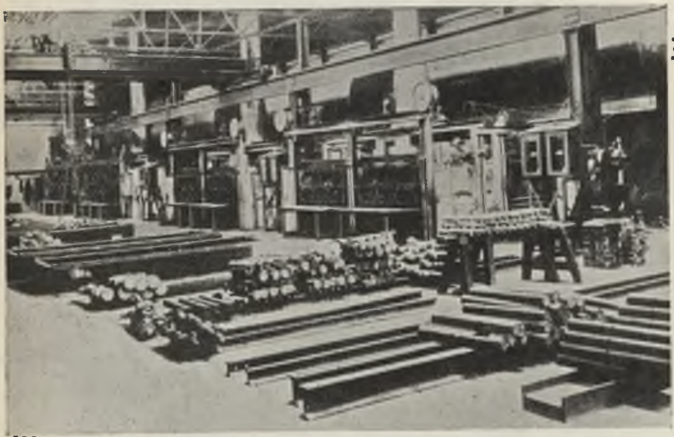
**Copper hot or cold water services can be installed more quickly when the joints are bronze-welded, particularly if weldable copper fittings are used, as the time taken for fitting is considerably reduced. Bronze-welded joints are as strong as the pipe-wall itself, and there is less risk of unequal expansion in the event of freezing. Bronze-welding is definitely cheaper. On a recent contract for nearly 1000 houses it was estimated that almost £1 per house was saved as compared with the cost of compression fittings.**

The BRITISH OXYGEN Co. LTD

**HEAD OFFICES: VICTORIA STATION HOUSE, WESTMINSTER, S.W.1**
42 FACTORIES IN GREAT BRITAIN, IRELAND, AND 21 IN AUSTRALIA, SOUTH AFRICA, AND INDIA
1002/CW

# Incandescent Furnaces

**for all Heat-Treatment Purposes** and for all Industries



Above is a Battery of Patent Incandescent Twin-Chambered, Coal-Fired Furnaces installed for the heat-treatment of the crankshafts of various well-known motor cars.

*We supply Furnaces for all Industries, Coal, Coke, Town's Gas, Producer Gas, Oil and Electrically Fired*

also

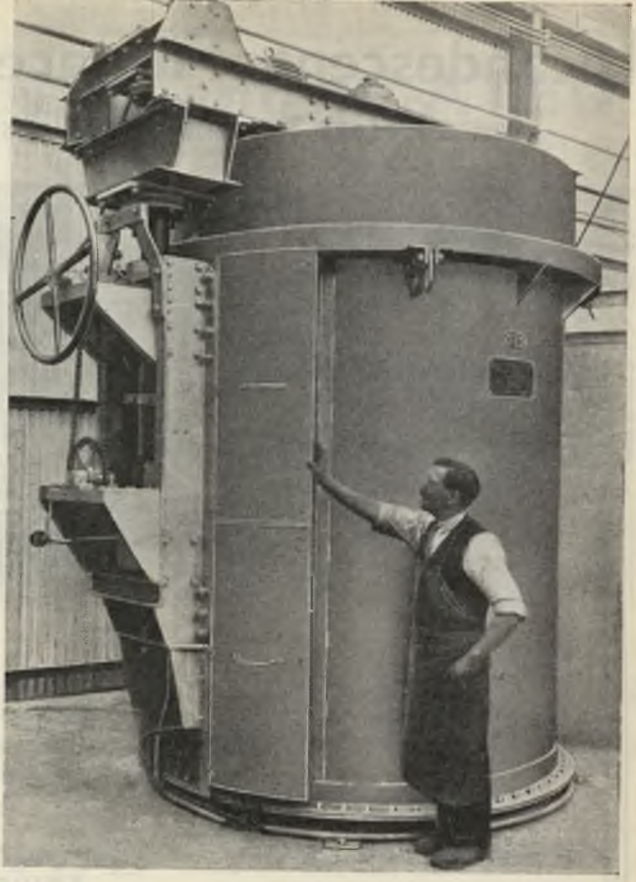
PYROMETRIC EQUIPMENT

Separate Brochure for every Industry

*Your enquiries are invited.*

**INCANDESCENT**
**HEAT COMPANY LIMITED**
**CORNWALL ROAD SMETHWICK**
**BIRMINGHAM**

Telephone: Smethwick 0875–7. Telegrams: 'Repeat,' Birmingham.



EFCO

*Large* **'EFCO'** *cylindrical type furnace with forced air circulation for the heat treatment of light alloy castings.*

*By courtesy of Messrs. J. Stone & Co. Ltd., Deptford.*

# EFCO

## FURNACES WITH FORCED AIR CIRCULATION FOR LOW TEMPERATURE HEAT TREATMENT

**ELECTRIC RESISTANCE FURNACE CO. LTD.**

17 VICTORIA STREET, LONDON, S.W.1

PHONE, ABBEY 4171 (5 lines) GRAMS, ELECTRIFUR, PHONE, LONDON

*Lindum*

# COLD ROLLING MILLS

Metal sheets and strip are rolled on such four-high mills. Each of the two housing screws is adjusted by a separate motor, an electro-magnetic coupling ensuring the synchronous running of both motors. The motors are controlled by push-buttons. The main driving motor is controlled by a master-switch mounted on the roll-housing.

MADE IN ENGLAND

For further particulars apply to

BROOKES (OLDBURY) LTD., OLDBURY near BIRMINGHAM

*Just published* *An important new book and edition*

**GENERAL FOUNDRY PRACTICE**

**By A. M'WILLIAM, A.R.S.M., D.Met., and PERCY LONGMUIR, D.Met., M.B.E.**

Giving a condensed and crystallised account of the science and practice of iron, steel, and brass founding. For designers, metallurgists, foundry managers and foremen. Also of great value to moulders. This, the Fourth Edition, now appears after complete revision and much re-writing by Dr. Percy Longmuir. New matter has been added on modern developments in this country and abroad, and everywhere the actual experience of current foundry practice is evident.

In Medium 8vo. Cloth. viii + 457 pages. With two Frontispieces and 303 illustrations. **21/- net.**

"*It represents ably, first-class modern practice from a really practical standpoint.*" *Iron and Coal Works Review* (on previous edition).

**ELECTRIC MELTING PRACTICE**

**By A. ROBIETTE, B.Sc. (Hons. Met.).**

A full and detailed treatise on a modern aspect of metallurgical engineering, dealing exhaustively with metallurgical practice and covering the Arc, Low Frequency, Coreless Induction, Resistor and all other types of furnace, in manufacture and remelting of steel, iron and non-ferrous metals. The question of furnace atmospheres is fully considered; and Iron-smelting and Ferro-Alloy work are dealt with.

In Medium 8vo. Cloth. viii + 324 pages. With 87 illustrations, including three Folding Plates. **15/- net.**

"*A wealth of useful information . . . should prove invaluable to all directly associated with the manufacture of metal and alloys.*"—*Metallurgia.*

*Postage extra. Send for prospectuses.*

**CHAS. GRIFFIN & Co., Ltd., 42 Drury Lane, London, W.C.2**

## a new service to members

Members who find it inconvenient to bring to the General Meetings copies of the Monthly Journal containing the papers to be discussed, may now purchase one loose copy of each paper. Orders, which must be for one whole year in advance, should be sent to the Secretary without delay. The service commenced with the Autumn Meeting, 1935, papers.

Annual charge 5s., post free.

HIDUMINIUM
ALLOYS
SPECIFIC GRAVITY 2·73

H D A

FOR STRENGTH WITH LIGHTNESS
HIGH DUTY ALLOYS LTD.
SLOUGH

T.S.G.

● Bring your reference library up to date . . .

A copy of our new Catalogue with details of Britain's finest Precision Balances and Weights gladly sent free on request to any industrial or educational laboratory. Please state whether interested in Chemical Balances, Assay Balances, or both.

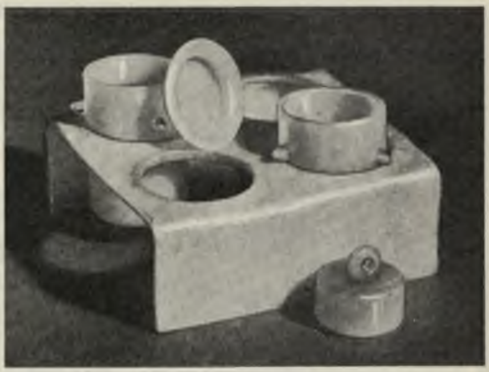
Oertling

Founded in London, 1849.

L. OERTLING Ltd., 65 HOLBORN VIADUCT, LONDON, E.C.1

TAS/On. 123

HEAT & ACID PROOF LABORATORY APPARATUS



VITREOSIL is specified for apparatus required in fuel analysis because it is heat proof. It is also acid resistant at all temperatures and therefore ideal for many other purposes in the laboratory.

**VITREOSIL**

**(Pure Fused Quartz and Silica)**

**THE THERMAL SYNDICATE LTD.**

**Vitreosil Works, Wallsend-on-Tyne**

Established over quarter of a century

**London depot : Thermal House, Old Pye Street, S.W.1**

---

STERLING METALS LTD

TROLLEY BUS MOTOR
END HOUSING

SAND AND
DIE CASTINGS
IN
ELEKTRON
REG NO 529678
MAGNESIUM ALLOYS

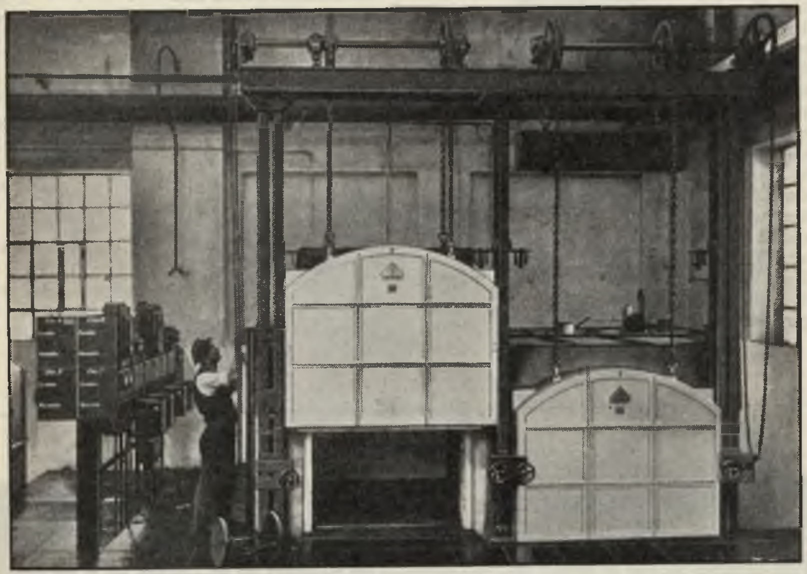
Telephones:
COVENTRY 8035
(3 Lines)

COVENTRY

Telegrams:
STERMET PHONE
COVENTRY

T.G.S.

# ELECTRIC FURNACES



Two electric hardening furnaces with nickel-chromium elements, 120 Kw. each, 950° C.

- Exact Heat Control
- High Efficiency
- Small Heat Capacity
- Simple Operation

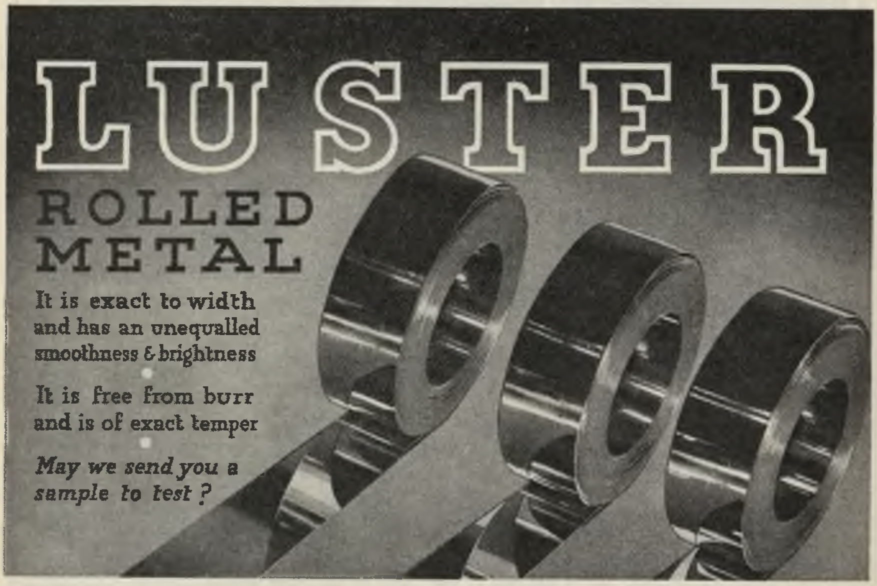
**SIEMENS**

Advt. of Messrs. Siemens-Schuckert (Gt. Britain) Ltd., 30/34 New Bridge St., London, E.C.4

# INDEX TO ADVERTISERS

## DECEMBER, 1935

---



**J. F. RATCLIFF (METALS) LTD.,** NEW SUMMER STREET, **BIRMINGHAM**

*Why the new industries—*

**TELEVISION, PLASTICS,**

**AVIATION—**

*have chosen*

1 Gas is cheap—not only on actual cost, but also because it eliminates fuel and ash handling and storage space, and reduces supervision to a minimum.

2 Gas is easily and accurately controlled. The required temperature can be reached in a shorter space of time, and held more accurately than by any other fuel.

3 **Gas never fails—**

GAS IS THE CHEAPEST CONTROLLED HEAT

The Gas Industry is anxious to help you to apply gas to your processes conveniently and economically. Write to—

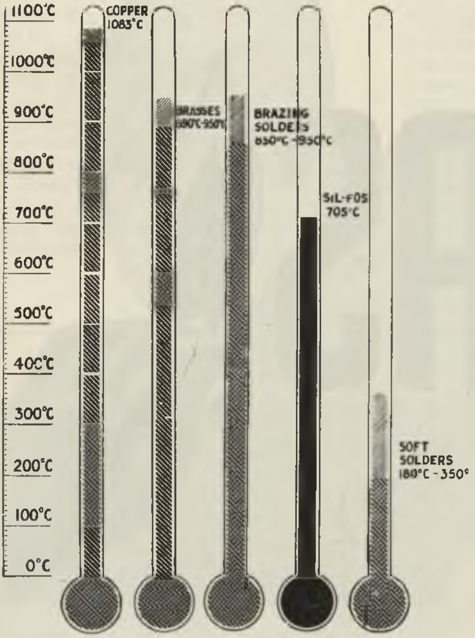
THE BRITISH COMMERCIAL GAS ASSOCIATION, 28 *Grosvenor Gardens, London, S.W.1*

*The importance of the*

MELTING POINTS

OF

BRAZING ALLOYS



The melting point of any jointing alloy is of vital importance.

If it is too high there is danger of melting the metal being brazed.

If it is too low the alloy will not withstand the temperatures and stresses which are involved in many manufacturing processes.

The melting point of Sil-fos has been adjusted to provide an ample margin of safety for use on copper, brass, and bronze.

Although melting at lower temperature, the strength of Sil-fos is equal to or greater than that of other brazing solders and welding rods.

Write for Booklet No. 90, which describes Sil-fos for use on copper, brass, and bronze, and Booklet No. 92, which describes other Matthey Jointing Alloys for use on brass, bronze, copper, nickel alloys, steel, stainless steel, and other metals.

**JOHNSON, MATTHEY & Co., LIMITED**

71/73, VITTORIA ST. BIRMINGHAM.I 73/83, HATTON GARDEN, LONDON E.C.I 38, BATH ST GLASGOW, C.2

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

TELEPHONE:
Victoria 2320.

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

# THE *Monthly Journal of the* INSTITUTE OF METALS

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

BIBLIOTEKA
Gliwice

**Volume 2** **DECEMBER, 1935** **Part 12**

## CONTENTS

### METALLURGICAL ABSTRACTS

---

The monthly issue of *Metallurgical Abstracts* may be cut up for card indexes, as members will receive early in 1936 the year's abstracts in bound form.

ALUMINIUM AND COPPER ALLOYS
TPJ
BRAND

NON-FERROUS ALLOYS

*are unequalled for*

CONSISTENT QUALITY

*and are produced in*

NOTCHED BARS, INGOTS, ROLLING SLABS
WIRE BARS, STICKS and SHOT

*to*

ADMIRALTY, A.I.D., B.E.S.A. and all Standard Specifications

*Particular attention is drawn to our*

STANDARDIZED ALUMINIUM ALLOYS fo
SAND-CASTINGS, GRAVITY and PRESSUR
DIE-CASTINGS and SPECIAL HIGH-TENSIL
ALLOYS for AIRCRAFT and ADMIRALTY WOR

**T.J. PRIESTMAN Ltd**

CONTRACTORS TO THE ADMIRALTY
AND PRINCIPAL RAILWAY COMPANIES

CUPRO FOUNDR
LEOPOLD STREE
BIRMINGHAM 1

PHONE. VICTORIA 2581-2-3 GRAMS. SPECIFIC BIRMING

# SCOPE OF INSTITUTE'S PUBLICATIONS

THE Council has felt for some time the desirability of widening the field covered by papers published in the *Journal*. Although the Institute has always been glad to publish papers of a more general kind, in practice nearly all the papers presented have reported the results of original research. Whilst it is intended that this class of matter should still form the greater part of our *Journal*, the Council wishes to encourage, in addition, papers covering a wider field, and will therefore be glad to consider for publication papers in any of the undermentioned classes :

(*a*) Papers recording the results of original research;

(*b*) First-class reviews of, or accounts of, progress in a particular field;

(*c*) Papers descriptive of works' methods, or recent developments in metallurgical plant and practice.

The Council also intends, when opportunity offers, to organize General Discussions on particular subjects, to which contributions may be specially invited. The first of these will take place on the evening of Tuesday, March 10, preceding the March Meeting. The subject will be **"Metallic Wear,"** and will be opened by Dr. H. W. Brownsdon, Member of Council. Members of allied societies are being invited to join in the discussion, particulars of which are given on p. 529.

In order to make more space available for these various classes of matter the Council is anxious to condense so far as possible reports of discussions, both oral and written. Members who take part in an oral discussion are urged to submit a *résumé* of their contribution to the Editor whenever possible, as this can frequently be made more concise than the shorthand writer's report.

# NEW INSTITUTE PUBLICATIONS

## In *Journal,* Volume LVII

## (No. 2, 1935)

The attention of members is directed to the fact that the next bound volume of the *Journal* will contain two contributions that have not appeared in the *Monthly Journal.*

One of these is entitled :

### The Structure of Metals and Alloys

By

W. HUME-ROTHERY, M.A., Ph.D.
Member.

This is the first of a series of reviews that the Council hopes to publish from time to time. Each review is the invited work of a specialist in a particular field.

Another important contribution is a

### Bibliography of the Literature Relating to Alloy Constitutional Diagrams

Compiled by

J. L. HAUGHTON, D.Sc.
Member of Council.

Both these publications will subsequently be on sale in pamphlet form.

# INSTITUTE NEWS AND ANNOUNCEMENTS

### Annual General Meeting.

The Twenty-Eighth Annual General Meeting of the Institute will be held from Tuesday, March 10, to Thursday, March 12, 1936, at Storey's Gate, Westminster, London, S.W.1, in the Hall of the Institution of Mechanical Engineers, which has been kindly placed at the disposal of the Institute by the Council of the Institution of Mechanical Engineers.

### General Discussion on "Metallic Wear."

The meeting will begin at 7.30 p.m. on Tuesday evening, March 10, with a General Discussion on **"Metallic Wear,"** which will be opened with a paper by Dr. H. W. Brownsdon, Member of Council.

This paper, which is printed in the present issue of the *Monthly Journal*, reviews some of the major factors involved in metallic wear and indicates a method by which they can be quantitatively assessed. The problems involved interest not only engineers, but chemists, physicists, and metallurgists, and it is hoped that these special aspects of the subject will be dealt with by contributors to the discussion. It is particularly desired that the discussion should not be restricted to the detailed observations made in the opening paper, but that it should be on a much wider basis, provided that it is limited to metallic wear in the presence of lubricants. The subject is one of wide interest and members of other institutions are being invited to attend the meeting and to participate in the General Discussion.

### Papers, Dinner, and Visits.

On Wednesday morning, March 11, official business will be transacted, including the induction into the Chair of the new President. Afterwards papers will be discussed, the meeting continuing during the afternoon. In the evening the Annual Dinner and Dance will be held at the Trocadero Restaurant.

On Thursday papers will be discussed during the morning, and in the afternoon visits will be paid to Broadcasting House, two Fleet Street newspaper offices, the Fuel Research Station at East Greenwich, and Greenwich Observatory.

The Council hopes that in view of the additional features that are being arranged in connection with the March Meeting there will be an unusually good attendance of members and visitors.

### May Lecture, 1936.

Mr. C. C. Paterson, O.B.E. (Member), Director of Research, The General Electric Company Limited, Wembley, has accepted the Council's invitation to deliver the 1936 May Lecture. Mr. Paterson will deal with the effect on electrical engineering of the liberation of the electron from metal conductors and controlling it in its freed state. In connection with the lecture there will be experimental demonstrations.

By the courtesy of the Council of the Institution of Mechanical Engineers the lecture will be delivered in the Hall of that Institution on the evening of Wednesday, May 6.

### Autumn Meeting in Paris.

The Council has accepted an invitation given by the Bureau International des Applications de l'Aluminium, with the cordial cooperation of the Chambre Syndicale des Métaux à Paris, to hold the 1936 Autumn Meeting in Paris from September 14 to 18. This will be the first occasion on which the Institute has met in France, and it is expected that there will be a large gathering of members from all parts of the world. Full particulars of the meeting will be announced in the *Monthly Journal* and in circular letters to be issued to members.

### Membership Additions.

The following was elected on December 13, 1934:

*As Member.*

RENTON, Gilbert, Rabaul, Territory of New Guinea.

The following were elected on December 12, 1935:

*As Members.*

Calderara, Colonel Attilio, London.
Edmundson, J. H., Napier, New Zealand.
Gibson, Commander Cuthbert Walter Sumner, R.N., London.
Glen, Manwell Alexander Burns, M.C., Drinska Banovina, Jugoslavia.
Kennett, Stanley John, Ph.D., A.R.S.M., Liverpool.
Klare, Fritz Alfred, London.
McConway, John, Hebburn-on-Tyne.
McCormick, John Thomas, M.Sc., Maribyrnong, Victoria, Australia.
Mishima, Professor Tokushici, D.Eng., Tokyo, Japan.
Panseri, Carlo, Dr.-Ing., Milano, Italy.
Price, George Henry Stuart, B.Sc., London.
Price, Ralph A., B.S., Chicago, Ill., U.S.A.
Ronaasen, Knut, B.Sc., N'kana, Northern Rhodesia.
Scattergood, Harry Gopsil, Birmingham.
Skript, George, Stoke Green.
Stevenson, Earl P., M.A., Cambridge, Mass., U.S.A.
Stockmeyer, Friedrich Wilhelm, Dipl.-Ing., Stuttgart, Germany.
Todd, George E., Cincinnati, O., U.S.A.
Wimpenny, Leonard, Widnes.
Wright, Albert, London.
Yoshioka, Vice-Admiral Yasusada, Kobe, Japan.

*As Student Members.*

Bull, Arthur Ramsay, Birmingham.
Gittins, M. G., Birmingham.
Hughes, John Richard, B.Sc., Birmingham.
Meats, Peter Annber Harold, B.A., Leicester.
Slator, Richard Henry, B.A., Bristol.
Tseng, Jun Chen, B.Sc., London.

### Bicentenary of the Birth of James Watt.

Members are invited to be present at the afternoon service in Westminster Abbey on Sunday, January 19, at the conclusion of which a wreath will be placed on the statue of James Watt, in commemoration of the bicentenary of his birth. The service will be attended by the Presidents and members of the leading engineering societies in London. Places will be reserved for the Presidents, and a limited number of seats will be set aside for members of institutions. The Secretary of the Institute should be notified by members who desire to be present at the service, which begins at 2.30 p.m.

### Empire Exhibition: South Africa, 1936.

From September to December, 1936, a South African Exhibition, which will include displays from all parts of the British Empire, will be held in Johannesburg. The Council of the Chemical, Metallurgical, and Mining Society of South Africa extends a welcome to members of the Institute of Metals to attend the Exhibition and to participate in the facilities that are being accorded to visitors by the Associated Scientific and Technical Societies of South Africa, including Honorary Membership of the Club House of the societies during the visitors' stay in Johannesburg. At the Club House visitors will be able to obtain information as to places of technical interest in the Union of South Africa, and introductions to local members of their respective professions, whilst visits will be arranged by the Associated Societies to places of mining, industrial, or general scientific interest. In general, it is proposed that all visitors from overseas Institutes and Societies should regard Kelvin House as their headquarters during their stay in Johannesburg.

Information regarding special travelling arrangements, and the facilities to be provided in Johannesburg, as well as a booklet dealing with the Empire Exhibition, are obtainable from the London Secretary, South African Exhibition, 21 Tothill Street, Westminster, London, S.W.1.

### Annual Supper-Dance.

The second Supper-Dance was successfully held on November 27 at Thames House, London, S.W.1. It was again organized by the London Local Section of the Institute (with the co-operation of the Council) and attracted an attendance of over 170 members, associates, and friends. In view of the increased number of persons present—as compared with last year's function—it would appear that the Supper-Dance is likely to become a regular event in the Institute's calendar.

### Christmas Holidays.

The offices and library of the Institute will be closed at 5 p.m. on Christmas Eve and will re-open at 9.30 a.m. on Monday, December 30.

## PERSONAL NOTES

MR. J. E. CHARD, B.Sc., A.R.S.M., has received his Associateship of the Institute of Chemistry.

MR. A. LOGAN, for more than 17 years Chief Chemist and Metallurgist with Messrs. R. &. W. Hawthorn, Leslie & Company, Ltd., has been appointed to a similar position with Messrs. The Light Production Company, Ltd., Slough. Mr. Logan commenced his new duties in October.

MR. J. MCNEIL, A.R.T.C., formerly Honorary Secretary of the London Local Section, has left for India to take up the post of Assistant Works Manager at the Metal and Steel Factory, Ichapur. Mr. McNeil's address is: The Park, Ichapur-Nawalsgaris, Bengal, India.

MR. W. MURRAY MORRISON was presented with his portrait, and an illuminated album containing signatures of his colleagues and friends, on November 26, to mark the completion of forty years with the British Aluminium Company, Limited, of which he is the Vice-Chairman. The presentation was made by the Chairman of the Company, Major R. W. Cooper. Mr. Murray Morrison is an Original Member of the Institute and a former Vice-President.

PROFESSOR A. PORTEVIN has been awarded the honorary degree of Doctor of the Ecole Supérieure des Mines de Přibram. This honour has been conferred for the first time on a person not of Czechoslovakian nationality. It was presented with the traditional rites of the college on October 13, at the Institute de Soudure Autogène, by Professor Dr. A. Glazunov, Professor Ing. Parma, and Professor Ing. Marik—who came specially from Přibram—in the presence of representatives of the Czechoslovakian Legation, of the Ministers for Public Education and for Foreign Affaires, and of numerous friends, professors, and metallurgists.

MR. S. M. PUDDEPHAT has been apointed Assistant Chemist to the Straits Trading Company, Pulo Brani, Singapore, Straits Settlements.

DR. B. D. SAKLATWALLA has opened offices in the Gulf Building, Pittsburgh, Pa., U.S.A., for an Industrial Development Organization which, besides serving the metallurgical and chemical industries in a consulting and advisory capacity, will undertake development and exploitation of new steels, alloys, and other technical products for specific requirements.

MR. JEROME STRAUSS, M.E., has been elected Vice-President in charge of Research and Development, of the Vanadium Corporation of America, with offices at Bridgeville, Pa., U.S.A.

DIPL.-ING. F. V. WURSTEMBERGER, consulting engineer, of Zürich, would be glad to hear (through the Editor), of any opening in England for his son who is just finishing his training as a mechanical engineer at the Zürich Technische Hochschule. The young man has not specialized, though he has studied steam turbines, gas- and Diesel-engines, water turbines, and textile machinery. He desires to continue his studies in an engineering works, to perfect his knowledge of English, and to "become familiar with English home life and culture."

# LOCAL SECTIONS NEWS

## SYNOPSES OF PAPERS TO BE READ AT COMING MEETINGS*

### London Section.

**Metals of the Platinum Group.** By R. H. Atkinson, M.A. (*January* 9.)

The lecture will deal with the history of the platinum metals, their occurrence, metallurgy, and uses. Reference will be made to the extensive primary deposits of platinum metals which were discovered in South Africa after 1920. A brief account will be given of the metallurgical treatment of the Sudbury nickel ores, including mention of operations at the Clydach plant of the Mond Nickel Company, in order to show how the precious metal concentrates are obtained. The extraction and refining of platinum metals from these concentrates at the Acton Refinery will then be discussed.

Interesting points in connection with the history of the fashioning and uses of platinum will be mentioned. For example, after being used for a century for the purpose of concentrating pure acids, platinum was rapidly replaced by vitreosil. Fortunately for the platinum industry, a demand then arose for platinum for jewellery as the metal provides an ideal setting for precious stones. Throughout the history of platinum, as one use has disappeared, other uses have been discovered.

Finally the author will review the present uses of platinum metals, including a survey of jewellery, dental, chemical, electrical, and miscellaneous uses.

The lecture will be illustrated by lantern slides.

### Manchester Metallurgical Society.

**Recent Developments in Alloy Steels.** By J. H. G. Monypenny. (*January* 15.)

Developments in alloy steels have proceeded from many causes; the latter may be divided, however, very broadly into two categories: those concerned with producing :

(*a*) properties at least as good as those found in existing steels but at a cheaper cost;
(*b*) unproved properties, or even a new order of properties not previously deemed possible.

These two underlying causes have had such wide ramifications that it is only possible to deal, even briefly, in a lecture with certain selected examples; these may be taken, however, as typical of present-day tendencies.

Cheapened production may be illustrated by considering steels, generally of high tensile strength, used in the automobile and aeronautical industries and also, to an increasing extent, for other engineering constructions. The low alloy steels, *e.g.* manganese–molybdenum, chromium–molybdenum, and other similar types, may be taken as typical of these.

As regards improved properties, instances may be given from among the various steels used for parts subjected to high steam temperatures or those having sufficient resistance to oxidation and stress to function satisfactorily at still higher temperatures than these. Corrosion-resisting steels provide another field, particularly in regard to the progress achieved in combating intergranular corrosion in austenitic steels and in producing modified types of the familiar 18–8 chromium–nickel steels which have greater resistance to severe corrosive attack than the latter.

### North-East Coast Section.

**Hot Pressings in Brass and Other Metals.** By J. Willis Beard. (*January* 14.)

The hot-pressing industry has developed in distinct stages. The first phase was that of providing an alternative to castings. The second stage

---

* For places and times of meetings the green folder programmes already issued should be consulted.

saw the more accurate production—by way of pressings—of the desired part, thus reducing the amount of metal scrapped, lightening of the parts, and providing for more economic production by means of semi-automatics and quick gripping fixtures. With the advent of the fully automatic machine came the third big change, *viz.* that of extreme accuracy, combined with the production of parts of more complicated design.

During these changes, very big advances have been made in the quality and capabilities of the die steels, and in the presses and other machinery employed; but it has almost been taken for granted that brass would remain the chief medium of pressings. The next stage in these phases of economic progression, is that of a change in metals. The author will show the result of recent experiments made to prove the possibility of producing non-ferrous pressings from an alloy that has the good features of brass but is approximately 25 per cent. cheaper; alternatively he will explain how it is now possible to make pressings of metals which were considered usable only in the form of castings.

## Sheffield Section.

**Gases and Metals.** By C. J. Smithells, M.C., D.Sc. (*January* 17.)

There are three different aspects of the relations between gases and metals which have been the subject of study in recent years. These are the adsorption of gases on metal surfaces, the diffusion of gases through metals, and the solubility of gases in metals. These three phenomena are very closely related, but have attracted the attention of rather different groups of workers. In the present paper attention is directed to the importance of each of these subjects, the bearing they have on each other and on our knowledge of the equilibria between gases and metals.

## Scottish Section.

**Fatigue in Relation to Automobile Engineering.** By Capt. L. W. Johnson, M.C., M.Met. (*January* 13.)

(*Joint Meeting with the Institution of Automobile Engineers.*)

To provide a *résumé* of the present extent of our knowledge on fatigue, a brief general survey will be made of the types of machines available for fatigue testing, together with the effect of various physical properties, physical conditions, metallographic features, &c., on the fatigue-strength. The influence of corrosion and stress concentration will be considered more especially from the point of view of automobile engineering; reference will also be made to work which has been carried out that has had a definite practical bearing on the subject.

## Swansea Local Section.

**The Modification of Alloys.** By A. L. Norbury, D.Sc. (*January* 21.)

An historical outline will be given of work on the modification of aluminium–silicon alloys with various modifiers. The paper will deal with the modification of other non-ferrous alloys; modification of grey cast-iron with certain slags and with a metal modifier; alterations in mechanical properties on modification; previous theoretical explanation of the modification process; generalization of systems and modifiers, and a suggested theoretical explanation.

# 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.

---

## ADVANCE SUBSCRIPTION PRICE

| | |
|---|---|
| Two Volumes: Names and Subjects | 25s. post free |
| One Volume: Names or Subjects | 15s. „ „ |

---

NOTE: If sufficient orders are secured it is hoped to publish the Names Index early next year.

**PAPER No. 720.** This paper is copyright. It may be reprinted, wholly or in part, in the Press (with due acknowledgment) after a General Discussion on "Metallic Wear," to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1, on March 10, 1936, at 7.30 p.m. The Institute as a body is not responsible for the statements or opinions expressed in this paper.

# METALLIC WEAR.*

By H. W. BROWNSDON,† M.Sc., Ph.D., MEMBER OF COUNCIL.

## SYNOPSIS.

The extent to which metallic wear takes place between two metallic surfaces in frictional contact and in the presence of a lubricant is dependent on a number of factors, the relative importance of some of which are briefly reviewed in the light of experimental results obtained on a simple machine described in the paper.

WEAR is caused by friction, and problems associated with wear are frequently approached indirectly through measurement of friction, instead of directly by measurement of wear. However closely wear and friction may be associated, direct experimental methods for determining wear are not without interest, and this contribution to the General Discussion on "Metallic Wear" is based on observations made during such experiments.

The conditions necessary for the measurement of wear between two metals are simple in principle and can be brought about by causing the periphery of a moving wheel of one metal to come in frictional contact with a flat sample of another metal under known conditions of dimensions and speed of wheel, load, lubrication, temperature, and time. If these conditions can be fulfilled, the dimension of the impression made on the flat sample may be taken as a measure of wear, much in the same way as the dimension of the impression of a ball or pyramid is taken as a measure of hardness.

There is nothing new in such an idea and much experimental work has been done on similar lines, but the experimental conditions have generally been somewhat cumbersome, complicated, and unsuitable for obtaining quick results, which are of prime importance if the effects of a large number of variables are to be reviewed adequately in a reasonable time.

The conditions of simplicity of apparatus, coupled with accuracy of measurement and the obtaining of quick results, are met by a machine designed on lines sketched in Figs. 1 and 2. Fig. 3 (Plate I) is a photograph of the actual machine used in obtaining the results later referred

---

* Manuscript received November 11, 1935.

† Research Manager, I.C.I. Metals, Ltd., Witton, Birmingham.

---

**Note to Abstractors and Other Readers.**—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LVIII, 1936. Reference should accordingly be as follows: *J. Inst. Metals*, 1936, **58** (Advance copy).

to, and Fig. 4 (Plate I) gives some idea of the form of impressions made. Rapid working and accuracy of measurement are considerably facilitated by giving the periphery of the wheel a suitable radius, for if this be flat, the stationary sample must also be perfectly flat and adjusted parallel to the flat face of the wheel, otherwise a rectangular and easily measurable impression is not produced. Further, the measurement of the relatively long major axis of an oval impression made by a radiused wheel provides a much more open scale for detecting small differences than does the measurement of the much shorter length of a rectangular impression made by a flat-faced wheel under similar conditions of testing.

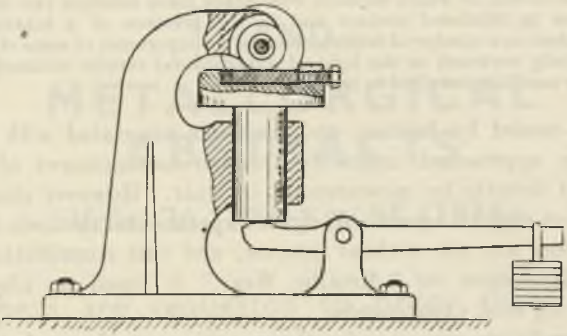


FIG. 1.

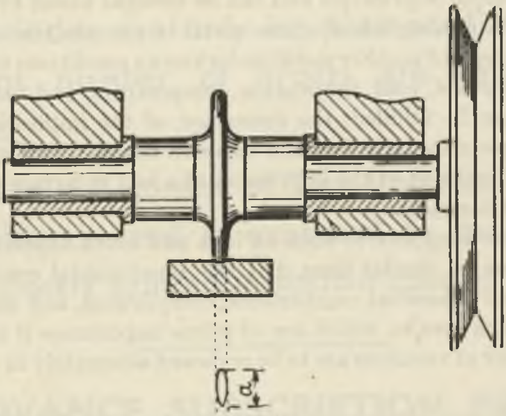


FIG. 2.

In most of the experimental work to be referred to, the wheel was of hardened steel (D.P. hardness 775), about 1 in. in diameter, 0·10 in. thick, the radius on the periphery being 0·05 in. The samples of metal tested were small flat plates about $\frac{1}{8}$ in. thick, 2 in. to 3 in. long, and

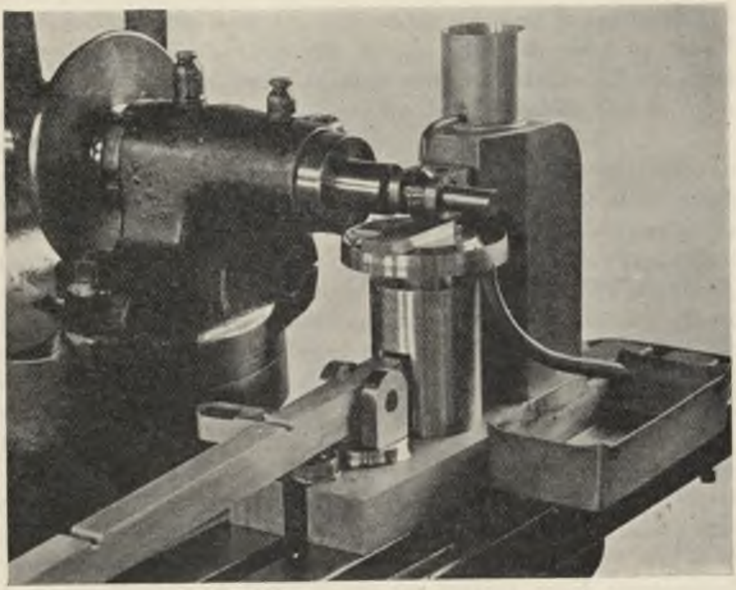


FIG. 3.

FIG. 4.

BIBLIOTEKA POLITECHNIKI ŚLĄSKIEJ

$\frac{1}{4}$ in. to $\frac{3}{4}$ in. wide, these being fixed during testing by clamping to the face of the movable table through which the load is applied. The surface finish on both wheel and sample was that given by "00" emery paper, the wheel being polished after each test. All the tests were carried out under conditions of flooded lubrication and at room temperature, generally at about 68° F.

A few preliminary experiments soon indicated that differences in the wear of different metals using the same lubricant or of the same metal using different lubricants were clearly shown by the dimensions of the impressions. It was then decided to carry out more systematic tests bearing on some of the major factors associated with wear and, while some of the results obtained confirm facts already known, others break new ground, and it is hoped that this experimental method for investigating wear and lubrication problems will help the metallurgist, chemist, physicist, and engineer in the study of their particular branches of the subject.

The author's interest in this subject arose from a desire to study die-fouling problems associated with the drawing of hollow metal products in certain non-ferrous metals, where pressures are heavy and speeds high. Experimenting on the actual drawing plant was slow and inconvenient, and some means for making rapid comparative experiments under controlled conditions in the laboratory appeared to be the only means to investigate satisfactorily the problems involved; by the aid of the machine referred to much useful information of direct bearing on the causes and prevention of die-fouling were obtained. The adhesion of the non-ferrous metal being drawn to the working surface of the steel die is akin to seizing in a bearing, and the effect of load, speed, lubrication, temperature, nature of the non-ferrous metal and that of the steel of the die, as well as surface smoothness of the die, all play some part in the phenomenon.

On testing a series of copper alloys, making the nature of the alloy the only variable, it was evident that different alloys differed considerably in the degree to which fouling of the steel wheel occurred, and that wear, as measured by the length of the impression, increased with fouling of the wheel. Some of the results obtained are shown in Fig. 5. Using a light mineral oil, Grade 40,* as lubricant, the zinc-containing alloys, brass, and nickel silver produced the most fouling or seizing on the wheel, the aluminium–bronzes fouled the wheel slightly, whilst no fouling was visible in the case of copper, tin–bronze, and cupro–nickel.

---

* Where a Grade oil is referred to in this and other graphs, the associated number refers to the Redwood Viscosity at 200° F.

The effect of wheel fouling on wear was further proved by cleaning the wheel with fine emery paper during a test on 70 : 30 brass, which reduced the wear very considerably.

Another delicate method for detecting fouling of the wheel is to run a series of, say, three 15-minute tests without cleaning the wheel after each test. If the wheel is fouling then it will be found that the length of the impression increases with each test, whereas if no fouling is taking place the length of the impression is practically constant for each individual test.

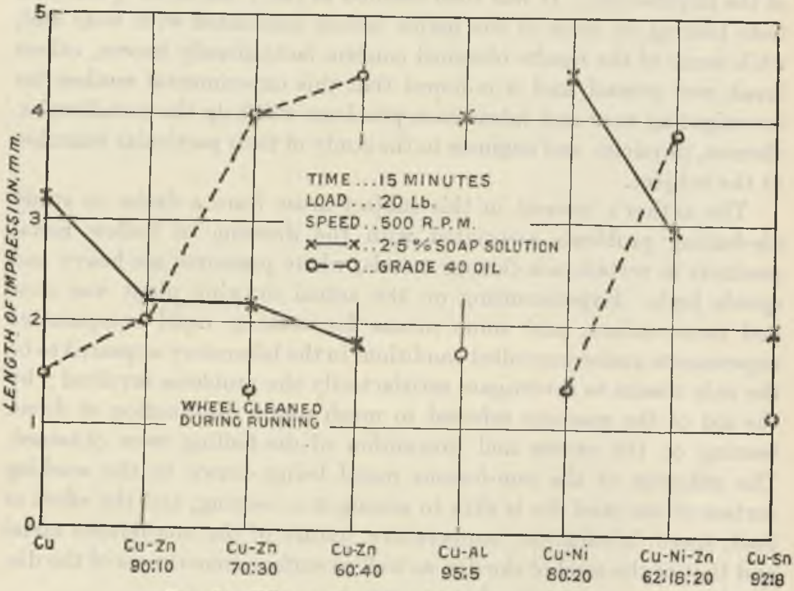


Fig. 5.—Effect of Metal and Lubricant on Wear.

As in drawing operations a soap solution is frequently used to serve both as a lubricant and coolant, a comparison was made between the wear obtained with Grade 40 oil and with a soap solution, some interesting results, also shown in Fig. 5, being obtained. Whilst copper, aluminium–bronze, and cupro–nickel gave much less wear with the mineral oil than with the soap solution, the brasses and nickel silver showed more wear. Two main points of interest emerge from a consideration of these results : (1) that the value of a lubricant as a preventative of wear may not be completely determined apart from the metals or alloys with which it is used ; and (2) that in a series of alloys, such as the brasses, wear may be influenced by composition. The latter point is shown more clearly for the brasses in Fig. 6 and further substantiated by similar tests on a series of tin–bronzes. In the case of brasses, it would appear as if the effect of zinc is not marked below 10 per cent., above which rapid increase in fouling of the wheel and resultant wear takes place, whilst for the tin–bronzes nothing is gained by increasing the tin content beyond about 6 per cent.

Fig. 6 includes some results obtained on a lead–tin–bronze containing 20 per cent. of lead and 7 per cent. of tin which indicate that the addition of lead to a tin–bronze does not improve its resistance to wear, but rather the reverse. This effect of the content of tin and lead on the wear of the tin–bronzes was confirmed at loads of 20, 5, and 1 lb., also shown in Fig. 6. Incidentally the close reproducibility of results shown by duplicate tests made on the series of tin–bronzes with the 20 lb. load and the parallel results given with the lower loads serve to illustrate the delicate nature of this test as a means for differentiating between the behaviour of different alloys.

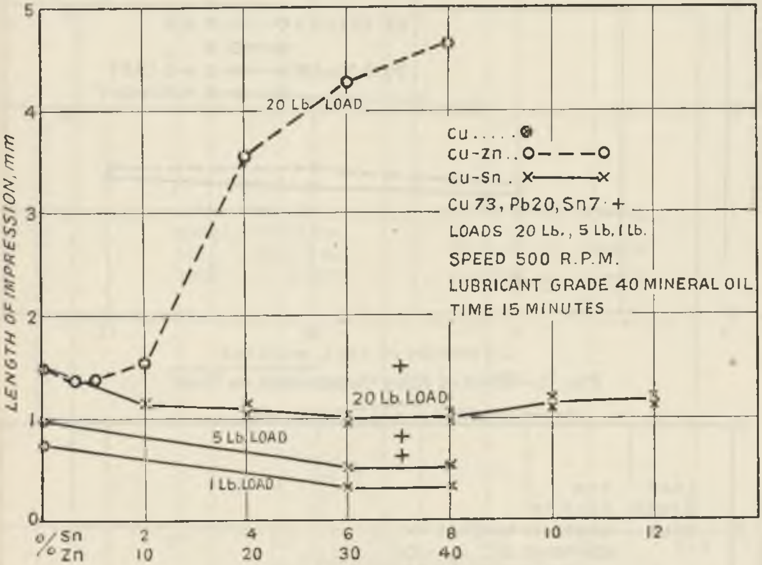


Fig. 6.—Effect of Alloy Composition and Load on Wear.

The advantages of bearing metals having a complex as against a homogeneous structure have frequently been put forward, but, in view of the results shown in Fig. 7, for a brass and a tin–bronze, there appears no justification for such a claim so far as resistance to wear is concerned. The differences in wear shown by different white metals are not so marked as is the case with copper alloys, as will be seen from Fig. 8, which shows results for three white metals.

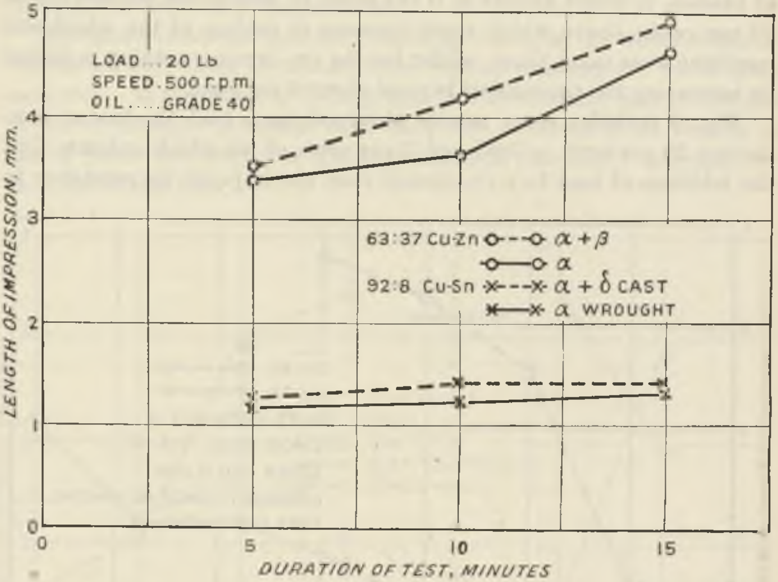


Fig. 7.—Effect of Alloy Constitution on Wear.

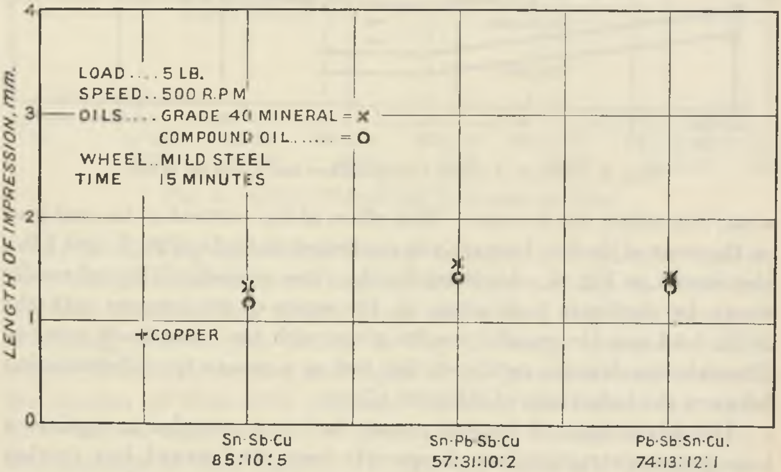


Fig. 8.—Wear of White Metals.

Before leaving the consideration of the behaviour of different alloys, the effect of their hardness on wear was investigated, and, as will be seen in Fig. 9, hardness is without effect, the data being obtained from tests on soft copper, brass, and tin–bronze rolled to different degrees of hardness.

Apart from the results given in Fig. 5 for a soap solution, the lubricant used in the foregoing experiments was a thin straight mineral oil (Grade 40) and it was to be anticipated that heavier oils would reduce wear. Results of tests made on this machine using straight mineral oils of different viscosity are given in Fig. 10, showing that increase in viscosity leads to reduced wear. The excellent lubricating properties of castor oil are shown in the same figure, the wear being somewhat less than with the mineral oil of highest viscosity.

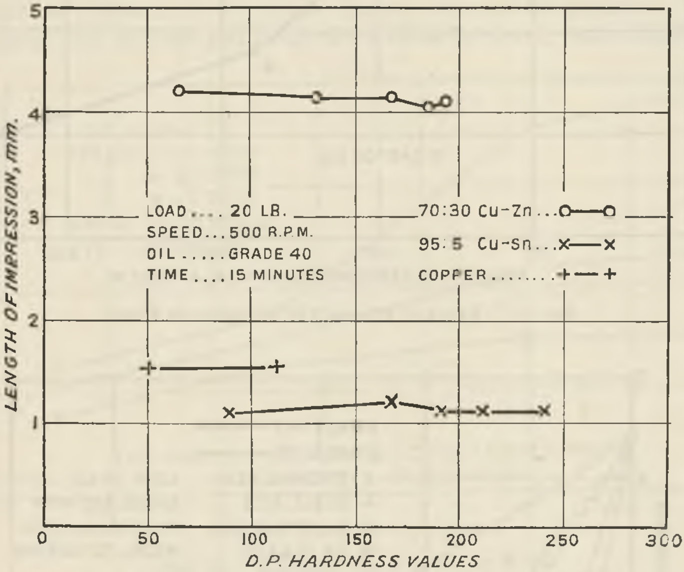


Fig. 9.—Effect of Metal Hardness on Wear.

The value of certain additions to mineral oils to improve their lubricating properties and so to reduce wear is clearly demonstrated by tests on oils of two different viscosities before and after small additions of other substances, some of the results obtained being given in Fig. 11. This experimental comparison of lubricants is facilitated by the choice of a bad wearing metal, such as brass, on which to make the tests, for this shows differences which would be less evident if a good wearing metal such as a tin–bronze were used. In the same way, differences in the wear behaviour of different metals become more apparent when using a relatively poor lubricant.

BIBLIOTEKA POLITECHNIKI

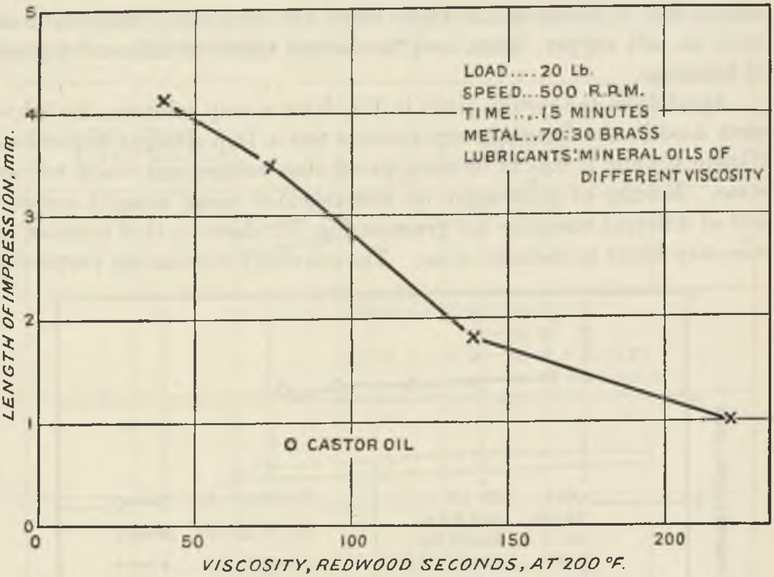


Fig. 10.—Effect of Mineral Oil Viscosity on Wear.

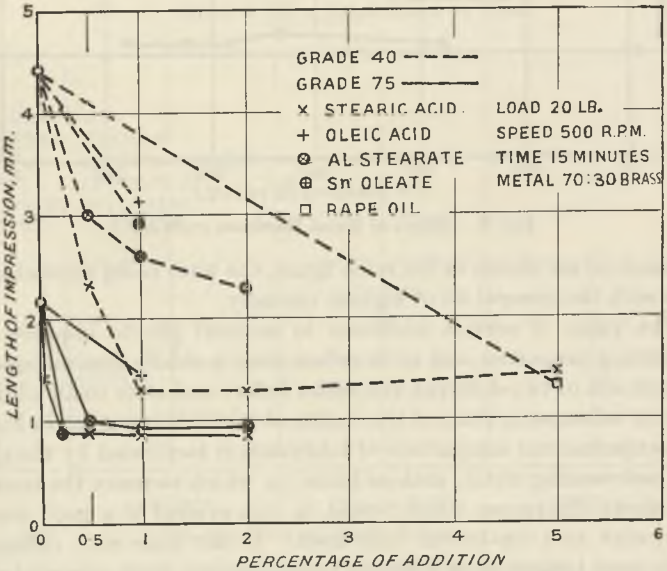


Fig. 11.—Effect of Additions to Mineral Oils on Wear.

The effect of speed of rotation of the wheel, which can easily be interpreted into feet of travel per minute, is indicated in Fig. 12, from which it would appear that whilst for any given time the higher the speed the greater is the wear, for any given number of revolutions or feet of travel the higher the speed the less is the wear.

It is recognized that the phenomenon of metallic wear is due to some degree of breakdown or lack of continuity in the film of lubricant, the more complete the breakdown the greater being the wear. This discontinuity in the film of lubricant can be shown by measuring the change in electrical resistance of the oil film during a test on this machine. With a metal such as brass and using castor oil as lubricant, under conditions which do not give rise to fouling of the wheel, curves are obtained by plotting galvanometer readings against time, as shown in Fig. 13. When at rest, metallic contact exists between the wheel and metal; when the wheel is revolved a film of oil is formed between the two surfaces and the resistance increases, the rate of increase being dependent on the load, being quicker for low loads than for higher loads, until a point of complete insulation is reached, indicating the presence of a continuous film of lubricant. It is interesting to note that the loads per unit area of the impressions at which insulation occurs are approximately the same for the 10 and 20 lb. loads.

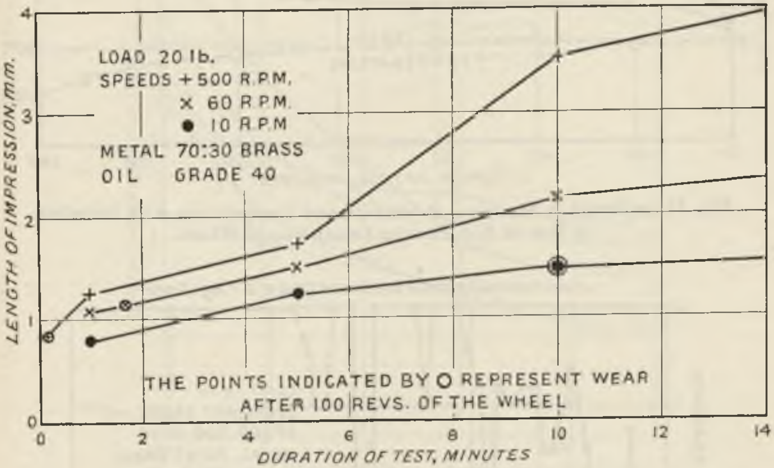


FIG. 12.—Effect of Wheel Speed on Wear.

When the wheel and sample were joined as a thermocouple, the curve shown at the bottom of Fig. 13 was obtained, indicating that as the load per unit area of impression diminished the oil film became more continuous, and the temperature due to friction gradually decreased, being at room temperature when insulation was complete.

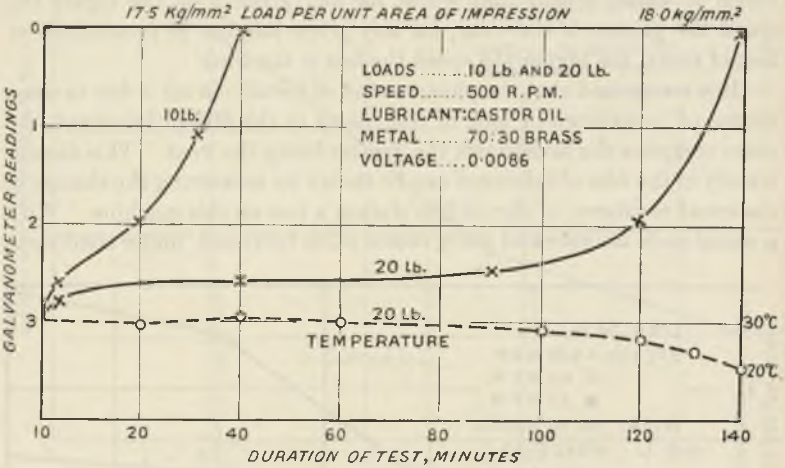


Fig. 13.—Change in Electrical Resistance and Temperature with Duration of Test in Non-Fouling Conditions of Wheel.

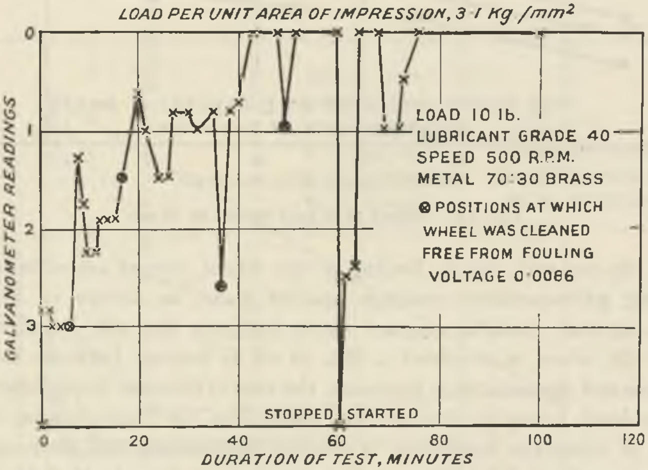


Fig. 14.—Effect of Wheel Fouling on Electrical Resistance of the Oil Film.

If the castor oil be replaced by Grade 40 mineral oil the effect of the metallic fouling produced on the steel wheel on the breakdown of the oil film at once becomes evident, as shown in Fig. 14. Instead of a gradual increase in resistance as was the case when using castor oil, frequent fluctuations occur, dependent on the more or less fouled condition of the periphery of the wheel. There is, however, a gradual increase in resistance as the load per unit area of impression becomes less, and, finally, when the impression is very large, a complete film of lubricant is formed and fouling of the wheel no longer occurs. The effect of fouling of the wheel on the continuity of the film of lubricant is also shown by the increase in resistance which follows cleaning of the wheel. The data obtained from such experiments give an insight into the degree of continuity of the oil film at different loads per unit area of bearing surface and also indicate the load at which the oil film becomes continuous.

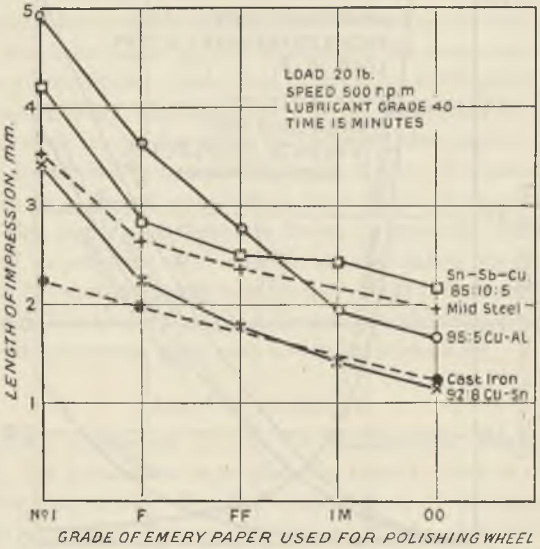


Fig. 15.—Effect of Surface Finish of Wheel on Wear.

It is evident that the results given by a machine of this type will vary with the surface condition of the periphery of the wheel, a perfectly smooth surface giving a smaller wear impression than a rougher surface. The results so far reported were obtained when using a highly polished wheel, the finish being that given by "00" emery paper; the very considerable effects of less highly polished wheel surfaces are shown in Fig. 15. Included in this figure are results obtained on a mild steel and a cast iron, which indicate that a machine of this type should prove just as useful in comparing the wear behaviour of ferrous metals as is the case with non-ferrous metals.

When the surface of the wheel becomes fouled with the metal being tested, conditions similar to that of a rough wheel arise and heavy wear naturally results.

For the sake of simplicity, the major axis of the oval impression has been made the basis for the comparative wear measurements. The area of the impression and the load per unit area are of more fundamental importance and the calculated relationships between length of impression, area, volume, and load per unit area are given in Fig. 16.

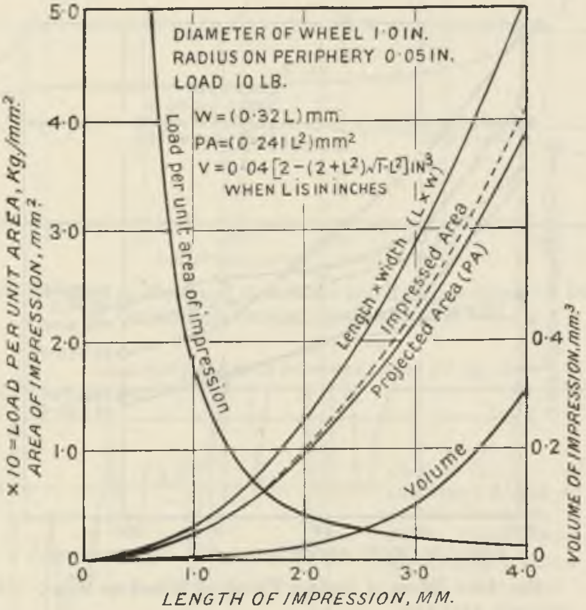


Fig. 16.—Relationship of Length of Impression to Area, Volume, and Load per Unit Area.

The strictly mathematical relationship between length and width of impression is not always obtained in practice; both length and width may be readily measured, however, and their product taken as an approximate value of the area. The fact that the load per unit area of impression diminishes as the area increases, permits observations being made over a very wide range of pressures.

In addition to the dimension of the impressions, a close examination of their appearance is of interest. Some show a slight burr, sometimes loose, sometimes tight, indicating a displacement or flow of the surface layers of metal. Microscopic examinations of the impressions, before and after etching, give useful information regarding their surface smoothness and structure.

