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1935, Vol. LVII.

Vol. 2.

Part 5.

*The Monthly Journal of the*

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MAY, 1935



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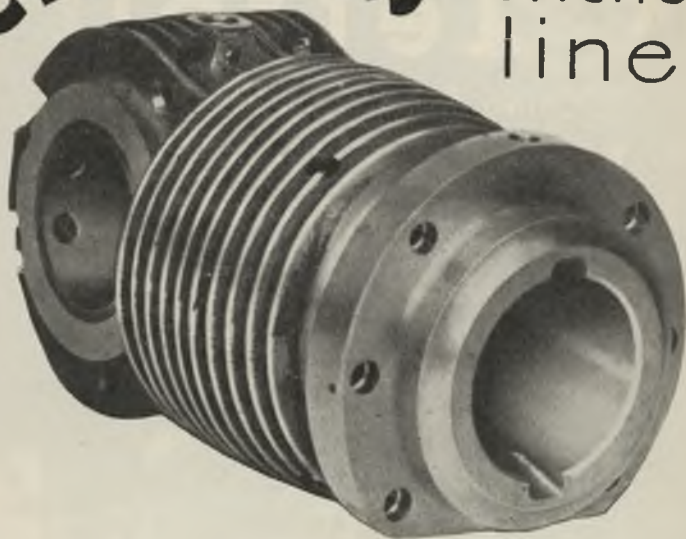
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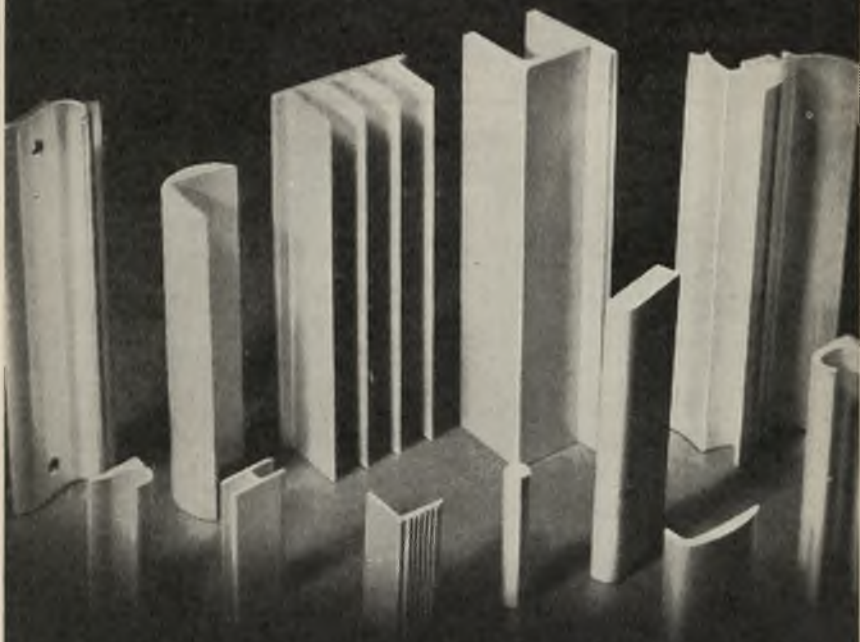
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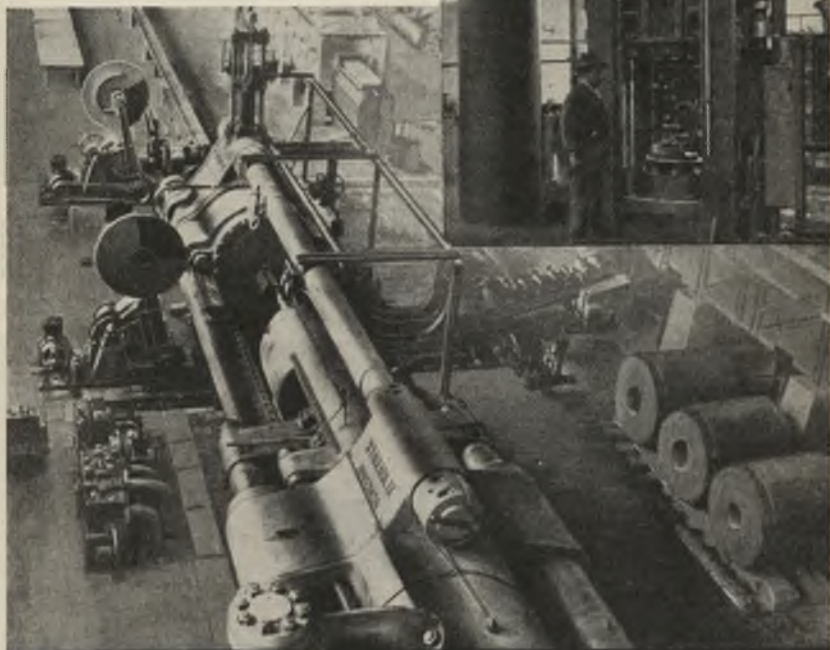
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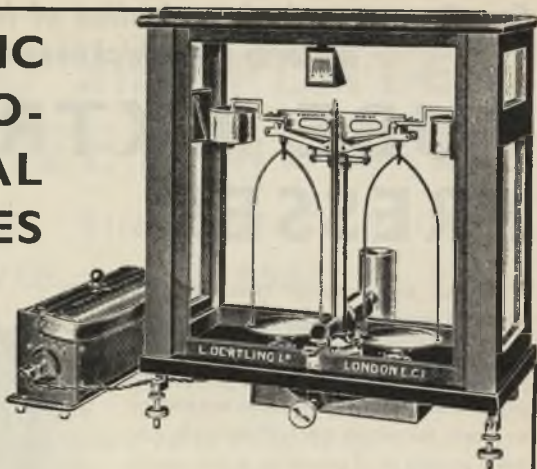


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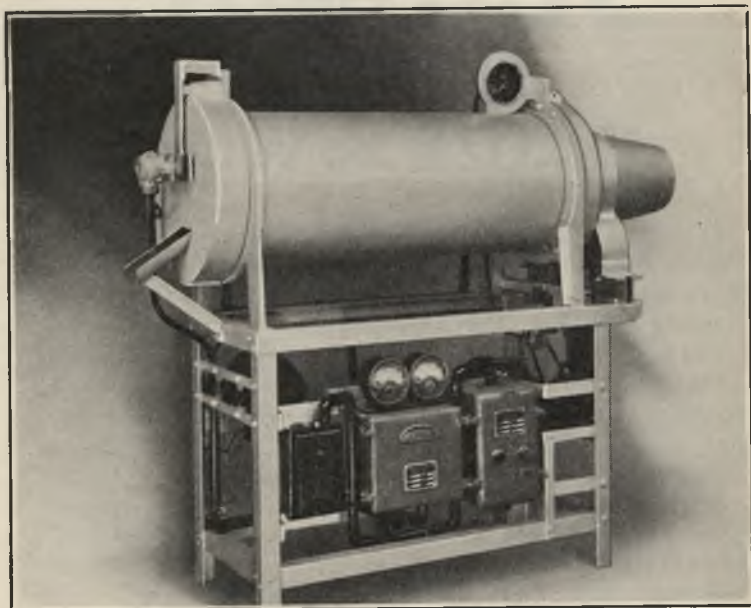
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Volume 2

MAY, 1935

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# INSTITUTE NEWS AND ANNOUNCEMENTS

## Council Nominations for 1936-1937.

At the Autumn Meeting to be held in Newcastle-on-Tyne from September 9 to 12, the Council will present a list of names of persons nominated for office in the year 1936-1937.

In accordance with the Rules, "Any ten members may also, at or before such ordinary general meeting, nominate in writing, with the written consent to act if elected of the person nominated, any duly qualified person other than one of those nominated by the Council. . . ."

## May Lecture.

At a General Meeting of the Institute held (by courtesy of the Council of the Institution) in the Hall of the Institution of Mechanical Engineers, London, on May 8, Professor W. L. Bragg, F.R.S., delivered the Twenty-Fifth Annual May Lecture on "Atomic Arrangement in Metals and Alloys." The lecture was given before a large audience, and afterwards members met for light refreshments and conversation.

The lecture will be published in the bound volume of the Proceedings (Volume LVI) that will be despatched next month to all members whose subscriptions are not then in arrear.

## Proposed General Index.

The attention of members is directed to a notice appearing on p. 242 of this issue, regarding the proposed General Index.

All members have received a circular and reply form with reference to the index and are requested to return the reply form without delay. Unless sufficient orders for the index are received *in advance*, the work cannot be put in hand.

Members who have mislaid their reply forms may obtain a duplicate on application to the Secretary.

## Annual Subscriptions.

Will members, particularly those residing Overseas, be good enough

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

## Membership Additions.

The following persons were elected on May 8, 1935 :

### *As Members.*

ADAM, James Norman, Bishopton.  
BACHMETEW, Professor Eugen Theodor, Moscow, U.S.S.R.  
BAILLIEU, Clive Latham, C.M.G., O.B.E., M.A., London.  
BELL, William Charlton, London.  
BIRKS, Norman Arthur, Assoc. Met., London.  
DYBOWSKI, Jan., Warszawa, Poland.  
FRIEDMAN, Leopold, Edgware.  
GIERDZIEJEWSKI, Casimir, Warszawa, Poland.  
GOODCHILD, Edmund Arthur, Chelmsford.  
HARRIS, Arnold William Elsmere, B.Sc., Birmingham.  
HRST, Thomas Bayliss Verney, London.  
HUDSON, Harold Edward, Birmingham.  
JANNETTO, Nicholas Anthony, Cleveland, O., U.S.A.  
LEWIS, William Richard, B.Sc., London.  
MATTHEWS, Howard David, B.S., E.E., Attleboro, Mass., U.S.A.  
MORRELL, Eric, Durham, North Carolina, U.S.A.  
PLAKSIN, Professor Igor Nicolas, Moscow, U.S.S.R.  
WAKEHAM, Frank, Hadley Wood.

### *As Student Members.*

BLACK, Archibald Niel, B.A., London.  
PARKER, Ronald, Luton.

## PERSONAL NOTES

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

DR. N. P. ALLEN, M.Met., until recently Lecturer in Metallurgy at the University of Birmingham, has been appointed Senior Research Metallurgist in the Research and Development Laboratory of the Mond Nickel Company, Ltd.

MR. P. G. BAMFORD, B.E., will shortly be on six months' leave of absence from Christchurch, New Zealand, and correspondence may be sent to him up to November 30 addressed BM/AMHS, London, W.C.1.

MR. ALFRED CHESTER BEATTY has been awarded the gold medal of the Institution of Mining and Metallurgy, the highest honour which it is in its power to bestow, in recognition of his distinguished services to the mining industry, and of his far-sighted vision as a mining engineer in the development of mineral deposits, with particular reference to the copper resources of Northern Rhodesia.

PROFESSOR G. H. STANLEY, D.Sc., A.R.S.M., Corresponding Member to the Council for South Africa, has been appointed Director of the new Minerals Research Laboratory, University of the Witwatersrand, Johannesburg, South Africa, for the establishment and operation of which a special grant of £6000 has been made by the Government Mines Department.

### Obituary.

PROFESSOR W. R. E. HODGKINSON, C.B.E., Ph.D., M.A., died at his residence in Blackheath on April 8 at the age of 83 years. Professor Hodgkinson was an Original Member of the Institute and, with one exception, its oldest member.

## EDUCATIONAL TOUR TO GERMANY

Forty students took part in the Institute's second Educational Tour, which this year took place in Germany and lasted from April 7 to 16. The tour was arranged in co-operation with the National Union of Students and was even more strenuous than the Belgian Tour last year.

Aachen, Cologne, and Düsseldorf were the three main centres from which the various trips were made. In between the various works' visits, many places of other than purely technical interest were seen or visited. The whole tour was splendidly arranged, not a moment was wasted, and everything for which Germany is renowned was enjoyed to the utmost in the short time available.

The following works and institutions were visited:

*Technische Hochschule, Aachen.*—Like all German Technical High Schools, this ranks equally high with the Universities and it is interesting to note that the demand in Germany for trained scientific men is so great that students of the Hochschule can obtain appointments before they have completed their courses. The party was shown over the Neumann Institut, which comprises the metallurgical sections of the Hochschule. In addition to the training provided, a great deal of research is carried out here with the help of magnificent apparatus and equipment. The Maschinen Laboratorium and Departments of Physics and Electro-technics were also inspected.

*Asten & Lynen, Stolberg.*—These are the oldest brass works in the world, but although of such historic interest, are completely modernized. Metal was being melted in gas-fired or electric furnaces and cast into Junker water-cooled moulds. Hot-rolling of brass and bright-annealing were in accordance with latest practice. Much hand-spinning of brass articles was also being carried out.

*Dürener Metallwerke A.G.*—Here are produced light alloys of the Duralumin type as well as heavy non-ferrous alloys. Large extrusion presses were seen in operation to-

## Educational Tour to Germany

gether with hot-forging, stamping, and rolling.

*Felten & Guillaume Carlswerk A.G.*—An enormous works producing an astonishing variety of articles on the one factory site—from nails and wire-netting to electric cables and steel cables for mines and suspension bridges. Some of the manufacturing processes were seen together with the testing of a stranded steel cable,

mann process, and the manufacture of locomotive fire-boxes.

*Forschungslaboratorium der Vereinigten Stahlwerke A.G.*—This was another magnificent research organization. Amongst other things shown were fatigue testing machines, torsion and bending tests, impact tensile tests on chains, the Losenhausen pulsator, creep tests, and corrosion tests.



The German guides and some of the party after visiting the works of Felten & Guillaume. The rest of the party are in the bus.

calculated to fail at a dead load of 240 tons and actually failing at 239 tons.

*Kaiser-Wilhelm Institut für Eisenforschung, Düsseldorf.*—The demand in Germany for research facilities is so great that the Institut is having to remove to a larger establishment. In spite of this, the remaining apparatus and equipment was very impressive.

*Vereinigte Deutsche Metallwerke, Duisburg.*—Here were seen the extrusion of non-ferrous sections, the production of tubes by the Mannes-

*Dortmunder Union Brauerei A.G.*—The “high spot” of the tour in more ways than one. After examining metallurgical aspects of the plant the party was invited to a “Kneipe” (English translation: a “let up”).

*Fried. Krupp A.G., Essen.*—The most extensive works visited. Blast-furnaces and the manufacture of steel were inspected together with the forging of a 100-ton steel billet in a 15,000-ton press, a most impressive spectacle.

*J. A. Henckel, Solingen.*—The famous “Twin” brand knives, scis-

## Educational Tour to Germany

sors, &c., were seen in course of manufacture, considerable admiration being aroused for the high degree of craftsmanship involved.

The predominant impression gained from the tour was the immense importance which German industry attaches to scientific research and the utmost use which is made of all technical and other resources.

Greatest thanks are due to the Directors and Staff of the various firms for their courtesy, trouble, and superb hospitality, and also to Messrs. Dockhorn and Rüschkamp who so successfully conducted the party throughout the German part of the Tour.—A. B.

### Internal Stresses in Metals and Alloys.

DR. HAROLD MOORE, C.B.E., President of the Institute, will deliver the second and third of three lectures on the above subject, under the auspices of the Company of Armourers and Brasiers, on Monday, May 20, and Monday, May 27, at the Sir John Cass Technical Institute, 31 Jewry Street, Aldgate, London, E.C., at 7 p.m. Admission is free, without ticket. All members of the Institute and their friends who may be interested in the subject are cordially invited to attend.

### Abstracting Service.

Authors of papers, books, or technical articles of direct or indirect interest to the science or practice of non-ferrous metallurgy, are requested to forward copies to the Institute in order that the abstracting and review service may be made complete. Loose copies are also found to be of value in the Library.

The Institute's library desires to be placed on mailing lists to receive copies of non-ferrous metallurgical **trade literature** from all parts of the world.

Copies of unpublished theses are also requested, for permanent preservation in the Institute's library.

### Periodical: "Metals and Alloys."

A copy of the February, 1935, issue of *Metals and Alloys* is required to complete the Institute's Library file. Will any member who is prepared to give or sell a copy of this issue kindly communicate with the Librarian? Copies of this issue are not obtainable now from the publisher.

### Film Symposium on Welding.

To afford visitors to London an opportunity to acquaint themselves with the important advances which have been made in welding, British Industries House Engineering Section has arranged a display of films, accompanied by commentaries, to be held on May 22 and 29, 1935, between the hours of 5 and 7 p.m. Persons interested may ask questions, which will be answered by the experts who will be in attendance during the film display. The films will primarily represent progress throughout the United Kingdom and Dominions, but will also embody features of special interest from other parts of the world.

A tea reception will be held in British Industries House Clubrooms, Marble Arch, W.1, between 4 and 5 p.m. each afternoon. The films are being shown by the courtesy of: Acetylene and Welding Consulting Bureau, Ltd., London; British Oxygen Company, Ltd., London; and Murex Welding Processes, Ltd., London. It is hoped that arrangements may also be made for practical demonstrations. Applications for tickets, mentioning this *Journal* reference, should be addressed to: Mr. Guy F. Dowding, A.M.I.Mech.E., Manager, Engineering Section, British Industries House, Marble Arch, London, W.1.

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

## OBSERVATIONS OF THE POROSITY AND SEGREGATION OF TWO BRONZE INGOTS.\*

By N. P. ALLEN,† M.Met., D.Sc., MEMBER, and S. M. PUDDEPHAT,‡  
B.Sc., MEMBER.

### SYNOPSIS.

The distribution of porosity and the variation in copper content in two 10 per cent. tin-bronze ingots have been found to be influenced principally by the flow of heat during solidification. There was a close connection between the porosity and segregation of the ingots.

### INTRODUCTION.

IN a previous paper<sup>1</sup> the processes leading to the formation of cavities in an ingot were discussed, and reasons were given for considering the phenomenon of inverse segregation to be largely the result of the same processes. The present work was undertaken in order to study further the distribution of porosity in ingots, and to obtain more evidence on the relationship between porosity and segregation.

### PREPARATION OF INGOTS.

Two ingots were cast from separate quantities of bronze made in the following way: 29 lb. of cathode copper was melted under a deep layer of charcoal in a gas-fired crucible furnace, and  $3\frac{1}{4}$  lb. of "Chempur" tin was added to it. The alloy was stirred thoroughly with a carbon rod, and cast at  $1100^{\circ}$  C. into a heavy copper mould, dressed with bone ash, and preheated to about  $90^{\circ}$  C. The metal was poured from the crucible in the ordinary way, the lip of the crucible being rested on the top of the mould, and a steady stream being maintained such that the mould was filled in about 20 seconds.

The mould was that described in the former paper. One ingot was cast with the wide end upwards, and the other with the narrow end upwards, and both were fed with the liquid metal remaining in

\* Manuscript received February 16, 1935.

† Lecturer in Metallurgy, University of Birmingham.

‡ Metallurgical Department, University of Birmingham.

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**Note to Abstractors and Other Readers.**—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LVII, 1935. Reference should accordingly be as follows: *J. Inst. Metals*, 1935, 57 (Advance copy).



the crucible. They weighed about 28 lb. each, and were  $9\frac{1}{2}$  in. long,  $3\frac{5}{8}$  in. square at the wide end, and  $2\frac{7}{8}$  in. square at the narrow end. The ingot cast wide end upwards had an average copper content of 89.39 per cent. and the other an average copper content of 89.94 per cent.

EXAMINATION OF INGOTS.

A slab  $\frac{5}{8}$  in. thick was cut vertically from the middle of each ingot, and, after it had been planed and its macrostructure examined, it was cut up in the manner shown in Fig. 1.

The densities of all the pieces were determined by Archimedes's method. The figures reported are the apparent densities in water at  $15^{\circ}\text{C}$ ., and are accurate within  $\pm 0.01$ .



FIG. 1.

Some exception has been taken to the use of density determinations in the study of the porosity of bronze, on the ground that the density of bronze is liable to vary, independently of the number of cavities present, on account of the varying quantities of eutectoid constituent which may be present. Whilst the metallographic principle involved is perfectly sound, its application to bronze is unnecessary, as it is clear from the values plotted in Fig. 2, that the densities of the  $\alpha$  solid solution

and the eutectoid are, within very close limits, the same. G. L. Bailey<sup>2</sup> and others who have reported results demonstrating the effect of casting temperature on the density of cast bronze, have, in fact, studied the effect of casting temperature on its porosity.

In order to determine the nature of the segregation, samples taken from about half the density pieces were analyzed for copper content by an electrolytic method similar to that devised by R. A. F. Hammond.<sup>3</sup> The method was thoroughly tested. Six analyses of a standard sample agreed to within  $\pm 0.01$  per cent. of copper, and the same order of agreement was obtained in several check analyses in the course of the work. It is considered that when all other errors are taken into account, variations of 0.04 per cent. must be regarded as significant.

## Porosity and Segregation of Two Bronze Ingots

Samples from many parts of the ingots were examined microscopically.

### OBSERVATIONS.

The macrostructures of the ingots were normal. Columnar crystals up to  $\frac{1}{2}$  in. in length had grown at the bottom and at a few places along the sides of the ingots, and elsewhere fine equi-axed crystals were present, and were smallest near the top.

The results of the measurements of density are plotted in Fig. 3. Both ingots were porous and had rather poor surfaces. Except where skin porosity was present, the density of the material in both ingots decreased regularly from the outside to the centre, and the density contours were generally symmetrical, and followed the shape of the ingot fairly closely. The cone of relative soundness found in copper and aluminium-copper alloy ingots was absent, though at the

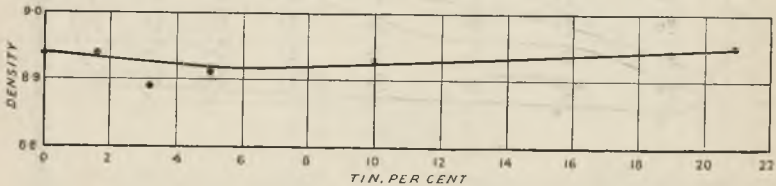


FIG. 2.—Densities of Copper-Tin Alloys. The figures are the apparent densities in water at room temperature of 30 gm. ingots of the alloys melted in fireclay boats at  $1150^{\circ}$  C. in dry nitrogen, and allowed to cool with the furnace.

bottom of the ingot cast wide end upwards the difference of density between the outside and the centre was quite small.

The mould taper had a very marked influence on the distribution of porosity. Whereas in the ingot cast wide end upwards the most porous material was confined to a cone in the upper part of the ingot, casting narrow end upwards resulted in the axis being very porous nearly all the way down.

Fig. 3 also shows the distribution of copper in the ingots. Differences as great as 1 per cent. were found. The segregation was inverse, and the contours of copper content, like those of density, were parallel to the sides of the ingots, except at the bottom, where they were turned inwards to form a small cone of tin-rich material. Except where there was skin porosity the material having the highest tin content had also the highest density. The relationship between density and copper content is shown graphically in Fig. 4. The two variables followed each other very closely, except at the bottom of the ingot cast wide end upwards, in which a variation of composition occurred without a corresponding change of density.

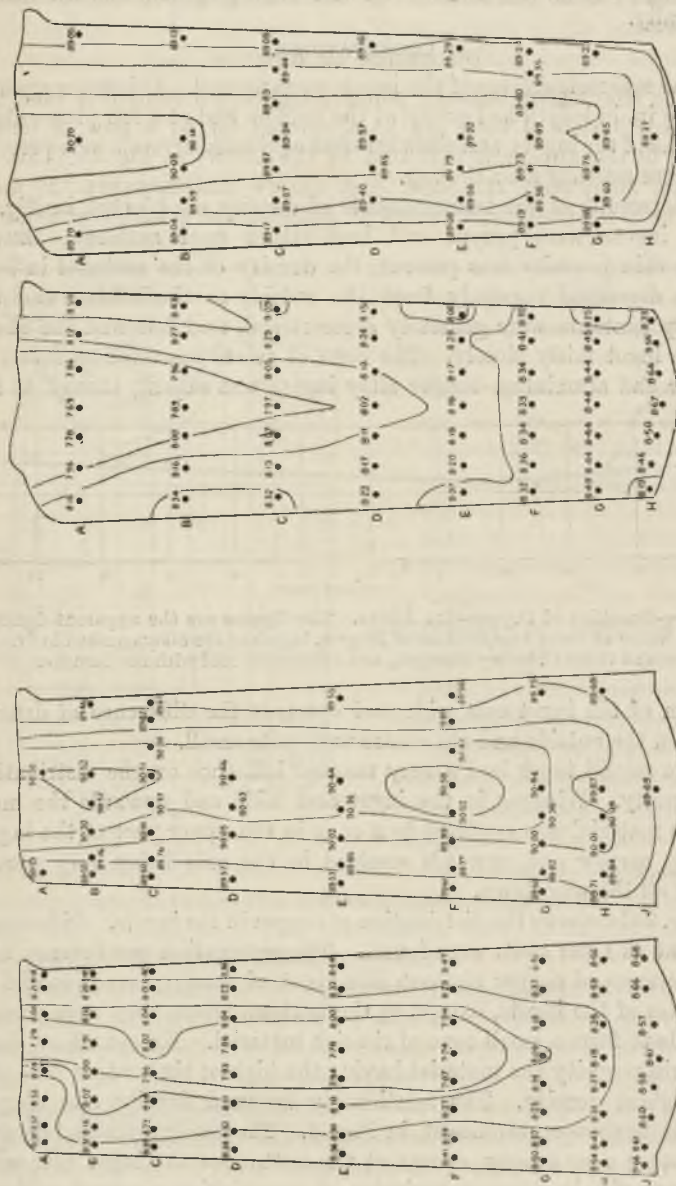


FIG. 3.—Distribution of Porosity and Segregation.

## Porosity and Segregation of Two Bronze Ingots

There was no relationship between the segregation and the macro-structure.

### DISCUSSION OF RESULTS.

The relationship between porosity and copper content is such that the distribution of both can be accounted for by a flow of tin-rich liquid in the directions indicated by the arrows in Fig. 1. This will explain completely the ingot cast narrow end upwards. It seems that at a relatively early stage of solidification a bridge of dendrites

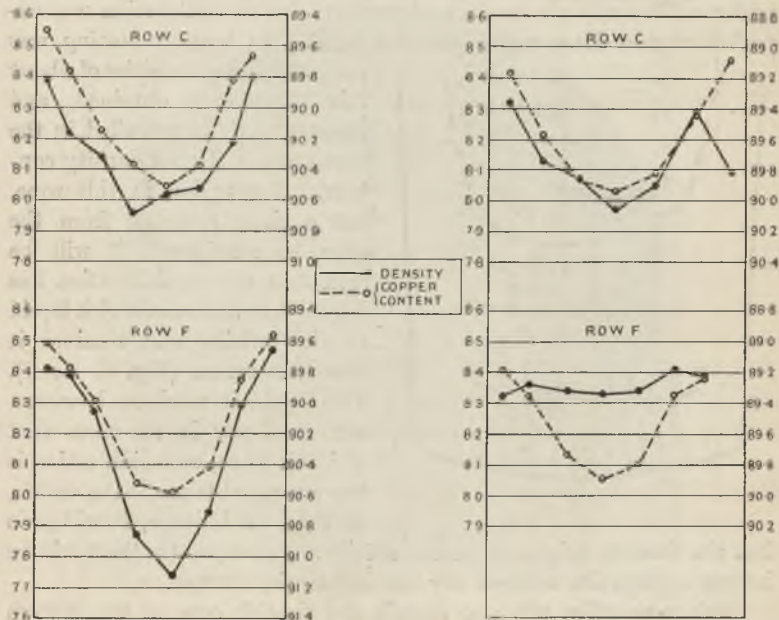


FIG. 4.—Relationship between Density and Composition.

was formed across the ingot about a quarter of the way down, and that the mass of liquid thereby entrapped in the centre subsequently fed the ingot in all directions. The "heat centre" of the ingot (about two-thirds of the way down the axis) consequently became extremely low both in density and in tin content.

Broadly, the behaviour of the ingot cast wide end upwards was similar, but in this case the downward movement of liquid was not restricted until a comparatively late stage of the process of solidification, so that there was a continuous increase of tin content and density down the axis.

The conditions at the bottom of this ingot require special attention. The variations of density in this region are misleadingly small on account of the skin porosity, but even when this is taken into account, they are much less than in other parts of the ingot. This is probably due to the excellent feeding of the bottom of the ingot. The porosity of an ingot is the resultant of two factors, the gas content, and the drop of pressure caused by contraction.<sup>4</sup> From the densities prevailing on the outside of the ingot (where skin porosity was absent) it appears that the gas content of the metal was such that when the metal froze under such conditions no drop of pressure due to contraction was experienced, the density was about 8.3-8.5. As long as feeding was

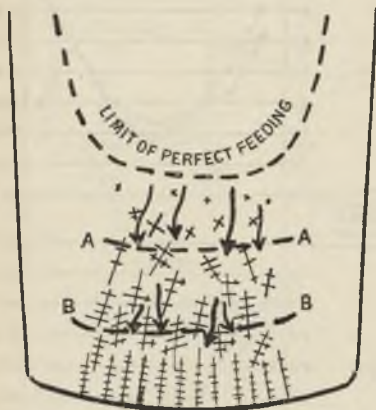


FIG. 5.

perfect uniform densities of about this value were obtained, and these conditions prevailed in the zone outside the 8.3 density contour. If a region in this zone, but a little removed from the edge be considered, it will be seen that, once solidification has begun, it both feeds tin-rich liquid to the outside and receives it from the centre (Fig. 5, *A*, *B*). The liquid it receives, however, will be lower in tin than that which it loses, as solidification is less advanced towards the centre, so that, on balance, it will gain

less tin than its neighbour on the outside. Consequently there will be inverse segregation without any marked density change.

This conception will also explain the tin-rich cone at the bottom of both ingots, for metal in the neighbourhood of *A* (Fig. 1) feeds the contraction in two directions and therefore loses an abnormal amount of tin-rich liquid, receiving in compensation (only) liquid poorer in tin from the centre. The final result is an abnormal loss of tin which is the counterpart, in inverse segregation, of the familiar "ingot corner segregation."

#### MICROSTRUCTURES.

The cavities were inter-dendritic in character and associated, as would be expected, with the  $\alpha$ - $\delta$  constituent.

Special attention was paid to the distribution of the  $\alpha$ - $\delta$  constituent, on account of the observations reported by F. Johnson in discussing a previous paper.<sup>1</sup> The particle size of the constituent increased from

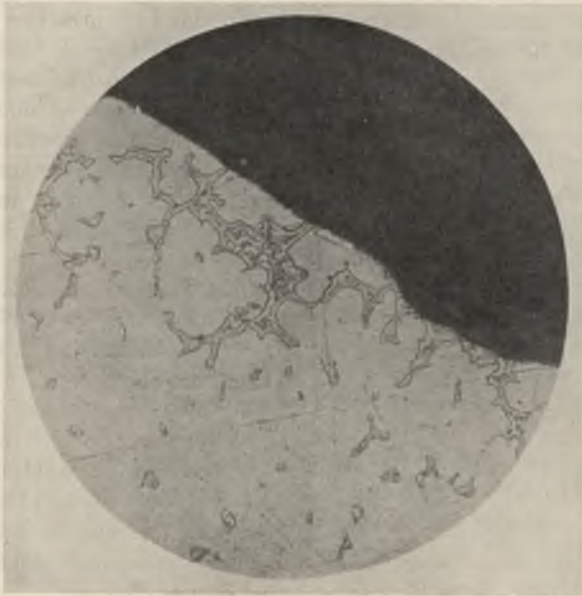


FIG. 6.  $\times 250$ .



THE HISTORY OF THE UNITED STATES

The first part of the book is devoted to the early history of the United States, from the discovery of the continent by Christopher Columbus in 1492 to the establishment of the first permanent settlements. This section covers the exploration of the New World, the struggles of the early settlers, and the growth of the colonies.

The second part of the book deals with the American Revolution, from the outbreak of hostilities in 1775 to the signing of the Declaration of Independence in 1776. It details the military campaigns, the political debates, and the ultimate triumph of the revolutionary forces over British rule.

The third part of the book focuses on the early years of the United States, from the signing of the Constitution in 1787 to the end of the War of 1812. It examines the challenges of building a new nation, the development of the federal government, and the expansion of the country's territory.

The fourth part of the book covers the period from the War of 1812 to the beginning of the Civil War in 1861. It discusses the westward expansion, the growth of industry, and the deepening divisions over slavery and states' rights.

The fifth part of the book details the American Civil War, from the outbreak of hostilities in 1861 to the final surrender of the Confederacy in 1865. It explores the military strategies, the political implications, and the profound impact of the war on the nation.

The final part of the book discusses the Reconstruction era and the subsequent decades, from the end of the Civil War to the beginning of the 20th century. It addresses the challenges of rebuilding the South, the struggle for civil rights, and the rise of industrialization.

## Porosity and Segregation of Two Bronze Ingots

side to centre of the ingot, which made it difficult to estimate the relative quantity, but after careful comparisons at many magnifications, it was concluded that over the greater part of the ingot there was no perceptible difference in amount. Nevertheless, there was a narrow border not more than 0.1–0.2 cm. wide round the edge of the section in which the particles were both very minute (0.001 cm. diameter) and decidedly less in quantity, and to this extent Johnson's observation was confirmed.

At the extreme edge a crust about 0.01 cm. thick of material very rich in eutectoid constituent was found. This crust was so narrow that it was easily rubbed away during preparation of the specimen, and it was found only in specimens mounted in Bakelite. The typical appearance is shown in Fig. 6 (Plate I). The formation was not an exudation from the surface, as the  $\alpha$ - $\delta$  constituent was quite flush with the  $\alpha$ , nor was it material thrust through from the centre, as observed by Genders,<sup>5</sup> for there were no streaks of  $\alpha$ - $\delta$  constituent leading to the centre. On the contrary, it was most marked where the band of material poor in  $\alpha$ - $\delta$  constituent was widest, and these two formations appeared to be related. The outline of the primary dendrites of  $\alpha$  constituent frequently suggested that solidification had been completed by the growth of crystals *towards* the edge, a process which is possible if it be assumed that some degree of under-cooling took place, and that the first nuclei appeared, not quite at the edge, but at a little distance within the metal.

The formation is mentioned on account of its metallographic interest. Its scale was so small that it could scarcely have affected the mass segregation as determined by the analyses reported here.

### CONCLUSIONS.

(1) In chill-cast 10 per cent. tin-bronze ingots the distributions of cavities and copper is determined by the flow of heat away from the casting, in such a way that the parts of the ingot which solidify last are most porous and richest in copper.

(2) Both distributions are largely explicable on the assumption that during solidification a liquid rich in tin travels towards the outside of the ingot.

(3) In this case, contraction during solidification was the principal cause of the movement.

### ACKNOWLEDGEMENTS.

The authors desire to express their thanks to Professor D. Hanson, D.Sc., who provided facilities for carrying out the work, to the British



## Porosity and Segregation of Two Bronze Ingots

Non-Ferrous Metals Research Association for the loan of the mould, and to Mr. W. F. Brazener for assistance in preparing the ingots.

### REFERENCES.

- <sup>1</sup> N. P. Allen, *J. Inst. Metals*, 1933, **52**, 193.
- <sup>2</sup> G. L. Bailey, *J. Inst. Metals*, 1923, **30**, 401.
- <sup>3</sup> R. A. F. Hammond, *J. Inst. Metals*, 1927, **37**, 268.
- <sup>4</sup> N. P. Allen, *J. Inst. Metals*, 1932, **49**, 317.
- <sup>5</sup> R. Genders, *J. Inst. Metals*, 1927, **37**, 241.

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## CORROSION BELOW DISCONTINUOUS OXIDE COATINGS, WITH SPECIAL REFERENCE TO MAGNESIUM.\*

By K. G. LEWIS,† M.Sc., MEMBER, and U. R. EVANS,† M.A., Sc.D., MEMBER.

### SYNOPSIS.

Protective processes fall into two classes: (a) safe processes, where even incomplete treatment lengthens the time of perforation; (b) dangerous processes, where inadequate treatment intensifies attack and brings quicker perforation than no treatment.

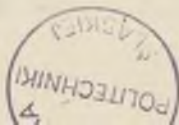
Magnesium, uncoated and coated with oxide layers produced by three different treatments applied for numerous different periods, has been subjected to sodium chloride in a new circulating apparatus. Time-corrosion curves and perforation periods have been obtained. The data show that these processes belong to the "safe" class.

THE value of any protective treatment depends not so much on its power to prevent attack where the treatment has been perfect, as on the happenings at points where the treatment has been originally insufficient or subsequently damaged. The studies of metallic coats<sup>1</sup> and paint coats,<sup>2, 3, 4, 5</sup> conducted in the authors' laboratory, have been concentrated mainly on phenomena at points where, of intention, the coating has been (a) applied so sparsely as to present discontinuities, (b) pierced by a scratch, or (c) broken by bending the metallic base. In exceptional cases, protection has been observed even at points where the metal was freely exposed to the corrosive agent. More often corrosion has been observed at the discontinuity, and, in exceptional circumstances, the attack has been locally more intense than if no coating were present. The idea, still prevalent to-day, that a faulty coating of a "cathodic" metal necessarily gives intensified corrosion at the fault, is quite erroneous, and rests on a misunderstanding of the electrochemical principles involved. Intensification of corrosion by an incomplete "protective" operation is, however, not uncommon in water-treatment. It has been found<sup>6</sup> that most alkaline inhibitors (sodium hydroxide, carbonate, silicate,

\* Manuscript received February 1, 1935.

† The University Chemical Laboratories, Cambridge.

**Note to Abstractors and Other Readers.**—This paper will be published, in permanent form, in the *Journal of the Institute of Metals*, Vol. LVII, 1935. Reference should accordingly be as follows: *J. Inst. Metals*, 1935, 57 (Advance copy).



or phosphate), added to a saline water in sufficient quantity, remove its corrosive power for many metals. If added in insufficient quantity, they reduce the area attacked more than the total destruction of metal, and, since the corrosion per unit area of the part affected is thus increased, the time needed for perforation is actually diminished. Theory indicates that this danger of premature perforation is to be expected of all inhibitors which act by stifling the anodic reaction, provided that the velocity of corrosion is determined even in part by the accompanying cathodic reaction; for, in such cases, the area attacked is likely to be diminished more quickly than the total destruction of metal. If the inhibitor acts by stifling the cathodic change, then there is no reason to expect accelerated perforation.

It is clearly important to distinguish two classes of protective treatment:—(a) a dangerous class, where incomplete treatment causes intensification of attack and brings about perforation sooner than it would occur on untreated metal; and (b) a safe class, where incomplete treatment, whilst not preventing attack, at least renders the time needed for perforation longer than that of unprotected metal. For many types of protective treatment much of the information necessary to assign processes to one or other class is available; but in regard to protection by oxide coats, there appears to be no record as to whether or not an insufficient coating can cause intensification of attack. Yet oxide coats are to-day largely used in protection, especially on magnesium and aluminium.

Now Whitby<sup>7</sup> and Schikorr<sup>8</sup> consider that the corrosion of magnesium is controlled, at least in part, by the anodic reaction. Some oxide coats, notably those containing chromium, probably inhibit largely by stifling the anodic reaction, whilst others, notably zinc oxide, inhibit mainly by stifling the cathodic reaction;<sup>9</sup> possibly some treatments—for instance, those studied by Sutton and Le Brocq<sup>10</sup>—retard both anodic and cathodic reaction. It is reasonable to hope that, in some at least of the processes available or capable of being worked out, “incomplete treatment” would cause no shortening of the perforation time. The experiments described below were designed to examine this matter. No attempt was made to realize in the laboratory any particular “service conditions”; rather the conditions of coating and corrosion were made as simple as possible, so as to obtain a simple answer to fundamental questions.

The work consisted of :

- I. Preliminary experiments on producing and testing oxide coats.
- II. Development of a simple method for measuring the hydrogen evolution from magnesium specimens with protected edges.

## *Oxide Coatings, with Special Reference to Magnesium*

### III. Experiments on untreated magnesium to study :

- (i) the effect of surface condition ;
- (ii) the effect of concentration of salt-solution.

### IV. Experiments on finely-ground magnesium pretreated for different periods in a solution depositing oxide coats, using

- (a) a new bath, containing zinc sulphate and ammonium nitrate ;
- (b) the bath containing potassium dichromate, alum, and sodium hydroxide, tested by Sutton and Le Brocq ; and
- (c) the bath containing potassium dichromate and sodium sulphate, tested by Sutton and Le Brocq.

### V. Experiments (with bath (a) only) using a rough surface.

### VI. Determination of perforation times after treatments (a), (b), and (c).

### VII. Intermittent spray tests, using sea-water on magnesium, treated by processes (a) and (c) and also (d) Bengough and Whitby's selenium treatment.

#### MATERIAL.

The magnesium used was sheet of 99.9 per cent. purity, furnished by the American Magnesium Corporation. The original thickness as rolled was 0.21 mm. (0.0083 in.), which was reduced to 0.20 mm. (0.0079 in.) after grinding one side only with all emery grades down to "00" French emery, and to 0.18 mm. (0.0071 in.) when ground on both sides.

#### I. PRELIMINARY EXPERIMENTS.

Numerous trials were made : (a) on magnesium abraded in different manners ; (b) with baths containing zinc, aluminium or lead salts, or a combination of these ; (c) in absence or presence of ammonium salts, especially ammonium nitrate ; (d) with or without application of cathodic treatment ; and (e) using fresh or old baths.

It was found that the coats of best appearance did not always give best protection. Certain coats, which were sufficiently compact and uniform to give interference tints, accelerated rather than reduced corrosion, whilst certain lead baths, which gave coats of poor appearance, reduced corrosion considerably in certain circumstances. In the end, for simplicity, the treatment selected for special study was a simple dip, without applied e.m.f., in a vertical position, in a bath containing zinc sulphate solution (50 grm./litre) and ammonium nitrate (50 grm./litre). Dipped in such a bath, the magnesium goes into solution, replacing zinc, not as metal but as oxide (probably hydrated). The oxide coat has a pearly greyish-white appearance in the early stages, but becomes duller after long dipping.

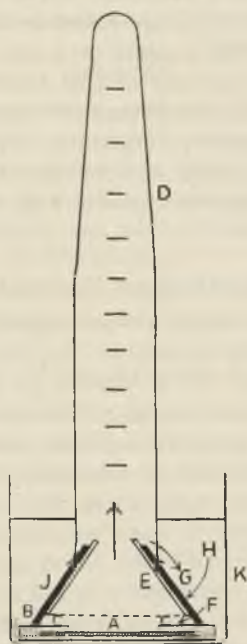
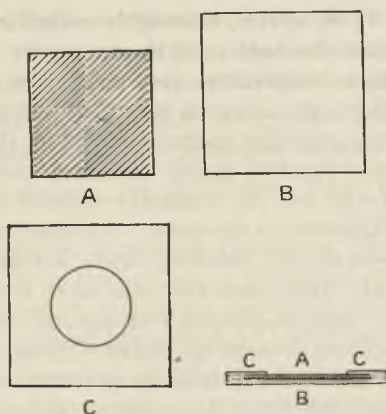


FIG. 1.—Apparatus (Diagrammatic).

II. METHOD OF MEASUREMENT.

The magnesium sheet was cut into panels 4 in.  $\times$  3 in., which were shuffled, abraded, and cut to 1 in. squares (Fig. 1, A). Pieces of

## Oxide Coatings, with Special Reference to Magnesium

blotting paper (*B*),  $1\frac{1}{4}$  in. square, thoroughly soaked in molten paraffin wax, served to protect the bottom of the specimens. The paper was allowed to come to a temperature just above the melting-point of wax, then a specimen was placed on it, and a second piece of warm waxed paper (*C*) with a circular aperture of 0.62 in. (1.6 cm.) diameter laid over the metal; the two pieces of waxed paper were pressed together, and a hot wire was run round the edges of the opening so as to produce perfect adhesion to the metal. The specimen, thus framed, was placed in a crystallizing dish (*K*), below a graduated tube (*D*), previously calibrated. Both dish and tube were filled with the corroding liquid (60 c.c. being used in each experiment), and the hydrogen rising from the specimen through the funnel (*E*) set up a circulation, the liquid entering the tube by opening (*F*) and leaving it at (*G*); thus the liquid above the metal was replaced at a rate roughly proportional to the degree of exhaustion. Strips of waxed paper, (*H*) and (*J*), served to ensure the necessary clearance between tube and funnel, and between funnel and the mask of the specimen.