Metallic wear occurs under such widely different conditions that any attempt to picture the relative importance of the many variable factors is difficult and the main value of this contribution to the discussion may lie perhaps in bringing a number of these factors to a clearer focus. Comparative experiments made on the machine described clearly indicate the relative importance of the many conditions governing wear and should help in the choice of those most favourable to minimum wear. With such a large number of variable factors it is impossible to give more than a bare outline of their relative bearing on wear problems. No attempt has been made to give reasons for the causes giving rise to some of the observations made, but it may be anticipated that the finding of satisfactory explanations will be facilitated by extended experimental work in the directions indicated in this paper.

It might be advisable to conclude with a note of warning against drawing wide and general conclusions from some of the observations recorded in this paper, for these are based on specified materials and conditions of experiment and should not be taken for granted as applying to other materials and conditions. Wear is the resultant effect of so many variables that unless these be very closely defined conclusions drawn from experimental work may easily be misleading.

## ACKNOWLEDGMENTS.

The author's thanks are due to the Management Board of I.C.I. Metals, Ltd., for permission to publish the results given in this contribution to the discussion. For the construction of the machine, the carrying out of most of the experimental work, the electrical measurements, and the mathematical analysis of the impressions, the author is indebted to his colleagues Messrs. H. F. Wagstaff, F. A. Harman, G. K. Duddridge, B.Sc., and E. C. Larke, respectively.

**PAPER No. 721.** This paper is copyright. It may be reprinted, wholly or in part, in the Press (with due acknowledgment) after the Annual Meeting of the Institute to be held on March 11, 1936. The Institute as a body is not responsible for the statements or opinions expressed in this paper, on which **written discussion** may be sent to the Secretary not later than April 1, 1936.

# THE PHYSICAL PROPERTIES AND ANNEALING CHARACTERISTICS OF STANDARD NICKEL SILVER ALLOYS.*

By MAURICE COOK,† M.Sc., Ph.D., MEMBER.

### SYNOPSIS.

A detailed study was made of the hardness and mechanical properties as affected by progressively increasing amounts of cold-work, and of the annealing characteristics of seven nickel silver alloys with a constant copper content and containing 10–30 per cent. nickel. The increase in hardness occurring on rolling reductions up to as much as 90 per cent. was determined for all seven alloys, and for the three alloys of highest, intermediate, and lowest nickel content the effect of cold-work on the mechanical properties was studied in detail. Similarly, the annealing characteristics were determined for all the alloys by means of hardness tests, whilst in the case of the three alloys already mentioned this information is supplemented by data on the mechanical properties.

The modulus of elasticity increases progressively with nickel content, and in the annealed condition the hardness also increases with the nickel content. This difference in hardness, however, is not maintained when the materials are cold-worked, and after a reduction of 90 per cent. in thickness by cold-rolling the order of hardness is reversed, *i.e.* the highest value is obtained with the 10 per cent. nickel alloy and the lowest with the 30 per cent. nickel alloy. In other words, the extent to which the alloys can be work-hardened decreases with the nickel content.

The temperature at which softening commences on annealing increases with the nickel content. In common with other copper-rich alloys, the temperature at which softening commences in an alloy of given composition decreases with increasing amount of cold-work and the extent to which hardening occurs immediately prior to the commencement of softening also increases with the amount of cold-work.

Information is given on the density, electrical and thermal conductivity, and thermal expansion of the alloys.

NICKEL silver alloys, a well-known group of commercial copper-rich alloys, have long been used in many applications; their use is comparatively limited, however, as compared with such alloys as the brasses. They are essentially copper–zinc alloys with additions of from 5 to 30 per cent. nickel, their degree of whiteness, which is an important factor in their application, increasing with the nickel content. They are not differentiated from the brasses, however, by colour only, for the presence of nickel also increases the modulus of elasticity.

* Manuscript received October 18, 1935.

† Assistant Research Manager, I.C.I. Metals, Ltd., Witton, Birmingham.

---

**Note to Abstractors and Other Readers.**—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LVIII, 1936. Reference should accordingly be as follows: *J. Inst. Metals*, 1936, **58** (Advance copy).

Since it is possible within fairly wide limits to vary the nickel, copper, and zinc contents of these alloys, a great number of compositions can be produced which may be classed as nickel silvers; in the absence of any official classification and standardization there has, in fact, in the past been more than a tendency for a bewildering variety of compositions to be produced. To obtain some sort of order out of the prevailing chaos, a committee was appointed by the British Standards Institution to standardize these alloys having regard to the requirements of producers and consumers. The work of this committee is still in progress, but the compositions given in Table I have been suggested as standard for wrought alloys, since, so far as can be ascertained, these alloys satisfactorily meet the requirements of the applications in which they are commonly employed.

TABLE I.—*Suggested British Standard Specified Compositions of Nickel Silver Alloys.*

| Nickel, Per Cent. | Copper, Per Cent. | Zinc, Per Cent. | Iron, Per Cent. (Max.). | Manganese, Per Cent. (Max.). | Lead, Per Cent. (Max.). | Other Impurities * including Tin, Per Cent. (Max.). |
|---|---|---|---|---|---|---|
| 10 ± 1 | 60–65 | remainder | 0·25 | 0·30 | 0·03 | 0·30 |
| 12 ± 1 | 60–65 | ,, | 0·25 | 0·30 | 0·03 | 0·30 |
| 15 ± 1 | 60–65 | ,, | 0·30 | 0·50 | 0·03 | 0·30 |
| 18 ± 1 | 60–65 | ,, | 0·30 | 0·50 | 0·03 | 0·20 |
| 20 ± 1 | 60–65 | ,, | 0·30 | 0·50 | 0·02 | 0·20 |
| 25 ± 1 | 60–65 | ,, | 0·30 | 0·75 | 0·02 | 0·20 |
| 30 ± 1 | 60–65 | ,, | 0·30 | 0·75 | 0·02 | 0·20 |

* These will include, in addition to tin, silicon, and carbon with (possibly) aluminium. Other elements should only be present in traces if reasonably high-grade raw materials are used in the preparation of the alloys.

A considerable amount of data on many of the properties of nickel silvers is available, and references to recent literature on the subject are appended to this paper. The present investigation was undertaken to obtain systematic data on the properties of alloys conforming to the requirements of composition specified by the B.S.I. Committee. The alloys were of constant copper content, and the information obtained supplements that available from earlier investigations.

The mechanical properties were determined on rolled strip, whilst some of the physical properties, such as electrical conductivity, and thermal conductivity, were determined on wires and rods. The alloys were made from heats composed of electrolytic copper, electrolytic zinc, and shot nickel, a little cupro-manganese being added to the molten alloys shortly before casting. No flux was used, but a little wood charcoal was added to the crucible before the first portion of the charge was introduced, and during the melting the crucible was covered with a lid. The metals were melted in plumbago crucibles in coke-fired pit furnaces, the casting temperature being increased with increasing nickel content. One ingot of each alloy, weighing approximately 50 lb. and measuring about 28 × $4\frac{1}{16}$ × $1\frac{5}{8}$ in., was made by pouring into a cast-iron mould, and a quantity of strip was produced from each of the seven alloys at a thickness of 0·30 in. by a suitable sequence of cold-rolling and annealing operations. The strip at this thickness was annealed at 800° C. and then cold-rolled without annealing to 0·031 in. in thickness, suitable samples being taken for testing at stages approximating to 10 per cent. reductions in thickness.

## EFFECT OF COLD-WORK ON HARDNESS AND MECHANICAL PROPERTIES.

On all seven alloys, at various stages of reduction ranging from 0 to 90 per cent., hardness determinations were made with a small Brinell machine using a 10-kg. load and 1-mm. ball and with a Vickers diamond pyramid indenter using a load of 10 kg. The results of these tests are given in Table III, and in Fig. 1 they are shown only for the alloys of highest, lowest, and intermediate nickel contents.

TABLE II.—*Compositions of Nickel Silver Alloys.*

| Alloy No. | Copper, Per Cent. | Nickel, Per Cent. | Zinc (difference), Per Cent. | Lead, Per Cent. | Iron, Per Cent. | Manganese, Per Cent. | Tin, Per Cent. | Silicon, Per Cent. | Carbon, Per Cent. | Sulphur, Per Cent. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 62·62 | 10·05 | 27·14 | 0·005 | 0·04 | 0·13 | Slight trace in all alloys | 0·009 | 0·007 | 0·003 |
| 2 | 63·17 | 12·33 | 24·31 | 0·005 | 0·04 | 0·13 | | 0·007 | 0·009 | 0·003 |
| 3 | 62·43 | 15·35 | 22·08 | 0·003 | 0·04 | 0·10 | | 0·003 | 0·014 | 0·004 |
| 4 | 62·05 | 18·40 | 19·36 | 0·004 | 0·07 | 0·12 | | 0·004 | 0·008 | 0·003 |
| 5 | 62·16 | 20·22 | 17·44 | 0·005 | 0·05 | 0·13 | | 0·003 | 0·012 | 0·005 |
| 6 | 61·96 | 25·56 | 12·31 | 0·004 | 0·07 | 0·10 | | 0·004 | 0·020 | 0·005 |
| 7 | 62·02 | 29·77 | 7·93 | 0·003 | 0·09 | 0·14 | | 0·007 | 0·019 | 0·002 |

The figures show that in the annealed condition the hardness increases with the nickel content. This difference in hardness, however, does not persist after different degrees of cold-work. The work-hardening effects after limited amounts of cold-work are greater with higher nickel contents, but after intermediate reductions the hardening effect in these alloys becomes less than in those of lower nickel content. The curves cross, and with relatively large reductions in thickness the hardness order becomes reversed and the highest values are obtained

TABLE III.—*Hardness Values of Cold-Rolled Nickel Silver Strips of Varying Nickel Content.*

| No.1. 10% Nickel. | | | No. 2. 12% Nickel. | | | No. 3. 15% Nickel. | | | No. 4. 18% Nickel. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduction in Thickness, Per Cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. | Reduction in Thickness, Per Cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. | Reduction in Thickness, Per cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. | Reduction in Thickness, Per Cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. |
| 0 | 68 | 66 | 0 | 77 | 76 | 0 | 73 | 72 | 0 | 80 | 76 |
| 10·0 | 114 | 99 | 11·0 | 125 | 110 | 10·0 | 126 | 112 | 11·2 | 129 | 116 |
| 19·7 | 134 | 122 | 20·3 | 152 | 129 | 19·4 | 149 | 132 | 20·1 | 158 | 140 |
| 29·3 | 160 | 140 | 30·6 | 172 | 149 | 29·8 | 165 | 151 | 30·6 | 176 | 154 |
| 38·7 | 173 | 156 | 40·2 | 183 | 165 | 40·1 | 187 | 163 | 40·7 | 191 | 168 |
| 49·7 | 192 | 169 | 49·3 | 202 | 175 | 49·5 | 198 | 171 | 49·6 | 200 | 174 |
| 61·3 | 208 | 181 | 61·0 | 209 | 184 | 60·6 | 207 | 182 | 61·5 | 205 | 181 |
| 68·3 | 222 | 191 | 68·7 | 228 | 194 | 67·6 | 218 | 193 | 69·4 | 214 | 192 |
| 81·0 | 237 | 207 | 81·7 | 235 | 204 | 79·0 | 231 | 200 | 79·3 | 224 | 200 |
| 88·7 | 246 | 216 | 89·2 | 242 | 216 | 89·0 | 241 | 212 | 89·1 | 239 | 211 |

| No. 5. 20% Nickel. | | | No. 6. 25% Nickel. | | | No. 7. 30% Nickel. | | |
|---|---|---|---|---|---|---|---|---|
| Reduction in Thickness, Per Cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. | Reduction in Thickness, Per Cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. | Reduction in Thickness, Per Cent. | D.P. No. 10 Kg. | Brinell No. 10 Kg. 1 mm. |
| 0 | 91 | 82 | 0 | 89 | 86 | 0 | 92 | 83 |
| 9·9 | 141 | 124 | 10·6 | 141 | 131 | 9·3 | 144 | 125 |
| 19·5 | 164 | 142 | 19·2 | 165 | 150 | 18·2 | 167 | 146 |
| 29·8 | 178 | 159 | 29·4 | 177 | 160 | 28·5 | 176 | 155 |
| 39·9 | 191 | 170 | 40·3 | 186 | 168 | 39·4 | 183 | 159 |
| 49·9 | 200 | 179 | 50·2 | 193 | 178 | 51·0 | 191 | 170 |
| 61·2 | 207 | 185 | 61·2 | 198 | 185 | 61·6 | 198 | 173 |
| 69·4 | 216 | 190 | 69·4 | 207 | 188 | 68·9 | 202 | 179 |
| 79·4 | 222 | 196 | 79·4 | 215 | 194 | 79·1 | 210 | 184 |
| 89·5 | 235 | 207 | 89·2 | 226 | 205 | 89·7 | 220 | 197 |

with the alloys of lower nickel contents, as shown in Fig. 1. Thus, the D.P. hardness of the 10 per cent. nickel alloy in the soft condition is 68, and this is increased to 246 by a reduction in thickness of 90 per cent., whereas the corresponding values for the 30 per cent. nickel alloy are 90 and 220, *i.e.* the alloy of lower nickel content work-hardens to a greater extent. That the extent to which the alloys work-harden over the range 0 to 90 per cent. reduction decreases with the nickel content is shown in Fig. 2, where the differences in hardness between the alloys in the annealed condition and after a 90 per cent. reduction are plotted against nickel content. The relationship between D.P.

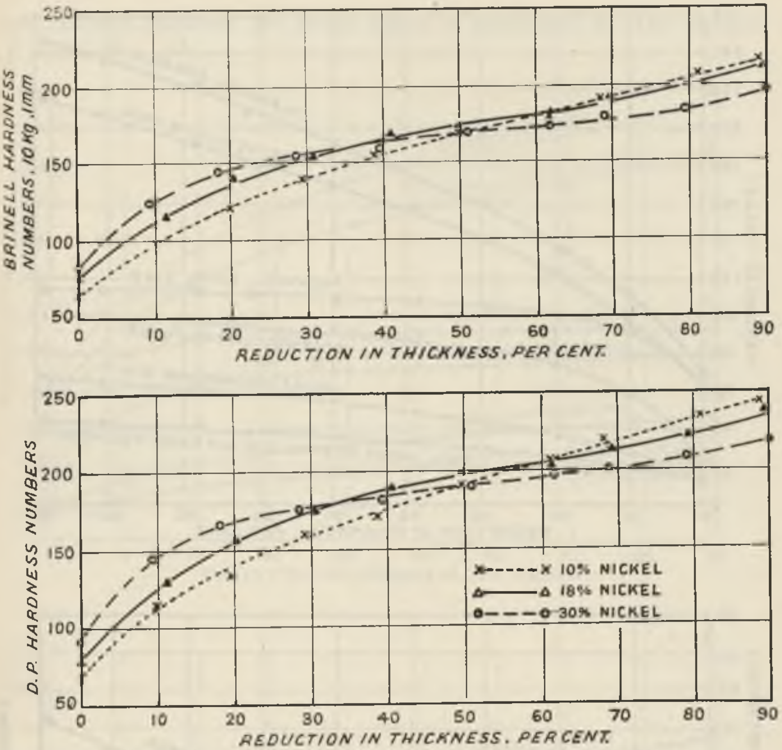


FIG. 1.—D.P. and Brinell Hardness of Cold-Rolled Nickel Silver Alloys.

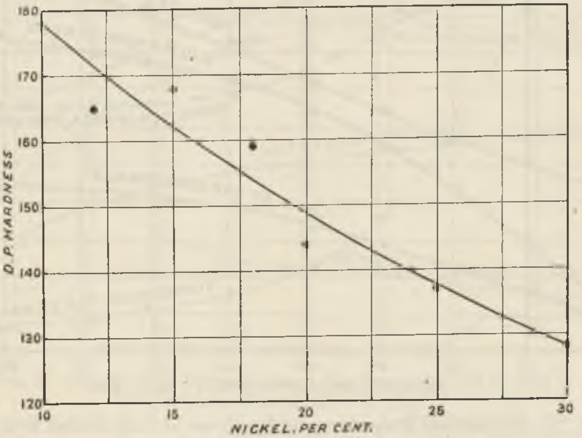


FIG. 2.—D.P. Hardness Increment for Alloys of Varying Nickel Content After 90 Per Cent. Rolling Reduction.

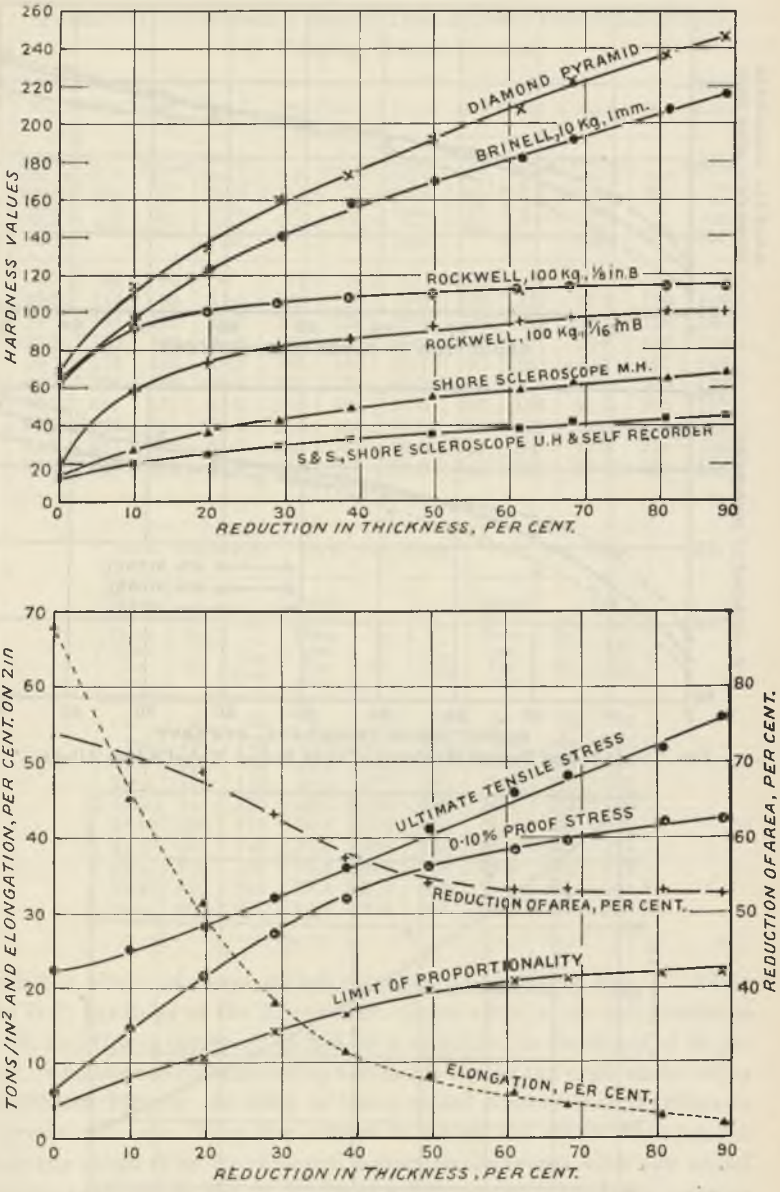
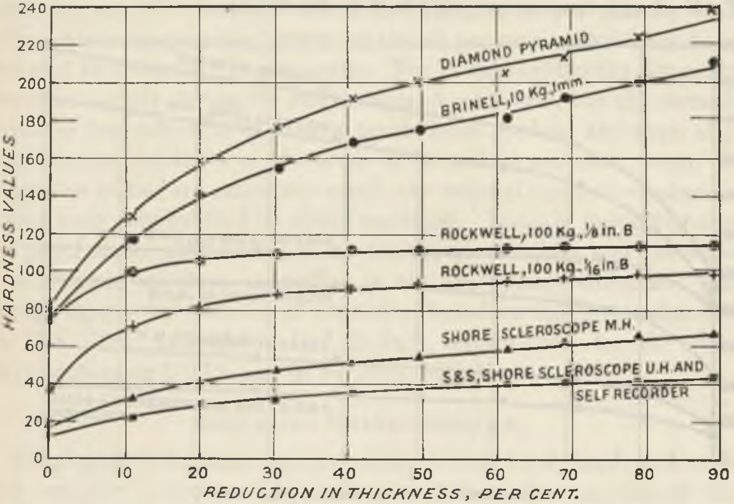


Fig. 3.—Mechanical Properties and Hardness of Cold-Rolled 10 Per Cent. Nickel Silver Strip.

and Brinell hardness for these alloys is expressed by the formula $D = 1{\cdot}2\ (B - 10)$.



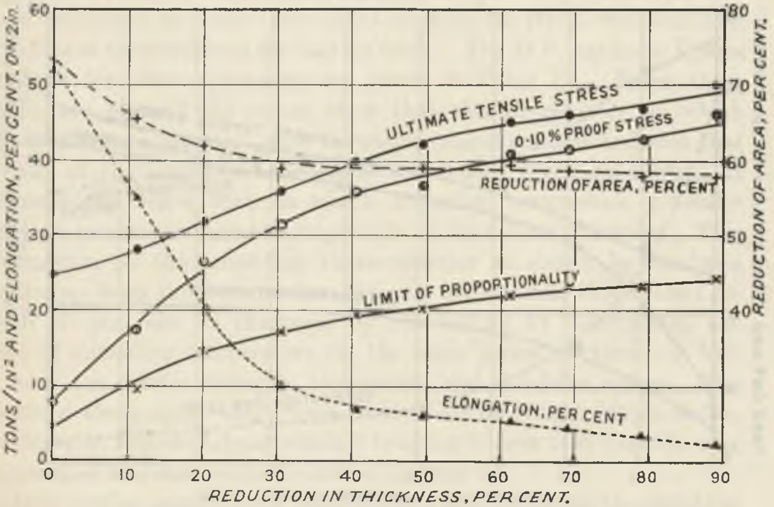


Fig. 4.—Mechanical Properties and Hardness of Cold-Rolled 18 Per Cent. Nickel Silver Strip.

The changes in other properties with progressive amounts of cold-work for the 10, 18, and 30 per cent. nickel alloys are shown in Figs. 3, 4, and 5, which give values for proof stress, limit of proportionality str ultimate tensile stress, reduction of area, elongation, and Brin D.P., Rockwell, Scleroscope, and S. & S. hardness..

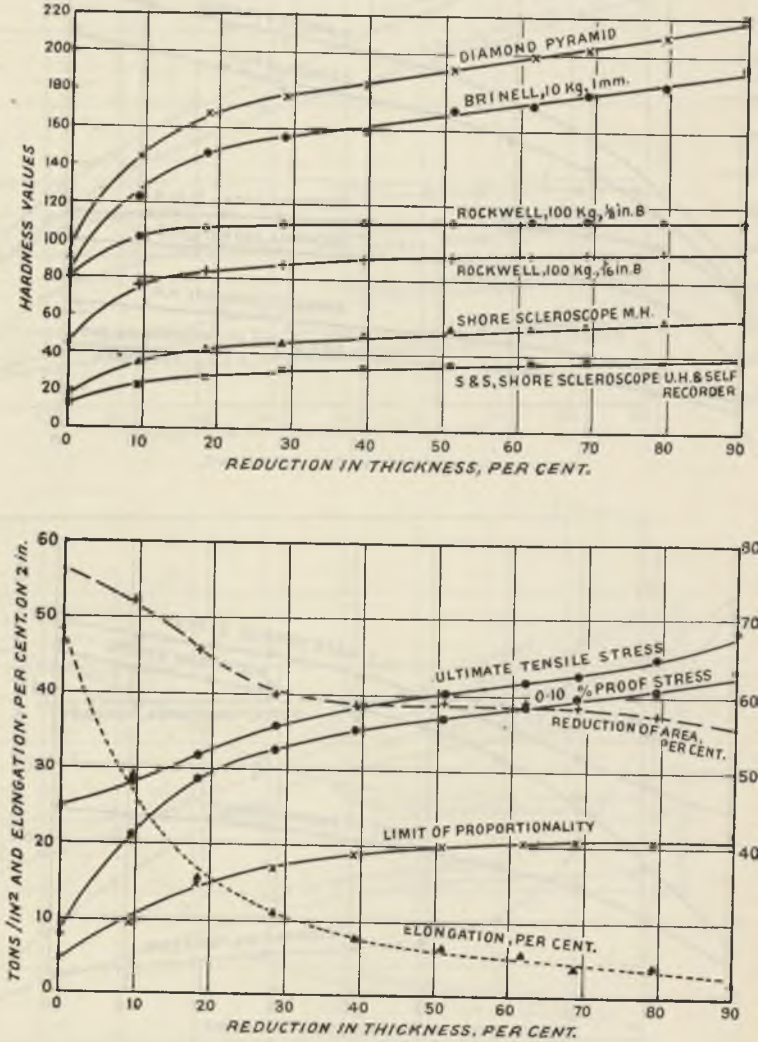


Fig. 5.—Mechanical Properties and Hardness of Cold-Rolled 30 Per Cent. Nickel Silver Strip.

As in the case of hardness, the tensile strength values show that th increase resulting from 90 per cent. reduction in rolling is greater for th

10 per cent. nickel alloy than for the 30 per cent. alloy. The tensile strength of the 10 per cent. nickel alloy was 22·0 tons/in.$^2$ in the annealed condition and 56·0 tons/in.$^2$ after a reduction of 90 per cent. by cold-rolling, the corresponding values for the 30 per cent. nickel alloy being 24·8 and 48·5 tons/in.$^2$, respectively. For all these alloys the elongation decreases rapidly during the early stages of cold-work, but the decrease in values for reduction of area is much more gradual and even after reductions in thickness of the order of 80 and 90 per cent., when the elongation values are extremely small, the original figures for reduction in area were only reduced by about one third. Limit of proportionality and proof stress values are similar for the three alloys and the effect of cold-work on these properties is not appreciably different. The average figures for modulus of elasticity, based on ten determinations, are 17·8, 19·6, and $21{\cdot}3 \times 10^{-6}$ lb./in.$^2$, respectively, for the three alloys containing 10, 18, and 30 per cent. nickel.

## ANNEALING CHARACTERISTICS.

The degree of hardness corresponding to half-hard, hard, and extra hard tempers is obtained by rolling reductions on material in the annealed condition of about 20, 35, and 60 per cent. in thickness, respectively. Samples of strip of all seven alloys were produced in these three conditions, and small specimens cut from the strips were annealed at different temperatures for half an hour. The D.P. hardness figures obtained for these specimens are given in Table IV. When these results are plotted, the curves show that the temperature at which softening occurs increases with increasing nickel content and also that for any of the alloys the hardening which may occur on heating at temperatures below that at which softening commences generally increases in amount with the magnitude of the rolling reduction. This information on the annealing characteristics as shown by hardness results has been supplemented in the case of the same three alloys reduced 60 per cent. in thickness by cold-rolling by determining the effect of annealing temperature for the same period of time, *i.e.* half an hour, on tensile strength, elongation, and Erichsen values. The results of these tests, which were carried out on strip 0·069 in. thick, are shown in Figs. 6–8, from which it is again evident that the softening temperature increases with the nickel content.

After similar conditions of cold-working and annealing the resulting grain-size decreases with the nickel content. Thus, for example, it was found to range from 0·06 mm. to 0·03 mm. in the 10 and 30 per cent. nickel alloys, respectively, after a cold-rolling reduction of 40 per cent. followed by annealing for 2 hrs. at 800° C.

TABLE IV.—*D.P. Hardness of Nickel Silver Alloys after ½ Hr. Annealing at Different Temperatures.*

| Temperature, 0° C. | Alloy 1. | Alloy 2. | Alloy 3. | Alloy 4. | Alloy 5. | Alloy 6. | Alloy 7. |
|---|---|---|---|---|---|---|---|
| *20% Reduction in Thickness.* | | | | | | | |
| ... | 135 | 146 | 146 | 154 | 161 | 162 | 158 |
| 100 | 135 | 147 | 146 | 156 | 161 | 164 | 160 |
| 200 | 137 | 147 | 147 | 157 | 164 | 165 | 162 |
| 300 | 134 | 146 | 148 | 159 | 165 | 167 | 165 |
| 400 | 127 | 140 | 143 | 152 | 160 | 160 | 163 |
| 500 | 115 | 127 | 131 | 140 | 134 | 146 | 150 |
| 600 | 80 | 93 | 89 | 98 | 100 | 118 | 131 |
| 700 | 74 | 82 | 80 | 88 | 89 | 91 | 93 |
| 800 | 69 | 81 | 79 | 84 | 88 | 89 | 92 |
| 900 | 67 | 80 | 78 | 82 | 86 | 85 | 88 |
| *35% Reduction in Thickness.* | | | | | | | |
| ... | 168 | 169 | 172 | 174 | 181 | 180 | 178 |
| 100 | 169 | 173 | 175 | 176 | 182 | 181 | 180 |
| 200 | 170 | 172 | 178 | 180 | 186 | 183 | 183 |
| 300 | 170 | 171 | 178 | 182 | 187 | 184 | 183 |
| 400 | 158 | 164 | 165 | 174 | 181 | 177 | 180 |
| 500 | 125 | 141 | 138 | 155 | 160 | 164 | 163 |
| 600 | 86 | 95 | 94 | 97 | 100 | 101 | 108 |
| 700 | 75 | 85 | 80 | 90 | 95 | 94 | 96 |
| 800 | 69 | 81 | 79 | 86 | 90 | 90 | 91 |
| 900 | 66 | 79 | 75 | 82 | 85 | 85 | 88 |
| *60% Reduction in Thickness.* | | | | | | | |
| ... | 210 | 209 | 209 | 209 | 207 | 201 | 196 |
| 100 | 213 | 211 | 211 | 210 | 207 | 201 | 198 |
| 200 | 222 | 218 | 215 | 214 | 211 | 203 | 203 |
| 300 | 224 | 225 | 224 | 218 | 216 | 204 | 203 |
| 400 | 214 | 212 | 212 | 210 | 207 | 199 | 196 |
| 500 | 121 | 127 | 124 | 133 | 136 | 149 | 181 |
| 600 | 94 | 103 | 100 | 110 | 110 | 108 | 115 |
| 700 | 80 | 88 | 88 | 97 | 94 | 99 | 100 |
| 800 | 72 | 84 | 84 | 89 | 89 | 92 | 94 |
| 900 | 69 | 79 | 76 | 83 | 84 | 85 | 87 |

## DENSITY, ELECTRICAL CONDUCTIVITY, THERMAL CONDUCTIVITY, AND THERMAL EXPANSION.

Density determinations were made on all the alloys in the form of strip cold-rolled with a 60 per cent. reduction in thickness and on the same strip after annealing at 800° C., the results, corrected to 20° C., are given in the first two columns of Table V. As would be expected, the density of the rolled material is higher than that of the annealed material and increases progressively with increasing nickel content.

The results of electrical conductivity measurements carried out by the double-bridge method on wires 0·057 in. in diameter in the hard-drawn state, with a reduction in cross-sectional area of 84 per cent., are given in the third column of Table V. These values show a progressive increase in specific resistance with increasing nickel content.

Thermal conductivity measurements were made on 1 in. diameter cast rods machined to $\frac{5}{8}$ in. in diameter in a guard-ring apparatus

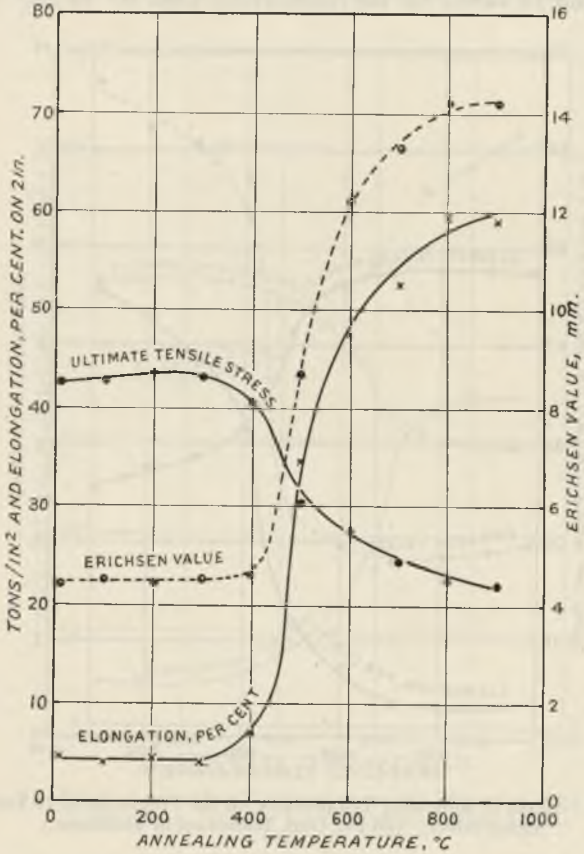


Fig. 6.—Effect of Annealing Temperature on the Properties of 10 Per Cent. Nickel Silver. (60 Per Cent. Reduction in Thickness.)

similar to that of Wilkes[5] and Smith,[22] except that the cooling head was of ebonite, the groove for cooling water being machined on the specimen itself. Accurate temperature control of the heating block was obtained by means of a potentiometer-type automatic regulator with variable resistances arranged to switch only a small proportion of the total necessary heating current. The temperature gradient in the specimen was determined by three copper–Constantan couples (calibrated to 0·1° C.) and the increase in temperature of the cooling water by a six-element differential thermocouple (to 0·005° C.). The e.m.f. was measured with a Cambridge potentiometer. Duplicate observations were made with the heating block at 150°, 250°, and 400° C., thus giving 18 values for the conductivity from 50° to 250° C. The conductivity values at 20° and 200° C., as well as the temperature coefficient $\alpha$ in the equation $K_t = K_{20}\,[1 + \alpha(t - 20°)]$, obtained from the mean conductivity–temperature curves, are given in Table V. It will be seen that the thermal conductivity decreases progressively with increasing nickel content, but that the temperature coefficient of thermal conductivity is practically the same—0·0012—for the four alloys examined. Values which are also given for the Wiedemann–Franz–Lorenz ratio ($K/\lambda T$, where $K$ = thermal conductivity, $\lambda$ = electrical

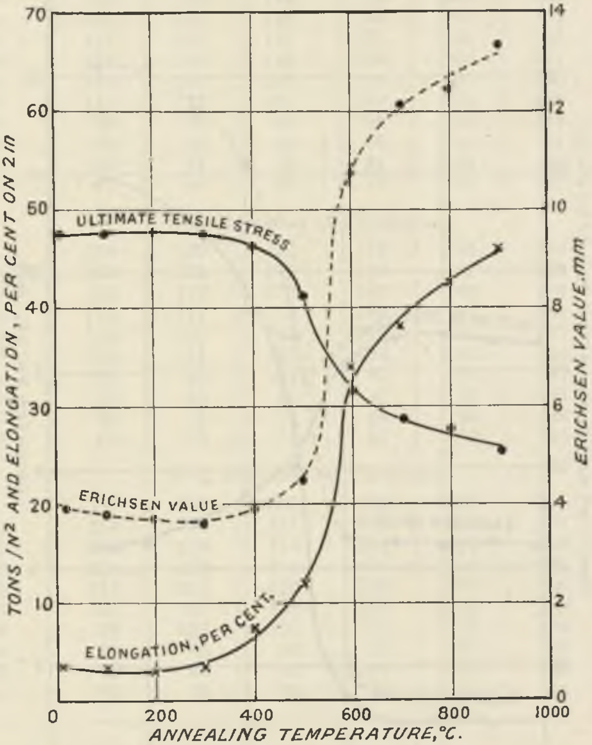


Fig. 7.—Effect of Annealing Temperature on the Properties of 18 Per Cent. Nickel Silver. (60 Per Cent. Reduction in Thickness.)

conductivity, and $T$ = absolute temperature) at 293° abs., show considerable variation with nickel content, a feature not uncommon in alloys containing this metal.

Thermal expansion up to 400° C. was determined on the alloys in the annealed condition by heating 5 in. × $\frac{5}{8}$ in. cylinders in a 12 in. × $1\frac{1}{2}$ in. tubular electric furnace of known temperature gradient.

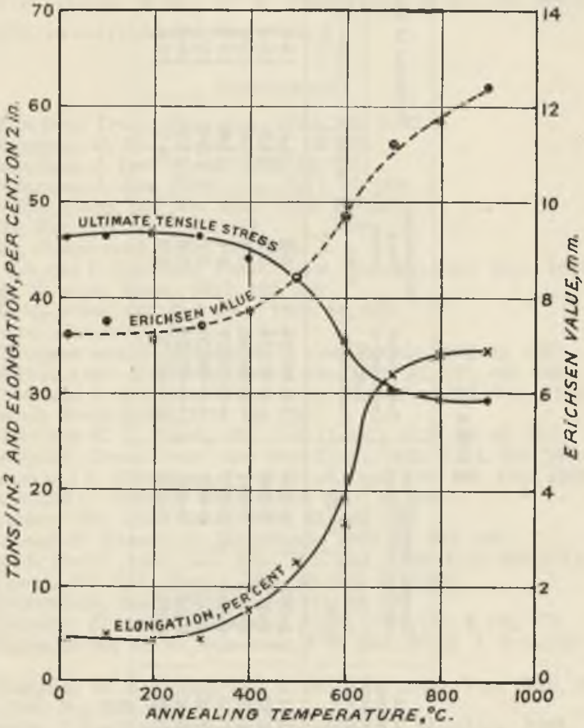


Fig. 8.—Effect of Annealing Temperature on the Properties of 30 Per Cent. Nickel Silver. (60 Per Cent. Reduction in Thickness.)

Exansion was read directly on a short gauge and corrected for expansion of the fused silica end rods. Temperatures were read by means of a platinum/platinum–rhodium thermocouple placed in a hole drilled in the centre of the test-piece. Values for the expansion over four temperature ranges are given in Table V, and showed that the coefficient remains constant up to about 18 per cent. nickel and thereafter increases somewhat with nickel content, this increase being more apparent at lower temperatures.

## TABLE V.

| Alloy No. | Density at 20° C. | | Specific Resistance, Microhms cm.$^3$ at 20° C. | Thermal Conductivity, cals./cm.$^2$/cm./° C./sec. | | Temperature Coefficient of Thermal Conductivity. | Wiedemann–Franz–Lorenz Ratio, $\frac{K}{\lambda T}$ $\times 10^9$. | Coefficient of Thermal Expansion. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Annealed Strip. | Cold-Rolled Strip. | | at 20° C. | at 200° C. | | | 0–100° C. $\times 10^6$. | 0–200° C. $\times 10^6$. | 0–300° C. $\times 10^6$. | 0–400° C. $\times 10^6$. |
| 1 | 8·609 | 8·621 | 20·71 | 0·089 | 0·108 | +0·00123 | 6·3 | 15·0 | 15·8 | 16·4 | 17·0 |
| 2 | 8·638 | 8·650 | 22·32 | 0·072 | 0·090 | +0·00124 | 5·5 | 14·8 | 15·4 | 16·2 | 16·8 |
| 3 | 8·672 | 8·688 | 24·70 | 0·064 | 0·081 | +0·00148 | 5·4 | 15·0 | 15·6 | 16·2 | 16·8 |
| 4 | 8·718 | 8·732 | 27·55 | 0·054 | 0·065 | +0·00114 | 5·1 | 14·8 | 15·4 | 16·0 | 16·8 |
| 5 | 8·740 | 8·754 | 29·03 | 0·052 | 0·063 | +0·00120 | 5·2 | 15·4 | 16·2 | 16·8 | 17·4 |
| 6 | 8·810 | 8·822 | 33·65 | 0·049 | 0·060 | +0·00124 | 5·6 | 15·8 | 16·4 | 17·0 | 17·6 |
| 7 | 8·868 | 8·880 | 37·89 | 0·046 | 0·056 | +0·00120 | 5·9 | 16·2 | 16·6 | 17·0 | 17·8 |

## ACKNOWLEDGMENTS.

The author's thanks are due to the Management Board of Messrs. I.C.I. Metals, Ltd., Witton, Birmingham, for permission to publish the results contained in this paper. He also gratefully acknowledges the help and encouragement which he has received from Dr. H. W. Brownsdon, M.Sc., and the valuable assistance of his colleagues Messrs. G. H. Blenkarn, E. Davis, M.Sc., G. K. Duddridge, B.Sc., H. Metcalf, and W. G. Tallis, in carrying out the work.

## BIBLIOGRAPHY.

[1] F. C. Thompson, *Trans. Chem. Soc.*, 1914, **105**, 2342.
[2] F. C. Thompson, *J. Inst. Metals*, 1916, **15**, 230.
[3] F. C. Thompson, *J. Inst. Metals*, 1916, **54**, 222.
[4] F. C. Thompson, *J. Inst. Elect. Eng.*, 1917, **17**, 119.
[5] G. B. Wilkes, *Chem. and Met. Eng.*, 1919, **21**, 241.
[6] L. Guillet, *Rev. Mét.*, 1920, **17**, 484.
[7] L. Guillet, *Compt. rend.*, 1920, **170**, 460.
[8] W. B. Price and P. Davidson, *Trans. Amer. Inst. Min. Met. Eng.*, 1921, **64**, 510.
[9] W. Voigt, *Z. anorg. Chem.*, 1922, **120**, 309.
[10] P. D. Merica, *Chem. and Met. Eng.*, 1921, **24**, 558.
[11] W. Schulte, *Metallbörse*, 1921, **11**, 741.
[12] F. C. Thompson and R. Whitehead, *J. Inst. Metals*, 1922, **27**, 226.
[13] P. D. Merica, *Amer. Machinist (New York)*, 1922, **57**, 397, 450, 484.
[14] W. B. Price and C. G. Grant, *Trans. Amer. Inst. Min. Met. Eng.*, 1924, **70**, 328.
[15] E. G. Jarvis, *Brass World*, 1924, **20**, 138.
[16] W. C. Gray and R. E. Ansell, *Met. Ind. (Lond.)*, 1926, **28**, 56, 81.
[17] D. J. McAdam, *Trans. Amer. Soc. Steel Treat.*, 1925, **7**, 54, 217, 581.
[18] E. O. Jones and E. Whitehead, *Trans. Amer. Inst. Min. Met. Eng.*, 1926, **73**, 834.
[19] C. Rothert and G. Dern, *Z. Metallkunde*, 1927, **19**, 158.
[20] A. C. Sturney, *Met. Ind. (Lond.)*, 1928, **33**, 485, 521.
[21] O. Bauer and M. Hansen, *Z. Metallkunde*, 1929, **21**, 357, 406.
[22] C. S. Smith, *Trans. Amer. Inst. Min. Met. Eng.*, **1930**, Inst. Metals Div., 84.
[23] E. R. Thews, *Met. Ind. (Lond.)*, 1931, **39**, 243, 315, 363.
[24] G. B. Gordon-Sale, *Met. Ind. (Lond.)*, 1931, **39**, 126.
[25] W. S. Bugakov, *Zhurnal Tehnicheskoy Fiziki*, 1932, [B], **2**, (2), 173.
[26] G. H. Keulegan and M. R. Houseman, *U.S. Bur. Stand. J. Research*, 1933, **10**, 289.
[27] T. E. Kihlgren, N. B. Pilling, and E. M. Wise, *Amer. Inst. Min. Met. Eng., Tech. Publ.* No. **610**, 1935.
[28] J. Schramm, "Kupfer–Nickel–Zink Legierungen," Würzburg, 1935.
[29] C. S. Smith and E. W. Palmer, *Metals Technology*, 1935, **2** (*Amer. Inst. Min. Met. Eng., Tech. Publ.* No. **648**).

# MEETINGS OF OTHER SOCIETIES

### *WEDNESDAY*, DECEMBER 18.

ELECTRODEPOSITORS' TECHNICAL SOCIETY.—Discussion on "Bright Nickel Plating." To be opened by S. Field. (Northampton Polytechnic Institute, St. John St., Clerkenwell, E.C.1, at 8.15 p.m.)

### *THURSDAY*, JANUARY 2.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—V. Harbord: "Metals and Alloys in Locomotive Construction." (Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 6 p.m.)

### *SATURDAY*, JANUARY 4.

INSTITUTE OF BRITISH FOUNDRYMEN, LANCASHIRE BRANCH.—A Preliminary Report on Moulding Costs by the Costing Sub-Committee of the Technical Committee. (Engineers, Club, Albert Sq., Manchester, at 4 p.m.)

### *MONDAY*, JANUARY 6.

BRADFORD ENGINEERING SOCIETY.—W. Dundas: "Industrial Power." (Technical College, Bradford, at 7.30 p.m.)

### *TUESDAY*, JANUARY 7.

INSTITUTE OF BRITISH FOUNDRYMEN, BIRMINGHAM, COVENTRY, and WEST MIDLANDS BRANCH.—B. Caplan: "Troubles Experienced in Electroplating Due to Unsuitable Castings." Joint Meeting with Electrodepositors' Technical Society. (James Watt Memorial Institute, Gt. Charles Street, Birmingham, 3, at 7.30 p.m.)

### *WEDNESDAY*, JANUARY 8.

INSTITUTE OF BRITISH FOUNDRYMEN, LONDON BRANCH.—Further Recommendations of the Costing Sub-Committee, covering Costs in the Moulding Department. (Charing Cross Hotel, London, W.C.2, at 8 p.m.)

### *SATURDAY*, JANUARY 11.

INSTITUTE OF BRITISH FOUNDRYMEN, SCOTTISH BRANCH.—W. Hamilton: "Refractories in the Foundry and Furnace." (Royal Technical College, George St., Glasgow, at 4 p.m.)

INSTITUTE OF BRITISH FOUNDRYMEN, WALES AND MONMOUTH BRANCH.—E. J. L. Howard: "Non-Ferrous Foundry Practice." (Technical College, Newport, at 6.30 p.m.)

### *TUESDAY*, JANUARY 14.

INSTITUTE OF BRITISH FOUNDRYMEN, LANCASHIRE BRANCH, BURNLEY SECTION.—A. Phillips: "Recent Foundry Developments." (Municipal College, Ormerod Rd., Burnley, at 7.15 p.m.)

# AUTHOR INDEX TO ABSTRACTS

# *Author Index to Abstracts*

# *Author Index to Abstracts*

## CORRIGENDUM

*Metallurgical Abstracts*, 1935, vol. 2.

Page 365, line 3. *For* " 99·99% " *read* " 99·85%."

line 4. *After* " as anodes." *add* " For the production of metal of a purity exceeding 99·99%, the principle of 3 superimposed layers is utilized in electrolyzing a bath of aluminium and sodium fluorides and barium chloride."

## APPOINTMENT VACANT

Junior Assistant with degree in Metallurgy required for analysis and experimental work in Works near London. Box No. 33, Institute of Metals, 36 Victoria Street, London, S.W.1.

## APPOINTMENT REQUIRED

Manager, Mech. and Elect. Eng., 15 yrs.' wide experience in non-ferrous metals manuf., full control large works, desires position of responsibility. Box No. 34, Institute of Metals, 36 Victoria Street, London, S.W.1.

# METALLURGICAL ABSTRACTS

## (GENERAL AND NON-FERROUS)

Volume 2 DECEMBER 1935 Part 12

## I.—PROPERTIES OF METALS

(Continued from pp. 497–502.)

***The Diffusion of Gases Through Metals. II.—Diffusion of Hydrogen Through Aluminium.** C. J. Smithells and C. E. Ransley (*Proc. Roy. Soc.*, 1935, [A], **152**, 706–713).—Hydrogen is found to diffuse at a measurable rate through aluminium at temperatures above 400° C. The rate of diffusion depends on the state of the surface; it is greatest for a surface freshly scraped in hydrogen, but it decreases rapidly, and after some hours reaches a steady value which is about $\frac{1}{10}$ of the initial rate. This decrease is attributed to contamination of the surface by oxygen. The effect of temperature ($T$) and pressure ($P$) on the rate of diffusion ($D$) are represented by $D = KP^{\frac{1}{2}}e^{-b/T}$. The value of $b$ for a freshly scraped surface is 15,600, and for an anodically oxidized surface about 21,500; $K$ varies from 3·3 to 0·42 for different states of the surface.—J. S. G. T.

***The Solubility of Hydrogen in Molten Aluminium.** L. L. Bircumshaw (*Trans. Faraday Soc.*, 1935, **31**, 1439–1443).—The solubility of hydrogen in aluminium is at 700° C. 0·23, at 800° C. 0·89, at 900° C. 1·87, and at 1000° C. 3·86 c.c. (N.T.P.) per 100 grm. of metal, and the "saturated" heat of solution 43,400 grm.-cal./grm.-mol. of dissolved gas. The solubility values agree closely with those of Röntgen and Braun (*Met. Abs.* (*J. Inst. Metals*), 1932, **50**, 721).—A. R. P.

***Study of the Phenomena of Plastic Deformation in Single Crystals of Aluminium under Tension.** A. Elnikow (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki* (*J. Exper. and Theoret. Physics*), 1934, **4**, 100–115).—[In Russian.] Pole diagrams of Laue spots of single crystals of aluminium deformed by tension show that during slip an axis of rotation of the crystal elements is formed in the plane of slip and perpendicular to the direction of slip. The angle of rotation is 5·5°–6·5° with a deformation of 18–20%. It is shown that the thickness of the bent layer is less than 0·17 mm., with a length of unit of slip of 1·2 mm. Accurate analysis of the diagrams indicates that there is also a subsidiary axis of rotation at right angles to the main axis and in the same plane. From the theory of elasticity the appearance of this axis indicates an elastic bending of the slip-planes and enables a value to be calculated for Poisson's coefficient. The shape of the bent surfaces has been determined mathematically.—N. A.

***The Nature of the Phenomena of "Rest" and Recrystallization in Single Crystals of Aluminium.** N. J. Seljakov and E. I. Sovz (*Dokladi Akademii Nauk* (*Rep. Acad. Sci. U.S.S.R.*), 1935, **2**, 125–133).—[In Russian and German.] During recovery in aluminium single crystals noticeable changes occur in the distribution of intensity of certain spots (accompanied by an increase in their sharpness) on X-ray plates taken at large angles. During recrystallization the position of the new crystals differs from that after deformation. After hot-deformation the lines are sharper than after cold-deformation. The recrystallization and deformation textures of polycrystalline aluminium are identical.—N. A.

---

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

***On the Recrystallization of Pure Aluminium.** J. Calvet, J. Trillat, and M. Paić (*Light Metals Research*, 1935, 4, 94–95).—Translated from *Compt. rend.*, 1935, **201**, 426–428. See *Met. Abs.*, this vol., pp. 453–454.—J. C. C.

***The Photoelectric Effect of Aluminium Films Deposited by the Vacuum Evaporating Process.** E. Gaviola and John Strong (*Phys. Rev.*, 1935, [ii], **48**, 483).—Abstract of a paper read before the American Physical Society. The effect has been studied using a carefully cleaned and partially outgassed glass cell provided with a quartz window and a charcoal–liquid air trap. The cell has the shape of a horn, so that absorption of the oncoming radiation is practically total. As light source a mercury lamp was used. The light was resolved by a Hilger quartz monochromator. It was found that the long wavelength limit of the sensitivity curve lies between 2800 and 2900 A., and that it has a definite selective maximum about 2700 A.—S. G.

***Researches to Convert Antimony into the Glassy Amorphous State.** G. Tammann and W. Müller (*Z. anorg. Chem.*, 1934, **221**, 109–112).—When antimony is melted with a small quantity of antimony selenide and allowed to fall in small drops of about 0·4 mm. diameter into liquid air at — 180° C., particles of glassy amorphous antimony are obtained which can be caused to crystallize by heating at 520° C. for 30 minutes. Since these effects are not obtainable with pure antimony it is assumed that the addition of selenium retards the rate of crystallization sufficiently to retain the amorphous state after severe quenching.—A. R. P.

***Studies on Explosive Antimony. II.—Its Structure, Electrical Conductivity, and Rate of Crystallization.** C. C. Coffin (*Proc. Roy. Soc.*, 1935, [A], **152**, 47–63).—Continuing previous work (*Met. Abs.*, 1934, **1**, 477), C. has shown that the explosive electrolytic deposit of antimony possesses a heterogeneous gel-like structure in which one phase is oriented parallel to the lines of the depositing current. This oriented phase is regarded as an $SbCl_3$–Sb complex due to the deposition of a complex ion. The other phase is probably amorphous antimony. In the case of fresh deposits, the specific resistance, $\rho$, which is about $10^5$ times that of ordinary antimony, and which has a negative exponential temperature coeff., is given by $\log \rho = (8{\cdot}7 \times 10^2)/T + 0{\cdot}095C - 3{\cdot}26$, where $T$ is the temperature (° C.) and $C$ the % of $SbCl_3$ in the metal. This equation is not valid for partially crystallized deposits. The conduction is probably metallic in character, Ohm's law being obeyed and Faraday's law not involved. Between 55° and 100° C. amorphous antimony crystallizes at a measurable rate which is independent of the amount of salt in the metal, and which can be represented by the equation referring to a first-order reaction. The Arrhenius equation applies and gives an energy of activation of 27,300 cal./grm. atom. The rate of crystallization at $T$° C. is given by the equation $\log k = 31{\cdot}40 \pm 27{,}300/RT$.—J. S. G. T.

**Molecular Arrangement of Amorphous Antimony.** J. A. Prins (*Chem. Weekblad*, 1935, **32**, 348–349; *Brit. Chem. Abs.*, **1935**, [A], 919).—See also *Met. Abs.*, this vol., p. 454. Amorphous ("explosive") antimony prepared by electrolysis of $SbCl_3$ contains occluded $SbCl_3$, which keeps the metal in a "dispersed" form. It can be produced in thin layers by distillation in a high vacuum, but thick layers crystallize immediately. The electron diffraction pattern corresponds with an atomic arrangement similar to that in crystalline antimony, of co-ordination number 6.—S. G.

***The Size and Arrangement of Bismuth Microcrystals Formed from Vapour.** C. T. Lane (*Phys. Rev.*, 1935, [ii], **48**, 193–198).—See *Met. Abs.*, this vol., p. 365.—J. S. G. T.

***The Electrical Resistance of Cadmium, Thallium, and Tin at Low Temperatures.** W. J. de Haas, J. de Boer, and G. J. van der Berg (*Physica*, 1935, **2**, 453–459; and *Comm. K. Onnes Lab. Leiden*, No. **236d**, 1935).—[In English.] The "ideal" resistance curves of cadmium and tin (calculated by means of Matthiesen's rule) show a dependence respectively on about $T^{4 \cdot 5}$ and $T^4$, where $T$ is the absolute temperature. The "ideal" resistance curve of thallium is not to be represented by one single power of temperature, because of the faint S-form of the curve on the logarithmic scale.—S. G.

***A Revision of the Atomic Weight of Cæsium.** Gregory Paul Baxter and Joseph Smith Thomas (*J. Amer. Chem. Soc.*, 1934, **56**, 1108–1110).—By comparison of pure cæsium chloride with silver the atomic weight of cæsium was found to be 132·91.—L. A. O.

***Investigations Relating to Allotropy Exhibited by Very Pure Calcium.** Alfred Schulze (*Physikal. Z.*, 1935, **36**, 595–598).—In continuation of previous work (*Met. Abs.*, 1934, **1**, 65), S. establishes, by determinations of cooling curves, measurements of electrical resistance, and of expansion, the definite existence of allotropic transformations of calcium at about 300° C. ($\alpha\beta$), and at about 450° C. ($\beta\gamma$). The transformation temperature ($\beta\gamma$) apparently increases with increasing purity of the metal, which in the present case was 99·9%.—J. S. G. T.

***Chemical Preparation of Cerium and Its Alloys.** A. Karl (*Bull. Soc. chim. France*, 1934, [v], **1**, 871–877; *C. Abs.*, 1935, **29**, 92).—After failing to obtain cerium in the electric furnace by reaction between ceric oxide and silicon carbide, K. succeeded in preparing cerium of 97·05% purity and some if its alloys by reducing cerous chloride with commercial calcium according to $2CeCl_3 + 3Ca \longrightarrow 3CaCl_2 + 2Ce$. The preparation of ferro–cerium offers no difficulties. The required quantity of iron can be added before or after the reaction with calcium. A typical analysis shows cerium 63·4, iron 35·85, copper 0·98, calcium 0·33, and magnesium 0·16%. The method and equipment finally adopted for preparing cerium and its alloys as well as the various methods for making cerous chloride are discussed.—S. G.

***A New Revision of the Atomic Weight of Chromium. II.—The Ratios of $CrO_2Cl_2 : 2Ag$ and $CrO_2Cl_2 : 2AgCl$.** F. González Núnez (*Anales soc. españ. fís. quím.*, 1935, **33**, 533–548; *C. Abs.*, 1935, **29**, 6807).—A value of 52·013 ± 0·001 was found for the atomic weight of chromium.—S. G.

***Solubility of Oxygen in Solid Cobalt and the Upper Transformation Point of the Metal.** A. U. Seybolt and C. H. Mathewson (*Metals Technology*, 1935, **2**, (Sept.); *A.I.M.M.E. Tech. Publ.* No. 642, 1–17).—From analysis and micrographic examination of specimens of cobalt soaked in air or oxygen for some days at 600°–1500° C., it is concluded that the solid solubility of oxygen (as cobalt oxide) in cobalt increases from about 0·004% at 550° C. to 0·020% at 875° C., at which temperature the hexagonal form of cobalt changes into the cubic face-centred form. This transformation occurs at about 850° C. in the oxygen-free metal, but is a very sluggish reaction. The solubility of oxygen in the cubic form of cobalt is 0·004% at 875° C. and increases almost linearly to 0·022% at 1450° C.—A. R. P.

**Change of Resistance of Cobalt in Longitudinal Magnetic Fields.** M. S. Alam (*Current Sci.*, 1934, **3**, 155–156; *Brit. Chem. Abs.*, **1935**, [A], 18).—See also *Met. Abs.*, this vol., p. 414. Contrary to McCorkle (*Phys. Rev.*, 1923, [ii], **22**, 271) the resistance of cobalt increases to a saturation value at 1200–1300 gauss in longitudinal fields. Hysteresis also occurs.—S. G.

***The Conductivity of Copper Castings.** Lyall Zickrick (*Gen. Elect. Rev.*, 1934, **37**, 187–190).—Read before the American Institute of Mining and Metallurgical Engineers. The sp. gr. and conductivity of copper deoxidized with silicon, calcium, boron carbide, calcium boride, and silico–manganese boride were determined for castings in sand and graphite moulds and before and after cold-working and annealing. Good density and conductivity figures are obtained only by using clean, pure copper with the minimum oxygen content and by regulating the amount of deoxidizer added so that the minimum excess remains in the casting. Elements which have a high affinity for oxygen and are insoluble or only slightly soluble in copper have the least effect on the electrical conductivity; care should be taken that the surface of the molten metal is protected from access to air by a suitable cover since the metal rapidly absorbs oxygen. Calcium boride, calcium, and boron carbide are the most satisfactory deoxidizers.—A. R. P.

***A Quantum Mechanical Investigation of the Cohesive Forces of Metallic Copper.** K. Fuchs (*Proc. Roy. Soc.*, 1935, [A], **151**, 585–602).—The binding energy in copper is calculated and found to be of the right order of magnitude, but a correction—which is deduced by a statistical method—is necessary to obtain the correct compressibility. The reason for the face-centred structure of copper is discussed; this structure for copper has a lower value of energy than the body-centred structure; for sodium both structures have almost equal energies.—J. S. G. T.

***Apparatus for Grinding Copper in a High Vacuum and Adsorption of Gases by the Powder Obtained.** F. Durau and H. Franssen (*Z. Physik*, 1934, **89**, 757–773; *C. Abs.*, 1935, **29**, 20).—A discussion of the problem whether gases adsorbed by metal powders will stay at the surface and can be removed by mere evacuation. Copper powder is ground in high vacuum with a specially-designed apparatus. From the amount of nitrogen, hydrogen, ethane, ethylene, and carbon monoxide adsorbed at room temperature no measurable quantities are retained in a vacuum, while oxygen and carbon dioxide are more persistent.—S. G.

***Diffusion of Positive Ions of Salts Through Copper, Silver, and Gold at High Temperature. Analysis of the Ions Emitted with the Aid of a Mass Spectrograph.** Jean Cichocki (*Ann. Physique*, 1933, **20**, 478–518; *C. Abs.*, 1934, **28**, 1920).—Cf. *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 66. Folded sheets of copper, silver, or gold containing various salts emit at high temperature simple metal ions of the salt and smaller amounts of complex ions of the sheet metal. The time for maximum emission at constant temperature is proportional to the thickness of the sheet, an indication of diffusion through the metal. An energy loss shown by the ions was explained by a hypothesis of large ion emission.
—S. G.

***On the Change of the Resistance of Single Crystals of Gallium in a Magnetic Field.—III.** W. J. de Haas and J. W. Blom (*Physica*, 1935, **2**, 952–958; and *Comm. K. Onnes Lab. Leiden*, No. **237d**, 1935).—[In English.] See also *Met. Abs.*, 1934, **1**, 285, 546. The change of the resistance of single crystals of pure gallium (which had the pseudo-tetragonal axis parallel to the length of the wire) in a magnetic field perpendicular to the wire was measured at liquid helium temperatures. At 4·22° K. the increase of the resistance is larger than at liquid hydrogen temperatures. At 4·22° K. and 1·35° K. the increase is nearly the same. The separation of the secondary maxima and minima in the rotational diagrams is larger at liquid helium temperatures.—S. G.

***Purification of Gallium by Fractional Crystallization of the Metal.** James I. Hoffman and Bourdon F. Scribner (*J. Research Nat. Bur. Stand.*, 1935, **15**, 205–209; and *Research Paper*, No. **823**).—It is shown in this paper that if gallium, containing (as impurities) small amounts of antimony, bismuth, chromium, cobalt, columbium, copper, gold, indium, iron, lead, manganese, mercury, molybdenum, nickel, osmium, palladium, platinum, rhodium, ruthenium, silver, thallium, tin, vanadium, and zinc, is subjected to fractional crystallization of the metal, all the impurities named tend to concentrate in the crystalline portion, with the following exceptions: silver, mercury, indium, lead, and tin are concentrated in the molten residue; copper and thallium remain about equally divided between crystals and residue; zinc is dissolved by the hydrochloric acid under which the crystallization takes place, and is entirely eliminated. It is also shown that separation from iron or platinum in excess of 0·001%, from indium or lead in excess of 0·01%, or from tin in excess of 0·02%, by fractional crystallization of the metal is impracticable. —S. G.

***Atomic Weight of Gallium.** G. E. F. Lundell and James I. Hoffman (*J. Research Nat. Bur. Stand.*, 1935, **15**, 409–420; and *Research Paper* No. **838**). —In this determination, weighed portions of the pure metal were converted to the hydroxide, the sulphate, and the nitrate, respectively. These were then heated until they were changed to the oxide, $Ga_2O_3$, which was finally ignited at 1200°–1300° C. By this procedure the atomic weight is related directly to that of oxygen. Preliminary tests showed that the metal was free from an appreciable film of oxide and did not contain occluded gases. The highly ignited oxide, obtained through the hydroxide or the sulphate, contained no gases and was not appreciably hygroscopic. The oxide obtained by igniting the nitrate was less satisfactory. To make possible the correction of the weights to the vacuum standard, the density of the oxide was also determined and found to be $5{\cdot}9_5$ grm./cm.$^3$. The value for the atomic weight based on this work is 69·74.—S. G.

***Thermal Effects Produced by the Exposure of Massive Gold to Saturated Water Vapour.** Frederick Barry and Elliott Pierce Barrett (*J. Amer. Chem. Soc.*, 1933, **55**, 3088–3098).—L. A. O.

***A Note on the Heat of Sorption of Water Vapour by Massive Gold.** Elliott Pierce Barrett (*J. Amer. Chem. Soc.*, 1933, **55**, 4006–4009).—See also preceding abstract.—L. A. O.