Twenty or thirty apparatus of this form could conveniently be erected side by side in an air-thermostat<sup>11</sup> controlled at 25° C. Each experiment was performed in triplicate. From the readings taken after 24 hrs. in 45 experiments (omitting three other experiments where the measuring tube was already full), calculations were made of the "coefficient of variation," as defined by the expression  $\frac{100}{n} \sum \frac{S}{M}$

where *n* is the number of experiments, *M* is the mean of each trio of results, and *S* the experimental standard deviation (namely,

$\sqrt{\frac{\delta_1^2 + \delta_2^2 + \delta_3^2}{v}}$ , where  $\delta_1$ ,  $\delta_2$ , and  $\delta_3$  are the three deviations from the mean). Two calculations were made for each bath, according as *v*

was taken as 3 (according to still common practice), or as 2 according to the probably more accurate views expressed by later statisticians.<sup>12</sup>

The actual values obtained were as follows :

Bath.	Treatment.	n.	Coefficient of Variation.	
			<i>v</i> = 2.	<i>v</i> = 3.
			Per Cent.	Per Cent.
(a)	Fine abrasion.	11	7.4	6.0
(b)	" "	10	8.4	6.7
(c)	" "	13	8.5	6.9
(e)	Coarse abrasion.	11	8.2	6.3
All baths		45	8.1	6.5

## Lewis and Evans : Corrosion Below Discontinuous

The mean "half-chance error" will be (for experiments in triplicate)

$$\frac{0.67}{\sqrt{3-1}} = 0.48$$

times the percentages shown, and will thus be 3.9 or 3.1 per cent. according to the basis adopted. This is as low as can be expected for corrosion of the hydrogen evolution type, where considerable scatter always occurs.

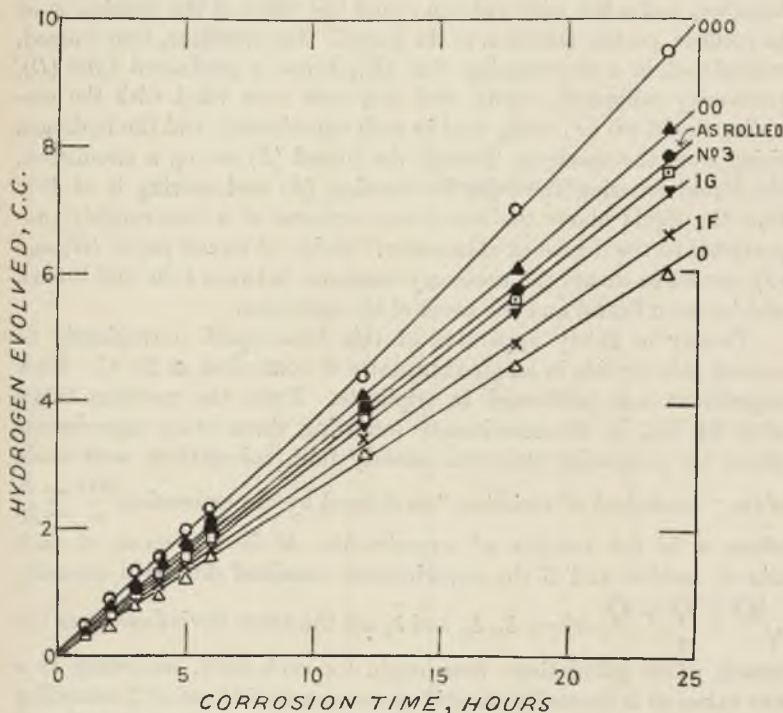


Fig. 2.—Effect of Surface Condition on Corrosion.

### III. EXPERIMENTS ON UNTREATED MAGNESIUM.

(i) *Effect of Surface Condition.* The conditions tested included the surface "as rolled," and the surfaces obtained by abrasion with No. 3, "1G," "1F," "0," "00," and "000" French emery papers. The abrasive procedure used for preparing metallographic specimens was adopted, starting with No. 3 and continuing with successively finer grades. In general, abrasion was performed under liquid paraffin, but one special series, abraded down to "000" emery without paraffin, with very slow abrasion to avoid over-heating, gave hydrogen evolution curves similar to those abraded under paraffin.

## Oxide Coatings, with Special Reference to Magnesium

Two panels were subjected to each abrasive treatment, yielding twelve specimens, which were washed with carbon tetrachloride and dried between blotting-paper, and then, after re-abrasion with the final paper without paraffin, twice washed with carbon tetrachloride,

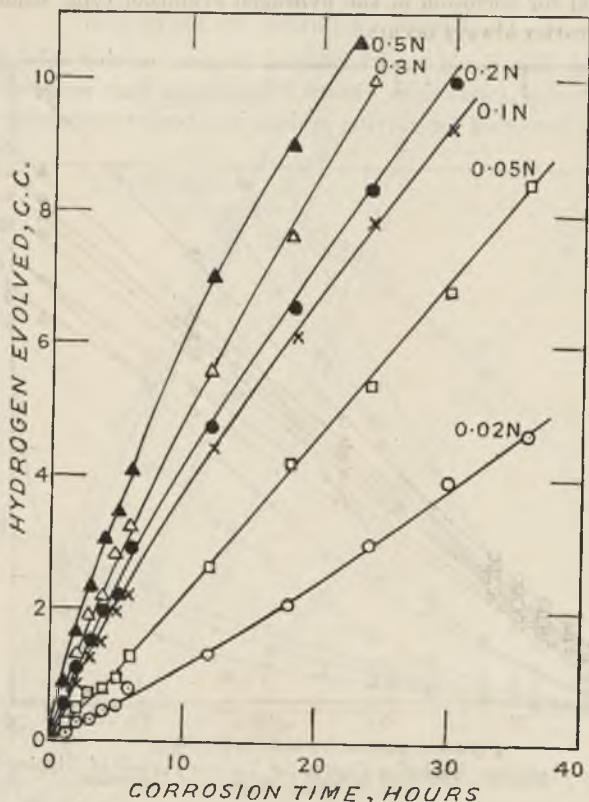


Fig. 3.—Effect of Concentration of Sodium Chloride Solution on Corrosion.

being dried between blotting paper after each washing. All specimens were stored for 24 hrs. in a desiccator before mounting.

The relations between hydrogen evolution and time during corrosion by 0.1N sodium chloride are shown in Fig. 2. The two most finely ground surfaces suffered the most rapid attack—a rather surprising result. Abrasion with all grades down to “00” emery was adopted as standard procedure, and will be referred to as “fine abrasion.” “Coarse abrasion” will denote a simple grinding with No. 3 paper.



## Lewis and Evans: Corrosion Below Discontinuous

(ii) *Effect of concentration.* Finely abraded specimens gave results shown in Fig. 3. The corrosion velocity regularly increases with concentration. For subsequent work, 0.2*N* sodium chloride was selected, as standard concentration.

### IV. EFFECT OF PERIOD OF IMMERSION.

*Bath (a).* The liquid used contained 50 gm. of zinc sulphate and 50 gm./litre of ammonium nitrate. Specimens were suspended and completely immersed for varying periods in a beaker containing 40 c.c.

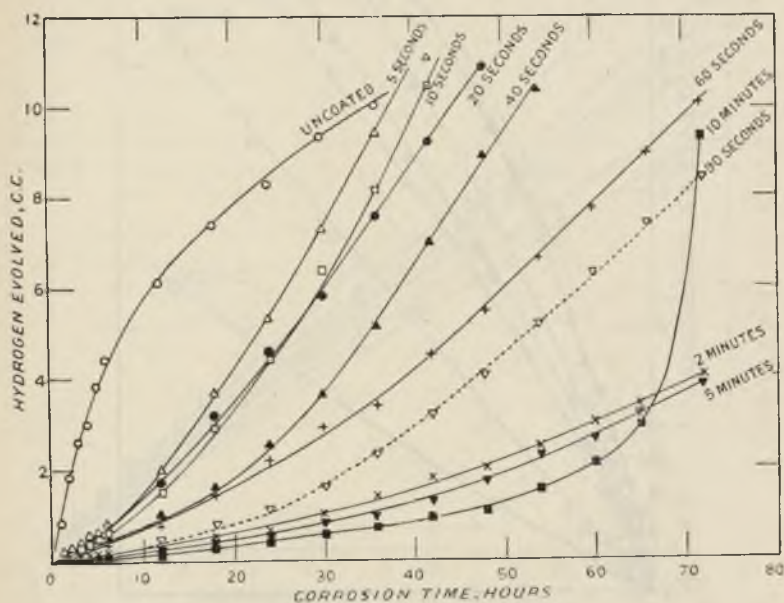


FIG. 4.—Hydrogen Evolution Curves for Various Periods of Dipping in the Zinc Sulphate Bath.

of solution contained in the thermostat at 25° C. After the chosen period, the specimen was quickly removed from the beaker and washed in ordinary distilled water, then in quartz-condensed water, and dried between sheets of blotting paper. It was then sealed into a waxed-paper jacket for the corrosion experiment.

Results are shown in Fig. 4. Up to a dipping period of 5 minutes increasing resistance is shown, but prolonging of the operation up to 10 minutes resulted in only a temporary improvement. It was noted that the surface after a 10-minutes' dip had a slightly corroded appearance across the middle of the specimen; the aspect, however, varied

## Oxide Coatings, with Special Reference to Magnesium

somewhat between the three triplicate specimens, although the quantities of hydrogen showed excellent agreement up to 72 hrs.

*Bath (b).* Specimens were immersed for varying times in a solution of 1.5 per cent. potassium bichromate, 1 per cent. alum, and 0.5 per

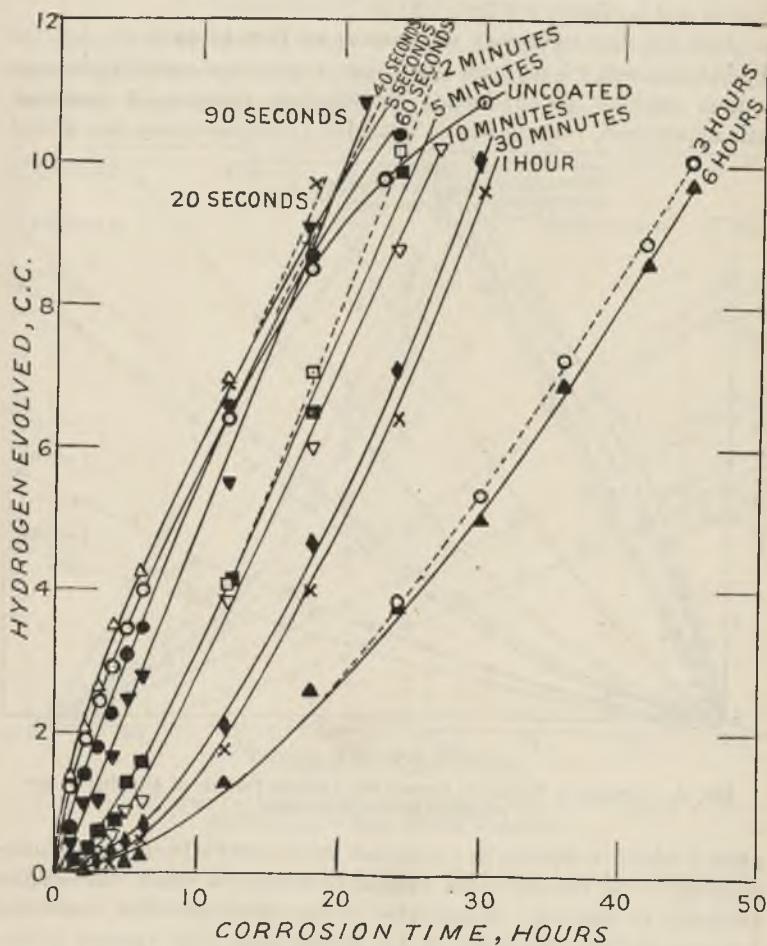


FIG. 5.—Hydrogen Evolution Curves for Various Periods of Dipping in Bichromate-Alum Solution.

cent. caustic soda, kept at 90°–95° C. At the end of the desired period they were quickly removed from the solution, washed in running distilled water and then in hot quartz-condensed water, and dried on blotting paper. The coatings obtained could hardly be noticed, apart

from an exceedingly slight dulling of the polished metal. The results obtained are shown in Fig. 5. The protection increases with time of dipping, but the hydrogen production was much more rapid than after the zinc sulphate treatment. The time of dipping recommended by Sutton and Le Brocq is 6 hrs.

*Bath (c).* The treatment was similar to that in bath (b), but the liquid contained 1.5 per cent. potassium bichromate and 1.5 per cent. sodium sulphate (decahydrate). The coatings possessed a characteristic appearance, varying from a faint dull yellow unevenly distributed

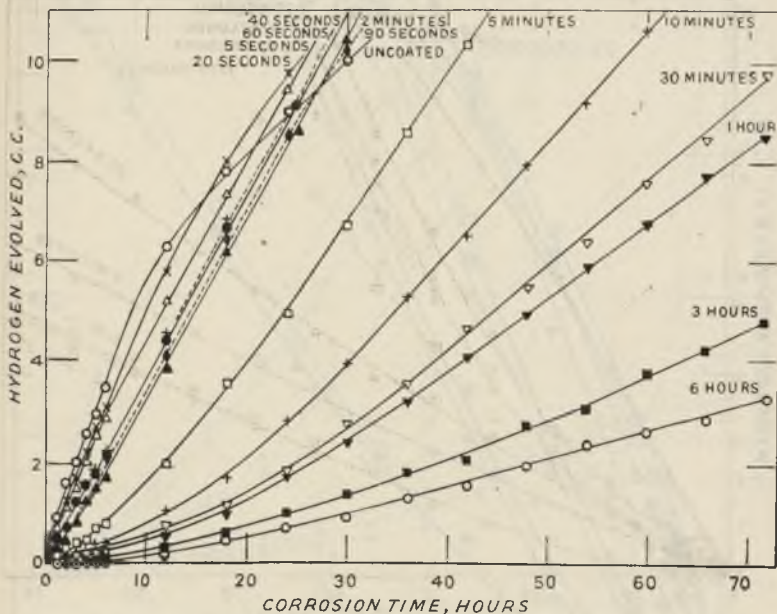


Fig. 6.—Hydrogen Evolution Curves for Various Periods of Dipping in the Bichromate-Sulphate Bath.

after 1 minute's dipping to a compact brown coat after 6 hrs. Unfortunately these thicker coats appear to possess a small but definite tendency to dissolve. If subjected to the usual corrosion conditions for over 40 hrs., the liquid in the crystallizing dish appears golden yellow, being deeper where the coating is obtained from longer dipping. Also, on removing the waxed-paper jacket, large areas can be seen in which the original coat appears to have diminished in intensity. The results in Fig. 6 show an increased protection with time of dipping. After a 5-minute dip, the hydrogen liberation is quicker than after a similar dip in bath (a), but lower than after bath (b).

## Oxide Coatings, with Special Reference to Magnesium

It was noted in the case of all the chromate-treated specimens that corrosion appeared to be localized and gave only a few very large holes, whilst the zinc sulphate bath gave numerous small ones.

### V. EXPERIMENTS WITH COARSE SURFACE.

Specimens abraded with No. 3 emery, and dipped in bath (a), gave more rapid evolution of hydrogen than specimens finely abraded and similarly dipped, the results being shown in Fig. 7. The type of

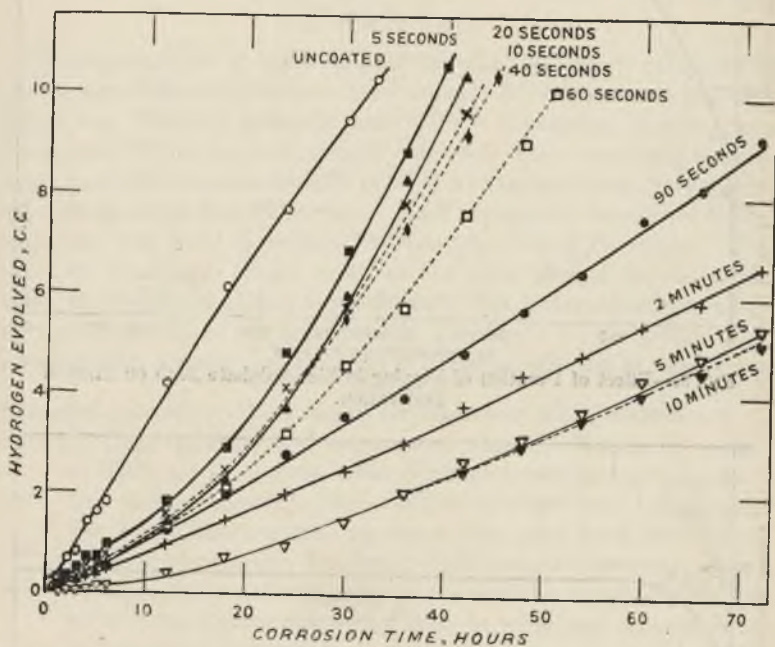


FIG. 7.—Hydrogen Evolution Curves for Various Periods of Dipping in the Zinc Sulphate Bath (Coarse Abrasion).

perforation somewhat resembled that of finely abraded magnesium dipped in baths (b) or (c).

### VI. PERFORATION TESTS.

Specimens finely abraded and dipped for different periods in baths (a), (b), and (c), were tested as usual in 0.2N sodium chloride, the individual experiments being terminated after different times in order to ascertain whether perforation had or had not occurred. The results are shown in Figs. 8-10, whilst the earlier stages are given in greater

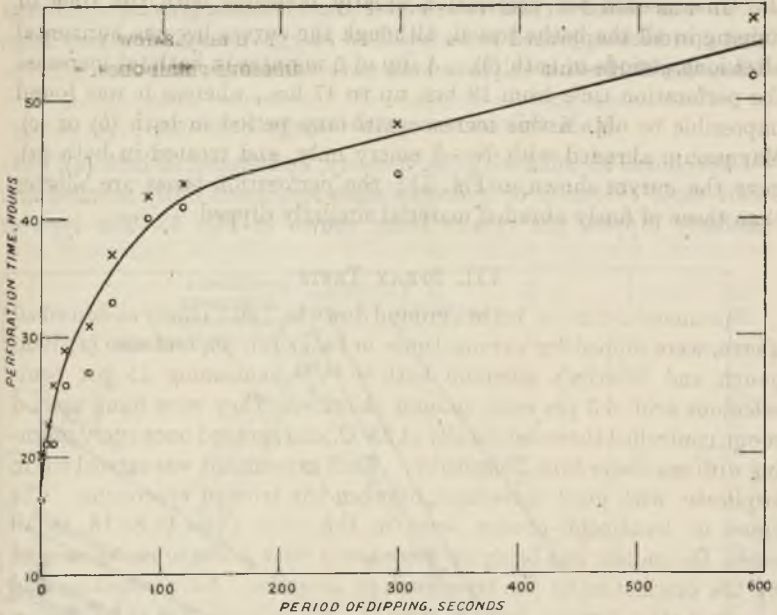


FIG. 8.—Effect of Duration of Dipping in Zinc Sulphate Bath on Time of Perforation.

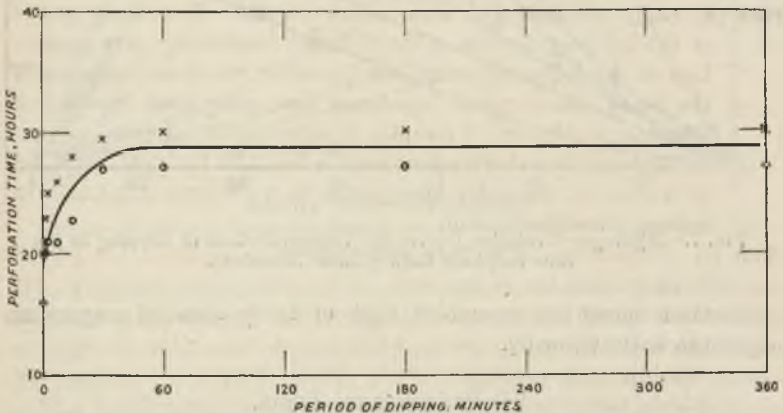


FIG. 9.—Effect of Duration of Dipping in Bichromate-Alum Bath on Time of Perforation.

detail in Fig. 12. Each point represents an experiment; the circles show experiments not leading to perforation, and the crosses show experiments causing one to three small holes. The curves prove that

## *Oxide Coatings, with Special Reference to Magnesium*

the time needed for perforation greatly increases with the time of dipping in all the baths tested, although the curves become horizontal after long periods in bath (b). A dip of 5 minutes in bath (a) increases the perforation time from 19 hrs. up to 47 hrs., whereas it was found impossible to obtain this increase with any period in bath (b) or (c). Magnesium abraded with No. 3 emery only, and treated in bath (a), gave the curves shown in Fig. 11; the perforation times are shorter than those of finely abraded material similarly dipped.

### VII. SPRAY TESTS.

Specimens 2.5 in.  $\times$  1.8 in., ground down to "00" emery as described above, were dipped for various times in baths (a), (c), and also (d) Bengough and Whitby's selenium bath<sup>13, 14, 15</sup> containing 15 per cent. selenious acid, 0.3 per cent. sodium chloride. They were hung up in a room, controlled thermostatically at 25° C., and sprayed once every morning with sea-water from Felixstowe. Each experiment was carried out in triplicate, with good agreement between the trios of specimens. The times of treatment chosen were in the ratio 1:2:4:8:16, in all cases, the middle one being approximately that hitherto recommended by the originators of the treatment in question. No perforation had occurred after 6 weeks, but the state of the specimens was as follows:—

*Untreated Specimens.* Very heavy corrosion over whole surface.

*Bath (a)* (Zinc sulphate and ammonium nitrate). Numerous points of lightish-grey deposit. The different treatments gave protection in the following order, the 2-minute specimen being much the best; the 4-minute specimen also gave good results: 2 minutes; 4 minutes; 1 minute; 8 minutes; 16 minutes.

Apparently a shorter treatment is desirable for metal intended to withstand sea-water spray than to withstand immersion in sodium chloride solution.

*Bath (c)* (Potassium dichromate and sodium sulphate). The specimens treated for 24 hrs. and 12 hrs. showed no corrosion, but the original brown coat was gradually washing off; in other cases, there was corrosion but less than with baths (a) and (d). Doubtless chromate-containing liquid flowing over specimens which have lost their coat gives some protection. 1.5 hrs.' immersion gave an unsatisfactory coat. Order of merit: 24 hrs.; 12 hrs.; 6 hrs.; 3 hrs.; 1.5 hrs.

*Bath (d)* (Selenious acid and sodium chloride). All specimens show some corrosion product at numerous fine points and tend to darken, losing their original reddish tint. Superficial examina-

tion is difficult, but the 2-minute specimens appear badly corroded, and the 16-minute, 8-minute, and 4-minute specimens are considerably superior to the 32-minute specimen. Order of merit: 16 minutes; 8 minutes; 4 minutes; 32 minutes; 2 minutes.

After 3 months, the order was more difficult to decide, but seemed to be still very much the same. There was no perforation, even on the untreated specimens.

#### DISCUSSION.

The hydrogen-evolution curves (Figs. 4-7) show clearly that, in conditions of complete immersion, each treatment tested diminishes the total destruction of metal, the diminution increasing as time of treatment is lengthened; in the case of the new zinc bath, the 10-minute curve given by finely abraded specimens suggests that the improvement decreases if the treatment is continued too long, owing to corrosion starting in the treatment bath. Fig. 13, giving the volume of hydrogen evolution in 25 hrs. for specimens dipped for different times in the various baths, serves to show the improvement conferred by each (note that the time-scales are not the same in each case). The perforation diagrams (Figs. 8-12) suggest that the new process belongs to the "safe" type, since the time needed for perforation increases steadily with the time of treatment; even the shortest treatments (5 or 10 seconds) produce a perceptible increase. The two bichromate baths tested also showed a tendency for the time of perforation to increase with the time of treatment, although in the case of bath (b) containing alum, the increase is very small. At short treatment times, there is a marked tendency for the perforation holes to be larger, although less numerous, than those obtained with the zinc bath or even with untreated magnesium.

The spray tests show that baths (a), (c), and (d) can give considerable protection. Clearly, service tests would be needed to decide the relative practical merits of the various processes. It must be remembered, also, that in practice a magnesium alloy (and not pure magnesium, as used in this research) would be involved, and further that parts usually receive an additional coat (paint, varnish, or lanoline) after the chemical pre-treatment.

The fact that under immersed conditions, the zinc oxide coats, even if only partially applied, cause no tendency to accelerated perforation tallies with the theoretical reasoning at the opening of the paper; 10 years ago, one of the authors<sup>16</sup> suggested that the automatic deposition of zinc oxide on iron (on wetting with zinc sulphate solu-

## Oxide Coatings, with Special Reference to Magnesium

tion) slowed down the attack owing to the interference with the cathodic reaction. On the other hand, iron dipped in chromate solution can certainly continue to act as cathode, and the stifling of

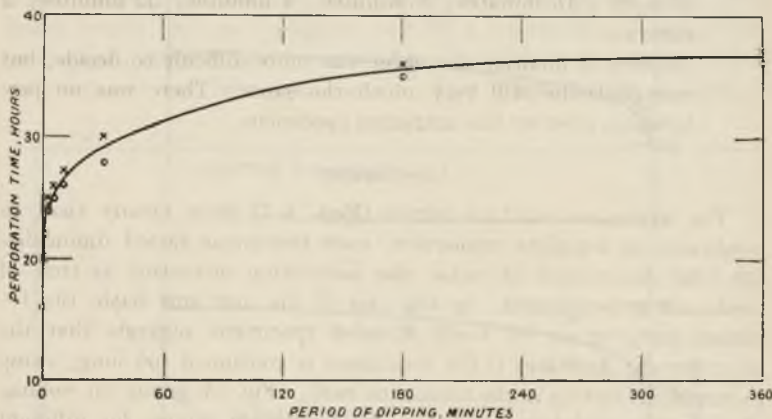


FIG. 10.—Effect of Duration of Dipping in Bichromate-Sulphate Bath on Time of Perforation.

corrosion is largely due to the prevention or reduction of the anodic reaction; thus *insufficient* dosage with chromate may lead to accelerated perforation, as was indeed found to be the case on iron.<sup>17, 18, 19</sup> The

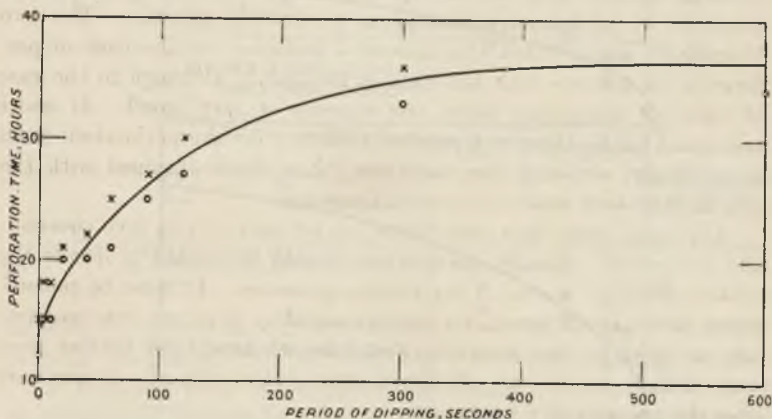


FIG. 11.—Effect of Duration of Dipping in Zinc Sulphate Bath on Time of Perforation (Coarse Abrasion).

new work on magnesium indicates that the chromate baths tested, although not causing premature perforation, may add to the size of individual holes, and this is probably due to a similar cause.



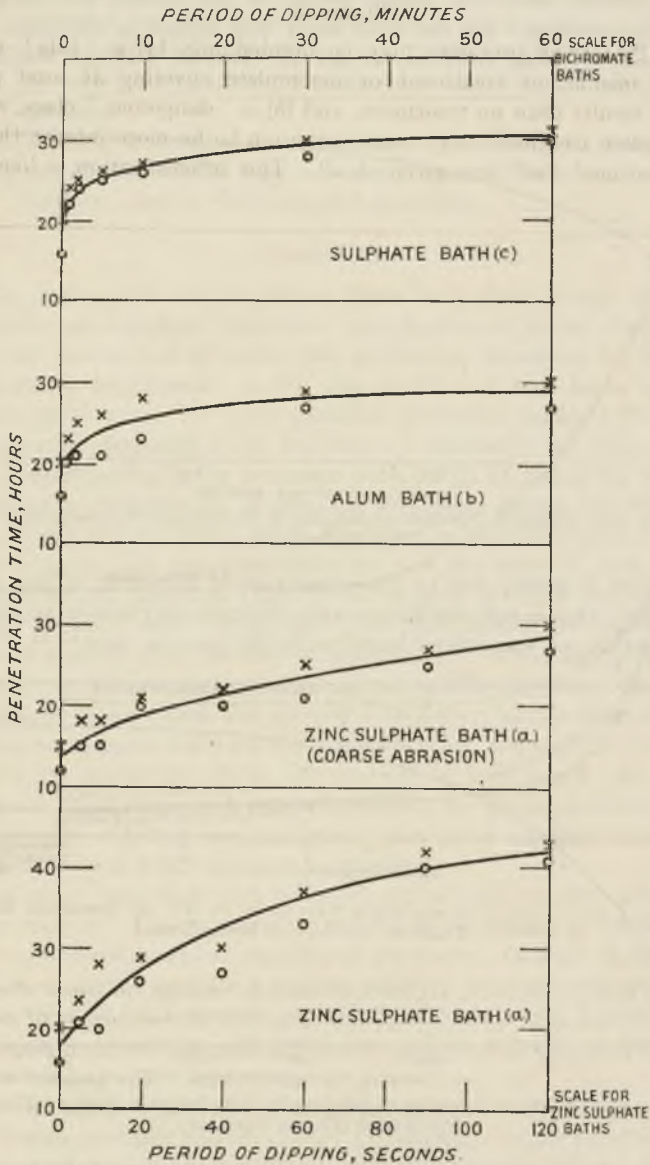


FIG. 12.—Early Stages of Penetration Experiments.

# Oxide Coatings, with Special Reference to Magnesium

## SUMMARY.

1. Protective processes may be divided into (a) a "safe" class, where insufficient treatment or incomplete covering at least gives better results than no treatment, and (b) a "dangerous" class, where incomplete treatment may cause corrosion to be more intense than if no treatment had been given at all. This intensification is likely to

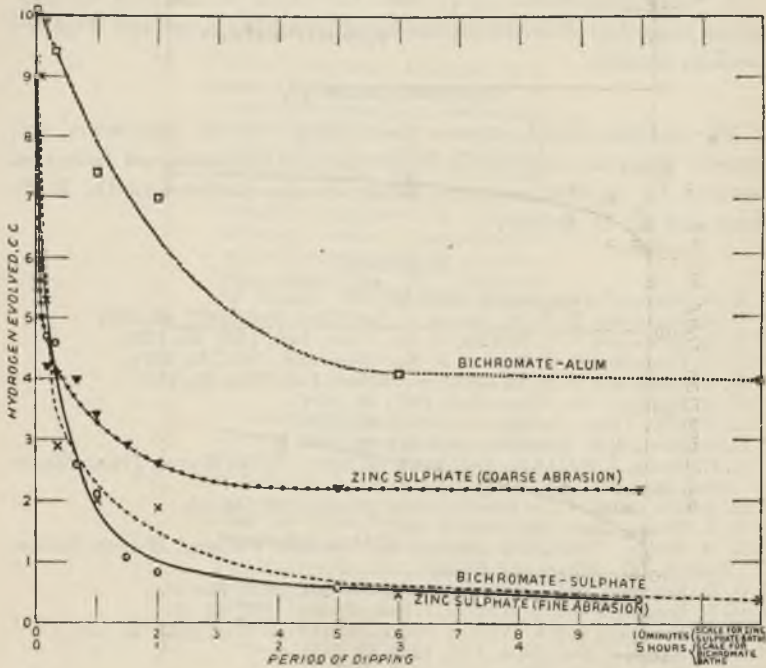


FIG. 13.—The Volume of Hydrogen Evolved in 25 Hrs. by Specimens Dipped for Different Times in the Various Baths Tested.

occur if the protection restricts the anodic change, in cases where the cathodic reaction mainly determines the rate of destruction of metal.

2. Previous work has explored the dangers of intensification at gaps or breaks in metallic coats or paint coats. The present research aimed at analogous information for oxide coats on magnesium.

3. Using a new "self-circulating" apparatus, time-corrosion curves have been obtained for: (i) untreated magnesium in sodium chloride (a) after different abrasions, and (b) in baths of different concentrations; (ii) magnesium treated in three different baths, two used pre-

## Corrosion Below Discontinuous Oxide Coatings

viously by Sutton and Le Brocq, and one a new bath containing zinc sulphate and ammonium nitrate, after different periods of treatment.

4. In addition, times of perforation have been determined after different periods of treatment in all three baths.

5. The results suggest that oxide coats on magnesium may, for the experimental conditions surveyed, be assigned provisionally to the "safe" class.

6. Some intermittent spray tests have been commenced on magnesium treated by different processes, including Bengough and Whitby's selenium process.

### ACKNOWLEDGMENTS.

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### REFERENCES.

- <sup>1</sup> U. R. Evans, *J. Inst. Metals*, 1928, **40**, 99.
- <sup>2</sup> U. R. Evans and R. T. M. Haines, *J. Soc. Chem. Ind.*, 1927, **46**, 363T.
- <sup>3</sup> U. R. Evans and S. C. Britton, *J. Soc. Chem. Ind.*, 1930, **49**, 173T.
- <sup>4</sup> U. R. Evans and S. C. Britton, *J. Soc. Chem. Ind.*, 1932, **51**, 211T.
- <sup>5</sup> K. G. Lewis and U. R. Evans, *J. Soc. Chem. Ind.*, 1934, **53**, 25T.
- <sup>6</sup> U. R. Evans, *J. Soc. Chem. Ind.*, 1927, **46**, 347T.
- <sup>7</sup> L. Whitby, *Trans. Faraday Soc.*, 1933, **29**, 1320.
- <sup>8</sup> G. Schikorr, *Mitt. Material., Sonderheft* **22**, 1933, 6.
- <sup>9</sup> U. R. Evans, *J. Soc. Chem. Ind.*, 1924, **43**, 321T. Cf. E. Herzog, *Trans. Electrochem. Soc.*, 1933, **64**, 92, 93.
- <sup>10</sup> H. Sutton and L. F. Le Brocq, *J. Inst. Metals*, 1931, **46**, 53.
- <sup>11</sup> U. R. Evans, *Chem. Ind.*, 1931, **9**, 66.
- <sup>12</sup> R. A. Fisher, "Statistical Methods for Research Workers," Fourth Edition, 1932, p. 46. (Oliver and Boyd.)
- <sup>13</sup> G. D. Bengough and L. Whitby, *J. Inst. Metals*, 1932, **48**, 147.
- <sup>14</sup> G. D. Bengough and L. Whitby, *J. Inst. Metals*, 1933, **52**, 85.
- <sup>15</sup> G. D. Bengough and L. Whitby, *Trans. Inst. Chem. Eng.*, 1933, **11**, 176.
- <sup>16</sup> U. R. Evans, *J. Soc. Chem. Ind.*, 1924, **43**, 321T.
- <sup>17</sup> U. R. Evans, *J. Soc. Chem. Ind.*, 1927, **46**, 347T.
- <sup>18</sup> B. E. Roetheli and G. L. Cox, *Indust. and Eng. Chem.*, 1931, **23**, 1084.
- <sup>19</sup> T. P. Hoar and U. R. Evans, *J. Chem. Soc.*, 1932, 2476.

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# GENERAL INDEX TO THE JOURNAL AND METALLURGICAL ABSTRACTS

Vols. 26 (1921) to 55 (1934)

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# METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 2

MAY 1935

Part 5

## I.—PROPERTIES OF METALS

(Continued from pp. 137-145.)

\***Gases in Aluminium.** J. A. Kliachko (*Legkie Metalli (Light Metals)*, 1934, (7), 24-30).—[In Russian.] Heated in an Oberhoffer-Hessenbruch apparatus at 800° C., a 10-20 grm. sample of aluminium evolves about 0.035 grm. of water vapour and 0.25-0.80 c.c. of other gases, of which 75-90% is hydrogen. At lower temperatures the solid metal evolves more water and less hydrogen. The metal tested contained 0.02-0.03% alumina before heating and 0.13-0.15% after. The hydrogen evolved is derived to some extent from the electrolytic bath, but principally from the reaction between the hot metal and adsorbed water.—D. N. S.

\***Diffusion of Hydrogen Through Aluminium.** C. J. Smithells and C. E. Ransley (*Nature*, 1935, 135, 548).—Hydrogen diffuses through aluminium at a rate which is easily measurable above 400° C. Preliminary measurements show that it follows the usual diffusion law with respect to temperature and pressure. The rate of diffusion at 400°-600° C. is of the same order as for hydrogen through copper, but the temperature coeff. is much greater. —E. S. H.

\***Change in the Properties of a Poly-Crystal [Aluminium] Accompanying Recovery (Erholung).** M. O. Kornfeld (*Physikal. Z. Sowjetunion*, 1933, 4, 668-674).—[In German.] See *Met. Abs.*, 1934, 1, 288.—J. S. G. T.

\***A Glassy State of Arsenic.** W. E. McCormick and Wheeler P. Davey (*Phys. Rev.*, 1935, [ii], 47, 330).—Abstract of a paper read before the American Physical Society. It is found that below 100° C. arsenic vapour condenses in pure hydrogen to give an amorphous (to the X-rays) powder of small particle size. When the vapour is condensed between 100° and 130° C., a mixture of powder and coherent sheet is obtained. Between 130° and 250° C. only the coherent sheet is obtained. The metallic lustre of the sheet increases with the temperature of condensation. X-ray examination shows the deposit to be non-crystalline. It might be described as a metallic glass. Above 250° C. the deposit has slightly less lustre, and is distinctly crystalline to the X rays. It is believed that this is the first report on the existence of 3 types of solid (amorphous flour, glass, crystal) for a single metal. Cf. Straumanis (*J. Inst. Metals*, 1932, 50, 38) on rate of crystal growth of zinc and cadmium; Ingersoll and De Vinney (*J. Inst. Metals*, 1926, 35, 478) on amorphous nickel films; Bettendorf (*Ann. Chemie*, 1867, 144, 110) on what he called (without experimental evidence) "amorphous arsenic" (probably the flour).—S. G.

\***The High-Pressure Transitions of Bismuth.** P. W. Bridgman (*Phys. Rev.*, 1935, [ii], 47, 427).—Abstract of a paper read before the American Physical Society. By an extension and improvement of previous methods (*Met. Abs.*, 1934, 1, 377), the transition parameters of bismuth have been determined at high pressures. There are two modifications of bismuth, each denser than the liquid. The transition line between I (ordinary bismuth) and II (first high-pressure modification) is linear and passes through the points 80°, 23,250 kg./cm.<sup>2</sup> and 180°, 17,850 kg./cm.<sup>2</sup>. The transition line between II

\* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.



and III (second high-pressure bismuth) is also linear and passes through 80°, 26,400 kg./cm.<sup>2</sup> and 180°, 17,600 kg./cm.<sup>2</sup>, with parameters :

$\Delta V_{II-I}$	= 0.00474 cm. <sup>3</sup> /gram.	Lat. ht. I-II	= 118 kg.-cm./gram.
$\Delta V_{II-IIq.}$	= 0.00025 "	Lat. ht. II-IIq.	= 186 "
$\Delta V_{IIq.-I}$	= 0.00449 "	Lat. ht. I-IIq.	= 304 "

By calculation, rough values for the triple point Liq.-II-III are found to be : 187.0°, 22,700 kg./cm.<sup>2</sup>, and

$\Delta V_{III-II}$	= 0.00279 cm. <sup>3</sup> /gram.	Lat. ht. II-III	= 44 kg. cm./gram.
$\Delta V_{II-IIq.}$	= 0.00020 "	Lat. ht. II-IIq.	= 186 "
$\Delta V_{III-IIq.}$	= 0.00299 "	Lat. ht. III-IIq.	= 142 "

Exploration has been made for still other modifications up to 50,000 kg./cm.<sup>2</sup>, but none has been found at room temperature or 125°. *Antimony* which crystallizes in the same system as Bi I shows no new modification in the same range.—S. G.

**\*A Method for the Determination of the Thermal Resistance of Metal Single Crystals at Low Temperatures [Bismuth].** W. J. de Haas and W. H. Capel (*Physica*, 1934, 1, 725-734; and *Comm. K. Onnes Lab. Leiden*, No. 231d; *Sci. Abs.*, 1934, [A], 37, 896).—[In English.] A new method for determining thermal resistance of metal single crystals at very low temperatures has been developed, and is described in detail. A certain amount of energy per second is supplied electrically to one end of the rod to be examined and the temperatures of the 2 ends of the rod are determined by 2 vapour tension thermometers, after the stationary state has been reached. Very pure bismuth (99.995%) is used for the preparation of the single crystals, the long axis of the rod being parallel to the trigonal principal axis. Several measurements are made in the temperature region of liquid hydrogen (16.5°-20° K.) and one in the region of liquid oxygen (81.4° K.). The results show that the change of conductivity of the crystals with temperature is in accordance with the general behaviour of very pure metals and diminishes with temperature down to the lowest temperature measured. There seems to be an indication that a minimum of thermal resistance may be reached at a still lower temperature.—S. G.

**\*The Thermal Resistance of Bismuth Single Crystals at Low Temperatures.** W. J. de Haas and W. H. Capel (*Physica*, 1934, 1, 929-934; and *Comm. K. Onnes Lab. Leiden*, No. 233a).—[In English.] In a previous paper de H. and C. (preceding abstract) gave the results of measurements of the thermal resistance of bismuth single crystals in a direction parallel to the trigonal principal axis. The measurements have now been extended to the principal directions perpendicular to this axis, namely the direction of a binary axis and the direction of a bissectrix between 2 binary axes. The measurements were made at 81.5° K. and at a temperature between 20° and 16.5° K. For the direction perpendicular to the principal axis the thermal resistance-temperature curve shows a minimum, which is not the case for the direction parallel to the principal axis down to 16.5° K. These results are discussed, and details given of the method of preparing the crystals.—S. G.

**\*On the Magneto-Resistance of Bismuth, Nickel, Iron, Cobalt, and Heusler Alloy by the Longitudinal Magnetic Field at Low and High Temperatures.** Yoshiharu Matuyama (*Rikwagakū-Kenkyū jō Iho (Bull. Inst. Phys. Chem. Res. Tokyo)*, 1934, 13, 283-313).—[In Japanese.] See *Met. Abs.*, this volume, p. 137.—S. G.

**\*Electrical Resistance of Cadmium Films.** Edith Townes and Duane Roller (*Phys. Rev.*, 1935, [ii], 47, 197).—Abstract of a paper read before the

American Physical Society. Continued experiments with a molecular beam apparatus in which pure cadmium films were deposited on a glass plate, cooled by either liquid air or solid carbon dioxide, show that these films first become electrically conducting at a thickness of  $2-7 \times 10^{-7}$  cm. and have a critical thickness of  $6-8 \times 10^{-7}$  cm. Special precautions were taken to have a good contact between the film and the electrodes, lack of which probably accounts for the large critical thickness previously reported (Roller and Wooldridge, *Met. Abs.*, 1934, 1, 229). The resistivity of cadmium at the critical thickness is about 15 times that of the bulk metal. The relations of these results to photoelectric phenomena in metallic films and to theories of film structure are discussed.—S. G.