***A Revision of the Atomic Weight of Lanthanum. I.—The Analysis of Lanthanum Bromide. II.—The Specific Gravities of Lanthanum Chloride and Bromide. III.—The Increased Efficiency of Calcium Bromide as a Drying Agent at Low Temperatures.** Gregory Paul Baxter and Evelyn Emma Behrens (*J. Amer. Chem. Soc.*, 1932, **54**, 591–601).—A value of 138·92 is found for the atomic weight of lanthanum.—L. A. O.

***The Atomic Weight of Uranium Lead from Great Bear Lake, N.W.T., Canada, Pitchblende.** John Putnam Marble (*J. Amer. Chem. Soc.*, 1934, **56**, 854–856).—The atomic weight of lead extracted from Great Bear Lake, N.W.T., Canada, pitchblende is 206·054. This figure is slightly lower than the " mean mass-number " calculated from Aston's observations on identical material. It is in accord with a value of approximately 206 for " pure " uranium lead, if $Pb^{208}$ reported in the sample is derived from " common " lead.—L. A. O.

***Photoelectric Properties of Pure and Gas-Contaminated Magnesium.** R. J. Cashman and W. S. Huxford (*Phys. Rev.*, 1935, [ii], **48**, 475).—Abstract of a paper read before the American Physical Society. Specially purified samples of metallic magnesium were freed from gas by successive distillations and very slow sublimation in a high vacuum. The photoelectric threshold was found to be at 3430 ± 20 A., both for layers deposited on molybdenum and tantalum plates and for those deposited on the glass walls of the tube. A threshold characteristic of hydrogen-contaminated surfaces lies at 5100 A. Minute amounts of oxygen sensitize pure magnesium, causing a shift in the threshold to about 6000 A. Further exposure of this sensitized surface to small amounts of oxygen results in deactivation, and a recession of the threshold to a value below 2000 A. Air and hydrogen, or mixtures of oxygen and hydrogen, cause a marked increase in emission, with excursions of the long wave-limit to 7000 A. and beyond. Magnesium surfaces are sensitized by nitrogen only when a glow discharge is set up in the gas. These changes in work-function are explained on the hypothesis that surface films of polar non-homonuclear molecules are formed by the action of the various gases. Fowler's theory is found to hold accurately for magnesium surfaces activated by hydrogen, the apparent threshold at 5100 A. being changed to the true value 5040 A.—S. G.

†**On the Production and Properties of Pure Manganese.** S. A. Pogodin (*Metallurg* (*Metallurgist*), **1935**, (2), 101–110).—[In Russian.] A review of the literature.—N. A.

***The Principal Expansion Coefficients of Single Crystals of Mercury.** Donald M. Hill (*Phys. Rev.*, 1935, [ii], **48**, 620–624).—The expansion coeffs. ($\alpha$) were measured at 5° intervals from $-$ 115° to $-$ 160° C. and mean values determined from $-$ 160° to $-$ 190° C. The upper limit of the measurements was set by a recrystallization process which set in between $-$ 115° and $-$ 110° C. $\alpha_{\|}$ was found to be larger and to increase more rapidly with temperature than $\alpha_{\perp}$. The relation between expansion and temperature is not linear as found by Carpenter and Oakley (*Met. Abs.* (*J. Inst. Metals*), 1931, **47**, 468). Several crystals had lower specific resistances than the values of $\rho_{\|}$ given by Grüneisen and Sckell (*Met. Abs.*, 1934, **1**, 547).—J. S. G. T.

***Anchoring the Mercury Pool Cathode Spot.** Lewi Tonks (*Physics*, 1935, **6**, 294–303).—Certain metals projecting through a mercury cathode are known to "anchor" the cathode spot and prevent it wandering over the cathode. This property is found to characterize iron, palladium, zirconium, platinum, chromium, columbium, iridium, molybdenum, tantalum, tungsten, and depends on wetting of the metal by the mercury, and this again depends on the metal surface being clean.—J. S. G. T.

***The Atomic Heat of Nickel from 1·1° to 19·0° K.** W. H. Keesom and C. W. Clark (*Physica*, 1935, **2**, 513–520; also *Comm. K. Onnes Lab. Leiden*, No. **235e**, 1935; and (abstract) *Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 490–491).—[In English.] The atomic heat of nickel was measured from 1·1° to 19·0° K. The atomic heat surpasses largely the heat capacity due to the atomic lattice, calculated from Debye's $T^3$ law with $\Theta = 413$. The additional heat capacity for the range 1·1°–9·0° K. can be represented, however, by $C = 0{\cdot}001744T$. It follows another law and considerably surpasses the contribution that will be due to the interaction energy of the electrons that are responsible for ferromagnetism. The hypothesis is put forward that it is connected with the energy of the conduction electrons. The fact that it is many times larger than follows from Sommerfeld's formula for free electrons then shows that in the corresponding energy band, at least at the level of the limiting energy, the density of the possible energy states is particularly large. —S. G.

***On the Validity of Becker's Relation for the Initial Permeability of Highly-Drawn Nickel Wire.** Gertrud Scharff (*Z. Physik*, 1935, **97**, 73–82).—Becker's relation is expressed by the equations $n_0 = J_0/H = J\infty^2/3\lambda_E Z$, where $n_0$ is the initial permeability in a weak field of strength $H$, $J_0$ is the corresponding magnetic moment per cm.³ of the wire, $J\infty$ corresponds to magnetic saturation at the appropriate temperature, $Z$ the tension in the direction of $H$ (parallel to the axis of the wire), and $\lambda_E$ is the longitudinal saturation magnetostriction (*Z. Physik*, 1931, **71**, 553). This relation has been established at room temperatures by Kersten. It is now established that at temperatures up to the Curie point in the case of a nickel wire under tension: (1) the initial magnetization curve is linear in the case of large tensions, *e.g.* from 6·9 to 18 kg./mm.²; (2) the initial permeability is proportional to $1/Z$ and (3) the value of $3n_0Z$ agrees with the experimental value of $J\infty^2/\lambda_E$. Becker's relation is thus found to be obeyed.—J. S. G. T.

***Magnetic Properties of Nickel in the Neighbourhood of the Curie Point.** L. Néel (*J. Phys. Radium*, 1935, [vii], **6**, 27–34).—Apparatus for the accurate measurement of magnetic susceptibilities ($\chi$) in fields of strengths 50–1000 oerstedts at temperatures between the Curie point (358° C.) and 368° C. (correct to within $\pm$ 0·3°) is briefly described. The value of $1/\chi$ is found to vary in a regular manner with the temperature ($T$); the same is true of the first derivative of $1/\chi$ with respect to $T$. The magnetic characteristics shown by the 2 specimens of nickel examined in the immediate neighbourhood of the Curie point indicate a certain "spread" (*étalement*) of the Curie point of the order of 1°, which is greater the less pure the nickel. The values of $d(1/\chi)/dH^2$ expressed as a function of $T$ agree with the results due to Weiss and Forrer and confirm the value of 1 Bohr magneton attributed to the elementary carrier of the magnetism of nickel. The value of $dT/d(1/\chi)$ at the Curie point is equal to 71·3.—J. S. G. T.

***The Negative Matteucci Effect.** E. Englert (*Z. Physik*, 1935, **97**, 83–93).—Becker's theory of magnetization of materials under tension is extended to the case of nickel wires under torsion. The negative Matteucci effect (see Ostermann and v. Schmoller, *Z. Physik*, 1932, **78**, 690; 1935, **93**, 35) exhibited by a twisted nickel wire and by a wire composed of iron 92, nickel 8%, and by a nickel tube is found to be in approximate quantitative agreement with the theory.—J. S. G. T.

***The Gyromagnetic Effect of a Ferromagnetic Substance above Its Curie Point.** W. Sucksmith (*Helv. Phys. Acta*, 1935, **8**, 205–210; *C. Abs.*, 1935, **29**, 6809).—The magnetic moment of the nickel atom in metallic nickel differs below and above the Curie point (0·6 and 1·6 Bohr magnetons, respectively). The measurement of the gyromagnetic effect below the Curie point shows that the magnetism of the nickel atom arises from electron spin. There is no contribution from the orbital moment, since to a good approximation the Landé $g$ factor is found to have the value 2·0. Measurements show that in the paramagnetic state, above the Curie point, nickel atoms also display pure spin magnetism. The $g$ factor was determined for ferromagnetic nickel-copper alloy above the Curie point. In this alloy the nickel atom has the same magnetism as in pure nickel, and the value found $g = 2$ for the paramagnetic state excludes any effect of the orbital moment.—S. G.

***Diffusion of Deuterium in Metals [Palladium].** T. Franzini (*Atti R. Acad. Lincei* (*Roma*), 1935, **21**, 577–580; *Sci. Abs.*, 1935, [A], **38**, 790).—See also *Met. Abs.*, this vol., p. 203. Since it is known that hydrogen is readily occluded by palladium, this metal is used in an attempt to discover if deuterium also diffuses through metals. The experiment, which depends for solution on spectroscopy and micro-photometry, again shows that occluded hydrogen is displaced by an electric field, but gives no support to an analogous effect for deuterium.—S. G.

**The Absorption of Gases by Liquids and Solids, with Particular Reference to Hydrogen and Palladium.** F. J. Tromp and B. de Loor (*J. Chem. Met. Min. Soc., S. Africa*, 1934, **35**, 169–181).—A theoretical physico-chemical discussion. —A. R. P.

***Adsorption of Hydrogen by Palladium in Presence and Absence of Water.** M. I. Temkin and A. N. Bakh (*J. Phys. Chim. U.S.S.R.*, 1934, **5**, 809–811; *Brit. Chem. Abs.*, **1935**, [A], 1068).—[In Russian.] Neither water nor oxygen has any effect on the rate or amount of hydrogen adsorbed by palladium or palladium black at 15°–20° C. The total adsorption is 67·5 c.c. per grm.—S. G.

***Diffusion of Hydrogen in Palladium.** B. Duhm (*Z. Physik*, 1935, **94**, 434–436).—It is shown experimentally that for hydrogen concentrations between 0 and 30 and between 800 and 1000 volumes of the metal, solution phases of hydrogen and palladium are present in which unhindered diffusion of the gas can occur. The diffusion coeff. ($D$) is the same within both ranges and is equal to $9 \cdot 6 \times 10^{-5}$ cm.$^2$/second. The effective charge of the protons in palladium is found to be a small fraction of the elementary charge; this is attributed to screening by a swarm of electrons.—J. S. G. T.

***Different Forms of Hydrogen. An Attempt to Separate Them by Diffusion Through Palladium.** Victor Lombard and Charles Eichner (*J. Chim. physique*, 1934, **31**, 396–406).—L. and E. refer to experiments undertaken by them in 1929–1930 whereby allotropic modifications of hydrogen (apparently heavy and ordinary hydrogen) were separated by diffusion through palladium.—J. T.

***Permeability of Palladium to Hydrogen. V.—New Researches on the Influence of Temperature. Tests with Pure and Commercial Palladium. Permeability at Low Temperatures.** Victor Lombard and Charles Eichner (*Bull. Soc. chim. France*, 1935, [v], **2**, 1555–1577).—When a foil of pure palladium is arranged so that on one side there is a vacuum and on the other a pressure of 1 atm. of hydrogen, the rate of diffusion of the hydrogen through the metal at $T°$ C. is such that the volume of the gas which passes through 1 cm.$^2$ of the metal 1 mm. thick in 1 hr. is $9{\cdot}55T^{1/2} . e^{-1279/T}$, when $T = 250°$–$650°$ C. At temperatures below 250° C. diffusion decreases rapidly, the rate at 125° C. being only 0·0005 times that at 225° C.—A. R. P.

**On the Mechanism of Electrodiffusion of Hydrogen Through Palladium.** N. I. Kobosew and W. W. Monblanowa (*Acta Physicochim. U.R.S.S.*, 1934, **1**, 611–650).—[In German.]

***Adsorption of Oxygen and the Catalysis of Hydrogen Peroxide by Platinum.** V. A. Roiter and M. G. Leperson (*Visti Ukrainskogo Naukovo Doslidchogo Institutu Fizichnoï Khemii*, 1934, **4**, 41–48; *Brit. Chem. Abs.*, **1935**, [A], 1068).—[In Ukrainian.] Most of the oxygen adsorbed by platinum in anode polarization and all the hydrogen adsorbed by platinum in cathode polarization reacts with hydrogen peroxide. In the electrolysis of dilute sulphuric acid there is no sorption of electrolytic gas at either electrode if a sufficient [hydrogen peroxide] is maintained (anode 0·5%, cathode 1·8% of hydrogen peroxide). Cathodic polarization increases the catalytic activity of platinum in the decomposition of hydrogen peroxide. Anodic polarization decreases it. The activity is constant if electrolysis occurs in presence of hydrogen peroxide.—S. G.

***The Effect of Adsorbed Gases on the Photoelectric Emissivity of Iron and Platinum.** A. Keith Brewer (*J. Amer. Chem. Soc.*, 1932, **54**, 1888–1900).

***The Influence of Gases on the Photoelectric Effect of Platinum.** Ernst Schaaf (*Z. physikal. Chem.*, 1934, [B], **26**, 413–427).—S. G.

**The Rate of Solution of Sodium in Solutions of Methyl- and Ethyl-Alcohol in Benzene, Toluene, and Xylene.** J. Szper (*J. Chim. physique*, 1935, **37**, 447–454).—The rate of solution of sodium in solutions of methyl- and ethyl-alcohol in benzene, toluene, and xylene is found to decrease with diminishing concentration of the alcohol in solution, and is proportional to the concentration of $H^+$ ions in the solution. Solution is a process of the nature of diffusion.—J. T.

***Vapour Pressure Curves of Thallium at Very Small Vapour Densities.** F. Müller (*Helv. Phys. Acta*, 1935, **8**, 152–164; *Sci. Abs.*, 1935, [A], **38**, 647).—[In German.] By means of the method of line absorption a relative determination of the vapour pressure of thallium was made in the range of pressure from $1{\cdot}2 \times 10^{-6}$ to $7{\cdot}4 \times 10^{-4}$ mm. mercury. The following formula for the vapour pressure was found suitable for the region from 350° to 1200° C.: $\log_{10} p = - 52{\cdot}23A/T + B$, where $A$ and $B$ are constants depending on the temperature. —S. G.

***The Influence of Mechanical Deformation on the Rate of Transformation of Polymorphic Metals [Tin].** Ernst Cohen, W. A. T. Cohen de Meester, and A. K. W. A. van Lieshout (*Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 377–387). —[In German.] See also *Met. Abs.*, this vol., p. 415. Deformation of white tin by rolling, drawing, or bending is shown to increase very considerably the velocity of transformation ($V$) of the metal into the grey modification. Tempering after deformation reduces $V$ very considerably. $V$ depends on the intensity of the deformation increasing with increased deformation.—J. T.

***The Magnetic Anisotropy of Crystals of Tin and of Tin with Added Antimony, Cadmium, and Gallium.** (Hoge.) See p. 581.

***I.—The Adsorption of Hydrogen on Tungsten. II.—Some Properties of Adsorbed Films of Oxygen on Tungsten. III.—Composite Films of Oxygen and Hydrogen on Tungsten.** J. K. Roberts (*Proc. Roy. Soc.*, 1935, [A], **152**, 445–463, 464–477, 477–480).—Cf. *Met. Abs.*, this vol., p. 92. (I.—) The adsorption of hydrogen on a bare tungsten wire is studied experimentally. The process is one of chemi-sorption. There is one atom of hydrogen per atom of superficial tungsten. The heat of adsorption when a hydrogen molecule strikes a bare tungsten surface is 45 kilocals. per mol. $H_2$; if the hydrogen molecule strikes a place where 2 adjacent tungsten atoms are bare and all surrounding places are covered, the heat of adsorption is 18 kilocals. per mol. $H_2$. (II.—) The heat of adsorption and the amount of oxygen in the well-known stable adsorbed film have been measured; a second molecular film has been found. The mechanism of the adsorption process is discussed. (III.—) The adsorption of oxygen on a surface already covered with hydrogen is investigated; when an oxygen molecule is adsorbed, a hydrogen molecule is thrown off from the surface. The behaviour of hydrogen at a surface partially covered with oxygen is also investigated.—J. S. G. T.

***Emissive Power of Tungsten in the Ultra-Violet at High Temperatures.** F. Hoffmann and H. Willenberg (*Physikal. Z.*, 1934, **35**, 713–715).—S. G.

***Measurements of the Thermal Expansion of Cast and Rolled Zinc.** H. Goulbourne Jones (*Proc. Phys. Soc.* 1935, **47**, 1117–1128).—The coefficients of expansion of small specimens of cast and rolled zinc were determined in conditions of steady and of continuously increasing temperature, and marked differences between the coeffs. were found. On rolling, the random orientation of crystals in the cast specimen is broken up, and most of the long axes are set perpendicular to the plane of rolling. No change is produced in the volume coeff. of expansion by rolling. When the zinc crystals are small, the continuous expansion is also small, but as the crystal size increases the continuous expansion also increases. Discontinuities in the continuous expansion are associated with the long axis of the crystals. It is suggested that very small specimens give rise to an anomalous effect that would not be detected in large specimens, and that the growth of zinc crystals during heating may affect the expansion of the zinc. Values of the constants $\alpha$, $\beta$, $\gamma$, $\delta$ in the expansion formula $L = L_0(1 + \alpha t + \beta t^2 + \gamma t^3 + \delta t^4)$ are derived as follows: unannealed cast zinc; $\alpha = 27{\cdot}84 \times 10^{-6}$; $\beta = -47{\cdot}52 \times 10^{-9}$; $\gamma = 1{\cdot}78 \times 10^{-12}$; $\delta = -18 \times 10^{-15}$; annealed cast zinc; $\alpha = 29{\cdot}65 \times 10^{-6}$; $\beta = 10{\cdot}84 \times 10^{-9}$; $\gamma = -68{\cdot}4 \times 10^{-12}$; $\delta = 129 \times 10^{-15}$.—J. S. G. T.

***The Exact Measurement of the Specific Heats of Solid Substances at Higher Temperatures. XIX.—The Specific Heats of Zinc, Magnesium, and Their Binary Alloy $MgZn_2$.** T. J. Poppema and F. M. Jaeger (*Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 510–520).—[In English.] The mean specific heats $\bar{c}_p$ of zinc at temperatures, $t°$ C., between 100° and 360° C. are found to be given by $\bar{c}_p = 0{\cdot}93335 - 0{\cdot}389 \times 10^{-6}t + 0{\cdot}4236 \times 10^{-7}t^2$; the true specific heats, $c_p$, are given by $c_p = 0{\cdot}93335 - 0{\cdot}778 \times 10^{-6}t + 0{\cdot}12708 \times 10^{-6}t^2$; the atomic heats at constant pressure are given by $C_p = 6{\cdot}1013 - 0{\cdot}50858 \times 10^{-4}t + 0{\cdot}83073 \times 10^{-5}t^2$. The formulæ are not applicable between 165° and 175° C. nor between 330° and 340° C. where discontinuous changes in the metal have been definitely established to occur. At 0° C. $C_p$ has the value 5·935. Approximate values of $C_v$, the atomic heat at constant volume, are derived as follows: 100° C., 5·528; 200° C., 5·548; 300° C., 5·714; 400° C., 6·022. Values of $\bar{c}_p$ for magnesium for various ranges of temperature between 100° and 550° C. are tabulated. Values of $c_p$ within this temperature range are given by $c_p = 0{\cdot}241306 + 0{\cdot}1052836 \times 10^{-3}t - 0{\cdot}4725 \times 10^{-10}t^2$. Values of $C_p$, the atomic heat at constant pressure, are given by $C_p = 5{\cdot}8637 + 0{\cdot}25585 \times 10^{-2}t - 0{\cdot}1148 \times 10^{-8}t^2$. Values of $\bar{c}_p$, the mean specific heat, of $MgZn_2$ within the range 100° are given by $\bar{c}_p = 0{\cdot}113545 + 0{\cdot}21902 \times 10^{-4}t$. Values of $c_p$ are given by $c_p = 0{\cdot}113545 + 0{\cdot}43804 \times 10^{-4}t$, while values of $C_p'$, the molecular heat, are given by $C_p' = 17{\cdot}60604 + 0{\cdot}679216 \times 10^{-2}t$. The alloy shows no polymorphic transformation. A volume contraction of about 8% occurs in the formation of the alloy from the elements.—J. S. G. T.

***Metallic Cohesion (Bindung).** Paul Gombás (*Z. Physik*, 1935, **94**, 473–488).—A theory of the binding forces in metals is developed. It is assumed that the binding energy in a metal is associated with the electrostatic interaction of the positive ionic lattice with the uniformly-distributed electron gas composed of metallic electrons. The theory is applied to calculated values of the lattice constant ($\delta$), heat of sublimation ($s$), and compressibility ($K$) of potassium with the following results (experimental values in brackets): $\delta_0$, 4·5$_2$ A., (5·15 A.); $s$, 20·8 k. cal./mol. (26·5); $k$, $1{\cdot}1 \times 10^{-11}$ cm.$^2$/dyne ($2{\cdot}0 \times 10^{-11}$). No empirical parameters are involved in the calculations. (See also following abstract.)—J. S. G. T.

**Theory of the Alkali Metals.** Paul Gombás (*Z. Physik*, 1935, **95**, 687–691).—In continuation of previous work (see preceding abstract), G. improves the theory and derives the following values for certain physical constants in the case of potassium: lattice constant, 5·43 A.; lattice energy, 112·4 k.cal./mol.; compressibility, $2{\cdot}6 \times 10^{-11}$ cm.$^2$/dyne; compared with respective experimental values 5·15 A.; 126·2 k.cal./mol.; $2{\cdot}0 \times 10^{-11}$ cm.$^2$/dyne.—J. T.

***Optical Constants of the Alkali Metals.** M. I. Sergeev and M. G. Chernikovskii (*Physikal. Z. Sowjetunion*, 1934, **5**, 106–114).—[In English.] See abstract from Russian source, *Met. Abs.*, this vol., p. 93.—S. G.

***Influence of Temperature on the Plasticity of Crystals.** Pol E. Duwez (*Phys. Rev.*, 1935, [ii], **48**, 484).—Abstract of a paper read before the American Physical Society. The theory of the plasticity of crystals recently published (*Met. Abs.*, this vol., p. 293) has been extended in order to take into account the influence of temperature on the stress–strain curve. The model of the deformed crystal, deduced from Zwicky's secondary structure theory, shows that the two quantities $G$ and $\tau_{\text{max.}}$, *i.e.* the modulus of elasticity and the stress producing rupture of the crystal, are dependent on the temperature. Further, $G$ and $\tau_{\text{max.}}$ vary independently. The relation between stress and strain, therefore, remains the same, with $G$ and $\tau_{\text{max.}}$ functions of $T$ instead of constants. The variation of $G$ is known for a number of metals over a wide range of temperature. In general, a linear function can be used, except in the neighbourhood of crystallographic or magnetic transition points. Very few data are available concerning the temperature dependence of $\tau_{\text{max.}}$ for single crystals. Many polycrystalline metals were studied up to their melting points. It seems probable that $\tau_{\text{max.}}$ is a function of the ratio $T/T_m$, $T_m$ being the melting temperature. The curve $\tau_{\text{max.}}$ $(T/T_m)$ is characteristic and is almost a straight line, except for values of the ratio $T/T_m$ approaching 0 and 1. Simple theoretical calculations may explain the general form of the function $\tau_{\text{max.}}$ $(T/T_m)$.—S. G.

***New Method for Studying the Plastic Deformation of Metals.** L. V. Nikitin and V. O. Sochevanov (*Metallurg* (*Metallurgist*), **1935**, (1), 23–34).—[In Russian.] The deformation of iron and some non-ferrous metals was studied by measurements of the electrode potential. The shape of the potential–load curve is closely connected with the degree of deformation, and the curve shows the elastic limit more precisely than do extensometric measurements. As the specimen elongates the potential becomes more negative owing to the increase in internal energy. The method enables measurements to be made of stresses in localized portions of metallic structures.—N. A.

***Hyperbolic Paraboloid of Volume Deformation.** Ig. M. Pavlov (*Metallurg* (*Metallurgist*), **1935**, (2), 88–100).—[In Russian.] The plane diagram of deformation (the relation between longitudinal and transverse deformation) is important both for the generalization of the various methods of pressure working and for understanding the phenomena of applied deformation and lateral extension. The space diagram of the general expression of deformation $\frac{H}{h} = \frac{L_2}{L_1} \cdot \frac{B_2}{B_1}$ (where $\frac{H}{h}$ = stretching, $\frac{L_2}{L_1}$ = longitudinal deformation,

$\frac{B_2}{B_1}$ = transverse deformation) has an inclined surface which is a hyperbolic paraboloid. Such a diagram is critically examined and the influence thereon of various factors considered.—N. A.

†**The Exploitation, by the Engineer, of the Resistance of Materials.** M. A. Caquot (*Génie civil*, 1933, **103**, 436).—Read before Société des Ingénieurs Civils. Deals largely with the resistance of materials to alternating stress.—W. P. R.

**A Note on the Surface Temperature of Sliding Metals.** F. P. Bowden and K. E. W. Ridler (*Proc. Cambridge Phil. Soc.*, 1935, **31**, 431–432).—A simple calculation shows that if one body slides on another the temperature at the rubbing surfaces may attain a very high value. Lead, sliding on steel with a velocity of 1570 cm./second, is found, experimentally, to attain a surface temperature of 327° C. (melting point 328° C.).—J. S. G. T.

***Calculation of the Heats of Relaxation of Metals from Recrystallization Data.** J. A. M. van Liempt (*Z. Physik*, 1935, **96**, 534–541).—It is shown that the heat of relaxation $E$ of a metal can be calculated from the equation $E = 4{\cdot}6C + 1200\beta$, where $C$ denotes the recrystallization constant and $\beta$ is the degree of physical deformation characterizing recrystallization. Approximately, $E = 4{\cdot}6\ C$ or, more nearly, $E = 80T_R$ where $T_R$ is the temperature of recrystallization. Another approximation is $E = 32T_S$, where $T_S$ denotes the melting point. Values of $E$ for iron, nickel, gold, silver, copper, aluminium, platinum, tantalum, tungsten, molybdenum, and lead are calculated and are found to be in good agreement with values otherwise obtained. The thermal diffusion formulæ of Langmuir and of v. L. are briefly discussed.—J. S. G. T.

***The Diffusion of Gases Through Metals.—I.** C. J. Smithells and C. E. Ransley (*Proc. Roy. Soc.*, 1935, [A], **150**, 172–197; and (summary) *Metallurgist* (Suppt. to *Engineer*), 1935, **10**, 68–71).—The rate of diffusion of hydrogen through copper, nickel, iron, and molybdenum, and of nitrogen through molybdenum was determined over a wide range of temperature and pressure. The effect of temperature is satisfactorily represented by the exponential term in Richardson's equation. The effect of pressure is only approximately represented by the equation $D = k\sqrt{P}$, the deviation from this relation being most marked at low pressures. All published data are examined and found to exhibit the same deviation. An allowance is made for the fraction of the surface covered by adsorbed gas, by introducing the Langmuir isotherm, and the equation $D = K\sqrt{P}(aP(1 + aP))$ accurately represents the experimental results. The effect of adsorption on diffusion is emphasized, and it is shown that activated adsorption is necessary for diffusion to take place. Adsorption coeffs. can be determined from diffusion measurements by means of the above equation. No diffusion of argon or helium could be detected with any metal, and if it does occur the rate is not more than $10^{-5}$ times the rate for the common gases. The rate of diffusion of hydrogen through a single crystal of iron is the same as through ordinary fine-grained iron.—Authors.

***Adsorption of Alkali Metals on Metal Surfaces. IV.—Adsorption of Atoms Next to Ions. V.—Influence of Temperature on the Normal Photoelectric Effect. VI.—The Selective Photoelectric Effect.** J. H. de Boer and C. F. Veenemans (*Physica*, 1935, **2**, 521–528, 529–534, 915–922).—[In English.]
—S. G.

***The Vapour Pressure of Metals.** F. F. Coleman (*Univ. Oxford Abstracts of Dissertations Doctor Philosophy*, 1934, **6**, 140–143).—The vapour pressures of magnesium, thallium, and zinc were determined by a refinement of Egerton's modification of Knudsen's effusion method. The data obtained satisfy the following gaussian root mean square straight-line equations: for magnesium, $\log p = -\ 7219/T + 8{\cdot}125$; for thallium, $\log p = -\ 9125/T + 8{\cdot}216$; and for zinc $\log p = -\ 6533/T + 8{\cdot}515$, where $T$ is the absolute temperature. The slopes of these equations give the following values for the heats of evaporation: magnesium 33,027 ± 260 at 711·0° abs., thallium 41,746 ± 330 at 878·7° abs., and zinc 29,886 ± 120 at 605·2° abs. Evaluation of the chemical constants of these metals from the data obtained shows good agreement with theory only in the case of thallium; the reason for the anomalous results for magnesium and zinc is discussed.—A. R. P.

***The Sputtering of Metals by Incidence of Slow Ions, and Measurement of the Threshold Values of Sputtering (Voltage).** Heinrich Lüder (*Z. Physik*, 1935, **97**, 158–170).—The sputtering of various metals by incidence upon them of slow argon or alkali ions is investigated. The following threshold values of the sputtering voltages for the respective voltages were found. (1) With argon: nickel, 7 v.; copper, 12 v.; iron, 14 v.; tungsten, 24 v. (2) $K^+$ ion with tungsten, 36 v.; $Cs^+$ ion with tungsten, 15 v.; $Li^+$ ion with tungsten, 80 v.; $Cs^+$ ion with copper, 15 v. The results agree better with theoretical results calculated in accordance with Holst's theory than with those deduced from Langmuir's theory.—J. S. G. T.

***A New Method and Apparatus for the Production of Highly-Dispersed Phases.** B. Claus (*Z. tech. Physik*, 1935, **16**, 80–82).—Apparatus for producing highly-dispersed phases, more especially of metals, employing a high-frequency quartz piezo-oscillator, is described and illustrated by reference to results obtained with mercury, silver, iron, and platinum.—J. S. G. T.

***The Reflection of Some Metals (Copper, Zinc, Nickel, Silver, Hochheim Alloy) in the Spectral Region from 300 to 186 mμ.** Franz Hlučka (*Z. Physik*, 1935, **96**, 230).—Values of the reflection coeffs. of copper, zinc, nickel, silver, and Hochheim alloy in the spectral region 300–186 mμ were determined.
—J. S. G. T.

***On the Reflection Factor of Very Thin Films of Metal.** Pierre Rouard (*Rev. d'Optique*, 1934, **13**, 23–79).—The reflection factor of thin films of gold and silver deposited on glass was measured for varying thicknesses of film and wave-lengths of light at the air–metal and glass–metal surfaces. In the latter case, the reflection factor decreased to a minimum with increasing thickness of the film, and subsequently increased: the position of the minimum depended on the wave-length, which also influenced the thickness of film at which the minimum occurred. The corresponding curve for the metal–air surface showed a distinct discontinuity. Normally incident white light produced characteristic colour effects in the case of the metal–glass surface.—P. M. C. R.

**Parachor and Entropy of Metallic Elements.** Binayendra Nath Sen (*J. Chim. physique*, 1935, **32**, 300–302).—Values of the entropy, $S$, of the elements copper, mercury, aluminium, zinc, lead, potassium, sodium, and cadmium are calculated using data relating to the parachor, atomic radius, atomic weight, melting point, atomic heat, and valency which are tabulated. Satisfactory agreement is found between observed and calculated values of $S$.
—J. S. G. T.

**Influence of Polarization on Photo-Voltaic Effects.** Marie Theodoresco (*J. Chim. physique*, 1934, **31**, 433–438).—The photo-voltaic effect observed with a copper electrode covered with cuprous or cupricoxide indicates that the surface of the electrode is irreversibly changed by polarization.—J. S. G. T.

**Photoelectronic Effect of Incandescent Metals.** C. M. I. Vercelli (*Atti Acad. Sci. Tornic*, 1934–1935, **70**, 462–471; *Sci. Abs.*, 1935, [A], **38**, 961).—The theory of the photoelectronic effect of surfaces (Hallwach's effect), put forward by Fowler, leads to the confirmation that the photo-thermoelectronic effect observed by Deaglio is a Hallwach's effect produced at high temperature by light of frequency notably lower than the photoelectronic frequency limit.
—S. G.

**The Volta Effect and the Peltier Effect.** Filippo Odone (*Nuovo cimento*, 1935, **12**, 273–284; *C. Abs.*, 1935, **29**, 7145).—Starting from Duhem's thermodynamic theory of electrical phenomena in metallic conductors, O. shows that there is an internal and an external Volta effect and relations between them and the Peltier effect are derived.—S. G.

***Displacement of the Curie Point by Tension.** E. Englert (*Z. Physik*, 1935, **97**, 94–96).—No displacement of the Curie point of a wire due to tension could be found; any such displacement (which was within the limit of experimental error) as did occur was certainly less than $\frac{1}{20}$ of that found by Ray-Chaudhuri (*Met. Abs.* (*J. Inst. Metals*), 1931, **47**, 642).—J. S. G. T.

***The Effect of Magnetization on Young's Modulus of Elasticity of Some Ferromagnetic Substances.** Kiyosi Nakamura (*Sci. Rep. Tôhoku Imp. Univ.*, 1935, [i], **24**, 303–331).—[In English.] Three methods for measuring Young's modulus and its variation in ferromagnetic substances are described together with suitable means for overcoming possible sources of error. For electrolytic iron and cobalt Young's modulus ($E$) remains const. on magnetization of the metal, but for electrolytic nickel it increases almost linearly with the intensity of magnetization ($I$), the increase in the value of $E$ being 17% when $I = 479$ c.g.s. units. In nickel–iron alloys $E$ varies with the nickel content, reaching a pronounced minimum at 30% nickel [*Note by Abstractor*: This value is taken from the graph, in the text 40% nickel is said to be the minimum] and a vague maximum at 85% nickel. The value of $dE/E$ produced by magnetization of iron–nickel alloys is very small and negative up to 30% nickel, then increases rapidly to a maximum at 50% nickel, decreases to a minimum at about 70% nickel, and finally again increases rapidly.—A. R. P.

**Thermo-Dynamics of Stationary Systems. I.—The Thermo-Element. II.—The Diffusion Element.** B. Bružs (*Proc. Roy. Soc.*, 1935, [A], **151**, 640–651, 651–665).—(I.—) The introduction of two arbitrary assumptions into the discussion of the thermodynamics of stationary systems leads to the result that the problem of the thermo-element can be reduced to a knowledge of thermal and electrical conductivities. (II.—) Equations connecting the Helmholtz coeff. with the Peltier coeff. and the coeff. of the homogeneous effect, and with the coeffs. of diffusion and electrical conductivity are derived. The problem of the diffusion element is thus reduced to a knowledge of diffusion and electrical conductivity.—J. S. G. T.

**Diamagnetism of Elements in the Powdered State.** Mulk Raj Verma and I. C. Gupta (*Current Sci.*, 1935, **3**, 611–612; *C. Abs.*, 1935, **29**, 6116).—The change in magnetic susceptibility of bismuth, antimony, gold, silver, and selenium, with particle size is critically reviewed. Dharmatti's work with selenium (*Nature*, 1934, **134**, 497) was repeated. By taking adequate precautions to prevent oxidation and other contamination, the magnetic susceptibility was found to be independent of the particle size. Oxidation is probably the major cause of the variations of magnetic susceptibility with particle size that have been reported.—S. G.

**Colloidalization and Cold-Working of Metals.** S. Ramachandra Rao (*Current Sci.*, 1935, **4**, 24–25; *C. Abs.*, 1935, **29**, 7246).—Non-ferromagnetic metals are assumed to consist of a lattice of metallic ions, the remaining electrons being associated with two or more nuclei, and considered as free or partly bound in accordance with their relative energy values. The magnetic susceptibility of the metal is the sum of the susceptibilities of the ions and of the valency electrons. The first is constant; the second is influenced by physical conditions. If the valency electrons have large orbits, or are loosely attached to two close atoms, as in graphite and bismuth, diamagnetism decreases on colloidalization, since large orbits are impossible at the surface. In good conductors, such as copper and silver, the electrons on the surface of the atoms are free. Cold-working of these metals gives rise to increased diamagnetism because of (1) diminution of free electrons and of the paramagnetic component (caused by expansion) and (2) the increase in the diamagnetic component due to the increased number of bound electrons. The same effect was produced in copper by colloidalization (in an inert organic liquid, in the absence of air). The discussion of the effect of impurities given by Verma and Gupta (preceding abstract) is criticized.—S. G.

***A Note on the Hall and Magneto-Resistance Effects.** D. Schoenberg (*Proc. Cambridge Phil. Soc.*, 1935, **31**, 271–276).—Kohler (*Ann. Physik*, 1934, **20**, 878, 891) on the basis of experimental work by Verleger (*Met. Abs.*, 1934, **1**, 593) has questioned the validity of the usual assumption that the linear Hall effect is entirely perpendicular to the current, as assumed by Voigt. The experimental work of van Everdingen supports the perpendicularity hypothesis. The rejection of this hypothesis leads to the conclusion that the magneto-resistance of a polycrystal or single crystal, *e.g.* bismuth, should differ for opposite directions of the magnetic field in the crystal; this is found not to be the case and the perpendicularity hypothesis is established as valid in the case of bismuth at least. A new type of Hall effect is predicted by the analysis. The dissymmetry of the Hall effect is discussed and some of Kohler's results are generalized and are to be investigated further.—J. S. G. T.

**The Variation of Thermal E.m.f. with Magnetization.** F. Woodbridge Constant (*Phys. Rev.*, 1935, [ii], **47**, 794).—Abstract of a paper read before the American Physical Society. The variation of the e.m.f. of a thermocouple when one of the metals is magnetized was first discovered by William Thomson in the case of iron and nickel. This means that a couple may be formed entirely of one material provided that the magnetization is not the same throughout. In spite of many investigations of this effect since Thomson's observation, the results are conflicting and the conclusions confusing. This paper attempts (1) to summarize previous work, and (2) to repeat measurements of the effect on as many different ferromagnetic metals as possible, in exactly the same conditions, in order that the resulting data might be more available for interpretation. Iron, nickel, cobalt, and Permalloy were tested by comparison of the ferromagnetic metal first unmagnetized and then magnetized in a uniform magnetic field against copper. There are indications of a connection between this effect, the change of length in a magnetic field and crystal structure which is of interest as regards theories of ferromagnetism. —S. G.

***The Variation with Magnetic Field and Temperature of the Thermoelectric Properties of Ferromagnetics.** F. E. Lowance and F. Woodbridge Constant (*Phys. Rev.*, 1935, [ii], **48**, 257–260).—It is known that a thermocouple may be composed entirely of iron or nickel provided that the metal is partly in and partly outside a magnetic field. Previous work on this subject is reviewed. Measurements on iron, nickel, cobalt, and Permalloy from room temperature to above the Curie point indicate that the e.m.f. produced by a magnetic field in these thermocouples is conditioned by (1) the crystal structure, and (2) the change in direction of the resulting spins or intrinsic magnetization in separate crystal regions, and that this effect is related to the change of length on magnetization. —J. S. G. T.

**Magnetism.—I.** R. Becker and L. Landshoff (*Die Physik*, 1935, **3**, 91–108; *Sci. Abs.*, 1935, [A], **38**, 671).—A review of the rapid developments of knowledge of magnetism which has taken place more particularly during the past 8 years, brought about by the discovery of electron spin and the application of quantum mechanics. More exact calculations were made possible, especially in dia- and para-magnetism, with consequent reaction on experimental investigations. The demands for improved quality of magnetic material in electrotechnics has also led to numerous researches and to a deeper insight into the process of magnetization. The subjects dealt with are: diamagnetism; ionic susceptibility; paramagnetism; rare earths; the iron group; palladium-, platinum-, and uranium-transition groups, homeopolar molecules and combinations of compound ions; ferromagnetism, general theory, gyromagnetic effects, the magnetization curve, its different parts; Heusler and related alloys, magnetization and resistance, Bitter's strips, permeability and frequency, magnetic after-effect. Detailed reference is given throughout to the *Physikalische Berichte*, where the original papers consulted are to be found.—S. G.

***The Demagnetization Factor of Cylindrical Rods.** F. Stäblein and H. Schlechtweg (*Z. Physik*, 1935, **95**, 630–646).—A method for calculating the demagnetization factor of cylindrical rods, simpler than that of Wurschmidt though having the same basis, is discussed mathematically. The mode of dependence of the factor on relative dimensions and susceptibility is given in the form of a table, which lends itself readily to graphical interpolation.
—J. S. G. T.

***Crystal Structure and Electrical Properties. VI.—The Eight Principal Electrical Conductivities of a Bismuth Single Crystal in a Magnetic Field.** O. Stierstadt (*Z. Physik*, 1935, **95**, 355–364).—See *Met. Abs.*, this vol., p. 413. The 8 parameters of magnetic change of resistance of a bismuth crystal in a magnetic field are discussed, and the correctness of Kohler's rules for their derivation in the case of weak magnetic fields is established. The importance of these parameters in the discussion of the anisotropy exhibited by the electrical conductivity of a crystal lattice in a magnetic field is stressed.
—J. S. G. T.

***Magnetic Change of [Electrical] Resistance in Metallic Crystals.** Max Kohler (*Z. Physik*, 1935, **95**, 365–382).—Anomalies exhibited by the change of the electrical resistance of metallic crystals in strong magnetic fields are explained if the expression for the effect of the field is developed as far as the sixth power of the field-strength. The significance of Stierstadt's work (see preceding abstract) is referred to. The paper is mathematical throughout.
—J. S. G. T.

**Theory of Superconduction.** M. v. Laue and F. and H. London (*Z. Physik*, 1935, **96**, 359–364).—F. London and H. London have developed a theory of superconduction in which Ohm's law is replaced by a series of differential equations (*Proc. Roy. Soc.*, 1935, [A], **149**, 71). Heat production by a steady current in a superconductor is discussed mathematically in accordance with this theory. The supercurrent in a superconductor is to be considered as a diamagnetic current, such that the magnetic field is itself produced by the current.—J. S. G. T.

***Theory of Superconduction of the Elements. III.—The Origin and the Range of Validity of the Proposed Criterion of Superconduction.** Z. A. Epstein (*Z. Physik*, 1935, **96**, 386–409).—A mathematical theory which enables the elements to be arranged in alternate groups of superconducting and non-superconducting elements is developed. It is shown that values of $a_m \sqrt{e}$ ($a_m$ denoting the maximum amplitude of atomic oscillation, and $e$ the interatomic distance) are not very different for superconductors and are less than corresponding values for non-superconductors. The special case of gallium is discussed; the apparently anomalous position of this superconductor is shown to conform to the general scheme of classification.—J. S. G. T.

***Phase Equilibrium of Superconductors in a Magnetic Field.** H. London (*Proc. Roy. Soc.*, 1935, [A], **152**, 650–663).—The disturbance of superconductivity by a magnetic field is treated thermodynamically in accordance with the electrodynamic equations of superconductors proposed by F. and H. London (*Proc. Roy. Soc.*, 1935, [A], **149**, 71). A threshold value of the current density and not of the magnetic field is the decisive quantity in the theory.—J. S. G. T.

**Phenomena of Superconductivity.** Olga Bertoli (*Nuovo cimento*, 1935, **12**, 93–119; *Sci. Abs.*, 1935, [A], **38**, 759).—A *résumé* is given of the work of Onnes and his collaborators on the effect of low temperatures, approaching absolute zero, on the electrical conductivity of metals and alloys. The effects of magnetic fields and electric currents are noted, and also the change in the critical point for a.c. of high frequency. Other properties of superconductivity are mentioned briefly.—S. G.

***†A Discussion on Superconductivity and Other Low Temperature Phenomena.** J. C. McLennan and others (*Proc. Roy. Soc.*, 1935, [A], **152**, 1–46).—McL. refers to new methods of liquefying helium, the properties of helium, lowest temperatures attainable, superconducting metals and their films, magnetic fields surrounding superconductors, the Hall effect, thermal conductivity, the anomalous behaviour of certain alloys more especially $PbTl_2$, low temperature calorimetry, specific heats, and electromagnetic theory. *W. H. Keesom* discussed the λ-phenomena in liquid helium, the thermodynamical temperature scale below 0·9° K., the heat capacity of electrons, and the calorimetry of superconductors. *W. Meissner* referred to magnetic effects occurring on transition to the superconducting state; *L. Brillouin* discussed the difficulties of interpreting superconductivity; *N. Kürti* and *F. Simon* discussed a preliminary determination of the thermodynamic scale of temperature below 1° K. *F. London*, in a mathematical paper, discussed the macroscopical interpretation of superconductivity.—J. S. G. T.

***Experiments at Very Low Temperatures Obtained by the Magnetic Method. II.—New Superconductors.** N. Kürti and F. Simon (*Proc. Roy. Soc.*, 1935, [A], **151**, 610–623).—It is shown how the measurement of the magnetic behaviour of a metal at low temperatures can be used for the detection of superconductivity, and for determining the transition point and threshold values. Cadmium, zirconium, and hafnium are found to be superconductive, the normal transition temperatures being, respectively, 0·54°, 0·70°, and 0·35° abs. Gold, copper, bismuth, magnesium, and germanium did not become superconductive at temperatures down to 0·05° abs.—J. S. G. T.

**†The Theory of Electrons in Metals: Superconductivity.** Léon Brillouin (*Rev. gén. Elect.*, 1935, **38**, 491–501).—A review of recent work.—J. C. C.

**On the Mean Free Path of Metal Electrons.** Mizuho Satô (*Sci. Rep. Tôhoku Imp. Univ.*, 1935, [i], **24**, 14–25; *Sci. Abs.*, 1935, [A], **38**, 950).—[In German.] Values of the mean velocity, impact number of electrons with atoms, and mean free path of metal electrons are derived by application of Fermi statistical theory. It is shown that the mean free path of the electrons decreases proportionally to the square of the absolute temperature in the case of a strongly degenerate condition of the electron gas. A formula for the electrical conductivity of metals is deduced, and Brownian motion is briefly discussed. —S. G.

**The Number of Free Electrons in a Metal.** H. Fröhlich (*Proc. Cambridge Phil. Soc.*, 1935, **31**, 277–280).—It is shown that a simple expression for the number of free electrons in a metal can be deduced mathematically from the general theoretical model of a metal as developed by Bethe without making special assumptions concerning the potential field in the metal.—J. S. G. T.

---

## II.—PROPERTIES OF ALLOYS

(Continued from pp. 503–510.)

***Kinetics of the Decomposition of Solid Solutions Al–Mg.** M. I. Zacharowa and W. K. Tschikin (*Z. Physik*, 1935, **95**, 769–774).—The following limiting solubilities of aluminium in magnesium were found at the temperatures stated (° C.): 150°, 2·0%; 218°, 3·3%; 300°, 6·2%. Decomposition of the cold-worked alloys is completed in about 30 minutes at 150° C.; in about 30 secs. at 218° C. In alloys, slowly cooled from 425° C. to these respective annealing temperatures the decomposition of the solid solution is a two-phase process; down to 300° C. the decomposition is one-phase in character.

The decomposition process at 218° C. lasts between 100 and 150 hrs. according to the concentration of aluminium. In quenched alloys, the decomposition process at 218° C. is at first single-phased then two-phased.—J. S. G. T.

***Quenching Stresses and Precipitation Reactions in Aluminium–Magnesium Alloys.** R. M. Brick, Arthur Phillips, and A. J. Smith (*Metals Technology*, 1935, **2**, (Sept.); *A.I.M.M.E. Tech. Publ.* No. 650, 1–16).—The stresses in quenched rods of copper– or magnesium–aluminium alloys are a function of the difference between the parameter of the alloy and that of pure aluminium as related to the concentration of solute atoms. In the magnesium alloys where the high temperature solubility of 16 atomic-% produces a lattice expansion of 0·0750 A. the stresses produced by quenching may greatly exceed the strength of the alloy and thus produce deformation or cracking; stresses of 32,000 lb./in.$^2$ were produced in a $\frac{1}{2}$ in. rod of the 10% magnesium alloy by quenching. The rate of precipitation on ageing quenched, fully saturated solid solutions is the same for the copper as for the magnesium series, but for solid solutions having the same concentration of solute atoms (1·8%) the copper alloy precipitates completely in 20 minutes, whereas the magnesium alloy requires 1000 hrs. owing partly to the slow rate of diffusion of the relatively large magnesium atoms. Ageing temperature, internal stress, and grain-size affect the rate of precipitation in so far as they affect the rate of diffusion of the solute atoms. In ageing the copper alloys at 140°–325° C. the maximum hardness occurs just before X-ray examination shows precipitation to be complete, whereas in the magnesium alloys at 175°–300° C. it occurs just after complete precipitation.—A. R. P.

***On the Influence of Metals of the Iron Group on the Age-Hardening of Aluminium Alloys of High Purity.** W. Koch and F. W. Nothing (*Aluminium*, 1935, **17**, 535–546; also (summaries) *Light Metals Research*, 1935, **4**, 135–138, and *Met. Ind.* (*Lond.*), 1935, **47**, 561–562).—The effect of additions of up to 2% of iron, cobalt, nickel, and molybdenum on the age-hardening of the 4% copper–aluminium alloy was investigated by constructing time–hardness curves for room temperature, 135° C., and 200° C. With increasing additions of iron the hardness of the alloys quenched from 525° C. and aged at 20°–200° C. is decreased, since the iron withdraws copper from solid solution forming the ternary compound $Cu_2FeAl_2$. Cobalt is practically insoluble in solid aluminium at any temperature but forms with it the compound $Co_2Al_9$, thereby increasing the concentration of the copper in solid solution in the remainder of the aluminium and thus increasing slightly the hardening effects. Nickel slightly reduces the hardening effect probably by forming a ternary compound, but $NiAl_3$ itself can produce a slight hardening effect. Molybdenum has a somewhat similar effect to that of nickel except that it appears to produce age-hardening effects after the alloy is quenched from 360° C. which are relatively greater than those produced by the molybdenum after quenching from 525° C.—A. R. P.

**Age-Hardening of Duralumin.** —— Bollenrath (*Metallurgist* (Suppt. to *Engineer*), 1932, **8**, 123–125).—A summary of a paper by B. in *Abh. Aerodyn. Inst. Tech. Hochschule Aachen*, **1931**, (10).—R. G.

**The Influence of Metallic Impurities on Aluminium and Magnesium Alloys.** A. S. Lugaskov (*Legkie Metalli* (*Light Metals*), **1935**, (5), 32–34).—[In Russian.] Review of the literature.—D. N. S.

***Aluminium Antifriction Alloy as a Substitute for Tin-Base Babbitts.** G. M. Hazkevich and N. M. Trembovler (*Liteinoe Delo* (*Foundry Practice*), **1935**, (6), 25–26).—[In Russian.] An aluminium-base bearing metal, containing copper 4–5, lead 8, and zinc 10%, is produced by adding to molten aluminium at 740°–750° C. under a layer of a salt flux first a 50 : 50 copper–aluminium alloy, then the zinc and finally the lead, and casting at 620°–640° C. into dry-sand moulds. The castings have a Brinell hardness of 65–70, a breaking strength of 13 kg./mm.$^2$, an elongation of 2%, and *d* 2·9. In Amsler tests under a pressure of 15 kg./cm.$^2$ the coeff. of friction is 50% smaller, and under 25 kg./cm.$^2$ is 17% smaller than that of tin-base Babbitt; the volume wear is 65% less than that of tin-base Babbitt. The results of tests under practical conditions in electric motors are given.—N. A.

***Investigation of the Kinetics of the Decomposition of Solid Solutions of Silicon in Aluminium.** M. I. Zacharowa (*Z. Physik*, 1935, **96**, 754–760).—The decomposition of the solid solution of silicon in aluminium is accelerated by plastic deformation. The isothermal decomposition of the undeformed alloys at 218° and 280° C. comprises three stages, *viz.* (1) a latent period, (2) a period of spontaneous decomposition, and (3) a period of growth and coagulation of the crystallites. The Brinell hardness of the alloys attains its maximum value at the commencement of the third period.—J. S. G. T.

***X-Ray Study of Aluminium–Zinc Alloys at Elevated Temperatures.** (Owen and Pickup.) See p. 592.

***Study of Diagrams of State of the System Chromium–Cobalt and Chromium–Nickel Carbides.** N. M. Zarubin and R. A. Trubnikov (*Redkie Metalli* (*Rare Metals*), **1935**, (2), 38–40).—[In Russian.] Chromium carbide was obtained by sintering carbon and chromium for 1–2 hrs. at 1500° C., or by sintering carbon and chromium oxide at the same temperature for 2–3 hrs. A mixture of $Cr_3C_2$, and $Cr_7C_3$ was obtained which, according to X-ray analysis, contained 13·1–13·6% carbon. The carbide sintered with the corresponding metal at 1450°–1600° C., the temperature depending on the carbide content. The solubility of chromium carbide in cobalt was found by microscopic examination to be 8%. The eutectic of cobalt carbide and cobalt solid solution was found to be at 35% carbide and 1415° C. The solubility of chromium carbide in nickel is 8%; the eutectic is at 30% carbide and 1375° C. —D. N. S.

**Alloys of Iron and Chromium.** V. N. Krivobok (*Trans. Amer. Soc. Metals*, 1935, **23**, 1–60).—Ninth Edward de Mille Campbell Memorial Lecture. While strictly not non-ferrous in character, this paper discusses fundamental ideas which are common to many, if not all, alloy systems, and the particular iron–chromium system is cited as an example. The whole field is examined critically in the light of physico-chemical conceptions, and especial attention is given to the influence of low and slightly elevated temperatures on certain mechanical properties of iron–chromium and iron–chromium–carbon alloys, and also to a study of the affinity of chromium (and hence of its alloys) for nitrogen. Anomalies in the usually accepted notions concerning alloys of solid solution type are discussed. A very comprehensive series of references mentioned in the text is coupled with a further list of those pertinent to the subject in a *bibliography*. Some exception may be taken to K.'s use of the term " ferrite " for a solid solution of iron, chromium, and probably some nitrogen.—W. A. C. N.

**On Highly Heat-Resistant Alloys of Chromium–Aluminium–Iron.** A. Grunert, W. Hessenbruch, and K. Schichtel (*Elektrowärme*, 1935, **5**, 2–11).—In attempts which have been made to discover cheap alloys for resistance heating wires, much attention has been devoted to the aluminium–chromium–iron system. Life tests have shown that there is no advantage in using more than 5% aluminium in the alloys and that the best chromium content is about 30%; greater % of either element make the alloys very difficult to draw into wire and thus increase the cost of the elements without improving their life at high temperatures. Addition of nickel causes hardening by stabilizing the austenitic structure and addition of cobalt has a similar effect to a minor degree. The melting points of the aluminium–chromium alloys lie between 1500° and 1520° C., and not at more than 1600° C. as frequently stated in the literature; addition of 3% of cobalt has no appreciable effect on the melting point. The oxide film formed at 1200° C. on the 12% aluminium–30%

chromium alloy consists of almost pure alumina and readily flakes off causing the wire to develop " carbuncles " during use; on the 5% aluminium alloy, however, the oxide film consists of alumina 40, chromic oxide 55, and ferrous oxide 5% and is dense, non-porous, and strongly adherent, so that the life of these wires is considerably prolonged. The structure, life, and electrical properties of numerous alloys are discussed at length.—A. R. P.

**On Highly Resistant Alloys of Chromium–Aluminium–Iron.** G. Nordström (*Elektrowärme*, 1935, 5, 79–85).—A general discussion is given of the properties and uses of aluminium–chromium–iron alloys for electrical heating. The melting point of the 5·4 : 29·9 : 64·7 alloy is stated to be 1640° C.; this alloy has proved very useful for winding dental furnaces operating at 1400°–1450° C. as well as for domestic heaters of all kinds. The electrical properties of this alloy are compared with those of similar alloys containing 3–5% cobalt, and of 80 : 20 nickel–chromium, and 65 : 15 : 20 nickel–chromium–iron alloys in a series of tables and graphs.—A. R. P.

**On Highly Heat-Resistant Alloys of Chromium–Aluminium–Iron With and Without Cobalt.** A. Grunert, W. Hessenbruch, and K. Schichtel (*Elektrowärme*, 1935, 5, 131–132).—A reply to Nordström (preceding abstract). The high value obtained for the melting point of the 5 : 30 : 65 aluminium–chromium–iron alloy is attributed to incorrect procedure in the determination. If the wire is held vertically instead of horizontally between the 2 thermocouple wires lower values are obtained since the oxide film ruptures immediately the metal melts. In this way the melting point of an alloy of iron with chromium 30·1, and aluminium 5·4% was found to be 1502° C., and that of an alloy of iron with chromium 20, cobalt 3, and aluminium 4% 1497° C. Megapyr wires will withstand 1350° C. continuously for 8 days and higher temperatures for shorter periods. Wires of alloys which form a tough oxide film on the surface can frequently be operated at temperatures above the melting point without fracture since the oxide film acts as a container for the molten metal. —A. R. P.

**Heat-Resisting Alloys.** —— (*Bur. Information Nickel*, **1935**, (F 2), 28 pp.).—The mechanical and electrical properties of various chromium–nickel and iron–chromium–nickel alloys used for heating elements and for the metal parts of furnaces operating at high temperatures are summarized. Similar data are given for heat-resisting steels and nickel–cast iron.—A. R. P.

***Thermal and Electrical Conductivities of Copper Alloys.** Cyril Stanley Smith and Earl W. Palmer (*Metals Technology*, 1935, 2, (Sept.); *A.I.M.M.E. Tech. Publ.* No. 648, 1–19).—The electrical and thermal conductivities of alloys of copper with silicon, aluminium, manganese, and nickel and of numerous ternary and polynary copper alloys are shown in a series of tables and graphs. In binary $\alpha$-solid solution alloys the conductivities decrease and the Lorenz ratio increases with increasing concentration of solute atoms at first slowly then more rapidly; the slope of the curves to the composition axis increases in the order zinc, tin, nickel, aluminium, manganese, silicon, phosphorus. Although the thermal conductivity of copper decreases with increase in temperature, that of the alloys increases. The ratio between the thermal and electrical conductivity varies considerably, but for all copper alloys all the results lie on a smooth curve (almost a straight line) which intersects the thermal conductivity axis at a small but definite value.—A. R. P.

**The Relation Between the Thermal and Electrical Conductivities of Copper Alloys.** Cyril Stanley Smith (*Phys. Rev.*, 1935, [ii], **48**, 166–167).—The thermal conductivity ($K$) and the electrical conductivity ($\lambda$) of over 100 copper alloys at temperatures between 20° and 200° C. are shown to be related to the temperature ($T$° C.) for some part of the temperature range by the relation $K = k + c\lambda T$, in which $k$ denotes the non-metallic part of the thermal conductivity, $\lambda$ the electrical conductivity, and $c$ a constant which can be regarded as a true Lorenz ratio for the metallic part of conductivity. The deviation from this linear relation becomes considerable for alloys of high conductivity.—J. S. G. T.

**Hardening Phenomena in Aluminium–Bronze** —— (*Metallurgist* (Suppt. to *Engineer*), 1935, **10**, 74–75).—A review of work on the subject, referring particularly to a paper by E. Söhnchen (*Met. Abs.*, this vol., p. 372) confirming, with pure alloys, that the change $\beta$ to $\alpha + \gamma$ takes place in 3 stages.—R. G.

**Influence of Bismuth and Arsenic on the Properties of Copper.** E. T. Richards (*Metall-Woche*, 1935, **1**, 3–4).—A review of the literature on the effects of bismuth on copper is followed by a brief account of the properties of arsenical copper. Arsenic reduces the affinity of copper to absorb oxygen and other gases from the furnace atmosphere and tends to overcome the deleterious effects of bismuth and sulphur on the mechanical properties, but it has a very serious effect on the electrical properties, thus 0·6% arsenic overcomes the embrittling effect of 0·1% of sulphur while 0·35% of arsenic in solid solution reduces the conductivity by 50%. A small quantity of antimony improves considerably the mechanical properties of arsenical copper.—A. R. P.

***Beryllium–Bronze.** D. G. Butomo (*Metallurg* (*Metallurgist*), **1935**, (5), 114–132).—[In Russian.] The higher iron and aluminium content of Russian beryllium does not affect the working of alloys of copper with up to 2·5% beryllium provided that they are quenched from 800° C. before cold-working. Quenching from 550° to 560° C. gives an alloy which may be lightly worked. Complete structural homogeneity is attained only by repetition of cold-working operations and anneals. The optimum mechanical properties in the pure beryllium alloy are obtained by ageing at 200°–250° C., and in the alloy containing iron at 300°–350° C. The presence of iron increases the elongation of the quenched alloy and increases the hardness and yield-point of the aged alloy. Cold-working after quenching decreases the elongation after ageing.—N. A.

***The Effect of Design on the Stability of Manganin Resistances.** E. H. Rayner (*J. Sci. Instruments*, 1935, **12**, 294–298).—The stability of the resistance of Manganin wire is largely dependent on freedom from strain. Variability in the resistance of wire covered with varnish, owing to variations of atmospheric humidity causing change in the stress of the varnish film, has been previously known. The effect is now shown to be of importance in the case of resistances immersed in oil and sealed from the atmosphere; designs ensuring stability are described. The following conditions must be complied with: (1) arrangement of the wire in its finished shape before final annealing; (2) annealing at 550° C. in an inert gas; (3) avoidance of the use of shellac for impregnation; (4) mounting the wire without constraint.—J. S. G. T.

***Further Investigations Relating to the Electrical Conductivity of Metallic Mixed Phases at Low Temperatures (CuPt Alloys).** H. J. Seemann (*Z. Physik*, 1935, **95**, 97–101).—The electrical conductivities of two copper–platinum alloys containing respectively 70 and 75% (atomic) Pt were determined at room temperature, at 0° C., and at the temperatures of liquid oxygen, nitrogen, and hydrogen, subsequent to the alloys having been subjected to various forms of heat-treatment. Tempering between 400° and 550° C. caused a considerable reduction in the specific resistance of the alloys measured at room temperature. This, according to Johansson and Linde, is attributable to the formation of an ordered mixed-phase having a cubical structure, corresponding to Tammann's "best mixture of atoms" with an atomic ratio 1 : 1. The resistance curves of the 75% (atomic) alloy resemble those of the $Cu_3Pt$ alloys previously investigated; those of the 70% (atomic) alloy exhibit anomalies which are apparently of ferromagnetic origin.—J. S. G. T.

***On the Constitution of the Alloys of Copper, Aluminium, and Silicon. I.—[The System Copper–Aluminium].** Chiuyo Hisatsune (*Tetsu to Hagane* (*J. Iron Steel Inst. Japan*), 1935, **21**, 726–742).—[In Japanese.] See abstract from

English source, *Met. Abs.*, this vol., p. 145. In addition to this investigation, a brief consideration is given to the binary diagrams of the aluminium–silicon and copper–silicon alloys.—S. G.

***On Some Copper Alloys Containing Silicon. First Report.** T. Tanabe and G. Koiso (*Tetsu to Hagane* (*J. Iron Steel Inst. Japan*), 1935, **21**, 575–584).—[In Japanese.] The mechanical properties of wrought "Silzin–Bronze" (invented in 1928 by T. Ishikawa) are reported. The effects of aluminium on the mechanical and chemical properties of wrought Silzin–Bronze were investigated, and a new series of alloys—named "SSZ"—discovered. The "SSZ" alloys are strong and ductile and have far better resistance to sea-water than Silzin–Bronze. Brittleness of wrought Silzin–Bronze, caused by annealing, is found to be nearly completely overcome by addition of aluminium. The mechanical properties and corrosion-resistance of "SSZ" and Silzin–Bronze are stated to be far superior to those of P.M.G. metal. Tests were also made of the mechanical and chemical properties of other industrial copper alloys containing silicon, namely P.M.G. metal, Tungum, A.R., Everdur, and Herculoy.—S. G.