†**Calcium, Its Metallurgy and Technology.** C. L. Mantell and Charles Hardy (*Trans. Electrochem. Soc.*, 1934, 66, 63-79; discussion, 79-83; and *Chem. Industries*, 1934, 35, 403-406).—See *Met. Abs.*, 1934, 1, 477.—S. G.

\***The Production of Metals of the Cerium Group.** Félix Trombe (*Trans. Electrochem. Soc.*, 1934, 66, 57-61; discussion, 61-62).—See *Met. Abs.*, 1934, 1, 478.—S. G.

\***Absorptive Power of Solid Cobalt for Hydrogen and Nitrogen.** A. Sieverts and H. Hagen (*Z. physikal. Chem.*, 1934, [A], 169, 237-240).—The adsorptive capacity of cobalt for hydrogen has been determined between 600° and 1200° C.; the amount of gas adsorbed at any temperature is proportional to the square root of the gas pressure and is not affected by the presence of up to 2.5% of iron in the cobalt. Differences in the behaviour of iron, cobalt, and nickel are due to differences in the crystal structure; the cubic face-centred  $\gamma$ -phase has the highest adsorptive power for hydrogen, then the  $\alpha$ -phase of iron, and finally the hexagonal cobalt phase has the lowest adsorptive power. Nitrogen is practically insoluble in cobalt up to 1200° C.—B. Bl.

**Niobium [Columbium].** A. F. Prede (*Redkie Metalli (Rare Metals)*, 1934, (6), 6-8).—[In Russian.] The history, occurrence, minerals, chemical and physical properties, and possible fields of application of columbium and its alloys are discussed.—D. N. S.

\***The Expansion of Copper from Absolute Zero to Its Melting Point.** W. J. Haring and Wheeler P. Davey (*Phys. Rev.*, 1935, [ii], 47, 337).—Abstract of a paper read before the American Physical Society. The total expansion of copper was measured from 75° to 1356° K. and the curve was extrapolated to 0° K. The total expansion from 0° K. to the melting point was thus found to be 3.01% of the length at 0° K. This is consistent with the theory of melting of face-centred cubic materials (Davey, *Phys. Rev.*, 1926, [ii], 27, 319) and with the spherical "shape" attributed to the atomic domain of such materials. The expansion over the whole range from 0° K. to 1356° K. is given by  $L = L_0 (1 + \alpha t)$ , where  $\alpha$  lies between  $2.24 \times 10^{-5}$  and  $2.35 \times 10^{-5}$ . It is given still more accurately between 200° and 1200° K. by  $L = L_0 (1 + \alpha t + \beta t^2)$  in which  $\alpha$  and  $\beta$  are  $2.26 \times 10^{-5}$  and  $-2.44 \times 10^{-9}$ , respectively, between 200° and 500° K. and  $2.08 \times 10^{-5}$  and  $1.66 \times 10^{-9}$ , respectively, between 700° and 1200° K.—S. G.

\***Investigation of the Vibration Endurance Strength of Cold-Drawn Copper and Pure Aluminium Wire.** W. Schwinning and E. Dorgerloh (*Z. Metallkunde*, 1935, 27, 33-37).—Graphs showing the change in tensile, elastic, and endurance properties of copper and aluminium wires with the % reduction in drawing consist of several linear sections. The slopes of the various sections of the graphs for copper become less steep, whereas those for aluminium become steeper with increase in reduction. The direction of the lines changes for copper at 40, 80, and 94% reduction and for aluminium at 60, 90, and 96% reduction. The Wöhler fatigue value for both metals increases slowly with increase in reduction up to 80% and then more rapidly, reaching twice the original value at 97% reduction. Drawing has no effect on the

electrical conductivity of aluminium, but reduces that of copper up to 80% reduction, and then increases it again up to 94% reduction. Wires for free transmission lines should be annealed for 2 hrs. at 100° C. to remove internal stress before use.—A. R. P.

**\*An Experiment on the Relation Between the Magnetic Susceptibility and the Elastic Stress [in Copper].** Yuzuru Watase (*Sci. Rep. Tôhoku Imp. Univ.*, 1934, [i], 23, 208–212).—[In English.] The variation of the magnetic susceptibility of copper was measured under a homogeneous elastic stress.—S. G.

**\*Optical Properties of Sputtered Metal Films [Copper].** J. B. Nathanson and H. F. Seifert (*Phys. Rev.*, 1935, [ii], 47, 328).—Abstract of a paper read before the American Physical Society. Semi-transparent copper films, each of variable thickness, were produced by sputtering in hydrogen. From the location of the observed interference fringes, and the assumed density and optical constants of copper in bulk, the masses of these films were computed as previously reported for manganese and platinum (*Met. Abs.*, 1934, 1, 229). The computed masses of copper were several times greater than those determined by weighing, as previously found for platinum. A higher refractive index, or lower density (or both) are thus indicated for the films as compared with these constants found for the metal in the bulk. A higher refractive index for copper was found (1) from independent observations of the film thickness by means of the Michelson interferometer; (2) from polarimetric observations following the method of K. Försterling (*Göttingen Nachrichten*, 1911, 58). The physical state of the platinum films seems to vary somewhat with ageing, since the location of the interference fringes was found to vary slightly over a period of about 20 months.—S. G.

**Europium, a Rare Member of the Rare Earth Group.** B. S. Hopkins (*Trans. Electrochem. Soc.*, 1934, 66, 49–56).—See *Met. Abs.*, 1934, 1, 546.

—S. G.

**Some Rarer Metals [Germanium, Gallium, Indium, Rhenium].** W. Wardlaw (*Ann. Rep. Prog. Chem.*, 1935, 31, 118–126).—A review of recent, published work on germanium, gallium, indium, and rhenium.—E. S. H.

**\*The Electrical Resistance of Gold, Copper, and Lead at Low Temperatures.** W. J. de Haas, J. de Boer, and G. J. van den Berg (*Physica*, 1934, 1, 1115–1124; and *Comm. K. Onnes Lab. Leiden*, No. 233b).—[In English.] The resistance curve of the gold wires measured (not very pure) has a minimum. The copper resistances measured show that it is impossible to apply Matthiesen's rule for these substances. The "ideal" resistance of lead calculated (by means of Matthiesen's rule) follows Bloch's formula at low temperature. The transition point of lead is 7.29° K.—S. G.

**\*The Influence of Impurities on the Properties of Lead. II.—The Effect of Heat-Treatment on the Mechanical Properties of Commercial Lead.** J. Neill Greenwood (*Proc. Australasian Inst. Min. Met.*, 1934, (95), 79–124).—See also *J. Inst. Metals*, 1933, 53, 114. The commercial lead used in this work contained bismuth 0.0023, iron 0.0007, antimony 0.0040, cadmium 0.0002, copper 0.0002, silver 0.0003, and zinc 0.0005%. Under a tensile stress of 1100 lb./in.<sup>2</sup> the behaviour of this lead depends on the time which has elapsed between the casting and the beginning of the test, if no heat-treatment has been given, the longer the time after casting the shorter being the time required for fracture to ensue. If the metal is cold-rolled and annealed at 125° C. its work-hardening capacity rises to a maximum 1 day after cooling, and then decreases for about 100 days. When the metal has reached a stable state after casting or after mechanical and heat-treatment, the time required for fracture under a load of 1100 lb./in.<sup>2</sup> is about 150 minutes and the elongation at fracture is 37%; if, however, the metal is refined electrolytically so that the impurities are reduced to 0.0005% and is melted and cast *in vacuo* the time required for fracture is only 42 minutes and the elongation is 50%, showing that even 0.007% of

impurities (plus an unknown amount of oxygen) increases the hardness of lead. Again vacuum-melted and cast electrolytic lead is, unlike commercial lead, quite insensitive to heat-treatment. Tests made under a load of 500 lb./in.<sup>2</sup> show that the initial stretch is smaller the longer the time elapsing between the last heating and the commencement of the test, that the precipitation of impurities from lead which has been heated is accompanied by a stiffening of the crystal structure, and that the life of the metal under this load is greater the longer the time between the last heating and the application of the load. Experiments are described which show that oxygen plays an important part in determining the behaviour of lead under tensile loads; complete elimination of oxygen from commercial lead renders it appreciably softer and more sensitive to deformation, recrystallization taking place after 3.5% elongation under a load of 500 lb./in.<sup>2</sup> Annealing of oxygen-free lead in air at 130° C. renders it identical with air-melted lead, and it therefore appears possible for oxygen to diffuse into lead at temperatures much below the melting point. (See also following abstract.)—A. R. P.

**\*The Influence of Impurities on the Properties of Lead. III.—The Influence of Silver on the Rate of Recrystallization of Distorted Lead.** R. S. Russell (*Proc. Australasian Inst. Min. Met.*, 1934, (95), 125–157).—See also *J. Inst. Metals*, 1933, 53, 114, and preceding abstract. The lead used in the tests was refined electrolytically in a perchlorate bath and contained copper 1, bismuth 2, iron 1, and zinc 1 p.p.m. After being cast and annealed *in vacuo*, and then distorted 2½% this lead recrystallized completely in 30 minutes at 11°–12° C. Annealing in air delays recrystallization slightly, and subsequent ageing at room temperature delays it further, but the maximum time of recrystallization is 2 hrs. Addition of even minute quantities of silver to this lead retards recrystallization to a remarkable extent, thus only 0.1 p.p.m. of silver extends the recrystallization time to 24 hrs. after a 5% distortion, whereas pure lead under the same conditions recrystallizes completely in 5 minutes. The presence of silver tends to enlarge the grain-size and make it uneven; in this state recrystallization may be delayed for 46 hrs. after a 5% distortion. An alloy with 5 p.p.m. of silver under the same conditions takes 64 days to recrystallize completely, and alloys with 0.005 and 0.025% silver do not recrystallize at room temperature, but take 20 and 17 hrs., respectively, to recrystallize at 125° C. These results show that the tendency of lead to recrystallize is a much better criterion of purity than is its grain-size.—A. R. P.

**Termites and Underground Electric Cables [Attack of Insects on Lead Cable Sheath].** D.-A. Allemand (*Rev. gén. Élect.*, 1934, 35, 886–888).—Examples are described of the attack of lead cable-sheaths by termites (white ants). Lead appears to have an attraction for the termites, but it is uncertain whether the attack is by the insects' teeth or by secreted acids. The appearance of attacked samples is illustrated and said to resemble that of a metal acted upon by acid. An attempt to prevent attack by encasing a cable in concrete was not completely successful.—J. C. C.

**\*Absorption of Hard X-Rays in Lead.** A. Alihanjan and M. Kosman (*Z. Physik*, 1934, 90, 779–787).—See *Met. Abs.*, this volume, p. 43.—J. S. G. T.

**Lithium.** Hans Osborg (*Trans. Electrochem. Soc.*, 1934, 66, 91–104; discussion, 104–105; and *Met. Ind. (Lond.)*, 1934, 45, 585–587, 617–618).—See *Met. Abs.*, 1934, 1, 478.—S. G.

**\*Anomaly in the Specific Heat of Lithium.** G. W. Pankow and P. Scherrer (*Helv. Phys. Acta*, 1934, 7, 644–647; *Sci. Abs.*, 1934, [A], 37, 1207).—[In German.] Debye's theory of specific heats should be applicable to monatomic substances crystallizing in the cubic system. However, diamond, silicon, grey tin, and the alkali metals deviate from the Debye curve. The anomaly has been explained by Simon in terms of an intra-atomic transformation which involves the absorption of energy and gives the specific heat an addi-

tional term which can be represented by a Schottky function. In applying this idea to lithium, Simon has represented the observed specific heat by means of a Schottky function with a characteristic transformation temperature at 205° C. together with a Debye function with a characteristic temperature  $\theta = 510^\circ$ . P. and S. have determined the characteristic temperature by measurement of the temperature dependence of the intensity of X-ray interference, between liquid air and room temperature, and obtained  $\theta = 350^\circ$ , which is much lower than that required by Simon's hypothesis. A value of  $\theta$  of the order of 350° is also in better accord with the specific heat measurements at very low temperatures and with the variation of resistance with temperature.

—S. G.

**\*X-Ray Investigations on the Thermal Expansion of Solids.—II.** [Magnesium, Cadmium, Zirconium, Cobalt.] Gunji Shinoda (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1934, [A], 17, 27–30).—Cf. *Met. Abs.*, 1934, 1, 6. The thermal expansion coeffs. of magnesium, cadmium, zirconium, and cobalt were determined by the X-ray method, and the following results were determined: Mg ( $\alpha_{11} = 23.8 \times 10^{-6}$ ,  $\alpha_1 = 23.5 \times 10^{-6}$ ), Cd ( $\alpha_{11} = 50.0 \times 10^{-6}$ ,  $\alpha_1 = 17.9 \times 10^{-6}$ ), Zr ( $\alpha_{11} = 2.5 \times 10^{-6}$ ,  $\alpha_1 = 14.3 \times 10^{-6}$ ), Co ( $\alpha_{11} = 16.1 \times 10^{-6}$ ,  $\alpha_1 = 12.6 \times 10^{-6}$ ). The expansion coeffs. of several hexagonal elements were determined by X-ray analysis in these experiments. The experimental method was almost the same as that described in the previous paper, but a new X-ray tube was constructed.—S. G.

**The Purification of Magnesium and Calcium by Sublimation.** J. Hérenguel and G. Chaudron (*Acières spéciaux*, 1934, 9, 415–417).—The apparatus for purifying magnesium and calcium by sublimation and the method of carrying out the process are described. By this method, magnesium of a purity above 99.99% can be obtained. By remelting in argon, pure alloys can be prepared without the use of a flux. In the case of calcium, metal of 99.5% purity is obtained. The metal is heated to 800° C. in argon under pressure to remove sodium. The calcium is first distilled to prevent loss which is kept down to 5–10%. Sublimation is effected at 800° C. *in vacuo*.—J. H. W.

**\*The Surface Tension of Mercury in the Presence of Gases. I.—Dry Air.** Marie Kernaghan (*Phys. Rev.*, 1935, [ii], 47, 202).—Abstract of a paper read before the American Physical Society. The main section of the apparatus and the method (flat-drop) are those used by K. (*J. Inst. Metals*, 1931, 47, 370) to find the surface tension of mercury in a vacuum. The surface tension, evaluated by application of Worthington's formula, was found to decrease rapidly from 464 dynes/cm. in a vacuum until an apparently critical pressure of 7 mm. was reached. Values for higher pressures remain fairly constant.—S. G.

**\*The Relation Between Field Emission and Work-Function of Liquid Mercury.** L. R. Quarles (*Phys. Rev.*, 1935, [ii], 47, 328).—Abstract of a paper read before the American Physical Society. The dependence on the cathode work-function of the breakdown field between a liquid mercury cathode and a spherical molybdenum anode has been investigated. Results have been obtained over a work-function range of 1 v., and, whilst the trend is that forecast by the Fowler-Nordheim equation, the fields, calculated on the assumption of a smooth surface, are much less than predicted.—S. G.

**\*Dependence of Frequency on the Permeability of Iron, Nickel, and Cobalt.** R. Sanger (*Helv. Phys. Acta*, 1934, 7, 478–480; *Sci. Abs.*, 1934, [A], 37, 928).—[In German.] A decrease of the permeability is observed at very high frequencies. Whether the observed decrease of the permeability at wave-lengths of 100 to 10 cm. is to be referred to a critical time (partition shifting process), or to a critical length (exhibition of skin effect) cannot be decided with the observation material existing at present. It would be interesting, in view of this, to extend the researches on iron, nickel, and cobalt to wires which are under different mechanical tension.—S. G.

**\*On Adsorption [by Nickel and Silver Wires].** Arnold Kemper (*Z. physikal. Chem.*, 1934, [A], **169**, 275–286).—Adsorption isotherms for methyl violet and methylene blue on silver and nickel wires have been determined. The adsorptive power decreases with the temperature at which the wires have been heated before the test and is extinguished to a great part by heating at 400° C. The higher the temperature and the longer the time of heating the thinner is the film adsorbed, and eventually it becomes much less than a monomolecular film. The absorptive power of nickel decreases at first more slowly than that of silver. Etching with sulphuric acid restores the adsorptive power, which is attributed to the activity of peaks and points of disturbance in the crystals; on heating these flatten out as the temperature is increased owing to the greater atomic activity as the melting point of the metal is approached.—B. Bl.

**\*The Occlusion and Diffusion of Hydrogen in Metals. A Metallographic Study of Palladium-Hydrogen.** Donald P. Smith and G. J. Derge (*Trans. Electrochem. Soc.*, 1934, **66**, 253–269; discussion, 270).—See *Met. Abs.*, 1934, **1**, 549.—S. G.

**\*Diffusion of Hydrogen Through Iron and Palladium.** W. R. Ham and J. D. Sauter (*Phys. Rev.*, 1935, [ii], **47**, 337).—Abstract of a paper read before the American Physical Society. As previously reported (*Met. Abs.*, 1934, **1**, 548), the rate of diffusion of hydrogen through palladium may be modified greatly by heat-treatment of the palladium in various atmospheres. This is also true of iron. In general, the apparent mass action law for diffusion of hydrogen through these 2 metals depends on rate alone, *i.e.* a sample of fresh palladium may be degassed until at 300° C. and 760 mm. pressure the rate is a certain amount; another sample may require heating to 600° C. at 760 mm. to obtain the same rate. The flow equations of both will be identical in so far as pressure changes at these temperatures are concerned. Iron exposed to nitrogen may have its diffusion rate for hydrogen increased 10–15 times, but after baking out at higher temperatures the diffusion curve comes back to its original position. Diffusion isotherms for iron and palladium and very slow rates always approach  $R_1 = A_1 p^{1.0}$ ; for very high rates  $R_2 = A_2 p^{0.5}$ . There is an apparently continuous variation from one exponent to the other.—S. G.

**\*Diffusion of Hydrogen Through Metals [Palladium].** Tito Franzini (*Nature*, 1935, **135**, 308).—Experiments on the adsorption and rate of diffusion through palladium of ordinary and heavy hydrogen lead to the assumption of an adsorption threshold on one side and an evaporation pressure on the other side of the metal.—E. S. H.

**\*On Platinum Black.** G. von Hevesy and T. Somiya (*Z. physikal. Chem.*, 1934, [A], **171**, 41–48).—Platinum black prepared by electrolysis of platinum chloride solutions containing lead acetate may contain up to 7% lead, most of which is not in solid solution. X-ray examination has shown that the best platinum black has the largest particle size.—B. Bl.

**\*The Formation of a Potassium Film on Silver.** James J. Brady (*Phys. Rev.*, 1935, [ii], **47**, 197).—Abstract of a paper read before the American Physical Society. Photoelectric studies were made of potassium films deposited on a freshly evaporated silver surface. The photoelectric cell was of the concentric sphere type used in the study of the energy distribution of photoelectrons. Current-voltage curves were obtained, particular attention being paid to the study of the saturation of the photocurrent. It was previously reported (*J. Inst. Metals*, 1933, **53**, 4) that films deposited on a surface at room temperature did not yield a constant photocurrent after deposition. The current decreases with time. Curves were obtained showing the way the photocurrent approaches saturation when the surface is at room temperature. A study was then made of the way these curves change with time after deposition. It was found that the photocurrent approaches saturation at lower voltages when examined immediately after deposition

than after the film has been standing for some time. This change in photo-current is much more pronounced with films less than 3 molecular layers than with thicker films. Similar studies were made with the condensing surface cooled with carbon dioxide snow. In this case the changes are much slower than at room temperature. Likewise, when the surface is cooled with liquid air the changes are very small even for the thinnest films examined. The formation of patches is suggested as a likely explanation for the phenomena.—S. G.

**\*Variation with Temperature of the Dark [Electrical] Conductivity of Selenium.** P. Scharawsky (*Physikal. Z. Sowjetunion*, 1934, 5, 511–515).—[In German.] The specific electrical conductivity,  $\sigma$ , of selenium, unexposed to light, is found to vary in accordance with Van t' Hoff's formula,  $\sigma = Ae^{-B/T}$ , for values of the absolute temperature,  $T$ , between 60° and –183° C.—J. T.

**\*Temperature Effects on Photo-Voltaic Current and E.m.f. of a Selenium Mono-Crystal Platinum Film Combination.** R. M. Holmes and L. C. Whitman (*Phys. Rev.*, 1935, [ii], 47, 337).—Abstract of a paper read before the American Physical Society. Lamellar crystals of selenium were grown in an evacuated tube by condensation of the vapour. Platinum films covering approximately  $\frac{1}{2}$  of each surface were deposited by sputtering. The combination was placed in a uniform temperature enclosure. Light transmitted through one of the films causes an electron flow from selenium to the illuminated film, then through an outside circuit returning to the non-illuminated film. The magnitude of the current depends on temperature. From –20° to 50° C. there is a reversible and nearly linear decrease, the rate at 50° C. being –4% per degree. Between 50° and 100° C. the decrease is smaller, reversible, and non-linear, while exposure to higher temperatures results in a permanent decrease caused by baking of the platinum films. By e.m.f. is meant the opposing p.d. introduced into the outside circuit to stop the current. This decreases linearly and reversibly from –20° to 20° C. at approximately 0.5 millivolt/degree. The decrease is reversible but smaller and non-linear up to 100° C. Baking of the films during exposure to higher temperatures causes a permanent decrease. These effects are described by a theory which relates the current and e.m.f. to resistances in the combination either reversibly or permanently changed by heating.—S. G.

†**The Production and Utilization of Thorium and Uranium.** J. W. Marden (*Trans. Electrochem. Soc.*, 1934, 66, 39–46; discussion, 46–47).—See *Met. Abs.*, 1934, 1, 480.—S. G.

**\*Magnetism of Tin.** Kotarō Honda and Yosomatsu Shimizu (*Nature*, 1935, 135, 108).—The change in the magnetic susceptibility of white tin from para- to dia-magnetic when reduced to particles of colloidal dimensions is analogous to the same change due to cold-working, and is traced to the greater distance between the layers of atoms near the surface as compared with the interior.—E. S. H.

**\*Heat Losses from a Tungsten Wire in Helium.** Walter C. Michels and Gladys White (*Phys. Rev.*, 1935, [ii], 47, 197).—Abstract of a paper read before the American Physical Society. One of the difficulties which arose in connection with the determination of the accommodation coeff. of a gas against a metal is that correction must be made for the thermal etching of the surface produced by the heat-treatment necessary to clean the wire. It is possible to compute the effect of this etching by means of Taylor and Langmuir's data on thermionic emission (*Met. Abs.*, 1934, 1, 5) or by measurement of the total emissivity of the wire used. The 2 methods check each other satisfactorily, and indicate that a stable condition of the surface can be achieved. The heat losses from a tungsten wire in helium have been studied at room temperature and an accommodation coeff. of 0.092 has been found. When the correction has been made for etching, the value of the coeff. for

a smooth, clean surface is 0.069, in good agreement with the lowest values obtained by Roberts (*Proc. Roy. Soc.*, 1930, [A], 129, 146). There is some evidence that the value of 0.17 obtained for a rough surface by both Roberts and Michels is due to a semi-stable condition of the etched surface.—S. G.

**\*Contact Potential of Thoriated Tungsten.** David B. Langmuir (*Phys. Rev.*, 1935, [ii], 47, 328).—Abstract of a paper read before the American Physical Society. The contact potential of thoriated tungsten has been measured for different values of surface coverage and temperature. The experimental tube consisted of 3 coaxial cylinders inside which were 2 filaments, one of tantalum and one of thoriated tungsten. High-vacuum conditions were obtained by evaporating tantalum from the first filament to the walls during exhaust. The metallic coating so formed on the glass constituted the cylindrical electrodes, and except for the filament and leads there were no other metal parts within the tube. With the tantalum filament as cathode, with the tungsten cold, the volt-amp. characteristic to the tungsten was obtained for different states of activation, other conditions being kept constant. The curves so obtained could be made to coincide by shifting parallel to the voltage axis, and the amount of this shift was taken as the contact potential. The logarithm of the emission from the filament at zero field is a linear function of the contact potential, but the slope is less than the theoretical value  $e/kT$ . This discrepancy can be explained largely by the temperature coeff., which was observed to be of the order of magnitude of 5  $k$ .—S. G.

**\*Thoriated Tungsten Filaments.** Irving Langmuir (*Acta Physicochimica, U.R.S.S.*, 1934, 1, 371–396).—[In English.] The same paper was published in *J. Franklin Inst.*, 1934, 217, 543–569. See *Met. Abs.*, 1934, 1, 554.—I. M.

**Ionization of Alkali Metal Atoms on Tungsten, Molybdenum, and Thoriated Tungsten.** L. Dobrezow (*Z. Physik*, 1934, 90, 788–801).—The variation with temperature of the thermal ionization of sodium and potassium from tungsten and molybdenum is in agreement with the Langmuir–Saha formula. Results in the case of thoriated tungsten suggest that over a certain range of ionization, there are present on the surface of this material regions of pure thorium whereat practically all the ionization is produced.—J. S. G. T.

**†Vanadium.** B. D. Saklatwalla (*Trans. Electrochem. Soc.*, 1934, 66, 33–38; discussion, 38).—See *Met. Abs.*, 1934, 1, 480.—S. G.

**\*On the Specific Heats of Zinc and Silver at Liquid Helium Temperatures.** W. H. Keesom and J. A. Kok (*Physica*, 1934, 1, 770–778; and *Comm. K. Onnes Lab. Leiden*, No. 232d; also (abstract) *Proc. K. Akad. Wet. Amsterdam*, 1934, 37, 377–378).—[In English.] Experiments were carried out in order to see whether the rapid descent of the  $TC^{-\frac{1}{2}}$ ,  $T$ -curve below 5° K. is connected with adsorption of a layer of helium at the surface of the metal, by measuring the heat capacity (1) of a zinc block with increased ratio surface : weight, and (2) of a silver block cooled by contact so that no adsorption of helium at the low temperatures can occur. The result is negative, leading to the conclusion that the effect mentioned is real. The hypothesis is introduced that the effect is due to the heat capacity of the free electrons. Below 3.0° K. the supplementary atomic heat for silver agrees with the heat capacity of the free electrons according to Sommerfeld's formula, assuming for the number of electrons 1 per atom. Above 3.5° K. the heat capacity of the free electrons decreases rapidly. For zinc no definite conclusion can be reached. The supplementary heat seems to be of the order of magnitude that results from Sommerfeld's formula with  $n = 1$ , but the latter value appears to be rather too large.—S. G.

**†Investigations Relating to the Free Alkali Metals.** H. Alterthum and R. Rompe (*Physikal. Z.*, 1935, 36, 69).—Information is given relating to the alkali metals which supplements that given in a previous review of the subject (*Met. Abs.*, this volume, p. 46).—J. S. G. T.



**\*Adsorption of Alkali Metals on Metal Surfaces. I.—Formation and Adsorption of Ions; Potential Curves.** J. H. de Boer and C. F. Veenemans (*Physica*, 1934, 1, 753-762; *Sci. Abs.*, 1934, [A], 37, 938).—[In English.] The atoms of alkali metals are adsorbed as ions at pure metal surfaces if  $Q_i + \epsilon\phi_0 > Q_a + I$ , where  $Q_i$  is the adsorption energy of the ions,  $\epsilon\phi_0$  the work done in extracting an electron from the surface,  $Q_a$  the adsorption energy for the atoms, and  $I$  their ionization potential. If in addition  $\epsilon\phi_0 > I$ , evaporation of the adsorbed positive ions in the form of positive ions occurs at higher temperatures. These adsorption phenomena can be explained on the basis of chemical attraction (van der Waals' attractive forces) as can be shown with the assistance of potential curves giving the energy of the ion at different distances from the surface. The surface acts as negative partner. The energies of various alkali ions are evaluated from these considerations.  
—S. G.

**\*Adsorption of Alkali Metals on Metal Surfaces. II.—Dipole Moment of Adsorbed Cs Ions; Adsorption Isotherm. III.—Adsorption Energy of the Ions.** J. H. de Boer and C. F. Veenemans (*Physica*, 1934, 1, 953-965).—[In English.] See also preceding abstract. The adsorption of  $\text{Cs}^+$  on a tungsten surface, together with the electrical images thus formed, is shown to give rise to a dipole moment which reduces the work-function of the surface. The theoretical and experimental results are in good agreement; Langmuir's views on the subject are disputed. The heat of vaporization of the atoms, the adsorption isotherm, and an expression for the electron emission are obtained on the electrical image theory. If a few positive ions are already attached to the surface, the negative image field evoked causes succeeding ions (up to a certain limit) to be still more strongly attracted. This increase in binding energy is shown experimentally for caesium ions; also, the effect on the electron emission formula is calculated.  
—S. G.

†**Physics of the Metallic State.** Franz Wever (*Z. tech. Physik*, 1934, 15, 418-421).—The following subjects are briefly reviewed: microscopy, thermal analysis, the phase-rule and equilibrium diagrams, X-ray analysis, alloy characteristics, hardening of steel, the kinetics of hardening.—J. S. G. T.

†**The Nature of the Metallic State.** W. Conard Fernelius and Richard F. Robey (*J. Chem. Education*, 1935, 12, 53-68).—The various lines of investigation into the nature of the metallic state are reviewed. The nature of the metallic linkage, although it has the characteristics of both the covalent (homopolar) and the electrovalent (heteropolar) linkage, is best regarded not as intermediate between these two, but as a separate and distinct type of bonding between atoms. The complex subject of alloys and metallic compounds is discussed, and a *bibliography* is appended.—J. H. W.

**\*A Magnetic Study of the Metallic State and the Fermi-Dirac Statistics.** Simon Freed and Harry G. Thode (*Phys. Rev.*, 1935, [ii], 47, 335).—Abstract of a paper read before the American Physical Society. The application of the Fermi-Dirac statistics to metals leads to a distribution of the spin of the electrons which does not vary much until about  $40,000^\circ \text{C}$ ., the so-called critical temperature, is reached. Hence, magnetic measurements of metals which register the magnetism associated with the spin could scarcely serve as a test of the statistics since the variations in magnetism expected from the statistics would set in at such temperatures. However, on diluting a metal with a non-metal, a lowering of the critical temperature would be anticipated. When the metal in the dilute state occupies a volume of say 20,000 times as great as in the pure state, the distribution at room temperature is practically the same on the Fermi-Dirac statistics as on the classical statistics; the elementary magnets would be almost independent of each other. F. and T.

have measured the magnetic susceptibilities of *sodium* dissolved in liquid ammonia at various concentrations, the dissolved metal occupying from 100 to 20,000 times the volume of pure metal. The atomic susceptibility of sodium varied from that of the pure metal to about 100 times as much. In the most dilute solution measured, the atomic susceptibility was about  $\frac{2}{3}$  the paramagnetic susceptibility which would arise from independent magnets having one-half unit of spin.—S. G.

**\*The Phenomenon of Supercooling.** Alexander Goetz (*Phys. Rev.*, 1935, [ii], 47, 257).—Abstract of a paper read before the American Physical Society. The phenomenon of super-cooling in metals is interpreted as group phenomenon (Goetz, *Z. Krist.*, 1934, 89, 310; *Internat. Conference Physics*, 1934, (2), 62) as due to the fact that the transition into the rigid crystalline state has to be anteceded by a paracrystalline mesophase. It can be concluded thus that supercooling is the more likely the more the lattice of the crystal differs from a statistical (close-packed) configuration and the more groups of paracrystalline qualities have been destroyed in the melt. Experiments prove that for metals with irregular lattices like gallium and bismuth, the supercooling can be induced over large ranges of temperature by superheating the melt or by surface forces acting on sufficiently thin metallic layers. The beginning of the mesophase is determined for bismuth and gallium to  $10^{\circ}$ – $12^{\circ}$  above the melting point and the size of a group estimated to  $10^{-4}$  cm.—S. G.

**The Need of Physicists to Study the Problem of Hardness and Its Measurement.** S. R. Williams (*Phys. Rev.*, 1935, [ii], 47, 427).—Abstract of a paper read before the American Physical Society. In spite of the wide use of the hardness test, there is no satisfactory definition of the term hardness, and the methods so far employed for measuring it are not based on any fundamental physical property. Modern atomic and colloid theories, and theories of elasticity and plasticity should be of advantage to the physicist in the study of hardness. Hardness should not be left for study by metallurgists and mineralogists alone. Desch has observed that "metallographic researches have resulted as yet in comparatively few far-reaching generalizations." In the field of hardness measurement there is some need for generalization. It is this phase of the work which should be considered by the physicist. The investigation of hardness as a physical property should percolate down through science departments until the students of general physics are studying allied properties, such as density, elasticity, thermal and electrical conductivity, and magnetic induction.—S. G.

**\*The Mechanism of Plastic Deformation.** A. W. Stepanow (*Physikal. Z. Sowjetunion*, 1933, 4, 609–627).—[In German.] See *J. Inst. Metals*, 1933, 53, 614.—J. S. G. T.

**\*Heightening of the Plasticity of Metals under Alternating Plastic Torsion.** V. D. Kuznetsov, D. V. Konvisarov, and V. I. Strokopitov (*Dokladi Akademii Nauk S.S.S.R. (Compt. rend. Acad. Sci. U.R.S.S.)*, 1934, 1, (7), 399–402).—[In Russian and German.] A special machine was constructed enabling an oscillating-torsional motion of one end of the specimen in relation to the other through an angle from  $0^{\circ}$  to  $\pm 60^{\circ}$ . Length of specimen, 70 mm.; diameters: for aluminium, 3.20 mm.; copper, 3.50 mm.; iron, 2.45 mm. With a stationary specimen with both ends rigidly fixed the bending deviation was small, even with considerable load placed on the centre of the specimen. When the machine was set in motion the specimen became very plastic, and began to flow under the influence of its own weight and gradually bent. Such a rod can be easily bent with the fingers, like lead. The plasticity disappeared as soon as the machine was stopped. The temperature increased only a few degrees.—N. A.

\***Change of Properties of a Strained Single Crystal by Recovery.** M. O. Kornfeld (*Physikal. Z. Sowjetunion*, 1934, 5, 185-190).—[In German.] See *Met. Abs.*, 1934, 1, 228.—J. S. G. T.

\***Recovery of Deformed Crystals [of Aluminium] During Rest.** M. O. Kornfeld (*Zhurnal eksperimental'noy i teoreticheskoy Fiziki (J. Exper. and Theoret. Physics)*, 1934, 4, (8), 873-882).—[In Russian.] The relation between the rate of recovery and the degree of deformation and the temperature of rest has been investigated. The relation between the limit of flow and the temperature of rest established by K.'s earlier work has been confirmed over a wider range of deformations. With temperatures above 550° C. a secondary uniform decrease in the limit of flow with annealing temperature takes place, resulting in complete restoration of the initial properties. It is shown that the coeff. of strength of a deformed crystal alters with the temperature of rest. Possible interpretations of the phenomenon of recovery are given.—N. A.

**Mechanics of Isotropic Bodies in the Plastic State.** H. Geiringer and W. Prager (*Ergeb. exakt. Naturwiss.*, 1934, 13, 310-363).—The present state of knowledge in this field is summarized. A *bibliography* of 38 references is given.—S. G.

\***Elastic Properties of Quasi-Isotropic Multiple Crystals.** A. Huber and E. Schmid (*Helv. Phys. Acta*, 1934, 7, 620-627; *Sci. Abs.*, 1934, [A], 37, 952).—[In German.] From the dependence on orientation of the modulus of elasticity and the modulus of torsion of cubic and hexagonal crystals, the moduli of the irregular quasi-multiple crystals are calculated by formation of average value over the whole range of orientation. See also following abstract.—S. G.

\***Calculation of Physical Constants of Quasi-Isotropic Multiple Crystals.** W. Boas and E. Schmid (*Helv. Phys. Acta*, 1934, 7, 628-632; *Sci. Abs.*, 1934, [A], 37, 952).—[In German.] The method described by Huber and Schmid (preceding abstract) for calculating the elastic moduli of quasi-isotropic multiple crystals from the behaviour of the single crystal has been verified by being applied to a series of metals, and by comparison with other methods of obtaining the average. The transfer of the method to the determination of other constants such as the coeff. of extension and the specific electrical resistance also lead to satisfactory results.—S. G.

\***Technique for Making Sound Ingots for Density Determinations.** P. G. Waldo and Wheeler P. Davey (*Phys. Rev.*, 1935, [ii], 47, 338).—Abstract of a paper read before the American Physical Society. Pure copper was melted by means of a gas-flame in Alundum crucibles inside an evacuated ("satin") quartz tube. At room temperature the pressure inside the tube was 0.004 mm. At 1080° C. the pressure increased to 1 mm., in spite of continuous pumping by means of a Cenco Hyvac pump. Surprisingly, this low pressure of gas was enough to give visible gas pockets in the copper, and the lattice parameter was different from that of pure copper. When the quartz tube was surrounded by a second quartz tube evacuated by a second Cenco Hyvac pump, the pressure in the inner tube only increased to 0.02 mm. and copper of normal density ( $8.994 \pm 0.004$ ) was obtained. It is thought that if the above technique had been observed by Phelps and Davey (*J. Inst. Metals*, 1932, 50, 164) their results would have been different.—S. G.

\***Further Investigations of the Thermal Expansion of Solids by X-Ray Method.** Gunji Shinoda (*Nippon Suugaku-Buturigakkwai Kizi (Proc. Phys.-Math. Soc. Japan)*, 1934, [iii], 16, 436-438).—[In English.] The thermal expansion coeffs. of platinum, gold, and tungsten were determined by the X-ray method, and the following results were obtained: platinum  $9.9 \times 10^{-6}$ , gold  $13.2 \times 10^{-6}$ , and tungsten  $6.8 \times 10^{-6}$ .—S. G.

\***The Validity of Antonow's Rule for the Solid-Liquid Interface [Mercury-Water], and the Consequent Measurement of the Surface Tension of Solids.** R. Loman and N. P. Zwikker (*Physica*, 1934, 1, 1181-1201).—[In English.]

—S. G.

**\*Vapour Pressure Measurements of High-Boiling Point Metals.** Emil Baur and Roland Brunner (*Helv. Chim. Acta*, 1934, 17, 958-969; *C. Abs.*, 1935, 29, 973).—An apparatus is described consisting of a carbon resistance furnace surrounding a tube of corundum or beryllium oxide containing the metal. A modification of von Wartenburg's apparatus is used to indicate the onset of ebullition. Temperature is measured by an optical pyrometer. Extrapolated boiling points are: zinc 907°, magnesium 1107°, lead 1692°, silver 1927°, manganese 2032°, aluminium 2270°, copper 2336°, silicon 2355°, tin 2362°, chromium 2660°, gold 2710°, and beryllium 2970° C. Heats of vaporization, Trouton quotients and empirical vapour pressure equations are also tabulated.—S. G.

**\*On Modifications in Homogeneous Substances.** G. Tammann (*Z. physikal. Chem.*, 1934, [A], 170, 380-390).—Transformations in crystalline materials are of 2 types, (a) those which are accompanied by a crystallization, and (b) those which occur in an unchanged homogeneous crystal. In the first case the properties change discontinuously at a definite temperature, but in the second case the properties change continuously over a temperature range. Equations are given for the course of a transformation in a homogeneous phase. The change in the specific heat at constant pressure in the softening range of glasses and in the transformation range of crystals is compared. The loss of ferromagnetism of iron and nickel with increase in temperature, the change in length of  $\beta$ -brass with temperature in the range 410°-480° C., and the transformation of  $\alpha$ - into  $\beta$ -quartz are discussed.—B. Bl.

**\*The Nitriding of Some Metals.** Paul Laffitte and Pierre Grandadam (*Compt. rend.*, 1935, 200, 1039-1041).—The effect of nitriding the following metals has been studied by observing the variations of the electrical resistance,  $R$ , as a function of the time,  $\theta$ , or the temperature,  $t$ , of fine wires in a current of nitrogen or ammonia at atmospheric pressure: copper (electrolytic) from 0°-900° C., aluminium (99.99%) 0°-600° C., magnesium (sublimed in argon) 0°-600° C., zinc 0°-400° C., iron (99.98%) 0°-775° C., nickel (99.635%) 0°-900° C., and tungsten 0°-900° C. The ( $R-t$ ) curves are completely reversible, indicating that nitrogen does not react on the metals in the range of temperature or conditions studied. The curves for aluminium of increasing purity show that the metal has no transformation in the solid state, but the curves of pure magnesium show a reversible allotriomorphic transformation at 285° C. Nitriding some metals in ammonia raises the ( $R-t$ ) curves initially above the standard curve (in an inert atmosphere). Reheating in hydrogen restores the standard resistance. This was not observed with copper and zinc. The isothermals ( $R-\theta$ ) for nitriding magnesium between 335° and 510° C. were different from those of other metals; their exponential form showed that this nitriding is autocatalytic. The reduction by hydrogen of nitrated wires of aluminium, iron, and tungsten is accompanied by an appreciable increase in the resistance. The ( $R-\theta$ ) curves in this case are identical with the isotherms of nitriding, and the formation of an amide can be assumed. The solution of the gas in the metal as a solid solution and its fixation as a chemical compound have been followed from the form of the isotherm ( $R-\theta$ ).—J. H. W.

**\*Method of Study of the Diffusion Coefficient of Metals by the Evaporation Method.** V. Bugakov and V. Neskuchaev (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, (7), 1342-1346).—[In Russian.] The proposed method is based on the theoretical considerations of G. A. Grinberg on the rate of volatilization of metals at high temperatures. Within the range 700°-950° C. the diffusion coeff. of zinc in brass is shown to be an exponential function of the temperature, i.e.  $D_x = Ae^{-302T_s/T}$ . The value of  $b$  is of the same order of magnitude as that most frequently found for other diffusion processes.—N. A.

\***The Migration of Adsorbed Atoms Along the Bounding Surfaces of Solids.** A. Gehrts (*Z. tech. Physik*, 1934, 15, 456-461).—The monatomic layer of thorium deposited upon thoriated tungsten or molybdenum fibres is associated with migration or slip of the adsorbed thorium atoms along the bounding surfaces of the crystal grains. The mechanism of the migration is discussed and numerical data involved are given.—J. S. G. T.

\***Influence of Gas Ions on the Electrothermal Homogeneous Effect.** C. Benedicks and C. W. Borgmann (*Arkiv Mat. Astron. Fysik*, 1934, 24B, (10), 1-5; *Sci. Abs.*, 1934, [A], 37, 820).—[In English.] By a simple resistometric method (essentially a Wheatstone bridge) measurement was made of the electrothermic effect in a platinum wire enclosed in an evacuated vessel and kept at a constant temperature. The electrothermic homogeneous effect was found to be a linear function of the potential difference of the ends of the wire. Certain variations were observed which were found to be due to the presence of a gas existing, at least partly, as ions. These ions, probably oxygen, cause a strong electrothermic homogeneous effect opposite to that of platinum. They must possess (at least in preference) a negative charge. The electrothermic homogeneous effect caused by the gas ions may be due also, at least in part, to a true migration of the oxygen towards the positive end of the platinum wire. (See also *Met. Abs.*, 1934, 1, 230, 441).—S. G.

\***Electrode Sputtering on Breaking Contact.** R. Holm (*Z. tech. Physik*, 1934, 15, 483-487).—By sputtering, due to the formation of an arc on breaking a metallic contact, the mass of metal sputtered is proportional to the quantity of electricity discharged in the arc. Values of the constant of proportionality and data for 21 metals and alloys in air or *in vacuo* are given.—J. S. G. T.

\***Conductivity of Thin Metallic Films in an Electrostatic Field.** R. Deaglio (*Nuovo cimento*, 1934, 11, 288-295; *Sci. Abs.*, 1934, [A], 37, 917).—Thin metallic films of gold, of platinum, and of tungsten on glass or quartz obtained by cathodic projection and by thermic projection exhibited conductivity strongly variable in a reversible way with the electrostatic charge. The effect depends on the sign of the field only with films obtained by cathodic projection. Variations of resistance up to 40% were observed for fields of the order of 5000 v./cm. close to the film. With regard to the relation to the sign of the field the effect differs from that described by Perkins and by Pierucci (*Nuovo cimento*, 1932, 9, 33-42).—S. G.

\***Second Effect of Electric Charge on the Conductivity of a Metallic Film.** M. Pierucci (*Nuovo cimento*, 1934, 11, 277-287; *Sci. Abs.*, 1934, [A], 37, 917).—Besides the first effect of the change of conductivity of a metallic film due to an electric charge (see Pierucci, *Nuovo cimento*, 1932, 9, 33-42; and Polvani, *Nuovo cimento*, 1932, 9, 69-71) P. has observed in certain conditions a second effect in a tungsten film much greater than the first, and consisting in an increase of conductivity produced by a positive charge or a negative charge. The magnitude depends on the previous electrostatic treatment of the film. After many thousands of repeated charges and discharges of the film the effect was 3000 times greater than the first effect. With a potential of 3500 v. and a temperature of  $-82.5^{\circ}\text{C}$ . there was an increased conductivity of about 1%. There exists a critical potential below which the effect does not appear and above which it acquires suddenly a notable value. The second effect is in magnitude and sign independent of the sign of the charge.—S. G.

\***Electrical Conduction Through Thin Metallic Films.** M. Fukada and Y. Saito (*J. Inst. Elect. Eng. Japan*, 1934, 54, 542-548; *C. Abs.*, 1935, 29, 55).—[In Japanese.] Electrical conduction through thin metallic films is explained mathematically and experimentally by assuming a metallic conductor and a semi-conductor in parallel. Lengthwise electrical resistance of thin films of silver was also studied, and suggestions are made regarding their use as high resistances.—S. G.

\***Magneto-Resistance and Magnetic Structure of Ferromagnets** [Nickel]. Giulia Alocco (*Nuovo cimento*, 1933, 10, 355-371; *Sci. Abs.*, 1934, [A], 37, 424).—The fundamental relations between the electrical resistance and reversible processes of magnetization in ferromagnets are utilized for putting in evidence a co-ordinated distribution of the single elementary moments in a polycrystalline material. The research, carried out with thin laminae of nickel, leads to the determination of the true aspect of the effects of longitudinal and transverse magneto-resistance, showing how these remain in all cases akin to those in monocrystals, provided that, taking account of the refraction of the lines of force, there is regard to the orientation of the internal field and of the current measured with respect to particular directions of anisotropy.—S. G.

\***The Influence of the Direction of Spontaneous Magnetization upon [Electrical] Resistance.** D. S. Steinberg and F. D. Miroshnitschenko (*Physikal. Z. Sowjetunion*, 1934, 5, 241-252).—[In German.] The effect of a change of direction of spontaneous magnetization on the electrical resistance of nickel, iron, and 2 alloys of these metals (15% nickel-iron alloy and Invar) is investigated experimentally. It is shown that the change of resistance,  $\Delta\rho$ , of ferromagnetic materials obeying the law  $\Delta\rho/\rho = D(\cos^2\phi_2 - \cos^2\phi_1)$  where  $D = (R_{\perp} - R_{\parallel})/R_0$  and  $\phi_1$  and  $\phi_2$  are the respective angles between the directions of spontaneous magnetization and of the current, is different when the material is strained elastically.—J. S. G. T.

\***Influence of the Anharmonic Part of the Thermal Oscillations of Atoms on the Electrical Resistance of Metals.** A. Smirnov (*Physikal. Z. Sowjetunion*, 1934, 5, 599-606).—[In English.] Cf. *Met. Abs.*, this volume, p. 94. It is shown that taking into account the anharmonic part of the thermal oscillations of atoms affords a satisfactory explanation of the variation of the resistance of metals with temperature.—J. S. G. T.

\***Theory of Superconduction.** (1) H. Bethe; (2) R. Schachenmeier (*Z. Physik*, 1934, 90, 674-679, 680).—Polemical. (1) B. contends that the basis of S.'s theory of superconduction (*Met. Abs.*, 1934, 1, 484) is unsound. (2) S. replies.—J. S. G. T.

\***Note on Supraconductivity.** A. J. Rutgers (*Physica*, 1934, 1, 1055-1058).—[In English.] A derivation is given of the equation  $(dH/dT_0)^2 = 4\pi\rho c/T_0$ , where  $dH/dT_0$  is the slope of the magnetic transition curve,  $\rho$  the density of the metal, and  $c$  the jump in the specific heat (i.e.  $c$  supra- $c$  normal) all at  $T_0$ , the normal transition temperature (see Gorter and Casimir, *Met. Abs.*, 1934, 1, 561).—S. G.

**Some Remarks on Supraconductivity and Fermi-Dirac Statistics.** J. A. Kok (*Physica*, 1934, 1, 1103-1106).—[In English.] Quantitative relationships are derived on the assumptions that the specific heat of a non-superconductor shows a supplementary heat capacity due to the Fermi-gas of free electrons, that the curve of the magnetic threshold values is a parabola, and that the specific heat of a superconductor follows a  $T^3$  law. The deductions are found to be in fair agreement with experimental data for tin, thallium, and indium, assuming the number of free electrons per atom to be equal to the valency.—S. G.

\***Further Experiments with the Magnetic Cooling Method.** N. Kürti and F. Simon (*Nature*, 1935, 135, 31).—Pure zirconium and hafnium are found to become superconductive at very low temperatures, the transition points being  $0.7^\circ$  and  $0.3^\circ$ - $0.4^\circ$  abs., respectively. Copper, gold, germanium, bismuth, and magnesium were not observed to become superconductive at temperatures down to  $0.05^\circ$  abs.—E. S. H.

**Magnetic Effect at the Commencement of Superconductivity.** W. Meissner (from the measurements with R. Ochsenfeld and F. Heidenreich) (*Z. ges. Kälte-Ind.*, 1934, 41, 125-130).—A review.—S. G.

**Electrical Phenomena at Extremely Low Temperatures.** J. C. McLennan (*J. Inst. Elect. Eng.*, 1934, 75, 693-709; and *Rep. Progress Physics*, 1934, 198-227).—Twenty-fifth Kelvin Lecture to the Institution of Electrical Engineers. Among the subjects discussed are the low-temperature electrical conductivity and thermal conductivity of metals and alloys; the magnetic properties of superconductors; a new magnetic test for superconductivity; superconductivity in rapidly alternating electric fields; the effect of superposing d.c. and a.c.; film thickness and super-conducting transition temperatures. A bibliography of 42 references is given.—J. S. G. T.

**\*Supposed Relation Between the Exit Work and the Electron Potential Energy in a Metal.** K. F. Niessen (*Physica*, 1934, 1, 623-626; *Sci. Abs.*, 1934, [A], 37, 818).—[In German.] Frenkel has given a relation between the exit work and the electron potential energy at the surface of a metal (*Z. Physik*, 1928, 49, 31-45). Bethe has shown that this relation, owing to an error in its derivation, cannot be regarded as valid. N. gives further evidence that the supposed relation is not a correct one.—S. G.

**\*Effect of Temperature upon the Volta Effect of Metals.** G. Mönch (*Z. Physik*, 1934, 90, 433-439).—The volta e.m.f. exhibited by aluminium and iron is found to be independent of temperature, from room temperature up to about 400° C. This result is more in accordance with the Fermi-Dirac statistics than with classical theory.—J. S. G. T.

**\*Thermoelectric E.m.f. Due to Magnetization.** T. Kousmine (*Helv. Phys. Acta*, 1934, 7, 732-772; *Sci. Abs.*, 1935, [A], 38, 228).—[In French.] The change in the thermoelectric e.m.f. of a couple comprising a ferromagnetic (iron or nickel) and an auxiliary metal (copper), due to the magnetization of the ferromagnetic was measured with the magnetic field (*a*) parallel, and (*b*) at right angles to the temperature gradient (junctions at 0° and 100° C.). The results are interpreted in the light of Perrier's theoretical work.—S. G.

**\*Galvanomagnetic Effects in Ferromagnetic Metals.** Nagatosi Tunazima (*Nippon Sugaku-Buturigakkwai Kizi (Proc. Phys.-Math. Soc. Japan.)*, 1934, [iii], 16, 85-94; *Sci. Abs.*, 1934, [A], 37, 634).—[In German.] A new theory is proposed which will connect the longitudinal and transverse effects. It is shown that the resistance (longitudinal) in a saturation magnetic field is greater than the resistance (transversal), but there is no indication that the former of these depends on the direction of the current. Expressions are found for the change of resistance of a single iron crystal in the transverse and longitudinal directions and are compared with the results of measurements. It is concluded that the same law holds for ferromagnetics as for ordinary metals.—S. G.

**\*The Interpretation of the Mechanical Damping [of Oscillations] of Ferromagnetic Materials Associated with Magnetization.** M. Kersten (*Z. tech. Physik*, 1934, 15, 463-467).—The increased damping of mechanical oscillations exhibited by ferromagnetic materials due to magnetization below saturation is attributed to eddy currents arising from variations of magnetization associated with the oscillations. Experimental results obtained with nickel and Permalloy agree with calculated values of the increased damping associated with magnetization.—J. S. G. T.

## II.—PROPERTIES OF ALLOYS

(Continued from pp. 145-156.)

**\*The Effect of Composition on the Mechanical Properties and Corrosion-Resistance of Some Aluminium Alloy Die-Castings.** E. H. Dix, Jr., and J. J. Bowman (*Aluminum Co. of America, Blueprint Copy*, 1934, 18 pp.).—Presented at the Fall, 1934, Meeting of the American Institute of Mining and Metallurgical Engineers. The mechanical properties, growth, and resistance to steam,

paraffin, salt-spray, and atmospheric exposure have been determined for several aluminium die-casting alloys, especially the 12% silicon alloy. The results show that the presence of copper in the alloys has a marked deleterious effect on the corrosion-resistance and that tin is almost as bad as copper in this respect. All the common impurities in the 12% silicon alloy affect the corrosion-resistance except iron, which is the most difficult to control in melting and casting. As regards the effect of impurities on the mechanical properties of this alloy, nickel and zinc have little effect, copper increases the strength but reduces the ductility, iron reduces the ductility and, in large amounts, the tensile strength, and tin reduces both the strength and ductility. Ageing for 12–46 weeks at room temperature causes no significant change in mechanical properties and ageing for 40 days in steam or paraffin at 100° C. has only a minor effect on the strength (maximum increase 4–6%). The maximum unit growth after 100 days at 100° C. in steam or paraffin is only 0.00005–0.00046 according to the composition, the presence of tin causing the greatest growth.—A. R. P.

**\*Electrical Resistance of Heat-Treated Aluminium Alloys Containing a Small Quantity of Iron.** Sakichi Kishino (*Nippon Kwagaku Kwai Shi (J. Chem. Soc. Japan)*, 1934, **55**, 1139–1142; *C. Abs.*, 1935, **29**, 1046).—[In Japanese.] The electrical resistance of aluminium containing iron was measured, after various heat-treatments; no noticeable change was observed. It is suggested that iron does not dissolve in aluminium in any condition, and that the presence of iron does not, therefore, influence the electrical resistance.—S. G.

**\*The Physical Properties of Iron-Aluminium Alloys.** C. Sykes and J. W. Bampfylde (*J. Iron Steel Inst.*, 1934, **130**, 389–410; discussion, 411–418).—See *Met. Abs.*, 1934, **1**, 562.—S. G.

**\*The Constitution of Iron-Rich Fe-Al-C Alloys.** F. R. Morral (*J. Iron Steel Inst.*, 1934, **130**, 419–428).—See *Met. Abs.*, 1934, **1**, 562.—S. G.

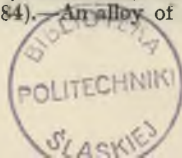
**\*Solid Solubility of Silicon in Aluminium.** Sakichi Kishino (*Nippon Kwagaku Kwai Shi (J. Chem. Soc. Japan)*, 1934, **55**, 1134–1139; *C. Abs.*, 1935, **29**, 1046).—[In Japanese.] The change of structure of aluminium-silicon alloys quenched at various temperatures was studied by measurements of the electrical resistance. It was ascertained by microscopic examination that the change of structure causes a sudden change in the quenching temperature-electrical resistance curve. It was found that the solid solubility of silicon in aluminium is 0.70% at 502° C. and 1.19% at 545° C.—S. G.

**Aluminium and Its Alloys.** A. Dumas (*Aciers spéciaux*, 1934, **9**, 399–403).—The preparation, heat-treatment, and mechanical properties of casting and forging alloys of aluminium with silicon, with copper, and with magnesium are described.—J. H. W.

**[Ceralumin C] A New Light Alloy.** Anon. (*Mech. World*, 1934, **92**, 51).—The composition of "Ceralumin C," a new light alloy, shows that it contains 0.15% cerium, which, in addition to having a refining action, suppresses the embrittling effect of the iron-aluminium constituent. Its mechanical properties are tabulated in the chill- and sand-cast conditions and before and after heat-treatment. It is claimed to be suitable for high-duty service in the form of chill-, sand-, and die-castings.—F. J.

**†Alloying Properties of the Elements Be, Mg, Zn, Cd, Hg, Al, and Sn.** U. Dehlinger (*Z. Elektrochem.*, 1935, **41**, 20–23; and (translation) *Light Metals Research*, 1935, **3**, 295–300).—The atomic properties and lattice constitution of mutual alloys of magnesium, zinc, cadmium, and mercury, and of the alloys with tin and aluminium are discussed.—J. H. W.

**Cadmium-Base Bearing Metals.** Alan S. Gill (*Proc. Australasian Inst. Min. Met.*, 1934, (95), 201–224; discussion, 224–227; and (abstract) *Commonwealth Eng.*, 1934, **32**, 81–84).—An alloy of cadmium with 1.5% copper and





1% magnesium is a satisfactory substitute for tin-base alloys for bearing metals; it has a compressive strength of 34.6 tons/in.<sup>2</sup>, a tensile strength of 11.9 tons/in.<sup>2</sup>, an elongation of 11%, a Brinell hardness of 57, sp. gr. 8.4, and freezing range 338°–315° C. The metal should not be heated above 420° C. and should be cast at 370°–380° C., using rosin as a flux, and the shell should be "tinned" with the zinc-cadmium eutectic alloy before casting the bearing liner. The average life of the cadmium-base alloy is about 2½ times that of a high-grade tin-base alloy, but its shrinkage is about 50% greater and in thin coats it tends to become brittle on prolonged storage at room temperature, the matrix of the alloy changing from the eutectic type to a single-phase type. This defect may be overcome by reducing the magnesium content to about 0.1%, but this reduces the hardness of the matrix and imparts a tendency to develop radial cracks under stress.—A. R. P.

**\*Magnetic Investigation of the System Cobalt-Palladium.** G. Grube and O. Winkler (*Z. Elektrochem.*, 1935, **41**, 52–59).—A special magnetometer for the investigation of the system cobalt-palladium was devised on the lines of the Tobusch magnetometer. For the determination of the phase limits in the ferromagnetic region of the system, the magnetizing temperature curves of pure cobalt and of different alloys up to 90 atomic-% of palladium were plotted. The transformation processes were traced by the deviations of these curves from the normal. It was found that for the alloys investigated up to pure cobalt, only those with 5 and 10 atomic-% of palladium show any transformation above room temperature, this occurring in heating and cooling to and from different temperatures. The temperature of the Curie point decreases with increasing palladium content. The nature of the transformation of pure cobalt and the 5 and 10 atomic-% alloys shows an important similarity to the shear transformation (Schubumwandlung) of the irreversible iron-nickel alloys. The position of the true equilibrium lines between the polymorphous solid solution phases cannot yet be determined. It is presumed that a continuous  $\beta$ -solid solution range up to at least 90 atomic-% of palladium exists.—J. H. W.

**The Ductile Alloys of Copper and Silicon.** H. H. Parrett (*Met. Ind. (Lond.)*, 1935, **46**, 349–350).—Ductile copper-silicon alloys as fine wires, having a tensile strength much higher than phosphor-bronzes, with an elongation of about 41–43%, can be obtained in the range 4–4.7% of silicon. Between 4% and 3% of silicon, the properties are not so good as, and with less than 3% they are probably no better than, those of phosphor-bronze. Above 4.7% of silicon, the alloys become brittle. A rapid continuous annealing at as low a temperature as possible is desirable. The alloys are not as resistant to corrosion by sea-water as the phosphor-bronzes.—J. H. W.

**\*Zinc in Bronze Bearing Liners.** A. P. Bludov and A. I. Samohotsky (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1934, **14**, (11), 94–97).—[In Russian.] Addition of up to 4% zinc to various tin-bronzes with a low lead content does not affect their tensile strength, but reduces the hardness at low temperatures. With increase in temperature, the hardness diminishes less than that of bronzes containing no zinc. Zinc has little effect on the rate of wear, but increases the impact strength. In alloys with 10–12% lead, zinc exerts a small beneficial influence.—D. N. S.

**\*Brass and Its Properties in Bearings as Compared with Tin-Bronze.** P. F. Svirin (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1934, **14**, (12), 102–106).—[In Russian.] The bearing properties of a 55.6% copper-zinc alloy with tin 0.6, manganese 0.5, and iron 1.3% have been compared with those of various bronzes. The brass had a tensile strength of 45.8 kg./mm.<sup>2</sup>, an elongation of 41.4%, reduction in area of 51%, and a Brinell hardness of 121. A bearing in which a steel shaft had made 500,000 revolutions and

performed 582 kg.-m. of work showed a loss in weight of only 1.5 mg.; the coeff. of friction of the brass against steel is only 0.00003.—D. N. S.

**\*Effect of Nickel on the Transformation Point of Beta-Brass and Heterogeneous Equilibria of the Ternary System Copper-Zinc-Nickel.** Keiji Yamaguchi and Kôzô Nakamura (*Rikwagakû-Kenkyû jo Iho (Bull. Inst. Phys. Chem. Res. Tokyo)*, 1934, 13, 89-108).—[In Japanese.] The transformation point of  $\beta$ -brass near 460° C. gradually rises on the addition of nickel until it touches the liquidus surface. This was found by thermal analysis and by change in electrical resistance. The heat of transformation increases as the concentrations of zinc and nickel increase.  $\gamma$ -brass ( $\text{Cu}_5\text{Zn}_8$ ) is isomorphous with the  $\gamma$ -phase ( $\text{NiZn}_3$ ) of the nickel-zinc system. For the range of composition where the copper and nickel contents exceed this  $\gamma$ -phase there exists no phase peculiar to a ternary system. On classifying  $\beta$ -brass into the  $\beta$ -phase which is stable at high temperature and  $\beta'$ , stable only at lower temperatures,  $\beta'$  is that phase which forms a continuous solid solution with the  $\beta$ -phase of the nickel-zinc system. As with the binary brass, the ternary  $\beta$ -phase cannot be retained in a metastable condition at room temperature by quenching from high temperatures and it is impossible with the microscope to identify  $\beta$  from  $\beta'$ . Since the transformation between them does not contradict the Phase Rule, the authors think it reasonable to consider them to be distinct. Some ternary  $\alpha$  and  $\beta'$  solid solutions show the characteristic Widmanstätten structure through the change of mutual solubility depending on temperature.—S. G.

**†The Work of the Alloys of Iron Research Committee. [Equilibrium Diagrams of Iron-Phosphorus, -Silicon, -Chromium, and -Manganese Alloys.]** C. H. Desch (*Proc. Inst. Mech. Eng.*, 1934, 127, 277-298).—The equilibrium diagrams of the systems iron-phosphorus, iron-silicon, iron-chromium, and iron-manganese are reproduced.—W. H.-R.

**\*Tensile Tests on Antimonial-Lead Tubes.** H. Sieglerschmidt and G. Fiek (*Z. Metallkunde*, 1935, 27, 38-40).—The tensile properties of lead tubes are improved by addition of antimony up to 0.8%, at which composition the breaking stress, yield-point and hardness are about double the corresponding values for pure lead. The rate of application of the load is immaterial within a time of 2.5-10 minutes. Values for the yield-point, tensile strength, elongation, and hardness of lead tube and strip containing 0.006-1.4% antimony are tabulated.—A. R. P.

**Lead-Base Bearing Alloys With High Copper Content.** A. Ricard and H. Ackermann (*Cuivre et Laiton*, 1935, 8, 85-87).—A consideration of these alloys bearing in mind the 3 characteristics necessary: feeble coeff. of friction, high resistance to compression, and ability to disseminate heat rapidly. Plasticity is considered in relation to the first 2 factors and a triangular diagram is given showing the lead-tin alloys grouped according to their plastic properties. The applications of the groups are summarized.—W. N.

**Magnesium-Base Ultra-Light Alloys. The Ternary System Mg-Ca-Zn.** P. Mondain-Monval and R. Paris (*Chim. et Ind.*, 1934, 32, 96).—A brief note on this system. The alloys are used for aeronautical parts, and are prepared in iron crucibles out of contact with the atmosphere.—W. A. C. N.

**A New Magnetic [Neodymium-Iron] Alloy with Very Large Coercive Force.** V. Drožina and R. Janus (*Nature*, 1935, 135, 36-37).—Neodymium containing about 7% of iron is strongly ferromagnetic. The value of the specific magnetization seems to correspond with about 7% of free iron, but the material shows an extraordinarily great coercive force, with a remanent magnetization equal to 70% of the maximal temporary value.—E. S. H.

**\*Alloys of Nickel and Barium.** D. W. Randolph (*Trans. Electrochem. Soc.*, 1934, 66, 85-89; discussion, 90).—See *Met. Abs.*, 1934, 1, 493.—S. G.

**\*New Heat-Treating Alloys Containing Nickel.** J. McNeil (*Metal Treatment*, 1935, 1, 38-42).—Nickel-copper alloys respond to heat-treatment after the

addition of appropriate quantities of aluminium. The composition of the hardening constituent is not yet known, but for each nickel content a range of aluminium values may be cited. In general it is necessary to quench these alloys from 700° to 900° C. and then reheat at 450°–650° C. The properties of "K" Monel metal, a heat-treatable form of that alloy, are described. Material of this nature having a strength of 70 tons/in.<sup>2</sup> at normal temperature has a strength of 63 tons/in.<sup>2</sup> at 400° C. The various "Kunial" alloys are also mentioned. In the silicon-nickel-copper system the compound Ni<sub>2</sub>Si is believed to be the hardening constituent. The characteristics of these alloys are discussed. Finally, the present state of knowledge of the beryllium-nickel-copper alloys is briefly reviewed.—W. A. C. N.

**Monel Metal.** Léon Guillet (*Cuivre et Laiton*, 1935, 8, 133–134).—The chemical composition and physical properties are given.—W. A. C. N.

**\*Relation Between Lattice Parameter and Ferromagnetism [of Nickel-Molybdenum and Cobalt-Manganese Alloys].** Werner Köster and Winfried Schmidt (*Arch. Eisenhüttenwesen*, 1934–1935, 8, 25–27).—The graphs showing the relation between the lattice parameter and the composition of alloys of these 2 systems consist of 2 linear sections intersecting at the composition at which the alloys change from ferromagnetic to paramagnetic; i.e. at 8% molybdenum in the nickel-molybdenum system, and at 30% manganese in the cobalt-manganese system. Extrapolation of the graphs to 100% nickel and 100% cobalt gives values for the lattice parameters of the ferromagnetic forms of the metals of 3.515 and 3.535 Å., respectively, and for those of the paramagnetic forms of 3.505 and 3.508 Å., respectively. Hence the change from ferromagnetic to paramagnetic nickel is accompanied by a decrease in the volume of an atom of 1%, and the corresponding change in cobalt a decrease of 2.3%. A similar effect occurs in the magnetic transformation of iron.—A. R. P.

**\*On the Equilibrium Diagram of the System Nickel-Zinc. (Second Report.)** Kanzi Tamura and Atomi Ōsawa (*Rikwagakū-Kenkyū jo Iho (Bull. Inst. Phys. Chem. Res. Tokyo)*, 1934, 13, 125–140; and *Kinzoku no Kenkyū*, 1935, 12, (3), 131–147).—[In Japanese.] In the course of cooling, in the thermal analysis of this system, it was often difficult to avoid the cracking of the crucibles containing the molten alloys with about 10% nickel. The cause of this trouble was studied by differential analysis, sp. gr. measurements, and microscopic examination. Measurements by means of the thermobalance were not successful on account of the lack of a suitable heating medium. The structures of the  $\alpha$ -,  $\beta$ -,  $\gamma$ -,  $\delta$ -, and  $\epsilon$ -solid solutions—which were not discussed in the previous report—were also determined by X-ray analysis. The following are the results of the investigation: (1) A peritectic reaction takes place at 517° C. between  $\gamma$  and melt, forming the  $\epsilon$ -phase, the range of the reaction lying between 13.5–0.5% nickel. (2) The alloys containing 10–11% nickel increase in volume by about 3% with the formation of the  $\epsilon$ -phase. (3) The  $\alpha$ -solid solution has a face-centred cubic lattice; the parameter increases very rapidly up to 20% zinc, and then more slowly, reaching 3.592 Å. at 38.9% zinc. (4) The  $\beta$ -solid solution has a body-centred tetragonal lattice,  $a = 2.724$  Å.,  $c = 3.168$  Å.,  $c/a = 1.163$ . (5) The  $\gamma$ -solid solution has a body-centred cubic lattice with 52 atoms to the unit cell,  $a = 8.927$  Å. A compound NiZn<sub>3</sub> was considered to be  $\gamma$ -solid solution in the first report, but X-ray analysis showed it as more likely to be Ni<sub>3</sub>Zn<sub>10</sub>. (6) The  $\delta$ -solid solution has a face-centred tetragonal lattice,  $a = 3.867$  Å.,  $c = 3.203$  Å.,  $c/a = 0.8278$ . (7) The  $\epsilon$ -phase has a tetragonal lattice and has 50 atoms to the unit cell;  $a = 8.922$  Å.,  $c = 9.254$  Å.,  $c/a = 1.0372$ . This phase has the formula Ni<sub>3</sub>Zn<sub>22</sub> and contains 10.9% nickel.—S. G.

**\*Alloys of Platinum and Antimony.** V. A. Nemilov and N. M. Voronov (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 17–25).—[In Russian.] Thermal hardness, electrical conductivity, and micrographic

methods have confirmed the existence of the stable compound  $\text{PtSb}_2$ , and indicated the existence of  $\text{PtSb}$  and  $\text{Pt}_2\text{Sb}$ , which undergo transformations in the solid state at about  $660^\circ$  and  $670^\circ$  C., respectively. There is, probably, a solid solution range at the platinum end of the system, and the thermal effect at  $630^\circ$  C. in platinum-rich alloys is due to a eutectic transformation. The compound  $\text{Pt}_5\text{Sb}_2$  does not exist.—N. A.

**\*Concerning Platinum-Rhodium Alloys.** V. A. Nemilov and N. M. Voronov (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 27–35).—[In Russian.] Investigation of the system micrographically and by measurements of the hardness, electrical resistance, temperature coeff. of resistance, and thermoelectric force has shown that platinum and rhodium form a continuous series of solid solutions, and that, therefore, the properties of the alloys may be represented by the U-shaped curves characteristic of such solutions. Tests at  $750^\circ$  and  $1150^\circ$  C. have shown that the alloys are highly resistant to oxidation, but that the resistance decreases somewhat with increase in rhodium content.—N. A.

**\*On Rhodium-Copper Alloys.** O. E. Zviagintzev and B. K. Brunovskiy (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 37–66).—[In Russian.] The system has been investigated by hardness measurements on, and micrographic examination of, quenched and annealed alloys. The hardness curve for the quenched alloys is characteristic of a continuous series of solid solutions, whereas that for annealed alloys has minima at 50 and 75 atomic-% rhodium. The microstructure of quenched alloys is homogeneous between 0 and 20, and between 90 and 100 atomic-% rhodium as well as at 50 and at 75–80 atomic-% rhodium; other alloys have a duplex structure. Owing to the rapidity with which alloys with 25–30 atomic-% rhodium oxidize in the air, they could not be obtained in a homogeneous state, and therefore a complete equilibrium diagram could not be obtained by thermal analysis. The cooling curve of the 1:1 (atomic) alloy showed an arrest at  $1015^\circ$  C., indicative of the formation of the compound  $\text{CuRh}$ . X-ray examination showed that quenched alloys with 0–20 atomic-% rhodium have the face-centred cubic lattice of copper, a increasing regularly with the rhodium content. Similarly, alloys with 90–100 atomic-% rhodium have the rhodium lattice; all other alloys have a structure containing both these phases ( $\alpha + \beta$ ). On annealing, alloys with about 50 atomic-% rhodium are converted into pure  $\beta_1$ ; and those with about 75 atomic-% rhodium into  $\beta''$ , whereas those with 25 atomic-% rhodium do not become homogeneous. These results and the presence of superstructure lines in photograms of alloys with an atomic ratio of 1:1, 3:1, and 1:3, indicate the existence of the compounds  $\text{RhCu}$ ,  $\text{RhCu}_3$ , and  $\text{Rh}_3\text{Cu}$ . The lattices of all the compounds are similar to that of the  $\beta$ -phase, and resemble each other in parameter.—N. A.

**\*Catalytic Decomposition of Sodium Amalgam.—II.** P. B. Zhivotinsky and A. P. Mashovets (*Ukrainski Khemichni Zhurnal (J. Chim. Ukraine)*, 1933, 8, (3/4), 366–371).—[In Ukrainian, with German summary.] Fatigue of the ferro-silicon catalyst during decomposition of sodium amalgam is attributed to covering of its surface by a layer of iron-mercury emulsion, which prevents contact with the amalgam. The catalyst can be regenerated, however, by shaking in air, or, preferably, in hydrogen. An apparatus for the continuous revival of spent catalysts is described; vigorous agitation of the amalgam by rotation of the vessel appreciably accelerates the decomposition. Increase in the silicon content of the catalyst from 12.8 to 52% also slightly accelerates the reaction.—M. Z.

**\*Catalytic Decomposition of Sodium Amalgam.—III.** A. P. Mashovets and P. B. Zhivotinsky (*Ukrainski Khemichni Zhurnal (J. Chim. Ukraine)*, 1933, 8, (3/4), 372–380).—[In Ukrainian, with German summary.] In the continuous catalytic decomposition of sodium amalgam in a revolving drum the

ferro-silicon catalyst shows no sign of fatigue after prolonged use, and the rate of decomposition is considerably accelerated, being about double that in the apparatus described in the preceding abstract. In addition the mercury consumption is reduced, and the iron formed, which is frequently in the form of small nuggets, can be removed continuously and quantitatively by means of an electromagnet, which is of considerable importance in preventing explosions.—M. Z.

**\*Making Clean Liquid Sodium-Potassium Alloy.** J. F. Birmingham, Jr. (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1935, **7**, 53).—Alloys of sodium with 25–50% potassium are liquid at 15° C. If the metals are alloyed under kerosene the product is usually a mass of small, dirty particles which will not coalesce. Bright globules weighing up to 30 grm. may be prepared, however, by transferring 1 grm. of the dirty alloy to 75 c.c. of benzene and adding a 10% solution of alcohol in benzene until the alloy reacts sufficiently to float; small particles of potassium and sodium are then added alternately until the globule is of the desired size. The resulting bright mobile alloy may be stored for 6 months in pure kerosene which has been distilled over sodium-potassium alloy.—A. R. P.

**\*Magnetoresistance in Sodium-Potassium Alloy.** C. W. Heaps and J. E. Armstrong (*Phys. Rev.*, 1935, [ii], **47**, 336).—Abstract of a paper read before the American Physical Society. It has been found by Fakidow and Kikoin (*J. Inst. Metals*, 1933, **53**, 615) that the liquid alloy NaK increases its resistance when subjected to a transverse magnetic field. This discovery has been further investigated, using longitudinal fields and specimens of very fine diameter. Contrary to expectations, it has been found that with tubes considerably finer than those used by Fakidow and Kikoin there appears to be a larger effect of tube diameter on magnetoresistance. A spurious effect due to motions in the liquid is thus shown to be present. However, a genuine, intrinsic effect is believed to exist. In a longitudinal field the magnetoresistance is larger than in a transverse field. To explain longitudinal magnetoresistance it is assumed that the field produces structural changes in atomic systems. For the liquid alloy, therefore, a magnetic field would seem to induce a pseudo-crystalline state. One point of view would be that the field is able to produce alterations in G. W. Stewart's cybotactic state. X-ray experiments are being carried out to test this theory.—S. G.

**\*An Electrochemical Investigation of Solid Thallium-Bismuth Alloys.** Arne Ölander (*Z. physikal. Chem.*, 1934, [A], **169**, 260–268).—The potentials of the cells:  $\text{Tl}_{\text{solid}} | (\text{Na}, \text{K}, \text{Tl}) \text{OCO} \cdot \text{CH}_3 | (\text{Tl}, \text{Bi})_{\text{solid}}$  between 245° and 295° C., and  $\text{Tl}_{\text{solid}} | \text{TlOCO} \cdot \text{CH}_3 | (\text{Tl}, \text{Bi})_{\text{solid}}$  between 120° and 165° C., and their temperature coeff. have been determined. The  $\gamma$ - and  $\epsilon$ -phases of the thallium-bismuth system appear to have random lattice structures, but the  $\epsilon$ -phase has an ordered lattice of the composition  $\text{Bi}_2\text{Tl}$ , although about a third of the elementary cells has a misplaced atom. The decrease in free energy, the increase in entropy, and the heat effect of alloying the elements have been calculated.—B. Bl.

**\*An Electrochemical and X-Ray Examination of Solid Thallium Amalgams.** Arne Ölander (*Z. physikal. Chem.*, 1934, [A], **171**, 425–435).—Thallium amalgams with 20–31% thallium consist of a phase with a face-centred cubic lattice; measurements of the potential of 16 alloys within this range against a 55% thallium amalgam in a 1% alcoholic solution of thallium acetate show that the formula of the phase is not  $\text{Tl}_2\text{Hg}_5$ . X-ray examination reveals random distribution of the atoms in the lattice at the compositions  $\text{Tl}_2\text{Hg}_5$ , not at  $\text{TlHg}_3$ , but probably regular distribution at  $\text{TlHg}_2$ ; no transformation occurs just below the melting point. A body-centred cubic phase exists in alloys with 86–96% thallium.—B. Bl.

**Special Alloys.** — (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, **55**, 456, 477, 497).—The composition and some properties and applications of the following alloys are given: Fahrig's antifriction metal, Fermet, Ferrul alloy, Ferry metal, Fletchers bearing metal, Flint metal, Fourdrinier metal, and French brass. Cf. *Met. Abs.*, 1934, **1**, 575.—J. H. W.

\*[Contribution] to the Theory of Undercooled Solid Solutions. S. Kono-bievskii (*Z. physikal. Chem.*, 1934, [A], **171**, 25–35).—On the assumption that an undercooled solid solution is metastable, the stability of such systems has been investigated mathematically both for the cases in which the disperse phase is not present. From the results obtained explanations are advanced for (a) the decomposition of a supersaturated solid solution of tin in copper at 300°–400° C. and the difference between the experimentally observed and the real solubility limits, (b) the eutectoid decomposition of steels with 10% manganese and 1% carbon at 400°–500° C., (c) the precipitation of silicon from solid solution in aluminium. The redistribution of the components in the lattice is assumed to be the first step before the lattice transformation; this change of concentration is explained statistically with the aid of the theory of fluctuations. The precipitation of  $\gamma$  from  $\alpha$ -tin-copper solid solutions and the formation of Widmanstätten structures are explained by the theory developed.

—B. Bl.

†Magnetism and the Atomic State of Metallic Solid Solutions. E. Vogt (*Z. Metallkunde*, 1935, **27**, 40–43).—The atomic susceptibility of solid solution alloys of manganese in copper or silver, and of nickel or iron in gold is a linear function of the concentration of the solute; the graphs for solid solutions of nickel and palladium in copper, palladium in silver, and chromium, palladium and platinum in gold are curved lines at high concentrations of the solute. Hence it is concluded that the ionization and quantum state of an atomic species are not the same in all alloys but are determined to a large extent by the nature of the other element present. It is considered probable that in Hume-Rothery compounds the transition elements have not all the same valency electron number; the transition elements follow the Hume-Rothery rule generally when they are of zero valency. Certainly the 3 elements with 10 outer electrons, nickel, platinum, and palladium, dissolve in copper, silver and gold with zero valency, but the elements before nickel appear to dissolve with one or two valency electrons.—A. R. P.

\*On the Disturbance of Superconductivity of an Alloy by an Electric Current. W. H. Keesom (*Physica*, 1935, **2**, 35–36; *Comm. K. Onnes Lab. Leiden*, No. 234f).—[In English.] For an alloy the disturbance of superconductivity by an electric current does not depend in the same way on the value of the magnetic field due to the current as Silsbee's hypothesis prescribes for pure metals.—S. G.

\*Penetration of a Magnetic Field into Superconductive Alloys. W. J. de Haas and J. M. Casimir-Jonker (*Nature*, 1935, **135**, 30–31).—Alloys of thallium-lead (containing 65% of lead) and thallium-bismuth ( $\text{Bi}_3\text{Tl}_3$ ), when made superconductive by cooling below 4° abs., allow electromagnetic fields above certain critical values to penetrate them. The relation between the value of the critical electromagnetic field and the temperature is given.

—E. S. H.

**Discussion Relating to Thermodynamic Equilibria.** (1) E. Justi and M. v. Laue, (2) A. Eucken (*Physikal. Z.*, 1935, **36**, 146, 147).—Continues a polemical discussion relating to the nature of the variation with temperature of the specific heat concerned in a transformation of the third class (see *Met. Abs.*, this volume, p. 155).—J. S. G. T.

## III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

(Continued from pp. 156-158.)

\***The Flotation of Non-Metallic Inclusions in Molten Metals.** R. Mitsche (*Carnegie Schol. Mem., Iron Steel Inst.*, 1934, 23, 65-105).—A solution of the problem of the grain-size of cast metals has been attempted in terms of the number of nuclei (lattice residues) and the speed of crystallization as affected by the intrinsic and extrinsic undercooling capacity. In flotation tests of alumina in aluminium, the considerable deviations found in the figures, checked by analytical tests, were caused by the particular way in which the non-metallic inclusions were distributed. No applicable method has been devised for directly determining the non-metallics in Silumin or cast iron. A slag-cloud theory was postulated to account for the "modification" of Silumin and was confirmed experimentally. Phenomena of heredity were reproducibly demonstrated and their causes indicated. The results of the investigation on Silumin afforded an indirect method for drawing conclusions regarding the non-metallics from the development of the structure. Direct methods were evolved for rendering the non-metallics visible, and the aluminium-alumina system was accurately investigated by means of the fluorescence microscope.

—J. H. W.

\***On the Theory of Linear Rate of Crystallization.** R. Kaischew and I. N. Stranski (*Z. physikal. Chem.*, 1934, [A], 170, 295-299).—The kinetic expression previously derived for the rate of formation of crystal nuclei is modified for the case of linear rate of crystallization.—B. Bl.

**Macro-Etching and the Reagents.** P. J. Orletz (*Zavodskaya Lab.*, 1934, 3, 534-541; *C. Abs.*, 1935, 29, 1759).—[In Russian.] The technique is discussed. Tables and photographs are given.—S. G.

\***The Anisotropy in the Velocity Growth of New Grains on Recrystallization [of Aluminium].** M. O. Kornfeld (*Zhurnal eksperimentalnoy i teoreticheskoy Fiziki (J. Exper. and Theoret. Physics)*, 1934, 4, (8), 869-872 (in Russian), and *Physikal. Z. Sowjetunion*, 1934, 6, 170-174 (in German).—The anisotropic rate of growth of new grains in polycrystalline aluminium may be observed at slightly above the recrystallization temperature, the degree of anisotropy depending on the temperature.—N. A.

\***Electrocrystallization of Metals. IV.—Electrolytic Deposits of Aluminium from Molten Salts (AlCl<sub>3</sub>-NaCl).** K. M. Gorbunova and Z. A. Adjemjan (*Dokladi Akademii Nauk S.S.S.R. (Compt. rend. Acad. Sci. U.R.S.S.)*, 1934, 1, (9), 564-570).—[In Russian and French.] Experiments on the electrolysis of the system AlCl<sub>3</sub>-NaCl were made in a specially constructed apparatus, which enabled a high purity of the electrolyte to be maintained. The electrolytes used were: (1) 19% NaCl, 81% AlCl<sub>3</sub>; (2) 52% NaCl, 48% AlCl<sub>3</sub>; (3) 40% NaCl, 60% AlCl<sub>3</sub> at temperatures 130°-210° C. and current density from 0.2 to 0.002 amp./cm.<sup>2</sup>. The deposits of aluminium obtained were subjected to microscopic and X-ray examination. No orientation of the crystals was discovered. Dimensions of the crystals composing the deposits varied between 10<sup>-2</sup> and 10<sup>-3</sup> mm.—N. A.

\***Metallography of Tantalum.** N. M. Zarubin and M. V. Suitin (*Zavodskaya Lab.*, 1934, 3, 821-830; *C. Abs.*, 1935, 29, 1042).—[In Russian.] The felt polishing operation can be reduced from 1-2 hrs. to 5-10 minutes by the use of a mixture of 35 grm. alumina (No. 1 or 2), 20 c.c. of 60% hydrofluoric acid, 20 c.c. of ammonium fluoride, and 1 litre of water. A mixture of equal parts of 20% ammonium fluoride and 60% hydrofluoric acid in the cold is ineffective; at 50°-60° C. it etches within 0.5-1 minute, showing the structure of pure and impure tantalum without colouring Ta<sub>2</sub>S<sub>5</sub> inclusions. One part of 20%

ammonium fluoride and 2 parts of concentrated sulphuric acid at 60° C. etches well in 1–2 minutes without colouring  $Ta_2S_5$ . These 2 reagents are considered the best. A mixture of equal parts of 20% ammonium fluoride and concentrated nitric acid in the cold acts very faintly; at 60° C. it colours  $Ta_2S_5$  black and etches pure tantalum rather poorly; it can be used in combination with the common reagent hydrofluoric acid + nitric acid as a special reagent for the disclosure of  $Ta_2S_5$ . At 80° C. 20% ammonium fluoride gives in 5–6 minutes etchings of pure tantalum, showing the granular structure without tinting and separating granules or colouring  $Ta_2S_5$ . A mixture of 2 parts of 20% ammonium fluoride and 1 part of 30% hydrogen peroxide on boiling does not show the structure of pure tantalum, but colours  $Ta_2S_5$  brown. A *bibliography* is given, as well as 29 comparative photographs.—S. G.

\***Geometry of Mechanical Twin [Crystal] Formation of Tin and Zinc.** G. Kolesnikow (*Physikal. Z. Sowjetunion*, 1933, 4, 651–667).—[In German.] Geometrical considerations indicate that twinning in tin and in zinc is not attributable, as in the case of  $\alpha$ -iron, to a pure displacement of the lattice junctions. A rotational displacement is required in addition.—J. S. G. T.

\***The State of the Cerium Atom Inside the Metallic Lattice.** R. Janus and V. Drožžina (*Dokladi Akademii Nauk S.S.S.R. (Compt. rend. Acad. Sci. U.R.S.S.)*, 1934, 2, (7), 411–414).—[In Russian and English.] Measurements of the magnetic susceptibility of an extremely pure polycrystalline sample of metallic cerium were made by the Faraday method at temperatures varying from  $-170^\circ$  to  $+100^\circ$  C. The dependence of  $1/\chi$  on the temperature is strictly rectilinear, the magnetic moment  $p = 11.4$  Mw. remains constant throughout the whole temperature interval. Comparing the observed value  $p = 11.4$  Mw. with the values corresponding to different theoretically possible states of the cerium atom, it may be concluded that the space-lattice of cerium metal may probably be regarded as consisting either of  $Ce^+$  or of  $Ce^{+++}$  possessing equal values of  $p$ . The chemical properties of  $Ce^+$  lead the authors to the assumption that  $Ce^{+++}$  is the most probable state. At temperatures below  $\theta = 6^\circ$  abs. cerium metal may become ferromagnetic.—N. A.