***The Nature of Silicon–"Bronzes" and Their Application for Shaped Castings.** M. P. Slavinsky, P. I. Alexandrov, A. I. Kukushkin, and M. S. Hoshhojev (*Metallurg* (*Metallurgist*), **1935**, (1), 57–74).—[In Russian.] The investigation was carried out on silicon–"bronzes" containing silicon 1·69–4·98 and iron 0·64–4·48%. The solidification range, mechanical properties, linear contraction, density, and resistance to corrosion were determined for alloys of copper with 1·69–4·98% silicon and 0·64–4·48% iron. The alloys may be prepared by dissolving either cupro–silicon or ferro–silicon in copper. The influence of manganese, lead, phosphorus, nickel, tin, aluminium, and zinc was investigated. For shaped castings "bronzes" with silicon 3–5, iron 1–2, manganese up to 1, and lead 1–5% are recommended, and for castings for service under hydraulic pressures from 50 to 100 atmospheres a "bronze" with silicon 3·5–4·5 and lead 1–5%.—N. A.

**The Bronzes: Some Practical Considerations.** —— (*Machines*, **1935**, (July), 1–6; (Aug.), 1–5).—An account of the occurrence and properties of copper is followed by a review of the binary copper–tin alloys and their principal industrial derivatives. The influence of additions of other elements (phosphorus, lead, zinc, nickel, aluminium) is considered in some detail from an industrial point of view. Important recent developments among the nickel and aluminium–bronzes are noted, and the influence of rolling and annealing on the properties of the latter is considered. Compositions and mechanical properties are indicated in the case of several industrial bronzes, the special applications of which are described.—P. M. C. R.

***Transformation of the α-Phase of Copper–Tin Alloys after Deformation.** S. Konobeevskii and V. Tarasova (*Physikal. Z. Sowjetunion*, 1933, **4**, 571–575; *C. Abs.*, 1934, **28**, 1254).—[In German.] The work of Westgren and Phragmen on the determination of the phase boundary between the $\alpha$ and the $\alpha + \delta$ phases of the copper–tin system is criticized because W. and P. disregarded the effects of deformation in the X-ray samples. The work is repeated; proper annealing preceded by deformation indicates a decreased solubility of $\alpha$ in $\delta$ as the temperature is decreased. It is thought that deformation aids heat in reaching equilibrium by redistributing the components in a metastable state, thus increasing the diffusion potential.—S. G.

***The Solubility Limit of the α-Phase in Tin–Copper Solutions.** S. Konobeevskii and V. Tarasova (*Physikal. Z. Sowjetunion*, 1934, **5**, 848–876).—[In German.] See abstract from Russian source, *Met. Abs.*, this vol., p. 150.
—S. G.

***Chemical and Metallographic Investigation of a Metal Mirror [Cu–Sn–Pb] Dating from Roman Times.** W. Geilmann and F. Weibke (*Nachr. Ges. Wiss. Göttingen, Math.-Phys. Klasse, Fachgruppe III*, 1935, **1**, (10), 103–108; *Bull. B.N.F.M.R.A.*, 1935, (**80**)).—The composition is copper 66·81, tin 22·87, lead 9·60%, with small amounts of impurities. The structure and patina were studied.—S. G.

**Bronze and Brasses Containing Lead.** —— (*Metallurgia*, 1935, **12**, 186).—A general discussion of the effect of lead on the constitution, properties, and manufacture of gun-metals, phosphor–bronzes, manganese–bronzes, and yellow brasses. Special consideration is given to improving machinability by lead additions and to results obtained from such additions.—J. W. D.

***Study of Special "Nickel Silvers."** D. G. Butomo (*Metallurg* (*Metallurgist*), **1935**, (4), 76–87).—[In Russian.] In the manufacture of alloys containing nickel 13–15, aluminium 2·3–3, iron 1·0, and manganese 1·0%, the nickel and aluminium are added as alloys with copper, and the alloy is cast at 1300°–1350° C. and forged at 950°–980° C. after a preliminary anneal for 2½–3 hrs. The optimum mechanical properties may be obtained either by slow cooling after forging or by quenching after forging at 750°–800° C. and then annealing at 600° C. The alloy has a tensile strength of 80 kg./mm.$^2$, a limit of proportionality of 45 kg./mm.$^2$, and an elongation of 10%. After quenching the tensile strength is 40 kg./mm.$^2$ and the elongation 45%.—N. A.

***Equilibrium Diagram of the Copper-Rich Ternary System Cu–Sn–Zn.** Keiji Yamaguchi and Isamu Nakamura (*Rikwagaku-Kenkyū-jo Iho* (*Bull. Inst. Phys. Chem. Res.*), 1932, **11**, 1330–1352).—[In Japanese.] The equilibrium of the ternary system copper–tin–zinc containing 0–38·6% tin and 0–60% zinc was studied by thermal and microscopic methods, and the stable phases at ordinary temperature and their features have been worked out. The transformation in the $\alpha + \beta$ range of the copper–tin system (**I**) (15–25% tin), which occurs at about 580° C., is due to the eutectoid reaction, and continues to the peritectic change liquid $+ \beta \rightleftarrows \gamma$, which occurs at about 750° C. The same system containing 35–38% tin has an invariant point at 644° C., and the transformation at 590° C., which hitherto has been considered a peritectic change $\gamma + \eta \rightleftarrows \delta$, is found at 590° C. in an alloy with 36–38% tin and at 595° C. in one with 32·5–36% tin. The ternary copper–tin–zinc system has no characteristic phase; it is remarkable, however, that the ternary system has in the $\delta$-phase a point at which 6% zinc is the melt, although the binary system forms almost no solid solution in the same phase, and the $\gamma$-phase of the copper–zinc system (**II**) pushes deep into the side of **I**. The $\gamma$-phases of **I** and **II** are not continuous solid solutions; the transformation at the ternary invariant point at 593° C. must be due to the change $\gamma + \varepsilon \rightleftarrows \delta + \eta$; the $\varepsilon$-phase can, however, be neglected in the ternary system containing more than 1% zinc. The $\alpha$-phases in both **I** and **II** are continuous, and the solubility of tin in the $\alpha$-phase does not vary more than 1% if the system contains less than 30% zinc. The abnormal point in the $\beta$-phase, at 450°–470° C. in **II**, has not been explained by the present work.—S. G.

***The Influence of Temperature and Time of Annealing on the Structure and Mechanical Properties of 67 : 33 Brass Sheets After Various Degrees of Cold-Work.** Władysław Łoskiewicz, Jerzy Guschlbauer, and Michal Mosowicz (*Prace nad Mosiadzami* (*Instytut Badań Materjałów Uzbrojenia*), 1934, [A], **1**, 1–121 [in Polish], 121–125 [French summary]).—Curves have been obtained showing the change in hardness, tensile strength, elongation, and grain-size of sheets of 67 : 33 brass annealed at various temperatures for different times and after different degrees of cold-work and a series of photomicrographs corresponding with the points on the curves is given. The results may be summarized as follows: Above a certain limiting temperature depending on the time of annealing the grain-size becomes constant independent of the degree of cold-work unless this is very small; annealing below this temperature produces grains which are finer the greater the cold-work. The annealing temperature which produces equalization of the mechanical properties irrespective of the degree of reduction is the lower the longer the time of annealing, and the difference in mechanical properties perpendicular and transverse to the direction of rolling decreases with increase in annealing temperature and approaches zero with 30–40% reduction. Below a certain temperature which depends on the degree of cold-work no recrystallization occurs; this temperature is the higher the smaller is the degree of cold-work. Increasing the time of annealing decreases the temperature of recrystallization provided that the metal has been sufficiently cold-worked. After the sudden change in properties due to recrystallization at a given temperature any increase in the time of annealing above the minimum necessary to produce the change has no further effect. For very high degrees of cold-work the time required to produce the limiting values of the properties on annealing is greater than that required for a small amount of cold-work.—A. R. P.

***On the Age-Hardening of Brass.** Kanji Tamaru (*Rikwagaku-Kenkyū-jo Iho* (*Bull. Inst. Phys. Chem. Res.*), 1935, **14**, 139–145).—[In Japanese.] Hansen (*Met. Abs.* (*J. Inst. Metals*), 1930, **43**, 465; 1930, **44**, 499) observed "*Inkubationszeit*" in ageing 60 : 40 brass, and concluded that in ageing the brass the electrical resistance does not increase initially for some minutes, but then begins to increase until it attains the value obtainable in the equilibrium condition. In other words, the electrical resistance of 60 : 40 brass in the equilibrium state is greater than that in the quenched state. This conclusion seemed remarkable, hence T. studied the question by hardness and electrical resistance measurements and differential thermal analysis. Specimens of brass containing 59·11% copper, of 4·2 and 1 mm. diameter, respectively, were quenched from 870° C. and aged at different temperatures in high vacuum. The results of the investigation were: (1) the "*Inkubationszeit*" was not found in the electrical resistance and hardness measurements; (2) the electrical resistance in the quenched state is greater than that in the annealed state, contrary to Hansen's conclusions; (3) the electrical resistance in the quenched state was nearly equal to the sum of the 3 values, *i.e.* for the annealed state, that due to the quenching stress and that due to the transformation; (4) in ageing, a faint heat absorption was found near 130° C. and at 460° C., a small heat evolution at 260° C. and a smaller one at 310° C. The first heat absorption seems due to the atomic rearrangement and the one at the higher temperature to the transformation from $\beta'$ to $\beta$. The small heat evolution is due to the separation of the $\alpha$-phase from $\beta$, and the larger one to the $\beta$–$\beta'$ transformation.—S. G.

***The Gold–Copper Alloys.** W. Broniewski and K. Wesolowski (*Ann. Acad. Sci. Tech. Varsovie*, 1935, **1**, 44–69; *Bull. B.N.F.M.R.A.*, 1935, (**80**)).—A study of the equilibrium diagram and of the mechanical properties of these alloys. A useful table is given of the mechanical properties of the alloys in use in various countries of the world. See also following abstract.—S. G.

**On Gold–Copper Alloys.** M. Le Blanc and G. Wehner (*Ann. Physik*, 1935, **23**, 570).—The surprising results obtained by Broniewski and Wesolowski (preceding abstract) are attributed to insufficient homogenization of their alloys.—v. G.

***The Physico-Chemical Investigation of the Phases of Variable Composition in the Gold–Copper System.** N. W. Ageew and D. N. Shoykhet (*Metallurg* (*Metallurgist*), **1935**, (7), 86–100).—[In Russian.] The intensity of the reflexes in the Debye röntgenogram, indicates that, in alloys with a nearly stoicheiometric composition, the degree of order is 0·89 for AuCu and 0·92 for $AuCu_3$, *i.e.* about 10% of the atoms are out of place. With the addition of excess of gold or copper to form solid solutions, the degree of order decreases and appears to be smaller than that theoretically possible. The composition–degree of order curves for AuCu and $AuCu_3$ are similar in character, both being convex towards the copper side. The chief factor which determined the change in properties of solid solutions, is the degree of order in the lattice structure. —N. A.

***Researches to Determine the Creep Strength of Lead Alloys.** H. Hanemann and W. Hofmann (*Metallwirtschaft*, 1935, **14**, 915–917).—The elongation of soft lead (99·98%) and lead containing 1·1% antimony has been determined under a constant tensile load maintained for 3–4 months. The table shows the load in kg./cm.$^2$ necessary to produce various rates of creep:

| Rate of Flow . . . . | $10^{-2}$ | $10^{-3}$ | $10^{-4}$ | $10^{-5}$ |
|---|---|---|---|---|
| Soft lead . . . . | 40 | 29 | 20 | 13 |
| Lead with 1·1% antimony . | ... | 62 | 44 | 27 |

The results show the marked superiority of antimonial lead over ordinary lead but are only in poor agreement with those obtained by Moore, Betty, and Dollins (*Met. Abs.*, this vol., p. 273).—v. G.

***Influence of the Conditions of Test on the Shrinkage [of Antimony–Lead].** O. Bauer and H. Sieglerschmidt (*Metallwirtschaft*, 1935, **14**, 854–858).—An alloy of lead with 16% antimony was chill-cast into rods, the lengths of which were determined for various casting conditions and rod dimensions.—v. G.

***The Study of Methods of Re-Melting and the Effect of Additions on the Burning-Out of the Constituents of Lead-Base Bearing Metals such as "Bahnmetall."** M. P. Slavinsky, A. V. Shashin, and N. A. Filin (*Metallurg* (*Metallurgist*), **1935**, (3), 66–81).—[In Russian.] Addition of potassium 0·5–1, barium 0·1–0·75, aluminium 0·2–1, cadmium 0·3–1, copper 5, or magnesium 5% to a lead alloy containing about 1% calcium and 1% sodium improves its bearing properties but reduces the resistance to corrosion. The greatest increase in hardness with ageing is observed in the calcium alloys. A carnallite flux is the best preventive against loss of alloying metal during melting. The substitution of magnesium for calcium in lead-base bearing metals has certain advantages and deserves further investigation.—N. A.

***Penetration of a Magnetic Field into Superconductive Alloys [PbTl and $Bi_5Tl_3$].** W. J. de Haas and J. M. Casimir-Jonker (*Comm. K. Onnes Lab. Univ. Leiden*, **233c**, pp. 7; and *Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 2–7).—[In English.] See also *Met. Abs.*, this vol., p. 219. It has been found that for two superconductive alloys (Pb–Tl and $Bi_5Tl_3$) there exists a critical magnetic field, far below the magnetic threshold field, which penetrates into the alloy but does not disturb superconductivity.—S. G.

***Some Experiments on a Superconductive Alloy [Lead–Thallium] in a Magnetic Field.** J. M. Casimir-Jonker and W. J. de Haas (*Physica*, 1935, **2**, 935–942; and *Comm. K. Onnes Lab. Leiden*, No. **237c**, 1935).—[In English.] A new method for detecting electrical resistance in a magnetic field is described. The method has been applied to the study of the magnetic transition curve of a lead–thallium alloy.—S. G.

**Lithium Alloys. Thermal and X-Ray Analysis of the Systems Lithium–Zinc and Lithium–Magnesium.** A. Baroni (*IX Congr. internat. quim. pura applicada*, 1934, **2**, 464–470; *C. Abs.*, 1935, **29**, 7259).—The methods reported in *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 437, and *Met. Abs.*, 1934, **1**, 77, show the existence of 2 intermetallic compounds immiscible in each other and in the pure metals, $Li_2Zn_3$ (probably monometric) and $LiZn_4$ which decomposes before melting (cf. Grube and Vosskühler, *Met. Abs.*, 1934, **1**, 125; Zintl and Brauer, *Met. Abs.*, this vol., p. 589). In the lithium–magnesium system there are two series of solid solutions with a region (70–85% magnesium) of immiscibility (cf. Masing and Tammann, *Z. anorg. Chem.*, 1910, **67**, 183). The monometric crystals 0–70% magnesium have $a = 3{\cdot}491$ to $3{\cdot}306$ A. In the series of hexagonal crystals 85–100% magnesium, the cell length changes regularly. Thermal evidence indicates a compound $Li_2Mg_5$ at 28·5% lithium, probably the end of the monometric series with $a = 3{\cdot}506$ A., the maximum distortion of the lithium lattice.—S. G.

***Equilibrium Diagram of the Magnesium–Lithium System.** P. Saldau and F. Schamray (*Z. anorg. Chem.*, 1935, **224**, 388–398; and (summary) *Light Metals Research*, 1935, **4**, 116–123).—The system has been re-examined by thermal analysis and by micrographic examination. (Composition is in all cases atomic-%.) The solid solubility of lithium in magnesium is 10% at 15° C., 12·5% at 465° C., and 19% at 500° C., the eutectic lies at 588·2° C., 21% lithium, the compound $LiMg_2$ melts congruently at 600° C. and forms a range of solid solutions with 29–95% lithium ($\beta$-phase), and the solid solubility of magnesium in lithium is constant at about 2%. Characteristic microstructures of alloys are shown.—A. R. P.

***On the Ageing of Binary Magnesium–Aluminium Alloys.** J. A. Amsterdamski (*Trudi Nauchno-Issledovatelskogo Instituta Legkih Metalov* "*Niisalumini*" (*Trans. Sci. Res. Inst. Light Metals*), **1934**, (9), 33–43).—[In Russian.] The changes in microstructure, hardness, and tensile strength of magnesium alloys containing aluminium 6·25–16, iron 0·01–0·04, and manganese 0·02–0·03% were determined during ageing at 25°–225° C. for 120 hrs. Increase in hardness on ageing coincides with the separation of $\gamma$- from the $\delta$-solid solution; this separation, which always starts at the grain boundaries, as well as the re-absorption of $\gamma$ on heating, takes place rapidly and is easily followed by the microscope. The tensile strength reaches a maximum value of 37·5 kg./mm.$^2$ with the 10–11% aluminium alloy after ageing at 150°–175° C. for 24 hrs.; this compares with 31 kg./mm.$^2$ for alloys quenched from 420° C. Ageing reduces the elongation from 9 to 3% and increases the Brinell hardness from 62 to 95.—D. N. S.

***The Solubility of Magnesium in Magnesium Chloride and Mixtures of Magnesium Chloride with Potassium Chloride and Sodium Chloride.** A. I. Jurin (*Metallurg* (*Metallurgist*), **1935**, (1), 89–97; (4), 87–99).—[In Russian.] Magnesium dissolves both in molten magnesium chloride and in mixtures thereof with potassium or sodium chloride the solubility increasing with rise of temperature, and decreasing with increasing concentration of alkali chloride, the solubility in pure alkali chloride being only $\frac{1}{15}$ that in magnesium chloride. Neither subhalides nor suboxides of magnesium exist at room temperature. The solidified melts consist of a mixture of magnesium chloride and the finely divided metal. Thermodynamic calculations show that magnesium dissolves in its chloride in the atomic state of dispersion.—N. A.

***Is an Intermetallic Homogeneous Phase Formed in the System Magnesium–Manganese? (Preliminary Communication.)** E. F. Bachmetev and J. M. Golovchinev (*Zhurnal Fizicheskoy Khimii* (*J. Phys. Chem.*), 1935, **6**, (5), 597–600).—[In Russian.] Magnesium alloys rich in manganese have a strong tendency to segregate, the manganese settling to the bottom of the ingot. X-ray examination of crystals from a shrinkage cavity showed a cubic symmetry; they appeared to be $\beta$-manganese. Apparently there are no intermediate phases in the magnesium–manganese system.—N. A.

***Equilibrium Diagram of the Magnesium-Rich Magnesium–Manganese Binary System.** Hachie Sawamoto (*Suiyokwai-Shi* (*Trans. Min. Met. Alumni Assoc.*), 1935, **8**, 763–768).—[In Japanese.] The equilibrium diagram of the magnesium-rich magnesium–manganese alloys was studied by thermal and microscopic methods. According to the section of the diagram determined, the new $\beta$-phase was found to be a solid solution of the intermetallic compound $Mg_9Mn$, which was formed by a peritectic reaction at 726° C.—S. G.

***Thermal Analysis of Ternary Alloys: Application to Mg–Si–Zn Alloys Rich in Magnesium.** E. Elchardus (*Publ. Sci. Tech. Ministère de l'Air*, 1935, (70), 131 pp.).—See also *Met. Abs.*, this vol., p. 374.—S. G.

***Research on Ternary Alloys of Magnesium, Based on the Magnesium–Zinc System.** Kazutaka Naguro (*Tetsu to Hagane* (*J. Iron Steel Inst. Japan*), 1935, **21**, 812–818).—[In Japanese.] As third constituents, 0·5, 1, and 2% of nickel, cobalt, copper, silver, calcium, cadmium, mercury, aluminium, thallium, silicon, tin, lead, arsenic, antimony, bismuth, chromium, tellurium, and manganese were added (alone) to binary magnesium–zinc alloys containing 2, 3, or 5% zinc. Tests were made of the corrosion-resistance of these alloys to an *N*-10 sodium chloride solution and to artificial sea-water. The Rockwell hardness of the alloys, after several heat-treatments, was also measured. Additions of nickel, cobalt, copper, aluminium, thallium, lead, and bismuth make the alloys more easily corroded; additions of arsenic, calcium, cadmium, mercury, and manganese, however, increase the corrosion-resistance, arsenic and manganese giving the best results. Quenching does not improve the corrosion-resistance of these ternary alloys, except those containing silicon, tin, thallium, and lead. The third constituents which harden the binary alloys are copper, nickel, silver, aluminium, silicon, and bismuth; the hardening effect is very small in the cases of cadmium, silicon, mercury, arsenic, antimony, and lead. Hardening due to ageing (at 150° C.) was observed for all specimens prepared except in the cases of alloys containing nickel and antimony.—S. G.

***The Exact Measurement of the Specific Heats of Solid Substances at Higher Temperatures. XIX.—The Specific Heats of Zinc, Magnesium, and Their Binary Alloy $MgZn_2$.** (Poppema and Jaeger.) See p. 561.

***Alloys of Iron and Manganese. XIII.—The Constitution of the Binary Alloys of Iron and Manganese.** F. M. Walters, Jr., and Cyril Wells (*Trans. Amer. Soc. Metals*, 1935, **63**, 727–746; discussion, 746–750).—Recent work on the system is critically reviewed and further X-ray and micrographic results are recorded which shed more light on the still obscure points in the equilibrium diagram. The solubility of manganese in $\alpha$-iron at room temperature probably extends to at least 10%. In alloys with 10–30% manganese the $\gamma$-phase transforms at about 170° C. on cooling into the hexagonal close-packed $\varepsilon$-phase but the transformation is complete only after cold-working; the reverse change $\varepsilon \longrightarrow \gamma$ occurs at 200° C. on heating. Between 30 and 50% manganese the $\gamma$-phase exists unchanged between 1000° and − 180° C. The $\gamma$-phase is face-centred cubic up to 70% manganese, but alloys with 70–94% manganese quenched from the $\gamma$-field are tetragonal; evidence is put forward which indicates that at high temperatures $\gamma$-manganese is cubic and the duplex $\gamma$-iron + $\gamma$-manganese field at high temperatures (see Gayler, *Met. Abs.*, 1934, **1**, 294) is therefore omitted from the new equilibrium diagram. The solubility limit of manganese in $\gamma$-iron at 650° C. is about 55%, the eutectoid temperature is about 695° C., and the composition about 68% manganese. There is a narrow field of $(\beta + \gamma)$-manganese at temperatures just above the $\beta$-range. A *bibliography* of 24 references is included.—A. R. P.

***Alloys of Iron, Manganese, and Carbon. XIV.—Iron–Carbon Alloys Containing Seven Per Cent. Manganese.** Cyril Wells and F. M. Walters, Jr. (*Trans. Amer. Soc. Metals*, 1935, **63**, 751–760).—Alloys with 7% manganese prepared by melting the constituents in magnesia crucibles in an argon atmosphere were examined micrographically after quenching from various temperatures. The eutectoid point is 0·4% carbon, 660° C., and the boundary lines between the duplex fields and the austenite–cementite–ferrite field, and between the latter and the ferrite + carbides field slope slightly towards higher temperatures with increasing carbon content.—A. R. P.

***A Study of Molybdenum–Carbon System.** W. P. Sykes, Kent R. Van Horn, and C. M. Tucker (*Metals Technology*, 1935, **2**, (Sept.); *A.I.M.M.E. Tech. Publ.* No. 647, 1–14).—The system has been examined by X-ray and metallographic methods up to 12% carbon. The solid solubility of carbon in molybdenum is 0·09% between 1500° and 2100° C., the $\beta$-phase ($Mo_2C$) exists over the range 5–6% carbon between 1400° and 2400° C., and the $\gamma$-phase exists in all alloys with more than 6% carbon, and appears to contain 12·3–13% carbon. The $\beta$-phase has a close-packed hexagonal structure, $a = 3{\cdot}001$, $c = 4{\cdot}723$ A., $c/a = 1{\cdot}573$. The eutectic between molybdenum and $Mo_2C$ lies at 2200° C. and 1·8% carbon, and a peritectic horizontal occurs at 2400° C. between 5·5 and 10% carbon.—A. R. P.

**[Kanthal] Alloys Good at Temperatures Above 2100° F.** Gunnar Nordström (*Metal Progress*, 1935, **28**, (4), 68–69).—An account is given of the Kanthal group of alloys, which contain about 35% of aluminium, cobalt, and chromium together, the remainder being iron. The life of these alloys under furnace conditions is compared graphically with that of nickel–chromium and nickel–chromium–iron resistance alloys of various (stated) compositions, and the design of furnaces incorporating Kanthal elements is described.—P. R.

***Experimental Investigation of the Skin Effect in Massive Ferromagnetic Conductors.** A. S. Zaimovskii (*Zhurnal Tehnicheskoi Fiziki* (*J. Tech. Physics*), 1934, **5**, 880–882; *C. Abs.*, 1935, **29**, 714).—[In Russian.] Graphs show the effect for various carbon contents.—S. G.

***Investigation of Iron–Nickel–Aluminium Alloys with High Coercive Strength.** A. S. Zaimovskii and M. Frumes (*Zhurnal Tehnicheskoi Fiziki* (*J. Tech. Physics*), 1934, **5**, 883–885; *C. Abs.*, 1935, **29**, 714).—[In Russian.] An iron alloy containing aluminium 15·5, nickel 23·5, carbon 0·16% had a magnetic reluctance greater than 400 oersteds. With less aluminium relative to nickel, the reluctance is less.—S. G.

***Heat-Treatment of Magnetic Materials in a Magnetic Field. I.—Survey of Iron–Cobalt–Nickel Alloys. II.—Experiments with Two Alloys.** (I) Joy F. Dillinger and Richard M. Bozorth. (II.) Richard M. Bozorth and Joy F. Dillinger (*Physics*, 1935, **6**, 279–284, 285–291).—(I.—) The changes occurring in the magnetic properties of iron–cobalt–nickel alloys when the alloys are annealed in a magnetic field are investigated. The maximum change for the iron–nickel alloys occurs between 65 and 70% of nickel; it is characterized by a large increase in maximum permeability and a hysteresis loop of rectangular shape. All the alloys with Curie points above 500° C. and with no phase transformations have their magnetic properties similarly changed. Thorough preliminary annealing increases the effect. With preliminary annealing at 1400° C. for 18 hrs., specimens of 65 Permalloy with the record value of maximum permeability of 600,000 have been obtained. The magnetic characteristics of materials treated in this way are relatively insensitive to stress, but are, however, highly anisotropic; the maximum permeability in one direction may be 150 times that at right angles. (II.—) Experiments with 2 alloys containing, respectively, nickel 65, iron 35% (65 Permalloy) and iron 20, cobalt 60, and nickel 20% (Perminvar) were carried out in order to elucidate the nature of the changes accompanying the very large increase of maximum permeability described in (I). These alloys can be effectively heat-treated in a magnetic field strength of 10 oerstedts if the temperature is above 400° C. and below the Curie point of the alloy. The changes occurring are due to the relief of magnetostrictive stresses which arise when the material becomes ferromagnetic on cooling through the Curie point or when an external field is applied; relief is effected by plastic flow or diffusion in separate domains. The relation between the establishment of superstructure and this relief is discussed.
—J. S. G. T.

***Gyromagnetic Effect in Ferromagnetic Substances Above the Curie Point.** W. Sucksmith (*Helv. Phys. Acta*, 1935, **8**, 205–210; *Sci. Abs.*, 1935, [A], **38**, 670).—[In German.] The magnetic moment of the nickel atom is not the same below and above the Curie point (0·6 and 1·6 Bohr magnetons). Measurement of the gyromagnetic effect below the Curie point shows that the magnetism of the nickel atom depends only on electron spin. The measurements carried out prove that in the paramagnetic condition above the Curie point the nickel atom in nickel–copper alloys exhibits pure spin magnetism. The Landé $g$ factor was determined for these ferromagnetic alloys above their Curie points, and the value found, *viz.* $g = 2$, excludes any effects due to orbital momentum. In these alloys, the nickel atom has the same magnetism as in pure nickel.—S. G.

***On Iron–Nickel–Copper Alloys of High Initial Permeability.** Otto von Auwers and Hans Neumann (*Wiss. Veröff. Siemens-Werken*, 1935, **14**, (2), 93–108).—In the ternary nickel–copper–iron system there is a long, narrow zone in which the alloys have a high initial permeability and a low coercivity; this extends from the 80 : 20 nickel–iron alloy to the 40 : 50 : 10 nickel–copper–iron alloy, maximum initial permeability being obtained with the 60 : 30 : 10 alloy. Addition of copper to iron–nickel alloys at first reduces the initial permeability then increases it rapidly to a maximum at the solid solution range. Magnetostriction is reduced to zero along a line which practically bisects the above-mentioned zone of high permeability, alloys on the nickel side of the line having a positive and those on the iron side a negative magnetostriction. Ternary diagrams are given showing the various magnetic properties after different heat-treatments.—A. R. P.

***Effect of Fibrous Structure and Cooling in a Magnetic Field on the Magnetization Process.** O. Dahl and Fr. Pawlek (*Z. Physik*, 1935, **94**, 504–522).—The effects of fibrous structure and cooling from 1000° C. in either a longitudinal or transverse magnetic field on the magnetic characteristics of iron–nickel alloys of high permeability containing, respectively, 40, 50, 60, 65, 70, 75, 80, and 90% nickel, Perminvar containing nickel 45, iron 30, and cobalt 25%, Armco iron, silicon–iron alloys containing 3 and 6% silicon, a nickel–iron alloy containing 8% nickel, and a cobalt–iron alloy containing 10% cobalt are investigated experimentally. Samples of the iron–nickel alloys characterized by an irregular arrangement of the constituent crystals and others having recrystallization structure were examined. The alloys containing 40, 50, and 90% of nickel exhibit a well-marked [100]-fibrous structure; in the case of the other alloys there is present, in addition, a second structural orientation. Corresponding to their magnetic anisotropy, the fibrous alloys containing 40 and 50% nickel are characterized by a very considerable improvement in the work of magnetization; in the case of the nickel-rich alloys this work is only slightly reduced. Cooling in a magnetic field confirms the magnitudes of the effects observed by Bozorth, Dillinger, and Kelsall. Fibrous structure is found to produce characteristic forms of the magnetization curve. The effect of a magnetic field on the magnetization characteristics of the iron-rich alloys is, on the whole, small, The results are discussed in terms of Bozorth's work.—J. S. G. T.

***Magnetic Studies of Pupin Cores of Novel Structure [Nickel–Iron Alloys].** J. L. Snoek (*Physica*, 1935, **2**, 403–412).—[In German.] Nickel–iron alloys containing 30–100% nickel can be made highly anisotropic by cold-rolling for more than 99% and subsequent recrystallization; by this process the crystals all assume a definite orientation relative to the strip so that the whole nearly behaves as a single crystal with one axis parallel to the strip and one cube face in the surface of the strip (cube position). If this material is rolled down again for 30%, a peculiar state is brought about, characterized by an unusually high magnetic anisotropy in the plane of the strip, with the elementary magnets in a position perpendicular to the rolling direction. From resistance measurements in a magnetic field and magnetic determinations, it followed that the elementary magnets have minimum energy only in a direction in the plane of the strip. The magnetization curve perpendicular to the plane of the strip is of the same type as the curve in the rolling direction; both have low permeability ($\mu = 35$ and 42).—S. G.

***Magnetic Reversal Nuclei. V.—Propagation of Large Barkhausen Discontinuities.** K. J. Sixtus (*Phys. Rev.*, 1935, [ii], **48**, 425–430).—In a nickel–iron in which a preferred direction of magnetization is created by tension, stable regions of anti-saturated magnetization can be produced by the short application of high local fields. These nucleus regions will not grow after the removal of the local field. The mechanism of the effect is examined. A natural nucleus in a stressed wire was found to have a length of a few mm. and a diameter of several $\mu$.—J. S. G. T.

***X-Ray and Electrical Investigation of Palladium–Silver–Hydrogen Alloys.** Gunnar Rosenhall (*Ann. Physik*, 1935, **24**, 297–325).—The electrical resistance and lattice constants of the ternary alloys were determined and the results are shown as a function of the composition in triangular diagrams. No definite indication could be obtained as to whether the hydrogen atoms are disposed in the interatomic spaces in the silver–palladium lattice or whether silver-like palladium–hydrogen complexes are disposed at certain of the lattice points. —v. G.

***Equilibrium Diagram and the Magnetic Properties of Platinum–Iron Alloys.** L. Graf and A. Kussmann (*Physikal. Z.*, 1935, **36**, 544–551).—The structures of the iron–platinum series of alloys were investigated microscopically and by X-rays and their magnetic properties determined. On the iron-rich side of the series the addition of platinum, up to about 9% (atomic), produces an increase of the saturation magnetization ($\sigma$) to the extent of about 10% compared with that of $\alpha$-iron. Thereafter the value of $\sigma$ decreases very considerably owing to the presence of cubic face-centred $\gamma$ crystals. Alloys containing about 26% (atomic) of platinum are composed almost entirely, at room temperature, of $\gamma$ crystals and are not ferromagnetic. Alloys containing from 30 to 70% (atomic) of platinum are strongly ferromagnetic; the saturation magnetization is of the order 14,000 and the Curie point in the region of 450° C. The magnetic character of these alloys is associated with the presence of $\gamma$ solid solution, which is transformed below 1200° C. into the ferromagnetic alloy FePt which is cubic space-centred in crystalline structure without superstructure and having a lattice constant, $a$, equal to 2·88 A. This alloy FePt has a Curie point about 100° C. higher than, and a value of saturation magnetization different from, that of the solid solution of similar composition. Alloys within this range of composition are characterized by an extraordinarily broad hysteresis loop with a coercive force which may be as large as 1800 gauss and a remanence of 3000–4000 c.g.s. units. These features are attributable principally to lattice distortion associated with passage of solid solution into the compound lattice.—J. S. G. T.

***The Transport Number and Valency of Silver in Liquid Silver Amalgams.** Karl Schwarz (*Monatsh.*, 1935, **66**, 218–221).—When liquid silver amalgam is subjected to electrolysis the silver migrates to the cathode, the quotient of the transport number divided by the concentration being $4 \times 10^{-4}$. The silver probably exists in solution in the mercury as a divalent ion, which corresponds with a diffusion constant of $1{\cdot}0 \times 10^{-5}$ cm./second.—A. R. P.

***X-Ray Studies on the Systems Tin–Antimony and Tin–Arsenic.** (Hägg and Hybinette.) See p. 594.

***The Magnetic Anisotropy of Crystals of Tin, and of Tin with Added Antimony, Cadmium, and Gallium.** Harold J. Hoge (*Phys. Rev.*, 1935, [ii], **48**, 615–619).—The principal magnetic susceptibilities of single crystals of white (tetragonal) tin were determined. Crystals were grown by the travelling furnace method. Perpendicular to the tetragonal axis the susceptibility per unit volume, $k_{\perp} =$

$0{\cdot}197 \times 10^{-6}$; parallel to the axis it is $k_{\parallel} = 0{\cdot}176 \times 10^{-6}$. The ratio $k_{\perp}/k_{\parallel}$ is strongly influenced by addition of small proportions of certain elements. For pure tin the ratio is 1·120. By adding (1) 0·60% of antimony the ratio becomes 1·200; (2) 0·76% cadmium, 0·923; 0·89 gallium, 0·897. These changes are compared with data given by Goetz and Focke for bismuth, and it is shown that they can be explained by assuming that the impurities are concentrated in the {110} planes.—J. S. G. T.

**The Significance of Physical Structure of White Anti-Friction Metals.** E. L. Parry (*Power Transmission*, 1935, **4**, 403–404).—The importance of the distribution of the hard and soft constituents in a bearing metal on its bearing properties is briefly discussed.—A. R. P.

**Some Useful Notes on White Metal Bearings.** I. D. Roe (*Power Transmission*, 1935, **3**, 594–595).—The composition of some of the commoner white metal alloys is given and the function of the various constituents is briefly outlined.—A. R. P.

**Friction and Lubrication.** S. Erk (*Die Physik*, 1935, **3**, 57–62; *Sci. Abs.*, 1935, [A], **38**, 592).—Brief summaries are given of recent papers on friction and lubrication. Among the subjects discussed are " dry " friction, *i.e.* friction without lubrication, particularly for the case of plane surfaces, the effect of oxidation films on the surfaces, friction with partial and complete lubrication, and the properties of a number of common lubricants and of bearing metals. —S. G.

**Stability of [Super-]Hard Alloys.** V. Fedorov and N. Trofimov (*Azerbaidgeanskoe Neftjanoe Khoziastvo* (*Oil Economy of Azerbaidjan*), **1932**, (5), 41–49; *Brit. Chem. Abs.*, **1933**, [B], 66).—[In Russian.] The durabilities of drilling alloys are: Stalinit 1·0; Sormait, Studite, and Spartan 0·8; Stellite 1·8, Blekor and Vokar 3·0, Pobedit 6·0, Borium 8·5, Widia 10·0.—S. G.

†**The Nature of Ageing of Zinc–Aluminium Alloys.** K. V. Peredelsky (*Liteinoe Delo* (*Foundry Practice*), **1935**, (8), 21–26).—[In Russian.] A review of the mechanism of ageing of zinc-base die-casting alloys.—N. A.

***An Investigation of the Zinc-Rich Portion of the System Iron–Zinc.** E. C. Truesdale, R. L. Wilcox, and J. L. Rodda (*Metals Technology*, 1935, **2**, (Oct.); *A.I.M.M.E. Tech. Publ.* No. 651, 1–37).—The solid solubility of iron in zinc is about 0·0009–0·0028%, the eutectic lies at 419·4° C. and about 0·018% iron, and the solid solubility of zinc in α-iron is about 18% at 20° C. and in γ-iron 26% at 625° C. The two peritectic horizontals occur at 672° and 782° C., the only two definite compounds that exist are $FeZn_7$ and $Fe_3Zn_{10}$, and the range of homogeneous composition of the former extends from 7·3 to 10·9% iron. $FeZn_7$ has a close-packed hexagonal lattice, $c/a$ 1·6, and $Fe_3Zn_{10}$ a body-centred cubic lattice containing 52 atoms per unit cube ($a = 8{\cdot}962$–$8{\cdot}992$ A.). The equilibrium diagram of the entire system is given based on the results of the present work and on the most reliable results of other investigators. —A. R. P.

†**The Zinc–Iron Equilibrium Diagram.** W. D. Jones and R. T. Parker (*Metallurgist* (Suppt. to *Engineer*), 1935, **10**, 56–58).—A survey of published information, summarizing the results of previous workers. The zinc end of the diagram is well established except for the doubt regarding the suggested eutectic at 0·08% iron. Above 24% iron the diagram is vague, although the evidence points to the existence of another compound. Further study is required on the system, the results of which should also be useful in the study of other systems of iron and easily volatilized metals.—R. G.

**Non-Ferrous Casting Alloys of High Strength.** A. J. Murphy (*Met. Ind.* (*Lond.*), 1935, **47**, 229–232, 319–321, 346–349, and *Found. Trade J.*, 1935, **53**, 270–274, 291–294).—Official Exchange Paper of the Institute of British Foundrymen to the 1935 Convention of the American Foundrymen's Association. The composition, details of casting and mechanical properties of manganese–bronze and aluminium–bronze are described. The composition, properties, and applications of the nickel, zinc, aluminium ("Y" alloy and Ceralumin series of alloys), and magnesium alloys in the group of high-strength non-ferrous casting alloys are given. The manner in which the term *high-strength* is related to various other properties is discussed, and the alloys considered are tabulated according to their specific tenacity, *i.e.* the ratio of the tensile strength to the sp. gr.—J. H. W.

**The Mechanism of Age-Hardening. A Review of Recent Researches.** —— (*Met. Ind.* (*Lond.*), 1935, **47**, 435–439, 464–468).—The basic mechanism of age-hardening is briefly but systematically reviewed, and the various theories put forward to account for this phenomenon from the time of Wilm to the present day are summarized. A *bibliography* of 121 references is appended.—J. H. W.

**Hardening of Solid Solutions (Age-Hardening).** C. Benedicks (*Jernkontorets Ann.*, 1935, **118**, 241–248; *C. Abs.*, 1935, **29**, 6867).—B. has previously developed the theory that hardening of metals which takes place on the addition of other components is due to the presence of supersaturated solid solutions. Where allotropy of the metal occurs, a further hardening may take place if the change to another allotropic modification reduces the solubility of the added component which is equivalent to an increase in degree of supersaturation. The theory is now elaborated to account for the increase in hardness which sometimes results even when no allotropic change is known to take place. B. proposes that this may be explained by the growth of "crystallization centres." These increase with time while the degree of supersaturation decreases, and the actual "age-hardening" effect is the sum of the two. The point of view advanced is a more precise statement of Merica's view that "some structural alteration other than precipitation" augments the hardness (*Trans. Amer. Inst. Min. Met. Eng.*, 1932, **99**, 13). The presence of small amounts of a third component often promotes the growth of "crystallization centres" and thereby produces a greater hardness.—S. G.

***The Effect of High Hydrostatic Pressures on Ageing.** Leland Russell van Wert (*Trans. Amer. Soc. Metals*, 1935, **63**, 633–643; discussion, 643–644).—The tests were made on commercial Duralumin, Duralumin containing 0·17% calcium as an ageing inhibitor, aluminium with silicon 1, iron 0·5, and magnesium 0·6%, aluminium with zinc 10, copper 1, iron 0·7, silicon 0·8, manganese 0·75, and magnesium 0·4%, lead with 0·04% calcium, and iron with 0·07% nitrogen. Except in the case of the iron alloy hydrostatic pressures up to 12,000 atm. decrease the rate of ageing but have no effect on the final hardening. Since the greatest influence of pressure is shown by alloys of greatest compressibility it appears that the retarding effect of pressure on age-hardening is due to an increase in the viscosity of the metastable solid solution and the consequent reduction in the rate of diffusion of the solute atoms through the lattice of the solvent.—A. R. P.

***Internal Stresses Resulting from Precipitation-Hardening.** H. Bühler and W. Tonn (*Stahl u. Eisen*, 1934, **54**, 1108–1110; *C. Abs.*, 1935, **29**, 712).—Cylinders of low-alloy chromium–copper steels and iron–tungsten alloys were treated to give precipitation-hardening. This resulted in the formation of compressive stresses at the interior and tensional stresses at the exterior. In the chromium–copper steels these stresses were no greater than after normalizing, but they were reversed.—S. G.

**Age-Hardening of Metals.** H. M. Boylston (*Indust. Heating*, 1935, **2**, 9–13).—A historical survey of the subject.—W. A. C. N.

**Modern Views of Intermetallic Compounds.** C. Degard (*Industrie chim. Belg.*, 1935, **6**, 350–360).—S. G.

†**New Methods and Results on the Detection of Intermetallic Compounds.** G. Grube (*Angew. Chem.*, 1935, **48**, 714–719).—The use of the following methods in investigating alloy systems is critically reviewed: X-ray, dilatometric, magnetometric, and conductometric. The results obtained by recent workers using these methods are shown in equilibrium diagrams of the systems lithium–

cadmium, cobalt–palladium, manganese–palladium, alkali metals–mercury, magnesium–antimony, and lithium–bismuth. The results for the two palladium systems do not appear to have been published before; they indicate that cobalt and palladium form a continuous series of solid solutions with a minimum melting point at about 40 atomic-% palladium (1210° C.) whereas manganese and palladium form the compound PdMn (melting at 1500° C.), a eutectic at about 1150° C., 75 atomic-% manganese, and a range of solid solutions between palladium and PdMn with a minimum melting point at about 1350° C., 35 atomic-% manganese.—A. R. P.

**Thermomagnetic Study of the Heterogeneity of Solid Solutions.** Pierre Chevenard (*IV Congr. Chim. Indust. Paris*, **1934**, (Oct.), 19 pp.).—The use of magnetometric tests at various temperatures in studying the equilibria in ferromagnetic alloys is described with special reference to chromium–nickel steels.—A. R. P.

***On the Solution of High-Melting Metals in Low-Melting Metals.** M. G. Oknov (*Metallurg* (*Metallurgist*), **1935**, (2), 17–30).—[In Russian.] From micrographic examination of the course of dissolution of iron, copper, nickel, aluminium, silver, and antimony in molten zinc, tin, cadmium, and lead it is inferred that the reaction is in all cases dependent on the nature of the equilibrium diagram. When several intermetallic compounds exist, that containing the greatest proportion of low-melting metal is formed first, and gradually layers of the other compounds are produced in order. Analogies between the diffusion process and the reactions in the systems liquid metal–solid metal and gas–solid metal are pointed out [*Note by Abstractor:* obsolete equilibrium diagrams are used in some cases].—N. A.

***Measurements on Thermoelectric Forces from 17·5° K. down to 2·5° K.** W. H. Keesom and C. J. Matthijs (*Comm. K. Onnes Lab. Leiden*, No. 238b, 1935; and (abstract) *Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 569).—[In English.] Thermoelectric forces against a silver alloy standard (silver + 0·3% gold) were measured from 17·5° K. down to 2·5° K. for an alloy of silver with gold and for gold with small quantities of iron, cobalt, nickel, manganese, or chromium, respectively. The present investigation forms a continuation of the measurements of thermoelectric forces down to the temperatures of liquid or solid hydrogen made by Borelius, Keesom, Johansson, and Linde (*Met. Abs.* (*J. Inst. Metals*), 1932, **50**, 422). Some of the thermocouples dealt with in this paper can be applied as thermometers at liquid helium and at liquid hydrogen temperatures. Gold with 1 or 2% cobalt against a silver–gold alloy, such as the silver alloy standard mentioned above, suits this purpose best, having the largest thermoelectric force per degree. Gold can also be taken with 1 or 2% iron or with 0·1–1% nickel against a silver–gold alloy.—S. G.

***Electrical Conductivity of Ternary Solid Solutions.** Keiji Yamaguchi and Kôzô Nakamura (*Rikwagaku-Kenkyû-jo Iho* (*Bull. Inst. Phys. Chem. Res.*), 1935, **14**, 73–75).—[In Japanese.] The relation between electrical conductivity and composition where the intermediate phase of a binary alloy A–B forms a solid solution with the intermediate phase of another binary alloy C–D was determined for the undermentioned 5 cases:

| No. | Solvent. | Solute. | Solubility. |
|---|---|---|---|
| 1 | $Cu_5Zn_8$ | $NiZn_3$ | perfect |
| 2 | $\epsilon$ of Cu–Zn | $\epsilon$ of Ag–Zn | „ |
| 3 | $Cu_5Zn_8$ | $Cu_{31}Sn_8$ ($\delta$) | imperfect |
| 4 | CuZn | NiZn | „ (perfect at high temperatures) |
| 5 | $Cu_5Zn_8$ | $\gamma$ of Ag–Zn | imperfect |

Except for No. 4, there is always a close linear relation between the composition by weight and the specific resistance; the inverted U-type usual in binary solid solutions does not occur. For No. 4 the resistance–composition curve was obtained, which lies intermediate between the two. The test-pieces were all made homogeneous by annealing at high temperatures.—S. G.

***Penetration of a Magnetic Field into Superconductive Alloys.** W. J. de Haas and J. M. Casimir-Jonker (*Proc. Akad. Wet. Amsterdam*, 1935, **38**, 2–7).—[In English.] The electrical resistances of two superconducting alloys, *viz.* $Bi_5Tl_3$ and a lead–tantalum alloy containing 64·8% of tantalum, have been investigated at temperatures in the region 3·5°–4·3° K. in magnetic fields of strengths up to 500 oerstedt. The transition temperature of $Bi_5Tl_3$ is 6·5° K., that of the lead–tantalum alloy is 3·8° K. Magnetic disturbance of the resistance of $Bi_5Tl_3$ could not be obtained at the boiling point of helium with the highest magnetic field available; it is known from previous work to occur about 4000 oerstedt. Measurements of the change of resistance at various temperatures between 2° K. and 4·2° K of a bismuth wire arranged within each of the alloys shows that no change of resistance occurs until a certain critical magnetic field has been established; when this value is exceeded there is almost as great a change in resistance as would occur if no superconducting alloy were present. The lowest value of the magnetic field which effects the resistance of the bismuth wire increases with increase of the "frozen-in" field, *i.e.* the field existing in the alloy initially. The magnitude of the field that can remain in the superconducting alloy is of the order of magnitude of the critical field.—J. S. G. T.

***Multi-Lamellar Cylindrical Magnetic Shields.** T. E. Sterne (*Rev. Sci. Instruments*, 1935, [N.S.], **6**, 324–326).—A method for the rapid computation of the shielding ratio, *F*, of a system of co-axial cylinders is described. The formulæ deduced are employed to determine the value of *F* for a shield consisting of 20 cylinders of Mumetal separated by copper, and either surrounded or not surrounded by a soft-iron cylinder.—J. S. G. T.

## III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 511–514.)

**Metal Microscopy as an Indispensable Aid in the Metal Industry, Especially in Foundry Practice.** H. Reininger (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 389–394, 411–417).—The value of micrography is illustrated with especial reference to the examination of castings of bearing metals and Silumin, of welds and soldered joints in aluminium and its alloys, of sprayed and plated coatings, and of powdered metals, sands, and the like; 43 micrographs are given and the significance of the features revealed is discussed.—A. R. P.

**The Interpretation of a Photomicrograph.** Josiah W. Jones (*Proc. Staff. Iron Steel Inst.*, 1933–1934, **49**, 48–61; discussion, 62–65).—The value of photomicrography for studying crystal grain structure, and its variation during mechanical and thermal treatment is discussed.—A. R. P.

**Metallographic Points of View on Powder Metallurgy with Special Reference to Hardened Metals.** Gösta Sterky (*Jernkontorets Annaler*, 1935, **119**, 255–280).—A review.—S. G.

***Independence of Grain-Size and Dendrite Fineness.** Ichirô Iitaka (*Rikwagaku-Kenkyū-jo Iho* (*Bull. Inst. Phys. Chem. Res.*), 1934, **13**, 1395–1400).—[In Japanese.] Grain-size and dendrite fineness were measured for various alloys solidified in different conditions. Grain-size *G* is defined as the mean diameter of the grains, and dendrite fineness *D* as the mean distance between the branches of dendrites. The alloys investigated were gun-metal, bronze, aluminium–" bronze " (5% aluminium), brass (20% zinc), Constantan, and a light aluminium alloy containing 5% magnesium. The alloys were cast in both metal and sand moulds at different temperatures, and in the case of metal moulds they were preheated to different temperatures. In some cases the rate of solidification was very slow, *e.g.* 0·5–2 hrs. to cool through the freezing range. 63 photomicrographs and 13 tables are given. I. concludes that in four cases grain-size was proportional to dendrite fineness, $G \propto D$; in three cases grain-size was inversely proportional to dendrite fineness, $G \propto 1/D$; in six cases dendrite fineness changed while grain-size remained constant, $G \neq f(D)$; in two cases dendrite fineness remained constant while grain-size changed, $D \neq f(G)$. In short, grain-size and dendrite finenesses are independent variables, having no functional relation to each other.—S. G.

**Grain Distortion in Metals During Heat-Treatment.** C. Nusbaum and N. P. Goss (*Trans. Amer. Soc. Metals*, 1935, 23, 621–631; discussion, 631–632).—A number of Laue X-ray photographs of steel and nickel–iron alloys is given to show that during the heat-treatment of cold-worked metals the grains may grow either in such a way that they have a perfect crystal shape as shown by sharply defined diffraction maxima or in such a way as to be more or less distorted as shown by diffuse or poorly defined diffraction maxima (" radial asterism "). The factors which determine the method of growth are the degree of cold-work, the chemical composition, the temperature of heat-treatment, and the time of treatment.—A. R. P.

†**Phase Boundary Energies in Phase Systems Comprising Pure Electro-Neutral Phases.** H. Hohn and E. Lange (*Physikal. Z.*, 1935, 36, 603–624).—The thermodynamics of inter-phase boundaries of multi-phase systems composed of pure phases is discussed principally in terms of interfacial tension and adhesion.—J. S. G. T.

**Notes on the Crystallization of Copper.** Alden B. Greninger (*Metals Technology*, 1935, 2, (Sept.); *A.I.M.M.E. Tech. Publ.* No. 643, 1–12).—Macromosaic structure is defined as mosaic structure which is on a large enough scale to produce splitting of Laue spots on back-reflection Laue X-ray patterns; the deviation from exact parallelism of neighbouring macromosaics varies from a few minutes to a few degrees. Micromosaics are those which are so small that they produce broadening (symmetrical or otherwise) of the Laue spots or distortion of the diffracted X-ray beam without perceptible broadening. In single crystals of copper grown from the melt the macromosaic structure is generally more pronounced the more rapidly the crystals solidify and the higher the silver content of the metal. Strain-anneal copper crystals show no macromosaic structure. In specimens having a marked macromosaic structure this structure is crystallographically uniform; the two lattices can be superimposed by rotating one $5''$ to 8° around the common axis of symmetry. There appears to be no connection between dendritic structure and macromosaic structure in copper. It is suggested that the crystallization of copper takes place as follows: after primary nucleation all deviations from exact parallelism begin as a lattice movement due to minute disturbances which initiate a micromosaic structure; in certain conditions these disturbances become cumulative and, if the resultant movement is small, a macromosaic, and if large a twin crystal is formed. Between these extremes movements may begin as a rotation about one axis and follow on by rotation about another to produce a near-parallel, near-twin, or random arrangement. Since the most favourable conditions for twin formation are large disturbances, in nearly equilibrium conditions grains in slowly solidified polycrystals will tend to become twins whereas those in rapidly solidified aggregates (castings) will tend toward the near-parallel arrangement. Once a grain has crystallized it may later be assimilated by a neighbouring grain partly or completely, or it may granulate; these changes frequently occur upon high-temperature annealing of a polycrystal. When a macromosaic nucleus has formed, dendritic growth may or may not determine the boundary limits of the resulting columnar mosaic. A dendritic structure is considered to be merely the result of a more rapid spread of crystallization in certain crystallographic directions.—A. R. P.

***†Growth of Very Thin Crystals. I.—A Qualitative Study. II.—A Quantitative Study. III.—A Theoretical Study.** Lew Kowarski (*J. Chim. physique*, 1935, **32**, 303–331, 395–405, 469–495).—(I.—) The growth of thin transparent crystals is followed by means of interference colours. (II.—) The growth of a crystal is registered by means of photomicrography at intervals of 10–15 secs. In crystal growth there occurs a period during which the crystal contour remains of similar shape throughout. Superficial growth and increase of thickness of a crystal appear to be independent processes. (III.—) Volmer's theory of crystal growth which contemplates the existence of a mobile film of condensed molecules at the crystal face for a certain period appears to be most in accord with experimental facts. The theory is extended to include both isotropic and anisotropic crystal growth.—J. S. G. T.

***The Nature of Recrystallization Processes. I.—Single-Grain Recrystallization and Deformed Single Crystals. II.—Investigations Relating to Recrystallization-Single Crystals. III.—Investigations Relating to Compressed [Powdered] Rock-Salt.** Horst Guido Müller (*Z. Physik*, 1935, **96**, 279–306, 307–320, 321–327).—See also *Met. Abs.*, this vol., p. 56. (I.—) Experiments concerned with the single-grain recrystallization of rock-salt show that the mean velocity, $v$, of grain-growth, both visible and invisible, is expressed as a function of the temperature, $T$, by the equation $v = A_1e^{-B_1/T} + A_2e^{-B_2/T}$. This relation holds between room temperature and 800° C. At all temperatures, grain production and grain-growth are possible. A special production of nuclei does not occur in the process of recrystallization; the germ-spots (*Keimstelle*) can be influenced by thermal recovery or the presence of foreign atoms. (II.—) The production of microscopic and ultramicroscopic cavities is shown to characterize the recrystallization process in compressed powdered rock-salt. (III.—) The tensile strength of tempered compressed powdered rock-salt is shown to depend qualitatively in the same manner on heat-treatment as in the case of compressed metals. Grain-growth is not dependent on a process of recrystallization due to the production of new grains; the velocity of grain-growth and the velocity of visible growth of recrystallization grains may correspond, however, with one another.—J. S. G. T.

***Recrystallization and Grain-Growth in Cold-Worked Polycrystalline Metals.** L. W. Eastwood, Arthur E. Bonsu, and C. T. Eddy (*Metals Technology*, 1935, **2**, (Oct.); *A.I.M.M.E. Tech. Publ.* No. 644, 1–19).—From a study of the grain-growth during recrystallization of brass, aluminium, steel, iron, and other metals the following principles of grain-growth have been deduced. Grains may grow at the expense of cold-worked grains (recrystallization) or of unstrained grains (coalescence), the grain-size immediately after complete recrystallization is independent of the time and temperature and depends only on the composition and previous history of the specimen prior to deformation, and on the degree of deformation. Rapid heating to a temperature above the germination temperature produces a coarse grain structure in cold-worked metals and a similar coarse structure may be developed in the just recrystallized metal by increasing the recrystallization temperature by one of the following methods : decreasing the degree of cold-deformation, adding an obstructing material and reducing the cold-work, increasing the temperature of deformtion, and increasing the original grain-size. The rate of growth of new grains in partly recrystallized $\alpha$-brass is independent of the degree of strain, the number of nuclei which serve as centres of recrystallization is independent of the temperature and unaffected by a previous low temperature anneal, and temperature gradients do not produce any abnormalities in the grain-growth.—A. R. P.

***On the Rolling and Recrystallization Texture of [50 : 50-]Nickel–Iron Alloy.** W. G. Burgers and J. L. Snoek (*Z. Metallkunde*, 1935, 27, 158–160).—X-ray examination of a sheet of 50 : 50 nickel–iron alloy annealed at 1100° C. in hydrogen after 70% reduction by cold-rolling showed that the structure could be considered either as a superimposing of the following two orientations : (*a*) [112] parallel to the rolling direction and {110} parallel to the plane of rolling, and (*b*) [111] parallel to the rolling direction and {112} parallel to the plane of rolling, or as a random distribution of the crystallites with [335] parallel to the rolling direction, and {135} parallel to the rolling plane. Magnetic tests on the sheets after complete recrystallization showed slight anisotropy the constant being $0{\cdot}3 \times 10^4$ compared with $4{\cdot}2 \times 10^4$ for pure iron and $-\ 3{\cdot}7 \times 10^4$ for pure nickel; hence the critical composition at which the anisotropy constant changes its sign must lie at slightly more than 50% nickel. —A. R. P.

***Rolling and Recrystallization Textures of Nickel–Iron Alloys in Relation to the Magnetic Properties.** Fr. Pawlek (*Z. Metallkunde*, 1935, 27, 160–165).—The rolling and recrystallization textures of reversible iron–nickel alloys are the same as those of pure nickel, *i.e.* the rolling texture is a combination of (110) in the rolling plane and [112] in the rolling direction with (112) in the rolling plane and [111] in the rolling direction, whilst the recrystallization texture is (010) in the rolling plane and [100] in the rolling direction. The recrystallization texture is obtained only after reduction of more than 90%, the actual minimum necessary being a function of the amount of impurity present. In certain conditions, annealing of the fibrous metal at above 1100° C. may lead to an extraordinarily coarse crystal growth. The recovery in the mechanical properties on annealing may proceeed in two very different ways according to whether recrystallization results in the re-formation of the random crystal orientation or in the further development of the fibre structure. The cubic texture is retained on rolling to reductions of 50–70% and subsequent annealing leads to the re-formation of the random crystallite orientation provided that at least 15% reduction has been given. With more than 90% reduction the resulting combination texture is reconverted on annealing into the cubic structure. The sheet obtained by rolling metal with a cubic texture shows the " isoperm " behaviour in the direction of rolling.—A. R. P.

***Influence of Lattice Distortion on Diffusion in Metals.** V. G. Mooradian and John T. Norton (*Metals Technology*, 1935, 2, (Sept.); *A.I.M.M.E. Tech. Publ.* No. 649, 1–9).—Duplex sheets made by depositing alternate thin layers of copper and gold, gold and silver, copper and nickel, and nickel and cobalt by electrolysis were examined by X-rays before and after heating for 24 hrs. at 150°, 200°, 300°, 400°, and 500° C. The results show definitely that lattice distortion in the original samples is not an aid to diffusion since it disappears completely before diffusion starts. It is possible that distortion is definitely a hindrance to diffusion and its removal is a necessary factor before easy diffusion can occur. Diffusion of metals in intimate contact may not be mutual, thus copper diffuses into gold at lower temperatures than gold into copper, but silver and gold and nickel and copper diffuse mutually. In the first case the difference may be due to difference in size of the atoms.—A. R. P.

**The Significance of the Persistence of the Crystalline State Above the Melting Point.** Robert E. Burk (*Science*, 1935, 81, 344–345).—The process of fusion is conceived as a process involving only a partial breakdown of crystalline structure. Such a conception receives support from Raman's theory of viscosity, Stewart's work on the structure of liquids as revealed by X-ray analysis, Ornstein's work on dielectric losses and X-ray investigations, and that of Bernal and Fowler on the nature of water.—J. S. G. T.

**A Criterion for the Occurrence of Orderly Atomic Distribution in Series of Metallic Solid Solutions.** H. J. Seemann (*Z. Physik*, 1935, 95, 796–798).—A criterion for the existence or non-existence of orderly or random atomic distribution in series of metallic solid solutions, based on the occurrence of an expansion or contraction, respectively, of the crystal lattice throughout the series is tentatively suggested.—J. S. G. T.

***The Effect of Thermal Agitation on Atomic Arrangement in Alloys.—II.** W. L. Bragg and E. J. Williams (*Proc. Roy. Soc.*, 1935, [A], **151**, 540–566).—The treatment of the order–disorder transformation in alloys given in a previous paper (*Proc. Roy. Soc.*, 1934, [A], **145**, 699) and the more rigorous analysis by Bethe (*Proc. Roy. Soc.*, 1935, [A], **150**, 552) are compared with the formal treatments of Borelius (*Ann. Physik*, 1928, **86**, 291), Gorsky (*Z. Physik*, 1928, **50**, 64), and Dehlinger (*Z. Physik*, 1930, **64**, 359; 1933, **83**, 832). The measurements by Sykes of the specific heats of the alloys CuZn and $Cu_3Au$ (*Proc. Roy. Soc.*, 1935, [A], **148**, 422) are used to estimate changes in internal energy due to transformation in these alloys and these results are compared with those deduced from the theory. The dependence of critical temperatures on composition is discussed.—J. S. G. T.

***The Effect of Thermal Agitation on Atomic Arrangement in Alloys.—III.** E. J. Williams (*Proc. Roy. Soc.*, 1935, [A], **152**, 231–252).—The equilibrium equation for the general case of an alloy, assuming the energy associated with the atomic arrangement to be uniquely determined by the super-lattice order, is derived from the Boltzmann distribution formula and also from the principle of minimum-free energy. Existing theory is discussed generally and possible modifications for improving theoretical results in relation to experimental results are briefly referred to.—J. S. G. T.

**†The Structure of Intermetallic Phases.** Gunnar Hägg (*Angew. Chem.*, 1935, **48**, 720–723).—A review of recent work on the nature of intermetallic compounds is given with a *bibliography* of 19 references.—A. R. P.

***Metals and Alloys. X.—The Valence Electron Rule and the Atomic Radius of Non-Noble Metals in Alloys.** E. Zintl and G. Brauer (*Z. physikal. Chem.*, 1933, [B], **20**, 245–271; *C. Abs.*, 1933, **27**, 2407).—X-ray analysis was made of some binary alloy systems. The following compounds have the structure of $\beta$-brass: LiAg, LiHg, LiTl, MgTl, CaTl, SrTl. The same structure as NaTl is shown by: LiZn, LiCd, LiGa, LiIn. These all have the composition $AB$ and have cubic space-centered structure. Investigation was also made of the systems Li–Au, Li–Sn, Li–Bi, Ba–Tl, K–Tl, Ca–Pb, Sr–Pb, Ce–Pb, Na–Ag, and Ca–Ag with various results. The results are all discussed in relation to the valency electron rule (Hume-Rothery, *J. Inst. Metals*, 1926, **35**, 295; Westgren and Phragmén, *J. Inst. Metals*, 1929, **42**, 520).—S. G.