\***The Fine Structure of X-Ray Absorption Edges of Copper and Zinc in Copper-Zinc Alloys.** D. Coster and R. Smoluchowski (*Physica*, 1935, 2, 1–12).—[In English.] X-ray absorption edges of copper and zinc in  $\alpha$ -,  $\beta$ -,  $\gamma$ -, and  $\epsilon$ -brass are investigated and compared with those for pure metals in the same kind of crystal lattice. As to the position of the maxima and minima of absorption it has been shown that, in agreement with Kronig's theory of fine structure, they are found in equivalent places for crystal lattices of the same type. In some cases more or less important deviations of the special form of the maxima and minima are found which may easily be understood from the theory.—S. G.

\***X-Ray Tests of the Recrystallization of Duralumin.** N. Kozhina (*Zavodskaya Lab.*, 1934, 3, 153–155; *C. Abs.*, 1935, 29, 1373).—[In Russian.] Cf. Bachmetew (*ibid.*, 1932, 1, (3)), and v. Göler and Sachs (*J. Inst. Metals*, 1927, 37, 517). A procedure was studied for the elimination of the difficulties in the structural analysis of recrystallized Duralumin caused by the occasional total or partial failure of Röntgenograms to show the first Debye circles.

—S. G.

\***The Atomic Structure Factor for Metallic Beryllium.** W. Ehrenberg (*Z. Krist.*, 1934, 89, 185–188).—The atomic structure factor of metallic beryllium has been determined by experiments with finely crushed powder, and with a mirror form prepared by evaporation. The results are compared with the theoretical values of Hartree, and the effects of extinction are discussed.

—W. H.-R.

\***Intensities of X-Ray Reflection from Bi Crystals Between 25° and 530° Abs.** R. B. Jacobs and A. Goetz (*Phys. Rev.*, 1935, [ii], 47, 257).—Abstract of a



paper read before the American Physical Society. The integrated X-ray intensities of Mo  $K_{\alpha}$ -radiation from (111) of highly purified bismuth crystals have been measured between the boiling point of hydrogen and the melting point of bismuth for the 2nd, 3rd, and 5th order. It was found that: (1) Between 25° and 480° abs. the integrated intensities follow the Debye-Waller function:  $I/I_0 = e^{-kT \sin^2 \theta}$  with better precision than was found by previous authors on cubic crystals (sodium chloride, aluminium, &c.) for higher temperatures and within smaller ranges of total energy variation, so far as  $I/I_0 = f(T)$  is concerned. This proves the validity of the above law in the  $T^3$ -region. (2) The comparison of the intensities among the different orders proves a good agreement for  $I/I_0 = f(\theta)$ , although the original theory does not include the hemihedral hexagonal system to which bismuth belongs. (3) For the last 40° before fusion a definite deviation from the law takes place, as  $d(I/I_0)/dT (< 0)$  begins to decrease and to reach even positive values, indicating a rearrangement in the sense of a larger degree of geometrical order within the crystal before fusion.—S. G.

**\*The Photoelectric Properties of the (100) and (111) Faces of a Single Copper Crystal.** Newton Underwood (*Phys. Rev.*, 1935, [ii], 47, 502-505).—See *Met. Abs.*, 1934, 1, 579.—S. G.

**\*Structure of Au<sub>2</sub>Pb.** H. Perltz (*Acta et Comm. Univ. Tartuensis*, 1934, [A], 27, 15 pp.; *Sci. Abs.*, 1935, [A], 38, 137).—[In English.] Cf. *Met. Abs.*, this volume, p. 15. From X-ray powder photographs it is concluded that the structure of Au<sub>2</sub>Pb is of the same type as that of MgCu<sub>2</sub> and KBi<sub>2</sub>. The unit cube contains 24 atoms and the length of the edge is 7.91 Å.—S. G.

**\*X-Ray Investigation of the Compound MgZn<sub>2</sub>.** L. Tarschisch, A. T. Titow, and F. K. Garjanow (*Physikal. Z. Sowjetunion*, 1934, 5, 503-510).—[In German.] Friauf's results relating to the crystal structure of MgZn<sub>2</sub> are confirmed. It is not possible to differentiate between the crystallographic classes D<sub>6h</sub> and D<sub>6</sub>. The crystal lattice of MgZn<sub>2</sub> comprises 2 interpenetrating spherical close-packings. The zinc atoms form a hexagonal spherical packing in which some of the lattice points are unoccupied, or more correctly are replaced by magnesium atoms. The magnesium atoms form tetrahedra which approximate to the regular form. The following are the minimum values of the respective interatomic distances: Mg-Mg, 3.16 Å.; Zn-Zn, 3.60 Å.; Zn-Mg, 2.02 Å.

—J. S. G. T.

**\*The Crystal Structure of Beta-Manganese.** Thomas A. Wilson (*Phys. Rev.*, 1935, [ii], 47, 332).—Abstract of a paper read before the American Physical Society. Extension of previous work in applications of mathematical crystallographic methods to powder X-ray data of the manganese system has resulted in the complete solution of the  $\beta$ -manganese structure. The structure is cubic; the space group is O<sub>h</sub><sup>8</sup>; the cube edge length is 12.58 Å.; the cube content is 160 atoms, arranged in the following groups of equivalent positions according to the Wyckoff tabulation: 8a, 8b, 48e, and 96i, with  $u = 0.11$  in 48e, and  $u = 0.10$ ,  $v = 0.33$  in 96i. These parameters have been checked by intensity calculations using structure factor values based on the Thomas atomic model. The X-ray density of  $\beta$ -manganese is calculated to be 7.29.

—S. G.

**\*On the Structure of Liquid and Solid Mercury Studied with Cathode Ray Diffraction.** Hikotaro Kakesita (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1934, [A], 17, 241-248).—Diffraction patterns of Debye-Scherrer rings were taken by the method of cathode-ray diffraction on the surfaces of liquid and solid mercury. K. observed that both patterns were face-centred rhombohedral and that the diameters of solid mercury were 10% larger than those of liquid mercury. It is concluded, therefore, that liquid and solid mercury have the same structure, but that the intermolecular distance of the solid state is contracted by this percentage as compared with that of the liquid state.—S. G.

\***On Osmiridium.** O. E. Zviagintzev and B. K. Brunovkiy (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 5–15).—[In Russian.] X-ray analysis of native osmiridium has shown it to possess a definite phase structure, and in some varieties have been found signs of incipient recrystallization; the probable causes of these phenomena are discussed. Laue photograms of a single-crystal specimen of the mineral revealed the presence of constituents with an orientation differing by  $10^\circ$  from that of the crystal itself.—N. A.

\***The X-Ray Examination of Selenium Crystals.** Kenzo Tanaka (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1934, [A], 17, 59–78).—Several forms of metallic selenium crystals, obtained by the condensation of selenium vapour, were examined by means of X-rays. The metallic selenium crystal grows most prominently on its trigonal axis; this growth is interpreted from the point of view of the growth of homopolar crystals. The degree of perfection and size of grain of the crystals were estimated from the fine structure of the spectral lines obtained with convergent X-rays. The intensity distribution along the spectral line was interpreted from the intensity distribution of the primary X-rays at various starting points on the surface of the anticathode. The transition point from the vitreous to metallic form was determined by X-ray examination and by measurement of the net densities.—S. G.

\***Further Investigation of the Crystalline Structure of Electrolytic White Tin.** Hideki Hirata and Yoshio Tanaka (*Mem. Coll. Sci. Kyoto Imp. Univ.*, 1934, [A], 17, 143–152).—The arrangement of micro-crystals in electrolytic specimens of white tin, deposited from sulphuric acid solutions, was examined with X-rays by the procedure used in the previous investigation, which dealt mainly with those deposited from hydrochloric acid solutions. From the diffraction patterns obtained it was found that micro-crystals of white tin have a tendency to be electrolytically deposited with the normals to their (111) faces arranged parallel to a definite common direction, as was the case in the previous research. In some other respects, however, especially with regard to the direction of growth of the deposited white tin, results dissimilar to those of the former results were observed. The cause of these dissimilarities is believed to be due to the difference in the chemical valencies of the ions in the electrolyte.—S. G.

\***On the Question of Primary Crystallization of Metals. Influence of the Temperature Gradient on the Orientation of Monocrystalline Zinc.** V. D. Kuznetsov, and D. D. Saratovkin (*Dokladi Akademii Nauk S.S.S.R. (Compt. rend. Acad. Sci. U.R.S.S.)*, 1934, 1, (5), 248–251).—[In Russian and German.] Zinc crystals were grown by the Bridgman method in glass tubes. The orientation of monocrystals is accidental and the most probable orientation is characterized by the angles  $0^\circ$  between the plane of the base and the axis of the specimen and  $30^\circ$  between the intersection of the base with the edge of the first-order prism and the main axis of cleavage.—N. A.

\***On the Method of X-Ray Analysis of Binary Metal Alloys at Elevated Temperatures (Preliminary Communication).** G. F. Kosolapov and A. K. Trapeznikov (*Zhurnal Tehnicheskoy Fiziki (J. Tech. Physics)*, 1934, 4, (8), 1622–1624).—[In Russian.] The following methods of heating of the specimen have been used: gas flame, heating in a furnace, heating in a current of hot air, heating by the passage of a current through the specimen. A camera with movable slide has been constructed from which up to 5 photographs can be obtained on one film.—N. A.

\***On the Determination of Crystal Lattice Constants by Electron Diffraction.** N. Shishakov and L. Tatarinova (*Dokladi Akademii Nauk S.S.S.R. (Compt. rend. Acad. Sci. U.R.S.S.)*, 1934, 2, (3), 164–168).—[In Russian, with English summary.] The new method of investigation of electronic diffraction by means of reflection from convex specimens has proved to be much simpler than the method introduced by G. P. Thomson. Not only a sharply outlined diffraction is obtained on the photographic plate, but also a spot from the

primary cathode beam. The cathode beam passes between 2 convex specimens and the double diffraction pattern is obtained on the photographic plate. Therefore, taking as the first specimen a substance the lattice constants of which are known, the lattice constants of the second specimen can be obtained by determining the wave-length from the diffraction pattern corresponding to the first specimen. The method suggested, being very simple, enables the main source of errors of the old method, which were due to the impossibility of determining high voltages with sufficient accuracy, to be avoided.—N. A.

†**The Structure of Polished Metal Surfaces.** Walter R. Meyer and Clarence C. Helmle (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (2), 29-39).—A review of recent work with especial reference to the electron diffraction and X-ray methods of examining the structure of polished layers on metals, and the bearing of the results on Beilby's theory; a *bibliography* of 25 references is given.—A. R. P.

**Electron Diffraction as a Method of Research.** G. P. Thomson (*Nature*, 1935, 135, 492-495).—A lecture to the Royal Institution, describing published work on the examination of metallic surfaces.—E. S. H.

"Extra" Rings and Bands in Electron Diffraction Patterns. G. I. Finch and A. G. Quarrell (*Nature*, 1935, 135, 183-184).—"Extra" rings observed in platinum, gold, silver, cobalt, nickel, chromium, iron, and tin electron-diffraction patterns are due to the shape of the minute crystals that compose the materials investigated, and may help in elucidating the shape of sub-microscopic crystals.—E. S. H.

\***A Mathematical Modulus Derived from X-Ray Data for Evaluation of Residual Distortion in Crystals.** G. L. Clark and M. M. Beckwith (*Phys. Rev.*, 1935, [ii], 47, 200).—Abstract of a paper read before the American Physical Society. From accurate measurement of the peripheral widening of diffraction intensity maxima from a series of silicon steel specimens with a widely varying residual grain distortion or strain, it has been possible to derive a mathematical modulus which enables the numerical evaluation of this distortion in points above a basic value. Comparisons are made in terms of degree of cold-work and temperature and time of heat-treatment. These values are then correlated with actual measurements of magnetic permeability, and a very close parallel is established.—S. G.

†**X-Ray Analysis of the Deformation Textures of Metallic Materials.** Franz Wever (*Kolloid-Z.*, 1934, 69, 363-368).—A review of published works, with special reference to the X-ray diagrams of cold-worked iron, copper, and aluminium.—E. S. H.

\***Depth of Penetration of Electrons Diffracted by Single Crystals.** H. E. Farnsworth (*Phys. Rev.*, 1935, [ii], 47, 330).—Abstract of a paper read before the American Physical Society. A known number of atom layers of one metal was deposited on the surface of a single crystal of another metal by evaporation in a high vacuum. Direct results on depth of penetration were obtained from measurements on electron diffraction as a function of the thickness of the surface layer. A silver film deposited on a copper crystal is amorphous. A layer 1 atom deep reduces the maxima of the beams from the copper lattice by at least 70% for energies up to 300 e. volts. A number of foreign atoms equal to a few hundredths of that contained in one atomic layer can be detected by this method. A silver film deposited on a gold crystal is crystalline. The surface atomic layer of silver contributes at least 50% to the maxima of beams from a thick crystal for energies up to 300 e. volts, while a surface layer 2 atoms deep contributes at least 90%. This predominating effect of the surface atomic layer for primary energies as high as 300 e. volts is not in accord with theoretical predictions of v. Laue.—S. G.

\***A New Method of Making Extremely Thin Films.** J. D. Howe and E. M. Purcell (*Phys. Rev.*, 1935, [ii], 48, 329).—Abstract of a paper read before the

American Physical Society. The method has been developed for general use. A hole in a metal plate is filled with a volatile solid and the surface polished. This slit is clamped to the bottom of a liquid air container in a high vacuum. The material to be deposited is evaporated and covers slit and opening with a continuous film of desired thickness. The slit is then placed into the apparatus for the investigation and on evacuating the volatile material evaporates, leaving the thin film freely supported on the slit. As volatile material camphor and naphthalene have been used. Since camphor produces in some cases oxidation (copper is deposited as cuprous oxide), purest naphthalene is now being used only. To avoid contact of the film with the air, a small container with naphthalene is placed, after deposition of the film, under the slit, slightly heated from the furnace below and another layer of naphthalene is deposited so that the film is protected from both sides. In this way, also, materials which oxidize easily can be investigated in thin layers.—S. G.

**\*Intensity Distribution in Electron Patterns.** K. Lark-Horovitz, H. J. Yearian, and J. D. Howe (*Phys. Rev.*, 1935, [ii], 47, 330).—Abstract of a paper read before the American Physical Society. With the method described by Howe and Purcell (preceding abstract) electron diffraction patterns of thin layers of bismuth, cadmium, calcium hydroxide, copper, cuprous oxide, gold, sodium nitride, nickel, tungsten oxide, zinc, zinc oxide and zinc sulphide have been obtained, using cathode rays from a gas discharge of 50–80 kv. The intensity distribution is discussed as a function of (a) surface condition of the crystallites; (b) refraction of the electron waves; (c) orientation; (d) atom factor. In all cases mentioned, “forbidden” orders have been found which in some cases exhibit an extremely sharp diffraction pattern. Their relation to refraction, inner potential and surface layers is being discussed. The values of  $\sin \delta/\lambda$  for the forbidden inner rings are the same for gold, silver, copper, cuprous oxide, nickel, and cadmium.—S. G.

**†X-Rays and the Investigation of Materials.** R. Glocker (*Z. tech. Physik*, 1934, 15, 421–429).—The applications of X-rays to the structural investigation of materials is discussed, among the subjects treated being: the detection of flaws, investigations relating to fine structure, precipitation processes, determination of stresses, and the estimation of the concentration of crystalline phases.—J. S. G. T.

**†The Problem of Materials, From the Point of View of the Physicist.** Adolf Smekal (*Z. tech. Physik*, 1934, 15, 405–413).—Matters relating to crystalline structure as they affect the properties of materials are reviewed.—J. S. G. T.

**\*The Lineage Structure of Crystals.** M. J. Buerger (*Z. Krist.*, 1934, 89, 193–220).—[In English.] Evidence is given that many crystals of both metals and non-metals are not ideally perfect, but consist of a “lineage structure,” which may be understood by considering the growth of a crystal from a dendritic skeleton. In an ideal crystal, corresponding branches of the dendrite would be exactly parallel, and the final crystal would form a continuous lattice. In actual crystals the branches of the dendrite are not exactly parallel, and the final crystal contains discontinuities or cracks. A cross-section may resemble a block structure, but this impression is misleading, since, from the above point of view, the crystal consists not of 3 dimensional blocks, but of a number of branches or lineages coming from a common nucleus. A number of discrepancies between the behaviour of actual and ideal crystals may be explained on this hypothesis which avoids some of the difficulties of the older “block” theories.—W. H.-R.

**†On the Mosaic Structure in Crystals.** Harold E. Buckley (*Z. Krist.*, 1934, 89, 221–241).—[In English.] The older theories of mosaic structure in crystals are reviewed critically. The theoretical basis of the theory of Zwicky is shown to be fallacious, and there is no reliable experimental basis for this kind of theory. The theory of Smekal is also criticized adversely, and

whilst the mosaic theory of Darwin accounts for some of the anomalies met with in the reflection of X-rays from crystal surfaces, the mosaic suggested raises many difficulties in other directions. B. emphasizes that in non-metallic crystals at least, perfect crystals are more common than is often supposed.—W. H.-R.

\***The Non-Existence of a Regular Secondary Structure in Crystals.** M. J. Buerger (*Z. Krist.*, 1934, **89**, 242-267).—[In English.] The theory of Zwicky regarding the existence of a regular periodic secondary structure in crystals is discussed critically. Many of the experimental facts used to support the theory can be attributed to well-known crystallographic phenomena, and no experimental results definitely require the existence of a secondary structure for their explanation. The supposed discrepancy between calculated and observed strengths of crystals may be fallacious. In plastic deformation, the atoms on either side of the plane of slip (except those at the front and rear edges of the slip-planes) are not moved far apart during the process of slip, and consequently calculated strengths based on the energy of rupture and separation of atoms may be unjustified. The theoretical basis of the Zwicky theory is also shown to be fallacious. An isolated crystal plane, or one partially isolated as at the surface of the crystal, will show a contraction of the type assumed by Zwicky, but the calculations cannot be applied to planes within the crystal without serious modifications, and there is no theoretical justification for assuming that greater stability is produced by a regular secondary structure of the Zwicky type. B.'s criticisms refer to the regular secondary structure postulated by Zwicky, and do not apply to theories ascribing effects to a lineage structure (see preceding abstract), or to imperfections, surface cracks, &c.—W. H.-R.

\***Thomas-Fermi Method in Metals.** H. M. Krutter (*Phys. Rev.*, 1935, [ii], **47**, 426).—Abstract of a paper read before the American Physical Society. —S. G.

#### IV.—CORROSION

(Continued from pp. 158-163.)

\***The Resistance of Aluminium to Chemicals.** Mario Pieri (*Chim. ind. agric. biol.*, 1934, **10**, 352-355; *C. Abs.*, 1935, **29**, 1759).—Experiments are described with hydrochloric acid, acetic acid, sodium chloride (5%), sulphuric acid (10%), nitric acid (10%), nitric acid (38° B $\acute{e}$ ), hydrogen sulphide, and sulphur vapours. Aluminium is absolutely unaffected by hydrogen sulphide and sulphur vapours.—S. G.

**To Which Acids and Alkalis is Aluminium Most Resistant?** — (*Illust. Zeit. Blechindustrie*, 1935, **64**, 331-333).—A summary is given of the effects of a large number of acid and alkaline media on aluminium; the influence of temperature, dilution and the presence of additional ingredients is considered in some cases. The physical properties of Anticorodal, AW 15, BSS-alloy, Duranalium, Hydronalium, and Silumin are summarized with a view to the selection of materials for industrial purposes, and certain special advantages of Silumin are emphasized.—P. M. C. R.

**Aluminium in the Chemical Industry.** Francis C. Frary (*Indust. and Eng. Chem.*, 1934, **26**, 1231-1237; *Amer. Inst. Chem. Eng. Advance Copy*, 1934, Nov., 14 pp.; and (summary) *Light Metals Rev.*, 1935, **1**, (14), 263-268).—Paper read before the American Institute of Chemical Engineers. See *Met. Abs.*, this volume, p. 58.—F. J.

\***The Effect of Heat-Treatment on the Corrosion of High-Purity Aluminium.** F. A. Rohrman (*Trans. Electrochem. Soc.*, 1934, **66**, 229-236; discussion, 236-237).—See *Met. Abs.*, 1934, **1**, 498.—S. G.

**The Corrosion of Copper.** M. Parmentier (*Aciers spéciaux*, 1934, 9, 418-420).—The corrosion of copper and copper alloys is considered; a *bibliography* is appended.—J. H. W.

**"Aluminium-Bronzes." Resistance to Corrosion.** R. Loiseau (*Aciers spéciaux*, 1934, 9, 421-424).—"Aluminium-bronze" has the best resistance to corrosion of all copper alloys. The aluminium content should be not less than 8%, better between 8.5 and 11%. It should be as free from zinc as possible, although up to 0.5% is usually harmless. The alloy should preferably be in the forged or rolled state. Great care is necessary in manufacturing the alloy or it will be difficult to work.—J. H. W.

**Comparative Corrosive Actions of Dinitrolycol and Nitroglycerin on Shell, Gun-Shell, and Cartridge Cases.** M. Kostevich (*Separate, Belgrade: 1934, 5-7; C. Abs.*, 1935, 29, 1639).—K. carried out the destruction of explosives remaining after the War and observed that powders containing dinitrolycol were free from exudation. Experiments further showed that the corrosive effect of nitroglycerin increases that of nitrolycol and that substitution of nitrolycol for nitroglycerin substantially reduces the exudation or entirely prevents it.—S. G.

**\*Corrosion Phenomena in Sugar House Evaporators.** M. Garino and M. Parodi (*Industria saccarifera italiana*, 1934, 27, 592-600; *C. Abs.*, 1935, 29, 1674).—The % of sodium chloride in beets is 0.02-0.15. Corrosion of iron evaporator tubes, carbon below 0.1%, is due to the iron (air)/iron couple. Sodium chloride removes the oxide coating and exposes the underlying surface. The rate of corrosion varies directly with the % of sodium chloride and temperature of the juice, whereas the density of the juice, 15°-45° Brix, has no marked effect. Tubes of 30:70 *copper-nickel alloy* are reported as satisfactory.—S. G.

**Lead and Corrosion.** J. Mahul (*Aciers spéciaux*, 1934, 9, 425-439).—The content of impurities and the physical and mechanical properties of pure lead are given. The resistance of commercial lead, with and without antimony, to atmospheric corrosion, as measured by loss in weight, and to aqueous corrosion, as measured by the solubility of the lead, is described, and the application of its high resistance to corrosion in the building and the chemical industries, especially in the manufacture of sulphuric acid, is discussed.—J. H. W.

**†The Corrosion of Ultra-Light Alloys.** P. Bastien (*Aciers spéciaux*, 1934, 9, 408-414).—The corrosion of alloys of aluminium and magnesium is of 2 kinds: (1) uniform solution, as in hydrochloric and citric acids, and (2) localized corrosion (pinholes and grooves) caused by saline solutions. The extent of corrosion in these alloys is measured by loss in weight, the volume of gas evolved, by the alteration in the mechanical properties, or by loss in reflecting power. The carrying-out of these measurements and the various methods of testing are described. Pure magnesium is more resistant to corrosion than the commercial metal, and the most resistant ultra-light alloys are the magnesium-manganese and the magnesium-aluminium-manganese alloys containing about 1.5% of manganese. The usual method of protecting these alloys is by rapid cleaning in dilute nitric acid followed by immersion for some hrs. in baths of dilute alkali chromates and bichromates heated to about 90° C.—J. H. W.

**The Resistance to Corrosion of Pure Nickel, Cupro-Nickel, Nickel-Brass, and Inconel. Applications which Result.** F. Renaud (*Aciers spéciaux*, 1934, 9, 387-388).—The mechanical and physical properties and the applications are given of pure nickel, low nickel (20-30%) and high nickel (Monel metal) copper-nickel alloys, nickel-brass (copper 45-70, nickel 6-30%, zinc the remainder) and Inconel (nickel 80, chromium 14, and iron 6%).—J. H. W.

**\*Corrosion Phenomena in Canning Tinplate.** O. Carrasco (*Ind. ital. conserve aliment.*, 1934, 9, 247-253; *C. Abs.*, 1935, 29, 1764).—The chemical and mechanical properties of the various samples of tinplate examined are not

concordant. The best examples contained less than 0.09% silicon and less than 0.04% chromium. Analytical data are tabulated, and photomicrographs are included.—S. G.

**Zinc and Its Alloys from the Point of View of Corrosion.** R. Cazaud (*Aciers spéciaux*, 1934, 9, 440-444).—The mechanical properties, heat-treatment, structure and resistance to corrosion of the zinc-rich zinc-aluminium alloys, with and without small quantities (0.5%) of antimony, magnesium, or bismuth, are described.—J. H. W.

**\*On the Dissolution of Metallic [Zinc] Single Crystals.** L. E. Sabinina and L. A. Polonskaja (*Zhurnal Fizicheskoy Khimii (J. Phys. Chem.)*, 1934, 5, (7), 946-953).—[In Russian.] Potential-time curves have been obtained in 0.1N and in *N*-sulphuric acid for the polycrystalline metal and for single crystals cut parallel to the basal plane. The differences between the curves are related to the surface structure of the specimens, that for the single crystal showing the existence of a well-defined period of induction. The dissolution of single crystal zinc is attributed to the presence of atoms of other metals in the space-lattice.—N. A.

**\*Anomalies Observed in the Rate of Corrosion of Zinc.** J. E. Maconachie (*Trans. Electrochem. Soc.*, 1934, 66, 213-220; discussion, 220-221).—See *Met. Abs.*, 1934, 1, 448.—S. G.

**\*Milk and Metals.** W. Grimmer (*Milchw. Forsch.*, 1934, 16, 435-439; *C. Abs.*, 1935, 29, 1891).—The iron content of milk from 3 cows during the year ranged from 0.40 to 0.67, the copper content 0.19 to 0.34 mg./litre, when milked into glass containers, while the milk from 1 sheep ranged in iron content from 0.50 to 0.64 mg./litre and in copper from 0.27 to 0.29 mg./litre. The dissolving capacity of hot and cold milk for iron, with poorly-tinned cans, the amount of iron and copper taken up by the milk from metal dairy equipment under plant conditions and the distribution of iron and copper in the whole milk, skim milk, cream, buttermilk, starter, and butter are reported. A metallic flavour in butter always appeared when the amount of iron was over 2.5 mg./kg., but a tallowy, metallic taste might appear with less iron.—S. G.

**Corrosion of Containers for Liquid Fuel.** Max Graempe (*Oel u. Kohle*, 1935, 11, 118-119).—Instances of corrosive attack, accompanied by the formation of a slimy deposit, are described in the case of petrol containers lined with lead and brass; tin appears to resist attack of this type. No appreciable attack was caused by pure petrol or benzole, the corrosive effects being attributed either to the addition of alcohol to the fuel, or to the presence in it of sulphur compounds. Copper and brass may safely be used with fuels of high purity: Pantal is also recommended, especially if an internal anodic coating has been given.—P. M. C. R.

**\*The Action of Nitrocellulose Solutions on Different Materials.** S. Sklyarenko, A. Pakshver, and O. Gelikonova (*Korrosion u. Metallschutz*, 1934, 10, 217-222).—See *Met. Abs.*, this volume, p. 60.—S. G.

**Atmospheric and Marine Corrosion of Metallurgical Products.** [C.] Gard (*Aciers spéciaux*, 1934, 9, 291-298).—The corrosion of metals by the atmosphere and sea-water is considered under 4 headings: (1) causes and effects, the causes are classified according as they are or are not dependent on the corroded material; (2) combating corrosion: by auto-protection, by the application of non-metallic or of metallic coatings, and chemical methods (Parkerization and Protalization); (3) tests and the control of corrosion; (4) practical applications. Under each of the first 3 headings, the work of the French Commission of corrosion is presented chronologically.—J. H. W.

**The Incidence and Prevention of Corrosion in Heating and Hot Water Supply Systems (Die Entstehung und Verhütung der Korrosion an Heizungs- und Warmwasser Bereichtungsanlagen).** O. Kröhnke and D. L. Stiegler (*Book* :

*Halle (Saale): Carl Haenchen, 1933, pp. 152; Building Sci. Abs., 1934, 7, 217).*—A discussion of the theory of corrosion, both chemical and electrochemical, is followed by a general review of the corrosion phenomena in hot-water supply and heating systems as affected by the nature of the water and by the metals used in their construction. A brief description is given of a laboratory study of chemical and electrochemical corrosion reactions. Consideration is then devoted to methods of corrosion prevention by chemical and other treatment of the water, by the use of particular metals and methods of construction, and by metallic and non-metallic protective coatings. The uses and behaviour of lead, iron, copper and other metals in their relationship to waters of different chemical compositions are discussed in some detail.—S. G.

**\*Theoretical and Experimental Studies on the Electrolytic Corrosion of Underground Pipework.** R. Gibrat (*Rev. gén. Elect.*, 1934, 35, 203–215, 239–253).—Cf. *Met. Abs.*, 1934, 1, 501. The distribution of stray currents in buried cables and underground metal work, due to leakage from the rails of tramway systems, is investigated mathematically. Expressions are derived for calculating the maximum current from cable to soil, and the value of this figure as an indication of the degree of corrosion is discussed. An extensive series of measurements of earth currents and differences of potential on the Roubaix tramway system are described, from which the conclusion is drawn that stray currents from this tramway system are not nearly so important as currents due to “autogalvanic corrosion.” Leakage currents from the system were only appreciable in the area where ordinary rail joints were used, and were negligible in the areas where the rails were joined by Thermit welds.—J. C. C.

**Underground Corrosion in the South-Eastern United States.** K. H. Logan (*J. Southeastern Sect. Amer. Water Works Assoc.*, 1934, 4, 51–71; *C. Abs.*, 1935, 29, 102).—The principal cause of underground corrosion is the unequal distribution of oxygen at or near the pipe surface. There are many factors influencing the rate of corrosion, such as temperature, acidity, moisture, &c. It is difficult to determine accurately the relative merits of pipe materials. The ferrous metals do not differ sufficiently to permit of any one of them being found superior by the data now available. L. discusses protective coatings.—S. G.

**\*Cathodic Protection of Pipe Lines from Soil Corrosion.—I, II, III.** Scott Ewing (*Gas Age-Record*, 1935, 75, 179–182, 219–222, 239–242).—A detailed report is given of work carried out by the American Gas Association on pipe coatings and corrosion. The report is to be concluded in a later number. The report describes methods for making preliminary surveys, for estimating costs, and for determining where drainage stations should be placed. Methods are also given for determining whether or not the protection is effective at any time subsequent to its installation.—J. S. G. T.

**Fatigue Under Corrosion.** L. Persoz (*Aciers spéciaux*, 1934, 9, 311–328).—The results of a large number of tests carried out by various observers on steels, bronzes, “aluminium-bronzes,” brasses, and copper-nickel alloys, showing the resistance of these alloys to fatigue under corrosion, are tabulated. The importance of the presence of oxygen on this property, the mechanism of fatigue under corrosion, the possibility of its having a limiting value, and protective coatings and inhibitors are discussed. A *bibliography* is appended.—J. H. W.

**Theories of Corrosion.** G. Chaudron (*Aciers spéciaux*, 1934, 9, 301–310).—The following factors bearing on the theory of corrosion are discussed: potential difference between metals and their salt solutions, electrochemical classification of metals, surface corrosion, methods of accelerating corrosion, depolarization, and hydrogen evolution, passivity and the protective film, the effect of corrosion on the mechanical properties of metals, intercrystalline corrosion, and resistance to corrosion.—J. H. W.



**Corrosion and the Use of Metals.** Albert Portevin (*Aciers spéciaux*, 1934, 9, 287-290).—A general conception of corrosion is outlined, including the effect of corrosion on the services rendered by metals and alloys, and the principles underlying the various forms of protection.—J. H. W.

**\*On Corrosion Phenomena. XVIII.—The Localization of the Restraining Action of Surface-Active Substances in the Dissolution of Metals in Acids.** A. Thiel and C. Kayser (*Z. physikal. Chem.*, 1934, [A], 170, 407-420).—Tests on so-called "zerlegten" local elements (cadmium in combination with platinized or grey platinum in 2*N*-sulphuric acid with addition of gelatin, gum arabic, or methyl violet, cadmium in combination with copper in 2*N*-sulphuric acid with addition of methyl violet, and zinc in combination with platinized platinum in 2*N*-sulphuric acid with addition of gelatin, gum arabic, or methyl violet) have shown that the additions influence only the evolution of gas on those metals which dissolve in acids but the dissolution of the metals themselves only to a very subordinate degree; this is contradictory to the work of Schunkert (see *Met. Abs.*, 1934, 1, 132).—B. Bl.

**\*The Theory of Passivity. XXVI.—The Limiting Current in Anodic Polarization of Metals in Aqueous Solutions.** W. J. Müller (Experimental work by E. Löw and W. Machu) (*Z. Elektrochem.*, 1935, 41, 83-86).—Photographs of anode surfaces at different points on the current-time curves of iron in sulphuric acid show that the current falls rapidly, only when the surface is almost completely covered with crystallites. The experimental results of E. Müller and K. Schwabe can be readily interpreted by W. J. M.'s film theory of passivity. Cf. *Met. Abs.*, 1934, 1, 601.—J. H. W.

**Tests of Corrosion of Metallurgical Products.** R. Cazaud (*Aciers spéciaux*, 1934, 9, 473-485, 489).—The effect of the dimensions, form, and state of surface of specimens for corrosion tests is discussed. The 3 types of test used for liquid corrosion are: (1) continuous immersion; (2) alternate immersion; and (3) spraying. The tests consist of optical or photometric examination, gravimetric, calorimetric, volumetric, mechanical or electrical measurements and micrographic examination. These various methods and the apparatus devised by different experimenters are described in detail. A bibliography of 18 references is appended.—J. H. W.

**Sea-Water. Its Definition for Corrosion Tests.** R. Legendre (*Aciers spéciaux*, 1934, 9, 486-489).—It is necessary that metals and alloys to be used in aviation should be tested in sea-water. Since it is often difficult to procure natural sea-water and to keep its composition constant, and since, in any case, the composition and properties of sea-water from different sources vary considerably, a composition for a standard artificial sea-water is proposed. This is prepared in a carefully standardized manner to facilitate the reproducibility of results, the tests being made at  $35^{\circ} \pm 2^{\circ}$  C.—J. H. W.

**Accelerated Corrosion Tests in Sea-Water.** E. Drouilly (*Aciers spéciaux*, 1934, 9, 490-492).—The results are given of accelerated tests of the corrosion of Alumag carried out in the laboratories of the Société des Tréfileries et Laminaires du Havre. The resistance of this alloy is compared with that of a copper alloy of high resistance.—J. H. W.

**\*A New Method for Measuring Corrosion of Metals.** W. R. van Wijk (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1935, 7, 48-53).—The method consists in evaporating films of the metal on to glass plates in a high vacuum and examining the decrease in thickness during corrosion by measuring the change in light transmissibility. Apparatus for preparing the films and testing them is described in detail with reference to diagrams. The films used are about  $8 \times 10^{-6}$  cm. thick and changes in their thickness of 5 atomic diameters can readily be measured by the method. Tests have been made in this way on the rate of corrosion of iron in various gas-oils. The question of producing homogeneous alloy films for testing is briefly considered.—A. R. P.

**The Corrosion of Metals.** E. S. Hedges (*Ann. Rep. Prog. Chem.*, 1935, **31**, 126–142).—A review of the present position of corrosion research, covering recently published work on film formation and passivity, corrosion in aqueous solutions, and atmospheric corrosion.—E. S. H.

### V.—PROTECTION

(Other than Electrodeposition.)

(Continued from pp. 163–165.)

**\*The Oxide Coating of Aluminium.** W. Ch. van Geel and H. Emmens (*Physica*, 1934, **1**, 415–416; *C. Abs.*, 1934, **28**, 4986).—[In English.] Aluminium can be covered by a crystalline hydrated oxide layer if used as anode in a  $H_3BO_3$  + borate solution with a current density of about 0.5 amp./dm.<sup>2</sup>, current efficiency less than 100%, current decreasing for constant voltage. The oxide layer formed is amorphous if a 4% oxalic acid solution is used, current density 4 amp./dm.<sup>2</sup> with cooling at room temperature, constant current efficiency 100% (cf. Burgers, Claassen, and Zernike, *J. Inst. Metals*, 1932, **50**, 289). Aluminium covered with the amorphous layer can be oxidized for a second time with formation of a crystalline layer under the amorphous one, with current efficiency for the second layer 100%. The amorphous layer behaves like a resistance in series with the crystalline layer. A primary crystalline layer cannot be covered with an amorphous one, but loosens and falls off.—S. G.

**Anodic Oxidation of Aluminium and Its Alloys.** A. Dumas (*Aciers spéciaux*, 1934, **9**, 550–552).—The types of oxide films, and the production of the film, its properties, subsidiary treatments, and the applications of this form of protection are briefly described.—J. H. W.

**Chemical and Electrochemical Surface Treatment of Aluminium.** W. Wiederholt (*Chem. Fabrik*, 1934, 361–364).—See *Met. Abs.*, 1934, **1**, 502.—S. G.

†**Electrolytic Surface Treatment of Light Metals in the Field of Raw Material Problems.** H. Fischer (*Z. Metallkunde*, 1935, **27**, 25–32; and (translation) *Light Metals Rev.*, 1935, **1**, 372–388).—The Eloxal anodic oxidation process is described and an extensive account is given of the properties of the films produced with especial reference to their resistance to corrosion and their light reflectivity.—A. R. P.

**Autoprotective Aluminium Alloys. The Alumags.** E. Drouilly (*Aciers spéciaux*, 1934, **9**, 404–407).—The Alumags are aluminium alloys containing about 3.5–6.5% of magnesium. They form homogeneous solid solutions of metals which have similar potentials, and have a very fine structure. These properties tend to prevent the formation of electrolytic cells, and favour the formation of a passive film, so that the alloys are spontaneously very resistant to corrosion. The principal mechanical properties of the 6.5% magnesium alloy in the sand- and chill-cast, annealed and cold-rolled states are given.—J. H. W.

**Bimetal: Vedal.** M. Pobellier (*Aciers spéciaux*, 1934, **9**, 535–536).—Duralumin, being more electronegative than aluminium, will not be attacked by a saline solution in the presence of aluminium. This fact is made use of in the manufacture of Vedal, which consists of Duralumin covered on both sides by pure aluminium. The mechanical properties and applications of Vedal are given.—J. H. W.

**The Manufacture of Aluminium Plate.** Harold Silman (*Met. Ind. (Lond.)*, 1935, **46**, 358).—A description is given of the dipping, Calorizing, spraying, and rolling processes of making aluminium-plated sheet iron.—J. H. W.

**Methods of Protecting Brass Binding Screws and Soldered Joints of an Accumulator Against Oxidation.** W. Seitz (*Z. tech. Physik*, 1935, **16**, 12–13).—Access of acid to the binding screw or soldered joint by creeping is prevented.

by the provision of a sacrificial material, e.g. zinc or marble fixed so that the acid reaches it before the screw, &c., is attacked. Alternatively, the screws, &c., may be similarly protected by a glass sleeve containing, for example, sodium bicarbonate.—J. S. G. T.

**\*Investigation of Protective Films on Magnesium Obtained by Application of Solutions of Sodium Silicate and Potassium Bichromate.** I. V. Krotow and G. G. Ivanov (*Izvestia Akademii Nauk S.S.S.R. (Bull. Acad. Sci. U.R.S.S.)*, 1934, (6), 921-929).—[In Russian.] A systematic investigation has been made of the conditions for obtaining corrosion-resistant films on magnesium as anode by electrolysis in a solution containing sodium silicate and potassium bichromate, the films obtained being tested with a 3% salt solution. The best results are given by a mixture of sodium silicate solution (120 c.c. of commercial water-glass diluted to 800 c.c.) 180 c.c., 3% potassium bichromate solution 6 c.c., and water 14 c.c., operated at 15° C. with a current density of 0.015 amp./cm.<sup>2</sup> at 5-5.9 v. for 20 minutes; the treated metal is dried at 120° C. for 1 hr.—N. A.

**The Protection of Magnesium by Coatings of Selenium.** Henri Fournier (*Aciers spéciaux*, 1934, 9, 506-508).—The method of protecting magnesium and ultra-light alloys against corrosion by coating them with selenium by simple immersion of the well-cleaned alloy in the acid or a salt of selenium, and the results of a number of tests showing the efficacy of this form of protection are discussed.—J. H. W.

**\*Electrolytic Treatment of Zinc.** Joseph Schulein (*Trans. Electrochem. Soc.*, 1934, 66, 223-226; discussion, 226-228).—See *Met. Abs.*, 1934, 1, 503.—S. G.

**Electrolytic Nickel Coatings and Protection Against Corrosion.** Marcel Ballay (*Aciers spéciaux*, 1934, 9, 553-559).—The properties and applications of thin (between 0.001 and 0.030 mm.) and thick (up to several millimetres) nickel deposits as protection against corrosion are described.—J. H. W.

**The Protection Against Corrosion by Means of Derived Electrolytic Actions.** R. Lecoeuvre (*Aciers spéciaux*, 1934, 9, 520-525).—The nature of the protection afforded to a metal or alloy by indirect electrolytic action derived from riveting a totally different (electrochemically) metal or alloy to it, and the practical applications of the process are described.—J. H. W.

**Chemical Deposits [as Protective Coatings].** Charles Boulanger (*Aciers spéciaux*, 1934, 9, 501-502).—The protection afforded by deposits from a number of salt solutions at 15°-50° and 100° C. on aluminium and Duralumin specimens with rolled and with polished faces was nil. The formation of a film of oxide on aluminium, and its mechanism in protecting the metal against corrosion, and the protection afforded by metallic deposits and the method of obtaining them are described.—J. H. W.

**Protection by Chemical Methods.** Jean Bary (*Aciers spéciaux*, 1934, 9, 503-505).—The methods of Parkerization and Protalization and the advantages of these processes are described. The former consists in protecting iron and steel by the formation of a passive coating on the surface; the latter consists in protecting aluminium and its alloys by the formation of complex halides of aluminium, titanium, and vanadium at their surfaces.—J. H. W.

**Protective Coatings.** J. Cournot (*Aciers spéciaux*, 1934, 9, 495-497).—An introductory article on the subject of protective coatings.—J. H. W.

**Formation of Hard Zinc [in Galvanizing Baths].** Heinr. Meyer auf der Heyde (*Metallwaren-Ind. u. Galvano-Tech.*, 1935, 33, 74-75).—The iron which causes the formation of "hard zinc" in galvanizing baths is derived chiefly from the action of molten zinc on the iron pot. This source of trouble can be obviated by avoiding local overheating, keeping the temperature of the metal below 475° C., and protecting the bottom of the pot with molten lead.—A. R. P.

**Aluminium Improves Finish in Galvanizing.** Wallace G. Imhoff (*Metal Cleaning and Finishing*, 1934, 6, 509-512, 526; *C. Abs.*, 1935, 29, 1374).—Small additions of aluminium to galvanizing baths produce zinc coatings of a bluish, bright metallic lustre. The term "block" spangle is applied to such finishes because the spangle or crystallization tends to take the form of irregularly shaped "blocks" or areas. These areas appear to possess an extremely thin coat of an aluminium alloy which has solidified over the coating. A very small addition of aluminium also arrests the formation of zinc oxide scum, making it possible to withdraw articles from the bath with a smooth, bright finish. The higher the bath temperature the more aluminium is required, but an excess of aluminium will again cause excessive formation of zinc oxide (by-products). The presence of iron in galvanizing baths greatly accelerates the oxidation of zinc, this reaction being particularly pronounced at 590° C. Articles to be coated should therefore be as rust-free as possible. When only small amounts of aluminium are used in the bath there is little or no effect on the fluxing conditions. Methods for making the addition of aluminium are described.—S. G.

**The Reasons for Putting Lead in the Bottom of Hot-Dip Galvanizing Pots.** Wallace G. Imhoff (*Amer. Metal Market*, 1935, 42, (62), 3, 6).—The chief value of lead in galvanizing pots is to protect the bottom, where the heat is greatest, from severe attack by the molten zinc and hence to prolong the life of the pot. In addition, the presence of lead in the zinc tends to reduce the amount of zinc-iron alloy "slush" in the bath and gives a smoother and less brittle zinc coating on the galvanized articles.—A. R. P.

**The Double-Dip Hot Galvanizing Process.** Wallace G. Imhoff (*Amer. Metal Market*, 1935, 42, (52), 3, 5).—In this process the articles after removal from the galvanizing bath and while the excess zinc is dripping off them are sprayed with finely powdered ammonium chloride and re-dipped into the molten zinc. In this way rough places and inclusions of dirt, oxides, &c., in the first coat are completely removed and a thin, bright, non-porous zinc coating highly resistant to corrosion is obtained.—A. R. P.

**Rapid Tests of Protective Coating Materials.** P. I. Karasik and T. A. Masterkov (*Zavodskaya Lab.*, 1934, 3, 838-843; *C. Abs.*, 1935, 29, 1047).—[In Russian.] The anti-corrosive properties of various grades of Russian petrolatum were tested by suspending coated steel rings and plates over nitric acid (*d* 1.4) in a desiccator for periods of from several hrs. to 2 days, depending on the nature of the petrolatum; the results were tabulated. The tests of samples coated by dipping in melted petrolatum gave the most uniform results. The results are comparable with those obtained after 6 months of exposure to an atmosphere containing 60% water at 30° C.—S. G.

**Metallization.** (Mlle.) S. François (*Aciers spéciaux*, 1934, 9, 526-534).—Hot or immersion metallization consists in galvanizing, or lead or tin coating. The preparation of the article to be coated, the metallization, the cooling-off, and the character of the coating in each case are described. Metallization by projection, in particular by means of the Schoop pistol, is described in detail, including the preparation of the surface, the nature and structure of the coating, the mechanical, thermal and chemical treatments subsequently given, and an indication of the wide applications of the process. A list of French patents of pistol metallization from 1909 to 1934 is appended.—J. H. W.

**The Metal Spraying of Cores and Castings.** A. Roger (*Found. Trade J.*, 1935, 52, 187-189; discussion, 209-210).—Read before the London Branch of the Institute of British Foundrymen. The history of metal spraying and a description of the various types of pistol at present in use are given. The preparation of the surface to be sprayed, filling defects in castings, the nature and microstructure of the coating, the properties of the sprayed metal, and mould and core spraying are described.—J. H. W.

**Sprayed Molten Metal Coatings.** E. V. David (*Paper Trade J.*, 1934, 99, (18), 34-37).—Cf. *Met. Abs.*, this volume, p. 61.—S. G.

**Aloyalum: a New Surfacing Material.** — (*Amer. Metal Market*, 1935, 42, (53), 2).—A brief note. Aloyalum, a liquid surfacing alloy with iron, steel, or whatever metal is processed with aluminium, may be applied by brush, spray, or dip, and the process completed by a short period of baking at 700° F. (371° C.) or higher. The alloy withstands a temperature of 2000° F. (1093° C.). The standard tests, including salt-water, various acids, &c., show a superiority in the use of Aloyalum at a ratio of upwards of 4:1. The process is said to be very economical.—I. M.

**\*Accelerated Tests of Paint Finishes on Aluminium.** Junius D. Edwards and Robert I. Wray (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1935, 7, 5-8).—An arrangement of tanks for testing the resistance to corrosion of Duralumin boxes coated with various protective films is described; the tanks are automatically filled with sea-water and then emptied and refilled in such a manner that the boxes are totally immersed for 10 minutes, then allowed to dry for about 40 minutes in cycles. The various surface treatments can be arranged as follows in decreasing order of protectivity: anodic oxidation, oxidizing the surface by immersion in reagent solutions, immersion of the metal in phosphoric acid solutions, treatment with phosphate solutions, cleaning with solvents. The best painting procedure for Duralumin parts of seaplane pontoons comprises the application of a phenolic resin priming coat pigmented with zinc chromate to the anodically oxidized sheet before assembly and the application of an aluminium paint made with the same vehicle after assembly. Numerous other types of paint and lacquer provide adequate protection under service conditions for several years, but appear to be inferior to the recommended treatment in the accelerated test described above.—A. R. P.

**\*Protection of Duralumin in Aircraft.** Erich K. O. Schmidt (*Farbe u. Lack*, 1934, 591-594; *C. Abs.*, 1935, 29, 1267).—Results are tabulated of durability, salt-water resistance, and adhesion tests on 33 painting systems for Duralumin. Details of composition are not given.—S. G.

**The Protection of Metallic Works by Painting with Tar and with Aluminium.** J. Roux (*Rev. Aluminium*, 1935, 12, 2745-2752).—Examples of protecting metallic structures by painting them with tar and aluminium powder, the methods of applying the coats, and the cost of the painting are discussed.

—J. H. W.

**Metal Priming Paints [Inhibiting Qualities and Influences of Reactions Within the Paint Film].** Harley A. Nelson (*Indust. and Eng. Chem.*, 1935, 27, 35-41).—Theories of corrosion and the external agents held accountable by each theory for the progress of corrosion, are discussed. Metal priming paints are considered as pigment-vehicle combinations subject to physical and chemical changes. The essentials for corrosion—water, carbon dioxide, acids, and hydrogen peroxide (a depolarizing agent)—are supplied during the decomposition of natural drying oils and resins. Pigments that give effective service in metal priming paints apparently are those which neutralize acids and reduce or decompose hydrogen peroxide without forming corrosive reaction products. The study of the decomposition products formed in organic binding media should assist in attacking the problem of formulating still better metal priming paints.—F. J.

**New Aluminium Paint for Steel Said to be Resistant at Elevated Temperatures [Ultra Fuson].** — (*Amer. Metal Market*, 1930, 37, (57), 4).—A chemically treated aluminium powder forms the basis of a heat-resisting paint. It will withstand sustained temperatures up to 2000° F. (1093° C.) and will retain its silver colour up to 1200° F. (649° C.) beyond which it becomes dark grey. It may be applied by brush, spraying, or dipping.—I. M.

## VI.—ELECTRODEPOSITION

(Continued from pp. 165-169.)

\*The Electrodeposition of Ternary Alloys of Cadmium, Zinc, and Tin. Lawrence E. Stout and Bernard Agruss (*Trans. Electrochem. Soc.*, 1934, **66**, 441-451; discussion, 451).—See *Met. Abs.*, 1934, **1**, 505.—S. G.

Chromium and Cadmium Plating. J. Loiseau (*Aciers spéciaux*, 1934, **9**, 560-564).—The effect of various factors, such as the  $H_2SO_4:CrO_3$  ratio, the  $CrO_3$  concentration, cathode efficiency, and current density on the character of electrolytic chromium deposits are described. The composition of the bath usually used is chromic acid 300, sulphuric acid 3 grm./litre at  $45^\circ C.$ , and a current density of 10 amp./dm.<sup>2</sup>. The operation of cadmium plating is briefly described. The usual composition of the bath is cadmium cyanide 41, sodium cyanide 49, and sodium hydrate 20 grm./litre at a current density of 1.5-2 amp./dm.<sup>2</sup>. The articles are subsequently placed in a brightening bath consisting mainly of either nitric or chromic acids.—J. H. W.

\*Investigations of the Structure and Properties of Electrolytic [Chromium] Deposits. V. I. Arharov and U. B. Fedorov (*Zhurnal Tekhnicheskoy Fiziki (J. Tech. Physics)*, 1934, **4**, (7), 1318-1325).—[In Russian.] Existing methods of determining the porosity of chromium plates are critically reviewed and their defects pointed out. A new method is proposed in which the chromium is plated on to brass which is then heated *in vacuo* and the volatilization of zinc through the pores determined. With increasing thickness of the deposit the porosity increases to a maximum, and then decreases again when a certain limiting thickness is obtained. The results obtained by the new method have been compared with those obtained by other procedures.—N. A.

\*Theory and Practice of Chromium Plating.—III. N. D. Biriukov and S. P. Makarieva (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1934, **14**, (8), 174-189).—[In Russian.] See *Met. Abs.*, this volume, p. 62. The electrolytic deposition of chromium is explained as follows: when equilibrium of the oxidizing-reduction processes is reached during the electrolysis of solutions of chromic acid containing sulphuric acid, one atom of deposited chromium corresponds to one molecule of chromium oxide reduced. During reduction of  $CrO_3$  at the cathode  $Cr_2O_3$  is first formed and then  $CrO$  whether sulphuric acid is present or not. In the absence of this acid, the process proceeds much more slowly than in its presence, since the products of reduction form with the chromic acid insoluble compounds such as  $Cr_2(CrO_4)_3$  and  $Cr_2(Cr_2O_7)_3$ , which retard diffusion towards the cathode. With sulphuric acid, however, soluble salts of type  $Cr_{2n}(CrO_4)_{3m-n}(SO_4)_n$  are formed the  $SO_4$  content of which depends on the amount of sulphuric acid in the electrolyte. The deposition of chromium on platinum in the absence of sulphuric acid is impossible, since the  $CrO$  produced by reduction is not protected from the oxidizing action of  $CrO_3$ . The soluble sulphate formed in the presence of sulphuric acid is converted eventually into chromium sulphate, which is partly reduced to  $CrO$ , and this is partly reduced to metal and partly oxidized, forming a somewhat protective layer. In this case the electrolyte near the cathode consists of 3 layers, the internal containing  $Cr^{II}$ , the intermediate  $Cr^{III}$ , and the outside  $Cr^{VI}$ . The intermediate layer protects the internal one from the oxidizing action of the  $Cr^{VI}$  in the external layer, and thence makes deposition of metallic chromium possible. The thickness of these layers is reduced when hydrogen is evolved at the cathode.—D. N. S.

\*Theory and Practice of Chromium Plating.—IV. N. D. Biriukov and S. P. Makarieva (*Vestnik Metallopromishlennosti (Messenger Metal Ind.)*, 1934, **14**, (11), 145-152).—[In Russian.] In the chromic acid plating bath all acids which form soluble chromous and chromic salts and which do not produce secondary

reactions at either electrode, have a similar action to sulphuric acid in determining the range of bright chromium plating. Addition of a soluble sulphate also has a similar effect to sulphuric acid, since the following reaction occurs:  $2\text{H}_2\text{CrO}_4 + \text{K}_2\text{SO}_4 \rightleftharpoons \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$ . Addition of chromic salts to the bath markedly affects the reducing action at the cathode by forming a protective layer in its neighbourhood without the use of a strong acid; similar effects may be obtained by addition of cations of such metals as nickel, copper, zinc, or iron, an optimum effect being obtained at a certain concentration in each case. The more electropositive the added metal the greater is its activity and the lower the concentration required for the maximum effect. Better current yields may be obtained at lower temperatures, since the rate of oxidation of chromous ion is thereby decreased. The effect of pulsating currents is explained thus: deposition of chromium and evolution of hydrogen ceases when the electrolyte is stirred by the hydrogen evolution so that the protective layer around the cathode is disturbed, and the hydrogen is consumed by reducing the chromic acid outside the protective layer. For hydrogen to be produced the rate of reduction of hexavalent and trivalent chromium to the divalent form must be greater than the rate of oxidation of divalent to trivalent chromium, and the chromic acid must be reduced chemically and not at the cathode.—D. N. S.

**Influence of Trivalent Chromium on Chromium Hardness.** R. J. Piersol (*Metal Cleaning and Finishing*, 1934, 6, 522-525; *C. Abs.*, 1934, 29, 1017).—The hardness of chromium plate at different rates of deposition varies with the amount of trivalent chromium in the bath. The optimum amount of trivalent chromium, selected from the present results alone, appears to be about 5-7 gm./litre. In this instance the resistance of the solution is increased only about 50%. Hard deposits may be obtained over a wide range of current density, and the plates are very good in appearance.—S. G.

**Influence of Iron on Chromium Hardness.** R. J. Piersol (*Metal Cleaning and Finishing*, 1934, 6, 557-560; *C. Abs.*, 1935, 29, 1329).—The addition of iron to chromium plating baths tends to increase the hardness of the deposit, 10 gm. of iron per litre appearing to be the most beneficial amount. A similar increase in hardness results from an optimum amount of trivalent chromium in the bath (see preceding abstract). P. believes that other methods than an iron addition are easier to control and are therefore generally to be preferred.—S. G.

**Chromium Plating Methods.** W. A. Koehler (*Metal Cleaning and Finishing*, 1934, 6, 613-616; *C. Abs.*, 1935, 29, 1329).—A general discussion of the theory and practice of chromium plating.—S. G.

**Cobalt Plating.** O. Macchia (*Industria meccanica*, 1934, 16, 744-745).—A review.—S. G.

**\*Copper-Plating of Aluminium Contacts.** N. J. Kudrjavzev and U. L. Derjavina (*Vestnik Elektropromishlennosti (Messenger Elect. Ind.)*, 1934, (8), 29-35).—[In Russian.] Methods are described for the preparation of aluminium surfaces for copper plating, to obtain the best quality of deposits. Very dirty surfaces should first be cleaned by mechanical brushing; the metal is then degreased by treatment with organic solvents (benzene, carbon tetrachloride, trichlorethylene), washed in 10% caustic soda solution, saturated cold with sodium chloride, washed with 2% hydrochloric acid, electrolyzed with alternating current for 1 minute in 0.50-0.75 *N*-oxalic acid at a current density of 25 amp./dm.<sup>2</sup>, 60-80 v., and etched in a hot (90°-95° C.) solution containing potassium carbonate crystals 23 gm., and sodium bicarbonate 45 gm./litre. Alternatively, after the first 4 steps outlined above, the metal may be immersed for 5-8 minutes in a hot solution of 0.1-0.7 *N*-hydrochloric acid containing 6-22 gm./litre of ferric chloride. Thorough washing after each operation is essential. The copper-plating electrolyte comprises a 1.5

*N*-solution of copper sulphate in *N*-sulphuric acid; plating is done at 18°–20° C. with a current density 1–1.5 amp./dm.<sup>2</sup>.—N. A.

**\*Adhesion of Electrolytic Copper Deposits.** Pierre A. Jacquet (*Trans. Electrochem. Soc.*, 1934, **66**, 393–418; discussion, 418–426).—See *Met Abs.*, 1934, **1**, 505.—S. G.

**\*A Study of Diffusion on Copper-Plated Zinc-Base Die-Castings.** William F. Castell (*Trans. Electrochem. Soc.*, 1934, **66**, 427–438; discussion, 438–440).—See *Met. Abs.*, 1934, **1**, 506.—S. G.

**\*Galvanic Deposition of Nickel-Iron Alloys.** E. Raub and E. Walter (*Z. Elektrochem.*, 1935, **41**, 169–174).—The effect of different additions to nickel baths on the injuriousness of iron, and at the same time the possibility of the production of galvanized nickel-iron alloy deposits as protectors against corrosion were investigated. Organic acids which form complex compounds with iron reduced stripping which occurs in deposits from iron-containing baths of low  $p_H$  value (3–4). At higher  $p_H$  values (4–6), the baths are relatively only a little less sensitive. For practical purposes, only citric, or possibly tartaric acid, need be considered. Lactic acid results in badly adhering porous or powdery deposits. Investigations on the production of galvanized iron-nickel alloy deposits as rustless coats gave no results.—J. H. W.

**The Electrolytic Treatment of Zinc.** Joseph Schulein (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, **22**, (3), 30–34).—Zinc may be coloured deep black by electrolyzing it in the usual chromium-plating bath using a.c.; there is no change in weight or in thickness of electrodeposits of zinc heated in this manner, but the resistance to corrosion is remarkably increased. Black zinc-plate does not wet as readily as ordinary zinc-plate and is highly resistant to chloride solutions, withstanding the salt-spray test for 5–6 times as long as ordinary plate.—A. R. P.

**The Economic Point of View in the Electrolytic Gilding Process.** M. Kraatz (*Metallwaren-Ind. u. Galvano-Techn.*, 1935, **33**, 96–97).—A modern gold-plating plant is illustrated and its operation described in general terms. Insoluble stainless steel anodes are used, and the bath is regenerated by the occasional addition of gold salts. The colour of the deposit may be modified by introducing other metals into the bath.—A. R. P.

**\*Rhenium Plating.** Colin G. Fink and P. Deren (*Trans. Electrochem. Soc.*, 1934, **66**, 471–474; discussion, 474).—See *Met. Abs.*, 1934, **1**, 507.—S. G.

**Tin Plating from an Alkaline Bath.** Mitsugu Shimada (*J. Electrochem. Assoc. Japan*, 1934, **2**, 367–371; *C. Abs.*, 1935, **29**, 1716).—[In Japanese.] Tin plating of copper, brass, zinc, lead, hard lead, iron, steel, and aluminium can be carried out best at 0.15–0.5 v. in an alkaline aqueous solution of stannous chloride or in an alkaline aqueous solution containing sodium stannite and sodium chloride with 0.12–0.2 gm./litre gelatin; a tin anode (anode current density 0.45–1.6 amp./dm.<sup>2</sup>) can be used; cathode current density is 0.2–1.5 amp./dm.<sup>2</sup>. The highest and lowest concentrations of the bath are 50 gm. tin salt for 2 mol. sodium hydroxide in aqueous solution and 12 gm. for 1 mol., respectively.—S. G.

**\*The Co-Deposition of Tungsten and Iron from Aqueous Solutions.** M. Leslie Holt (*Trans. Electrochem. Soc.*, 1934, **66**, 453–458; discussion, 458–460).—See *Met Abs.*, 1934, **1**, 507.—S. G.

**\*Dropping Tests for Determining the Local Thickness of Electrodeposited Zinc and Cadmium Coatings.** R. O. Hull and P. W. C. Strausser (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, **22**, (3), 9–14).—The method consists in allowing drops of a liquid to fall at the rate of 80–120 per minute on the point of the specimen to be tested, the specimen being inclined meanwhile at 45° to allow the liquid to run off quickly without attacking other areas. The surface of the metal must be cleaned with an organic solvent followed by light rubbing with a suspension of magnesia so that it is free from "water-



break," and should be dry at the beginning of the test. For cadmium coatings the corroding liquid is an 11% solution of ammonium nitrate containing 10 c.c./litre of hydrochloric acid ( $d$  1.18); this solution removes 0.00001 in. of the coating per second. To effect the same rate of dissolution of zinc coatings the corroding liquid should contain 10% of ammonium nitrate and 55 c.c./litre of nitric acid ( $d$  1.42).—A. R. P.

**Testing and Controlling Metallic Coatings on Wire.** John H. Hruska (*Wire and Wire Products*, 1935, 10, 9–11, 46).—The Glazunov test is based on the changes between the anode and the electrolyte during an electrolytic dissolution of a specimen representing the plated article. Simultaneous and periodic measurements of the voltage and current intensity, together with the exact determination of the size and shape of the specimen are the only experimental measurements required. The method of applying this test to the control of nickel plating on wire is described.—J. H. W.

**\*The Relation of Coating Thickness to Outdoor Service Life on Zinc Alloy Die-Castings.** E. A. Anderson (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (2), 11–20).—Preliminary results of a large-scale series of corrosion tests on various platings (chiefly nickel) on zinc-base die-casting alloys indicate that coatings 0.00015 in. thick are definitely inferior in protective power to coatings of double this thickness, but that there is a tendency for certain of the thicker coatings to crack during prolonged atmospheric exposure. The work is being continued.—A. R. P.

**The Mechanical Strain in Electrolytic Plates as a Cause for Peeling.** Sándor Földes (*Veysi Ipar*, 1934, 33, (18/19), 2–3; *C. Abs.*, 1935, 29, 1717).—The theoretical side is reviewed. Practically, good chromium deposits are easily obtained with an undercoat of nickel, the latter from a bath of not too high a  $p_{\text{H}}$  and close control of conditions.—S. G.

**Suspended Matter in Plating Solutions.** J. M. Cosgrove (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (3), 27–30).—The importance of clear solutions for obtaining good plating results is emphasized.—A. R. P.

**\*Efficiency of a Horizontal Plating Barrel.** Albert Hirsch (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (2), 7–10).—Tests on a load of steel articles, having a surface area of about 50 ft.<sup>2</sup> plated with copper from a cyanide bath in a horizontal barrel operated for 2 hrs. at 12 v. with a current of 100 amp., showed that the efficiency was only about 20%. The efficiency of a nickel-plating barrel using a nickel sulphate electrolyte under similar conditions was found to be about 38.5%.—A. R. P.

**Galvanoplastics.** V. P. Sacchi (*Industria meccanica*, 1934, 16, 808–811, 885–888; *C. Abs.*, 1935, 29, 1718).—Methods of metal deposition, chemical composition of electrolytes, effect of variations in composition, and general practice are reviewed.—S. G.

## VII.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

(Continued from p. 169.)

**\*Investigation on the Electrolytic Growth of Metal Crystals. I.—Growth of Silver Crystals in Aqueous Solutions.** T. Erdey-Grúz (*Z. physikal. Chem.*, 1935, [A], 172, 157–187).—The conditions under which cast spherical single crystals of silver can be grown by electrolysis in aqueous solutions to develop regularly definite crystal faces have been determined. Solutions of single silver salts are unsuitable, but in most complex salt solutions the faces of the single crystals can be grown with current densities of  $10^{-5}$ – $10^{-4}$  amp./cm.<sup>2</sup>. The components of the solution, independent of their concentration and the current density, determine which faces will develop on the

growing crystal; thus the faces which develop in various electrolytes are as follows: (1) silver iodide in potassium iodide solution {100}, {211}, {521}; (2) silver bromide in potassium bromide solution {111}, {720}, {211}; (3) silver bromide in ammonium bromide solution {111}, {310}; (4) silver bromide in aqueous ammonia {111}, {720}, {110}; (5) silver chloride in ammonium chloride solution {111}, {510}; (6) silver chloride in magnesium chloride solution {111}, {100}, {310}, {211}; (7) silver chloride in aqueous ammonia {111}, {100}, {110}; (8) silver oxide in aqueous ammonia {100}, {111}; (9) silver cyanide in potassium cyanide solution {111}, {110}, {100}, {hkO}. The results are compared with the Kossel-Stranski growth theory, and the deviations (development of some faces not predicted by the theory and the failure of certain theoretical faces to appear) are explained by adsorption of certain molecules and ions of the electrolyte. To determine the partial processes which determine the rate of metal deposition in solutions in which regular growth occurs, current-potential curves have been constructed; these are of 3 types: (a)  $\log I \sim 1/\eta$  in solutions 1 and 8, (b)  $\log I \sim \eta$  in solutions 2, 5, and 9, and (c)  $I \sim \eta$  in solutions 4, 7, and 9. ( $I$  = current density,  $\eta$  = overvoltage.) In (a) the frequency of nuclei formation determines the rate of growth, in (b) the discharge of the ions, and in (c) the rate of supply of ions to the growing surfaces.—B. Bl.

**The First Achievement of Obtaining Silumin Alloys and Drawing Up a Technical Flowsheet of Production of These Alloys at the Dnieper Aluminium Works.** V. N. Verigin (*Legkie Metalli (Light Metals)*, 1934, (10), 1-9).—[In Russian.] The development and early stages of industrial production of Silumin at the Dnieper Aluminium Works are described. The alloy is produced in 2 stages: (a) by smelting in an arc furnace a mixture of quartz, kaolin, and charcoal to obtain an aluminium alloy with 70-75% silicon (power consumption 16-22 kw.-hr., electrode consumption 0.24 ton per ton of alloy), and (b) by adding this alloy to the cryolite bath used for the production of pure aluminium or to the correct amount of molten aluminium in a Gautschbrandt furnace.—D. N. S.

**\*A Large-Scale Laboratory Experiment for Obtaining Metallic Calcium.** Z. V. Vasiliev, V. P. Mashovets, B. V. Popov, and A. J. Tayts (*Legkie Metalli (Light Metals)*, 1934, (10), 28-34).—[In Russian.] Electrolysis of molten calcium chloride at 820°-850° C. in an externally heated cell, with a submerged cathode using current at 12 v., affords metallic calcium with a current efficiency of about 50% and an energy consumption of 20-30 kw.-hr. per kg.—D. N. S.

**The New Chromium Electrolyte.** K. Altmannberger (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, 40-42).—An electrolyte containing 50 grm./litre of green chromium chloride is suggested. The  $p_{\text{H}}$  value is maintained at about 5. A cathode efficiency of 85-95% is predicted.—W. A. C. N.

†**A Review of the Electrochemistry of Gallium.** H. C. Fogg (*Trans. Electrochem. Soc.*, 1934, 66, 107-115).—See *Met. Abs.*, 1934, 1, 509.—S. G.

**\*Electrolytic Production of Tungsten Metal from a Fused Phosphate Bath.** Shoo-Tze Leo and Tsing-Nang Shen (*Trans. Electrochem. Soc.*, 1934, 66, 461-469).—See *Met. Abs.*, 1934, 1, 509.—S. G.

**\*The Electrolysis of Rare Earth Metal Salts in Non-Aqueous Solvents.** B. S. Hopkins and L. F. Audrieth (*Trans. Electrochem. Soc.*, 1934, 66, 135-142).—See *Met. Abs.*, 1934, 1, 509.—S. G.

**\*The Normal Potential of Beryllium.** Frederick H. Getman (*Trans. Electrochem. Soc.*, 1934, 66, 143-152).—See *Met. Abs.*, 1934, 1, 508.—S. G.

**\*On the Electrochemistry of Magnesium.—II.** Sven Bodfors and Harald Kajmer (*Z. physikal. Chem.*, 1934, [A], 171, 190-198).—The electrolytic potential of magnesium of various degrees of purity has been determined in acid solutions of various normalities buffered with 0.1N-magnesium sulphate and 0.1N-sodium salt of the various acids; no definite relation was found

between the potential and the degree of purity. The  $p_{H^+}$  anion, and stirring effects previously noted were confirmed. The effect of additions of fluorides, ammonium salts, and pyrocatechol on the potential has been determined. The rate of dissolution of the metal in the buffered solutions is at a sufficiently high concentration of the dissolving agent exactly proportional to the time, and to the acid content, but is nearly independent of the ratio acid : salt; it increases with the nature of the acid in the following order: citric, malonic, succinic, acetic, formic; oxalic acid behaves differently to any member of this series.—B. Bl.

**\*Potentiometric Studies of Passivity.** John Steiner and Louis Kahlenberg (*Trans. Electrochem. Soc.*, 1934, **66**, 205–212; discussion, 212).—See *Met. Abs.*, 1934, **1**, 452.—S. G.

**\*Theory of Overvoltage and Common Discharge of Ions.** O. Essin (*Z. physikal. Chem.*, 1934, [A], **171**, 341–347).—Based on the overvoltage theory of Volmer, an equation has been derived for the current distribution between different ions discharged simultaneously at the cathode in reversible and irreversible electrolysis. The equation is compared with the results of E.'s researches on the simultaneous discharge of cadmium and hydrogen ions and with the results of others for zinc and copper ions, zinc and hydrogen ions, nickel and hydrogen ions, mercuric and mercurous ions.—B. Bl.

**†The Delayed Discharge of Ions as Cause of Hydrogen Overvoltage or Generally of Cathodic Polarization.** A. Smits (*Z. physikal. Chem.*, 1935, [A], **172**, 470–472).—To prevent misunderstandings in the literature it is pointed out that the theory of electromotive equilibrium of S. leads to the conclusion that hydrogen overvoltage must be ascribed to the slow discharge of hydrogen ions and that cathodic polarization is, in general, caused by the retardation of the ionic discharge. Hydrogen overvoltage is, therefore, only a special case of the phenomenon of cathodic polarization. The theory explains in a similar manner the primary process of anodic polarization.—B. Bl.

**The Definition of Polarization, Overvoltage, and Decomposition Potential.** W. Blum and G. W. Vinal (*Trans. Electrochem. Soc.*, 1934, **66**, 359–366; discussion, 367).—See *Met. Abs.*, 1934, **1**, 452.—S. G.

**\*Investigations on Hydrogen Electrodes.** M. Volmer and H. Wick (*Z. physikal. Chem.*, 1935, [A], **172**, 429–447).—Measurements have been made of the course of hydrogen deposition and dissolution at iridium, platinum and copper electrodes in carefully purified electrolytes. The current–potential curves in the neighbourhood of the equilibrium potential are linear in agreement with the discharge theory of overvoltage. The subsequent course of the anodic curves, however, deviates from the simple logarithmic relation; this is investigated and discussed with relation to the change in the activity of the electrode and its dependence on various factors, and the effect of poisoning the electrode surface with arsenic on the evolution of hydrogen is investigated. This effect is threefold, the activation threshold of the discharge is increased and displaced into the double layer, and a retardation of the rate of recombination of the hydrogen atoms is probable although it has not been detected with certainty.—B. Bl.

**\*Cathodic Polarization of Metal Electrodes.** I. Zlotowski (*Bull. Acad. Polonaise Sci.*, 1934, **3–4A**, 115–160; *Sci. Abs.*, 1935, [A], **38**, 212).—[In English.] An instrument was devised for the periodic and continual renewal of solid metal electrodes, and a polarograph for the study of cathodic polarization of solid metal electrodes was elaborated. By means of these devices, overpotentials of zinc, cadmium, and lead, and the current–voltage curves due to electrodeposition of hydrogen on renewed and non-renewed metallic electrodes were investigated.—S. G.

**\*The Cathodic Film in the Electrolysis of Solutions Containing the Bichromate Ion.** Erich Müller and Wilhelm Stein (*Z. physikal. Chem.*, 1935, [A], **172**, 348–352).—Gold and platinum on cathodic polarization, and the

base metals on simple immersion in bichromate solutions become covered with an invisible film, the presence of which can be proved by the fact that it prevents adherence of a silver deposit when the metal is made the cathode in a silver cyanide bath.—B. Bl.

### VIII.—REFINING

(Continued from p. 106.)

**\*Thermodynamic Data on Some Metallurgically Important Compounds of Lead and the Antimony Group Metals and Their Applications.** Chas. G. Maier (*U.S. Bur. Mines, Rep. Invest. No. 3262, 1934, 54 pp.*).—Thermodynamic data on lead, arsenic, antimony, and bismuth are tabulated and discussed, and their application to lead softening processes is described at some length. From theoretical considerations it is shown that the antimony may be removed from a low antimony-lead alloy by melting it with a slag of basic lead antimonite containing 43.4–65% of lead oxide; the resulting lead antimonite slag is used for the removal of antimony from a high antimony-lead alloy under such conditions that antimony tetroxide is volatilized and a lead alloy suitable for the first stage of the process is produced.—A. R. P.

### IX.—ANALYSIS

(Continued from pp. 169–172.)

**\*Spectrum Analysis as a Device for Testing and Specifying Materials.** Walther Gerlach (*Z. tech. Physik, 1934, 15, 451–453*).—The application of the interrupted arc discharge to the quantitative analysis of metals and alloys is described and exemplified. Many very pure metals, more especially the refractory metals, contain Ca, which is readily determined by using a small sample. Other examples given are: the distribution of Fe in Au–Ag alloys, and the presence of V in bituminous schists.—J. S. G. T.

**\*Investigation of Materials by Means of Flame [Spectral] Analysis.** F. Waibel (*Z. tech. Physik, 1934, 15, 454–456*).—The desirable technique of flame spectrum analysis, its advantages over arc spectrum analysis, and its application to chemical and metallographic analysis are briefly discussed. The following limiting concentrations are determinable by flame spectrum analysis: 1/100,000 mol., Li, Na, K, Rb, Cs, Ca, Sr, Tl, Mn, Cu, Ag; 1/10,000 mol., Cr, Fe, Co, Ni; 1/1000 mol., Ba, Er, Mg, Pd, Pr, Pb, Ra, Y; 1/100 mol., Au, Cd, Nd.—J. S. G. T.

**\*A Simple Method of Analyzing Gases for Technical Gas Research.** Hellmuth Schwiedessen and Günther Barth (*Arch. Eisenhüttenwesen, 1934–1935, 8, 15–20*).—In the analysis of flue gases from industrial furnaces, *i.e.* gases which contain not more than traces of hydrocarbons, carbon monoxide is often reported although its presence is highly improbable. This error is due to incomplete absorption of O<sub>2</sub> by the usual reagents, and to its subsequent absorption by the Cu<sub>2</sub>Cl<sub>2</sub> reagent. A better procedure consists in mixing the gases with a definite volume of air, absorbing the CO<sub>2</sub> with KOH, burning the combustible gases over a Pt spiral, again absorbing the CO<sub>2</sub> with KOH, adding a definite volume of H<sub>2</sub> and exploding the mixture to obtain the O<sub>2</sub>. Descriptions of the necessary apparatus and of the method of calculating the results are given and a modified procedure for the analysis of fresh gas for firing the furnace is described.—A. R. P.

**\*Contribution to Our Knowledge of the Thermal Reduction of Alumina and Magnesia with Carbon in the Electric Arc Furnace [Analysis of Aluminium and Magnesium Containing Carbides].** Josef Hartnagel (*Dissertation: Tech. Hochschule Zurich, 1934, 56 pp.*).—Carbide occurs in electrothermal aluminium

as  $Al_4C_3$  and in electrothermal magnesium as  $MgC_2$ ; in the first case treatment with acids results in the formation of  $CH_4$ , and in the second case of  $C_2H_2$ ,  $H_2$  equivalent to the free metal present being evolved in both cases. After measuring the total gas evolved the  $C_2H_2$  is absorbed in a 20% solution of  $Hg(CN)_2$  in 2*N*- $NaOH$ , the  $H_2$  is oxidized to  $H_2O$  by passage over  $CuO$  at  $300^\circ C.$  and the  $CH_4$  then burnt to  $CO_2$  and  $H_2O$  by passage over  $CuO$  at  $300^\circ C.$ —A. R. P.

**\*Systematic Analysis of Ferro-Aluminium Alloys by Means of 8-Hydroxyquinoline.** S. L. Zinberg (*Zavodskaya Lab.*, 1933, 2, (6), 13-17; *C. Abs.*, 1935, 29, 70).—[In Russian.] Directions are given for determining  $Cu$ ,  $Al$ ,  $Ti$ , and  $Mg$  with the aid of "oxine."—S. G.

**\*Analysis of Gold-Palladium-Silver Alloys.** Gotthard E. Lenk (*Metall u. Erz.*, 1935, 32, 95-98).—Alloys with less than 31%  $Au$  can be parted directly in  $HNO_3$  (*d* 1.3). The solution containing  $Ag$  and  $Pd$  should be diluted to 400-900 c.c. according to the  $Pd$  content before precipitating the  $Ag$  with  $HCl$ ; after precipitation, the solution should contain 1%  $HCl$  to reduce the solubility of the  $AgCl$  to a minimum. The  $Pd$  in the filtrate from the  $AgCl$  is precipitated with dimethylglyoxime, and the filtrate from this process is used for the determination of  $Ni$  and  $Cu$  if these are present.—A. R. P.

**Analysis of Refined Osmium.** B. G. Karpov, S. E. Krasikov, and A. N. Fedorova (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 159-162).—[In Russian.] The metal (10-15 gm.) is heated in  $O_2$  for 2 hrs. to volatilize the  $Os$  as  $OsO_4$ , which is collected and analyzed as usual. The residue is extracted with hot 1 : 3  $HCl$  and the solution analyzed for  $Fe$  and  $Ba$  and the insoluble material for  $SiO_2$  by the  $HF$  method. The residue from the  $HF$  treatment is fused with  $K_2S_2O_7$  to dissolve the last traces of  $Fe$  and  $Rh$ ; the  $Rh$  is separated from the solution by  $H_2S$ , and the  $Fe$  by  $NH_4OH$ . Any insoluble from the fusion is fused with  $NaOH$ , whereby  $Ru$  dissolves leaving a residue containing  $Ba$  and other  $Pt$  metals.—N. A.

**Analysis of Melted Platinum.** B. G. Karpov and A. N. Fedorova (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 163-167).—[In Russian.] A method for the determination of  $Ir$ ,  $Rh$ ,  $Pd$ , and  $Fe$  in  $Pt$  containing less than 0.3% of impurity is described.—N. A.

**\*Contribution to the Systematic Quantitative Spectrographic Analysis of Elements. Investigations on Tin and Lead.** Hans Schubert and Kurt Cruse (*Z. physikal. Chem.*, 1935, [A], 172, 143-155).—Examination of the spark spectrographs of 40 lead-tin alloys of various compositions has shown that no proportionality exists between the intensity of the light emitted and the number of atoms of the excited metal present. The photographs of the spectra were made with an intermediate rotating logarithmic sector. The curves showing the rise in intensity of single lines with the concentration of the metal are discussed theoretically. Very pure tin (with a lead content of less than 0.00057 atomic-%) has been prepared by electrolysis of the compound of stannic chloride with propionitrile ( $SnCl_4 \cdot 2C_2H_5 \cdot CN$ ).—B. Bl.

**\*The Electroanalysis of Zinc in the Presence of Iron.** Robert Weiner (*Z. Elektrochem.*, 1935, 41, 153-158).—The electroanalysis of zinc in the presence of different amounts of  $Fe$  was investigated by deposition from the usual electrolytes and with different cathodes. Dilute acids ( $H_2SO_4$  and organic acids) and simple and complex alkaline solutions, especially those containing cyanide, were tried as electrolytes, and  $Cu$ - or  $Ag$ -plated  $Pt$  or amalgamated brass grids as cathodes. Analysis of the cathodically deposited  $Zn$  showed, in nearly all cases, the presence of co-precipitated  $Fe$  which, especially on  $Hg$  electrodes and in acid solutions, often occurred quantitatively. The amount of iron deposited was least in cyanide solutions. Acid and simple alkaline solutions were quite unsuitable for the electroanalytical separation of  $Zn$  and  $Fe$ . A consideration of all the factors involved showed

that no unobjectionable results can be obtained by this analytical method, successful results being mostly due to the mutual compensation of different errors.—J. H. W.

**\*Rapid Analysis of Zinc Alloys.** A. Milovidova and Z. Glazunova (*Zavodskaya Lab.*, 1934, 3, 369; *C. Abs.*, 1935, 29, 1744).—[In Russian.] Digest the weighed sample with 4.5*N*-H<sub>2</sub>SO<sub>4</sub>. Filter off the undissolved Pb and Cu, dissolve the residue in 50% HNO<sub>3</sub> and electrolyze for PbO<sub>2</sub> and Cu. Add NH<sub>4</sub>Cl and an excess of NH<sub>4</sub>OH to the H<sub>2</sub>SO<sub>4</sub> solution, filter off the Fe and Al precipitate and wash with 5% NH<sub>3</sub> solution. Dissolve this precipitate in acid and repeat the precipitation with NH<sub>4</sub>OH. In the combined, ammoniacal filtrate determine Zn by electrolysis. Evaporate the electrolyzed solution to expel NH<sub>3</sub>, filter off a little Al(OH)<sub>3</sub> and add to the main precipitate obtained previously. Determine Mg in the filtrate in the usual way.—S. G.

**†A Critical Study of Cacotheline for the Detection of Tin.** J. Laird Newell, Joseph B. Ficklen, and Lewis S. Maxfield (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1935, 7, 26-27).—The cacotheline test for Sn<sup>++</sup> is interfered with by metals which give coloured solutions and by the presence of substances which oxidize or otherwise react with the Sn<sup>++</sup>; powerful reducing agents also interfere by producing a similar coloration. The test will detect 1-2 p.p.m. of Sn<sup>++</sup> in the presence of dilute HCl, and hence may prove useful in corrosion tests on tinplate, &c.—A. R. P.

**\*The Quantitative Separation of Metals by Hydrogen Sulphide. VII.—Separation of Zinc from Chromium and a New Method of Separating Chromium from Nickel, Cobalt, and Iron.** Hisaji Katō (*Nippon Kwagaku Kwai Shi (J. Chem. Soc. Japan)*, 1934, 55, 1152-1155; *C. Abs.*, 1935, 29, 1029).—[In Japanese.] At  $p_H$  2.3-4.0, Zn is precipitated as ZnS by means of H<sub>2</sub>S while Cr remains in solution. Make the  $p_H$  of the solution, containing Ni, Co, Fe, and Cr, 5 by means of the buffer consisting of AcOH and AcONa, then introduce H<sub>2</sub>S. Ni, Co, and Fe precipitate as sulphides, while Cr remains in solution.—S. G.

**\*The Importance of Hydrogen-Ion Concentration for the Estimation and Separation of Metals by Anthranilic Acid.** Hidehiro Gotō (*Nippon Kwagaku Kwai Shi (J. Chem. Soc. Japan)*, 1934, 55, 1156-1163; *C. Abs.*, 1935, 29, 1029).—[In Japanese.] The precipitation of Zn, Cd, Ni, Co, Mn, and Cu by means of anthranilic acid from the buffer solution consisting of AcOH and AcONa was studied, and the  $p_H$  range for precipitation was determined. The minimum  $p_H$  for complete precipitation and the maximum  $p_H$  at which no precipitation takes place are, respectively, for Zn, 4.72, 3.76; Cd 5.23, 4.25; Ni 4.51, 3.64; Co 4.41, 3.36; Mn 5.15, 4.10; Cu 2.79, 1.40. Thus it is possible to precipitate Cu alone from a solution containing the above metals.—S. G.

**\*Approximate Determination of Aluminium by the Drop Method.** A. M. Shapovalenko (*Zavodskaya Lab.*, 1933, 2, (6), 17-18; *C. Abs.*, 1935, 29, 72).—[In Russian.] The difficulties of determination of Al by the spot method in the presence of other cations is partly overcome by the following procedure: Make the solution (tested and standard) alkaline to litmus with NaOH, place 0.002 c.c. on thin filter paper, cover with a drop of saturated solution of NH<sub>4</sub>SCN mixed with 3 parts of Ba(NO<sub>3</sub>)<sub>2</sub>, allow to stand 5-10 seconds, add 1 drop of alcoholic alizarin, heat over an alcohol lamp to the appearance of red colour, wash off the yellow excess of alizarin with alcohol and compare the colour with that produced by known quantities of Al.—S. G.

**\*Rapid Determination of Boric Acid in Nickel-Plating Baths.** R. S. Ashel<sup>†</sup> rod and M. L. Erukhimova (*Zavodskaya Lab.*, 1934, 3, 121-122; *C. Abs.*, 1935, 29, 79).—[In Russian.] Concentrate on a water-bath 10-22 c.c. of Ni bath liquor, add dropwise with stirring 40-60 c.c. 95° alcohol, cool, filter from inorganic salts, wash with alcohol, add to the filtrate an excess of 20% NaOH (up to 10 c.c.), evaporate to dryness, heat over a small flame to expel

$\text{NH}_3$  and decompose any organic matter (e.g. citric acid), dissolve the residue in water, filter, make acid to methyl orange with  $\text{HCl}$ , boil to expel any absorbed  $\text{CO}_2$ , dilute to about 100 c.c., neutralize to a pink tint with methyl orange, add 20 c.c. of previously neutralized glycerol or some mannitol with 0.1N-NaOH against phenolphthalein.—S. G.

**\*Determination of Lead and Bismuth in Cupelled Silver.** Franklin G. Hills (*Canad. Chem. Met.*, 1935, 19, 80).—The  $\text{HNO}_3$  solution of the metal is treated with  $\text{NH}_4\text{OH}$  until nearly neutral, then with  $\text{Na}_2\text{CO}_3$  until the Ag, Bi, and Pb are precipitated as carbonates; on cautious addition of KCN the  $\text{Ag}_2\text{CO}_3$  dissolves leaving a residue of basic Pb and Bi carbonates which is collected, washed free from Ag, and redissolved in  $\text{HNO}_3$ . The solution is evaporated with  $\text{H}_2\text{SO}_4$  until fumes are evolved and the cold solution is mixed with 50 c.c. of  $\text{C}_2\text{H}_5\text{OH}$ ; next day the  $\text{PbSO}_4$  is collected, washed with  $\text{C}_2\text{H}_5\text{OH}$  and redissolved in  $\text{CH}_3\cdot\text{CO}_2\text{Na}$  solution, the solution is made alkaline with 5% NaOH, any  $\text{Bi}(\text{OH})_3$  removed, and the Pb determined colorimetrically with  $\text{H}_2\text{S}$  or volumetrically as  $\text{PbCrO}_4$ . The Bi determination is made by the usual  $\text{NHOH}-(\text{NH}_4)_2\text{CO}_3$  method or colorimetrically.—A. R. P.