***Metals and Alloys. XI.—Lattice Structure of NaIn and the Deformation of Atoms in Alloys.** E. Zintl and S. Neumayr (*Z. physikal. Chem.*, 1933, [B], **20**, 272–275; *C. Abs.*, 1933, **27**, 2408).—An X-ray powder diagram was obtained for the alloy NaIn and it was found to have the same structure as NaTl with $a = 7{\cdot}297$ A., $r^{[8]}_{Na} = r^{[8]}_{In} = 1{\cdot}58$ A.—S. G.

***The Interpretation of the Hume-Rothery Rule Relating to Intermetallic Compounds.** U. Dehlinger (*Z. Physik*, 1935, **94**, 231–240).—The electron configuration in the Bloch $k$-space of the Hume-Rothery phases of the type of $\gamma$-brass ($Cu_5Zn_8$) has been discussed by Jones (*Met. Abs.*, 1934, **1**, 237), who found the Bloch waves of the first zone, in accordance with experimental data relating to the number of valency electrons, approximately completely occupied by electrons. This result is now shown to hold even more satisfactorily for the hexagonal $\varepsilon$-phase ($CuZn_3$), whilst in the case of the highly symmetrical $\beta$-phase (CuZn) the experimental electron number is insufficient for such complete occupation. This last deduction appears to be in conformity with the experimental result that the $\beta$-phase is stable only at relatively high temperatures. Both facts are in agreement with a hypothesis relating to rotation of the distribution of electric charge, previously postulated, and now discussed at some length.—J. S. G. T.

***Numerical Relationships in Binary Metallic Systems.** D. Stockdale (*Proc. Roy. Soc.*, 1935, [A], **152**, 81–104).—The Hume-Rothery valency rules are summarized, and the work of Hume-Rothery, Mabbott, and Evans on the depressions of the melting and freezing points of copper and silver by the addition of elements of the *B* sub-groups, together with the solid solubility limits in these alloys, is discussed. Other integral relationships probably exist between the numbers of atoms in a binary alloy. The following empirical rules are suggested: (1) in a saturated solution at the temperature of the eutectic or peritectic horizontal, there is a simple integral relationship between the number of solvent and solute atoms; (2) there is a similar relationship in a saturated solid solution in contact with a second solid phase at the temperature of transformation of the second phase; (3) in copper and silver-rich alloys, the solubilities at the two above temperatures are simply related, and it is possible to predict the solubility at the lower temperature if that at the higher is known; (4) in eutectic mixtures the elements are present in a simple integral atomic ratio, and (5) the ratio of the numbers of atoms, irrespective of their kind, in the two phases is simple. None of these 5 rules may be exact but their use gives results which are more accurate than most of those obtained experimentally.—J. S. G. T.

***On the Nature of the Polished Layer on Metals.** Mituwo Miwa (*Sci. Rep. Tôhoku Imp. Univ.*, 1935, [i], **24**, 222–239; and (in Japanese) *Kinzoku no Kenkyu*, 1935, **12**, 484–492).—[In English.] Cathode ray examination of metal surfaces during polishing shows that the diffraction lines gradually become blurred and finally coalesce into 2 very diffused lines; calculation of the atomic distances from the spacing of these 2 lines indicates that polished surfaces of chromium, iron, cobalt, nickel, copper, zinc, and silver consist of a truly amorphous layer like a supercooled liquid, whereas those of cadmium, tin, and antimony consist of minute pseudo-crystals which are probably an intermediate stage in the transition from the crystalline to the amorphous state. Polishing of silicon, manganese, and bismuth failed to produce the amorphous layer, probably owing to the extreme brittleness of these metals.—A. R. P.

†**The Structure of Metal Surfaces.** L. L. Bircumshaw (*Metal Treatment*, 1935, **1**, 149–151).—Electron diffraction methods have been used to study the structure of the oxide films on lead, tin, and (more recently) copper. Successive oxidations and reductions produced a surface on copper which gave a spectrum showing broad rings. This is interpreted as being due to a large decrease in the grain-size of the oxide. A number of the papers read at the Faraday Society Symposium on metallic coatings is reviewed. See *Met. Abs.*, this vol., pp. 284–289, 468–470.—J. C. C.

***Examination of Electrodeposited Nickel Coatings by X-Ray Diffraction.** W. A. Wood (*Phil. Mag.*, 1935, [vii], **20**, 964–971).—Specimens of electrodeposited nickel differing in hardness and initial brightness were examined by X-ray diffraction. Brightness is found to be associated with the degree of selective orientation of the metal grains; hardness is associated with the degree of diffusion of the X-ray diffraction spectra. The softest nickel deposits are composed of crystallites of sizes of the order $10^{-5}$ cm.; in the hardest deposits, crystallites are of sizes of the order $10^{-6}$ cm. Hardness is associated with the state of the crystalline structure of the metal in this latter subnormal crystallite size.—J. S. G. T.

***The Structure and Physical Properties of Thin Films of Metal on Solid Surfaces.** E. N. da C. Andrade and J. G. Martindale (*Phil. Trans. Roy. Soc.*, 1935, [A], **235**, 69–100).—The structures and physical properties of films of silver and of gold of thicknesses 30–100 atoms produced on various surfaces by cathodic sputtering are investigated. It is shown that many of the irregularities of previous results are due to uncontrolled heating of the film during preparation. By slow sputtering on a cooled surface, perfectly uniform and reproducible films can be produced. When films, about 50 atoms thick, are maintained at about 230° C. for silver, and slightly higher for gold, the first stage of crystallization occurs; this consists in the formation of small aggregates which show a characteristic figure in polarized light. The phenomenon is independent of the nature of the non-metallic support. The aggregates are formed by motion of the upper layers of the film only. Prolonged heating at about 100° C. above these respective temperatures leads to rapid growth of the aggregates into a well-defined outline characteristic of the cubic lattice. The crystals are all arranged with the (111) face parallel to the support; growth normal to the (111) surface proceeds with difficulty. Crystal-growth leads to the development of large, irregular, more transparent areas from which the metal has, in part, retreated. An increase of temperature causes crystallization in these regions of thinner film. The upper layers of a thick film are more mobile than is a thin film on a rigid substrate. Evidence is obtained for the existence of submicroscopic surface cracks in certain types of amorphous and of crystalline substances. The results generally may be classed under two headings, *viz.* (1) in which a series of changes by heating has been established which are independent of the nature of the support, and (2) in which alignments of the minute crystalline particles have been found which are characteristic of the support and these appear to be adapted to throw light on the question of crystal flaws as accounting for the weakness of the natural, as distinct from the ideal, crystal lattice.—J. T.

***About the Structure of Crystalline Bismuth and Selenium Layers Produced by Condensation in Vacuum.** A. Goetz and L. E. Dodd (*Phys. Rev.*, 1935, [ii], **48**, 165).—The cross-section of layers of crystals of bismuth and selenium, deposited *in vacuo,* showed in the direction of crystallization *two* distinctly different structures. The layer which is deposited first shows a microcrystalline structure of such fineness that it has almost an amorphous appearance. This is especially the case with selenium. The layer is homogeneous throughout its whole thickness of $\frac{1}{100}$ cm.; its structure then changes suddenly into a macrocrystalline one with fibrous texture, characterized by a homogeneous orientation giving the layer the characteristics of a single crystal with a regular mosaic structure. For both substances, [111] is parallel to the direction of growth. The phenomenon is apparently associated with the temperature of the surface on which condensation progressively occurs, and can be compared with Kapitza's observation that the production of bismuth single crystals from the vapour phase is not successful below 200° C.
—J. S. G. T.

**A Note on the Reflection of Cathode Rays from a Crystal Surface.** Shizuo Miyake (*Sci. Papers Inst. Phys. Chem. Res. Tokyo*, 1935, **27**, (892), 286–294).—[In English.] The spectrum of cathode rays reflected by a crystal is deduced on the wave-mechanical theory.—J. S. G. T.

***Diffraction of Electrons by Metal Crystals and by Mica.** J. A. Darbyshire and E. R. Cooper (*Proc. Roy. Soc.*, 1935, [A], **152**, 104–123).—The spot patterns obtained by transmitting an electron beam of 30 kv. through thin crystalline films are investigated; patterns obtained from cadmium, zinc, and bismuth are described. The crystals of these metals were produced by withdrawing the surface oxide film from the molten metals in air and in oxygen. The spot patterns are shown to be due chiefly to distortion of the diffracting crystals.—J. S. G. T.

***The Origin of the " Extra Rings " in Electron Diffraction Patterns.** K. Lark-Horovitz, H. J. Yearian, and J. D. Howe (*Phys. Rev.*, 1935, [ii], **48**, 101).—Electron diffraction patterns containing sharp " inner rings " in positions similar to those found by Rupp in the case of gold were obtained for aluminium, cadmium, copper, cuprous oxide, gold, lead, lead oxide, nickel, silicon, and silver. This diffraction pattern is shown to be due to an adsorbed surface layer of the substance (naphthalene) upon which the films were originally deposited. No " inner rings " are obtained when the films are deposited on ammonium chloride, which is driven off by heating. The rings can be produced by contact of the films with organic vapours.—J. S. G. T.

***X-Ray Study of Aluminium–Zinc Alloys at Elevated Temperatures.** E. A. Owen and Llewelyn Pickup (*Phil. Mag.*, 1935, [vii], **20**, 761–777).—Apparatus was designed to obtain rotation, powder X-ray photographs of metals and alloys at temperatures up to about 400° C. *in vacuo*, and to obtain accurate measurements of parameter values and temperature. Such apparatus is essential for the X-ray study of the $\beta$-phase in aluminium–zinc alloys, owing to its spontaneous decomposition below 270° C. Tanabe's equilibrium diagram most generally agrees with the present X-ray results. The only marked divergence is in the extent of the $(\beta + \gamma)$ region above about 360° C.; O. and P. find it to extend over about 3% at 360° C. compared with about 8% in Tanabe's diagram at this temperature. Above this temperature, the $(\beta + \gamma)$ region up to the peritectic line at 440° C. occupies an exceedingly narrow range of composition. Owing to the large decrease in parameter as zinc dissolves in the $\gamma$-phase above 270° C., this phase shows a decrease in parameter as the temperature increases. As a result of this, both the transformation temperature and the $(\beta + \gamma)$–$(\gamma)$ boundary were determined from a study of the thermal expansion curves of the $\gamma$-phase in certain alloys. The transformation temperature is found to be 272° C. (cf. 270° Tanabe, 280° Isihara, 256° Hanson and Gayler). The phase boundaries expressed in weight-% aluminium are: $(\alpha + \beta)$–$\beta$, 17·4% (360° C.), 18·0% (340° C.), 19·0% (315° C.); $(\beta)$–$(\beta + \gamma)$, 29·5% (360° C.), 28·0% (340° C.), 23·5% (315° C.): $(\beta + \gamma)$–$(\gamma)$, 32·0% (360° C.), 42·0% (350° C.), 27·6% (340° C.), 51·4% (330° C.), 58·5% (315° C.), 30·5% (365° C.), 40·9% (352° C.), 54% (322° C.). The $\gamma$-phase parameter in the $(\beta + \gamma)$ region decreases with increasing temperature; this may produce the age-hardening found in alloys containing comparatively little of the $\beta$-phase.—J. S. G. T.

***X-Ray Study of Electrodeposited Cadmium.** A. Rubio and J. García de la Cueva (*Anales soc. españ. fís. quím.*, 1935, **33**, 521–532; *C. Abs.*, 1935, **29**, 7197).—The improved bath contained CdO 39·4, KCN 128·2, $Na_2SO_4$ 50·0, and $NiSO_4$ 1·0 grm. The size of the grain is greater than $10^{-6}$ cm. and plane $11\bar{2}2$ is oriented in a direction parallel to the surface of the cathode.—S. G.

***Crystal Structure and Composition of Rhombic Cobalt Silicide.** Bertil Borén, Sven Ståhl, and A. Westgren (*Z. physikal. Chem.*, 1935, [B], **29**, 231–235).—The crystal structure of the cobalt-rich intermediate phase of the cobalt–silicon system was determined from the results of an earlier X-ray examination. The phase has the composition $Co_2Si$ and an atomic arrangement resembling those of FeB and $Cr_3C_2$, in which the atoms of the metalloid form a folded chain.—K. S.

***An X-Ray Examination of Lattice Distortion in Copper and Nickel Powders.** G. W. Brindley and F. W. Spiers (*Phil. Mag.*, 1935, [vii], **20**, 882–893).—The atomic scattering factors of copper and nickel were determined for chemically-prepared and filed powders of these metals. The values for the filed powders are definitely less than those for the chemically prepared powders. This effect is attributed to crystal lattice distortion caused by filing, and it is shown that most of the results can be explained by assuming that the distortion is a random displacement of the atoms from the points of the undistorted lattice. The magnitude of this displacement is 0·106 A. for copper and 0·083 A. for nickel. Scattering factors for the (200) reflections from both filed powders are reduced much more than can be explained in this way, and this may mean that the lattice distortion is not an entirely random one.—J. S. G. T.

***An X-Ray Investigation of Lattice Distortion in a Copper–Beryllium Alloy.** G. W. Brindley and F. W. Spiers (*Phil. Mag.*, 1935, [vii], **20**, 893–902).—The average atomic scattering factor ($f$) was determined experimentally for a powdered CuBe alloy containing 0·72% of beryllium (by weight). The results are compared with the values of $f$ calculated for the ideal undistorted alloy.

The experimental values are less than the calculated values; this is attributed to lattice distortion produced partly by the filing process by which the alloy was obtained in powder form, and partly by the presence of beryllium atoms in the lattice. The ratio of the observed to the calculated scattering factor can only be partially explained in terms of a random displacement of the atoms from the lattice points.—J. S. G. T.

***The Crystal Structure of $Cu_2Sb$ and $Fe_2As$.** Majken Elander, Gunnar Hägg, and A. Westgren (*Arkiv Kem. Min. Geol.*, 1935, [B], **12**, (1), 6 pp.; *C. Abs.*, 1935, **29**, 6811).—The lattices of $Cu_2Sb$ and $Fe_2As$ are end-centred tetragonal, with $a_0 = 3{\cdot}992$, $c_0 = 6{\cdot}091$, and $a_0 = 3{\cdot}627$, $c_0 = 5{\cdot}973$ A., respectively. There are 6 atoms to the elementary cell. The space group is $D^r_{4h}$, with the following parameters: 2Cu(or Fe) in 2 $(a)$ : 0 0 0, $\frac{1}{2}\,\frac{1}{2}\,0$; 2Cu(or Fe) in 2$(c)$ : 0 $\frac{1}{2}$ $u$; $\frac{1}{2}$ 0 $\bar{u}$; 2Sb(or As) in 2$(c)$ : 0 $\frac{1}{2}$ $\nu$, $\frac{1}{2}$ 0 $\nu$. Comparisons calculated with visually estimated intensities give: $u = 0{\cdot}27$, $\nu = -0{\cdot}30$ for $Cu_2Sb$, and $u = 0{\cdot}33$, $\nu = 0{\cdot}265$ for $Fe_2As$. The Cu–Sb and Fe–As distances are shorter than those calculated from normal atomic radii.—S. G.

***The Crystal Structures of $AuBe_5$ and $PdBe_5$ and Their Relation to the Cubic $AB_2$ Structure.** Lore Misch (*Metallwirtschaft*, 1935, **14**, 897–899).—Both $AuBe_5$ and $PdBe_5$ are cubic, the former having $a = 6{\cdot}085$ A. and the latter $a = 5{\cdot}982$ A. The distribution of the atoms about the lattice points is described.—A. R. P.

***The Solid Solution Series $MgCu_2$–MgNiZn and $MgZn_2$–MgCuAl.** Werner Doering (*Metallwirtschaft*, 1935, **14**, 918–919).—Since the lattice constants alter continuously with the composition both systems form a continuous series of pseudo-binary solid solutions.—v. G.

***On the Isomorphism of the Ternary Compounds $Mg_3Zn_3Al_2$ and $Mg_4CuAl_6$.** F. Laves, K. Loehberg, and H. Witte (*Metallwirtschaft*, 1935, **14**, 793–794).—Both compounds are cubic with 161 atoms in the unit cell; $Mg_3Zn_3Al_2$ has $a = 14{\cdot}16$ A. and $Mg_4CuAl_6$ $a = 14{\cdot}25$ A.—v. G.

***X-Ray Analysis of the Structure of Homogeneous Phases in the Mg–Ni System.** E. F. Bachmetev (*Zhurnal Fizicheskoy Khimii* (*J. Phys. Chem.*), 1935, **6**, 590–592).—[In Russian.] See *Met. Abs.*, this vol., p. 513.—N. A.

**X-Ray Evidence of Lattice Distortions in Cold-Worked Nickel.** W. E. Schmid and Ernst A. W. Müller (*Z. tech. Physik*, 1935, **16**, 161–164).—The magnitude of the internal stresses produced in multi-crystalline nickel by plastic extension has been estimated by Kersten from magnetic observations (*Met. Abs.* (*J. Inst. Metals*), 1931, **47**, 642; 1932, **50**, 597; 1933, **53**, 487). These stresses ($s$) have now been estimated from determinations of the widths of lines in the spectra of cold-worked, technically pure nickel. As is the case with copper and iron, the widths of the nickel X-ray lines increase approximately linearly with increase of the tension applied. The values of $s$ so deduced agree neither in their relation to the extension nor in their absolute magnitude with the values found by Kersten.—J. S. G. T.

***Phosphides and Arsenides with Modified Nickel Arsenide Structure.** K. E. Fylking (*Arkiv Kem. Min. Geol.*, 1935, [B], **11**, (48), 1–6; *Sci. Abs.*, 1935, [A], **38**, 685).—[In English.] A number of crystals akin to NiAs was investigated and shown to have orthorhombic symmetry, with parameters (in A.):

| | *a*. | *b*. | *c*. |
|---|---|---|---|
| MnP . . | 5·905 | 5·249 | 3·167 |
| FeP . . | 5·782 | 5·177 | 3·089 |
| CoP . . | 5·588 | 5·066 | 3·274 |
| MnAs . . | 6·38 | 5·63 | 3·62 |
| FeAs . . | 6·016 | 5·428 | 3·366 |
| CoAs . . | 5·96 | 5·15 | 3·51 |

—S. G.

***Investigations on the Phosphides and Arsenides of Zinc and Cadmium. The $Zn_3P_2$ Lattice.** M. von Stackelberg and R. Paulus (*Z. physikal. Chem.*, 1935, [B], **28**, 427–460).—The physical and crystallographic properties of single crystals of $Zn_3P_2$, $Zn_3As_2$, $Cd_3P_2$, $Cd_3As_2$, $ZnP_2$, and $CdP_2$ were determined. The crystals have pseudo-cubic properties. The paper contains a detailed summary of the parameter values obtained and preliminary results on the structure of the compounds with the formula $MeX_2$ are given.—K. S.

***Mixed Crystal Structure (Mischkristallbildung) and Lattice Constants of Silver–Copper Alloys.** P. Wiest (*Z. Physik*, 1935, **94**, 176–183).—The crystal lattice isotherms of cast single crystals and recrystallized multi-crystalline samples of a copper–silver alloy containing about 6% of silver are determined; contrary to a previous conclusion (*Met. Abs.* (*J. Inst. Metals*), 1932, **50**, 308), the inclined part of the isothermal is the same for both materials; the horizontal part occurs, however, at a somewhat higher value of the lattice constant in the case of the former than for the latter type of crystalline material. Accordingly an increasing difference in the solubility of silver in copper in the two crystalline states accompanies a decrease of temperature, thus at 600° C. the solubility of silver is about 0·6% greater in the single-crystalline than in the multi-crystalline material; at 400° C. the difference is about 0·8%.—J. S. G. T.

***X-Ray Studies on the Systems Tin–Antimony and Tin–Arsenic.** G. Hägg and A. G. Hybinette (*Phil. Mag.*, 1935, [vii], **20**, 913–929).—The structures and homogeneity ranges in these systems were studied by X-rays. In the system tin–antimony, the phase existing at room temperature around the composition SnSb has a homogeneity range between about 45 and 55% (atomic) antimony. At the limit richest in tin it has a deformed NaCl structure. The unit cell is a rhombohedron with $r = 6{\cdot}117$ A., $\alpha = 89{\cdot}70°$, and volume $228{\cdot}9$ A$^3$. With increasing antimony content the volume and deformation of the unit cell increase and at the limit richest in antimony the rhombohedron has $r = 6{\cdot}138$ A., $\alpha = 89{\cdot}18°$, and volume $231{\cdot}2$ A$^3$. In the system tin–arsenic no solubility of arsenic in the tin phase was detected. Two intermediary phases were found with very narrow homogeneity ranges at the compositions $Sn_3As_2$ and SnAs. The Laue symmetry of $Sn_3As_2$ is $D_{3d}$ and its unit cell is a rhombohedron with $r = 12{\cdot}33$ A. and $\alpha = 19{\cdot}22°$. This rhombohedron contains 7 atoms which occupy positions nearly corresponding to a simple cubic lattice. The structure corresponds probably to an ideal formula $Sn_4As_3$ where some arsenic atoms have been replaced by tin atoms. The most probable space group is $D^5_{3d}$. In the stable phase, $Sn_3As_2$, arsenic atoms in the $Sn_4As_2$ structure are probably replaced at random by tin atoms. The phase SnAs has a NaCl structure with a lattice constant 5·716 A.; the homogeneity range is very narrow. Arsenic dissolves about 21% (atomic) of tin. The dissolved tin increases the rhombohedral edge and decreases the rhombohedral angle of the arsenic phase.—J. S. G. T.

**†Investigations on the Problem of Differences in Lattice Constants.** G. Wassermann (*Metallwirtschaft*, 1935, **14**, 813–815).—A summary of the results of various investigations on the question as to whether the lattice constants depend on the grain-size.—v. G.

**Crystal Structures and Electron Configuration of the Transition- and Uni-Valent Metals.** U. Dehlinger (*Z. Physik*, 1935, **96**, 620–633).—The crystal structures of the transition- and uni-valent metals, as influenced by their respective electronic configurations are discussed. Four general rules are established.—J. S. G. T.

***Influence of the Temperature on the Plasticity of Crystals.** Pol E. Duwez (*Phys. Rev.*, 1935, [ii], **48**, 484).—Abstract of a paper read before the American Physical Society. D.'s theory of the plasticity of crystals has been extended to take into account the influence of temperature on the stress–strain curve. The model of the deformed crystal, deduced from Zwicky's secondary structure theory, shows that $G$, the modulus of elasticity, and $\tau_{max.}$, the stress producing rupture, are dependent on temperature, and vary independently. In general, $G$ is a linear function of the temperature except in the neighbourhood of crystallographic or magnetic transition points. It is probable that $\tau_{max.}$ is a function of $T/T_m$, where $T_m$ denotes the melting point.—J. S. G. T.

**X-Rays and Elastic Deformation of Metals.** V. Montoro (*Giorn. chim. ind. appl.*, 1933, **15**, 8–13; *Brit. Chem. Abs.*, **1933**, [B], 352).—A review of work on the application of X-ray interference diagrams to the study of lattice distortion produced by mechanical stress.—S. G.

**On Bitter's Patterns.** F. Zwicky (*Phys. Rev.*, 1935, [ii], **48**, 111).—By sedimentation methods, Bitter has obtained regular striations on ferromagnetic single crystals (*Met. Abs.* (*J. Inst. Metals*), 1932, **50**, 75). His experiments afford a direct proof for the contention that a perfect thermally stable crystal cannot be completely described by an ideal atomic lattice; there must exist in the crystal secondary structures, the characteristic lengths, $D$, of which are large compared with the ordinary lattice constants, $d$, equal to about $10^{-8}$ cm. Z. shows theoretically that the minimum value of $D$ is of the order $1{\cdot}4 \times 10^{-3}/n$ cm., where $n$ is a pure number of the nature of a refractive index.—J. S. G. T.

***Limitations of Crystal Symmetry on Physical Phenomena with Particular Reference to Diamagnetic Magnetostriction.** D. Schoenberg (*Proc. Cambridge Phil. Soc.*, 1935, **31**, 265–270).—The limitations imposed by considerations of crystal symmetry on the physical properties of crystals are deduced by means of tensor analysis in a more direct manner than that given by Voigt (" Lehrbuch der Kristallphysik," **1928**). The phenomenon of magnetostriction is discussed in some detail and formulæ are derived for the variation of the longitudinal and transverse magnetostriction effects with crystal orientation in the case of bismuth.—J. S. G. T.

## IV.—CORROSION

(Continued from pp. 514–519.)

***Testing of Sea-Water-Resistant Aluminium Alloys in the North Sea.** H. Röhrig and W. Nicolini (*Aluminium*, 1935, **17**, 519–529).—Specimens of 99·7% aluminium, Albondur, Pantal, Hydronalium, K.S.-Seewasser and B.S.-Seewasser alloys have been exposed for 18 months in the hard-rolled, partly annealed, and fully annealed states to the action of North Sea water in such conditions that they were fully immersed at high tide and completely out of the water at low tide. The two Seewasser alloys and Hydronalium, despite a heavy growth of marine fauna and flora, showed practically no change in tensile strength or elongation in either the hard or soft states, and the other alloys no change in tensile strength. The surface layer of pure aluminium on Albondur was badly corroded and hard-rolled 99·7% aluminium showed an appreciable loss both in strength and ductility after the test. The numerical data obtained on plain sheets and on riveted sheets are tabulated, and photographs of the specimens after exposure are included.—A. R. P.

**Age-Hardening and Corrosion [of Copper–Aluminium Alloys].** E. Söhnchen (*Metal Treatment*, 1935, **1**, 121–122).—Abridged translation from *Giesserei*, 1935, **22**, 294–296; see *Met. Abs.*, this vol., p. 381.—J. C. C.

***Corrosion of Alloys in Conditions of Cellulose Production.** O. I. Ver, I. S. Vuidrin, and M. M. Romanov (*Rep. Leningrad Inst. Metals*, 1935, (**15**), 134–142; *C. Abs.*, 1935, **29**, 7071).—[In Russian, with English summary.] Special bronzes, plain and alloyed iron, and special steels were tested in cellulose boilers, at the Syas cellulose plant. The cellulose was prepared by the sulphite method. Chromium–manganese steel containing carbon 0·20, chromium 17·26, and manganese 8·10% proved the most resistant alloy, showing a loss of 0·06 grm./m.$^2$/hr.—S. G.

***Resistance to Corrosion of Condenser Tubes.** A. Siegel (*Wärme*, 1935, **58**, 173–177; *Sci. Abs.*, 1935, [B], **38**, 257).—The corrosion of iron and non-ferrous metals in electricity stations and on ships is caused by stray currents. Practically all the common metals used for mechanical purposes are corroded in the same manner by electrolysis. S. describes a series of electrolytic tests on tubes using currents of the order of 2 amp. at about 2 v. A 3% salt solution was used as corrosive fluid and the tube walls were eaten through in 22–25 minutes. Brass tubes were corroded by tap-water in similar test conditions. A photographic record of the last-mentioned test shows that there was a ring of small pits in the surface at a diameter of about 15 mm. from the main corrosion pit where the electrode had been in contact. The tests are stated to show that all metals used for condenser tubes are equally good provided that no stray currents occur, and that they are all corroded to the same extent by electrolysis. In this case the alloys with the highest Brinell hardness have a longer life. The only remedy for corrosion in metals, it is stated, is entirely to eliminate stray electric currents.—S. G.

***A Previously Unknown Cause of Corrosion of Hot-Water Systems.** L. W. Haase and G. Gad (*Gesundheits-Ing.*, 1935, **58**, 526–529; *C. Abs.*, 1935, **29**, 7263).—Hot-water systems made up of parts of two different metals, especially of copper or brass and iron or galvanized iron, were studied. As small amounts of copper were found in the corrosion deposits on the iron it was assumed that slight amounts of copper dissolved from the copper or brass units of the system are deposited by contact action on the iron or galvanized surfaces, thus forming local galvanic elements. The zinc is then dissolved by simple galvanic action independently of the presence or absence of dissolved oxygen; thus the iron is exposed. The iron is also dissolved by galvanic action, but only in the presence of dissolved oxygen, which acts as a depolarizing agent. Plating of the copper parts with tin, the production of a protective coating on the iron by the use of sodium phosphate, &c., or complete removal of dissolved oxygen is recommended to prevent corrosion in this type of system.—S. G.

**Prevention of Corrosion of Lead in Buildings.** F. L. Brady (*Dept. Sci. Indust. Res.*, *Building Res. Bull.* No. **6**, 1935, 4 pp.).—Lead is rapidly corroded when set in damp Portland cement; pipes or damp courses thus set should be protected by an insulating layer of felt, bitumen, or mortar rubble. Lead is converted into basic carbonate when built into structures in which it comes into contact with damp wood since this slowly evolves volatile organic acids which act like acetic acid in the Dutch process of making white lead; oak is particularly active in this respect. Attack of lead pipes in the soil may be prevented by packing them with limestone or old mortar rubble which neutralizes the soil acids.—A. R. P.

***Corrosion of Lead and the Intensification of the Chamber Process.** I. E. Adadurov and L. M. Serchel (*Zhurnal Prikladnoĭ Khimii* (*J. Applied Chem.*), 1935, **8**, 1–12; *C. Abs.*, 1935, **29**, 6709).—[In Russian.] After a detailed discussion of the data available in the literature and of the experimental results obtained by the authors, it is shown that the increase in the nitric oxide content in the chamber gases required for the intensification of the process can be brought up to $\frac{2}{3}$ of the content of sulphur dioxide in the gases. In the chamber process it generally does not exceed 0·75–1% (by volume), whilst in the authors' experiments it was brought up to 1·9%. The corrosive properties of the gases are caused by an irregular and excessive content of water vapour, leading to a hydrolytic decomposition of the $NO{\cdot}HSO_4$ formed, and improper process temperatures. It is recommended, therefore, in intensification of the process, to feed the chambers with weak sulphuric acid, which stabilizes the maximum temperature. 18 references are given.—S. G.

**Corrosive Action of Nitrose in Lead.** I. E Adadurov and E. A. Bauman (*Zhurnal Prikladnoĭ Khimii* (*J. Applied Chem.*), 1935, **8**, 13–18; *C. Abs.*, 1935, **29**, 6709).—[In Russian, with French summary.] The minimum corrosion caused by nitrose lies at a content of 60–70% sulphuric acid. However, since the average strength of sulphuric acid in the towers is 58°–59° Bé., the corrosive action can only be decreased by decreasing the process temperature and the nitrose content in the individual towers. The greatest nitrose content is observed in the fourth tower having a temperature of 76°–80° C., while the highest temperature is in the third tower, which has a nitrose content of 1·9% nitric acid. This explains the high corrosion effect observed in the second, third, and sometimes in the fourth tower. Consequently, the temperature in the productor and stabilizer must be decreased to at least 90° C. and even lower, whereby the efficiency of the plant is increased considerably. The lead lining can also be saved by increasing the size of the towers. The substitution of lead by iron is strongly recommended for equipment in contact with hot acid, such as the Glover towers and coolers. It is generally recommended to replace lead by iron or other non-corroding metals or alloys of lead in the towers. 5 references are given.—S. G.

**Cable-Sheath Corrosion : Causes and Mitigation.** J. B. Blomberg and N. Douglas (*Elect. Engineering*, 1935, **54**, 382–387; *Sci. Abs.*, 1935, [B], **38**, 358).—Discusses the causes of corrosion of lead sheaths of telephone cables and indicates how the trouble can be minimized by maintaining the sheath at a negative potential relative to the earth. Details are given of trouble experienced and remedied in this manner on the St. Louis–Kansas City toll cable and on the Wichita telephone plant (U.S.A.).—S. G.

**Corrosion of Telephone Cable-Sheaths.** C. J. Griffiths (*J. Inst. Eng. Australia*, 1935, **7**, 113–123).—The various types of corrosion to which lead telephone cable-sheaths are subjected are reviewed, and an outline is given of methods of prevention, with particular regard to conditions in Victoria. —S. G.

***The Rate of Oxidation of Tin.** Ernst Cohen and H. L. Bredée (*Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 130–132).—[In German.] By means of a sensitive gas-dilatometer it is shown that oxidation of grey tin proceeds with measurable velocity at 18° C.—J. S. G. T.

**Gases in Canned Foods. I.—Fruits.** G. Hornor (*Ann. Rep. Fruit Vegetable Preservation Res. Station, Campden*, **1933–1934**, 50–63; *C. Abs.*, 1935, **29**, 7518).—It is stated in the earlier stages of hydrogen development the rate of corrosion, as measured by the gas changes, was greater in the plain cans. The corrosion of cans was accelerated by storage at 95° F. (30° C.)—S. G.

**Corrosion of Containers by Fruit Preserves.** —— von Morgenstern (*Braunschweig Konserven-Zeit.*, **1934**, (35), 3–4; *C. Abs.*, 1935, **29**, 6966).—Corrosion may be due to faultily coated containers, but is usually caused by incomplete removal of oxygen and the use of insufficient sugar.—S. G.

***Corrosion of Zinc in Presence of Oxidizing Agents.—I.** F. Krochmal (*Roczniki Chemji*, 1935, **15**, 122–135; *Brit. Chem. Abs.*, **1935**, [A], 939).—Corrosion of zinc immersed in water saturated with oxygen varies with the crystalline structure of the samples; reproducible results are obtained more readily with coarsely than with finely crystalline samples.—S. G.

***Kinetics of the Oxidation of Metallic Wires.** Gabriel Valensi (*Compt. rend.*, 1935, **201**, 602–604).—The investigation of the oxidation of nickel (cf. *Met. Abs.*, this vol., p. 516) has been continued to include the case when the oxide is a protector, *i.e.* more voluminous than the original body. If $m$ is the degree of oxidation (number of gram-atoms combined with an original gram-atom), $r_0$ the initial radius, $t$ the time in hrs., and $\alpha = \frac{n^2}{t}$, where $n$ is the weight of fixed oxygen per cm.², then for nickel the following relation has been deduced:

$$F(m) = (1{\cdot}47 + m) \log\ (1 + 0{\cdot}68m) + (1 - m) \log\ (1 - m) = 0{\cdot}2514\ \frac{\alpha}{r_0^2}t$$

(log = common logarithms). As a result of this relation, it follows: (*a*) that in the oxidation of metallic wires, the expression $F(m)$ varies with the time, (*b*) that the slopes, *C*, of the representative curves are connected with α by the relation: $C = 0{\cdot}2514 \frac{\alpha}{r_0^2}$, (*c*) the law of corresponding time: all wires of the same metal obey the same law of oxidation: $m = f(\tau)$, a function of the ratio $\tau = \frac{t}{r_0^2}$.—J. H. W.

**The Stability of Metals, Especially Rustless Steel, to Corrosion in Cooling Brines.** P. Schafmeister and W. Tofaute (*Molkerei-Zeit.* (*Hildesheim*), 1935, **49**, 590–593; *C. Abs.*, 1935, **29**, 7262).—Cast steel is more resistant to a 21% sodium chloride brine at $p_H$ 12·5 than at $p_H$ 4·0. The influence of the reaction is even more marked in the case of a 23% calcium chloride brine. Likewise, copper is more resistant in an alkaline than in a neutral chloride brine; this is not true of zinc and aluminium. Corrosion of steel is decreased by adding 0·4% soda to a calcium chloride brine or 1% to a sodium chloride brine; also by adding chromate, silicate, organic colloids, or buffers. V2A steel is one of the most resistant metals for the construction of compressors, pipes, and coils. A 20–25% sodium chloride solution containing 1% soda is a satisfactory brine. Corrosion of a metal surface is influenced by the composition of the brine, by the temperature, by the presence of dissolved oxygen, and by galvanic action. V2A steel with a polished surface undergoes less galvanic corrosion than nickel, copper, or copper alloys. The measured value for galvanic current was not as great as the calculated value, because of the large area of cathodic V2A steel surface compared to the small area of anodic material, and because of surface resistance due to rust. Galvanic corrosion is of less importance than natural chemical decomposition.—S. G.

***Corrosion of Metals in the Process of Reaction Between Sodium Nitrate and Potassium Chloride.** M. A. Miniovich and M. S. Komarovskii (*Khim. Mashinostroenie*, **1935**, (3), 11–13; *C. Abs.*, 1935, **29**, 7594).—[In Russian.] A study was made of the causes of corrosion of iron, copper, aluminium, and chromium–nickel–steels in contact with a solution containing components of the reaction: $NaNO_3 + KCl = KNO_3 + NaCl$, at 90°–120° C. Air blown through the solution for the purpose of mixing promotes corrosion, and it is recommended to use live steam instead. The presence of a large amount of chlorides in solution, high temperature of operation and violent splashing of the liquid against the metal are the other causes of corrosion. Iron was the most resistant, the loss being 0·0784 mm. in depth, or 0·167 grm./m.$^2$/hr. Contrary to data given in the literature, it was found that red copper is less resistant than iron. Aluminium can be used only when the amount of sodium chloride in solution is less than 3%. Yellow copper is entirely unsuitable. No conclusive data were obtained regarding nickel–chromium steels.—S. G.

**Corrosion of Materials by Phosphoric Acid and Its Control at the Voskresensk Works.** D. L. Zuirlin (*Mineral. Udobreniya i Insektofungisidui*, 1935, **1**, (3), 20–31; *C. Abs.*, 1935, **29**, 7589).—[In Russian.] Various measures are proposed for the control of the corrosion of equipment in the production of phosphoric acid by decomposition of phosphorites with sulphuric acid.—S. G.

***The Corrosion of Metals in Sugar Plants.** V. Mastalíř (*Listy Cukrovar.*, 1935, **53**, 357–360; *C. Abs.*, 1935, **29**, 7690).—In light and heavy liquors, laboratory experiments revealed that oxygen is necessary for corrosion, especially at temperatures below 100° C.—S. G.

**Corrosion Tests in Various Refinery Services.** J. E. Pollock, E. Camp, and W. R. Hicks (*Metals Technology*, 1935, **2**, (Aug.); *A.I.M.M.E. Tech. Publ.* No. 639, 1–19).—Tabulated data showing the behaviour of more than 100 ferrous and non-ferrous metals and alloys in various liquids handled in oil refineries are given and briefly discussed. High copper alloys appear to be the most resistant to very weak acid wash liquors and to very dilute hydrochloric acid solutions separated from naphtha in the distillation of crude oil.

Brass, bronze, and Monel metal impellers have a longer life than most ferrous alloys in pumps handling only acid waters.—A. R. P.

**Corrosion-Resisting Materials for Gas Appliances.** A. L. Ward and W. H. Fulweiler (*Amer. Gas J.*, 1935, **143**, (5), 42).—Read before the American Gas Association. Copper alloys used in the manufacture of safety pilots, time controls, and thermostats for automatic gas appliances corrode and scale at high temperatures owing to organic sulphur compounds contained in the gas. Alloys containing less than 63% copper are almost perfectly resistant to this type of corrosion and their resistance is still further improved by the addition of 1–2% of lead or aluminium. Aluminium tubing is recommended where the tubing does not come in contact with alkaline insulating material, and either tin-plated tubing or bi-metallic tubing with aluminium on the inside and brass or copper on the outside in other cases.—J. S. G. T.

***Practical Studies on Stray Current Corrosion, 1934.** R. Gibrat (*Conférence Internationale des Grands Réseaux Électriques à Haute Tension* (Preprint No. 206), **1935**, 32 pp.; *Bull. B.N.F.M.R.A.*, 1935, (**81**)).—See also *Met. Abs.*, this vol., p. 229. Notes on investigations carried out by means of the Schlumberger differential apparatus. The cases dealt with include high-tension cable, gas and water pipes, &c.—S. G.

**On the Origin of Corrosion Phenomena with Oxygen Depolarization.** G. W. Akimow, S. A. Wruzewitsch, and H. B. Clark (*Korrosion u. Metallschutz*, 1935, **11**, 145–156).—A theory of electrochemical cells with oxygen depolarization is developed and basic equations are deduced connecting the variables $V$ (potential difference at time $t$), $Q$ (the quantity of hydrogen collected on the cathode at time $t$), and $I$ (the current flowing through the cell) with the time. Analysis of these equations indicates that after establishment of a stationary state the current density is constant with constant depolarization and is independent of $V$ and $\omega$ (resistance of the system), the value of $V$ is independent of the initial ($t = 0$) potential difference ($V_1$) and the value of $Q$ is $V_1/A - I_D\omega/A$, where $A$ is a constant. The theoretical deductions have been confirmed to a large extent by experiments on systems of copper with another metal in 3% sodium chloride solution. The systems copper–lead, copper–antimony, and copper–bismuth in 3% salt solution do not obey the above rules since they do not operate with oxygen depolarization. The application of the theory to numerous practical problems is discussed.—A. R. P.

**The Electrochemical Theory of Corrosion.** Oliver P. Watts (*Z. Dampfkesselunters.- u. Versicher.-Ges. A.G.*, 1934, **59**, 5–7, 17–18).—Cf. *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 635, and *Met. Abs.*, 1934, **1**, 181. Corrosion theories are critically reviewed.—S. G.

**Methods for Testing Corrosion, and Their Respective Fields of Application.** —— Herzog (*Usine*, 1934, **43**, (42), 37).—S. G.

**Corrosion Research at the Chemistry Research Laboratory, Teddington.** —— (*First Report of the Chemistry Research Board*, **1935**, 9–14).—A brief account of 10 years' work.—S. G.

**Why Metals Corrode.** Robert M. Burns (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, **22**, (11), 33–42; discussion, 42–46).—An elementary account is given of the principles underlying corrosion and its prevention.—A. R. P.

---

## V.—PROTECTION

(Continued from pp. 519–523.)

**Protection of Metal by Coatings.** W. H. J. Vernon (*Metal Cleaning and Finishing*, 1935, **7**, 333–338, 348; *C. Abs.*, 1935, **8**, 7261).—Natural and artificial oxide coatings, " rolled on " metal coatings, hot-dip processes, coatings by cementation, metal sprays and electrodeposition for metal protection are discussed, and the various operations are briefly described.—S. G.

***Chemical and Physical Structure of the Protective Layer on Aluminium.** F. Pavelka (*Oesterr. Chem.-Zeit.*, 1935, **38**, 39–41).—Anodically produced oxide films on aluminium are shown to consist of a porous layer of dehydrated alumina, the electrical capacity, internal resistance, and residual current being due to this porosity. Oxide films produced by simple immersion (*i.e.* chemically) consist chiefly of hydroxide and have similar properties to the electrolytically-produced films but a much higher adsorptive power for dyes. Dehydration of the electrolytic films is ascribed to arcing within the pores, which gives rise to the light effects observed at high formation potentials. —A. R. P.

***Dielectric Behaviour of Electrolytically Produced Oxide Films on Aluminium.** H. Zauscher (*Ann. Physik*, 1935, **23**, 597–626).—Eloxal films on pure aluminium absorb up to 6 volume-% of water from moist air but this is reduced to 1% by impregnating the film with Bakelite and to zero by impregnating with linseed oil or wax. The breakdown voltage of a film 0·01 mm. thick is over 200 v. and of a film 0·1 mm. thick over 500 v.—v. G.

***Electrolytically Produced Fluoride Coatings on Magnesium and Its Alloys.** Hellmut Fischer and Walter Schwan (*Wiss. Veröff. Siemens-Werken*, 1935, **14**, (2), 54–62).—Magnesium alloys, *e.g.* Elektron, can be coated satisfactorily with a thin, strongly adherent film of fluoride by anodic treatment in baths of fused fluorides in which magnesium fluoride is insoluble. To overcome technical difficulties it is advisable to use salt mixtures with relatively low melting points; the best results have been obtained with an 80 : 20 mixture of potassium hydrogen fluoride and metaboric acid (produced by prolonged heating of boric acid at 120° C.) which can be operated at 160° C. in air and at 110° C. under a heat-insulating layer of paraffin wax. The baths are operated with a voltage of 35–40 and a constant current density of 1·5–2 amp./dm.$^2$. The films obtained are always porous and hence not very resistant to corrosion, but they form a good foundation for impregnating materials, such as cellulose lacquers, lanolin, artificial resins, &c. The treated films offer a very good resistance to the salt-spray, but unlike the oxide films on aluminium they cannot be dyed.—A. R. P.

**The Lead Plating of Cold-Rolled Strip for Sheathing, Flexible Shafts, and Electric Conductors.** —— Günther (*Kalt-Walz-Welt*, **1935**, (4), 30–31).—The coating process may consist in dipping the strip in molten lead; a continuous process is described, which includes degreasing, pickling, and rinsing, prior to introduction into the lead bath. Precautions for ensuring uniformity of coating are described. This method is considered superior to the electrodeposition of lead, a brief description of which is given.—P. M. C. R.

**New Method of Electrolytic Tinning.** (Freitag.) See p. 606.

**Electrographic Testing of the Porosity of Metallic Deposits [of Tin and Zinc on Iron].** A. Glazunov and J. Teindl (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 371–372).—The article is covered with a piece of filter paper soaked in a 5–10% solution of potassium ferricyanide, and a piece of aluminium sheet is placed over the paper to act as cathode; on the passage of a current from the iron to the aluminium, places where the iron is exposed rapidly produce blue spots on the paper. For tinplate an applied e.m.f. of 3 v. and for galvanized iron 12 v. is necessary.—A. R. P.

**Thickness of Zinc Coatings on Galvanized Wire and Sheet, and Methods of Estimation.** Heinrich Meyer auf der Heyde (*Draht-Welt*, 1934, **27**, 723–725; and *Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 456–458).—See *Met. Abs.*, this vol., p. 385.—P. M. C. R.

**Galvanizing Faults on Steel Sheets Caused by Faulty Steel.** M. von Schwarz and H. Fromm (*Korrosion u. Metallschutz*, 1935, **11**, 241–245).—The effects of variations in the composition and structure of the steel on the adhesion of the zinc coating are briefly discussed.—A. R. P.

**The Development and Control of Spangles on Galvanized Iron.** Wallace G. Imhoff (*Metal Cleaning and Finishing*, 1935, 7, 69–72, 85, 121–126, 136, 173–177, 245–249, 281–284, 309, 403–406).—Discusses factors affecting the production of spangles, *viz.* treatment of the base metal, soaking-pit practice, rolling, and heat-treatment in steel production, pickling, draining, fluxing, and drying. —S. G.

**The Use of Aluminium in Hot-Galvanizing.** Heinz Bablik (*Aluminium and Non-Ferrous Rev.*, 1935, **1**, 9–10).—Aluminium added to a galvanizing bath in the form of a 5–10% aluminium–zinc alloy, results in a more flexible zinc coating. No iron–zinc alloy layers are found. The spangles produced are unfortunately small, but larger sizes can be obtained by adding also cadmium, tin, or bismuth. Owing to oxidation of the aluminium, regular additions amounting to 0·1–0·2% of the weight of sheets galvanized are made. A " dry " process, in which the articles are first dipped in zinc chloride solution and stoved before galvanizing, is necessary, since a zinc chloride flux layer on the bath would rapidly react with the aluminium.—J. C. C.

**Galvanizing Pot Life May Be Increased by Changing the Dross Level.** Wallace G. Imhoff (*Amer. Metal Market*, 1935, **42**, (182), 3).—The depth of the dross in the pot may be varied by changing the lead level at the bottom; methods of doing this and of measuring the depth of lead in the pot are briefly described. —A. R. P.

**Economics of Electrogalvanizing Iron and Steel Strips.** Heinrich Meyer auf der Heyde (*Metallwaren-Ind. u. Galvanotech.*, 1934, **32**, 385–386, 405–406). —S. G.

**Improved Electrolytic Method of Galvanizing Wire.** See p. 607.

**What is to be Noticed in Galvanizing Works.** Heinrich Meyer auf der Heyde (*Oberflächentechnik*, 1935, **12**, 195–197).—Discusses methods of galvanizing iron wire.—A. R. P.

**The Mechanical Galvanizing of Small Articles by Centrifuging.** A. Forny (*Galvano*, **1935**, (42), 28–29).—The centrifugal process is entirely suitable for galvanizing rails, screws, &c., but a speed of 600 r.p.m. is required as against 300 r.p.m. for tinning and lead coating. The fully mechanical method of operation, in which the baskets of articles are immersed in the zinc, withdrawn, and centrifuged all by machinery, is very much more suitable than the semi-mechanical method, in which only the centrifuging is done mechanically. Operating details are given for several types of small articles.—C. E. H.

**Points of Importance in Galvanizing Plant for the Production of Fine Wire.** Heinrich Meyer auf der Heyde (*Draht-Welt*, 1935, **28**, 83–84, 99–100).—The connection between size and shape of work, zinc content of bath, fuel consumption, and rate of deposition is demonstrated by numerical examples in the case of cylinders, discs, and wire of diam. 0·2–1·3 mm. Tables and diagrams show the influence of the gauge of the wire on the rate of feed and the speed of rotation of the drums, and these factors are correlated with the former. Losses of heat and material are briefly analyzed. The relative efficiencies of different numbers of drums are compared for wire of different gauges.—P. M. C. R.

**Estimated and Actual Costs and the Calculation of Profits in Hot-Galvanized Wire Plants.** Heinrich Meyer auf der Heyde (*Draht-Welt*, 1935, **28**, 195–197, 211–213, 227–229).—The importance of careful costing is emphasized in the case of small installations, where neglect of thorough analysis leads to considerable losses. Costs are considered under the headings: material, cost of processing, overhead charges, and waste. Methods of estimating are described, and are illustrated by numerical examples in each case.—P. M. C. R.

**On the Preservation of the Galvanizing Bath from Attack and Adhesion (Hot Process).** Heinrich Meyer auf der Heyde (*Kalt-Walz-Welt*, **1934**, (10), 77–78).—Overheating of the galvanizing bath may be obviated by using a gas-heated regenerator furnace, and by coating the bath with fireclay in order to prevent the direct impingement of the flame. Such a furnace is described and illustrated, with the method of mounting and supporting the bath. —P. M. C. R.

**The Struggle Against Waste of Materials.** H. Meyer auf der Heyde (*Kalt-Walz-Welt*, **1934**, (11), 83–85).—The hot process of zinc plating is stated to be more wasteful of zinc than the electrolytic process, where anode deposits can easily be utilized. The losses of zinc owing to "hard zinc" formation are analyzed in a number of cases, and it is urged that losses of other non-ferrous metals should be similarly investigated.—P. M. C. R.

**The Proper Method of Dipping-Out Galvanizing Pots for Temporary Idleness.** Wallace G. Imhoff (*Amer. Metal Market*, 1935, **42**, (202), 5, 6).—During bailing out of the molten zinc and subsequent cooling of the pot, a cover should be kept on as much as possible so as to minimize heat losses and allow the pot to cool very slowly. In this way flaking of the brittle zinc–iron alloy from the sides of the pot is prevented and its life prolonged. In starting up again the pot should be filled with water, the fire lit, and the water boiled off before charging in the metal so as to provide sufficient time for the surrounding brickwork to get hot and prevent overheating of the pot which causes the alloy layer to flake off.—A. R. P.

**Metallization.** I. D. Roe (*Power Transmission*, 1935, **4**, 82–83).—The Schoop spray process is briefly described with especial reference to the building-up of bearings by the process.—A. R. P.

**Schori Metal-Spraying Equipment.** —— (*Machinery* (*Lond.*), 1935, **46**, 806–807).—An illustrated account of a metal-spray pistol in which 100–300-mesh metal powder is projected through an oxy-acetylene heating flame. —J. C. C.

**Exploring the Worth of Metallizing.** R. A. Axline (*Metallizer*, 1934, **2**, (1/2), 8, 9, 24).—A short description of the metal-spraying process is given. Tables show the sp. gr., tensile strength, and elongation of sprayed metal. The structure of sprayed metal is described. The importance of choosing the right metal for each application is stressed. Some examples of industrial applications are described.—W. E. B.

**Spraying Liquid Metal to Decrease Corrosion.** R. E. Kunkler (*World Petroleum*, 1935, **6**, 525; *C. Abs.*, 1935, **29**, 7261).—K. cites many successful applications of spraying liquid aluminium to eliminate corrosion.—S. G.

**Metal-Sprayed Surfaces Pass Acid Test.** R. A. Axline (*Metallizer*, 1934, **2**, (6), 7).—Test-pieces, sprayed respectively with Monel metal, cadmium, lead, and phosphor–bronze, were subjected to a works' test by bolting them into a washing pan in a paper mill, and exposing them to the alkaline liquors from the cooking of wood by the sulphate process. The corroding agents were sodium hydroxide, sulphur, and sulphides. The tests proved that Monel metal coatings were the most satisfactory, followed by lead and cadmium. The bronze was not successful.—W. E. B.

**Sprayed Metal Wire Again Proven Superior to Powder.** J. W. Hishon (*Metallizer*, 1935, **3**, (11), 5).—A series of tests by a testing Company on steel sprayed with the wire metal-spraying and the powder metal-spraying pistols, shows that the coatings from the former are better than those from the latter. —W. E. B.

**Canadian National Railways Called for a Test [of Metal Spraying].** R. J. McWaters and J. W. Hishon (*Metallizer*, 1935, **3**, (8), 2, 3).—A description is given of a test carried out by the Canadian National Railways at Toronto, on the relative merits of metal spraying by a wire-fed pistol and a pistol fed with powder. The cost of the powder spray was found to be three times that of the wire-spraying method. A good deal of loss was experienced with the powder gun. It is suggested that there is very much more oxidation with the powder gun.—W. E. B.

**The Progress of Metallizing in Canada.** R. S. Teur (*Metallizer*, 1935, 3, (12), 8, 9).—T. describes work carried out in Canada by the metal-spraying process and mentions the use of a zinc spray for repairing the welded portions of galvanized drums, coatings of zinc on water tanks, coating of propellers and propeller shafts with Monel metal, &c.—W. E. B.

**Surface and Underground Transportation Companies Save.** D. A. Watson (*Metallizer*, 1935, 3, (12), 4, 5).—A description is given of work carried out by metal spraying, which work has been used in connection with railways. The spraying of rail ends and connecting plates is mentioned, and a case is cited where such ends and connecting plates zinc-coated were entirely satisfactory after 3 years' use in a tunnel. Building up with bronze on bronze axle bearing liners is also mentioned and some description is given of the use of metal spraying in connection with bridge work.—W. E. B.

**Develop Big New Field for Metallizing in Lowering Railroad Maintenance Costs.** L. E. Kunkler (*Metallizer*, 1934, 2, (6), 2, 3, 12).—A description is given of metal-spraying work carried out for American railways. Special mention is made of zinc coatings for water tanks, water troughs, fish-plates, rail-boats, &c. Lead coatings have been used for protecting signals and tunnel equipment. Aluminium coatings have been used for boilers and fireboxes, and bearings have been sprayed with Babbitt metal. The use of metallizing for rolling stock, including floors of kitchens and parts of refrigeration cars, is described.—W. E. B.

**Applications of Metallizing in Ship-Building Field are Increasing Rapidly.** S. R. Morrison (*Metallizer*, 1934, 2, (5), 5–6).—A description of the use of metal spraying for filling cavitation holes in bronze propellers. Aluminium is used for protection of superheaters. Zinc is used for hatch battens, ventilator cowls, stacks, &c. Some tests on shell plates sprayed with zinc and then painted are described.—W. E. B.

**Protection of Floating Roofs on Oil Tanks [by Metal Spraying].** R. A. Axline (*Metallizer*, 1935, 3, (2), 2, 12).—Areas of a roof of a working tank containing sour naphtha were sprayed with different metals of varying thicknesses; plates were also hung inside the tank. At the end of 6 months, the coatings were inspected. Zinc and cadmium were of no value in these conditions, but the aluminium coating has possibilities. The best results were obtained with a lead coating of at least 0·020 in. thick. Tests are to be continued.—W. E. B.

**Power Plant Accomplishes Great Economies by Preventing Heat Corrosion on Boiler Tubes [by Metal Spraying].** H. R. Leland (*Metallizer*, 1934, 1, (5), 2–3).—Tubes in the water-cooled walls of 10 boilers, each of 250,000 lb. of steam per hr. capacity, were giving corrosion trouble owing to high-temperature oxidation. This was entirely prevented by spraying with pure aluminium to a thickness of 0·013 in.—W. E. B.

**Preventing Corrosion in Dow Hot Oil Pumps [by Metal Spraying].** W. M. Fraser (*Metallizer*, 1934, 2, (1/2), 6).—Valve parts of the pumps were wearing very rapidly, but by spraying with a heavy coating of aluminium the corrosion was prevented over the test period of 1264 hrs.—W. E. B.

**[Metal Spraying] Developments in the Oil Industry.** H. R. Leland (*Metallizer*, 1934, 2, (1/2), 20–24).—A description is given of the spraying with aluminium of a test-section of the interior of a Dubbs' coke chamber. After 9 months the applied aluminium was found to withstand successfully the action of sulphuretted hydrogen and the abrasion due to the removal of the coke. The dome of a flash-tower was also treated with aluminium with promising results. Mention is made of the difficulties experienced in spraying this dome owing to the presence of oil in the cavities in the surface of the steel. Aluminium was also found to be a satisfactory coating for Dow surge pots, valves, and dephlegmaters. Descriptions are given of similar work on various oil plants. Lead coatings have been used on acid tanks and zinc coatings for gasoline storage tanks.—W. E. B.

**Metallizing an Important Factor in Prevention of Corrosion in Refineries.** H. R. Leland (*Metallizer*, 1935, 3, (7), 4, 5, 10).—Aluminium sprayed coatings have been found to give fair protection to bubble towers, even when chlorides have been present at temperatures up to 550° F. (288° C.). A coating of 0·008 in. aluminium has also been successful in reaction chambers.—W. E. B.

**The Use of Aluminium [in Metal Spraying].** L. E. Kunkler (*Metallizer*, 1935, 3, (9), 8, 9, 10, 11).—The article is intended to show how metal-sprayed aluminium can be used to protect steel against various attacks. A list is given, compiled by the Aluminum Corporation of America, showing the action of various chemicals on aluminium sheets, and K. suggests that the same results would be obtained with sprayed aluminium.—W. E. B.

**[Metal Spraying] A Step Forward in Aircraft Design.** D. Hoggson (*Metallizer*, 1934, 2, (1/2), 10–11).—Describes the protection of the fuselage, landing gearing, engine mountings, &c., of a seaplane by means of a sprayed coating of cadmium. Other planes were successfully coated with zinc.—W. E. B.

***Investigation of the Adhesion of Brass Coatings (on Steel) Deposited by Schoop's Method.** J. V. Petrov (*Metallurg* (*Metallurgist*), **1934**, (3), 66–68).—[In Russian.] The force of cohesion of brass coatings deposited on steel by the Schoop pistol is 18·6 kg./cm.$^2$; with an intermediate zinc coating this is reduced to 16·4 kg./cm.$^2$. In 1 hr. the thickness of the coating is reduced 0·0015 mm. by abrasion at a pressure of 0·5 kg./cm.$^2$.—N. A.

**Food Industries Use Metallizing for Sanitation.** M. D. MacRoberts (*Metallizer*, 1934, 2, (3), 2–3).—Sprayed tin coatings give long service, due to the possibility of using heavy coatings. The patching of glass-lined tanks with sprayed tin is successful provided that the methods used for cleaning do not bring about rapid changes of temperature.—W. E. B.

**Big Soap Plant Continually Develops New Uses for Metallizing.** C. K. Stipp (*Metallizer*, 1934, 2, (5), 7).—Sprayed zinc is used for lining internally tank wagons for carting high-grade glycerine. Tin coatings used for salt-dump trucks and pumps are treated with cadmium. Fan rotors are coated with lead. Monel metal coatings are used for soap-bins and lead for filter presses.—W. E. B.

**Zinc [Spraying] Stopping Corrosion.** L. E. Kunkler (*Metallizer*, 1934, 2, (5), 3–4).—Description of the uses to which metal spraying has been put, *e.g.* in large tanks for drinking water storage, constructional iron-work, &c.
—W. E. B.

**Test on Zinc-Metallized Steel in Canada Proves Superiority.** J. E. Clark (*Metallizer*, 1935, 3, (1), 9).—A report from the Canadian Inspection Testing Company on steel samples sprayed with zinc to a thickness of 0·003, 0·006, and 0·009 in. The samples were tested against standard-weight galvanized sheet in salt-spray in the following cycle: sprayed for 1 hr., allowed to stand in a salt-spray atmosphere for 7 hrs., dried, washed with water. The hot-galvanized sample failed in 10 days; 0·003 in. coating of zinc, in 45 days; 0·006 in. coating of zinc, in 75 days; 0·009 in. coating of zinc, in 90 days. Cadmium-sprayed samples were also tested with equally good results.
—W. E. B.

**Corrosion of Iron and Steel. Metallizing the Only Solution.** J. W. Hishon (*Metallizer*, 1935, 3, (7), 2, 3, 13).—Describes very briefly the theories of the corrosion of iron and the troubles brought about in paint layers by weather and sunlight. H. suggests that metal spraying with zinc is the only method for protecting large structures and that while most metals oxidize progressively, zinc does not do so owing to the formation of zinc salts during corrosion.—W. E. B,

**Metallizing in Industry.** J. W. Hishon (*Metallizer*, 1935, 3, (9), 2, 3, 4, 5, 11).—The metallizing of lock-gates with zinc in France in 1922 is described; on inspection in 1934 they were found to be free from rust. Other work which had been done on the Continent by metal spraying is described, and a description is given of work done in America, mainly in connection with electrical transmission, conveyor systems, brewing, and the textile industry.—W. E. B.

**Canadian Demonstration Proves that Corrosion of Steel Bridges can be Stopped [by Metal Spraying].** R. J. McWaters (*Metallizer*, 1934, 2, (6), 4, 5, 6).—A description of the zinc spraying of a railway bridge on the Canadian National Railways at Toronto. The bridge was corroded badly owing to the dripping of brine from refrigeration cars on to the bridge.—W. E. B.

**Zinc and Its Uses in Metallizing.** W. C. Reid (*Metallizer*, 1935, **3**, (11), 8, 9, 10).—The conditions of metal-sprayed zinc are described and a list is given showing the action that may be expected from various reagents on zinc coatings. The list is apparently compiled from the booklet of the American Zinc Institute, and evidently refers to either cast or rolled zinc.—W. E. B.

**Cleaning of Condenser Tubes.** K. Weiss (*Wärme*, 1935, **58**, 9–11).—S. G.

**Use of Pure Lac Resin for Coating Metals (Copper, Tinplate, Aluminium Foil, and Tin Foil).** L. C. Verman (*London Shellac Research Bureau Bull.* No. **1**, 1935, 10–16; *Bull. B.N.F.M.R.A.*, 1935, (77)).—In the course of a paper to the Plastics Group of the Society of Chemical Industry, on "Some Industrial Possibilities of Pure Lac Resin," V. directs attention to the use of this material for electrical wire enamel for service at 120° C. in small electric motors, for lacquers for fruit canning, and for lacquers for aluminium and tinfoils.—S. G.

**Prevention of Chemical Corrosion of Metals by Coating with Rubber.** L. M. Antonov (*Khim. Mashinistroenie*, **1935**, (4), 21–24).—[In Russian.] A review.
—S. G.

## VI.—ELECTRODEPOSITION

(Continued from pp. 524–528.)

***X-Ray Study of Electrodeposited Cadmium.** (Rubio and García de la Cueva.) See p. 592.

**Electrodeposition of Chromium.** M. Le Marchands and M. Abramovitch (*Bull. Soc. chim. France*, 1933, [iv], **53**, 429–431; *Brit. Chem. Abs.*, **1933**, [B], 833).—Chromic acid is chemically and economically unsuitable for electrodeposition of chromium. Deposits have been obtained from aqueous solutions of chromium sulphate containing 71–100 grm. chromium per litre at 18° C., using 12–28 amp./dm.$^2$ and a soluble chromium anode. Copper is the best cathode material. Ammonium chloride (0·05%) may be added with advantage. The cathode efficiency is about 25%.—S. G.

**Imperfections in Electrodeposits. Studies in the Electrodeposition of Cobalt.** A. Chaybany (*Met. Ind.* (*Lond.*), 1935, **47**, 423–426).—It is considered that the presence of faint traces of arsenic in cobalt baths is responsible for a large number of imperfections in the deposits. The disagreement of other workers is probably due to their using insufficiently pure salt. With sufficiently pure baths, direct coatings of the order of 0·005 mm. thick were obtained on steel. After a few months' exposure to rain only a very few small spots of rust appeared and adherence remained perfect. A voltage of 6–9 was used, giving a current density of 8–10 amp./dm.$^2$ in a bath containing 40 grm./litre of metallic cobalt.—J. H. W.

**From the Practice of Wire Gilding.** A. Wogrinz (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 455–456).—Methods of preparing the plating bath and of calculating the speed of passage of the wire through the bath to obtain a definite weight of gold plate per kg. of wire are described.—A. R. P.

**Nickel- and Chromium-Plating of Aluminium and Its Alloys.** K. Krause (*Kalt-Walz-Welt*, **1935**, (4), 28–30).—See *Met. Abs.*, this vol., p. 166.
—P. M. C. R.

***Control of the Density in Plating and the Microstructure of Bimetal (Iron–Tombak).** N. N. Ivanov-Skoblikov and B. F. Grashchenko (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (1), 71–76).—[In Russian.] Bimetal sheets consisting of iron coated on both sides with Tombak layers 5–6% of the sheet thickness were examined micrographically and their mechanical properties determined. The tensile strength of sheets 1 and 3 mm. thick was 34 and 40 kg./mm.$^2$ and the elongation 30 and 29%, respectively.—D. N. S.

**[Copper and Nickel] Electroplating Zinc-Base Die-Castings.** Charles H. Costello (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, **22**, (10), 14–23; discussion, 23).—Practical hints are given for all the operations, cleaning, copper-plating, and nickel-plating, with details of the composition of the solutions and tests for controlling the composition and operation of the baths. —A. R. P.

**Nickel- and Chromium-Plating of Zinc Articles.** Fritz Schäfer (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 459–460).—Methods of polishing, degreasing, etching, copper-plating, and nickel- or chromium-plating zinc-base alloys are briefly described.—A. R. P.

***The Effect of Oxidizing Agents on Nickel Deposition. II.—Chromic Acid.** A. W. Hothersall and R. A. F. Hammond (*Trans. Faraday Soc.*, 1935, **31**, 1574–1582).—See *Met. Abs.*, this vol., p. 22. Addition of chromic acid to nickel plating solutions produces a marked decrease in current efficiency and renders the deposits at first bright, then exfoliated, burnt, and finally inhibits nickel deposition completely, the effects being greater the higher the $p_H$ of the solution. Chromic acid does not diminish pitting, and more than 0·03 grm./litre produces a rapid increase in the rate of gas evolution. The effects of chromic acid on nickel deposition can be connected only indirectly with depolarization of hydrogen; at low concentrations initial depolarization results in precipitation of basic nickel compounds containing chromium at the cathode, and the discharge of hydrogen is thus favoured whilst the cathode efficiency is reduced, whereas at high concentration the chromic acid attacks the cathode metal and forms a selectively permeable film on its surface which completely prevents deposition of nickel.—A. R. P.

**Most Common Defects Shown by [Electro-]Deposits of Nickel.** O. Macchia (*Industria chimica*, 1933, **8**, 571–574; *Brit. Chem. Abs.*, **1933**, [B], 710).—M. summarizes the causes of various types of defects shown by nickel electrodeposits and the methods for treating the plating bath to eliminate such defects.—S. G.

**The Economics of Nickel Plating.** Eugen Werner (*Oberflächentechnik*, 1935, **12**, 219–222).—Methods of avoiding difficulties in nickel plating and of running the bath under the most economical conditions are discussed with especial reference to the effect of the nature of the anode on the operation of the bath.—A. R. P.

**The Investigation and Supervision of Nickel Baths and the Analysis of Nickel Salts for Plating Baths.** (Raub and Bihlmaier.) See p. 611.

**Quantitative Determination of Boric Acid and Citric Acid in Nickel Baths.** (Vincke.) See p. 611.

***Examination of Electrodeposited Nickel Coatings by X-Ray Diffraction.** (Wood.) See p. 590.

**New Method of Electrolytic Tinning.** —— Freitag (*Oberflächentechnik*, 1935, **12**, 152).—An economical method of tinning iron or copper or their alloys consists in making the metal the cathode in a bath of fused stannous chloride at 270° C., using a carbon anode and a current of 75–100 amp./ft.$^2$ at 0·75 v. Since the tin is deposited in a molten condition it adheres well and is non-porous; the current efficiency is 100% and the bath is maintained in operation simply by adding more of the salt as required.—A. R. P.

***Electrodeposition of Tin Alloys from Alkaline Stannate Baths.** R. G. Monk and H. J. T. Ellingham (*Trans. Faraday Soc.*, 1935, **31**, 1460–1468).—Bright deposits of tin alloys containing 18–25% nickel may be obtained from alkaline baths containing tin (as sodium stannate) 90–100, nickel (as potassium nickelocyanide) 2, and free potassium cyanide 5 grm./litre using nickel anodes and a current density of 0·15–0·5 amp./dm.$^2$ at 70°–75° C.; the deposits become matt when the thickness exceeds 0·0005 in. and their hardness is about 7 times that of pure tin. At any given current density the nickel content of the deposit can be increased by increasing the nickel content of the solution or by reducing the tin content, but with increasing nickel content the current efficiency decreases and the deposit becomes hard and brittle. The deposits with 20–25% nickel are fairly resistant to hot dilute sulphuric acid and are practically unattacked by nitric acid of any concentration at any temperature, but dissolve fairly readily in hot dilute hydrochloric acid. Alloy deposits containing tin and antimony in almost any proportion are obtained at 100% current efficiency from a bath containing tin (as sodium stannate) 89, antimony (as sodium thioantimonate) 2, and free sodium hydroxide 4 grm./litre operated at 70°–75° C., the antimony content decreasing with increasing current density from 82% at 0·1 amp./dm.$^2$ to 6·5% at 9 amp./dm.$^2$. Good deposits at least 0·0005 in. thick can be obtained only with alloys containing less than 50% antimony, but all the deposits are very brittle and, although harder than pure tin, are likely to have poor resistance to wear.—A. R. P.

**Improved Electrolytic Method of Galvanizing Wire.** —— (*Draht-Welt*, 1935, 28, 179–180).—The precautions employed in purifying the plating solution are described. The form of the electrodes ensures the deposition of a uniform layer of zinc on the wires, 8 of which are passed through each cell after preliminary annealing in molten lead, cleaning in caustic soda, and electrolytic deoxidation. Wire plated by this method can sustain severe deformation without damage to the deposit, which is stated to be exceptionally dense, ductile, and strong.—P. M. C. R.

***Electrolysis of Zinc Sulphate Solutions.** P. Guareschi (*Industria chimica*, 1933, 8, 704–708, 822–826; *Brit. Chem. Abs.*, **1933**, [B], 751).—Additions of various substances to zinc sulphate solutions to prevent disturbance of the electrodeposition of zinc by iron, arsenic, antimony, cobalt, and nickel were investigated. Rochelle salt results in a good, compact deposit, but, if much cobalt is present, is expensive; ordinary glue gives poor results; gum arabic results in a good deposit, but a poor current yield; tannic acid, in quantity about 4 times that of the cobalt or other metallic impurities, is efficacious, except when much copper is present, but it is cheaper to use an infusion of quebracho or other wood containing tannic acid and carbohydrates; $KMnO_4$, $Na_2O_2$, and $Ca(CN)_2$ (1 grm./litre) give good results. An outline of all the operations is given.—S. G.

**Simultaneous Cathodic Discharge in the Electrolysis of Zinc.** O. Essin and A. Balabaj (*J. Chim. physique*, 1934, **31**, 559–567).—Satisfactory agreement is obtained between theoretical results and experimental results obtained by Röntgen and Hoegel for the simultaneous electrodeposition of H and Zn ions from solution.—J. S. G. T.

**The Finishing [Plating] of Zinc Alloy Die-Castings and Rolled Zinc.** —— (*Imperial Smelting Corp. Tech. Bull.*, **1935**, Sept., 12 pp.).—Deals with polishing; cleaning; acid dip; rinsing; primary coating; plating time; nickel plating; nickel–copper–nickel deposits; copper–nickel deposits; bright nickel deposits; secondary coatings (brass, silver, gold, chromium); direct finishing with chromium, black nickel or cadmium; stripping methods; purification of solution, and measurement of the thickness of the coating.—S. G.

**Making Moulds for Plastic Materials by the Electroplating Process.** Herbert Chase (*Machinery* (*Lond.*), 1935, **46**, 808–809).—See *Met. Abs.*, this vol., p. 388.—J. C. C.

**Application of Rapid Electrographic Methods for Testing Plated Coatings.** (Glazunov.) See p. 611.

**Analysis of Plated Articles.** (Arnold.) See p. 610.

†**Electrochemistry's Debt to Edgar Fahs Smith. Cathode Film Control in Electro-Metal Deposition.** Colin G. Fink (*Science*, 1935, **82**, (2114), 1–5).—Edgar Fahs Smith Memorial Address, delivered at University of Pennsylvania, May, 1935. Reviews S.'s contributions to electrochemistry. Amongst the subjects discussed are: copper deposition with high-speed cathode; ductile electrolytic iron; gold from sea-water; recovery of polonium; effect of cathode speed on deposition of alloys; what the high-speed cathode accomplishes. The high-speed cathode is recommended to the attention of all interested in the electrodeposition of metals and alloys which have not, so far, been produced from aqueous solution in a solid, adherent, compact, metallic form.—J. S. G. T.

---

## VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from p. 528.)

***Formation of Alloys from Galvanic Elements.** V. A. Plotnikov and D. P. Zosimovitsch (*Zhurnal Obshtchey Khemii* (*J. General Chem.*), 1935, **5**, 327–333; *Brit. Chem. Abs.*, **1935**, [A], 1080).—[In Russian.] On closing the circuit between two electrodes immersed in a fused salt, or in its aqueous solution, the baser metal is deposited on the nobler one, yielding an alloy. The e.m.f. of the cell Zn | fused $ZnCl_2$ | Cu changes with time to that of Zn | fused $ZnCl_2$ | $\beta$-brass. A deposit of brass forms on the platinum electrode of a Daniell cell containing copper sulphate and zinc sulphate.—S. G.

***Production of a Copper-Containing Alloy from Aluminium Dross in an Electrolytic Bath.** A. I. Zhelesnov and B. N. Maksimenko (*Legkie Metalli* (*Light Metals*), **1935**, (6), 18–26).—[In Russian.] The utilization of waste from aluminium alloy production, splashings from crucibles, and melting dross in the production of aluminium–copper alloys by electrolysis in the ordinary cryolite bath is described. The dross averages aluminium 35·5, alumina 35–44, copper 5, silicon 4, iron 1%; to ensure normal working in electrolysis, the non-metallic portions of the dross must be ground to 50–100 mesh, and the metallic portions thoroughly stirred. The alloy obtained contained copper 1–1·5, silicon 2–3·5, and iron 1–1·5%.—D. N. S.

***Electrolytic Production of Magnesium–Aluminium Alloys in a Cryolite Solution.** A. M. Romanovski and J. K. Berent (*Legkie Metalli* (*Light Metals*), **1935**, (6), 27–40).—[In Russian.] Attempts to obtain magnesium–aluminium alloys by electrolysis of mixed fluoride melts were unsuccessful, the aluminium obtained containing only traces of magnesium. Continuous production of aluminium was also impossible owing to the anode effect.—D. N. S.

***Production of a Titanium–Aluminium Alloy in an Electrolytic Bath.** A. I. Zhelesnov and B. N. Maksimenko (*Legkie Metalli* (*Light Metals*), **1935**, (4), 24–32).—[In Russian.] Describes an experiment for obtaining a titanium–aluminium alloy in ordinary baths for the electrolytic production of aluminium. The bath was charged with $TiO_2$. The metal was thoroughly stirred during the anodic effects and before removing from the bath, as the titanium is apt to be segregated in the bottom layers.—D. N. S.

***Electrode Dispersion of Noble Metals.** Andr. Voet (*Trans. Faraday Soc.*, 1935, **31**, 1488–1491).—Electrolysis of acid, alkaline or neutral solutions with gold or platinum electrodes at high current density and potential differences causes disintegration of the anode and the formation of an unstable colloidal suspension of the metal. These phenomena are accompanied by rapid pulsations of the current and occur only when the concentration of the electrolyte exceeds a certain minimum value which depends on the potential drop between the electrodes. The Wehnelt effect is not the cause of cathode dispersion, since it can occur without any dispersion being observed if the temperature exceeds 50° C. Experiments are described which indicate that dispersion is the result of the repulsion of a periodically formed oxide layer on the anode surface.—A. R. P.

***The Electrolysis of Extremely Dilute Solutions. The Normal Potentials of Bismuth and Polonium.** M. Haïssinsky (*J. Chim. physique*, 1935, **32**, 116–125).—Values of the critical potentials for the cathodic deposition of bismuth in solutions of concentrations between $10^{-5}N$ and $10^{-12}N$ were determined, using radium-*E* and thorium-*C* as indicators. The normal potential of the electrode $Bi/Bi^{+++}$ is found to be $+ 0{\cdot}226$ v. Corresponding values for a polonium electrode are calculated as follows for $Po/Po^{++++}$, $E_N = 0{\cdot}775$ v.; for $Po/Po^{+++}$, $E_N = 0{\cdot}38$ v.; for $Po^{+++}/Po^{++++}$, $E_N = 1{\cdot}96$ v. A method for detecting quantities of bismuth or lead of the order $10^{-10}$ grm. is suggested. —J. S. G. T.

**On the Maxima of the Polarization Curve of Mercury Cathodes.** A. Frumkin and B. Bruns (*Acta Physicochim. U.R.S.S.*, 1934, **1**, 232–246; *Brit. Chem. Abs.*, **1935**, [A], 1079).—[In German.] Previous theories are discussed and considered to be unsatisfactory. It is suggested that the charge and discharge of the double layer and disturbances in the neighbourhood of the cathode, occasioned by local differences in the surface potential, are the primary factors in the polarization phenomena.—S. G.

***Study of the Activity of the Cell Lead Amalgam | $PbSO_4$ | $CuSO_4$ | Copper Amalgam.** A. Lebettre (*J. Chim. physique*, 1934, **31**, 348–359).—Measurements of the e.m.f. of the cell confirm the conclusions reached by Quintin (*ibid.*, 1933, **30**, 320) for a cell containing mercury and mercurous sulphate in place of copper amalgam and copper sulphate.—J. S. G. T.

---

## VIII.—REFINING

(Continued from p. 475.)

***Contributions to the Electrolytic Refining of Precious Metal Alloys.** Günther Hänsel and Adelbert Grevel (*Wiss. Veröff. Siemens-Werken*, 1935, **14**, (2), 63–92).—Procedures are described for the electrolytic refining of silver–copper alloys containing any proportion of the metals. For higher silver contents than 90% the usual nitrate electrolysis to obtain pure silver cathodes is the only method available, and for silver contents of less than 20% electrolysis in acid copper sulphate baths to obtain a silver anode slime and cathodic copper is the only economical process. When the alloy contains 10–20% of silver a superimposed alternating current is necessary to prevent building-up of a passive silver film on the anodes. For alloys containing 20–80% silver no direct electrolytic process is available which gives either metal in the pure state, but a new procedure has been developed in which the two metals are dissolved in the anode compartment, the anolyte is circulated over sheets of cathode copper to precipitate the silver and the resulting pure copper sulphate solution is passed to the cathode compartments of the cell. In this way pure copper is obtained at the cathode, and the silver collects partly as anode slime but chiefly as cement silver which are melted together into anodes and refined in the usual nitrate electrolyte. The process is described in detail with especial reference to the refining of low-grade coinage silver; it can also be advantageously employed for refining jewellery scrap containing up to about 40% gold, since this metal collects in the anode slimes whilst the copper and silver dissolve, and can be recovered therefrom by treatment with nitric acid and melting under a suitable flux. Schemes for the large-scale refining of various alloys are shown diagrammatically and briefly discussed.—A. R. P.

***Electrolytic Refining of Silver Containing Palladium.** G. Hänsel [with K. Dorsch] (*Metall u. Erz*, 1935, 32, 161–163).—In the electrolytic refining of silver in a slightly acid nitrate electrolyte small quantities of palladium dissolve, if present in the silver, and, when a certain amount has accumulated in the electrolyte, part is deposited with the cathode silver. The amount of palladium dissolved increases with increasing gold content of the anodes and with an increase in the concentration of the nitric acid. Thus when an anode containing silver 798, gold 23, palladium 6, platinum 1·5, copper 100, nickel 7·6, zinc 1·6, and iron 2°/₀₀ was electrolyzed in a bath containing silver 73 and nitric acid 4 grm./litre until the composition of the bath changed to silver 42, copper 70, and nitric acid 4 grm./litre the amount of palladium in the bath was 0·53 grm./litre, the first 40% of the silver deposited was free from palladium, and the remainder contained an average of 0·32°/₀₀, *i.e.* 83·4% of the total palladium remained in the anode slime, 12·5% remained in the electrolyte, and 4·1% was deposited on the cathode.—A. R. P.

## IX.—ANALYSIS

(Continued from pp. 528–531.)

***Simple Means for Distinguishing the Various Aluminium Alloys.** E. Zurbrügg (*Aluminium*, 1935, 17, 531–533).—Mn is detected by placing a drop of 20% NaOH on the surface, rinsing it into a test-tube after 10 minutes, placing a drop of 30% $HNO_3$ on the same spot, rinsing it into the same tube after 5 minutes, adding more $HNO_3$, and boiling the solution with 1–2 drops of 5% $AgNO_3$ solution and 1 grm. of $(NH_4)_2S_2O_8$; a pink colour indicates Mn. For the detection of Ni the NaOH and $HNO_3$ treatment is repeated, the $HNO_3$ drop being tested with $NH_4OH$ and dimethylglyoxime. To detect Mg a drop of conc. HCl is placed on the metal, and when the vigorous action has ceased, the solution is rinsed into a beaker, filtered, and treated with a few drops of tetrahydroxyanthraquinone solution and 20% NaOH to alkalinity; a cornflower-blue precipitate indicates the presence of Mg. Further tests on the nature of alloys may be made by local heat-treatment and hardness tests, full details of which are given.—A. R. P.

***Studies on Beryllium.—I.** Ichirô Iitaka, Yasuzô Aoki, and Tomosada Yamanobe (*Rikwagakû-Kenkyu-jo Iho* (*Bull. Inst. Phys. Chem. Res.*), 1935, 14, 741–748).—[In Japanese.] The gravimetric analysis of Be was carried out, after the method of Bleyer and Boshart, using $NH_4OH$ and $NH_4Cl$ or KI and $KIO_3$ as reagents for the precipitation of $Be(OH)_2$, which was converted to BeO by ignition, and weighed. Both pairs of precipitating agents gave fairly good results. For volumetric analysis, the colorimetric titration method using quinalizarin as indicator, as was done by H. Fisher, gave a very satisfactory estimation. In Fisher's method, there was no need to separate Be or Cu by changing the former to aluminate with NaOH, or the latter to a colourless, complex ion, $Cu(CN)_3^{--}$, with KCN. The presence of Al or Cu has no disturbing effect on the accuracy of the estimation, and the colorimetric titration may be carried out as usual. When Mg is present, however, it is necessary to separate Be by the use of $NH_4OH$ and $NH_4Cl$; the reagents precipitate $Be(OH)_2$ only, which may be redissolved in HCl and the titration can be carried out as usual.—S. G.

**Standard Methods of Chemical Analysis of Ferro-Tungsten and Ferro-Molybdenum (A 104–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 60–68).—S. G.

**Analysis of Plated Articles.** E. Arnold (*Chem. Listy*, 1933, 27, 73–78; *Brit. Chem. Abs.*, **1933**, [B], 393).—A current is passed through a filter paper moistened with acid or alkali and placed on the metal surface to be examined; characteristic colorations are obtained by placing drops of various reagents on the paper in the vicinity of the cathode. This method serves for the identification of Au, Cu, Sb, Cr, Al, Sn, Cd, Co, Ni, Pb, Ag, Zn, and Fe surfaces, as well as those of alloys containing the above-mentioned metals.—S. G.

**Application of Rapid Electrographic Methods for Testing Plated Coatings.** Alexander Glazunov (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 347–349).—Au plate can be distinguished from Cu by making the article the anode in a circuit comprising an Al cathode and a piece of filter paper impregnated with a 1% solution of benzidine in 10% $CH_3COOH$; Au produces a dark blue colour whilst Cu produces none. Au–Cu alloys are distinguished similarly except that the paper is impregnated with $K_4Fe(CN)_6$, when the presence of Cu produces a brown spot. Al plate can be detected by using 10% NaOH on the filter paper and adding alcoholic alizarin which produces a cherry-red colour. Pb gives a brown spot with 2% $K_3Fe(CN)_6$, Cd a grey spot with $NH_4CNS$ which becomes yellow on adding $Na_2S$, Cr gives a yellow spot with $NH_4CNS$ which becomes blue with benzidine, Co gives a greenish-blue spot with 10% $NH_4CNS$ in acetone, Ni a pink spot with dimethylglyoxime, and Ag a red spot with $K_2Cr_2O_7$.—A. R. P.

**The Investigation and Supervision of Nickel Baths and the Analysis of Nickel Salts for Plating Baths.** E. Raub and K. Bihlmaier (*Mitt. Forschungsinst. Edelmetalle*, 1935, **9**, 61–69).—Methods of detecting Cu, Fe, Zn, Cd, and Cr in Ni-plating baths are briefly described and quantitative tests for $Cl'$, $H_3BO_3$, citric acid, Mg, Na, and $NH_4^{\cdot}$ are given.—A. R. P.

**Quantitative Determination of Boric Acid and Citric Acid in Nickel [Plating] Baths.** E. Vincke (*Oberflächentechnik*, 1935, **12**, 161–163).—A portion of the solution (15–25 c.c.) is made ammoniacal and electrolyzed to remove Ni, $Na_2CO_3$ is added and the solution boiled to expel $NH_3$, the solution is cooled, neutralized with HCl (methyl red), treated with 25 c.c. of glycerol, and titrated with $CO_2$-free NaOH at 15° C. for $H_3BO_3$. A second portion is distilled with $CH_3{\cdot}CO_2H$, whilst 1·5% $KMnO_4$ is added at the rate of 5–8 drops in 5 minutes; after 10 minutes the distillate, containing acetone produced by the oxidation of the citric acid, is made alkaline with NaOH, treated with an excess of $I_2$ to convert the acetone into $CHI_3$, acidified with $H_2SO_4$, and titrated with $Na_2S_2O_3$.—A. R. P.

**Quantitative Spectroscopic Investigation of Copper Alloys for Analysis of Prehistoric Bronzes.** J. E. R. Winkler (*Veröff. Landesanstalt für Volkheitskunde, Halle*, **1935**, (7), 32 pp.; *Bull. B.N.F.M.R.A.*, 1935, (79)).—A general review of the technique of spectrographic analysis. W. describes the method which he has adopted, and gives analytical tables for the determination of Ag, Ni, Sn, Bi, As, and Sb in Cu. The method is stated to have been used in the analysis of 315 prehistoric bronzes, but no details are given.—S. G.

***Effect of Particle Size on Intensity in X-Ray Spectroscopic Analysis.** Gorton R. Fonda (*J. Amer. Chem. Soc.*, 1933, **55**, 123–127).—The intensity of a diffracted X-ray beam has been found to be decreased by surface irregularities of the target in proportion to their magnitude and to the coeff. of absorption of the target material for the wave-length involved. This effect was studied for grids of various sizes and powdered particles of various diameters of Sn, Mo, Cu, Co, Fe, Pb, and W. For accuracy in quantitative chemical analysis based on X-ray spectroscopy, attention must therefore be given to fineness of the powdered sample, more especially when $L_a$ radiation is involved.—L. A. O.

***Detection of Small Quantities of Indium, Gallium, and Thallium.** E. Pietsch and W. Roman (*Z. anorg. Chem.*, 1934, **220**, 219–224).—All 3 metals give characteristic precipitates with quinalizarin in the presence of $NH_4OH$ and $NH_4Cl$, the Tl reaction being the least sensitive. The test is satisfactory for the detection of these metals in Al if ethylamine is used instead of $NH_4Cl$, and in Zn if pyridine is also added to the reaction mixture. Analytical details are given.—A. R. P.

**Detection of Alkali Metals by Their Arc Spectra : Curves of Sensitiveness.** Pierre Urbain and Masao Wada (*Compt. rend.*, 1934, **199**, 1199–1201).—S. G.

***On a New Sensitive Detection of Some Non-Metallic Impurities in Metals.** K. W. Fröhlich (*Angew. Chem.*, 1935, **48**, 624–627).—The metal is made the cathode in a solution containing 5% NaOH and 5% KCN and the $H_2$ evolved is passed (*a*) over dry $AgNO_3$ paper, a yellow stain indicating the presence of As, (*b*) over moist filter paper impregnated with ammoniacal $AgNO_3$, a black stain indicating As or P, (*c*) through a heated tube then over paper as in (*b*), a mirror in the tube soluble in NaOCl solution indicates As, and a brown stain on the paper P. A second test is then made using 5% $H_2SO_4$ as electrolyte and the gas is passed (*d*) over $(CH_3{\cdot}CO_2)_2Cd$ paper, a yellow stain indicating S, (*e*) over the same paper as in (*b*), a black stain indicating Sb (if S is absent), (*f*) through the hot tube and over the test-paper as in (*c*), a mirror insoluble in NaOCl solution indicating Sb and a black stain on the paper P or S.—A. R. P.

**Organic Reagents in Qualitative Analysis. I.—The Separation of Iron, Chromium, and Aluminium.** Leo Lehrman, Elvin A. Kabat, and Harold Weisberg (*J. Amer. Chem. Soc.*, 1933, **55**, 3509–3511).—In certain conditions $Fe^{\cdot\cdot\cdot}$, $Cr^{\cdot\cdot\cdot}$, and $Al^{\cdot\cdot\cdot}$ may be separated from other members of the $(NH_4)_2S$ group by precipitation with $(CH_2)_6N_4$.—A. R. P.

***Studies of Various Methods for the Separation of the Common Elements into Groups. II.—The Separation by Means of Sodium Hydroxide and Sodium Peroxide.** Ernest H. Swift and R. C. Barton (*J. Amer. Chem. Soc.*, 1932, **54**, 4155–4172).—See *Met. Abs.* (*J. Inst. Metals*), 1933, **53**, 258, 318. Zn, Ni, Co, and Fe can be separated from Al, Cr, and Mn by treatment with $H_2S$ of a solution containing a controlled excess of $NaHCO_3$ and enough $Na_2C_2O_4$ to prevent precipitation of Al or Cr; the method affords a qualitative separation of these elements into the " Zinc Group " and the " Aluminium Group." 1 mg. of any metal of one group can be separated from 500 mg. of any metal of the other, and 250 mg. of any metal of the Zinc Group from 250 mg. of any element of the Aluminium Group, with the loss of less than 1 mg. of the latter in the precipitate.—L. A. O.

***On the Separation of Manganese at a Mercury Cathode.** V. M. Zvenigorodskaia (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (2), 160–162).—[In Russian.] Conditions were studied for the electrodeposition of Mn from solutions of its salts in the presence of various reducing agents and without them. Complete deposition of Mn was not obtained in any instance.—D. N. S.

***Sensitive Detection of Metals with Thionalide.** Richard Berg and W. Roebling (*Angew. Chem.*, 1935, **48**, 430–432).—A 1% solution of thionalide $(C_{10}H_7{\cdot}NH{\cdot}CO{\cdot}CH_2{\cdot}SH)$ in glacial $CH_3{\cdot}CO_2H$ gives characteristic precipitates with various metals the sensitivity of which (in p.p.m.) is as follows : in acid solution, Cu 0·1, Ag 0·2, Au 0·4, Hg 0·06, Sn 0·08, As 0·01, Sb 0·02, Bi 0·1, Pt 0·1, and Pd 0·1; in alkaline tartrate solution, Cu 0·5, Au 5·0, Hg 1·0, Cd 0·4, Tl 0·1; in tartaric acid and KCN, Au 5·0, Tl 0·1, Sn 4·0, Pb 0·1, Sb 0·5, Bi 0·4; in NaOH and KCN, Tl 0·1.—A. R. P.

**The Formation of Metallic Complexes by the Thioglycol Acids and Their Derivatives Especially " Thionalide."** Richard Berg and W. Roebling (*Ber. deut. chem. Ges.*, 1935, [B], **68**, 403–407).—The thioglycol acids produce characteristic metallic complexes with Cu, Au, and Ag in the presence of mineral acids. The scope of the reaction is extended to Hg, Sn, As, Sb, Bi, Pt, and Pd by weighting the carboxyl group with $(-NH_2)$ or amino-naphthalide groups, especially the latter. The relative sensitivities of the reactions are tabulated; the introduction of amino-naphthalide groups renders the reaction applicable to Pb, Co, Ni, and Mn in alkaline and neutral solution. It is especially recommended, however, for the detection and estimation of Cu, Hg, Ag, and Bi, and gravimetric and iodometric methods are described.—P. M. C. R.

***Determination and Separation of Metals with Thionalide.** Richard Berg and W. Roebling (*Angew. Chem.*, 1935, **48**, 597–601).—Cu, Hg, Bi, and Ag are quantitatively precipitated from mineral acid solution on addition of a 1% alcoholic solution of thionalide at 80°–85° C. The Cu compound contains 12·37% Cu, the Bi compound 23·87% Bi, and the Hg compound 31·74% Hg, after drying at 105° C.; the Ag compound must be ignited to Ag for weighing. Hg must be precipitated from chloride, Cu from sulphate or nitrate, and Bi and Ag from nitrate solutions. The method is particularly useful for determining Bi and Ag in Pb alloys and Bi in fusible metals containing Cd, Zn, and Pb. Excess of the precipitant may be removed from the filtrate by treatment with $I_2$ (or KI + $KIO_3$) which converts it into insoluble dithionalide.—A. R. P.

***A New Volumetric Determination of Aluminium.** W. Daubner (*Angew. Chem.*, 1935, **48**, 589).—The cold neutral or feebly acid Al solution is poured into a solution containing $NH_4Cl$ 5, $CH_3{\cdot}CO_2H$ 5, and $As_2O_5$ 0·45%, the mixture is heated to boiling and the precipitated $AlAsO_4$ collected, washed with 90% $C_2H_5OH$, and dissolved in HCl. The $As^V$ is reduced to $As^{III}$ and this is titrated with $I_2$ in the presence of $NaHCO_3$.—A. R. P.

***Determination of Aluminium Oxide in Aluminium and Its Alloys.** F. K. Gerke and N. W. Zolotareva (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (1), 39–47).—[In Russian.] Four methods for determining $Al_2O_3$ in metallic Al and its alloys were tested: (1) Decomposition of the specimen with $Hg(NO_3)_2$, fusion of the residue with $KNaCO_3$, and colorimetric estimation with Na alizarinsulphonate; this method is long and not accurate owing to the yellow colour of the reagent. (2) Decomposition in a stream of HCl, treatment of the residue first with $CuCl_2$, then with $HNO_3$ (1 : 5); the method is tedious but the results satisfactory. (3) Decomposition in a stream of $Cl_2$; simple, rapid, and gives concordant results. (4) Decomposition by $CuCl_2$ solution; good but tedious owing to the difficulty of washing out $Cu_2Cl_2$. Addition of $NH_4Cl$ to the $CuCl_2$ overcomes this difficulty and affords a clean residue of $Al_2O_3$ and $SiO_2$ from which the former is rapidly recoverable by known methods.—D. N. S.

***Certain Methods of Determining Aluminium Oxide in Aluminium and Its Alloys.** J. A. Kliachko (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (1), 48–50).—[In Russian.] The metal is dissolved in $CuCl_2$ solution under conditions which preclude the separation of $Cu_2Cl_2$. The $CuCl_2$ can be replaced by a 7–8% solution of $BiCl_3$, and finally the Bi is dissolved in HCl and $H_2O_2$ to leave a residue of $Al_2O_3$.—D. N. S.

***Applications of Ceric Sulphate in Volumetric Analysis. X.—The Determination of Antimony and Arsenic.** N. Howell Furman (*J. Amer. Chem. Soc.*, 1932, **54**, 4235–4238).—Sb may be determined by titration with $Ce(SO_4)_2$ at room temperature without a catalyst in the presence of 30–50% by volume of HCl (*d* 1·19). Minor amounts of As do not interfere, and may subsequently be determined by continuing the titration after addition of ICl as a catalyst.
—L. A. O.

***The Volumetric Determination of Arsenic. Potentiometric Titrations of Reduced Arsenic Solutions with Potassium Iodate in Sulphuric and Hydrochloric Acid Solutions.** Irl C. Schoonover and N. Howell Furman (*J. Amer. Chem. Soc.*, 1933, **55**, 3123–3130).—Operating details are given.—A. R. P.

***Rapid Determination of Small Quantities of Bismuth in Copper.** M. Garino and R. Catto (*Chimica e Industria* (*Italy*), 1935, **17**, 218–220; *C. Abs.*, 1935, **29**, 7215).—The method is based on that of Glazunov (*J. Inst. Metals*, 1929, **42**, 508). The electrolyte consists of 1 grm. of cinchona dissolved in 60 c.c. water, and acidified with HI until a light precipitate is formed. This is filtered, and the solution diluted to 100 c.c. A piece of the copper to be tested, exactly 20 cm.², is taken, and a wire is soldered to it so as to act as electrode. A piece of sheeting of the same area impregnated with 10% $HNO_3$ solution to act as a buffer to prevent precipitation of cinchonine iodobismuthate from adhering to the Cu surface, which would increase resistance and thus prevent quantitative precipitation of the Bi, is placed on the electrode. Over this is placed another sheet soaked with cinchonine iodide. An Al cathode is pressed down on to the metal and fabric, and a current of 100 ma. at 4 v. is passed through for 4 minutes. A red-orange imprint is left by Bi on the reagent sheet, the colour being proportional to the amount present. Differences of 0·002% Bi are readily distinguished for amounts up to 0·01%. For higher concentrations, the time of electrolysis is reduced.—S. G.

***A New Macro and Micro Gravimetric Method for the Determination of Copper.** G. Spacu and C. G. Macarovici (*Z. anal. Chem.*, 1935, **102**, 351–352).—The neutral solution containing less than 0·01 grm. of Cu in 50–75 c.c. is mixed with 40–50 c.c. of 1% $NH_4CNS$ solution and 10–20 c.c. of an alcoholic solution of benzidine (or tolidine) whereby the Cu is completely precipitated as the very voluminous compound $[CuBzd(SCN)_2]$, ignition of which affords CuO for weighing. The method is particularly suitable for micro-analysis.—A. R. P.

***Electrolytic Determination of Copper in Aluminium Alloys.** J. A. Kliachko and G. F. Burlak (*Zavodskaia Laboratoria* (*Works' Laboratory*), 1934, **3**, 585–588).—[In Russian.] The effects of acidity, temperature, current density, stirring, and voltage have been determined, and the following procedure is recommended: Dissolve 1 grm. of alloy in a mixture of 1 c.c. conc. $H_2SO_4$, 3 c.c. conc. $HNO_3$, and 20 c.c. $H_2O$, dilute the solution to 150 c.c. and electrolyze for 10 minutes at 80° C. with stirring, using 0·5–2 amp. at 2–3 v.—D. N. S.

***More on the Determination of Copper in Aluminium Alloys.** J. A. Kliachko and E. E. Gurevich (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (2), 230–231).—[In Russian.] Cf. preceding abstract. 1 grm. of shavings is dissolved in 40 c.c. of a mixture of acids (50 $HNO_3$, 35 $H_2SO_4$, and 100 $H_2O$). The volume of the solution is brought up to 100 c.c. and is electrolyzed for 7 minutes at 70° C.—D. N. S.

***A More Rapid Method of Determining Copper in Zinc.** M. I. Shubin (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (2), 155–158).—[In Russian.] The method consists of direct electrolysis of a highly acid (25–27 c.c. $HNO_3$ (1·4) in 200 c.c.) solution of the metal. The duration of electrolysis is 2–3 hrs. at 30° C. and the accuracy is up to 0·001%. The method has been tested on specimens of absolutely pure Zn to which were added Fe 0·05, As 0·05, Sb 0·05, and Cu 0·008–0·03%.—D. N. S.

***A More Rapid Method for Determining Copper and Zinc in Brass.** M. J. Klinov and T. I. Arnold (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (1), 109–111).—[In Russian.] The brass (0·5 grm.) is dissolved in 10 c.c. of 3 : 1 $HNO_3$, the Fe oxidized with Br, the solution diluted to 30 c.c., neutralized with $NH_4OH$, treated with 3–4 drops of 25% $KHF_2$ solution, and 2 grm. of KI, and titrated with 0·1$N$-$Na_2S_2O_3$ for Cu. The solution is then boiled, the $Cu_2I_2$ precipitate removed and the excess of $Na_2S_2O_3$ accurately titrated; 5 grm. of $(NH_4)_2SO_4$ and 1–1·5 c.c. of 5% $K_3Fe(CN)_6$ are added, and the liberated $I_2$ titrated, more $K_3Fe(CN)_6$ being added, and titration continued until the yellow solution no longer becomes blue after 2 minutes.—D. N. S.

***Rapid Method of Determining Copper, Iron, and Zinc without Preliminary Separation.** S. J. Fainberg and M. I. Troitskaia (*Zavodskaia Laboratoria* (*Works' Lab.*), 1935, **4**, (1), 104–108).—[In Russian.] The process is essentially the same as described in the preceding abstract except that the Fe is determined iodometrically after the Cu, the added $KHF_2$ being destroyed previously by addition of $H_3BO_3$, $H_2SO_4$, and KCNS. The interference of Fe in the Zn titration is overcome by addition of $Na_4P_2O_7$ and neutralization with $NH_4OH$ after filtering off the $Cu_2I_2$ and oxidizing the Fe with $KBrO_3$.—D. N. S.

***Detection and Determination of Gold with the Aid of Carbon Monoxide.** Rodica N. Costeanu (*Z. anal. Chem.*, 1935, **102**, 336–338).—Filter paper impregnated with the solution containing the Au as $AuCl_3$ is exposed to the action of CO and the colour produced compared with that of a series of standards prepared similarly.—A. R. P.

**Electrolytic Determination of Small Amounts of Lead in Copper and Copper–Zinc Alloys.** V. Shubin (*Zavodskaya Laboratoria* (*Works' Lab.*), **1932**, (2), 28–37; *Chem. Zentr.*, 1934, **105**, II, 2716; *C. Abs.*, 1935, **29**, 7217).—[In Russian.] The most favourable conditions for the determination of slight amounts of Pb in Cu and Cu–Zn alloys electrolytically are: (1) slight acidity, *i.e.* 3–5 c.c. $HNO_3$ (*d* 1·40) to 150–250 c.c. of electrolyte; (2) Cu concentration should not exceed 10–12 grm. in 150 c.c.; (3) electrolyte temperature 20°–50° C.; (4) current density at the gauze electrode 1·2–1·5 amp.; and (5) vigorous stirring of the electrolyte. In these conditions slight amounts of Pb (0·05%) can be determined with an accuracy of 0·003%.—S. G.

***The Electrolytic Determination of Lead in Zinc.** M. I. Shubin (*Zavodskaya Laboratoria* (*Works' Lab.*), **1932**, (3), 25–31; *Chem. Zentr.*, 1934, **105**, II, 2716; *C. Abs.*, 1935, **29**, 7217).—[In Russian.] Experiments showed that conditions necessary for the electrolytic determination of Pb in Zn are analogous to those for its determination in Cu (cf. preceding abstract). The electrolyte must not contain more than 1 grm. Cu. Directions are given for the determination of slight amounts of Pb (0·2%) in the best grades of Zn and also for greater amounts in specimens containing more than 0·2% Pb.—S. G.

**Spectrographic Determination of the Lead Content of Commercial Tin.** H. Kringstad (*Angew. Chem.*, 1935, **48**, 565–566).—The spectrum is obtained by the condensed-spark method and the intensity of the lines 2873·2, 2833·0, 2614·2, and 2203·5 compared with standard spectra made from alloys of known composition. The results are in fair qualitative agreement with chemical analysis.—A. R. P.

**Volumetric Determination of Magnesium.** W. Daubner (*Angew. Chem.*, 1935, **48**, 551).—The Mg is precipitated as $MgNH_4AsO_4$ which, after washing, is dissolved in HCl, the $As_2O_5$ is reduced to $As_2O_3$ with $SO_2$, the excess of the latter is removed with $CO_2$ after 1 hr., the acid is neutralized with $NaHCO_3$, and the $As_2O_3$ titrated with $I_2$.—A. R. P.

**Rapid Determination, Employing a Direct Measurement of α-Radiation and Radium Radiation, for Ascertaining the Polonium Content of Natural Radio-Lead.** Marthe Leblanc (*J. Chim. physique*, 1935, **32**, 332–337).—A method for the quantitative determination of Po in radio-lead, based on measurements of radioactivity is proposed and tested.—J. S. G. T.

**Determination of Silver and Copper in Alloys Without Preliminary Separation.** F. Sierra and E. Burriel (*Anal. Soc. españ. Fís. Quím.*, 1933, **31**, 129–133; *Brit. Chem. Abs.*, **1933**, [B], 792).—The sample (1·5 grm.) is dissolved in $HNO_3$, the excess of acid is removed, and the solution is neutralized (Me-orange) with NaOH and diluted to 250 c.c. The Cu is titrated by adding the solution from a burette to a mixture of 20 c.c. of $0{\cdot}05N$-$Na_2S_2O_3$, 30 c.c. of $0{\cdot}2N$-KI starch, and 10 drops of $0{\cdot}1N$-$AgNO_3$, and the Ag is determined by titration of 50 c.c. of the Ag–Cu solution with $0{\cdot}05N$-KI, benzidine sulphate being used as indicator unless the Ag concentration is less than $0{\cdot}01N$, when benzidine acetate is preferable.—S. G.

***Electrometric Determination of Thallium.** Winifred R. A. Hollens and James F. Spencer (*Analyst*, 1935, **60**, 672–676).—The chloride solution is treated with a stream of $Cl_2$ to oxidize the TlCl to $TlCl_3$, the excess of $Cl_2$ is removed with a current of $CO_2$, KI is added, and the liberated $I_2$ titrated with $Na_2S_2O_3$ or $Na_3AsO_3$ using as indicator $CHCl_3$ or the bimetallic electrode of Foulk and Bawden (*J. Amer. Chem. Soc.*, 1926, **48**, 2045). The Tl concentration must be at least $0{\cdot}002N$. Tl and Cu may be determined simultaneously by the method and the Cu then determined iodometrically in a separate portion of the solution which is not oxidized with $Cl_2$.—A. R. P.

***Volumetric Method of Determining Zinc in Metallic Magnesium and Elektron Alloys.** J. I. Gamzulov (*Zavodskaia Laboratoria* (*Works' Laboratory*), 1934, **3**, 984–985).—[In Russian.] The alloy is dissolved in dilute $H_2SO_4$, the residue filtered off, and the filtrate treated with 5 grm. of $K_2SO_4$ and neutralized with $Na_2CO_3$ to an incipient turbidity; dissolve the latter with 1 drop $H_2SO_4$; 0·5–2 grm. of KI are then added followed by an excess of $K_3Fe(CN)_6$ solution, and the $I_2$ liberated is titrated with $Na_2S_2O_3$.—D. N. S.

**Use of a Sulphate–Hydrosulphate Buffered Solution for the Precipitation of Zinc Sulphide.** C. E. P. Jefferys and Ernest H. Swift (*J. Amer. Chem. Soc.*, 1932, **54**, 3219–3228).—The precipitation of ZnS from $Na_2SO_4$–$NaHSO_4$ solutions is complete (within 0·25 mg.) at $p_H = 1{\cdot}6$, and affords a means of separating Zn from Ni, Fe, Mn, Cr, and Al, but not from Co. High Cl′ concentration increases the solubility of ZnS. When igniting ZnS precipitates the temperature should be closely controlled at 500° C. and at 900° C. when igniting $ZnSO_4$ to ZnO.—L. A. O.

## X.—LABORATORY APPARATUS, INSTRUMENTS, &c.

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

(Continued from pp. 531–532.)

**Construction and Operation of Platinum Resistor Furnaces for the Laboratory to Operate at 1550° C.** K. G. Kumanin (*Zhurnal Prikladnoi Khimii* (*J. Applied Chem.*), 1935, **8**, 177–183; *C. Abs.*, 1935, **29**, 6843).—[In Russian.] Details are given of construction using the spiral platinum wire or ribbon winding.—S. G.

***Apparatus for Raising or Lowering the Temperature of a Laboratory Furnace in a Pre-Determined Manner.** Frank Adcock (*J. Sci. Instruments*, 1935, **12**, 285–288).—An essential part of the device is a moving potential divider providing a steadily increasing or decreasing e.m.f. This latter is opposed to the e.m.f. due to a controlling thermocouple in the furnace, and the resulting small current deflects a mirror galvanometer operating a photo-cell. By means of a thyratron and small electric motor the photo-cell regulates the furnace heating current. The apparatus can be used for the control of a furnace in which thermal analysis is conducted, and facilitates the interpretation of thermal curves obtained with heated specimens exhibiting weak or diffuse thermal arrests.—J. S. G. T.

***The Construction of Incandescence Filaments and [Small, Electric] Furnaces from Nernst Material.** C. Tingwaldt (*Physikal. Z.*, 1935, **36**, 627–629).—The production of Nernst filaments and small tubular furnaces from a mixture of zirconia and yttria is described. Tubular furnaces of internal diameter 14 mm. have been constructed by Kurlbaum and Schulze (*Verh. d. Phys. Ges.*, 1903, **5**, 428). Temperatures up to 2300° C. have been attained in smaller furnaces.
—J. S. G. T.

**Microscope Inclination Unit.** W. Watson and Sons, Ltd. (*J. Sci. Instruments*, 1935, **12**, 330).—A prism system fitting above the nosepiece of the microscope into the dovetail, normally carrying monocular or binocular tubes, is illustrated.—J. S. G. T.

**Photo-Electric Eyepiece for Measuring the Reflecting Power of Opaque and Transparent Minerals, and of Metals and Alloys.** J. Orcel (*Rev. d'Optique*, 1934, **13**, 59–62).—An illustrated description is given of an eyepiece for use with any type of metallurgical microscope. A photo-electric cell is excited by light reflected from the sample to an extent measurable by a galvanometer; the method of calibration is discussed and described. The probable error is of the order of 1%.—P. M. C. R.

**"Panphot," a Modern Micro-Camera for Metallography and for the Examination of Metal Fabrics.** Hugo Freund (*Draht-Welt*, 1935, **28**, 643–645).—See also *Met. Abs.*, this vol., p. 245. An illustrated description of this apparatus. —P. M. C. R.

**The Micro-Influentiometer.** G. Magnel (*Rev. d'Optique*, 1934, **13**, 288–301). —The apparatus consists of a series of microscopes, with micrometer movement, and magnifying about 100 diameters. These are focussed on selected points of the model under investigation; influence lines are observed by polarized light, and the effects of stress are measured by test micrometers. The necessary adjustments are fully described.—P. M. C. R.

**The Exact Measurement of the Specific Heats of Solid Substances at Higher Temperatures. XVIII.—On the Use of Dewar Vacuum Vessels in the Metal Block Calorimeter for the Control of the Cooling Rate.** F. M. Jaeger, R. Fonteyne, and E. Rosenbohm (*Proc. K. Akad. Wet. Amsterdam*, 1935, **38**, 502–509).—[In English.] It is shown that Dewar vacuum vessels can be used satisfactorily in high-precision calorimetry at high temperatures provided precautions be taken to safeguard that a *continuous control* be exercised over variations of the cooling modulus during the whole duration of the experiment.—J. S. G. T.

***Precision Comparator [The Orthotest].** —— (*J. Sci. Instruments*, 1935, **12**, 267–268).—The "Orthotest," especially suitable for the rapid inspection of mass-produced components, is described. Variation in size is indicated by a pointer moving over a scale reading in increments of 0·00005 in. The working tolerance has a working range of 0·004 in. It can be applied to the gauging of fine wire and sheet metal, the measurement of end rods, cylindrical plug and limit gauges, gudgeon pins, rings, punches, &c.—J. S. G. T.

***A Camera for Electron Diffraction.** Raymond Morgan and Newbern Smith (*Rev. Sci. Instruments*, 1935, [N.S.], **6**, 316–319).—A comparatively simple form of electron diffraction camera, designed for the investigation of the electron diffraction spectra of reflection specimens, transmission specimens, gases, and vapours, is described.—J. S. G. T.

**A Method for Determining the Orientation of a Crystal under a Microscope.** R. G. Wood and S. H. Ayliffe (*J. Sci. Instruments*, 1935, **12**, 299).—A simple modification of the universal goniometer devised by Hutchinson, employing components that are readily available, is described.—J. S. G. T.

**X-Ray Equipment for Studying Metal at High Temperatures.** Norman P. Goss (*Metal Progress*, 1935, **28**, (4), 163–166, 176).—The apparatus described includes a new type of specimen and film holder (diffraction cassette). A Bakelite cylinder transmits practically the whole of the diffracted radiation from a molybdenum target, whilst absorbing scattered radiation. The film, in a light-tight envelope, is wrapped round the cylinder, with its centre near the axis of the beam of X-rays. The specimen holders act as electrodes for a heating current, and the temperature is measured optically through a thin glass window in the tube. Some characteristic diffraction patterns obtained at high temperatures are reproduced; structural changes over a considerable range can be observed by this method.—P. M. C. R.

***Precision (X-Ray) Photography Employing the Debye–Scherrer (Powder) Method.** M. Straumanis and O. Mellis (*Z. Physik*, 1935, **94**, 184–192).—It is shown that, suitable precautions being taken, X-ray photographs of spectra taken with an ordinary type of Debye–Scherrer camera of diameter 57·4 mm. give results almost as good as those obtained by use of the best precision methods.—J. S. G. T.

**An Illuminator for Printing Laue Photographs.** L. W. McKeehan (*Rev. Sci. Instruments*, 1935, [N.S.], **6**, 329).—McK. points out that the copying method for Laue photographs, described by Dwight and Kersten (*Met. Abs.*, this vol., p. 532) is essentially that used by Trendelenburg (*Naturwiss.*, 1933, **21**, 173).—J. S. G. T.

**Apparatus for the Measurement of Breakdown Voltage Between Metal Electrodes in Vacuum.** H. W. Anderson (*Rev. Sci. Instruments*, 1935, [N.S.], **6**, 309–314).—Apparatus, including special shielding devices, for the measurement of breakdown voltages up to 500 kv. between metal electrodes, is described.—J. S. G. T.

---

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

(Continued from pp. 532–533.)

**General Specifications for Inspection of Material.** —— (*U.S. Navy Dept.*, **1934**, 20 pp.).—S. G.

**Inspection of Materials in Automobile Engineering.** —— (*Metallurgia*, 1935, **12**, 187–188).—Routine tests are discussed with special reference to the methods employed by a well-known firm of motor-car manufacturers, and some metallurgical features, such as the use for pistons of an aluminium alloy having a much lower coeff. of expansion than the older type of aluminium piston alloys, are described. Certain foundry developments in moulding are also described.—J. W. D.

**Mechanical Testing with Small and Large Test-Pieces.** —— (*Metal Treatment*, 1935, **1**, 133–134).—A review of recent work, incorporating an abridged translation of a paper by P. Chevenard on "Photographically Recording Micro-Machines for the Mechanical Testing of Metals"; see *Met. Abs.*, this vol., p. 392.—J. C. C.

**The Principles of the Testing of Welded Joints.** K. Daeves (*Elektroschweissung*, 1935, **6**, 172–174).—The numerous tests available for use with welds are critically reviewed. The importance of testing the whole joint and not merely the weld metal is pointed out and the value of tests which determine the probability of crack formation under the type of stressing to be expected in service, is emphasized.—H. W. G. H.

**Electromagnetic Fatigue Tests.** —— (*J. Sci. Instruments*, 1935, **12**, 264–265).—An electromagnetic instrument is described and illustrated, in which reversals of stress at the rate of 1,000,000 per hr. are applied to a bar, the stress being a maximum at the centre of the bar so that failure always occurs thereat.—J. S. G. T.

**A Research into Tests for Materials Used in Cold-Pressing Operations, with Special Reference to the Fluid-Pressure Cupping Test.** (Gough and Hankins.) See p. 630.

**The Principal Sources of Error in Pendulum Hammers.** Fr. Dubois (*Machines*, **1935**, (July), 8–14; (Aug.), 18–26; (Sept.), 10–25; (Oct.), 20–27).—Impact tests carried out on Charpy and Amsler testing machines show consistently higher values in the case of the former. A tabulated series of notched-bar tests shows that the maximum discrepancy is associated with low values of the energy required to fracture the test-piece. Energy losses are estimated and analyzed by a comparative series of "crusher" tests on soft annealed copper specimens. A theoretical analysis is given of the principal sources of loss of energy inherent in the method; these are: (*a*) imperfect elasticity of apparatus; (*b*) loss of energy to foundation of machine; (*c*) losses through vibration of the frame; (*d*) losses through vibration of the pendulum rod. Minor sources of loss are air resistance, friction at pendulum suspension, &c. The practical evaluation of (*a*), (*b*), (*c*), and (*d*) is described, and the results are compared with the result of direct determinations of the total loss of energy (rebound method). For impact energy values of 30–60 kg. the energy losses show an average of 16–18% of the total impact energy in the case of the Charpy apparatus, the corresponding percentage being 6–9%

in that of the Amsler machine. These losses are analyzed as follows: incomplete elasticity, Charpy 68%, Amsler 54%; total losses: energy absorbed by foundation, Charpy 10%, Amsler 14%; vibration of frame, Charpy 21%, Amsler 28%; vibration of rod, Charpy 1%, Amsler 4%.—P. M. C. R.

***Some Dynamic Methods for Determination of Young's Modulus.** John M. Ide (*Rev. Sci. Instruments*, 1935, [N.S.], **6**, 296–298).—The natural frequency of longitudinal vibration of a rod, set into vibration by electrostatic traction, is determined and Young's modulus, $E$, calculated from the result. The necessary apparatus is described. Values of $E$ for aluminium, glass, lead, nickel, silver, and steel so determined agree well with accepted values.—J. T.

**An Extensometer Comparator.** Ambrose H. Stang and Leroy R. Sweetman (*J. Research Nat. Bur. Stand.*, 1935, **15**, 199–203; and *Research Paper* No. **822**).—An extensometer comparator for the calibration of extensometers, compressometers, micrometer dials, and strain gauges is described. The comparator has given satisfactory results in calibrating length-measuring instruments used for testing materials.—S. G.

**The Measurement of Surface Hardness.** G. Lebruly (*Rev. fonderie moderne*, 1934, **28**, 311–313).—Methods and apparatus are described briefly.—S. G.

***Dependence of the Hardness of Metals, as Determined by the Cone-Pressure Test, on Temperature.—I.** J. Engl and G. Heidtkamp (*Z. Physik*, 1935, **95**, 30–41).—Apparatus is described incorporating a synthetic corundum single crystal, set in corundum rod, designed for the determination of the hardness of metals up to about 1900° C. Experimental results relating to the hardness of single- and poly-crystalline copper at temperatures up to about 1000° C. are discussed. Measurements were made on surfaces of the single crystal cut parallel respectively to the (001), (011), and (111) planes. The respective hardnesses up to 850° are in the following order of increasing magnitude: polycrystalline $<(001)<(011)<(111)$. The metal is characterized by a measurable hardness just below the melting point. Above 850° C. all the surfaces possessed the same hardness. The results are discussed. The polycrystalline material used was pure copper: the single crystal had the composition copper 98, silver 2%.—J. S. G. T.

**Standard Method of Test for Determining the Temperature-Resistance Constants of Resistance Alloys (B 84–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 83–88).—This method provides for determining the change of resistance with temperature of wires of the Manganin and Constantan types (alloys of the type having compositions similar to copper 84, manganese 12, and nickel 4%; and copper 55 and nickel 45%, respectively) and for computing the constants of the resistance–temperature equation. It is applicable in the range 0° to 80° C. and is suitable for wires to be used in precision electrical apparatus.—S. G.

**Standard Definitions of Terms, with Units and Symbols, Relating to Magnetic Testing (A 127–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 69–74).—S. G.

---

## XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from p. 533.)

**A Simple Means of Measuring the Temperature of Aluminium Ingots.** A. v. Zeerleder (*Light Metals Research*, 1935, **4**, 124–128).—Translated from *Aluminium*, 1935, **17**, 199–201; see *Met. Abs.*, this vol., p. 306.—J. C. C.

**Piston Temperatures in High-Speed Air- and Water-Cooled Petrol-Engine Cylinders.** H. Wright Baker (*Proc. Inst. Automobile Eng.*, 1934–1935, **29**, 312–342; discussion, 343–351).—Temperature measurements, taken by the "cooling-curve" method and made on pistons in either air- or water-cooled cylinders at engine speeds ranging from 2000 to 4000 r.p.m., are discussed.

Points receiving attention include: effects of the velocity of the cooling stream, pressure, throttle setting; effect of ring width, crown thickness, and ribs; a flat-topped piston is about 6° C. cooler at the centre than a domed piston.—J. S. G. T.

**Measurement of Waste Gas Temperatures.** E. Graf (*Feuerungstechnik*, 1935, **23**, 100–102).—The measurement of true waste gas temperatures by extrapolation from results obtained using 3 thermo-elements of different thicknesses of wire is described. The results are compared with the readings of a mercury thermometer either unprotected from radiation or variously protected.—J. S. G. T.

***Cross-Filament Optical Pyrometer.** —— (*J. Sci. Instruments*, 1935, **12**, 303–304).—The pyrometer is of the disappearing-filament type, the incoming radiation being reduced by means of a wedge-like absorption screen until the filament of a standard electric lamp, which is maintained at a definite constant temperature, disappears into the background. In the standard lamp employed for standardizing the pyrometer filament temperature there are 2 filaments, one a ribbon, the other a wire flattened at the centre and crossing the ribbon. They are composed of 2 materials of quite different temperature–current characteristics and appear equally brilliant at one temperature only—the standardizing temperature—which is quickly and easily obtained.—J. S. G. T.

***The Optical System of the Disappearing-Filament Pyrometer.** F. A. Cunnold (*Proc. Roy. Soc.*, 1935, [A], **152**, 64–80).—It is shown, both theoretically and experimentally, that reflection at the surface of the round filament is negligible in the usual type of disappearing-filament optical pyrometer. The bright lines seen at the edges of the filament are attributable to deviations from Lambert's cosine law. A tentative theory of diffraction effects at the filament edge is suggested, and a simple deduction therefrom is shown to be in good agreement with the facts. Perfect disappearance of the filament is not essential for the attainment of maximum accuracy in pyrometry. The influence of "edge effects" on the design of optical pyrometers is discussed, and it is shown that the aperture limits suggested by previous workers can be considerably widened so that pyrometers transmitting more light can be constructed and the optical scale of temperature thereby extended downwards.—J. S. G. T.

***A Study of Arc Temperatures by an Optical Method.** C. G. Suits (*Physics*, 1935, **6**, 315–322).—Sound waves passing through arcs in air are photographed with a rotating mirror camera; their velocity in the arc core is deduced and the arc temperature then calculated. The following arc temperatures (° K.) have been thus determined: a cored carbon, 5500°; sodium chloride-cored carbon, 4740°; aluminium-cored carbon, 6160°; tungsten-cored carbon, 6220°; tungsten (6 mm. electrodes), 5950°; tungsten (9·5 mm. electrodes), 6440°; tungsten–iron, 6150°; iron–iron welding arc, 6020°. The experimental error is ± 100° at 5500° K. The gas temperature across the arc is constant within the experimental error. The results are applied to test the thermal ionization theory. The dissociation of the arc atmosphere between a coated iron welding rod and a steel plate is found to be 81%. This high degree of dissociation points to the importance of the dissociation–diffusion–recombination process for heat transfer in welding arcs, and explains the negative results of attempts to arc-weld in pure argon.—J. S. G. T.

**The Practice of Partial Radiation Pyrometry.** G. Naeser (*Stahl u. Eisen*, 1934, **54**, 1158–1160).—Describes an optical pyrometer in which the temperature of a bare molten metal is corrected for black-body conditions by means of colour filters so that a very close approximation to the true temperature is obtained.—S. G.

**Resistance Thermometry below 10° K.** J. D. Babbitt and K. Mendelssohn (*Phil. Mag.*, 1935, [vii], **20**, 1025–1040).—Only one out of about a dozen phosphor–bronze wires proved suitable for use as a resistance thermometer below

10° K. Apparently both the proportions of the constituents and the previous treatment of the material greatly affect the form of the resistance–temperature curve. A superconducting component which may be responsible for the variation of resistance with temperatures below 7° K. is tin–phosphorus with a transition temperature at 8·9° K. A lead–silver wire containing 5% lead can be used as a resistance thermometer between 7° and 3° K.—J. S. G. T.

***The Temperature Scales of Columbium, Thorium, Rhodium, and Molybdenum at 0·667 μ.** L. V. Whitney (*Phys. Rev.*, 1935, [ii], **48**, 458–461).—To establish temperature scales for columbium, thorium, rhodium, and molybdenum, spectral emissivities of these metals were measured for radiation $\lambda = 0{\cdot}667\ \mu$. The respective emissivities were found to have the following values and to be constant within the stated ranges of temperature (° K.): columbium, 0·374, 1300°–2200°; thorium, 0·380, 1300°–1700°; rhodium, 0·242, 1300°–2000°; molybdenum, 0·382, 1300°–2100°.—J. S. G. T.

***A Recent Improvement in Precision Potentiometers.** D. C. Gall (*J. Sci. Instruments*, 1935, **12**, 284–285).—In precision potentiometers in which the degree of sub-division is carried in definite steps to 1 part in 180,000, reading from 1·8 v. to 10 micro-v. or 0·18 v. to 1 micro-v. there is usually a minimum residual potential above zero, which prevents the balancing of very small potentials. A method for overcoming this residual potential and also allowing small negative potentials to be balanced is described.—J. S. G. T.

**Temperature Control with Simple Aids.** E. Zurbrügg (*Aluminium*, 1935, **17**, 533–534).—The temperature of aluminium alloys during heat-treatment can be gauged by observing the changes which occur in sugar crystals, soap, or wood placed on the surface. Sugar melts at 160°–170° C., becomes yellow in 1 minute at 180° C., in 5 seconds at 200° C., and in 2 seconds at 225° C., and golden yellow in 20 seconds at 200° C., 5 seconds at 225° C., and immediately at 250° C. Soap becomes yellow at 250° C. in 10–20 seconds, brown in 5 seconds at 350° C., black in 10 seconds at 400° C., and black and dry in 10 seconds at 450° C. A wood chip becomes black at 500° C. and inflames at 550° C.—A. R. P.

**Automatic Temperature Control of Electric Furnaces.** J. Smittenberg (*Chem. Weekblad*, 1932, **29**, 614–615; *Brit. Chem. Abs.*, **1933**, [B], 25).—A hermetically-sealed, nitrogen-filled thermoregulator is used to make and break the current through a resistance placed in parallel with a second resistance in the main heater circuit. A temperature of, for example, 300° C., may be maintained to within ± 0·4° C.—S. G.

---

## XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 534–536.)

**Modern Foundry Practice.** W. G. Morgan (*J. Inst. Production Eng.*, 1935, **14**, 480–490; discussion, 491–494).—A general review.—J. C. C.

**Foundry Practice for Large Non-Ferrous Castings.** M. C. Oldham (*Met. Ind.* (*Lond.*), 1935, **47**, 483–486).—The effects of casting temperature, variations in freezing range, and uniformity of temperature in making large non-ferrous castings are discussed.—J. H. W.