**Microdetermination of Lead, Electrolytic-Colorimetric Method.** Merle Randall and Marian N. Sarquis (*Indust. and Eng. Chem. (Analyt. Edn.)*, 1935, 7, 2-3).—Small quantities of Pb (2-15 mg.) may be accurately determined by electrolysis of the nitrate-sulphate solution for 12-18 hrs. using a Pt gauze anode and then determining the Pb remaining in solution by the colorimetric sulphide method after addition of  $\text{NH}_4\text{OH}$  and NaCN. About 95-99% of the Pb is deposited as  $\text{PbO}_2$  on the anode in the electrolysis. The original must be consulted for full details of the procedure.—A. R. P.

**\*The Qualitative and Quantitative Determination of Lithium, Rubidium, and Cæsium by the Spectrum Method.** U. M. Tolmachev (*Dokladi Akademii Nauk S.S.S.R. (Compt. rend. Acad. Sci. U.R.S.S.)*, 1934, 1, (8), 464-470).—[In Russian and German.] The qualitative and quantitative determination of Li, Rb, and Cs is best carried out with the intensive components of the first doublets of the main series. A higher sensitivity of the determination is attained by using neocyanine as a sensitizer, than by working with the secondary doublets. With this method the lines Rb 7800.3, Cs 8521.1, and Li 6707.8 disappear last, with diminishing concentration.—N. A.

**Microchemical Determination of Magnesium.** Alfredo Quartaroli (*Annali chim. applicata*, 1934, 24, 383-390; *C. Abs.*, 1935, 29, 74).—In the presence of Mg,  $\text{Cu}(\text{OH})_2$  precipitated by addition of NaOH to  $\text{CuSO}_4$  solution will not darken except on prolonged standing. The principal of negative catalysis has been applied to the microdetermination of Mg. Ca has a similar action, but to a much smaller degree. To avoid the need for removing any Ca present, Q. adds a known amount which is so large compared to that which may be present with the Mg, that the latter has little effect. Prepare a solution of  $\text{CaCl}_2$  by dissolving 10 grm. of  $\text{CaCO}_3$  in  $\text{HCl}$ , diluting to 250 c.c. and finally diluting 20 c.c. of this solution to 250 c.c. Place 1 c.c. of this last solution in a graduated tube, add the Mg solution, and dilute to 15 c.c.; add 0.75 c.c. of a 2%  $\text{CuSO}_4$  solution and shake. Heat to  $50^\circ\text{C}$ ., and add 0.75 c.c. of 20% NaOH solution and continue heating. In the blank with  $\text{CaCl}_2$  alone the  $\text{Cu}(\text{OH})_2$  begins to darken in 3-6 minutes; with no  $\text{CaCl}_2$  the change is instantaneous. When 12  $\gamma$  or more parts of Mg are present, the  $\text{Cu}(\text{OH})_2$  remains unchanged during the 30 minutes. With 11  $\gamma$  the precipitate begins to show darkening, while at 10  $\gamma$  the character is distinct. Even at 1  $\gamma$  the change can be seen if the solution is only shaken 10 minutes. Reading the volume of precipitate is a rough check on the determination, as in the blank the volume is 0.8-1 c.c., while with 11  $\gamma$  Mg the volume is only 0.3-0.4 c.c.—S. G.

**Potentiometric Titration of Platinum and Iridium.** A. A. Grinberg and B. V. Ptizin (*Izvestia Platinogo Instituta (Ann. Inst. Platine)*, 1935, (12), 133–158).—[In Russian.] Methods are described for the determination of Pt<sup>++</sup>, Pt<sup>+++</sup>, Ir<sup>+++</sup>, and Ir<sup>++++</sup> alone and in admixture with one another and with other precious metals.—N. A.

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

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

(Continued from pp. 172–173.)

**\*A Tube Generator for Induction Heating.** W. Fischer (*Elektrowärme*, 1934, 4, 269–273; *C. Abs.*, 1935, 29, 1715).—Principle and arrangement are described of a high-frequency generator of the electron-tube type for more than 10,000 cycles/second, which was developed for laboratory melting of metals in small quantities where the usually accepted frequencies are too low. With the tube the frequency can be adjusted within very wide limits by the capacity and induction of the circuit. An apparatus for 3.5–4.5 kw. with a crucible of 40 c.c. has an efficiency of 90–95% with a pure graphite crucible, for iron in the magnetic state 80–85%, while for metals of good conductivity it is only 25–35%. The highest temperatures can be produced with graphite and similar materials; the limit depends mainly on the heat insulation. A solid graphite cylinder of 20 mm. diameter could be heated to 2300° C. within a few minutes at a frequency of about 100,000 cycles/second. Current and voltage curves are shown.—S. G.

†**Microphotography with Long-Wave Light.** G. G. Reinert (*Z. wiss. Mikroskopie*, 1934, 51, 344–352).—To-day the spectral region available for photographic purposes extends from 2100 to 9500 Å. Plates, filters, and illuminating apparatus for long-wave infra-red photography are described, and the resolving power of objectives for this work is discussed. Infra-red photography is useful for the examination of thin metallic coating of glass and for the detection of silver selenide in silver.—B. Bl.

**Panphot, a New Microscopic and Photomicrographic Instrument.** H. Freund (*Z. wiss. Mikroskopie*, 1934, 51, 441–446).—The apparatus comprises a vertical universal microscope for reflected, transmitted, and polarized light, mounted on a heavy stand carrying the stage and surmounted by a camera.—B. Bl.

**Toolmakers' Microscope.** — (*J. Sci. Instruments*, 1935, 12, 96).—A note describing an instrument for the measurement and examination of screwed components, form gauges, taps, &c. It can be fitted with a projection attachment, which enables the work to be projected against a drawing.—W. H. R.

**\*A Magnetic Dilatometer.** T. C. Richards (*Iron Steel Ind.*, 1935, 8, 261–264).—A new form of expansion apparatus, incorporating a pendulum and a magnetic system, is described. The specimen, in the form of a rod  $\frac{1}{2}$  in. in length, is situated at the closed end of a silica tube in the uniform temperature zone of a cylindrical electric furnace. Expansion is communicated by means of a silica tube to the pendulum, and the magnified movement at the lower end of the pendulum is considerably further magnified by the magnetic system. The principle involved is that lateral displacement of an iron element in a curved magnetic field results in considerable rotation. Visual or photographic observations are made with a lamp and scale, and a correction is made for unwanted expansions. The apparatus is particularly suitable for investigating the anomalies which exist in the expansion of metals and alloys.—J. W. D.

**A Simple Camera for X-Ray Structural Analysis of Large Crystalline Material.** E. Schwarz (*Physikal. Z. Sowjetunion*, 1934, 5, 443–445).—[In



German.] A simple form of X-ray camera is described in which the crystal can be readily rotated while remaining throughout on the axis of the cylindrical photographic film.—J. S. G. T.

\***A Camera for Electron Diffraction.** J. A. Darbyshire and E. R. Cooper (*J. Sci. Instruments*, 1935, 12, 10-14).—Full details are given of a camera suitable for a wide range of experiments on electron diffraction.—W. H.-R.

\***A New Type of Self-Registering Microphotometer.** L. A. Woodward (*J. Sci. Instruments*, 1935, 12, 17-22).—W. H.-R.

\***A Non-Recording Photoelectric Microphotometer.** — ( *J. Sci. Instruments*, 1935, 12, 27-28).—W. H.-R.

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

(Continued from pp. 173-175.)

**New Testing Machines and Apparatus.** W. Fleischhauer (*Anz. Masch.*, 1935, 57, (17), 98-105).—The following are briefly described: static and dynamic universal tensile machines, dynamic bending and torsion machines, wear testing machines, apparatus for the visual examination of metals with X-rays.—B. Bl.

**The Testing of Castings.** Francis W. Rowe (*Metallurgia*, 1935, 11, 163-164).—A discussion of the relative merits and demerits of the cast-on or loose test-bar in assessing the uniformity of a casting either for commercial or research purposes. The regular examination of the physical properties of pieces cut out of the actual casting is to be preferred to either method, and gives more information regarding the source and situation of weaknesses, and the effect of variations in mass, design, and moulding practice.—J. W. D.

**Problems of Fine Working [Calculation of Surface Roughness of Metals].** G. Ströer (*Anz. Masch.*, 1935, 57, (17), 112-114).—Formulae for calculating the surface roughness of metals are given and 2 microscopes for the comparison of worked surfaces with standards are described.—B. Bl.

\***The Beginning of Plastic Flow and Its Dependence upon Stress Distribution and the Nature of the Material.** Erich Siebel and Heinz Friedrich Vieregge (*Mitt. Inst. Eisenforschung*, 1934, 16, 225-239).—Tensile, bending, and torsion tests were carried out on ferrous alloys in order to investigate the effect of experimental conditions and non-uniformity of load on the point at which plastic flow begins. Tests in which tubes were submitted to external hydraulic pressure are also described.—W. H.-R.

†**The Measurement of Stress by Means of Optical Double Refraction.** Ludwig Föppl (*Z. tech. Physik*, 1934, 15, 430-436).—The determination of stresses in materials by means of optical double refraction is discussed and illustrated.—J. S. G. T.

**The Measurement of Internal Stresses in Tubes.** H. Gerdien (*Z. tech. Physik*, 1934, 15, 481-483).—Describes a testing machine comprising a steel sphere supported on a horizontal axis and capable of being rolled on the inner surface of tubes, whereby the internal diameter of the latter can be determined. An accuracy of the order 1 part in 100,000 is attainable.—J. S. G. T.

\***Indication and Measurement of the Absorption of Energy in Materials.** W. Späth (*Z. tech. Physik*, 1934, 15, 477-481).—Apparatus for the indication, measurement, and recording of the energy loss in materials subjected to a periodically varying torsional deformation is described.—J. S. G. T.

**The Interpretation of Creep Tests.** P. G. McVetty (*Proc. Amer. Soc. Test. Mat.*, 1934, 34, (II), 105-116; discussion, 117-122).—See *Met. Abs.*, 1934, 1, 455.—S. G.

**Creep Testing of Metals.** Elbert S. Rowland (*Mineral Ind., Pennsylvania State Coll.*, 1934, 3, (7), 4).—See also *Met. Abs.*, 1934, 1, 615. Conclusion of a discussion.—S. G.

**\*Testing of Welded Aluminium Tyres.** L. N. Milanov (*Legkie Metalli (Light Metals)*, 1934, (10), 23–26).—[In Russian.] The electrical resistance of welded aluminium tyres is only 3–4% greater than that of similar seamless tyres, and the temperature increase caused by passage of a current through them is identical.—D. N. S.

**The Notched-Bar Impact Test.** J. H. Lavery (*Commonwealth Eng.*, 1934, 22, 139–147).—The dimensions of the standard notch form (Charpy—small and large, Mesnager, British standard, U.S. Bureau of Aircraft, and Frémont) and the types and actions of the various machines used in the notched-bar impact test are described. The most recent machine, the Oxford pendulum, has the two advantages of avoiding transference of energy to earth and a less complicated method of loading the specimen. The mechanism of failure and the application of the Izod test to welds are discussed.—J. H. W.

**\*A New Surface Extensometer.** T. W. K. Clarke (*J. Sci. Instruments*, 1935, 12, 84–91).—Describes the details of construction of a surface extensometer capable of measuring surface extension to about one millionth of an inch over a range of 0.0014 in. on a gauge-length of 0.2 in. The instrument is designed for measuring stresses in plate work under conditions where the gauge-length must be small. Experiments on the coeff. of friction of Duralumin using rounded and polished needle points indicated curious effects due to the thin film of hydroxide which is rapidly formed on a newly cut surface. If the steel and Duralumin are clean, and are brought together under a pressure sufficient to crush the Duralumin, they weld together to a certain extent, and the Duralumin adheres very firmly to the needle point, but normally the hydroxide coating prevents this welding.—W. H. R.

**\*The Determination of the Tensile Strength of Electric Overhead-Lines on the Basis of Tension Diagram.** Béla Prause (*Elektrotech. Z.*, 1935, 56, 201–203).—A graphical method for determining the dimensions of overhead electrical conductors subject to high overloads is described based on the tension-elongation curve of the material of the wire.—B. Bl.

**\*Comparison of Brinell and Scratch Hardness.** Erich Scheil and Willi Tonn (*Arch. Eisenhüttenwesen*, 1934–1935, 8, 259–262).—If the Martens scratch hardness numbers are plotted against the Brinell hardness numbers for pure metals and homogeneous alloys (solid solutions) the resulting curve is slightly convex to the Brinell axis. The scratch hardness of heterogeneous alloys depends on the nature and distribution of the constituents and, unlike the Brinell hardness, is unaffected by deformation, precipitation-hardening, or a martensitic structure.—A. R. P.

**\*Magnetic Methods of Testing Materials.** Walther Gerlach (*Z. tech. Physik*, 1934, 15, 467–469).—In a region of inhomogeneity of a ferromagnetic material the magnetic induction differs from its value at normal parts of the material. A method for determining the variation of field strength along a test-piece is described. For non-ferromagnetic materials a method based upon the detection of eddy currents is proposed.—J. S. G. T.

#### RADIOLOGY

**X-Ray Examination of Materials.** Franz Wever (*Anz. Masch.*, 1935, 57, (17), 96–97).—The use of X-rays in works practice is briefly outlined.—B. Bl.

†**The X-Ray Inspection of Magnesium Castings.** N. C. Hypher (*Metallurgia*, 1935, 11, 151–153).—Owing to the ease of penetration of magnesium castings by the X-rays and to the difficulty of obtaining good contrast, low voltages have to be used and fluorescent screens dispensed with. Radiographic examination is also to be preferred to visual examination. Inter-crystalline

porosity, common to magnesium castings, is not revealed by ordinary X-ray methods, and castings are subjected under pressure to a special radio-opaque substance of great X-ray density, which passes through the casting, gets trapped in the spongy metal, and shows up readily on X-ray examination. Radiographs of various aeronautical and automobile castings before and after impregnation are shown.—J. W. D.

**\*X-Ray Measurement of Depth of Cold-Work.** Charles S. Barrett (*Phys. Rev.*, 1935, [ii], 47, 338).—Abstract of a paper read before the American Physical Society. Spots on Debye rings from a metal lose distinctness when the metal is cold-worked. The depth of a cold-worked layer on the surface of a metal may be determined by a series of photograms using non-penetrating X-rays. Each photogram is made with a different thickness of metal removed from the surface by etching. The method is direct and sensitive. It finds a practical application in the recently developed technique of surface cold-rolling of shafts to increase their endurance to alternating stresses. A fatigue specimen of axle steel (0.42% carbon), whose surface was cold-worked by rollers of 2 in. diameter and 1.5 in. contour radius which were pressed against the specimen by a 400 lb. radial force, was studied by this method. The specimen proved to have been cold-worked to a depth of 0.055 in.  $\pm$  0.005. X-ray penetration into the specimen was negligible; reflections from (310) planes with cobalt radiation were used in a back reflection camera. R. E. Peterson, who furnished the specimen, predicted about 0.067 in. for the depth in this instance, on the basis of a stress distribution under the rolls as calculated by Thomas and Hoersch.—S. G.

**\*Practical Application of the Reflected X-Ray Method for the Measurement of Elastic Stress.** Hermann Möller (*Arch. Eisenhüttenwesen*, 1934–1935, 8, 213–217).—The method consists in causing a beam of X-rays to be reflected from the surface of the metal at a small angle and allowing the reflected interference cone to fall on a photographic film placed at right angles to the incident beam. In this way the lattice constant is measured in a direction perpendicular to the surface of the specimen. If the value for the constant obtained in this way is  $a$  and the true lattice constant is  $a_0$ , then  $(a - a_0)/a_0$  is the transverse contraction ( $\epsilon$ ) due to elastic stress in the metal. With a uniaxial longitudinal stress of  $\sigma$ ,  $\epsilon = -(\nu/E) \cdot \sigma$ , where  $\nu$  is the Poisson number and  $E$  the elastic modulus, but in the general case of a triaxial state of stress the X-ray method measures the sum of the principal stresses ( $\sigma_1 + \sigma_2$ ) at the surface of the metal and hence  $\epsilon = -(\nu/E)(\sigma_1 + \sigma_2)$ . Tests on Duralumin show that the elastic stress in a pure tensile test follows Hooke's law, but in a specimen which has been bent into a semicircle and annealed before the test the stress is of opposite sign in the inner and outer surfaces.

—A. R. P.

**\*Detection of Internal Strain by Radiographs.** Shinosuke Tanaka and Chujiro Matano (*Nippon Suugaku-Buturigakkwai Kizi (Proc. Phys.-Math. Soc. Japan)*, 1934, [iii], 16, 288–290; *Sci. Abs.*, 1934, [B], 37, 567).—[In English.] By means of radiographs of light elements which have had heavier elements cast in them, in the form of wires, the changes in shape of test-pieces which are deformed by bendings, &c., are studied.—S. G.

**\*X-Ray Diffraction and the Fatigue of Metals.** Charles S. Barrett (*Phys. Rev.*, 1935, [ii], 47, 333).—Abstract of a paper read before the American Physical Society. Some preliminary results of an extended X-ray diffraction study of the fatigue process in various alloys are as follow: The radial widening of Debye lines is relatively insensitive to changes in the metal brought about by fatigue; in fact an aluminium alloy (25 S.T.) shows no detectable widening of this type and a silicon steel shows only a minute amount although both had received more than  $10^7$  reversals of stress just below the endurance limit. On the other hand, a sensitive detector of changes

during fatigue is the peripheral widening of spots in Debye rings, or the equivalent asterism. With the unbroken steel specimen mentioned above, the spots from highly stressed areas are much broader than those from slightly stressed areas, while areas at a given stress level give similar spots. Photograms of various areas on broken surfaces of fatigue specimens vary somewhat but always exhibit extreme widening.—S. G.

†**Determination of Particle Size by X-Ray and Electron Analysis.** R. Brill (*Kolloid-Z.*, 1934, 69, 301-312).—The theory of the method is described non-mathematically. Results are given for a number of substances, including electrodeposited nickel.—E. S. H.

**A New Portable X-Ray Apparatus for Material Testing.** — (*Elektrotech. Z.*, 1935, 56, 43).—The construction and applicability of the apparatus are described.—B. Bl.

## XII.—TEMPERATURE MEASUREMENT AND CONTROL

(Continued from pp. 175-176.)

**Temperature Regulations for High Temperatures.** Johannes Förster and Erhard Gruner (*Z. Elektrochem.*, 1935, 41, 9-10).—A secondary furnace, having a resistance  $\frac{1}{10}$  of that of the main furnace, is connected in series with the main furnace. As its temperature increases above a predetermined amount, mercury is caused to rise in a capillary tube and make contact with a wire fixed to an adjustable set-screw, thereby completing a battery circuit containing an electromagnet. The magnet acts on a mercury switch and breaks a circuit containing a secondary resistance in parallel with the main resistance, and the main current is accordingly reduced. It is claimed that temperatures between 300° and 1000° C. can be maintained for one month with an accuracy of 1°-2° C.—J. H. W.

**Couples with Adjustable Thermoelectric Power: Application to the Measurement of Thermoelectric Power and to the Construction of Compensating Leads for Pyrometers.** Léon Dubar (*Rev. gén. Elect.*, 1934, 35, 809-812).—General formulæ are established for calculating the e.m.f. generated when one element of a thermocouple is constructed of wires of a number of different metals connected in parallel. Applying the results, it is shown that compensating leads, strictly equivalent in thermo-electric power to any couple, may be constructed from such multiple conductors. Exact equivalence is secured by inserting a suitable resistance in series with one of the wires of the duplex lead.—J. C. C.

\***Vacuum Tube Amplifier for Thermocouple E.m.f.** R. P. Johnson, M. E. Bell, and W. B. Nottingham (*Phys. Rev.*, 1935, [ii], 47, 426).—Abstract of a paper read before the American Physical Society. An amplifier has been developed for measuring small d.c. voltages arising in low-resistance sources such as thermopiles. The source is placed in series with a "balancing out" e.m.f., a platinum to platinum cam-driven contact, and the primary of a 1:100 ratio transformer. The contacts are closed about 90% of each revolution of the cam, during which time the current builds up in the primary circuit, thus storing "magnetic" energy in the iron of the transformer. The instant the contact opens an oscillation starts in the secondary. After  $\frac{1}{4}$  period of the oscillation practically the entire energy stored in the iron is delivered to charge the grid to filament capacity in parallel with the secondary distributed capacity. The voltage pulse delivered to the grid is practically equal to the thermal e.m.f. multiplied by the turns ratio and the ratio of the time constant ( $L_1/R_1$ ) of the primary to the  $\frac{1}{4}$  period of the secondary circuit. Thus with an initial amplification of about 8000, it has been possible to detect thermal e.m.f.'s of  $10^{-9}$  v. with reliability. In the present arrangement the pulsating current is rectified after passing through a 3-stage audio-

amplifier giving a galvanometer output of 3 mm. per  $10^{-9}$  v. in an 8 ohm primary circuit.—S. G.

\***A Precision Optical Pyrometer.** R. J. Bracey, F. A. Cunnold, and A. C. Egerton (*J. Sci. Instruments*, 1935, 12, 80-84).—Describes the details of construction of a disappearing filament pyrometer giving alternative overall magnifications of 20 and 5, and provided with monochromatic filters in the red and green, and absorption screens for the measurement of very high temperatures. By measuring the current to 0.01%, temperatures can be measured to an accuracy of about 1 part in 3000 at the gold point.—W. H.-R.

**Portable Temperature Recorder.** — (*J. Sci. Instruments*, 1934, 11, 395).—Describes the "Ovenograph" temperature recorder made by Messrs. Negretti and Zambra. This is specially designed for use in large stoving ovens in the motor industry, and is essentially a "Nersteel" temperature recorder with the recording instrument enclosed in heat-insulating material so that it can be passed through the oven with the work, the insulation being sufficient to prevent damage during the normal period of stoving.—W. H.-R.

### XIII.—FOUNDRY PRACTICE AND APPLIANCES

(Continued from pp. 176-179.)

**The Exhibition of Foundry Technique.** Joh. Mehrrens (*Anz. Masch.*, 1935, 57, (29), 29-32).—Foundry apparatus shown at the Leipzig Fair is described briefly.—B. Bl.

**Laboratory Control in the Foundry.** I. S. Svet (*Zavodskaya Lab.*, 1934, 3, 68-71).—[In Russian.]—S. G.

**Difficulties in the Production of Metal Castings.** Werner Fröhlich (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, 55, 475-476, 514-517).—The difficulties that arise in casting bronze, brass and aluminium alloys, and the methods of overcoming them are described. Special attention is given to blow-holes and pipes.—J. H. W.

**Metal Rose Out of the Gate and Riser: Cause and Prevention.** A. Heinz (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, 55, 452-453).—When metal rises in gates and risers after pouring is finished, it is always thoroughly porous and quite useless. This happens especially to copper and nickel alloys, and the cause is absorbed gas, usually hydrogen, but also sometimes sulphur dioxide and hydrocarbons. Precautions for handling the material and regulating the melting conditions in the case of both of these and of aluminium alloys are described. Briefly, the melting time must not be unduly prolonged, good cover for the material must be provided, clean material must be used for the charge, and the melting operations must be carefully controlled.—J. H. W.

**The Testing, Analysis, Properties, Applications, and Manufacture of Aluminium Alloys.** — (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, 55, 432-433).—The chemical composition, mechanical properties of the sand-, chill- and die-cast alloys, applications, corrosion-resistance, and the method of melting and refining the following alloys are described: Silumin (Alpax), copper-Silumin, Silumin-Beta, Silumin-Gamma, and LIV alloy (silicon 2, copper 4%).—J. H. W.

**The Manufacture and Testing of Aluminium Castings.** E. Becker (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, 55, 455-456).—The manufacture, pickling, cutting, and polishing of aluminium castings, and the applications of the oil test for detecting slag inclusions and hair cracks are described.—J. H. W.

**Influence of Dust Films on the Fluidity of Molten Cast Iron and Duralumin.** V. J. Fundator (*Niimash. Izvestia Nauchno-issledovatel'skogo Instituta Mashinostroeniya i Metalloobrabotki (Bull. Sci. Res. Inst. Machinebuilding and Metal-Treatment)*, 1934, (8), 66-70).—[In Russian.] The increase in the fluidity

of Duralumin in sand moulds dressed with various substances is as follows: talc paint 50%, quartz powder 43%, talc dust 40%, kerosene 9.8%, lycopodium powder 9.4%; the figures represent the % increase in length of castings made in dressed as compared with undressed moulds.—N. A.

**Present and Future Progress in Bronze Founding.** F. W. Rowe (*Metal Treatment*, 1935, 1, 13–16).—A general discussion of modern tendencies in the bronze foundry. Slow melting of any bronze alloy is not a desirable feature. Crucible manufacturers are invited to produce a crucible which is impermeable to gases at 1300° C. and has equal or better heat conductivity than silicon carbide. Reducing and sulphurous gases are more deleterious than oxidizing ones. Forced-draught reverberatory furnaces are coming into favour and displacing crucible furnaces in some instances. Sand-castings rarely attain maximum density. Improvement in this can be achieved by die-casting and generally increasing the rate of solidification of the metal, even in sand.—W. N.

**Pouring Temperatures of Bronzes.** Edmund R. Thews (*Foundry*, 1934, 62, (3), 24–25, 52; (4), 24–25, 53).—The influences of varying the pouring temperature on porosity, grain-size, liquation, &c., of various complex tin-bronzes is discussed. In the case of 88 : 10 : 2 zinc-bronze, an examination of collected data shows that temperature ranges recommended by various authorities, in spite of obvious disagreements, all include a range of 1150°–1177° C., which may be regarded therefore as a suitable basis for determining the proper casting temperature in each particular case as governed by type of mould, size and shape of casting, mechanical properties desired, &c. The effect of dissolved gases in relation to pouring temperatures is also discussed.

—F. J.

**Problems in Bronze.** Harold J. Roast (*Iron Steel Canada*, 1934, 17, 84–89; discussion, 89–90).—An address to the Montreal Chapter of the American Society for Metals. The problems dealt with are concerned with gas absorption, shrinkage, burning-in, segregation, the use of control test-bars, risers, gating and feeding, fractures, and metal exudations (sweat).

—J. H. W.

**\*The Crystalline Structure of Copper-Zinc Alloy Ingots on Melting and Casting from Ajax Furnaces.** M. P. Slavinsky, V. A. Danilov, A. K. Konstantinov, P. G. Kusmarzev, and J. A. Yenson (*Metallurg (Metallurgist)*, 1934, (8), 3–17; (9), 3–12).—[In Russian.] The effects on the properties of brass ingots cast from an induction furnace of current frequency, period of rest before pouring, rate of pour, temperature of pouring, mould temperature and rate of crystallization, and furnace atmosphere have been determined. Pouring temperature was found to have the most important effect, but the effects of furnace atmosphere may often mask the beneficial effect of the induction stirring. Alloys cast in water-cooled copper moulds are superior to those cast in iron moulds; 70 : 30 brass shows inverse, and 63 : 37 brass direct zonal segregation under similar casting conditions, the difference being due to differences in the solidification range and expansion.—N. A.

**Fabrication and Uses of Magnesium Alloys.** A. W. Winston (*Iron Age*, 1935, 135, (11), 12–16).—The manufacture of magnesium-base alloys (e.g. Dow metal, containing 88–98.5% of magnesium) in the forms of sand-castings, die-castings, extruded shapes, forgings, and sheet stock is described and their various applications are set out. The special treatment given to the surface of the metal and the method of painting it in order to minimize corrosion are discussed.—J. H. W.

**Replacing Heavy Metals by Aluminium Pressure Castings.** K. Altmannberger (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, 25–28).—A review of aluminium alloys used for pressure casting, and a description of a special casting machine. The latter works at 700°–750° C. and a pressure of 15–30 atm.—W. A. C. N.

**Sound Die-Castings of Aluminium-Bronze Produced by the Use of Vacuum.** Charles O. Herb (*Machinery (N.Y.)*, 1935, 41, 404-407).—Typical castings made by vacuum die-casting from an alloy of copper 89, aluminium 10, iron 1% are illustrated. A gate at the bottom of the die is immersed several inches below the level of the metal, which is then drawn up into the die by a vacuum of 5-25 in. of mercury. The castings are claimed to be free from blowholes and oxide inclusions, the oxide on the rising metal surface being deposited as a film on the walls of the die. Sand cores and metal inserts can be used. For pump impellers an alloy of copper 81, zinc 14, silicon 5% has been used.—J. C. C.

**Die-Casting in Brass.** E. Stevan (*Met. Ind. (Lond.)*, 1935, 46, 321-322).—A vertical and a horizontal type of machine for die-casting "aluminium-bronze" and, in particular, brass, and the construction of the dies are briefly described. For brass die-casting, an alloy containing copper 57, zinc 40, tin 2.5, and aluminium 0.5% is recommended.—J. H. W.

**Advanced Die Design Extends the Field of Die-Casting.** Charles O. Herb (*Machinery (N.Y.)*, 1935, 41, 329-334).—A case-study of die design, based on the casting of an oil-burner float-valve from a zinc alloy.—J. C. C.

**Making and Arranging the Moulds for an Aluminium Casing with a Sand Core and an Iron Shell.** Ferd. Brobeck (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, 55, 473-475).—Details of construction are given.—J. H. W.

**Moulding with Old Broken Castings.** Erich Becker (*Z. ges. Giesserei-Praxis: Das Metall*, 1934, 55, 513-514).—The use of old broken castings as cores in moulding is described.—J. H. W.

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

(Continued from p. 179.)

**Treatment of Coppersmiths' Waste.** A. Eyles (*Machinist (Eur. Edn.)*, 1935, 79, 99E).—After the usual operations of cleaning and concentration, coppersmiths' waste is heated on the hearth of an inclined furnace, or over a grating. This leaves more or less clean copper, and the tin, lead, and antimony are in an alloy form readily acceptable in the scrap market.

—J. H. W.

**The Remelting and Refining of Scrap Nickel.** Edmund R. Thews (*Met. Ind. (Lond.)*, 1935, 46, 265-268).—The effect of the gas content, of solid sulphur, carbon, and silicon, and of magnesium and arsenic on the properties of nickel is discussed. The melting and refining of the metal is carried out in a reverberatory furnace with as basic a lining as possible. When the metal is molten, most of the impurities are removed by oxidation, which is effected by opening the furnace doors by the addition of nickel oxide or by blowing in preheated air. The removal of lead is facilitated by the addition of zinc. Magnesium is subsequently added as a deoxidizer and desulphurizer. The various types of furnace used and the method of testing the nickel are discussed.—J. H. W.

#### XV.—FURNACES AND FUELS

(Continued from pp. 179-180.)

**Factors Affecting the Capacity and Thermal Efficiency of Furnaces.** H. Southern (*Metal Treatment*, 1935, 1, 17-21, 29).—A consideration of a simply constructed furnace, its general characteristics, the consumption of energy and fuel economy as these are affected by general design, weight of the charge, and the time-temperature cycle of operations. These 3 factors should be correctly balanced. S. arrives at the following formula for a simple non-recupera-

tive or non-regenerative furnace using gaseous fuel:  $E = \frac{100 \times U_g}{C_g} \times \left( \frac{H}{H+S} \right)$ .

Where  $E$  = theoretical percentage efficiency per cycle;  $U_g$  = available or useful heat of the gas—B.Th.U./ft.<sup>3</sup>;  $C_g$  = higher calorific value of the gas—B.Th.U./ft.<sup>3</sup>;  $S$  = total thermal losses through walls, doors, and other openings per cycle—B.Th.U.;  $H$  = total heat absorbed by gross charge per cycle—B.Th.U. Economical furnace operation therefore depends largely on the relationship of the weight of charge to the total thermal losses through walls, doors, and openings. The heat absorbed by the charge should not be less than the total thermal losses. The heat absorbed by charges in efficient intermittent furnaces is 2-3.5 times greater than the thermal losses per cycle, and in continuous furnaces is from 3.5 to 6 times greater than those losses per unit of time.—W. A. C. N.

**The Bases of Technical Heat Calculations for Furnaces.** W. Heiligenstaedt (*Stahl u. Eisen*, 1935, 55, 334-336).—The application of theoretical principles to a number of practical problems is demonstrated and discussed. The 5 laws of conservation of energy, temperature gradients, heat transfer, conduction, and combustion are invoked.—W. A. C. N.

**\*Nomograms for Gas and Firing Technique.** W. Schreiber (*Gas- u. Wasserfach*, 1934, 77, 716-718).—The construction of nomograms for the following are described: (i) the reduction of gas volumes and calorific values to N.T.P. for the dry gas, (ii) the conversion of volumes and calorific values of gases to works conditions (N.T.P. dry, 15° C. and 760 mm. moist, and 15° C. and 735.5 mm. moist), (iii) the determination of the density of illuminating gases by the Bunsen-Schilling method.—B. Bl.

**Heating Plant in the Light Metal Industry.** H. R. Gautschi (*Aluminium*, 1935, 17, 131-135).—A description is given of modern practice in melting, casting, annealing, and heat-treating aluminium and its alloys, with especial reference to the types of furnace used, their advantages and disadvantages.

—A. R. P.

**On the Danger of Explosions in Salt-Bath Furnaces.** — (*Aluminium*, 1935, 17, 144).—Electrical heating of salt-baths for the heat-treatment of aluminium is preferable to gas or oil heating, not only because a steadier temperature can be maintained but also because leakage of the salts (chiefly alkali nitrate) into the heating chamber when a fuel is used may cause explosion. Even with electrical heating the walls of the bath may become perforated and the molten salt penetrate the surrounding refractory and cause explosions; it is recommended, therefore, that provision be made for collecting and removing any leakage of salt.—A. R. P.

**White Metal Melting with Controlled Heat.** S. T. Olinger (*Gas Age-Record*, 1935, 75, 233-234, 238, 242).—The design and operation of kettles fired with radiant-heat gas-fired burner for white metal melting are described briefly.

—J. S. G. T.

**The Selection and Management of Gas- and Oil-Fired Heat-Treatment Furnaces.** C. H. Barker (*Metallurgia*, 1935, 11, 145-146).—The many factors, including type of furnace (batch or continuous), furnace design, heat insulation, method of regulation, cost of fuel, fuel storage, and speed of heating, are considered and stressed in relation to their importance and requirement for maximum efficiency in the heat-treatment of materials. Consideration is also given to the importance of a satisfactory fuel-air ratio and to the automatic control of oil and air valves.—J. W. D.

**Recent Developments in Electric Furnaces for Non-Ferrous Metals.** A. G. Robiette (*Met. Ind. (Lond.)*, 1935, 46, 355-357, 383-385, 388).—Read before the Scottish Section of the Institute of Metals. Presents an outline of the trend of progress in the application of electric furnaces to the melting and heat-treatment of non-ferrous metals.—J. H. W.



**Electric Heating in Industry.** Fr. Knoops (*Bull. Assoc. suisse Élect.*, 1935, 26, (7), 161-170, and discussion).—An illustrated description is given of electric furnaces for metallurgical use. The respective applications of arc, induction, and resistance furnaces are described, and the approximate power consumption is given for certain specified operations. Among alloys used for winding resistance furnaces, Silit, Globar, and a chromium-nickel-iron alloy giving a working temperature of 1250° C. are recommended. The electrical heating of drying ovens and pickling baths is also described.—P. M. C. R.

**\*The Most Recent Electric Melting Furnace for Light Metals.** E. Fr. Russ (*Aluminium*, 1935, 17, 136-141).—Tiltable induction furnaces of the crucible type for melting aluminium are described with reference to photographs and diagrams. The average power consumption is 350 kw.-hr./ton of aluminium; *i.e.* the thermal efficiency is 86%, which is much greater than that of the usual electrically-(resistance) heated hearth furnace. Aluminium melted in the induction furnace is generally much freer from gas than that melted in fuel-fired furnaces, and hence shows a larger shrinkage on solidification.—A. R. P.

**Carbon Resistance Electric Radiation Furnaces and Their Application to the Melting of Metals.** Henri George (*Rev. gén. Élect.*, 1934, 35, 851-856).—A description is given of a 100 kw. melting furnace, built in the form of a horizontal, refractory-lined cylinder with dished ends, in which the charge is heated by radiation from a single carbon-rod heating element passing through the centre of the furnace above the level of the metal. A special construction of graphite and amorphous carbon is employed to prevent losses at the electrical connections at each end. Details are given of melting time and carbon and current consumption when melting cast iron in an 80 kg. furnace and bronze in a 100 kg. furnace. This construction may be applied to furnaces for melting and distilling magnesium and for centrifugal casting. Advantages claimed are that temperatures up to 2000° C. may be rapidly reached, overheating and "hot spots" do not occur, the metal bath is not agitated, there is no carburization, and the atmosphere is controlled.—J. C. C.

**\*The Temperature History and Rate of Heat Loss of an Electrically Heated Slab.** Albert B. Newman and Louis Green (*Trans. Electrochem. Soc.*, 1934, 66, 345-358; discussion, 359).—See *Met. Abs.*, 1934, 1, 521.—S. G.

**High Current Condensers for High-Frequency Melting Furnaces.** — (*Elektrotech. Z.*, 1935, 56, 178-179).—A H.-F. furnace equipment designed to melt charges of 600 kg. with a rating of 18 kw. and operating at 2100 v. and 970 hertz is described with special reference to the construction of the condensers.—B. Bl.

**Resistor Materials Now Available for Industrial Furnaces.** L. Moennich (*Elektrowärme*, 1935, 5, 15-17; *C. Abs.*, 1935, 29, 1715).—A review of materials up to an operating temperature of 1350° C., including alloys of chromium, aluminium, and cobalt. The influence on furnace design of these materials is discussed, and the longer life of furnaces due to better design and better heating elements emphasized.—S. G.

**\*The Ramming of Linings of Rotary Furnaces.** W. J. Rees (*Bull. British Cast-Iron Res. Assoc.*, 1935, 4, (3), 86).—A note. In order to obtain effective union of the different layers of the refractory lining of a rotary furnace, a ramming tool with a chisel-shaped end should be used; blunt-ended tools may cause defective linings.—W. H.-R.

**\*The Current-Conducting Properties of Slags in Electric Furnaces.—I. Errata.** Axel Wejnarth (*Trans. Electrochem. Soc.*, 1934, 66, 343).—Corrections to the paper published in *Trans. Electrochem. Soc.*, 1934, 65, 177.—S. G.

**\*The Current-Conducting Properties of Slags in Electric Furnaces.—II.** Axel Wejnarth (*Trans. Electrochem. Soc.*, 1934, 66, 329-343).—See *Met. Abs.*, 1934, 1, 623.—S. G.

**\*Maximum Load for Silit (Silicon Carbide) Heating Elements.** H. Friedrich (*Elektrowärme*, 1934, 4, 274-275; *C. Abs.*, 1935, 29, 1715).—The temperatures obtainable in the furnace or in the material to be heated for the maximum permissible temperature of the Silit heating elements were experimentally determined as :

Temperature of Furnace or Material, °C.	Surface Load of Heating Element, w./cm. <sup>2</sup> .	Overtemperature, °C.	Temperature of Silit Rod, °C.
1000	30	450	1450
1100	26	350	1450
1200	21	250	1450
1250	17	200	1450
1300	13·5	150	1450
1350	9	100	1450
1400	4·6	50	1450

Suggestions for proper selection of surface load and arrangement of the elements are discussed.—S. G.

**Something About Furnace Arches.** M. Volkel (*Tonind. Zeit.*, 1935, 58, 1001-1002, 1170-1171).—The construction of sprung arches, cupola arches, and hanging roofs, and their advantages and disadvantages in furnace construction are discussed.—B. Bl.

## XVI.—REFRACTORIES AND FURNACE MATERIALS

(Continued from p. 180.)

**\*Investigations in the Range of High and Very High Temperatures. Sintering Behaviour of Alumina Refractories and the Preparation of Zirconium Metal.** W. Dawihl (*Tonind. Zeit.*, 1934, 58, 449-451, 463-465, 477-478, 485-487).—The sintering behaviour of pure alumina and of alumina with admixture of silica, zirconia, zirconium oxychloride, magnesia, ferric oxide, chromic oxide, beryllia, rare earth oxides, boric acid, phosphoric acid, and fluorides has been examined. The effect of the origin and the previous treatment of the alumina is referred to and laboratory furnaces for firing refractory shapes at high temperatures are described. By the reduction of zirconia in an arc furnace products containing 93% of the metal base have been obtained; a 96% ferrozirconium has also been prepared.—B. Bl.

**On the Question of Shaping in the Production of Refractories.** Hans Kremiski (*Tonind. Zeit.*, 1934, 58, 353-355).—The subject is discussed from the point of view of suitable shape of bricks for cupolas.—B. Bl.

**The Iron Content of Magnesite.** — (*Tonind. Zeit.*, 1935, 58, 755-756).—An iron oxide content of 4% has a beneficial action on the mechanical properties of magnesite bricks without affecting adversely the other properties.—B. Bl.

**On the Volume Stability of Fireclay Bricks.** — Beninga (*Tonind. Zeit.*, 1934, 58, 239-240).—The effects of the contraction on drying, the shaping and firing operations, the size of the grog particles, and the nature of the clay and binders on the stability of the volume of the fired bricks is discussed.—B. Bl.

**Iron Oxide in the Firing of Fireclay Bricks.** — Beninga (*Tonind. Zeit.*, 1934, 58, 389-390).—Ferric oxide in fireclay acts not only as a flux, but, if the brick is fired at a high temperature, it has an unfavourable effect on the porosity owing to its thermal dissociation.—B. Bl.

**Iron Oxide in the Firing of Fireclay Bricks.** Otto Krause (*Tonind. Zeit.*, 1934, 58, 803-804).—The influence of the thermal dissociation of ferric oxide on the porosity of firebricks is discussed.—B. Bl.

**On the Improvement of Quality of Silica Bricks.** — ( *Tonind. Zeit.*, 1934, 58, 30-31).—The influence of so-called " mineralizers " on the volume stability of silica bricks is discussed with reference to German patent literature.—B. Bl.

**\*On the Testing of Refractories for Industrial Fire-Places.** A. Möser (*Tonind. Zeit.*, 1934, 58, 288-290).—Two cases of the destruction of refractory materials by coal ash are described, and details are given of a method of testing refractories by cementing a specimen to a fireclay support, covering it with the powdered slag, heating until fusion occurs, and then repeating the process.—B. Bl.

**\*On the Testing [of Refractories] Towards Slag Corrosion.** G. Sachs (*Tonind. Zeit.*, 1934, 58, 1195-1197).—Refractory bricks are subjected to the action of molten slags, and their appearance and change of volume after the test are examined.—B. Bl.

### XVII.—HEAT-TREATMENT

(Continued from p. 180.)

**\*Annealing Pure Aluminium.** Jean J. Trillat and M. Paic' (*Compt. rend.*, 1935, 200, 1037-1039).—Virtually completing the work of J. Calvet (cf. *Met. Abs.*, this volume, p. 137), the modification of the structure as a function of the temperature and time of annealing in the case of 2 brands of commercial aluminium containing aluminium 99.0, iron 0.7, silicon 0.3, and aluminium 99.0, iron 0.3, silicon 0.7%, respectively, and of refined aluminium of approximately 99.993% purity have been investigated. After rolling, the specimens were annealed in baths of potassium and sodium nitrates at 150°-500° C. for from 10 minutes to 5 hrs. With pure aluminium, the temperature of initial recrystallization for 10 minutes' annealing was 150°-180° C., and that of complete recrystallization 230°-250° C. Irregularities were attributed to segregation of impurities. Prolonged annealing did not materially affect the structure. Between these 2 temperatures, the structure was definitely unhomogeneous. With commercial aluminium, the temperatures of initial and final recrystallization were 200°-220° C. and 280°-300° C., respectively. Increasing the silicon content appeared to increase the rate of annealing. The commercial aluminium recrystallized in relatively small grains, whilst the pure aluminium recrystallized in very large crystals. In general, the mechanical properties varied with the alterations of the structure; long annealing at temperatures above 200° C. did not materially alter these properties.—J. H. W.