***The Capacity of Alloys to Reproduce the Shape of Moulds.** M. P. Slavinsky and A. F. Andreeva (*Liteinoe Delo* (*Foundry Practice*), **1935**, (1), 11–18).—[In Russian.] The reproducibility of mould shapes was studied by casting copper–antimony and copper–aluminium alloys into conical and cuneiform moulds with various apex angles. The capability of reproducing detail depends on the composition and may be utilized in the study of equilibrium diagrams. The casting temperature and condition of the mould surface affect the ability of the alloys to reproduce detail. The decisive factor in the execution of fine angles is not the oxidizability of the alloys, but the surface tension and hardness of the surface layer. Maximum castability is obtained with eutectic alloys; with solid solution alloys the castability decreases with increasing concentration of the solute.—N. A.

**The Use of Alkali Metals as Deoxidizers.** —— (*Metallurgist* (Suppt. to *Engineer*), 1935, **10**, 71–72).—A review of the methods given in papers by H. Osborg (*Met. Abs.*, this vol., p. 494; use of lithium and its alloys for deoxidation of various metals) and by B. A. Weimer (*Met. Abs.*, this vol., p. 308; referring to a sodium–zinc alloy (2 : 98) for any alloy in which 2% zinc would be permissible). Insufficient information appears to be available for proper assessment of the merits of these methods.—R. G.

**Progress in the Founding of Aluminium.** —— Dumas (*Bull. Assoc. tech. Fonderie*, 1934, **8**, 86–90).—A review.—A. R. P.

**Casting of Aluminium Wire Bars and Plates at the Volkhov Aluminium Works.** L. N. Lysenko (*Legkie Metalli* (*Light Metals*), **1935**, (8), 18–23).—[In Russian.] A detailed description is given of the method of casting used at the Volkhov aluminium works. Melting is carried out in 2·5-ton Gautsch–Brandt furnaces. The charge consists of 50% refined aluminium or waste from previous castings and 50% ingots from electrolytic baths. The metal is cast direct from the furnace at 700° C. into moulds heated to 300°–400° C. and inclined at an angle of 85° to the vertical; towards the end of the filling process these are brought into a vertical position.—D. N. S.

**Casting of Aluminium Pistons in Metal Moulds.** A. M. Duhota (*Liteinoe Delo* (*Foundry Practice*), **1935**, (4), 17–20).—[In Russian.] The production of aluminium pistons at the Gorkovsk motor works is described.—N. A.

**The Influence of Silicon on Aluminium in the Presence of Other Elements.** V. M. Pljazkiy (*Liteinoe Delo* (*Foundry Practice*), **1935**, (3), 35–37).—[In Russian.] The influence of silicon on the casting properties of aluminium is discussed with reference to the reduction of shrinkage cavities, internal stress, and heat capacity.—N. A.

**Aluminium–Copper Alloys. Foundry Practice and Properties.** —— (*Met. Ind.* (*Lond.*), 1935, **47**, 368–371, 391–394).—Abstract of a report by the Non-Ferrous Division of the American Foundrymen's Association through its Recommended Practice Committee.—J. H. W.

**Melting Non-Ferrous Alloys [Brasses and Bronzes] in a Cupola-Type Furnace.** W. C. Alvin (*Trans. Amer. Found. Assoc.*, 1934, **42**, 737–742; discussion, 742–744).—Cupolas such as are used in iron foundries may be used satisfactorily in large bronze and brass foundries provided that a suitable fume plant is provided for removing the zinc oxide from the flue gases. The furnace is operated with by-product pitch coke using a metal : fuel ratio of 12 : 1 and tapping is continuous 75 minutes after starting the furnace. Losses of lead and zinc during melting are made up by adding the requisite amount to the casting ladle. This method of melting is more convenient for continuous pouring, more flexible as regards output, and more economical than any other method.—A. R. P.

**The Production and Control of Bronze Castings.** Francis W. Rowe (*Met. Ind.* (*Lond.*), 1935, **47**, 459–462; discussion, 462–465, 475).—Abstract of a paper read before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, Birmingham Metallurgical Society, and Staffordshire Iron and Steel Institute).—J. H. W.

**Deoxidation and Degasification of Non-Ferrous Casting Alloys: General Principles. An Introduction to Symposium.** C. H. Lorig (*Trans. Amer. Found. Assoc.*, 1934, **42**, 152–159; also (summaries) *Met. Ind.* (*Lond.*), 1935, **46**, 530–532; and *Found. Trade J.*, 1935, **52**, 173–174).—Present knowledge of the subject is briefly reviewed with especial reference to the effects of moisture in the furnace atmosphere, the solubility of hydrogen in metals and means for its elimination.—A. R. P.

**Deoxidation and Degasification of Red Brass and Bronze.** Committee of the A.F.A. Non-Ferrous Division (*Trans. Amer. Found. Assoc.*, 1934, **42**, 160–172; also (summaries) *Met. Ind.* (*Lond.*), 1935, **46**, 532–534, 543; and *Found. Trade J.*, 1935, **52**, 411–412).—Recent work is reviewed with especial reference to the effects of sulphur and hydrogen in causing porosity, and to the action of silicon and aluminium on the shrinkage of castings. A *bibliography* of 70 references is appended.—A. R. P.

**Deoxidation and Degasification of Yellow Brass.** L. A. Ward (*Trans. Amer. Found. Assoc.*, 1934, **42**, 173–183; also (summaries) *Met. Ind.* (*Lond.*), 1935, **46**, 597–598; and *Found. Trade J.*, 1935, **52**, 89).—From a review of the effects of the various metals present in common yellow brass W. concludes that aluminium, silicon, manganese, phosphorus, lithium, and calcium when added as deoxidizers can have no other effect than to increase the fluidity; their deoxidizing effect is probably nil since the metal is effectively deoxidized by the zinc present. Steam and hydrogen are the most deleterious gases in brass, the former being introduced with damp scrap and the latter occluded in electrolytic copper; the best method for their elimination is to keep the casting temperature as low as possible. Air inclusions may be prevented by avoiding too vigorous a stirring of the metal and too turbulent casting.—A. R. P.

**The Use of Charcoal in the Non-Ferrous Foundry.** R. J. Keeley (*Trans. Amer. Found. Assoc.*, 1934, **42**, 184–190; and (summary) *Met. Ind.* (*Lond.*), 1935, **46**, 599–600).—Charcoal should be placed on the bottom of the crucible before charging the metal when melting brasses or bronzes in pit furnaces; when the metal is molten the crucible is removed from the furnace, the entire inner surface scraped lightly to release small particles of charcoal from below the metal surface, and, after imparting a whirling motion to the metal, the dross and charcoal removed completely before pouring. When using oil- or gas-fired reverberatory furnaces the charcoal should be placed in the bottom of the ladle used to transfer the metal to the moulds so that the reducing action of the gases generated by the charcoal neutralizes the oxidizing effect of the furnace atmosphere. Charcoal should never be used in electric arc furnaces as it tends to " gas " the metal.—A. R. P.

**Discussion—Symposium on Deoxidation and Degasification of Non-Ferrous Casting Alloys.** —— (*Trans. Amer. Found. Assoc.*, 1934, **42**, 191–198).—A discussion on the 4 papers abstracted above.—A. R. P.

***Deoxidation of Bronzes by Phosphorus.** Hideo Nishimura (*Suiyokwai-Shi*, (*Trans. Min. Met. Alumni Assoc.*), 1935, **8**, 751–762).—[In Japanese.] The oxide contents of copper and bronzes were estimated by the hydrogen-reduction method. It is concluded that the reduction should be made for 4 hrs. at 900° C. The tin oxide in bronzes can be estimated in a similar way to that for copper oxide in copper. Industrial bronzes do not contain more than 0·3% of tin oxide and usually about 0·1%. When such oxidized bronze is deoxidized by phosphorus, a certain amount of phosphorus always remains in the alloy. S. discusses, from the theoretical point of view, the reason why the deoxidation by phosphorus should be carried out before the addition of tin.

—S. G.

**Copper Alloys. Influence of Melting Losses on the Cost. General Considerations on the Melting and Sand-Casting of Bronze.** A. Brizon (*Bull. Assoc. tech. Fonderie*, 1934, **8**, 2–8).—The lay-out of a bronze foundry is shown diagrammatically and the various operations are discussed in detail. Casting should be done at as low a temperature as possible having regard to the complexity of the pattern, and always while the temperature is still rising; for the 83 : 7 : 5 : 5 copper–tin–lead–zinc alloy the best casting temperature is 1180° C.—A. R. P.

**Some Factors which Influence the Compactness and the Soundness of Ferrous and Non-Ferrous [Bronze] Castings.** E. Longden (*Bull. Assoc. tech. Fonderie*, 1934, **8**, 384–395; also (summaries) *Found. Trade J.*, 1934, **51**, 87–88, 117–123; *Met. Ind.* (*Lond.*), 1934, **45**, 129–130; and *Rev. Fonderie moderne*, 1934, **38**, 235).—The subject is discussed chiefly with reference to cast iron, but brief notes on the absorption of gases by bronze during melting are included.

—A. R. P.

**On the Preparation of Oxide-Free, Dense Castings of Bronze Ingots from Reverberatory Furnaces.** Richard Thews (*Metall-Woche*, 1935, **1**, 1–3).—The scrap metal is first melted under a glass slag, the copper is then added, and the charge deoxidized with phosphor–copper before adding first any zinc necessary and then the tin. Sulphur is removed by adding sodium carbonate and manganese peroxide to the slag and stirring vigorously. The metal should be tapped from the bottom of the furnace into a ladle, the surface of the metal being kept covered with the slag during tapping to prevent gas absorption from the fire gases. About 0·2–0·5% of 10% phosphor–copper should be added to the metal in the ladle to complete the deoxidation, the metal allowed to stand quietly for 1–2 minutes, the slag skimmed off, and the metal covered with coarse lumps of charcoal before casting.—A. R. P.

**Production of Sound Bronze Ingots. Problems of Deoxidation and Degasification.** Edmund R. Thews (*Met. Ind.* (*Lond.*), 1935, **47**, 419–422).—Discusses the contamination of scrap, premelting, the effect of firing method, oxidizing effect of fuel gases, order of charging, fluxes for bronze melting, casting methods, and preparation of moulds.—J. H. W.

**The Casting of Carillon Bells.** —— (*Cuivre et Laiton*, 1935, **8**, 231–233).—An illustrated description of special casting methods and the steps which are taken to obtain a correct range of tones. The use of a new alloy containing copper 77, tin 21, chrome–nickel 1% is mentioned. The introduction of the chrome–nickel is said to give a higher and purer tone.—W. A. C. N.

**Porosity in Leaded-Bronze Bushings.** A. W. Lorenz (*Trans. Amer. Found. Assoc.*, 1934, **42**, 311–322; also (summaries) *Met. Ind.* (*Lond.*), 1935, **46**, 621–623; and *Found. Trade J.*, 1935, **52**, 377–378).—The chief types of porosity met with in leaded-bronze bushings are blowholes and shrinkage voids, the former being generally due to too low a casting temperature or to the entrapment of gas caused by the metal flow in the mould. An investigation of the cause of porosity in a large bushing indicated that incorrect gating was the cause of the trouble, and that most mould washes also produce porosity in heavy castings. Tests on an alloy of copper 80, tin 7, and lead 13% showed that addition of 1 oz. of phosphor–copper or 1 lb. of zinc per 100 lb. of melt was sufficient to produce undesirable shrinkage in heavy sections, from which it is concluded that over-reduction is the cause of most shrinkage troubles. —A. R. P.

**Bearings of Lead–Bronze.** L. M. Marienbach (*Liteinoe Delo* (*Foundry Practice*), **1935**, (2), 31–38).—[In Russian.] Methods of casting bearing bushes of lead–bronze in American and Russian works are described, with special reference to centrifugal casting, the use of a reducing atmosphere without fluxes, the mass production of bearings, and the Schoop process.—N. A.

**Special Methods of Casting of Magnesium Alloys.** A. S. Lugaskov (*Liteinoe Delo* (*Foundry Practice*), **1935**, (4), 13–16).—[In Russian.] Chill- and pressure-casting methods as applied to magnesium alloys are reviewed.—N. A.

**Cast Magnesium Alloys.** A. S. Lugaskov (*Liteinoe Delo* (*Foundry Practice*), **1935**, (3), 15–18).—[In Russian.] A review.—N. A.

**On the Melting Treatment of Silver for Casting.** E. R. Thews (*Metall-Woche*, 1935, **1**, 41–42, 62–63).—In melting sterling silver it is recommended to place the copper granules in the bottom of a graphite crucible and cover this with 12 times as much silver; the whole is then covered with coarse wood charcoal and heated to 1200°–1250° C., the charcoal removed, and the metal covered with a boric acid–borax mixture through which 0·2–0·3% of 15% phosphor–copper is added to deoxidize the melt. Finally a small amount (0·3–0·4%) of zinc or cadmium is added to prevent oxidation of the copper during casting and subsequent heat-treatment. The charcoal layer added during melting may be replaced advantageously by a mixture of potash and charcoal.—A. R. P.

**Melting and Casting Temperatures of the White Bearing Metals.** E. Richards (*Metall-Woche*, 1935, **1**, 77–78, 97–98).—Melting, casting and mould temperatures, and the mechanical properties of the resulting castings are given for 4 tin-base and 7 lead-base bearing alloys with brief notes on the best methods of melting and casting.—A. R. P.

**Preparation and Properties of Britannia Metal.** —— (*Metall-Woche*, 1935, **1**, 5–6).—An historical survey of the development of pewter alloys.—A. R. P.

**Aluminium Die-Castings and Their Field of Usefulness in the Telephone Industry.** François van Laethem (*Elect. Communication*, 1935, **14**, 121–132).—An account is given of the construction and operation of an aluminium die-casting machine, and the chief factors affecting the design of the castings are briefly reviewed. Die-castings now in use in the telephone industry include rotary system selector and brush carriage frames, line-finder switches, sequence switch frames, subscriber set housings, and finger- and back-plates for dials. Illustrated descriptions are given of these and of the moulds used in their manufacture.—J. C. C.

**Die-Casting—What the Industry Has Learned and Given to Others.** Sam Tour (*Min. and Met.*, 1935, **16**, 82–85).—A review.—A. R. P.

**Which Alloy for Die-Castings ?—I–II.** Herbert Chase (*Machinist* (*Eur. Edn.*), 1935, **79**, 601E, 615–616E).—(I.—) The properties and applications of zinc-, aluminium-, copper-, lead-, tin-, and magnesium-base die-casting alloys are briefly described. (II.—) The nominal composition, properties, and applications of a number of alloys for die-castings are tabulated.—J. H. W.

**Aluminium Coatings for [Sand] Cores.** M. Desplats (*Bull. Assoc. tech. Fonderie*, 1934, **8**, 532).—Core dressings of linseed oil containing aluminium powder assist in obtaining good castings with a smooth surface.—A. R. P.

**Sand Problems in a Brass Foundry.** F. Howitt (*Found. Trade J.*, 1935, **53**, 241, 244).—A report of the discussion on H.'s paper and his reply. See *Met. Abs.*, this vol., p. 394.—J. H. W.

**Flowability of Moulding Sand.** H. W. Dietert and F. Valtier (*Trans. Amer. Found. Assoc.*, 1934, **42**, 199–206; discussion, 206–210).—Flowability is defined as the property which enables sand to flow under the application of ramming energy; it can be determined by measuring the amount of movement of the sand grains after an initial ramming. Flowability is increased by a decrease in moisture, in clay content, in green-sand strength and in green permeability and by an increase in grain fineness. Addition of sea-coal to a sand decreases its flowability.—A. R. P.

**Specification for Foundry Sands for Use in Foundry of U.S. Naval Gun Factory.** —— (*U.S. Navy Yard, Naval Gun Factory Publ.* **O.S. 791**, 1935, 7 pp.).—S. G.

**The Circulation of Moulding Sand in Foundries.** A. Rodehüser (*Giesserei*, 1934, **21**, 425–429).—S. G.

**Selecting Foundry Conveying Equipment.** R. J. Heisserman (*Trans. Amer. Found. Assoc.*, 1934, **42**, 565–574; discussion, 575–576).—A suitable installation for the mechanical handling of foundry materials is outlined and its operating and maintenance costs are discussed.—A. R. P.

**Foundry Maintenance.** Jas. Thomson (*Trans. Amer. Found. Assoc.*, 1934, **42**, 633–648; discussion, 649–654).—A typical organization for a maintenance department of a large foundry using standardized equipment is described with especial reference to record-keeping.—A. R. P.

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

(Continued from p. 536.)

**Smelting Complex Type Ashes.** C. C. Downie (*Chemistry and Industry*, **1934**, 996–998).—Describes a method for smelting waste metallic materials from printing works.—S. G.

## XV.—FURNACES AND FUELS

(Continued from pp. 536–537.)

**Notes on Heating Furnace Economy and Operations.** M. H. Mawhinney (*Metal Progress*, 1935, **28**, (4), 33–34, 38).—Important factors in estimating furnace costs are: design and operation of conveyors, life of linings and metal parts, maximum permissible rate of heating, operating temperature, and energy equivalent of fuel. The latter, together with the approximate working temperature, is tabulated for the case of a variety of operations involving ferrous and non-ferrous metals. A table shows the relation of various fuels to electricity in respect of cost, calorific value and temperature range.—P. M. C. R.

**Modern Equipment Used in Crucible Melting.** Richard H. Stone (*Trans. Amer. Found. Assoc.*, 1934, **42**, 265–277; discussion, 278; and (summary), *Met. Ind.* (*Lond.*), 1935, **46**, 671–673).—Cf. *Met. Abs.*, this vol., p. 481. Modern types of gas- and oil-fired crucible furnaces for melting brass, bronze, and aluminium are illustrated and discussed and recent advances in refractory linings are briefly described.—A. R. P.

**Gas Heating for Brass Melting.** G. E. Thomas (*Gas Times*, 1935, **11**, (19), 30–31; *Bull. B.N.F.M.R.A.*, 1935, (78)).—Gives detailed results obtained in a works' test: gas consumption, temperatures reached, time required, &c.—S. G.

**Some New Data on the Fundamentals of Gas Combustion.** E. O. Mattocks (*Metal Progress*, 1935, **28**, (4), 21–26).—Smaller furnaces are rendered practicable by improved furnace and burner design, which substantially increase the amount of gas burned per cubic foot of furnace space. Initial cost and radiation losses should thus be minimized. The dissociation of water vapour and of carbon dioxide can be obviated by premixing the fuel-gas with air: the requisite proportions are shown in a series of curves for natural gas and coke-oven gas under various conditions of preheating and flue-gas temperature. The oxygen content of the flue-gas may be used to determine the proportion of excess air. Maximum turbulence is ensured by using the maximum number of burners: the danger of pre-ignition is minimized by reducing the size of the ports.—P. M. C. R.

***The Combustion Balance.** A. R. Leye (*Feuerungstechnik*, 1935, **23**, 102–105).—The significance of the " balance equation of combustion " suggested by L. is discussed and its application as a means of control of combustion is described and illustrated by diagrams, employing tri-linear co-ordinates, referring to the combustion of coal and coke-oven gas.—J. S. G. T.

**The Regenerative Air Preheater.** —— (*Fuel Economist*, 1935, **11**, (121), 20–23).—The Ljungstrom air pre-heater, comprising a continuously-rotating drum containing the heating surface built of mild-steel elements or plates arranged in sections each of which passes in turn through the heat-absorbing zone then through the heat-releasing zone, the cycle being repeated as long as desired, is described and illustrated.—J. S. G. T.

**Different Methods of Bright-Annealing.** —— Rippert (*Draht-Welt*, 1934, **27**, 643–645).—The majority of the methods described depend on the loss of air from the annealing box during the heating process, and the consequent freedom from oxidation of the annealed material over this period. Protection during cooling may be afforded by a special hood with controlled atmosphere, by the burning of an excess of hydrocarbons within the hood, by the displacement of air by neutral gases, or simply by the preservation of a partial vacuum in the box during cooling. The tube-annealing process is stated to be more rapid than most other methods, and to ensure unusual constancy of temperature during the annealing period.—P. M. C. R.

**Practical Experience in the Bright-Annealing of Copper Wire by the Box Method in Tubular Electric Furnaces, with Subsequent Tempering.** H. Hillger (*Draht-Welt*, 1935, **27**, 659–660).—The electric is compared with the coal-fired furnace in respect of cleanliness, temperature control, transport costs of fuel and waste products, durability, and necessary thickness of box and lagging. The electric tube furnace and its method of operation are briefly described, with some details regarding output and power consumption. The process is recommended for very fine copper wire intended for electrical apparatus.—P. M. C. R.

**Electric Furnaces at the Paris Mint.** —— (*Electrician*, 1935, **115**, 9). —S. G.

**Graphite Resistor Radiation Furnaces.** Henri George (*Met. Ind.* (*Lond.*), 1935, **47**, 469–470).—Abstract of a paper read at the International Foundry Congress in Brussels. See also *Met. Abs.*, this vol., p. 482.—J. H. W.

**High-Frequency Induction Furnaces in Modern Metallurgical Practice.** N. Frati (*Elettrotecnica*, 1934, **21**, 828–832; *Sci. Abs.*, 1935, [B], **38**, 71).—F. distinguishes between furnaces employing a magnetic core carrying the primary winding with the material to be melted forming a closed secondary circuit and those in which there is no core and the primary winding is placed outside the crucible containing the metal. The former type is suitable for low frequencies while the latter is operated at frequencies varying from 350 to 20,000 cycles per second. The article is mainly devoted to a description of the latter type and describes, with illustrations, the necessary equipment of H.-F. generators, static condensers, water-cooled heating coils, and control circuits. F. discusses the advantages possessed by the H.-F. type of furnace, the energy consumption of which is stated to be from 650 to 500 kWh. per ton for furnaces of 0·5–4 tons capacity.—S. G.

**Electric Heat in the Non-Ferrous Metal Industry.** [Fr.] Knoops (*Elektrowärme*, 1935, **5**, 151–155).—See also *Met. Abs.*, this vol., p. 254. Induction, resistance, and rocking-arc furnaces for melting metals and various types of electric furnaces for the heat-treatment of non-ferrous metals are described and illustrated.—A. R. P.

**Electric Furnaces.** C. Wilwertz (*Bull. Soc. Belg. Élect.*, 1934, **50**, 417–438; *Sci. Abs.*, 1935, [B], **38**, 14).—An exhibition of modern electric furnaces was held at Liége in 1934. The exhibits included arc furnaces in which improved methods of charging and control of electrodes are incorporated; furnaces for numerous special metallurgical purposes; H.-F. induction furnaces; special furnaces for annealing and heat-treatment. The field for expansion in the use of electric furnaces in Belgium is particularly favourable on account of the highly organized and co-ordinated methods in force for the production of electrical energy.—S. G.

**Electric Furnaces.** S. Sammarco (*Elettrotecnica*, 1935, **22**, 395–407; *Sci. Abs.*, 1935, [B], **38**, 442).—S. gives a general review of the types of electric furnace most widely used in Italy, including the direct and indirect arc, H.-F. and L.-F. induction and resistance types; describes the construction and operation of these furnaces and discusses their suitability for various classes of work together with their relative installation costs and economy of performance. The article is illustrated with photographs of furnace plants installed by the Società Metallurgica Italiana.—S. G.

**The Accuracy of Combustion Calculations.** Wilhelm Gumz (*Feuerungstechnik,* 1935, **23**, 109–110).—Account being taken of the true composition of the air and assuming a humidity of the air equal to 80% at 20° C. it is shown that combustion calculations relating to coal in which the composition of the air is assumed to be oxygen 21, nitrogen 79%, and humidity is neglected, may be in error by about 1–2%.—J. S. G. T.

## XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from pp. 537–538.)

***Small Cast Thorium Oxide Crucibles.** H. K. Richardson (*J. Amer. Ceram. Soc.*, 1935, **18**, 65–69).—Crucibles were made from thorium oxide by casting from a slip made according to ceramic practice; the presence of cryolite in the slip ensured its successful use. These were fired to 1885° C. in a gas-fired furnace of special construction. The addition of zirconium oxide makes a crucible easier to manufacture. The finished crucibles were used successfully in vacuum-induction furnaces to melt pure metals to 2300° C. No contamination of the metals resulted. Expansion curves indicate a peculiar action of the crucibles made with zirconium oxide in the 700°–900° C. region. The mean coeff. of expansion of fused thoria is found to be $93 \times 10^{-7}$ from 0° to 600° C. These crucibles are (*a*) fairly resistant to chemical reagents, but not enough for chemical work, and (*b*) resistant to wetting by molten metals of high melting point.—S. G.

**German Crucible Graphite.** Erich Buchholtz (*Ber. deut. keram. Ges.*, 1935, **16**, (1), 19–26).—S. G.

**Specialized Electric Furnace Refractories.** J. A. King (*Metal Progress*, 1935, **28**, (4), 27–31).—A comparative table gives the loss by spalling and by high-temperature abrasion, the cross-breaking strength at 20° and 1350° C., and the thermal conductivity between 595° and 1350° C., of silicon carbide, fused alumina, and 7 commercial refractories in general use. The manufacture and special applications of silicon carbide and fused alumina refractories are described. It is stated that a coating of silicon carbide cement gives excellent results when applied to high-temperature insulating brick of kaolin or of material of equivalent quality.—P. M. C. R.

**Electric Furnace Refractories in the Brass Industry.** H. M. St. John (*Metals and Alloys*, 1933, **4**, 183–191).—S. G.

**Refractories for Foundry Use.** W. J. Rees (*Brit. Clayworker*, 1935, **44**, 188–190; and *Engineering*, 1935, **140**, 289–290; *C. Abs.*, 1935, **29**, 7602).—Refractoriness under load is diminished with an increase in alumina. The $Fe_2O_3$ content should be kept to a minimum, because of the action of carbon monoxide. Refractories should be chosen with the following characteristics: absence of black cores, abrasion, glaze and corrosion-resistance and low volume change in service, and they should be well made.—S. G.

**Recent New Refractory Products.** —— (*Fuel Economist*, 1935, **11**, (121), 36).—Reference is made to various patching cements, sillimanite and mullite bricks, and diatomite refractories.—J. S. G. T.

***The Reliability of Measurements of the Thermal Conductivity of Refractory Brick.** J. B. Austin and R. H. H. Pierce, Jr. (*J. Amer. Ceram. Soc.*, 1935, **18**, 48–54).—S. G.

## XVII.—HEAT-TREATMENT

(Continued from p. 538.)

**Heat-Treatment of Metals.** P. Schoenmaker (*Chem. Weekblad*, 1932, **29**, 682–686; *Brit. Chem. Abs.*, **1933**, [B], 108).—A general account of the influence of heat-treatment on the mechanical properties and microstructure of steels and Duralumin, and particularly of the slow changes which occur on " soaking."—S. G.

**Heat-Treatment in Magnetic Fields.** G. A. Kelsall (*Bell Lab. Record*, 1935, **14**, 26–28).—By applying a magnetic field to samples of 78·5 (% nickel) Permalloy or Perminvar whilst they are slowly cooled from above the Curie point, very high values of maximum permeability are produced in the direction of the applied field. The greatest effects are obtained with fields of 1·5 oersteds for 78·5 Permalloy and 20 oersteds for Perminvar. See *Met. Abs.*, 1934, **1**, 419.—J. C. C.

**Investigations of Nitrate Melts in Heat-Treatment Baths.** B. Pretsch (*Metallwirtschaft*, 1935, **14**, 798).—Correction of a printer's error in the original paper (*Met. Abs.*, this vol., p. 538).—v. G.

**Alloy Containers for Heat-Treating in Liquid Baths.** F. K. Ziegler (*Metal Progress*, 1935, **28**, (4), 59–63).—The life of containers for fused chlorides or cyanides or for molten lead depends to some extent on the composition of the material, but its absolute soundness is of much greater importance. The most suitable compositions are stated to be (*a*) nickel 35–40, chromium 12–15%, remainder iron; (*b*) nickel 60–65, chromium 12–15%, remainder iron; (*c*) nickel 8–10, chromium 25–30%, remainder iron. The last type is resistant to sulphur attack, but is liable to crack if the thermal cycle is too rapid; it is mainly used in oil-fired furnaces.—P. M. C. R.

**Grain-Distortion in Metals During Heat-Treatment.** (Nusbaum and Goss.) See p. 586.

**Influence of Temperature and Time of Annealing on the Structure and Mechanical Properties of 67 : 33 Brass Sheets After Various Degrees of Cold-Work.** (Loskiewicz, Guschlbauer, and Mosowicz.) See p. 574.

## XVIII.—WORKING

(Continued from p. 538.)

†**Advances in the Knowledge and Operation of Processes of Plastic Deformation.** E. Siebel (*Metallwirtschaft*, 1935, **14**, 893–897).—A summary of recent work.—v. G.

***Power Consumption in Forging and Pressing Aluminium Alloys.** A. v. Zeerleder and R. Irmann (*Z. Metallkunde*, 1935, **27**, 145–148; and (translation) *Light Metals Research*, 1935, **4**, 36–44; (summary) *Met. Ind.* (*Lond.*), 1935, **47**, 350–353).—Duralumin requires more power for hot-rolling (450° C.) than does steel (1100° C.), whereas pure aluminium and Anticorodal require much less power. For extruding angle sections the pressure required for aluminium at 475° C. is 40–30, for Anticorodal at 475° C. 75–40, for Peralumin 7 at 420° C. 100–70, and for Avional at 440° C. 85–80 kg./mm.$^2$, the higher figure in each case being the power necessary to start the extrusion. The power consumption in forging aluminium alloys is increased only slightly by addition of copper or magnesium silicide but very greatly by addition of magnesium. Manganese also increases the power consumption in forging aluminium alloys containing magnesium and copper. Three dimensional diagrams are given showing the relation between forging power, forging temperature, and composition for various aluminium alloys.—A. R. P.

***†A Research into Tests for Materials Used in Cold-Pressing Operations, with Special Reference to the Fluid-Pressure Cupping Test.** H. J. Gough and G. A. Hankins (*Proc. Inst. Automobile Eng.*, 1934–1935, **29**, 543–581).—Mechanical tests for sheet metal used in pressing operations are reviewed. Among tests referred to are the Jovignot fluid-pressure cupping test, the Erichsen test, the Avery test, the Guillery test, the A.E.G.-type test, the K.-W.-I. test, and, more especially, a comparatively new form of fluid-pressure cupping test developed at the National Physical Laboratory, which, though not yet fully explored, appears to possess some advantages, and may be of service to industry as a simple and practical test. Tests on a large number of materials are reported. Very valuable information relating to the suitability of a metal for cold-pressing operations can be derived from a load–extension diagram; such diagrams are much more discriminating than the usual tensile test data or the bursting stress and "cupping coefficient" obtained from a cursory fluid-pressure cupping test. A *bibliography* of 41 references and 4 specifications is appended.—J. S. G. T.

**†Cold-Pressing and Drawing—The Metallurgical Aspect.** C. H. Desch (*Proc. Inst. Automobile Eng.*, 1934–1935, **29**, 582–587).—The characteristics of metals and alloys used in cold-pressing and drawing, the nature of the processes, and the stresses involved are briefly reviewed. The greater part of the paper is concerned with steel. Methods of achieving the desired grain-size and texture in the metal, the production of an unoxidized surface during annealing, and applications of ductile stainless steels are discussed. A *bibliography* of 13 references is appended.—J. S. G. T.

**†New Researches on the Drawing of Cylindrical Shells.** G. Sachs (*Proc. Inst. Automobile Eng.*, 1934–1935, **29**, 588–600).—The following factors, of importance in recent developments of deep-drawing, are briefly discussed: the clearance between punch and die; tool form and drawing capacity; blank holder and drawing capacity; stresses and strains in deep-drawing; testing of sheet ductility. A *bibliography* of 39 references is appended.

—J. S. G. T.

**Discussion on "Cold-Pressing and Drawing."** —— (*Proc. Inst. Automobile Eng.*, 1934–1935, **29**, 601–630).—*W. H. Hatfield* considered that progress in cold-pressing operations will be determined entirely by improvements in the control of the microstructure and in the surface of the sheet or strip. *H. W. Brownsdon* referred to difficulties in the manufacture of the material and its subsequent drawing. *G. C. Richer* expressed doubt as to the possibility of any one simple form of test conclusively indicating the suitability of a material for deep-drawing. *J. C. Arrowsmith* was of the opinion, based on Gough and Hankins' work, that no *single* test as yet provides the desired information. *A. Allison* thought it might be possible to specify an acceptance test for a particular pressing. *J. R. Handforth* was doubtful whether tests of the cupping type were satisfactory tests for indicating the behaviour of materials in service. *W. R. D. Jones* drew attention to the Jenkins' bend tester. *E. R. Mort* rather favoured the Jovignot test. *G. A. Hankins* drew attention to tests included in British Standard Specifications for sheet and strip materials. *G. L. Kelley* was of the opinion that the K.-W.-I. test would, in certain conditions, be more useful than the Jovignot test. *M. Cook* directed attention to the fact that the success of a pressing operation is determined just as much by the conditions of pressing as by the properties of the pressed material. *H. H. Stanley* referred to the occurrence of stretcher–strain bands consisting of alternate strained and unstrained regions in stretched material. *J. W. Berry* was of the opinion that the results of research on fluid-cupping tests are inconclusive. *T. Swinden* thought the fluid-cupping test had certain advantages over other types of tests. *H. J. Pollard* thought the results contained in the papers indicated that exhaust manifolds of aircraft engines might profitably be manufactured by deep-drawing. *E. Coupland* expressed disappointment with the existing state of affairs in cold-pressing production and suggested a classification of pressings. *A. B. Winterbottom* suggested the possibility of making instantaneous measurements of temperature- and pressure-distribution throughout a pressing. The several authors replied to the discussion.—J. S. G. T.

***The Influence of Lubrication on the Stretching of Metal During Rolling.** Ig. M. Pavlov and I. S. Gallay (*Metallurg* (*Metallurgist*), **1935**, (7), 3–30).—[In Russian.] Compression tests on cylinders with a co-ordinate net indicate that the lubricant reduces the volume of the strained portion and consequently increases the deformation of the metal. The effect of lubrication on deformation was determined by comparing the stretching of a lubricated, with that of a dry, strip. The width of the strip above 40 mm. has no influence on the effectiveness of the lubricant; with narrower strips the effect of the lubricant decreases with reduction in width. Lubrication increases the stretching of the metal by up to 100% for iron, somewhat less for brass and copper, and least for aluminium. The greater the fatty acid content of the lubricant, the greater is the stretching. The best oils, therefore, are the vegetable and animal oils (castor oil, hempseed oil, and lard), and the worst the mineral oils (engine oil, paraffin). The heavier the pressure and the more strongly the metal is hammered, the more effectively does the lubricant influence the stretching. When the strip is oiled only on one surface, it bends over towards the other. The investigation has demonstrated the practical importance of lubrication.—N. A.

**The Resistance to Deformation During Hot-Rolling of L–62 Brass.** L. G. Roshkovskiy (*Metallurg* (*Metallurgist*), **1935**, (7), 31–43).—[In Russian.] Determinations of the resistance to deformation during the hot-rolling of brass in a high-speed mill, indicate that, other conditions being equal, it increases with increasing compression and with decrease in the thickness of the metal.—N. A.

**[Discussion on] The Hot-Rolling of Sheets.** —— (*Met. Ind.* (*Lond.*), 1935, **47**, 487–488).—Abstract of an open discussion before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, Birmingham Metallurgical Society, and Staffordshire Iron and Steel Institute).—J. H. W.

**Faults in the Production of Silver Sheets.—III.** E. Raub (*Mitt. Forschungsinst. Edelmetalle*, 1935, **9**, 69–75).—The faults which develop during casting and working ingots of 835-fine silver when the casting temperature is too high or too low are illustrated and briefly discussed.—A. R. P.

***The Drawing Process in Polar Co-Ordinates.** V. Zverev (*Metallurg* (*Metallurgist*), **1935**, (4), 100–102).—[In Russian.] If the drawing process is considered as linear and the stresses as equally distributed over the surface of a sphere the following expression describes the process in polar co-ordinates: $\sigma = k\left(1 + \frac{\tan\alpha}{\mu}\right)\left[1 - \left(\frac{D}{D_0}\right)^{2\mu/\tan\alpha}\right]$ and the drawing force is given by the expression: $P = \sigma\pi D^2/4$.—N. A.

**Safety Appliances in Cold-Rolling.** Karl Rohling (*Kalt-Walz-Welt*, **1935**, (9), 65–66).—Precautions regarding the screening of moving parts, the prevention of overloading and consequent short-circuits in the case of motors, and the provision for rapid stoppage in case of accidents are enumerated. Pickling requires special safeguards in respect of ventilation, especially where the evolution of arsenic trihydride is likely: most ventilating hoods are only partially effective, and R. prefers the use of chemical additions to the bath. These minimize or prevent the evolution of gas, and may be used in conjunction with either hydrochloric or sulphuric acid. Certain types of protective clothing are briefly described.—P. M. C. R.

**Demag Sheet-Metal Rolling Mills.** —— (*Demag News*, 1935, 9, 17–20).—A description with illustrations is given of various types of 2- and 3-high rolling mills for thin sheets.—A. R. P.

**Modern Wire-Drawing.** Ch. Bernhoeft (*Draht-Welt*, 1935, 28, 627–631, 645–647, 661–662).—A survey of the necessary machinery, dies, furnaces, and other equipment of a modern wire-drawing plant, with suggestions regarding dimensions and estimates of the probable output for various types of work, together with fuel consumption and average loss of material.
—P. M. C. R.

**The Manufacture of Aluminium Wire.** Adam Zuerner (*Draht-Welt*, 1935, 28, 355–356).—Aluminium of 96–98% purity is used in the production of electrical conductors and of wire fabric. The material is cast in cylindrical ingots, annealed at 320° C., and extruded at that temperature; the product is then ready for finer drawing, the various stages of which are described. Directions are given for annealing and pickling.—P. M. C. R.

**Reduction of Area and Breaking Stress in the Cold-Drawing of Copper.** —— (*Draht-Welt*, 1935, 28, 35–36).—The relation between breaking stress and reduction of area has been examined in the case of copper of high electrical conductivity (copper 99·963%, remainder oxygen) under the following conditions: single draws with increasing load, continuous draw of medium severity, continuous light draw, and severe single draw.—P. M. C. R.

**Grooving and Power Consumption in the Rolling of Copper Wire.** Ch. Bernhoeft (*Draht-Welt*, 1935, 28, 307–309, 323–325, 339–341).—A semi-automatic installation is considered from the standpoint of electric power consumption, as influenced by the form and dimensions of grooving, size and condition of the original bars, running time, and reduction to be effected by each pass; a comparison is made of practical and calculated reductions. Idle running is obviated by a suitable lay-out, an example of which is described. The optimum order of operation of a series of rolls of square and oval grooving (dimensions given) is indicated. The electric power consumption of a large installation is estimated at 60% of that of a small plant, whilst the corresponding consumption where the prime mover is steam is shown to be much higher. This observation is confirmed by reference to the production of aluminium wire.—P. M. C. R.

**The Diamond as a Tool Material.** Carl Michael (*Draht-Welt*, 1935, 28, 547–549).—The properties, occurrence, special varieties, and industrial applications of diamonds are described, and an account is given of the construction of diamond dies, which are used in the production of wire of very small diameter.—P. M. C. R.

**In What Respects are Hard Metal Dies Superior to Iron Dies?** Carl Michael (*Draht-Welt*, 1935, 28, 563–564).—Improved methods of manufacture have facilitated the production of "hard metal" and diamond dies of great hardness, density, and permanence of dimensions. Maintenance of such dies requires special skill, and on this account iron or steel dies are still preferred in some quarters, but the early brittleness associated with the "hard metal" group has now been eliminated. Dies of this type permit the use of several drawing rings in series, and the reduction per draw is increased. Suitable dimensions are suggested for various sizes of work.—P. M. C. R.

**Can the Shape of Die Orifices be Determined?** Carl Michael (*Draht-Welt*, 1935, 28, 611–613).—The drawing angle and the length of the cylindrical contact surface within the die can be determined accurately by examination of a sample of wire which has been partially drawn through the die, lightly etched on the zone of emergence, and subsequently pushed back. The cylindrical area and the drawing angle are then determined micrometrically; an optical system for rapidly performing the latter measurement is described and illustrated.—P. M. C. R.

**Does the Form of the Die Affect Its Life and Efficiency?** Carl Michael (*Draht-Welt*, 1935, **28**, 659–661).—Observations on the drawing of copper and of iron wire are cited to illustrate the importance of the " drawing angle," the influence of which on energy expended, the development of " cupping " and actual rupture of the wire is analyzed. The surface of the die in contact with the metal is shown to depend on the drawing angle and on the diameter of the die aperture, and suitable diameters are suggested for various sizes of die. These are necessarily subject to modification for different types of material. —P. M. C. R.

**Refractory Metals in the Electrical Industry. History, Metallurgy, and Uses [of Tungsten and Molybdenum].** P. Fustier (*Rev. Ind. minérale*, **1935**, (350), 325–342).—A review, especially of the method of manufacture of tungsten wire and sheet.—A. R. P.

**The Machining and Grinding of Monel Metal.** —— (*Henry Wiggin & Co., Ltd.*, **1935**, (MA3), 8 pp.).—Practical hints are given on the turning, drilling, threading, screwing, tapping, milling, and grinding of Monel metal. Turning tools should have a positive rake and a wide clearance angle. For screwing the metal should be used in the hard cold-drawn state with self-opening dies ground with a positive rake, and for grinding the best results are obtained with a " Borocarbone C 24 K " wheel.—A. R. P.

---

## XIX.—CLEANING AND FINISHING

(Continued from p. 539.)

**Cleaning Metal Surfaces and Removing Fats and Oils.** R. Plücker (*Seifensieder-Zeit.*, 1935, **62**, 558–559; *C. Abs.*, 1935, **29**, 6870).—Discusses the cleaning of metal surfaces by means of various agents (*e.g.* organic solvents, mixtures of sodium phosphate and water-glass) or by electrolysis.—S. G.

**Tested Cleaners for Dairy Plants.** Forrest Grayson (*Food Ind.*, 1935, **7**, 231–232, 281–282; *C. Abs.*, 1935, **29**, 7511).—$Na_2SiO_3 \cdot 5H_2O$ and soap solutions were effectively used on all kinds of dairy equipment. This substance is much less corrosive to tin than any other alkaline substance tried. Recommended concentrations are given for the various pieces of equipment. The usual recommended temperature of the solutions is 50°–60° C.—S. G.

***Tests on Washing Compounds for Use in the Canning Industry.—II.** Erling Mathiesen and Erling Mikkelsen (*Tids. Hermetikind.*, 1934, **20**, 185–192; *C. Abs.*, 1935, **29**, 7526).—The greatest surface was cleaned by a solution of a mixture of NaOH 2·8, soap 0·2, water-glass 14·1, and NaOCl 4·8 (Cl 2·3%), but this has some corrosive action. For general use, a mixture comprising essentially $Na_2CO_3$ and water-glass, with a little soap, is most effective for both tinplate and sheet aluminium.—S. G.

**Sandblasting.** R. E. Kunkler (*Metallizer*, 1935, **3**, (12), 6, 7).—K. discusses the most suitable machine and abrasives for sandblasting preparatory to metal spraying. Tables are given showing the approximate flow in lb./hr. of various abrasives through different nozzles, and the air-flow in ft.$^3$ through different-sized nozzles at various pressures.—W. E. B.

**Metallizing Surface Preparation.** F. G. Sharpe (*Metallizer*, 1934, **1**, (5), 6).—Discusses the merits of sand and shot blasting for cleaning preparatory to metal spraying and favours the use of angular steel grit when possible. Suitable grades of abrasive are mentioned.—W. E. B.

**The Wire Brush Industry.** J. E. Pinkes (*Draht-Welt*, 1935, **28**, 51–54).—The almost universal use of wire brushes in cleaning and finishing metal surfaces is attributed to the efficiency of the brush in entering crevices and cleaning re-entrants. The considerations governing the selection of brushes are illustrated by practical processes (the cleaning of copper plates, jewellery, boiler tubes, steam pipes, engineering structures). Suitable forms of brush and bristle are indicated in many instances. The principal methods of manufacture are described.—P. M. C. R.

**Finishing Zinc and Aluminium Die-Castings.** Herbert Chase (*Machinery* (*N.Y.*), 1935, **42**, 120–122, 181–184).—The relative costs of organic and electroplated finishes on die-castings are discussed. The preparation of the parts prior to plating is described and details given of baths suitable for nickel plating zinc- and aluminium-base die-castings. The general procedures in lacquering, japanning, varnishing, and enamelling are described.—J. C. C.

**The Colouring of Metals.** Harry MacFayden (*Monthly Rev.·Amer. Electroplaters' Soc.*, 1935, **22**, (11), 13–19; discussion, 19–21).—Small metal articles can be tinned by simple immersion for 20 minutes in a bath containing stannous chloride 2, sodium hydroxide 2·5, and sodium cyanide 1 oz./gall., or coppered by tumbling in a solution containing copper sulphate 2 and sulphuric acid 1 oz./gall. Methods of producing lacquer, Bakelite, and enamel finishes are also briefly described.—A. R. P.

**Colouring Brass Articles Black.** R. Liebetanz (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, **33**, 458–459).—The articles are degreased and copper-plated in a bath containing sodium carbonate 3·5, potassium cyanide 2·5, sodium hydroxide 3·5, copper cyanide 1·2, and sodium bisulphite 0·12%, using 5–8 v. at a c.d. of 2–5 amp./m.$^2$ for 2–3 minutes; they are then hung by brass (not iron) wires in a cold solution containing 200 grm. of basic copper carbonate dissolved in 1 litre of ammonia (*d* 0·91) and kept moving until the desired tint is obtained. The colour film may subsequently be stabilized by lacquering. —A. R. P.

**Grinding and Polishing the Light Metals.** F. Weiss (*Oberflächentechnik*, 1935, **12**, 151–152).—Practical hints.—A. R. P.

**Polishing in Drums.** F. Schwarz (*Oberflächentechnik*, 1935, **12**, 243–246).—Various types of polishing barrels are described and illustrated, and the compositions of liquids suitable for use in polishing various metals are given. For copper and its alloys the best solution is one containing soft soap 3, potassium carbonate 2, and sodium cyanide 1 kg./100 litres, and for aluminium and light alloys one containing soap flakes 3 and concentrated ammonia 1 kg./100 litres.—A. R. P.

**The Finishing of Metal Surfaces.** Rudolf Plücker (*Werkstatt u. Betrieb*, 1935, **68**, 257–259).—A tabulated summary is given of the various stages of polishing, ball-burnishing, grinding (*e.g.* of cylinders), ordinary burnishing, tumbling, and other processes, the special applications and characteristics of which are subsequently discussed.—P. M. C. R.

## XX.—JOINING

(Continued from pp. 539–541.)

**The Effect of Temperature Treatment on Glass-to-Metal Seals.** J. L. Littleton (*J. Amer. Ceram. Soc.*, 1935, **18**, 239–245).—It has been known for some time that glass cooled from well above the annealing temperature contracts at a rate depending on its cooling rate and the temperature from which its cooling begins. Expansion measurements on the glass during later heating do not follow the original contraction curve. A photoelastic method is described which gives information as to how the contraction of the glass is affected by these temperature considerations. The observations are of particular interest when applied to glass-to-metal seals.—S. G.

**Adherence of Glass to Metals.** Nelson W. Taylor (*Glass Ind.*, 1935, **16**, 243–246; *C. Abs.*, 1935, **29**, 7032).—Oxidation of the metal is an essential requirement for wetting the metal surface by the glass phase.—S. G.

**Soldering and Welding of Light Metals.** L. Rostosky (*Maschinenbau*, 1935, **14**, 321–322).—A brief review of modern procedures.—K. S.

**Soldering Aluminium Brass Joints.** F. H. Sims (*J. Sci. Instruments*, 1935, **12**, 233).—Aluminium foil is soldered to brass by means of "Kookaburra" solder applied to the former and ordinary solder applied to the latter. The joint though mechanically strong is generally not air-tight but can be made so by painting with amyl acetate lacquer.—J. S. G. T.

**Soldering Lead Cable Electrically.** —— (*Bell Lab. Record*, 1935, **14**, 65).—For repairing sheath defects in aerial cable, wiped joints may be superseded by electrical soldering. Current from a storage battery is led to a copper-plated carbon-rod anode, which is used to melt a stick of wire solder and manipulate the molten metal to fill the defect.—J. C. C.

**Practical Cable Jointing.** W. Rowland (*Mining Elect. Eng.*, 1935, **15**, 244–245).—The types of cable joints in use are briefly described.—S. G.

**The Manufacture of Assemblies by Means of Soldering.** Jon. Wenz (*Draht-Welt*, 1934, **27**, 611–613, 627–628).—Soldering is of great importance to the designer, as in cases where its effective use is possible it affords the cheapest and usually the most ornamental method of joining metal parts. The solder may be embedded in the material to be treated, and flow out on heating, but a cheaper method is to apply the heated solder externally. The selection of a suitable flux is discussed, and the most economical and rapid methods of working are illustrated by reference to 10 examples. Compositions of suitable solders for Tombak, Neusilber, silver, and gold are discussed, and the use of soldering powders is described. An illustrated description of the production of soldered chain is given, and the advantages of a recently developed wire-soldering process are emphasized in the case of metal fabric.—P. M. C. R.

**Some Considerations in Spot-Welding as Applied to Light Alloys.** G. Mandran (*Métaux*, 1935, **10**, 159–169).—After a study of R. H. Hobrock (see *Met. Abs.*, this vol., p. 362). The process of spot-welding light alloys and the effects of various factors, especially recrystallization, on the resulting weld are described.—J. H. W.

**Applications of Copper Welding. I.—Locomotive Fireboxes.** Herbert Herrmann (*Welding Ind.*, 1935, **3**, 167–170).—The technique required for welding thick-walled, tough-pitch copper parts is described. Welding rods of the Canzler type are recommended. Corroded parts must be chiselled out to obtain a clean surface; no more than 3–4 in. of weld metal are deposited at a time, welding being continued only after the weld metal has been thoroughly hammered.—H. W. G. H.

**Copper–Copper Phosphide Eutectic Alloy Welding Rods.** —— (*Indust. Gases*, 1935, **16**, 96).—Corrosion tests were carried out on joints made in copper with "Cuprotectic" rod. Liquid sulphur dioxide and the dry gas produced no corrosion. There was definite attack by moist sulphur dioxide, but the joint proper was not corroded to the same extent as the copper.
—H. W. G. H.

**Bronze Joints for Copper.** H. L. Fetherston (*J. Amer. Weld. Soc.*, 1935, **14**, (4), 2–4).—Cf. article in *Oxy-Acetylene Tips*, 1935, **14**, 53–55 (*Met. Abs.*, this vol., p. 363), on process piping in paper machine plant.—H. W. G. H.

**Spot and Seam Welding Brasses and Bronzes.** R. L. Briggs (*Welding Eng.*, 1935, **20**, (8), 36–37).—A short note on the power required for welding brasses and bronzes and the results to be expected.—H. W. G. H.

**Oxy-Acetylene Welding of Pure Nickel.** —— (*Soudure et Oxy-Coupage*, 1935, **12**, 261).—Rightward welding is recommended: the blowpipe should have a capacity of 100–150 litres per hr. per mm. thickness.—H. W. G. H.

**Hard-Facing Materials and Methods.** R. E. Brown (*Metal Progress*, 1935, **28**, (4), 136–140, 144).—Hard-facing, or the welding of a thin coating of a highly resistant alloy to the wearing surface of a metal part, is usually applied to tungsten carbide, alloys of the Stellite group, or to other alloys rich in chromium, nickel, tungsten, cobalt, or silicon. The selection and welding of hard-facing materials are discussed, and the special applications of hard-facing are enumerated. These include coal-cutters, conveyors, rock-drills, and steam-valves.—P. M. C. R.

**Welded Repairs to Zinc-Base Die-Castings.** C. W. Mace (*Welding Ind.*, 1935, **3**, 203–204).—Two examples of actual repairs are described (an oil-pump housing and an automobile door-handle) with full details of the technique adopted.—H. W. G. H.

**Welding Zinc and Galvanized Surfaces.** A. E. Peters (*Machinist* (*Eur. Edn.*), 1935, **79**, 582E).—The precautions for welding thin zinc sheets and galvanized surfaces are given. The blowpipe flame should have a slight excess of acetylene. Powdered sal ammoniac is used as a flux, and the filler-rod should be of the purest zinc available. Care must be taken not to inhale the fumes.—J. H. W.

**Distortion Control Procedure.** David Boyd and Gordon Cape (*Symposium on Welding of Iron and Steel, Iron Steel Inst.*, 1935, **2**, 39–49).—See *Met. Abs.*, this vol., p. 540.—S. G.

**Oxy-Acetylene Welding Practice and Technique.** C. G. Bainbridge (*Symposium on Welding of Iron and Steel, Iron Steel Inst.*, 1935, **2**, 7–18).—See *Met. Abs.*, 1935, **2**, 486).—S. G.

**Specifications Relative to Welding Rods for Oxy-Acetylene Welding.** —— (*Rev. Soud. autogène*, 1935, **27**, (257), 2–10; and *Welding Ind.*, 1935, **3**, 251–254, 321–323, 326).—The complete tentative specifications are given, as submitted for criticism by the French welding industry before being finally approved by the Société des Ingénieurs Soudeurs, the Office Central, the Institut de Soudure Autogène, and the Chambre Syndicale de l'Acétylène et de la Soudure Autogène. There are 7 sections, covering rods for welding steel, cast iron, copper, brasses, bronzes, aluminium and its alloys, miscellaneous alloys, and "bronze-welding." Dimensions, packing, and tests, including a tensile test on an all-weld-metal specimen, are specified.
—H. W. G. H.

**Factors to Consider when Designing Parts for Projection or Spot Welds.** A. M. Wallace (*Machine Design*, 1935, **7**, (8), 26–29).—Spot-welding methods as applied to, *inter alia*, aluminium are described with reference to diagrammatic sketches.—A. R. P.

**A Resistance Welding Problem: Electrodes for Spot-Welding.** J. Fassbinder (*Rev. Soud. autogène*, 1935, **27**, (258), 5–7).—The properties required of spot-welding contact points are explained, some alloys in use, such as copper–tungsten, copper–cadmium, copper–beryllium, are mentioned, and the need for further research is emphasized.—H. W. G. H.

**Concerning Spot-Welding Electrodes.** G. Komovski (*Rev. Soud. autogène*, 1935, **27**, (259), 14).—See *Met. Abs.*, 1935, **2**, 485.—H. W. G. H.

**Valve Control of Spot and Seam Welders.** A. C. Croskell (*Welding Ind.*, 1935, **3**, 272–274).—A brief explanation of the use of thyratrons for controlling welding time and current.—H. W. G. H.

**Electric Resistance Seam Welding and Its Applications.** L. A. Ferney (*Welding Ind.*, 1935, **3**, 171–173, 209–212, 249–250).—The scope of the process is made clear, the characteristics of the various types of machine available are explained and compared, and the essentials governing the economics of the process are set forth.—H. W. G. H.

**Theoretical Problems Regarding Resistance Welding.** Marcel Mathieu (*Bull. Assoc. Suisse Élect.*, 1935, [v], **5**, 941–964).—A survey of the principal problems involved in resistance welding is followed by a theoretical analysis of the following aspects: average power required to produce a given weld;

possible working limits of a given machine; power-factor of welding machinery; influence of skin-effect; fall in potential at the point of contact. A *bibliography* is appended.—P. M. C. R.

**The Development of Resistance Welding in France.** J. Languepin (*Bull. Soc. franç Elect.*, 1935, [v], **5**, 925–940).—Resistance welding is especially applicable to automobile, railway, and vehicle construction. French practice favours high voltages and rapid processes, and possesses highly developed methods of control. Spot-welding is said to have been developed to a very high standard of excellence. Illustrated descriptions of important types of plant are given.—P. M. C. R.

**Ignitron Timing of Resistance Welding.** J. W. Dawson (*Symposium on elding of Iron and Steel, Iron and Steel Inst.*, 1935, **2**, 55–66).—The use of "Ignitron tubes," mercury pool cathode valves, in the control of resistance welding is explained in detail. Developments, such as the photoelectric timer, giving interrupting rates up to 2400 per minute, and heat control, by causing a short interval of delay between successive loops of welding current, are also described. Applications to aluminium and copper alloys are illustrated.—H. W. G. H.

**Thyratron Control of Resistance Welding.** A. L. Whiteley (*Symposium on Welding of Iron and Steel, Iron Steel Inst.*, 1935, **2**, 205–212).—The principle of the thyratron is explained and its use in the primary circuit of the welding transformer and for timing control is described. It is shown that the duration of the welding current can be accurately controlled from several seconds to one cycle.—H. W. G. H.

**The Control of Electric Resistance Welding.** P. W. Townsend (*Symposium on Welding of Iron and Steel, Iron Steel Inst.*, 1935, **2**, 189–196).—A review of the principal methods of automatic control available, with some indication of their scope.—H. W. G. H.

**High-Voltage Condenser Welding.** G. I. Babat (*J. Amer. Weld. Soc.*, 1935, **14**, (8), 6–8).—A condenser is charged to high voltage by a rectifier fed from single-, or three-phase mains, and is discharged through the primary winding of the welding transformer by means of a special mercury-cathode tube which can pass impulses, of short duration, of several hundred amps. The transformer is so designed that more than 90% of the energy stored in the condenser is released at the weld. The advantages claimed for the method are: (1) the quantity of energy delivered for each weld may be measured off with an accuracy quite unattainable by any other method; (2) the welding time is easily and simply regulated down to 0·0001 second; (3) the a.c. main is equally loaded and the average power consumed by the apparatus is fairly low, although the instantaneous power developed at the moment of discharge is high.—H. W. G. H.

**Direct Measurement of Contraction of Butt Welds.** O. M. Harrelson and Searcy B. Slack (*J. Amer. Weld. Soc.*, 1935, **14**, (8), 21–22).—An apparatus is described for measuring the transverse contraction and some preliminary results are given for gas and arc welds on steel. The hypothesis is advanced that the amount of contraction is proportional to the size of the pool of molten metal in the arc crater or under the flame of the blowpipe, while the weld is being made.—H. W. G. H.

**Electric Arc Welding.** Ernst Schröder (*Draht-Welt*, 1935, **28**, 291–292).—The scope of fusion welding has been increased not only by its application to a number of light alloys, but by developments in welding machinery. The average current range is indicated in the case of machines for the welding of very fine sheet and for average and heavy work. The high amperage required by the latter is due in part to the increasing popularity of the heavier type of electrode, and partly to the necessity for considerable currents in the welding of certain special tool materials and in electric cutting. Recent modifications

in the design of small and medium-sized portable machines are described, and suitable electrode materials are indicated for different types of work.
—P. M. C. R.

**The Position of Arc-Welding in France.** J. Brillié (*Bull. Soc. franç. Elect.*, 1935, [v], 5, (57), 911–924).—The development of arc-welding is reviewed from the electrical, metallurgical, and economic points of view. Special attention is paid to recent types of automatic welding plant. In connection with atomic hydrogen welding, the use of the 3-phase arc appears especially promising, as the life of electrodes is increased.—P. M. C. R.

**A Comparative Study of Direct and Alternating Currents in Arc Welding.** J. Legrand (*Symposium on Welding of Iron and Steel, Iron Steel Inst.*, 1935, 2, 119–132).—See *Met. Abs.*, this vol., p. 485.—S. G.

**Some Notes on the Selection of Electric Arc Welding Plant.** R. W. Happé (*Symposium on Welding of Iron and Steel, Iron Steel Inst.*, 1935, 2, 105–114).—See *Met. Abs.*, this vol., p. 485.—S. G.

**Electronic Voltmeter for D.C. Arc Welding.** W. Richter (*Electronics*, 1935, 8, 82–83).—S. G.

**Use of Monel Metal in Electric Welding.** P. M. Golman (*Vestnik Ingenerow i Tehnikow* (*Messenger of Engineers and Technologists*), **1935**, (1), 50–51).—[In Russian.] The electric welding of pig-iron with Monel metal electrodes is described.—N. A.

**Chemical and Metallographic Study of Welds.** Maurice Michaud (*Métaux*, 1935, **10**, 101–111).—A number of papers by various authors read before the Société des Ingénieurs Soudeurs at Rome are summarized (cf. *Bull. Soc. Ingénieurs Soudeurs*, **1935**, (33), 1586).—J. H. W.

**Modern Methods for Repairing Non-Ferrous Metals and Alloys.** C. W. Brett (*Aluminium and Non-Ferrous Rev.*, 1935, 1, 38–40).—A brief review of the methods used in welding aluminium alloy castings and copper alloys.—J. C. C.

**Influence of Form on the Mechanical Properties of Welded Joints.** H. Gerbeaux (*Rev. Soud. autogène*, 1935, **27**, (259), 2–10).—A mathematical analysis is made of the stress distribution in various types of welded joints, from which it is evident that butt welds are far more reliable than fillet welds, since the latter, even when perfect, introduce serious concentrations of stress. This conclusion is confirmed by experimental work on the fatigue-strength of welds, examples of which are quoted.—H. W. G. H.

**The Principles of the Testing of Welded Joints.** (Daeves.) See p. 638.

**A List of Fundamental Research Problems in Welding.** Fundamental Research Committee, American Bureau of Welding (*J. Amer. Weld. Soc.*, 1935, **14**, (8), Suppl. 1–10).—The function of the Bureau in correlating welding research is explained, a list of fundamental research problems is set forth, and the investigators already at work, their affiliations and subjects, are tabulated. Progress in welding technique, during the second half of 1934, is reviewed in an appendix. A distressing absence of non-ferrous work is evident.—H. W. G. H.

## XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 541–543.)

†**Aluminium in Food.** G. W. Monier-Williams (*Rep. Public Health and Medical Subjects* (*Ministry of Health*), No. 78, 1935, 34 pp.; and (abstract) *Met. Ind.* (*Lond.*), 1935, **47**, 448).—Previous work on the alleged toxicity of aluminium and contamination of foods prepared in aluminium vessels is reviewed with reference to an extensive *bibliography*, and a method for the determination of minute amounts of the metal in foods by the use of 8-hydroxyquinoline is described. Some tests carried out on various cooking utensils showed that boiling distilled water is not contaminated with aluminium after contact for

24 hrs., whereas tap-water under the same conditions takes up 7–19·2 p.p.m. of aluminium. Mutton broth prepared in an aluminium saucepan contained 7 p.p.m. of the metal, which increased to 11·5 p.p.m. after keeping for 2 days and reheating. These minute amounts of aluminium have been found to be quite innocuous; even much larger amounts have no effect whatever on health, except possibly in cases of certain people who possess an idiosyncrasy toward aluminium, although aluminium salts in doses which are not unreasonably high have been shown to have some action on digestive processes.—A. R. P.

**The Most Recent Studies on the Alleged Harmfulness of Food Prepared in Aluminium Utensils.** K. B. Lehmann (*Arch. Hyg.*, 1931, **106**, 336–345; *C. Abs.*, 1932, **26**, 3851).—The evidence offered is not sufficient to prove that the ingestion of small quantities of aluminium is harmful to health.—S. G.

**The Use of Aluminium Castings in Large Arc Furnaces.** A. von Zeerleder (*Aluminium*, 1935, **17**, 529–530).—Water jackets of cast Alufont (aluminium with iron 1·4, copper 2, zinc 12, and magnesium 0·2%) have been used successfully for building up the outer shell of 3000 kw. Miguet arc furnaces for the manufacture of ferro-alloys. Illustrations of such a furnace are included. —A. R. P.

**Rotors with Cast Conductors.** E. C. Wadlow (*Elect. Rev.*, 1935, **116**, 265–266).—See also *Met. Abs.*, this vol., p. 541. Composition and details of manufacture are given for the use of aluminium and its alloys for casting rotor cages in gramophone motors.—S. G.

***Photographs on Aluminium (Seo-Foto Process).** A. Jenny and N. Budiloff (*Chem. Fabrik*, 1935, 8, 359–363; and (summary) *Light Metals Rev.*, 1935, 2, 79–81).—The aluminium is sensitized by anodic oxidation and impregnation of the alumina layer with light-sensitive compounds. The plate is then exposed in the usual way and developed and fixed without the use of alkaline or mercury-containing solutions which attack the aluminium. The tones of the photograph can be varied by treatment with suitable chemicals and by heat-tinting; to retain the finished photograph in perfect condition it should be treated with a solution of wax, oil, or linseed-oil varnish. The products are highly resistant to salt-spray and to air containing oxides of nitrogen or sulphur, or chlorine-containing gases, and the process has been used successfully in the manufacture of scales for scientific instruments, permanent plans and pictures, and various indicators.—A. R. P.

**Wrought Aluminium Alloys for Structural Applications.** E. H. Dix, Jr. (*Pennsylvania State Coll. Bull.* No. **18**, 1935, 113–127; *C. Abs.*, 1935, **29**, 7256).—Aluminium–magnesium and aluminium–silicon are the lightest and aluminium–zinc the heaviest. The modulus of elasticity is not affected appreciably by the various alloying elements. Weight and strength comparisons are made with steel. The properties of various aluminium alloys and their chief fields of usefulness are reviewed.—S. G.

**Light Alloys in Automobile Engines.** A. R. Code (*Modern Engineer* (*Melbourne*), 1934, **8**, 308–314; *Bull. B.N.F.M.R.A.*, 1935, (**77**)).—Discusses in detail the best types of light alloys for various parts of automobile engines. Operating conditions are precisely specified as to load, temperature, &c., and the properties of various materials considered desirable for satisfactory service performance are enumerated. Numerous references are given.—S. G.

**The Use of Light Metals in Automobile Construction.** —— (*Automobiltech. Z.*, 1935, **38**, 461–466).—The advantages of light-alloy vehicle construction are summarized. Design is necessarily modified by the possibilities, especially with regard to die-casting, offered by the light alloys, and diagrams show possible types of construction in considerable detail. Special reference is made to the increasing use of the tank container, and the weights and capacities of a number of vehicles in actual use are tabulated. Coal and mineral trucks are now frequently made of Duralumin.—P. M. C. R.

**Recent Developments in Light-Alloy Pistons.** H. J. Maybrey (*J. Inst. Production Eng.*, 1935, **14**, 495–501; discussion, 502–506).—The development of pistons of silicon–aluminium alloys (silicon 18, copper 3%), low in weight, and having low thermal expansion, is described. Excellent service has been given by such pistons with a Brinell hardness below 60. Heat-treatment is not recommended, particularly since the additional hardness so imparted falls rapidly when the alloy is exposed to high working temperatures.—J. C. C.

**Aluminium Wire for Electrical Conductors.** —— (*Draht-Welt*, 1934, **27**, 676–677).—The relevant German standard specifications are briefly discussed. —P. M. C. R.

**Specifications for Aluminium Wire and Steel-Reinforced Aluminium Cables for Electric Conductors.** —— (*Draht-Welt*, 1934, **27**, 741–742).—P. M. C. R.

**Aluminium in Electric Conductor Wires.** —— (*Draht-Welt*, 1934, **27**, 772–773).—Aluminium conductor wires, especially those of the steel-reinforced type, have found increasing application in the U.S.A., Great Britain, Rumania, and Palestine: data derived from this experience are summarized, together with some results recently obtained in Germany with regard to mechanical strength, creep, maximum (electrical) load, and fatigue due to vibration, and certain modifications in the method of erection are suggested.—P. M. C. R.

**Aluminium Hollow-Core for Oil-Filled Cables.** —— (*Elektrotech. Z.*, 1935, **56**, 84).—S. G.

**Astronomical Mirrors Coated with Aluminium.** —— (*Science Supplement*, 1935, **82**, (2125), 6).—Experiences of a number of astronomers with aluminium-coated astronomical mirrors are referred to in a discussion held by the American Association for the Advancement of Science. An alloy of magnesium and aluminium has been found very suitable for deposition *in vacuo*. The alloy has a reflecting power 4% higher than that of aluminium. Aluminium-coated mirrors have shown no deterioration so far.—J. S. G. T.

**Fire Control for Passenger Vessels.** George G. Sharp (*J. Amer. Soc. Nav. Arch. and Marine Eng.*, **1933**, (41), 87–138; discussion, 138–159).—A series of tests on the inflammability of materials used for bulkheads, furniture, and fittings in marine work is described and illustrated. Aluminium showed a very fair resistance to the severe testing conditions, and is classified as a "Class B" fire-resisting material, *i.e.* as being capable of withstanding a temperature of 1000° F. (538° C.) for 30 minutes. The U.S. safety code permits the use of such materials as panelling, light bulkheads, linings, heavy or vertical mouldings, balustrading, drought doors, wardrobes, &c. In discussion, *H. D. McKinnon* described further tests on aluminium panelling.—P. M. C. R.

**Aluminium Foil for Insulation.** J. H. Callender (*Architectural Forum*, 1934, **60**, (1), 67–71).—S. G.

**Copper in the Brewery.** G. du Bois (*Cuivre et Laiton*, 1935, **8**, 275–282).—Various pieces of apparatus in which copper is used as the principal material are discussed. Diagrams and descriptions of laying copper linings, and of their jointing, are given.—W. A. C. N.

***Poisoning of Yeast by Copper During the Process of Brewing.** R. Koch (*Woch. Brau.*, 1935, **52**, 57–63, 65–71, 76–80, 86–88, 93–95).—S. G.

**Copper and Beer.** P. Petit (*Brasserie et Malterie*, 1935, **25**, 193–197.—Discusses the findings of Koch (preceding abstract).—S. G.

***Studies on the Metabolism of Copper.** E. J. Coulson, R. E. Remington, and K. M. Lynch (*U.S. Bur. Fisheries Invest. Rep.* **23**, 1934, 12 pp.).—S. G.

**Copper Work in Buildings.** Basil Marriott (*Plumbing Trade J.*, 1935, **15**, 144–146, 173–176).—A review of the characteristics of copper from the point of view of its suitability in building work, and a description of its present uses for pipes, roofing, gutters, damp-courses, &c. Some notes are also given on methods of handling and installation.—C. E. H.

***Life of Copper Switch Contacts.** L. Weiler (*Elektrotech.-Z.*, 1935, **56**, 52–53; *Sci. Abs.*, 1935, [B], **38**, 147).—Results are given of experimental investigations of the relations between controlled power and length of life of switch contacts in switchgear and control equipment, for open and oil-immersed conditions. Reference is made to the possibility of lengthening the life of contact pieces in switchgear by making them of special metals. The use of noble metals in such connection is indicated in the cases of rolling mill and foundry practice where the switching operations are frequent.—S. G.

**Copper Pipe for Gas Services.** J. Barker (*Gas Times*, 1935, **2**, (21), 19; *Bull. B.N.F.M.R.A.*, 1935, (76)).—In Nairn, copper housing tube has been used exclusively for gas services for the past 8 years. Various advantages are claimed as compared with iron.—S. G.

**Wear and Fatigue in Trolley Wire.** J. F. Neild (*Mass Transportation*, 1935, **31**, 103–104; *Bull. B.N.F.M.R.A.*, 1935, (78)).—Discusses the questions from the practical point of view; copper, bronze, and cadmium–copper are mentioned.—S. G.

**Copper in Gold and Silver Coins and in Bullion.** V. Briard (*Cuivre et Laiton*, 1934, **7**, 455–457).—S. G.

**Oil-Saving and Oil-Less Bearings.** G. Baum (*Oel u. Kohle*, 1935, **11**, 697–699).—" Oil-saving " bearings are partly self-lubricating; they consist of some metallic or non-metallic material impregnated with graphite. A graphitized bronze is stated to have excellent bearing properties; cavities formed during the moulding process are subsequently filled with graphite. The properties of oil-impregnated wooden bearings have latterly been improved by forcing metal into the wood by a " metallization " process, prior to impregnation. Certain copper–tin or copper–lead alloys possess excellent bearing properties, which are improved by the addition of graphite up to 5% during manufacture.—P. M. C. R.

**Bronzes Without Tin.** M. Rezkov (*Vestnick Standartizazii* (*Messenger of Standardization*), **1935**, 1(61), 21–26).—[In Russian.] Technical reasons are given for the choice of composition of the Russian Standard " bronze " OST/VKS 7502.—N. A.

**Specification for Manganese–Bronze: Bars, Plates, Rods, and Shapes.** —— (*U.S. Navy Dept. Specification* **46B15c**, 1934; *Bull. B.N.F.M.R.A.*, 1935, (**81**)).—The alloy is to contain copper 57–60, tin 0·5–1·5, iron 0·8–2·0, and *maximum* manganese 0·5, aluminium 0·25, and lead 0·20%.—S. G.

**Technique of Spraying Bronze on Bronze.** R. A. Axline (*Metallizer*, 1934, **1**, (5), 4).—Metal spraying may be used to fill holes in bronze castings, but it is necessary (1) to use a wire which will match the casting in colour; (2) to cut round the hole to form a cavity which has edges perpendicular to the surface and with some undercutting; and (3) to finish by machining at high speed with a fine cut.—W. E. B.

**Copper Powder for Metallo-Ceramic Applications.** B. A. Borok, M. I. Balshin, and N. A. Gavrilov (*Niimash* (*Bull. Sci. Res. Inst. Machinebuilding and Metal Treatment*), **1935**, (3), 27–33).—[In Russian.] The production of copper powder by electrolysis and its properties are described.—N. A.

**Gold.** D. McDonald (*Sci. J. Roy. Coll. Sci.*, 1934, **4**, 7–17).—An account of the occurrence, extraction, and refining of gold is followed by a note on the economic importance of rapid handling. The uses of gold and the types of alloy employed are briefly considered.—P. M. C. R.

**Lead in Drinking Water.** F. Weyrauch and H. Müller (*Z. Hyg. Infektionskrankh.*, 1935, **117**, 196–201).—S. G.

**Satco [Bearing] Metal.** —— (*Dutch Boy Quarterly*, 1935, **13**, (1), 7–8).—Brief notes on composition, structure, and uses for bearings.—A. R. P.

**Satco [Bearing Metal] and the New Haven " Comet."** —— (*Dutch Boy Quarterly*, 1935, **13**, (2), 12–13).—Experience on modern stream-lined high-speed trains in America has established the superiority of lead-base Satco bearing metal for this type of work; such bearings showed no signs of wear after 60,000 miles of service, whereas tin-base Babbitt linings have never lasted for more than 40,000 miles and lead–bronze linings for more than 30,000 miles in similar conditions. The success of Satco is due to its relatively high melting point and to its ability to retain its strength at high temperatures; the strength of Satco at 392° F. (200° C.) is twice that of tin Babbitts and 3 times that of lead-base Babbitts—A. R. P.

**The United States Storage Battery Industry.** —— (*National Battery Manuf. Assoc.* (*U.S.A.*), **1935**, 26 pp.; *Bull. B.N.F.M.R.A.*, 1935, (**81**)).—A pamphlet giving statistics of the industry. The total consumption of lead (primary, secondary, and antimonial) in the manufacture of storage batteries in the U.S.A. in 1934 was 163,000 short tons, and corresponding figures are given for previous years to 1925.—S. G.

**Lead in Building Construction.** J. Mahul (*Aciers spéciaux*, 1933, **8**, 339–342).—S. G.

**Lithium and Its Use.** G. F. Silina (*Redkie Metalli* (*Rare Metals*), **1935**, (1), 44–47).—[In Russian.] A review.—D. N. S.

**Magnesium.** —— (*Metallurgist* (Suppt. to *Engineer*), 1935, **10**, 65–66).—A discussion of the history and development of magnesium and its alloys.
—R. G.

**Mercury for Dental Amalgams.** A. Isaacs (*J. Amer. Dental Assoc.*, 1932, **19**, 54–57; *C. Abs.*, 1933, **27**, 1088).—The presence of 0·001% of copper, zinc, tin, lead, bismuth, cadmium, or antimony, but not of gold or silver ($\not>$ 0·1%), causes film formation and tailing. The solubility of arsenic in mercury is much less than 0·001%. Dental mercury should not film or tail, and the residue non-volatile at red heat should be $\not>$ 0·02%.—S. G.

**Standard Specifications for Ferro–Molybdenum (A 132–1934).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 55–56).—Cover the standard grade of ferro–molybdenum only.—S. G.

**Standard Specifications for Low-Carbon Ferro–Molybdenum (A 145–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 57–58).—S. G.

**Metallic Linings for [Sulphite Pulp] Digesters.** W. C. Johnson (*Paper Trade J.*, 1933, **96**, T.A.P.P.I. Sect., 125–127; *Brit. Chem. Abs.*, **1933**, [B], 392).—Installations of chromium–nickel pipe and digester fittings justify the use of this material for linings. Expansion differences between it and the steel base to which it is welded are overcome by using an intermediate bond plate.
—S. G.

**Nickel–Chromium Alloys for Electrical Resistances.** Fred P. Peters (*Metal Progress*, 1935, **28**, (4), 63–67).—Alloys for electrical resistances must possess high resistivity, a low and constant temperature coeff., high resistance to oxidation and scaling at temperatures above red heat, a restricted melting range and a high melting-point, together with sufficient ductility and good high-temperature mechanical properties. The physical and mechanical properties, composition, high-temperature strength, liability to growth and approximate price of nickel silver, "nickel steel," Cupron, several nickel–chromium and aluminium–chromium–iron alloys are tabulated in comparison. The nature of an effective oxide coating is discussed. An account is given of the iron-base chromium–aluminium alloys, which are recommended for either non-heating resistance elements or high-temperature resistances, whilst the nickel–chromium series are better adapted to industrial and domestic heating.
—P. M. C. R.

**Standard Specifications for Drawn or Rolled Alloy, 80 Per Cent. Nickel, 20 Per Cent. Chromium, for Electrical Heating Elements (B 82–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 75–78).—S. G.

**Standard Specifications for Drawn or Rolled Alloy, 60 Per Cent. Nickel, 15 Per Cent. Chromium, and Balance Iron, for Electrical Heating Elements (B 83–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 79–82).—S. G.

***Stainless Steel [versus Nickel–Copper Alloy] in the Rayon and Silk Industries.** B. L. Hathorne and Robert Zametkin (*Amer. Dyestuff Reporter*, 1935, **24**, 503–504; *C. Abs.*, 1935, **29**, 7665).—Practical factory-scale tests are said to indicate that stainless steel is superior to nickel–copper alloy and wood for dye-kettle construction. Chemicals and dyestuffs normally used in processing rayon and acetate fabrics cause no staining or change of shade due to the stainless steel itself. All-metal machines are stated to be definitely superior to those made of wood, as judged by flexibility of use and ease of changing from shade to shade.—S. G.

**Recommended Materials for Electrical Appliances.** —— (*Bur. Information Nickel*, **1935**, (AA8), 6 pp.).—Specifications for cast iron, nickel–copper, nickel–copper–zinc, nickel–manganese, nickel–iron, nickel–chromium–iron, nickel–chromium, and steel alloys for domestic heating, cooking, and lighting appliances and for industrial electric furnaces, rheostats, &c., are given. —A. R. P.

**Nickel Bearing Alloys in the Production and Refining of Petroleum.** Byron B. Morton (*Min. and Met.*, 1935, **16**, 411–414; and *Oil and Gas J.*, 1935, **34**, (4), 49–50, 64).—Monel metal is used for sucker rods for wells containing corrosive waters containing sodium chloride and hydrogen sulphide, also for seat-valves, pump-rods, and linings of apparatus subject to corrosion.—A. R. P.

**Non-Sparking Tools.** W. Hessenbruch (*Z.V.d.I.*, 1935, **79**, 586).—Copper–nickel alloys containing beryllium are suitable for the manufacture of non-sparking cutting tools. The properties of these alloys are discussed.—K. S.

**Palladium in the Noble Metal Industry.** E. R. Thews and R. W. Harbison (*Deut. Goldschmiede-Zeit.*, 1932, **35**, 232).—Discusses the use of palladium in alloys, and describes the properties of some alloys.—S. G.

**Precious Metals.** F. Michel (*Chem. Zeit.*, 1935, **59**, 803–806).—A review of the occurrence, methods of extraction from ores, &c., and uses of gold, silver, and the platinum metals.—A. R. P.

**On Silver Linings and Their Use for Apparatus in Chemical Factories.** Hans M. Forstner (*Oberflächentechnik*, 1935, **12**, 91–94, 109–112, 119–122, 137–138).—A review of recent literature on the subject with 110 references. —A. R. P.

**Bactericidal Properties of Silver and Its Application to Water Disinfection.** J. Just and A. Szniolis (*Gaz i Woda*, 1935, **15**, 201–211).—S. G.

**Tantalum Capacitators.** Bernard H. Porter (*Transit J.*, 1935, **15**, (Aug.), 14–15; *C. Abs.*, 1935, **29**, 6846).—Tantalum has advantages over aluminium for electrolytic condensers of very low internal resistance in that its oxide is not soluble in the electrolyte and it resists the corrosive action of all chemicals except strong caustic alkalis and mixtures containing hydrofluoric acid. The cathode of the tantalum cell may be any material not soluble in the electrolyte, pure molybdenum and molybdenum–tungsten being satisfactory for use in sulphuric acid solutions.—S. G.

**Beer Cans—A New Use for Tin and Steel.** M. W. von Bernewitz (*Min. and Met.*, 1935, **16**, 452).—Cans made of 30-gauge tinplate lacquered inside and out are used for preserving beer in America; the cans will withstand 80 lb./in.$^2$ of internal gas pressure.—A. R. P.

**New Wire Permits Babbitt-Sprayed Bearings.** A. H. Levy (*Metallizer*, 1934, **2**, (5), 9–10).—It is now possible to obtain Babbitt in wire form, and this can be sprayed on bearings. It is claimed that sprayed bearings will not lift from the shell, that no tinning is required on the shell, that sprayed bearings are free from blowholes. There are certain advantages in thin Babbitt linings, and sprayed linings can be made thinner than cast ones.—W. E. B.

**Pouring versus Spraying Babbitt.** A. H. Levy (*Metallizer*, 1935, **3**, (2), 3).—A short description of the troubles experienced with cast bearings is followed by a description of the bearings in a heavy rolling mill made by metal spraying with Babbitt.—W. E. B.

**Babbitt.** A. H. Levy (*Metallizer*, 1935, **3**, (11), 7, 13).—The advantages of thinly-lined white metal bearings and the difficulty of casting thinly-lined bearings are discussed. It is claimed that metal-sprayed bearings are much superior.—W. E. B.

**Babbitts.** A. Bochvar (*Vestnick Standartizazii* (*Messenger of Standardization*), **1935**, 1(61), 18–20).—[In Russian.] The basis for selection of a standard Babbitt is indicated and the relation of the Soviet standard to the OST/VKS 88 Babbitt is given.—N. A.

**Standard Specifications for Ferro–Tungsten (A 144–34).** —— (*Suppt. to Book of A.S.T.M. Standards*, **1934**, 53–54).—Cover the standard grade of ferro–tungsten only.—S. G.

**[Tungsten Alloy Used to House] Radium at the Westminster Hospital, London.** —— (*Science*, 1935, **82**, (2127), 320).—A new tungsten alloy, of density 1·5 times that of lead, is to be used to house the 4 grm. of radium at Westminster Hospital. Brief particulars of the "housing" of the radium bomb are given.—J. S. G. T.

**The History of Zinc Roofing up to 1835.** Otto Vogel (*Illust. Zeit. Blechindustrie*, 1935, **64**, 1084–1086, 1115–1117).—The production of zinc sheet is traced to Sage, who describes the method of rolling current in 1781. The work of Crell, Guyton, Hobson, Randall, and Sylvester is summarized. The use of zinc roofing spread rapidly after its experimental adoption in Prussia in 1810. Methods of attachment and forms of sheet and contemporary methods used in France are described and illustrated.—P. M. C. R.

***Time of Melting of Thin Fuse Wires.** J. A. M. van Liempt and J. A. de Vriend (*Z. Physik*, 1934, **93**, 100–110; *Sci. Abs.*, 1935, [B], **38**, 146).—G. J. Meyer as long ago as 1907 suggested that the time $t$ taken by a fuse wire to melt could be represented by $t = C(A/I)^2$, where $A$ is the cross-sectional area of the wire, $I$ is the short-circuiting current, and $C$ is a const. for the material. This expression was verified for thick wires of copper and silver. Experiments are described involving the use of a cathode-ray oscillograph to measure $t$ and $I$, and give results for wires down to 100 $\mu$ in diameter. The experiments confirm the original formula, and values of $C$ are given for wires of copper, tin, platinum, nickel, silver, Constantan, Monel metal, 98 : 2 nickel–manganese, and 70 : 30 iron–nickel.—S. G.

**Standards for Die-Cast Alloys.** —— (*Metallwirtschaft*, 1935, **14**, 899–903).—Tentative standard specifications are given for die-casting alloy with a basis of lead, aluminium, magnesium, zinc, and tin.—v. G.

**Recent Developments in Materials and Processes.** H. Warren (*Electrician*, 1934, **113**, 691–692).—Summarizes recent outstanding developments in materials and processes used in various industries.—S. G.

**Metals and Alloys for Internal Architectural Purposes.** —— (*Metallurgia*, 1935, **13**, 7–10).—The more important characteristics of some of the wide range of metals and alloys available for decorative purposes are discussed as well as their various applications. These include the architectural bronzes suitable on account of their colour, strength, corrosive-resistance properties, and the ease with which they are worked and machined; the nickel–bronzes used on account of similar properties; and certain aluminium alloys, both cast and wrought, which are not only light in weight, but can also be obtained in various finishes as the result of the anodic process, sand-blasting, scratch-brushing, and treatment with caustic soda and nitric acid.—J. W. D.

**Metallurgy, Metals, and the Winery.** R. Hughes (*Wine Review*, 1935, **3**, (4), 12–15; *C. Abs.*, 1935, **29**, 7009).—Relatively small amounts of metals added to wines by corrosion may affect their flavour, bouquet, colour, and clarity. Tests on Californian wines and musts show heavy corrosion of iron, steel, and tin after brief exposure. Lead and zinc should not be used because of the possibility of poisoning. Stainless steel and nickel alloys appear to be the most satisfactory for resisting corrosion.—S. G.

**Thermal Conductivity of Metals in Relation to Their Use in the Chemical Industry, Especially the Manufacture of Acids and Explosives.** Z. Stefan (*Chim. et Ind.*, 1933, **29**, Special No., 964–975; *Brit. Chem. Abs.*, **1933**, [B], 970).—The applicability of various metals and alloys for numerous types of plant is discussed in respect of their thermal conductivity, resistance to corrosion, and mechanical properties, rules governing the conductivity being given. The heat transfer of air and vapours and of boiling, moving, and stationary liquids across copper and lead partitions has been calculated. The working of these metals and alloys for the construction of plant is considered.—S. G.

**Machinery in the Chemical Works.** F. A. M. Wülfinghoff and G. Jungnitz (*Chem. Fabrik*, 1933, **6**, 8–17; *Brit. Chem. Abs.*, **1933**, [B], 128).—Describes typical apparatus used in chemical works, and discusses the special advantages of iron, steel, alloy steels, copper, nickel, aluminium, lead, Monel metal, wood, and earthenware.—S. G.

**Practice and Theory of the Protection of Equipment in the Leather Industry.** K. Bittner (*Collegium*, **1935**, 183–186).—Discussion of materials of construction.—S. G.

**Modern Dairy Equipment.** J. Hinde (*Food*, 1935, **5**, 64–67).—Describes the characteristics and present-day applications of aluminium, nickel, and nickel alloys in this field. Illustrated.—C. E. H.

**Care of Creamery Equipment.** L. O. Ott (*Proc. 7th Ann. State Coll. Washington Inst. Dairying*, **1934**, 85–93; *C. Abs.*, 1935, **29**, 6962).—Suggestions are given for treatment of water and brine so that milkstone or corrosion will not impair the usefulness of the equipment.—S. G.

**Pipe Line Contaminations [in Food Factories] and How to Avoid Them.** Haldane Gee (*Food Ind.*, 1935, **7**, 422–424; *C. Abs.*, 1935, **29**, 7519).—Unclean pipe lines are prolific causes of mould, yeast, and bacterial contaminations in food factories. Dead ends, bad angles, and corroded metals are the main offenders. These pipes may serve as reservoirs of contamination from day to day. Metallic contamination of foods may also occur from unclean and corroded pipes.—S. G.

**The Uses of Metals and Their Alloys in the Nitrogen Industry.** Bruno Waeser (*Metall-Woche*, 1935, **1**, 25–27).—A review of recent literature with 34 references.—A. R. P.

**Possible New Applications of Metal Wire Fabrics.** Fritz Ohl (*Draht-Welt*, 1935, **28**, 67–69).—Fine wire fabric is now used for the strengthening of safety (non-splintering) glass and of synthetic resin products. The material of the wire (steel, aluminium, zinc, or Monel metal) considerably influences the rapidity of setting of the matrix; where Monel metal is used, the setting time may be 90 seconds, as against 150 seconds in the case of the resin alone. The influence of various types and sizes of metal gauze on the strength of the product is discussed, as is the optimum type of mesh. The corrosive effect of the matrix is stated to be very slight or non-existent. It is anticipated that wire-reinforced resins will find extensive application in light structural work.—P. M. C. R.

**Non-Ferrous Metals Used in Aircraft.** J. B. Johnson (*Metal Progress*, 1935, **28**, (4), 123–128, 130; and *Light Metals Rev.*, 1935, **2**, 103–105).—Light alloys now comprise about 75% of the total weight of large bombing and transport aircraft. The nominal composition, principal mechanical properties, and special applications of the most important of such alloys are tabulated. A further table shows the effect of low temperatures (— 40° C.) on the properties of Duralumin 25 S, a light alloy casting, and a 90·5–9·05 magnesium–aluminium–zinc alloy. Analyses and properties of lead–tin, lead–silver, and cadmium–silver solders are reproduced.—P. M. C. R.

**Metals in Airplanes.** —— (*Eng. and Min. J.*, 1935, **136**, 557).—Enumerates the metals and alloys used.—R. Gr.

**All-Metal Valves.** O. W. Pike and G. F. Metcalf (*Electronics*, 1934, **7**, 312–313; *Sci. Abs.*, 1935, [B], **38**, 129).—The advantages of metal valve envelopes are summarized; the possibility of mass production of such valves can now be realised in view of the advances in metal–glass seal technique, welding and sealing-off metal exhaust tubulation. Various types of seal are discussed using Fernico, an alloy having the same temperature coeff. of expansion as the glass employed, and the advantage of thyratron control for timing resistance welds is stressed, particularly in connection with reproducibility. Details of various designs are given; they are said to be superior in properties and less expensive than the usual glass valve.—S. G.

**Seven Types of Metallized Surfaces Subjected to Exhaustive Year-Long Test on Water Turbine.** R. A. Axline (*Metallizer*, 1934, **1**, (5), 8).—In order to determine the practicability of repairing cavitated water-turbine runners by metal spraying, the buckets of a large Francis type turbine were treated by spraying with zinc, bronze, aluminium, copper, lead, stainless steel, and high-carbon steel. Bronze, copper, stainless and high-carbon steel were found to give satisfactory results.—W. E. B.

**Metal-Spraying Process in Electrical Manufacturing.** J. A. Campbell (*Metallizer*, 1935, **3**, ( ), 5, 6, 7, 9).—A description is given of the metal-spraying process as applied to the electrical industry, with special mention of copper-spraying carbon brushes and contacts, shielding of radio valves, and copper spraying of resistors to reduce contact noise. Zinc coatings for refrigerators, and copper-sprayed X-ray bulbs are mentioned—W. E. B.

**Plated Metal and Its Preparation.** R. F. Makukh (*Khim. Mashinostroenie*, **1935**, (3), 31; *C. Abs.*, 1935, **29**, 7261).—[In Russian.] A review of the materials from which plated metal is prepared, methods of preparation, and uses.—S. G.

## XXII.—MISCELLANEOUS

(Continued from pp. 543–544.)

**Leonard Archbutt.** John White (*Analyst*, 1935, **60**, 579–581).—Obituary notice of A., formerly Member of Council of the Institute of Metals.—S. G.

**Planning and Equipment of a Metallurgy Department for a Technical College.** —— (*Association of Technical Institutions, Report on Technical College Buildings*, **1935**, 79–82).—S. G.

**The Work of the Kaiser Wilhelm-Institut für Metallforschung.** —— (*Metallwirtschaft*, 1935, **14**, 942).—A review and summary of the year's work. —v. G.

**The Aluminium Industry.** E. C. Harder and E. V. N. Kennedy (*Canad. Min. Met. Bull.* No. **279**, 1935, 355–362; and *Aluminium and Non-Ferrous Rev.*, 1935, **1**, 10–14).—A review of the present position and future possibilities of the industry with particular reference to Canada. The subject is treated mainly from an economic point of view.—C. E. H.

**World Economics of Aluminium.** A. K. Timashev (*Legkie Metalli* (*Light Metals*), **1935**, (6), 48–50).—[In Russian.] Statistics of the world production of aluminium.—D. N. S.

**Modern Electrolytic Aluminium Works in W. Europe and America.** P. F. Antipin (*Legkie Metalli* (*Light Metals*), **1935**, (3), 39–50).—[In Russian.] A brief description of a number of aluminium works.—D. N. S.

***Chemical Investigations of the Ancient Metallic Implements in the Orient. VI.—The Ancient Chinese Bronze Implements.—5. The Ancient Chinese Iron Implements. I.—Relics Unearthed at Lo-Lang, Korea.** Tsurumatsu Dôno (*Nippon Kwagaku Kwai Shi* (*J. Chem. Soc. Japan*), 1935, **56**, 819–824).—[In Japanese.]—S. G.

**Test Showing Approach of Lead Poisoning.** Carey P. McCord, F. R. Holden, and Jan Johnston (*Science Supplement*, 1935, **82**, (2128), 8).—Read before the American Public Health Association. A blood test showing the approach of lead poisoning is briefly referred to. Counts are made of embryonic blood cells, which in normal persons rarely exceed 1% of the total red cells in the blood, but which in the case of lead-poisoning may be as high as 4–10%.
—J. S. G. T.

**†The Progress of the Magnesium Industry in Japan.** Shoichiro Imatomi (*Sci. Papers, Inst. Phys. Chem. Res.*, 1935, **28**, (600), 57–67).—[In English.] Discusses: (1) the history of the magnesium industry in Japan; (2) raw materials; (3) comparison with raw materials available elsewhere; (4) methods of manufacture; (5) magnesium alloys; (6) method of casting magnesium alloys, and anti-corrosion methods; (7) future of the industry in Japan.—J. S. G. T.

**Prospects of the Development of a Magnesium Industry.** A. M. Romanovski (*Legkie Metalli* (*Light Metals*), **1935**, (2), 58–60).—[In Russian.] Recent work on the production of magnesium from its chloride and oxide is reviewed.
—D. N. S.

**The Technique of Magnesium Production.** V. M. Guskov (*Metallurg* (*Metallurgist*), **1935**, (1), 81–88).—[In Russian.] A review.—N. A.

**Niobium Alloys.** —— (*Amer. Metal Market*, 1935, **42**, (215), 8).—A very brief note of a new patented process for the production of niobium alloys from ores. The compounds are reduced with silicon or silicon alloys.—L. A. O.

**Phenomena of the Transference of Ions and Charged Particles in Gaseous Media in an Electric Field.** U. V. Baimakov (*Metallurg* (*Metallurgist*), **1935**, (3), 90–100).—[In Russian.] The article gives the characteristics of disperse systems, their origin and properties; the principles of electro-precipitation, production indicators, fields of application (including copper casting), the charging of particles and their motion in electric fields, the mechanism of precipitation, and the design of apparatus.—N. A.

**Some Impressions of Engineering Research in America.** H. J. Gough (*Proc. Inst. Automobile Engineers*, 1935, **29**, 442–474).—G. recounts experiences on a visit to America in Autumn, 1933, when he inspected 30 Universities, research laboratories, and industrial plants. Details are given of the organization of engineering research in America and of the various institutes associated with such organization. Major items observed and discussed at 30 institutes are usefully tabulated in an appendix.—J. S. G. T.

## XXIII.—BIBLIOGRAPHY

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

(Continued from pp. 544–550.)

***American Society for Testing Materials.** *A.S.T.M. Standards on Preservative Coatings for Structural Materials* (*Paints, Varnishes, Lacquers, and Paint Materials*). Prepared by Committee D-1 on Preservative Coatings for Structural Materials. Med. 8vo. Pp. 387. 1935. Philadelphia, Pa.: The Society, 260 S. Broad St. ($1.75.)

***American Society for Testing Materials.** *1934 Supplement to Book of A.S.T.M. Standards.* Med. 8vo. Pp. vi + 216, illustrated. 1935. Philadelphia, Pa.: The Society, 260 S. Broad St.

***Aviation and Allied Industries.** *Planes Directory of the Aviation and Allied Industries.* First Edition. Demy 8vo. Pp. xxviii + 331. 1935. London: Planes Publishers, Ltd., 4 Johnson's Court, Fleet St., E.C.4. (12*s.* 6*d.*)

***Bobovnikov, N. D.** *Corrosion of Magnesium Alloys.* Part VI.—*Corrosion of Rolled Magnesium Alloys.* [In Russian, with English Summary.] (Transactions of the Research Institute for Aircraft Materials, No. 31.) Roy. 8vo. Pp. 62, with 79 illustrations. 1935. Moscow and Leningrad: ONTI. (Rbl. 1.80.)

**Brady, F. L.** *The Prevention of the Corrosion of Lead in Buildings.* (Department of Scientific and Industrial Research; Building Research Bulletin No. 6.) Roy. 8vo. Pp. iv + 4, with 1 plate. 1935. London: H.M. Stationery Office. (3*d.* net.)

***Bräuer, Adolf,** und **Josef Reitstötter.** Herausgegeben von. *Fortschritte des chemischen Apparatewesens.* Dargestellt an Hand der Patentschriften des Deutschen Reiches unter Mitwirkung zahlreicher Fachgenossen mit Unterstützung der Dechema, Deutsche Gesellschaft für chemisches Apparatewesen E.V. *Elektrische Öfen.* Unter Mitwirkung von O. Feussner, W. Fischer, Theo Frantz, F. K. Frhr. v. Göler, G. Müller, V. Paschkis, M. Pirani, J. Rossman, F. Singer, F. Sommer, G. Stieg, F. Walter gemeinsam mit den Herausgebern bearbeitet durch **H. Alterthum.** Imp. 8vo. Lief. 2, 3, u. 4. Pp. 65–176 + Patentregister, Pp. 89–448. 1935. Leipzig: Akademische Gesellschaft m.b.H. (Brosch., R.M. 28; subscription price, R.M. 22; members of Dechema, R.M. 20, each part.)

**Brockman, C. J.** *Electrochemistry. Principles and Practice.* Pp. 348. New York: D. Van Nostrand Co., Inc. ($4.00.)

**Broemel, L.,** and **J. S. Daugherty.** *Sheet Metal Workers' Manual.* Pp. 552. 1935. Chicago: Frederick J. Drake and Co. ($2.00.)

[A practical manual on sheet metal working, with chapters on the machinery and tools used, and a course in pattern drawing. Information is given on oxy-acetylene and electric welding, hand-forging and welding, brazing, and pipe bending.]

***Bureau of Information on Nickel.** *Heat-Resisting Alloys.* (F 2.) Sup. Roy. 8vo. Pp. 28, illustrated. [1935.] London: The Bureau, Thames House, Millbank, S.W.1. (Gratis.)

***Bureau of Information on Nickel.** *Recommended Materials for Electrical Appliances.* (AA 8.) Sup. Roy. 8vo. Pp. 6. [1935.] London: The Bureau, Thames House, Millbank, S.W.1. (Gratis.)

**Cheftel, H.** *La corrosion du fer-blanc et l'Industrie des conserves alimentaires.* Pp. 78. Paris: Gauthiers-Villars et Cie. (9 francs.)

***Copper Development Association.** *Some Facts for Architects and Others Interested in Building about Copper Alloy Extruded and Drawn Sections* for such Purposes as: Handrails and Balustrades; Doors, Windows, and Glazed Screens; Architraves, Skirtings, and Picture Rails; Shop Fronts and Showcases; Cover Strips and General "Trim" and Architectural Metalwork of all kinds. 7¼ in × 8½ in. Pp. 24, illustrated. [1935.] London: The Association, Thames House, Millbank, S.W.1. (Gratis.)

**Creighton, H. Jermain.** *Principles and Applications of Electrochemistry.* Volume I.—*Principles of Electrochemistry.* Third Edition, revised and enlarged. Med. 8vo. Pp. xviii + 502. New York: John Wiley and Sons, Inc. ($4.00); London: Chapman and Hall, Ltd. (20*s.* net).

***de Croes, J.** *Les emplois industriels du Gaz dans la métallurgie.* (Extrait du Bulletin de l'Association des Gaziers Belges, Année 1934.) 8½ in. × 12 in. Pp. 138, with 284 illustrations. 1934. Bruxelles : Électricité et Gaz de l'Agglomération Bruxellois (Électrogaz) S.A.

***Duesing, F. W.,** und **A. Stodt.** *Freiformschmiede.* Erster Teil. *Grundlagen, Werkstoff der Schmiede, Technologie des Schmiedens.* Zweite, völlig neu bearbeitete Auflage des zuerst von P. H. Schweissguth bearbeiteten Heftes. (Werkstattsbücher für Betriebsbeamte, Konstrukteure und Facharbeiter. Herausgeber Eugen Simon. Heft 11.) Med. 8vo. Pp. 60, with 161 illustrations. 1934. Berlin : Julius Springer. (R.M. 2.)

***Favalora, E. W.** *Practical Design of Exhaust and Blower Systems.* Demy 8vo. Pp. ix + 274, with 91 illustrations. 1935. New York : Edwin A. Scott Publishing Co., Inc. ($5.00.)

***Glasstone, S.,** and **A. Hickling.** *Electrolytic Oxidation and Reduction : Inorganic and Organic.* (Being Volume Nine of a Series of Monographs on Applied Chemistry under the Editorship of E. Howard Tripp.) Demy 8vo. Pp. ix + 420, with 31 illustrations. 1935. London : Chapman and Hall, Ltd. (25*s.* net.)

***Hodgman, Charles D.** (Editor-in-Chief). *Handbook of Chemistry and Physics. A Ready-Reference Book on Chemical and Physical Data.* Twentieth Edition. Fcap. 8vo. Pp. xiv + 1951. 1935. Cleveland, O. : Chemical Rubber Publishing Co. ($6.00.)

***Iron and Steel Institute.** *Charter, Bye-Laws, and List of Members and Associates of the Iron and Steel Institute.* (Corrected to July 31, 1935.) Demy 8vo. Pp. 96. 1935. London : The Institute, 28 Victoria St.

***Iron and Steel Institute.** *Symposium on the Welding of Iron and Steel.* Volume I.—*Present-Day Practice and Problems of Welding in the Engineering Industries.* Pp. xx + 676, illustrated. Volume II.—*Welding Practice and Technique, including Welding Apparatus. The Metallurgy of Welding. Specification, Inspection, Testing, and Safety Aspects of Welding.* Pp. vii + 974, illustrated. Demy 8vo. 1935. London : The Institute, 28 Victoria St. (Two volumes, £2 2*s.* + postage (Great Britain, 1*s.*; other countries, 2*s.*); members of I. and S.I., 30*s.* + postage.)

***Junior Institution of Engineers.** *Index to Papers Published in the Journal from 1885 to 1935.* Compiled by Herbert G. Riddle. Demy 8vo. Pp. 39. [1935.] London : The Institution.

**Kautny, Theo.** *Leitfaden für Azetylenschweisser. Verschmelzen und Durchbrennen von Metallen.* 11 Auflage. Herausgegeben von Hermann Holler. Pp. viii + 284. 1935. Halle: Carl Marhold. (M. 4.50.)

**Koehler, Walter A.** *Principles and Applications of Electrochemistry.* Volume II.—*Applications.* Pp. 568. New York : John Wiley and Sons, Inc. ($5.00.)

***Kroenig, W. O.,** and **S. E. Pavlov.** *Corrosion of Magnesium Alloys.* Part V.—*The Influence of Manganese on the Corrosion of Magnesium.* [In Russian, with English Summary.] (Transactions of the Research Institute for Aircraft Materials, No. 30.) Roy. 8vo. Pp. 34, with 24 illustrations. 1935. Moscow and Leningrad : ONTI. (75 k.)

**Library Association.** Issued by the. *The Subject Index to Periodicals, 1934.* Roy. 4to. Pp. xii + 283. 1935. London: Library Association. (70*s.*)

***McWilliam, Andrew,** and **Percy Longmuir.** *General Foundry Practice.* Fourth Edition. Revised throughout and enlarged by Percy Longmuir. Med. 8vo. Pp. viii + 457, with 2 plates and 303 illustrations in the text. 1935. London: Charles Griffin and Co., Ltd. (21*s.* net.)

***Mathewson, C. H.** Edited by. *Modern Uses of Non-Ferrous Metals.* By F. M. Becket, J. O. Betterton, F. E. Carter, E. W. Engle, B. E. Field, F. C. Frary, J. A. Gann, J. E. Harris, Zay Jeffries, R. H. Leach, K. C. Li, D. J. Macnaughtan, C. H. Mathewson, P. D. Merica, W. E. Milligan, W. M. Peirce, W. H. Phillips, C. N. Schuette, W. C. Smith, W. S. Sykes, E. M. Wise, and W. A. Wissler. (A.I.M.M.E. Series.) Post 8vo. Pp. x + 427, illustrated. 1935. New York: American Institute of Mining and Metallurgical Engineers. ($3.00 net.)

**Metallurgy.** *Métallurgie. Construction mécanique et électrique.* Pp. 224. Forest-Bruxelles: D. Hallet. (30 Belgian francs.)

***Metals and Alloys.** *Cumulative Index of Metallurgical Abstracts published in Vols. III–V of "Metals and Alloys," January 1932–December 1934.* 8 in. × 11 in. Pp. 272. 1935. New York: Reinhold Publishing Co. ($10.00.)

***Mitchell, Robert W.** *The Metal Cleaning Handbook.* Med. 8vo. Pp. 213, with 287 illustrations. 1935. Garwood, N.J.: Magnus Chemical Co. ($1.00.)

***Monier-Williams, G. W.** *Aluminium in Food.* (Ministry of Health. Reports on Public Health and Medical Subjects, No. 78.) Med. 8vo. Pp. 34, with 1 illustration. 1935. London: H.M. Stationery Office. (9*d.* net.)

***van Nieuwenburg, C. J.** *A Short Manual of Systematic Qualitative Analysis by Means of Modern Drop Reactions.* Second Edition. Med. 8vo. Pp. 96. 1935. Amsterdam: D. B. Centen's Uitg. Maatschappij (N.V.). (Fl. 3.75.)

***Office International de Chimie.** *International Repertory of Centres of Chemical Documentation.* 8½ in. × 11¾ in. Pp. 115. [1935.] Paris: Office International de Chimie, 28 Rue Saint-Dominique (7e).

**Permanent Consultative Committee on Official Statistics.** *Guide to Current Official Statistics of the United Kingdom.* Volume 13 (1934): Being a Systematic Survey of the Statistics appearing in all Official Publications issued in 1934. Roy. 8vo. Pp. 350. 1935. London: H.M. Stationery Office. (1*s.* net.)

**Sauveur, Albert.** *Metallurgical Dialogue.* Pp. 166. Cleveland, O.: American Society for Metals. ($3.00.)

***Schramm, J.** *Kupfer–Nickel–Zink–Legierungen.* Die Gleichgewichtsgesetze bei und nach der Erstarrung, sowie ihr Gefügeaufbau nach Ergebnissen des thermischen, mikroskopischen und röntgenographischen Verfahrens. Med. 8vo. Pp. 129, with 126 illustrations. 1935. Würzburg: Verlag Konrad Triltsch. (R.M. 4.)

**Seldin A.** *The Practice of Chromium Plating.* [In Russian.] Pp. 135. 1935. Moscow and Leningrad: ONTI. Glaw. red. lit-ry po tschernoi metallurgii. (Rbl. 1.)

**Shdanow, W. A.,** and **W. L. Zegelski.** *Arc Welding with Metallic Electrodes.* [In Russian.] Second Edition. Pp. 136. 1935. Moscow and Leningrad: ONTI. Glaw. red lit-ry po maschinostrojeniju i metalloobrabotki. (Rbl. 1.20.)

***Society of British Aircraft Constructors.** *International Index to Aeronautical Technical Reports.* Med. 8vo. Pp. 157. 1935. London: Sir Isaac Pitman and Son, Ltd. (5*s.*)

**Sserebrowski, A. P.** *The Gold Industry.* [In Russian.] Volume III. Pp. 617. 1935. Moscow and Leningrad: Isd-wo Akad. nauk S.S.S.R. (Rbl. 23.)

***Sutton, Francis.** *A Systematic Handbook of Volumetric Analysis.* Twelfth Edition. Revised throughout, with numerous Additions, by **A. D. Mitchell.** Demy 8vo. Pp. xvi + 631, with 128 illustrations. 1935. London: J. and A. Churchill, Ltd. (35*s.*)

***Taylor, F. Johnstone.** *Workshop Practice. A Practical Text-Book.* Cr. 8vo. Pp. xx + 759, with 542 illustrations. 1935. London: Technical Press, Ltd., 5 Ave Maria Lane, E.C.4. (16*s.* net.)

**Taylor, F. Sherwood.** *Tables for Qualitative Analysis.* 14 cards. 10 in. × 7 in. 1935. London: William Heinemann. (1*s.* 3*d.*)

***Treadwell, F. P.,** and **William T. Hall.** *Analytical Chemistry.* Volume II.—*Quantitative Analysis.* Based on the text of F. P. Treadwell; translated, enlarged, and revised by William T. Hall. Eighth Edition, rewritten and reset. Pp. xiii + 858, with 153 illustrations. 1935. New York: John Wiley and Sons, Inc. ($6.00); London: Chapman and Hall, Ltd. (30*s.*).

***Wiggin and Company, Ltd., Henry.** *The Machining and Grinding of Monel Metal.* (The Second of a Series of Working Instructions.) Sup. Roy. 8vo. Pp. 8, with 7 illustrations. [1935.] London: The Company, Thames House, Millbank, S.W.1. (Gratis.)

---

## XXIV.—BOOK REVIEWS

(Continued from pp. 550–552.)

**Cast Metals Handbook.** 1935 Edition. Med. 8vo. Pp. xii + 424 + 76, with 125 illustrations and 125 tables. 1935. Chicago: American Foundrymen's Association. ($4.00.)

This volume has been produced as the joint effort of a number of committees of experts, under the auspices of the American Foundrymen's Association, with the object of presenting to designers, engineers, students, and users of castings, condensed, up-to-date, and authoritative data on cast metals.

Writers on foundry topics have long urged the need for closer co-operation and better understanding between the designer and the foundry, and this work contains a wealth of information which should prove helpful to both in bridging the gap.

The first section, "Recommendations to Designers," lays down precepts which will be endorsed heartily by all foundrymen, whilst the second section for "Buyers of Castings" sets out the information which should be furnished when enquiring for castings. The remaining sections deal, respectively, with cast iron, malleable iron, cast steel, and non-ferrous casting alloys.

The information is well presented and remarkably comprehensive, and includes numerous graphs and tables, which collect and summarize much important work. The sections on cast iron and cast steel include useful bibliographies. Unfortunately, the non-ferrous alloys have not been accorded the same thorough consideration and treatment. In the foreword to this section it is stated that in accordance with the A.S.T.M. recommendation to reduce the number of alloys of similar composition and properties, the data given are confined to what are considered the more standard casting alloys and "that essential data for certain properties are lacking for some alloys." Whilst agreeing with the principle of elimination of duplication of similar alloys, it is regretted that in these circumstances the information given should be so sparse. This section contains no micrographs, diagrams, graphs, or bibliography, and it is to be hoped that in future editions this section may be brought to the same high standard as the others.

A full index is provided and the book is well printed and bound, and the price is reasonable.

—J. E. Newson.

**Review of Oxidation and Scaling of Heated Solid Metals.** (Department of Scientific and Industrial Research.) 8vo. Pp. vii + 104, with 5 illustrations. 1935. London: H.M. Stationery Office. (2*s.* 6*d.* net.)

This critical survey of existing knowledge of the oxidation and scaling of heated solid metals has been prepared under the auspices of the Metallurgy Research Board of the Department of Scientific and Industrial Research, as a prelude to further research work.

The review is in six sections, each contributed by a well-known authority, and deals with theoretical aspects of oxidation, constitution and formation of scale on ferrous alloys, quantitative aspects of the oxidation and scaling of iron and steel at elevated temperatures, the oxidation of non-ferrous metals, oxidation and scaling of ferrous metals from an industrial point of view, and the practical aspects of the oxidation and scaling of non-ferrous alloys. Attention is directed to problems requiring further research. Each section concludes with a list of references which should prove invaluable to those interested in the theoretical and practical aspects of this subject.

This happy combination of the theoretical and practical consideration of the oxidation and scaling of both ferrous and non-ferrous metals and alloys should ensure a very wide sale for the volume. In fact, unless this was anticipated it is difficult to see how it is possible to produce such an excellent volume for the very low price of 2*s.* 6*d.*—S. V. Williams.

**Handbuch der Metallspritz-Technik.** Von M. U. Schoop und C. H. Daeschle. 4to. Pp. 170, with 96 illustrations. 1935. Zurich, Leipzig, Stuttgart, u. Wien: Rascher & Cie A.G. Verlag. (Kart, M. 8; Lw., M. 10.)

The book which the inventor of the now widely used metal-spraying process produced with Gunther, in 1917, is now out of print and the present volume may be regarded as a re-issue of that volume and an attempt to bring the subject up to date for German readers who are ignorant of developments of the process in other countries. No endeavour is made in this book to refer to the extensive American and English literature on the subject; of the twelve references given, only one is other than German and that refers to Nicolardot's pre-war work. Since the process is now widely used and supported by powerful interests, the book cannot be regarded in English-speaking countries as giving a satisfactory picture of the present state of the process in industry.

From the point of view of the history of the process, however, this book is probably the only one in existence in which one can follow those most interesting early experiments which led to the perfection of Schoop's original invention. Any serious student of metal spraying would be well advised to read this book, as it illustrates very clearly the almost innumerable systems of operation which have been considered, tried, and rejected before arriving at the three or four fairly widely-used systems of operation now used in industry. When an English book appeared, about 10 years ago, dealing with the subject, it was criticized on the assumption that the process would be of little value. Justification for the present volume lies in the fact that the process has found world-wide application in a great variety of industries and also in the fact that one of the authors is the inventor of the system most widely used.—T. Henry Turner.

**Untersuchungsmethoden für zyankalischer Bäder.** Von Hermann Wagner. Med. 8vo. Pp. 51, with 3 illustrations. 1935. Leipzig: Max Jänecke. (R.M. 1.80.)

Satisfactory control of the operation of cyanide plating baths can be obtained only by maintaining the composition within certain well-defined limits, which naturally necessitates frequent analysis of the bath, not only for its content of essential constituents but also for the presence of deleterious impurities which may accumulate during use, either by decomposition of some of the bath constituents or by the introduction of foreign matter from the material being plated. In this little mimeographed booklet Dr. Wagner has collected a number of useful analytical procedures for the examination of silver, gold, copper, zinc, cadmium, and brass plating baths containing the metals as double cyanides. In all cases the chemistry of the process is explained and exact analytical details are given; in addition the electrochemical reactions which occur during plating are described and the function of the various constituents of the bath is briefly discussed. The book should prove very useful to students of electroplating and to electroplaters who can read German.—A. R. Powell.

**Platers' Guidebook.** By Oliver Sizelove. Fourth Edition Demy 8vo. Pp. 64. 1935. New York: Metal Industry Publishing Co. (25 cents.)

Bath compositions and operating data are given for plating baths used in the deposition of nickel, copper, brass, bronze, zinc, tin, chromium, cadmium, lead, iron, silver, gold, and rhodium. In addition there are short sections describing methods of testing the protective value of plated coatings on steel, methods of obtaining coloured finishes on silver, copper, and brass, methods of anodically oxidizing aluminium and its alloys, simple methods of analyzing plating solutions, and methods of pickling and descaling ferrous metals for plating. Altogether a mine of useful information for the foreman plater and his assistants is presented in a readily assimilable tabloid form.—A. R. Powell.

**Buffing and Polishing Methods. Reference Book and Complete Instruction Manual.** Fourth Edition. Pp. 96. 1935. Waterbury, Conn.: Lea Manufacturing Co. ($1.)

This edition of a useful workshop handbook contains 118 recipes for polishing and buffing all kinds of ferrous and non-ferrous alloys and some non-metallic materials, such as wood, vulcanite, and Bakelite, using the special proprietary compounds manufactured by the publishers. In addition useful notes are included on the selection, care, and maintenance of wheels for polishing and buffing.—A. R. POWELL.

**Law and Practice of Hall-Marking Gold and Silver Wares. With a Chapter on Licences to be Taken Out by Auctioneers, Pawnbrokers, and Dealers in Gold and Silver Plate.** By J. Paul de Castro. Second Edition, enlarged. Pp. xxxvii + 372. 1935. London: Technical Press Ltd., 5 Ave Maria Lane, Ludgate Hill, E.C.4. (21*s*.)

The principal change in this edition is the insertion of a preliminary chapter of 17 pages dealing with changes in the law and practice of hall-marking during the years 1925–1935. These concern chiefly the introduction of 14- and 9-carat standards in place of 15- and 12-carat, the "weighting" of silver ware, the hall-marking of "solder-filled" wire, hall-marking charges, the Jubilee Mark, Irish hall-marking, licences to deal in gold and silver plate, forged hall-marks, &c. The effect of these additions is to bring the book right up to date and to increase its usefulness to all who are concerned in the manufacture and sale of gold and silver ware.—A. R. POWELL.

**Liquid Fuels: Their Manufacture, Properties, Utilization, and Analysis. A Practical Treatise for Engineers and Chemists.** By Harold Moore. Med. 8vo. Pp. viii + 263, with 65 illustrations. 1935. London: The Technical Press, Ltd. (21*s*. net.)

This book, in effect, replaces the author's earlier volume on "Liquid Fuel for Internal Combustion Engines." The scope is enlarged and now embraces fuels for external combustion in addition to those for purely engine purposes. It is a concise manual intended to serve the needs of a variety of people—those engaged in oil production and utilization, engineers, and students. It has also much useful information for the industrial chemist.

The six parts into which the book is divided deal, respectively, with: (1) the chemistry of liquid fuels; (2) preparation of liquid fuels; (3) the relationships between the chemical and physical properties of fuels and engine efficiency; (4) fuels for internal combustion; (5) fuels for external combustion; (6) the significance of tests and analytical methods.

The section on the chemistry of liquid fuels is a simple review of the organic constituents and their relative configurations and properties. The compounds of oxygen, of sulphur and of nitrogen, which are occasionally found in oils in small quantities, are also mentioned. After chapters on the preparation of liquid fuels: the nature of the products from shale oil, coal tars, lignite tars, and from the distillation of wood, peat, and animal and vegetable oils; synthetic fuels; the relationship between fuels and engine efficiency; and the properties requisite in fuels for engines fitted with carburettors and vaporizers and for those fitted with atomizers—of the Diesel or semi-Diesel type; the author deals with fuels for external combustion, those mentioned being "bottled gas," consisting of 95–99% propane, liquefied butane, kerosene, the gas-oil fraction of crude oils, and residual fuel-oils. Various types of burners for the domestic and industrial utilization of oil are illustrated and described. In the last section standard and specialized methods of analysis are given. The relative importance and application of the various tests are discussed. The Horning engine, which has been specially designed for research purposes, is described and illustrated.

The book is well produced. In comparatively few pages the salient points of production and use are well covered.—W. A. C. NEWMAN.

**Anwendungen der Durchstrahlungsverfahren in der Technik.** Von J. Eggert und E. Schiebold. Ergebnisse der technischen Röntgenkunde. Band V. Pp. vi + 118, with 118 illustrations. 1935. Leipzig: Akademische Verlagsgesellschaft m.b.H. (Brosch., R.M. 13.50; geb., R.M. 15.)

In certain human activities, time is, as it were, taken by the pre-forelock: the 6.30 p.m. editions of our London daily papers appear shortly after noon, and the 1936 models of radio-receivers and motor-cars have already been on the market for some months (I write this in November 1935). In the application of scientific discovery to industrial invention there would appear to be, however, considerable time-lag. More than 40 years elapsed before Maxwell's theoretical work and Hertz's pioneering experimental researches finally gave us broadcasting as we know it to-day. And what of industrial applications of X-rays and other penetrating radiations? The medical profession was quick in its perception of the application of these discoveries to the diagnosis (I wish I could say the cure) of disease. In our heavy industries, however, these radiations have not been employed to anything like the extent they might be. X-rays, I am afraid, are being too exclusively regarded as a tool for the hand of the research worker in the laboratory, for the examination of crystal structure, &c. This book should do much to remove this notion, for it sets out how X-rays and other penetrating radiations have been and are being applied to supply most valuable information in the building of railways, airships, bridges, boilers, and in heavy industrial operations generally. The fare is solid and substantial, like roast beef and Yorkshire pudding. The work has been done principally in Germany; a little has originated at Woolwich Arsenal. A cynic has remarked that this age which invented the loud-speaker has nothing to say worth saying. That is not the case; it is merely that people are indisposed to listen. Well here is a book saying much that is worth saying. It has much to interest our industrialist leaders. It is nicely got up, is well printed on good paper, is profusely illustrated, and is provided with adequate name and subject indexes and valuable exposure data. I recognize only three amongst the names of authorities cited—the others are presumably of high industrial standing. Despite the book's rather high price, I most strongly recommend it to the notice of all concerned with metallurgical operations.—J. S. G. Thomas.

**Annual Reports on the Progress of Chemistry for 1934.** Volume XXXI. Pp. 442. 1935. London: Chemical Society. (10*s.* 6*d.*)

This volume of the Chemical Society's Annual Reports contains several sections of interest to the members of this Institute, probably the most interesting being the very able review of modern trends in research on the corrosion of metals written by E. S. Hedges. The author discusses recent work on film formation and passivity with special reference to W. J. Müller's theory of "*Bedeckungspassivität*," corrosion in aqueous solution, and atmospheric corrosion; the work described covers a period of several years and the review presents a lucid account of modern thought on this most important subject. Other monographs with more or less metal interest are those on metallic carbonyls and on some rarer metals (germanium, gallium, indium, and rhenium) by W. Wardlaw, and on the use of organic reagents in the determination of metals by B. A. Ellis. In addition to these "metal" subjects the book contains thoughtful and well-written reviews of practically all branches of pure chemistry: physical, inorganic, organic, and biochemical. Modern progress in the more complex branches of the science is well illustrated by the monographs on heavy hydrogen, vitamins, and hormones. Taken altogether the Reports provide a fascinating picture of the wide ramifications of chemical research, an excellent guide to the research worker, and a means of keeping the specialist in touch with progress in fields outside his own.—A. P. Powell.

**Annual Survey of American Chemistry.** Volume IX. 1934. Edited by Clarence J. West. Demy 8vo. Pp. 396. 1935. New York: Reinhold Publishing Corp. ($4.50.)

This volume follows the usual lines of these Reports in giving a broad survey of the advances in pure and applied chemistry made by American investigators during 1934. Only two chapters are of non-ferrous metal interest, namely those on Non-Ferrous Metals by Sam Tour and on Advances in Electrochemical Practice by C. L. Mantell. The former makes no attempt to cover theoretical metallurgy, which was the subject of a Technical Publication of the A.I.M.M.E., but "is confined to an outline of the increasing development in the fabrication and application of non-ferrous metals during the last few years"; in actual fact it consists only of a collection of rather vague notes on numerous not very new uses to which copper, aluminium, magnesium, zinc, lead, and nickel and their alloys have been put during the last 5 years or so. The electrochemical section covers only 4½ pages and also is not very informative except to direct attention to 51 papers in the A.I.M.M.E. Transactions and the Transactions of the Electrochemical Society. The main fault to be found with most of the other articles is their tendency to become mere catalogues; in very few cases is a broad outline of the outstanding advances given, generally an attempt has been made to mention, irrespective of its merits, every paper, and frequently also every patent, in the field covered by the article.—A. R. Powell.

BIBLIOTEKA POLITECHNIKI ŚLĄSKIEJ

Made by

EXTRUDED RODS AND SECTIONS

PRESSINGS, CHILL CAST BARS, AND INGOTS.

McKECHNIE BROTHERS LIMITED

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

METAL WORKS: ROTTON PARK STREET, BIRMINGHAM 16

*Telephone: Edgbaston* 0180 (7 *lines*).

*Telegrams: "McKechnie, Birmingham"*

LONDON—17 Victoria St., Westminster, S.W. 1.
NEWCASTLE-ON-TYNE—90 Pilgrim Street.
MANCHESTER—511-13 Corn Exchange Bldgs. 4
LEEDS—Prudential Buildings, Park Row.
SMELTING WORKS: WIDNES, LANCS.

---

EMPIRE

'AZ' BRAND
**CADMIUM**
99·95% GUARANTEED

C.C.R. BRAND
**SELENIUM**

**THE BRITISH METAL CORPORATION LTD.**

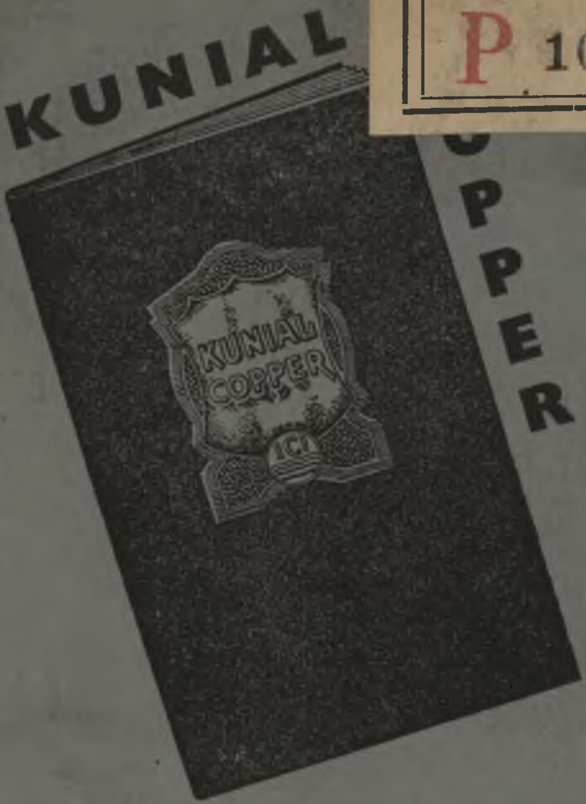
PRINCES HOUSE,
93 GRESHAM STREET,
LONDON, E.C.2

'Phone: METROPOLITAN 0111.

BIRMINGHAM
'Phone: CENTRAL 6441.

SWANSEA
Phone: SWANSEA 3166.

BIBLIOTEKA GŁÓWNA
Politechniki Śląskiej
P 100/35



Kunial copper possesses the same general characteristics as Kunial brass in respect of the effects produced by a simple reheating.
Kunial copper, however, does not work harden to the same extent as Kunial brass. The other interesting properties and applications of Kunial copper are described in detail in

**THE BOOKLET ILLUSTRATED ABOVE WHICH WILL BE SUPPLIED ON REQUEST.**

**I.C.I. METALS LTD.,**
(A subsidiary company of Imperial Chemical Industries Ltd.)
**KYNOCH WORKS, WITTON, BIRMINGHAM, 6.**

**I.C.I. METALS LTD., Kynoch Works, WITTON, BIRMINGHAM, 6.**

Please send me free copy of booklet "Kunial Copper."

*Name* ____________________

*Address* ____________________

____________________

21

Printed in Great Britain by Richard Clay and Sons, Ltd., Bungay, Suffolk.