**Bright-Annealing of Metals in Electric Furnaces.** John Dummelow (*Wire Industry*, 1934, 1, 355-360, 391-393).—Electric heat-treatment furnaces facilitate uniform heating with accurate temperature control and with a low temperature gradient. Bright-annealing gives improved and uniform surface finish with accurate control of dimensions, eliminates waste by oxidation, and obviates subsequent pickling, drying, and cleaning, and metal recovery. The production of suitable artificial atmospheres for use with continuous and with batch-type furnaces is discussed. Except for brasses and other zinc-bearing alloys (which present difficulties due to volatilization of zinc) and certain alloys such as nickel-brass (which require a short-period annealing cycle), the problem has been simplified by the discovery that with material heated in a closed chamber complete protection against oxidation is necessary during the cooling period only. This principle is applied in the Grünwald system (see *J. Inst. Metals*, 1931, 46, 548), which is especially suitable for coils of wire and strip, chains, coinage blanks, small parts, &c. Typical Grünwald furnaces are described. The annealing cycle for copper wire and strip occupies about

3 hrs., and the current consumption is 90–120 kw.-hr. per ton. Mention is made of the possibilities of utilization of heat recuperation, and also of a method of increasing the effective thermal conductivity of the charge in the case of materials of low intrinsic conductivity. Maintenance costs are low, since the pots neither carry the charge nor stand on the furnace floor, whilst the tops of the covers and the sealing rings are placed well away from the heated zone. Labour charges are low also, as attention is required only for loading, transferring, and unloading the pots.—W. E. A.

## XVIII.—WORKING

(Continued from pp. 181–182.)

**\*New Autographic Apparatus for Indicating Roll-Pressures.** — (*Elektro-  
tech. Z.*, 1934, 55, 1120–1121).—The apparatus comprises a type of mercury manometer which operates 32 electric lamps which are switched on successively as the pressure rises. The current consumption of the lamps is a measure of the roll pressure. Temperature changes in the mercury are compensated for by a regulating device.—B. Bl.

**Some Characteristics Concerning the Hot- and Cold-Rolling of Flat Stock.** J. Selwyn Caswell (*Met. Ind. (Lond.)*, 1935, 46, 407–411).—Read before the Sheffield Metallurgical Association. The following characters associated with different methods of hot- and cold-rolling flat stock are discussed: the 2-high mill, malalignment, effect of the forces on the mill parts, deflection of the mill rolls, elastic change in the mill housings and other parts subjected to direct stress, reduction of roll deflection, disposal of energy supplied to a mill, roll neck bearings, roll temperature control, and stock tension.—J. H. W.

**Completes New Sheet-Lead Mill.** — (*Iron Age*, 1934, 134, (4), 35, 80).—The casting equipment, rolling mill and accessory equipment of a new sheet-lead manufacturing plant in the U.S.A. are described. Since the building and manufacturing plant are entirely new and it was not necessary to utilize existing facilities, it is believed to be the most complete and efficient sheet-lead mill in existence.—J. H. W.

**Lead Purification Device for Vertical Extrusion Presses.** — (*Elektro-  
tech. Z.*, 1934, 55, 196–197).—A device is described for preventing entry of lead oxide into the extrusion chamber of presses making lead cables.—B. Bl.

**†Stresses and Material Flow in Tube Drawing.** E. Siebel and E. Weber (*Stahl u. Eisen*, 1935, 55, 331–334).—An illustrated mathematical exposition of the forces operative during drawing. The relationships of stress, form of tube, and angle and shape of the die are discussed.—W. A. C. N.

**\*Studies of the Wire-Drawing Process. VII.—The Application of Metallic Coatings as Lubricants, with Special Reference to the Drawing and Properties of a Lead-Coated Austenitic Chromium-Nickel Steel.** E. L. Francis (*Carnegie Schol. Mem., Iron Steel Inst.*, 1934, 23, 47–63).—An austenitic chromium-nickel steel wire was coated with lead by the Duozele process, and its drawing properties, using a cocoon-oil soap as a lubricant, were compared with those of an uncoated wire. The influence of the lead was mainly of a mechanical nature, facilitating the formation of a stable soap film which enables much greater reductions to be performed. Friction during drawing is slightly greater with the lead coating. The mechanical properties are but little influenced by the coating over a wide range of reductions, but at the heaviest reductions, the coated wire was rather the softer and more ductile. Very heavily reduced coated wires show a remarkable combination of high tensile strength and ductility. It is suggested that there may be some connection between the work-hardening capacity of the metal (Meyer's exponent,  $n$ ) and its resistance to torsional stresses. Cf. *Met. Abs.*, 1934, 1, 321.—J. H. W.

**Steel Dies. Hand and Machine Setting.** Richard Saxton (*Wire Industry*, 1934, 1, 375-376).—Written from the point of view of the ferrous rather than of the non-ferrous wire-drawer. S. describes the method of hand-setting of steel dies for wire-drawing, and compares it with the Slinger three-drill mechanical method. The advantages and disadvantages of each are considered, and S. sums up in favour of hand-setting. Brief reference is made to several attempts which have been made to improve on the three-drill method.

—W. E. A.

**The History of Wire Netting.** — (*Wire Industry*, 1934, 1, 303).—A short historical account of the development of the manufacture of wire netting by Barnards, Ltd., of Norwich.—W. E. A.

**\*The Manufacture and Uses of Metal Powders.** J. C. Chaston (*Metal Treatment*, 1935, 1, 3-10, 12).—Read before the London Section of the Institute of Metals. In making powders, fractures may be induced by (1) intercrystalline fracture, usually brought about by introducing some impurity which segregates on the crystal boundaries and causes weakness; (2) fracture on a cleavage plane, e.g. in antimony or bismuth; (3) transcrystalline fracture which is applicable to practically all metals. Cutting small particles by a tool or by grinding is one of the oldest processes by which powders have been produced. A comprehensive list of the commercial methods adopted, the sizes of the particles produced and their uses is followed by brief descriptions of the individual processes. Among these are those involving stamps, eddy mills, ball mills, granulation in water, production of brittle aggregates by electrodeposition, condensation, reduction of metals from their oxides and salts, chemical precipitation from solution. Some attempts have been made to press and sinter powdered metals, thus producing a solid mass comparable with a casting. The following are stated to be the advantages: (1) freedom from pipes and inclusions; (2) no need for deoxidizers; (3) obtain a purer product; (4) can produce alloys otherwise unobtainable; (5) can produce intimate mixtures of metals and non-metals; (6) can manufacture bi-metals by filling moulds with different powders. A bibliography is included.—W. N.

**New [Process for the] Manufacture of Aluminium Powder [The Hametag Process].** A. Dumas (*Rev. Aluminium*, 1935, 12, 2739-2744).—In the Hametag process the operations of grinding are effected in hermetically-sealed chambers filled with an inert gas, and the usual crushing mills are replaced by tube mills with steel balls. The operations consist in rough grinding the material, crushing it to fine pieces, and brightening or polishing the powder; the process is described in detail. It is claimed that the time of crushing is very much reduced, and that the danger of explosion is removed by this process.—J. H. W.

**\*Investigation of Processes for Sintering Molybdenum Bars.** A. N. Koptzik and J. M. Jasny (*Redkie Metalli (Rare Metals)*, 1934, (6), 27-35).—[In Russian.] The grain-size, microstructure, hardness, malleability, and suitability for drawing of molybdenum bars made by pressing powder having a mean grain-size of 1-3  $\mu$  have been examined after sintering the bars with a current of 90, 85, and 80% of that necessary for melting. The results are shown in the following table:

	Sintering Current in % of Melting Current.	Rockwell Hardness.	Grains/mm. <sup>2</sup> .	Yield after Forging and Drawing.	Number of Breaks after Drawing.
A	90	30.7	421	78.5	31
B	85	32.7	3420	85.3	36
C	80	29.7	4091	83.0	19

The best results appear to be those of test B; the current should be increased from zero to the maximum in 3 minutes, maintained there for 10 minutes, and brought back to zero in 1 minute.—D. N. S.

**The Machining of Light Metals.** Otto Rambuschek (*Anz. Masch.*, 1935, 57, (17), 106).—Modern cutting and drilling tools and machines for working light metals are described.—B. Bl.

**Tungsten Carbide Reduces Tool Sharpening.** Charles O. Herb (*Machinery* (N. Y.), 1934, 41, 213–215).—Examples are given of the performance of Widia tungsten carbide tools and their life between resharpenings when machining cast iron, bronze, and aluminium parts in a sewing-machine factory. Tools which are lapped remain sharp longer than ones which are merely ground.

—J. C. C.

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## XIX.—CLEANING AND FINISHING

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(Continued from pp. 182–183.)

**Recent Developments in Metal Cleaning.** R. W. Mitchell (*Monthly Rev. Amer. Electroplaters' Soc.*, 1935, 22, (3), 15–26).—The most efficient alkaline electrolytic degreasers comprise mixtures of sodium (or potassium) silicate, borate, and phosphate together with an emulsifying and wetting agent. A large number of organic compounds of high complexity produced by sulphonation of the higher alcohols and subsequent coupling of the products with naphthol derivatives, &c., have recently been tried as wetting agents and have given good results; a description of certain of these compounds and of their function in metal cleaning is given.—A. R. P.

**The Preparation of Metallic Surfaces by Pickling and Degreasing Before Coating.** P. Orłowski (*Aciers spéciaux*, 1934, 9, 498–500).—The methods of degreasing with petrol, with sodium phosphate and carbonate, with trichloroethylene and by electrolysis, the method of pickling steel and the regeneration of the pickling and degreasing baths are described.—J. H. W.

**\*The Bullard-Dunn Electrochemical Metal Descaling Process.** Colin G. Fink and T. H. Wilber (*Trans. Electrochem. Soc.*, 1934, 66, 381–391; discussion, 391–392).—See *Met. Abs.*, 1934, 1, 523.—S. G.

**Grinding and Polishing of Nickel and Alloys with a High Nickel Content.** B. Trautmann (*Anz. Masch.*, 1935, 57, (1), 5–6).—Numerous practical hints, such as the grain-size of the polishing powder, the kind and size of polishing disc, cutting and polishing pastes, r.p.m. of the disc for the various polishing operations on nickel, copper-nickel, and chromium-nickel alloys are given.

—B. Bl.

**Polishing and Buffing Operations.** Waldo Hutchinson (*Canad. Mach.*, 1935, 46, (3), 22–23, 42, 45).—A distinction is drawn between polishing, the completion of the grinding process, and buffing, the production of lustre or colour on a polished surface. Suitable abrasives for different classes of work are considered. Wheel speeds must frequently be reduced below the rate giving the highest abrasive efficiency on account of possible adverse thermal effects on the metal. A description is given of the buffing operation, and of several standard types of buffing wheel.—P. M. C. R.

**Boron Carbide. A New Crystalline Abrasive and Wear-Resisting Product.** Raymond R. Ridgway (*Trans. Electrochem. Soc.*, 1934, 66, 117–132; discussion, 132–133).—See *Met. Abs.*, 1934, 1, 524.—S. G.

**Preparation of an Artificial Patina on Copper.** E. T. Richards (*Metallbörse*, 1935, 25, 306–307, 338–339).—A review of modern practice with brief descriptions of recent processes.—A. R. P.

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## XX.—JOINING

(Continued from pp. 183-185.)

**Gas Welding and Soldering of Aluminium and Its Alloys.** A. von Zeerleder (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, 29-34).—A discussion of the utility, methods of production, and quality of autogenous aluminium welds. Tables showing physical properties and behaviour in various conditions are reproduced. The design of the burner and the proper preliminary preparation of the parts to be joined are reviewed in detail. The composition of the fluxes most suitable for different kinds of welds are discussed. A short bibliography is given.—W. A. C. N.

**High-Voltage Carbon Arc Welding of Copper and Its Alloys.** C. E. Swift (*J. Amer. Weld. Soc.*, 1935, 14, (1), 26-29).—A filler rod containing about 10.5% tin and 0.3% phosphorus is used. A high-voltage, high-current arc is struck from the rod, the end of which is laid in the bottom of the Vee. Extremely high welding speeds are essential. Whenever possible, a backing plate is used: where it is not possible, the bevelled edges are butted tightly together, a run made with incomplete penetration, and a light sealing run made on the opposite side. Recommended current values for different sheet thicknesses, and the mechanical test results obtained on copper, bronze, and brass are tabulated.—H. W. G. H.

**Atomic Arc Welding: Its Advantages and Possibilities.** E. Thiemer (*Tech. Zentr. prakt. Metallbearbeitung*, 1935, 45, 102).—This recently developed process has the advantage of enabling the operator to break off a weld and re-start without any disadvantage, and also to manipulate the joint to a much greater extent. The arc is struck between 2 pointed tungsten electrodes in a hydrogen atmosphere and the gas is dissociated by the intense heat—a temperature of about 4000° C. being attained. The piece being welded maintains a moderate temperature only, and impurities tend to rise to the surface of the weld. It is stated that welded sheets 2.5-3 mm. thick exhibit no sign of the junction when rolled to 0.28-0.6 mm., and their physical properties are not impaired. The apparatus used is illustrated.—W. A. C. N.

**Present State of the Technique of Electric Arc Welding.** R. d'Aboville (*Rev. gén. Elect.*, 1934, 36, 403-413).—A general review, dealing particularly with electrode composition, generators, automatic welding, and methods of testing. Recent experiments carried out by the Chemin de Fer du Nord on welding wagon bodies from aluminium alloys and in repairing copper fire-boxes by welding are described. These indicate that welding produces a more reliable product than riveting.—J. C. C.

**Thermal State During Fusion Welding.** A. Portevin and D. Séférian (*Compt. rend.*, 1934, 199, 34-36).—See also *Met Abs.*, this volume, p. 77.—S. G.

**Welding of Structures in the Chemical Industry.** C. O. Sandstrom (*Chem. and Met. Eng.*, 1935, 42, 94-95).—The influence of the old riveting practice on fusion welding is shown to be non-progressive and must be eschewed if evolution in design is not to be hampered. The design of built-up columns and struts, trusses, towers, and frames is described and illustrated.—F. J.

**Welded Chemical Equipment from Special Metals.** Emerson P. Poste (*Indust. and Eng. Chem.*, 1935, 27, 128-134).—By the use of fusion welding a continuous smooth surface is obtained when making pressure vessels from nickel-clad steel. The pick-up of iron at the weld is much less than with the fillet weld which is required to calk the lap construction of a riveted joint. Nickel-clad steel is difficult to weld, owing largely to gas-absorption, resulting in porosity. This is overcome by peening and a properly-made weld presents a good nickel surface to the contents of the vessel.—F. J.

**Welding in Chemical Industries.** C. O. Sandstrom (*Chem. and Met. Eng.*, 1934, 41, 360-364).—The need for correct design in welded work is stressed, the vast majority of weld failures having been caused by faulty design and not by poor welding. Weld types, lessons from riveted joints, welded joints, effects of tangents in cylinders, fillet welds, end and edge welds, calking welds and sheet steel joints are discussed. Various types of weld are illustrated. A few notes on the use of Stellite, copper, bronze, and aluminium in welding operations are given. Brass is not satisfactory for welding, owing to the vaporization of zinc at the welding temperatures.—F. J.

**Welding Pipe and Pressure Vessel Joints in Chemical Industries.** C. O. Sandstrom (*Chem. and Met. Eng.*, 1934, 41, 476-481).—The welding of pipe, pipe nipples and their reinforcing rings, fired and unfired pressure vessels, and flanges is described and a variety of methods illustrated.—F. J.

**Observation Tests on Welds.** — (*Mech. World*, 1934, 96, 71).—Notes from a booklet issued by the Linde Air Products Co. Observation tests of welds do not give an indication of mechanical or physical properties; they give some indication of the ability of the operator. The points to be observed are: (1) contour; (2) reinforcement; (3) undercutting; (4) penetration. These are all illustrated and briefly described.—F. J.

**Welding Technique and Material Efficiency.** Wolf von Bleichert (*Anz. Masch.*, 1935, 57, (29), 38-40).—Welding machines and apparatus shown at the Leipzig Fair are briefly described.—B. Bl.

## XXI.—INDUSTRIAL USES AND APPLICATIONS

(Continued from pp. 185-189.)

**On the Re-Examination of Standards for Primary Aluminium.** B. F. Graschtschenko (*Legkie Metalli (Light Metals)*, 1934, (9), 41-45).—[In Russian.] Details are given of the American, British, French, and Russian standards for primary aluminium. A scheme for a new standard worked out by the Scientific Research Institute for Light Metals proposes that the following 5 grades of aluminium be standardized:

	Al, %.	Fe, %.	Si, %.	Pc-Si, %.	Cu-Zn, %.
A0	99.7	...	...	0.2-0.3	...
A1	99.5	0.2	...	0.5	0.05
A2	99.0	0.4	...	1.0	0.1
A3	98.0	0.4	1.25	...	0.1
A4	97.5	1.0	1.25	...	0.2

The uses of the different grades are indicated.—D. N. S.

**Aluminium Alloy Standards DIN 1713.** — (*Aluminium*, 1935, 17, 145-151).—Standard specifications (composition, mechanical properties, and uses) are given for 8 rolling alloys, 9 casting alloys, and various "aluminium-bronzes."—A. R. P.

**\*The Operating Temperatures of Cast-Iron and Aluminium Pistons in a 12-Inch Bore Oil Engine.** H. Wright Baker (*Proc. Inst. Mech. Eng.*, 1934, 127, 217-243; discussion, 243-248; and (abstracts) *Light Metals Rev.*, 1935, 1, 292-293; *Mech. World*, 1934, 95, 450-452).—The temperatures have been measured at 23 points on a "mushroom"-type aluminium piston in a single-cylinder vertical Diesel engine, having a 12-in. bore and 18½ in. stroke, and running at 250 r.p.m. Two different types of cast-iron cylinder were also examined. Temperature distributions throughout the pistons are illustrated diagrammatically. The radial temperature differences for the aluminium and



cast-iron pistons are roughly in the ratio 1 : 5½, and, on warming up, the aluminium piston reaches its maximum temperature in about half the time required by the cast iron. The use of rings of forged "Y" metal was also studied, and reduced the piston temperatures slightly in both cast-iron and aluminium pistons. Interesting details are given of adjustment of thermocouples for indicating the temperatures of moving parts.—W. H. R.

**Light Alloy Pistons and Cylinder Heads.** H. Petit (*Technique automobile et aérienne*, 1935, 26, (168), 1-10).—The use of materials of high thermal conductivity for the pistons and cylinder-heads of internal combustion engines improves engine performance and checks premature ignition. Excessive thermal expansion may be balanced by insets of Invar or by modifications in design, e.g. the slotted piston. The coeffs. of thermal expansion, at 20° and 200° C., the average thermal conductivity between 0° and 200° C., the tensile strength, Brinell hardness, elongation and sp. gr. are tabulated for 10 light alloys and for cast iron. The beneficial effect of light alloys on the compression ratio is discussed, and alterations in design, entailed by the substitution of such alloys for cast iron, are described.—P. M. C. R.

**Gas Cylinders in Light Alloys.** E. Hermann (*Schweiz. Tech. Z.*, 1934, 31, 682-686).—It has been shown that the cause of failure of steel cylinders, lies in the hardness rather than otherwise—except when due to thermal explosion. Experiments are described leading up to the manufacture of comparatively large vessels in non-ferrous alloys. The results of destruction tests are given. Mostly aluminium alloys were used. Practically no change in dimensions was noted when vessels were subjected to repeated variations of pressure up to 225 atm., and simultaneous changes of temperature normally experienced. It was found that bursting pressure in vessels made of Lantal, Avional, and Anticorrodal varied with the length of the tube.—W. A. C. N.

**An Application of Light Alloy Gas Cylinders in the Transport of Compressed Gas [Alumag].** M. Bocaudé (*Rev. Aluminium*, 1935, 12, 2701-2704).—The use of Alumag—a forged aluminium alloy containing 6.5% of magnesium—in the construction of compressed-gas cylinders and the great saving in weight of transport are described.—J. H. W.

**The Use of Light Metals in the Construction of Motor Trains.** R. Kauffmann (*Rev. Aluminium*, 1934, 11, 2637-2646).—J. H. W.

**Cellometal.** — (*Textile Mercury*, 1935, Feb. 2; *Light Metals Rev.*, 1935, 1, 371).—Cellometal is composed of 48% cellophane and 52% aluminium foil and glue, and may be used for decorative purposes.—I. M.

**Roofs in the Tropics: "Tropical Strapazoid" and "Emed-Alu-Strapazoid."** — (*German Echo Export and Import Rev.*, 1935, Feb.; *Light Metals Rev.*, 1935, 1, 366).—Strapazoid is lighter and possesses greater insulating powers than the corrugated sheet iron or tiles commonly used in tropical countries. It contains bituminous substances and the outer coating is of polished aluminium. A special type is "Emed-Alu-Strapazoid" which is reinforced by felted, fire-zincd wiring in such a manner that it can be laid over rafters or round timber without a base of boards, the stability not being affected.—I. M.

**Uses of Beryllium.** — (*Anz. Masch.*, 1935, 57, (11), 5).—Beryllium-copper alloys are used for watch springs, clock bearings, hypodermic needles, oil-pipes in aircraft, electric switches, and manometer tubes.—B. Bl.

**General Review of the Specifications Governing the Electrolytic Copper Trade.** — (*Cuivre et Laiton*, 1935, 8, 79-84).—W. A. C. N.

**The Precious Metals—Gold, Silver, and Platinum.** Edmund Downs (*Met. Ind. (Lond.)*, 1935, 46, 323-325, 332, 359-361, 386-388, 419-420).—Read before the Midland Metallurgical Societies (Birmingham Local Section of the Institute of Metals, Birmingham Metallurgical Society, and Staffordshire Iron and Steel Institute). The history, occurrence, extraction and

refining, properties and applications of platinum and gold, and the technique of platinum plating and the working of gold are briefly described. The effect of very small quantities of silver in raising the softening temperature of copper, silver plating, the use of silver in photography and mirror making, and the oligo-dynamic action of silver in the Catadyne (Katadyn) process of water and food sterilization are discussed (see *Met. Abs.*, this volume, p. 187).—J. H. W.

**The Use of Lead in the Chemical Industry.** — (*Chim. et Ind.*, 1934, 32, Special No. (Oct.), 135–136).—Normal lead used in industry contains at least 99.9% of the metal, but material may be obtained assaying 99.993% lead and containing only the impurities antimony 0.0015 and bismuth 0.0035%. For dilute sulphuric acid corrosion increases but slightly with moderate increases in temperature, but with stronger acid it rapidly accelerates as the temperature is increased. Many metals have been added in small quantities to lead to resist corrosion in particular circumstances. 0.05–0.1% addition of tellurium is advantageous. For higher temperatures 0.2–0.5% of copper appears to be favourable. At ordinary temperatures, however, it is generally conceded that the purer the lead the less the attack. Lead vessels are now employed in the manufacture of many chemicals, e.g. acetic acid, aluminium sulphate, phosphoric acid, ammonium sulphate, &c.—W. A. C. N.

**The Uses of Lead on Board Ship.** — (*Shipbuilder*, 1935, 42, 221).—In sheet form, lead is extensively used in pantries and galleys and in refrigerating chambers for lining in cargo and passenger ships, and under deck fittings to prevent corrosion in special-service ships. In the form of pipes it is used for bilge and ballast lines, and in high-class passenger ships for ships' plumbing.

—J. W. D.

†**Nickel Alloys in Aircraft Engineering.** Yashushi Taji (*Japan Nickel Rev.*, 1935, 3, 20–90).—[In English and Japanese.] Deals mainly with alloy steels. Monel metal is favourably considered, owing to its power of resistance to corrosion, and has been used for seaplane floats in tropical waters. In the section dealing with materials for construction of aircraft engines, aluminium alloys, including Hiduminium, "R.R." and "Y" alloy, nickel-bronzes and nickel-aluminium-bronzes are discussed. Tables and curves of physical properties of these materials when variously treated are inserted.—W. N.

**Silver May Answer Your Corrosion Problem.** B. A. Rogers (*Chem. and Met. Eng.*, 1934, 41, 631–633).—The properties of silver which are of significance in the use of the metal in the construction of equipment in the chemical manufacturing and food-packing industries, are discussed; also the types of construction available for such equipment and the methods of joining silver or parts in which base metal is lined with silver. In the latter case 3 kinds of lining are considered: (1) those which are fitted in without being permanently attached to the outer wall; (2) electrodeposited linings; (3) duplex metal walls, using a method of fabrication similar to that of the old Sheffield plate. (2) and (3) are superior to (1) as regards heat transmission, but inferior as regards reclamation of silver after the equipment has completed its useful life. Some equipment is made entirely of "fine" silver, e.g. stills for the production of high-grade acetic acid and tanks for fusing alkalis. Silver sheets up to 60 in. wide and 20 ft. long and tubes up to 20 in. diam. have been made. The technique of making joints in silver equipment is also discussed. Cast silver equipment is not used in quantity, but globe and stop-cock valves have been made in cast silver. The effects of annealing on the mechanical properties of cold-rolled silver are tabulated.—F. J.

**Ionic Silver Sterilization (Industrial Sterilization by Minute Dosages of Silver).** C. H. Brandes (*Indust. and Eng. Chem.*, 1934, 26, 962–964).—By utilizing the solution pressure of metallic silver surfaces exposed to clear water, the concentrations of a few hundredths of a mg./litre of water, sufficient to destroy most forms of micro-organisms, can be reached. For com-

mercial purposes, such an enormous surface exposure of metal is required and so long a time, that ionic solution is now promoted by inducing an electric potential between the silver plate and the liquid. The equipment is described. Alcohol, wine, vinegar, fruit juices, beer, &c., can be treated to improve odour and flavour (in the case of alcohol) and to prevent bacterial cloudiness in the other liquids. The initial cost in the silver treatment of water is somewhat greater than that of chlorine treatment, but the silver-treated water is tasteless, odourless, and non-toxic.—F. J.

**Titanium in Metallurgy.** M. A. Hunter and A. Jones (*Trans. Electrochem. Soc.*, 1934, **66**, 21-31; discussion, 31-32).—See *Met. Abs.*, 1934, **1**, 528.—S. G.

**Present State of Electric Lamp Technique.** H. Marty (*Ind. élect.*, 1934, **43**, 485-493, 519-524).—An address to the Société amicale des Ingénieurs de l'École supérieure d'Electricité. Includes a review of the characteristics of tungsten filaments.—J. C. C.

**Recent Progress in the Manufacture of Incandescent Lamps.** R. d'Aboville (*Rev. gén. élect.*, 1935, **37**, 161-164; and *Ind. élect.*, 1935, **44**, 66-69).—The factors governing the efficiency of gas-filled tungsten filament lamps are discussed, and the "super arga" lamp, employing a "coiled-coil" filament construction, is described.—J. C. C.

**Strip and Sheet Material.** P. Mabb (*Machinery (Lond.)*, 1935, **45**, 574-576).—In specifying the dimensions of cold-rolled sheet and strip, it is often possible to make appreciable savings in cost by keeping in mind the conditions of manufacture. Commercial tolerances in the width of brass, copper, phosphor-bronze, nickel-brass, aluminium, and steel strip are tabulated.

—J. C. C.

**The Development of Electric Technology in Recent Times.** Report of the Verband deutscher Elektrotechniker (*Elektrotech. Z.*, 1934, **55**, 621-660).—Section 11 of this report deals with the use of new chromium-nickel alloys, molybdenum, and tungsten as resistance elements for electrical heating, the arrangement and insulation of the resistances, the advantages of medium frequency induction furnaces over the high-frequency type, and modern types of thermocouples containing precious metals and tungsten. Section 16 contains information on the electrolytic production of copper, cadmium, tin, and the precious metals.—B. Bl.

**\*New Current Leads for Vacuum Vessels.** H. Handrek (*Z. tech. Physik*, 1934, **15**, 404-406).—Employing glass as an intermediary, it has been found possible to provide vacuum vessels with metal lead-in conductors set in ceramic materials. The most important condition to be satisfied in order that the glass-ceramic material may afford a permanent gas-tight joint is that the coefficient of expansion of the glass must be smaller than that of the ceramic material.—J. S. G. T.

**Abrasion-Resistant Coke-Handling Equipment.** Chas. R. Locke (*Chem. and Met. Eng.*, 1934, **41**, 352-354).—Abstract from paper read before the A.G.A. Production and Chemical Conference, 1934. The chief applications of non-ferrous metals for abrasion-resistance are in the form of welding-rods, applied to wear-resisting surfaces by either acetylene or electric welding. These rods are usually alloys of cobalt, tungsten, and chromium (*e.g.* Stellite). Hammers for coal pulverizers, large sprocket teeth, ram shoes, carbon cutters, water-cooled beams in water-gas machines are instances of such applications. The use of nickel-copper alloy has increased the life of impellers of a quenching pump from 6-8 weeks to more than 2 years.—F. J.

**Rebuilding Pulp Grinder Shafts.** Harry A. Walker and D. S. Lloyd (*J. Amer. Weld. Soc.*, 1935, **14**, (1), 9-10).—Corroded threads in 8-15 in. diameter steel shafts are turned out and rebuilt with bronze, deposited by the oxy-acetylene process and then machined. The part of the shaft to be treated is preheated evenly all round.—H. W. G. H.

**Metallic Wallpaper.** A. F. Dufton (*J. Inst. Heat. Ventilating Eng.*, 1934, 2, 218-220; *Building Sci. Abs.*, 1934, 7, 413).—In an earlier paper (*Met. Abs.*, 1934, 1, 370) it was suggested that if the inner surfaces of the external walls of a room were covered with metal foil they would act as reflectors and thus reduce the heat loss from the room. Study of this possibility has been carried out since at the Building Research Station, Watford, in which comparison has been made of the heat requirements of rooms with and without metallic wallpaper. The investigation showed that the use of such paper results in a saving of heat of 8%.—S. G.

## XXII.—MISCELLANEOUS

(Continued from p. 189.)

**The Origin of Metal Alloying.** Ernest A. Smith (*Met. Ind. (Lond.)*, 1935, 46, 375-377).—The earliest intentional alloys were those of the precious metals, such as Electrum, which is gold containing 20-30% of silver, made at least 4000 years B.C. and probably very much earlier. Base metal alloys were made and used long before they were produced by direct melting. The production and the use of early bronzes and nickel-copper alloys are discussed.—J. H. W.

**Discover Ancient Bronze in Sweden.** Sixten O. V. Nilsson (*Foundry*, 1934, 62, (5), 24-25, 54).—The excavation of a mound near Enköping, not far from Stockholm, Sweden, revealed a number of moulds, castings, and small clay crucibles, dating back about 3000 years. Some of the castings, e.g. pins with ornamental heads, used for fastening the clothing, are described. Many of the castings indicate that the ancient Swedish foundrymen were highly skilled craftsmen.—F. J.

**A Modern Research Department.** — (*Mech. World*, 1934, 96, 4-8).—The new central research department which the United Steel Companies, Ltd., have built at Stocksbridge is described and illustrated.—F. J.

**The Electric Equipment of the Physico-Chemical Institute in Madrid [Spain].** — (*Elektrochem. Z.*, 1935, 56, 175-176).—B. Bl.

## XXIII.—BIBLIOGRAPHY

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

(Continued from pp. 189-192.)

- \***Altmannsberger, K.** *Neuzeitliche galvanische Metallveredelung. Wege und Winke zur Erzielung hochwertiger Metallaufstagen und Arbeitsmethoden der heutigen Galvanotechnik.* Med. 8vo. Pp. 160, with 11 illustrations. 1935. Coburg: Müller und Schmidt. (Kart, R.M. 5.)
- \***Association of British Chemical Manufacturers.** *Directory of British Fine Chemicals produced by Members of the Association.* Demy 8vo. Pp. 62. 1935. London: The Association, 166 Piccadilly, W.I.
- \***Bowe, Jas. F.** *Foundryman's Reference Book. A Convenient Reference Book for Those Interested in the Grey Iron, Malleable Iron, or Non-Ferrous Casting Industries.* Revised by A. A. Grubb. Post 8vo. Pp. 219, illustrated. 1934. Albany, N.Y.: Albany Sand and Supply Co. (\$2.00, post-free.)
- Bromlei, W. G.** *Thermal Treatment of Metals.* [In Russian.] Pp. 192. 1934. Moscow and Leningrad: Kois. (Rbl. 2.50.)
- \***Campbell, Harry L.** *The Working, Heat-Treating, and Welding of Steel.* Supplemented with a Series of Laboratory Assignments. Med. 8vo. Pp. ix + 185, with 94 illustrations. 1935. New York: John Wiley and Sons, Inc. (\$2.25); London: Chapman and Hall, Ltd. (11s. 6d. net).

- Compton, Arthur H., and Samuel K. Allison.** *X-Rays in Theory and Experiment.* Second Edition of "X-Rays and Electrons," by Arthur H. Compton. Med. 8vo. Pp. xiv + 828. 1935. New York: D. Van Nostrand Co., Inc. (\$7.50.)
- Dymow, A. M.** *Laboratory Guide for the Technical Analysis of Metals.* [In Russian.] Third Edition. Pp. 207. 1934. Moscow and Leningrad: Goschimtechisdat. (Rbl. 3.)
- Electrical Industry.** *The Blue Book, 1935: the Directory and Handbook of the Electrical and Allied Industries.* Fifty-Third Edition. Roy. 8vo. Pp. xxviii + 1436. 1935. London: Benn Bros., Ltd. (25s. net.)
- Ferrer, E. J.** *L'Alumini i els seus aliatsges.* Pp. 59. 1935. Barcelona: Editorial Instituto de Estudios catalanes.
- \***Geisler, Kurt W.** *Unsere Verbrauchsgüter und ihre Herstellung. Ein technologisches Lesebuch.* Med. 8vo. Pp. vi + 177, with 117 illustrations. 1935. Berlin: VDI-Verlag G.m.b.H. (Br., R.M. 3.90; VDI.-Mitgl., R.M. 3.50.)
- Gilchrist, Donald B.** Edited by. *Doctorial Dissertations Accepted by American Universities, 1933-1934.* Compiled for the National Research Council and the American Council of Learned Societies by the Association of Research Libraries. Pp. 88. New York: H. W. Wilson Co. (\$1.00.)
- Giua, M., e C. Guia-Lollini.** *Dizionario di Chimica.* Volume 2: F-Z. Pp. 1208. 1934. Torino: Unione Tipografico-Editrice Torinese. (175 lire.)
- Gold and Platinum.** *Concentration and Metallurgy of Gold and Platinum. Collected Scientific Works.* [In Russian.] Pp. 162. 1934. Moscow, Leningrad, and Swerdlowsk. Metallurgisdat. (Rbl. 3.)
- \***Greaves, Richard Henry.** *Chromium Steels.* (Department of Scientific and Industrial Research.) Med. 8vo. Pp. vi + 321, with 78 illustrations in the text and 4 plates. 1935. London: H.M. Stationery Office. (7s. 6d. net.)
- [This book takes the form of a critical summary of the literature of chromium steels, but it also contains a description of some hitherto unpublished work carried out at the Research Department, Woolwich, on the influence of such quantities of silicon and manganese as may be found in the plain chromium steels, and on the influence of mass in heat-treatment. The evidence which has led to the present views on the constitution of the binary and ternary alloys of iron, carbon, and chromium is described and illustrated by the necessary diagrams. Many gaps still exist in our knowledge of the constitution of chromium steels, but the present position is summarized and physical data, with which any ultimate conclusions must conform, are quoted in detail. Mechanical and physical properties are discussed in the light of numerical values, which are fully reproduced, and a short account of the principal uses of the plain chromium steels is supplemented by an ample bibliography, dealing with the uses of chromium steels for structural purposes, rails, gauges and dies, ball bearings, magnets, valves. The volume should thus prove to be of value to the engineer, as well as to the metallurgist, whilst the chemist, interested in analytical procedure, will find in an appendix a full critical survey of the methods of chemical analysis suitable for chromium steels. The price is a most reasonable one.]
- \***Guillet, Léon.** *La Cémentation des Produits Métallurgiques et sa Généralisation.* Tome II.—*Généralisation de la Cémentation.* Roy. 8vo. Pp. x + 465, with 428 illustrations. 1935. Paris: Dunod. (Broché, 135 francs; relié, 145 francs.)
- \***Helsby, Cyril, and Conrad Wilson Hamann.** Edited by. *The Welding and Cutting Year-Book, 1934-1935.* Demy 8vo. Pp. 250, with 130 illustrations. 1935. Reading: The Berkshire Printing Co., Ltd. (6s.)

- \***Herty, C. H., and Associates.** *The Physical Chemistry of Steel Making.* (Mining and Metallurgical Investigations under auspices of Carnegie Institute of Technology and Mining and Metallurgical Advisory Boards.) Med. Svo. Pp. xvii + 31 + 48 + 42 + 43 + 104 + 60 + xxiv, illustrated. 1934. Pittsburgh, Pa.: Carnegie Institute of Technology. (\$3.00; or in form of separate Bulletins: Bull. 64, 50 cents; Bull. 65, 50 cents; Bull. 66, 50 cents; Bull. 67, 50 cents; Bull. 68, \$1.25; Bull. 69, 75 cents.)

[This book contains the following six Bulletins of the "Metallurgical Investigations," bound in convenient form. The Bulletins are also purchasable separately. Bulletin 64: C. H. Herty, Jr., M. W. Lightner, and D. L. McBride, "The Effect of Deoxidation on the Rate of Ferrite Formation in Plain Carbon Steels"; Bulletin 65: C. H. Herty, Jr., D. L. McBride, and S. O. Hough, "The Effect of Deoxidation on Grain-Size and Grain-Growth in Plain Carbon Steels"; Bulletin 66: C. H. Herty, Jr., and B. N. Daniloff, "The Effect of Deoxidation on the Ageing of Mild Steels"; Bulletin 67: C. H. Herty, Jr., and D. L. McBride, "Effect of Deoxidation on the Impact Strengths of Carbon Steels at Low Temperatures"; Bulletin 68: C. H. Herty, Jr., C. F. Christopher, H. Freeman, and J. F. Sanderson, "The Physical Chemistry of Steel Making. The Control of Iron Oxide in the Basic Open-Hearth Process"; Bulletin 69: C. H. Herty, Jr., "The Deoxidation of Steel." Each Bulletin contains a useful bibliography.]

- \***Hiltner, Werner.** *Ausführung potentiometrischer Analysen nebst vollständigen Analysenvorschriften für technische Produkte.* Med. 8vo. Pp. vii + 141, with 16 illustrations. 1935. Berlin: Julius Springer. (R.M. 6.60.)

- Hoke, C. M.** *Testing Precious Metals. Identifying, Buying, Selling.* Second Edition. Pp. 60. New York: Jewellers' Technical Advice Co. (\$1.00.)

- Hug, A.** *Die wirtschaftliche Bedeutung des Aluminiums.* 8vo. Pp. 243. 1934. Berlin: N.E.M.-Verlag. (R.M. 6.)

- Index Generalis.** Quinzième édition française. Annuaire général des Universités et des Grandes Écoles; Académies, Archives, Bibliothèques, Instituts scientifiques, Jardins botaniques et zoologiques, Musées, Observatoires, Sociétés savants. Publié sous la direction de R. de Montessus de Ballore. Cr. 8vo. Pp. vi + F 176 + US 228 + BE 232 + 1284 + 1921 + 2462. 1935. Paris: Éditions Spes. (225 francs.)

- \***International Conference on Physics, London, 1934.** *Papers and Discussions.* In two volumes. 4to. Volume I.—*Nuclear Physics.* Pp. viii + 257, illustrated. Volume II.—*The Solid State of Matter.* Pp. viii + 182, illustrated. 1935. London: Physical Society. (Bound, 12s. 6d.; unbound, 10s., per volume, post free.)

[Volume II, contains, among others, the following papers: F. Hund, "Description of the Binding Forces in Molecules and Crystal Lattices on Quantum Theory"; P. P. Ewald and M. Renninger; "The Mosaic Texture of Rock Salt"; A. Goetz, "Experimental Evidences of Group Phenomena in the Solid Metallic State"; A. Joffé, "On the Cause of the Low Value of Mechanical Strength"; A. Joffé, "On the Mechanism of Brittle Rupture"; E. Orowan, "The Rupture of Plastic Crystals"; A. Smekal, "The Structure-Sensitive Properties of Salt Crystals"; W. G. Burgers, "Shear Hardening and Recrystallisation of Aluminium"; E. Schmid, "On Plasticity, Crystallographic, and Non-Crystallographic." The papers form the subject of discussions on the structure of molecules and of the ideal lattice; deviations of real crystals from the ideal lattice structure, and plasticity and strain-hardening in crystals.]

- \***International Conference on Physics, London, 1934.** *International Union of Pure and Applied Physics. Reports on Symbols, Units and Nomenclature.* Approved by the General Assembly of the Union at its Meeting in London on 5th October, 1934. 4to. Pp. v + 40. 1935. London: Physical Society. (Bound, 5s.; unbound, 2s. 9d., post free.)

\***Iron and Steel Institute.** *Third Report of the Corrosion Committee.* Being a Report by a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council. Demy 8vo. Pp. ix + 214, with 53 illustrations. 1935. London: Iron and Steel Institute, 28 Victoria St., S.W.1. (16s.)

[The contributions to this report are of purely ferrous interest.]

**Korenblit, A. I.** *Deutsch-russisches technisches Wörterbuch.* 5 Auflage, Teil III.—*Praschen-Zypressenmoos.* Pp. iv + 1601-2440. 1934. Lenin-grad: Goschimtechisdat. (Rbl. 7.)

\***Lange, Norbert Adolph.** Compiled and Edited by. Assisted by **Gordon M. Forker.** *Handbook of Chemistry. A Reference Volume for all Requiring Ready Access to Chemical and Physical Data Used in Laboratory Work and Manufacturing.* With an Appendix of Mathematical Tables and Formulæ by **Richard Stevens Burlington.** Demy 8vo. Pp. xiv + 1265 + 248 + 29. 1934. Sandusky, O.: Handbook Publishers, Inc. (\$6.00.)

\***McClelland, E. H.** *Review of Iron and Steel Literature for 1934.* A Classified List of the More Important Books, Serials, and Trade Publications during the Year: with a few of Earlier Date not Previously Announced. (Reprinted, with additions, from "The Blast Furnace and Steel Plant" and "Heat-Treating and Forging," Jan.-Feb., 1935.) Cr. 8vo. Pp. 26. 1935. Pittsburgh Pa.: Carnegie Library of Pittsburgh.

\***McCombs, Lois F., and Morris Schrero.** Compiled by. *Bibliography of Non-Metallic Inclusions in Iron and Steel.* (Mining and Metallurgical Investigations under auspices of Carnegie Institute of Technology and Mining and Metallurgical Advisory Boards. Cooperative Bulletin No. 70.) Med. 8vo. Pp. xii + 308. Pittsburgh, Pa.: Carnegie Institute of Pittsburgh. (\$4.00.)

[2136 items are listed, with a subjects index.]

\***Marsh, J. S.** *Principles of Phase Diagrams.* With a Foreword by John Johnston. (Alloys of Iron Research Monograph Series.) Med. 8vo. Pp. xv + 193, with 180 illustrations. 1935. New York: McGraw-Hill Book Co., Inc. (\$3.30); London: McGraw-Hill Publishing Co., Ltd. (18s. net).

\***Metal Statistics.** *Metal Statistics, 1935.* Twenty-Eighth Annual Edition. Post 8vo. Pp. 560. 1935. New York: American Metal Market. (\$2.00.)

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

- \*Moore, Herbert F., Bernard B. Betty, and Curtis W. Dollins. *The Creep and Fracture of Lead and Lead Alloys*. A Report of an Investigation Conducted by the Engineering Experiment Station, University of Illinois, in cooperation with The Utilities Research Commission. (University of Illinois Bulletin. Vol. XXXII, No. 23; Bulletin No. 272 Engineering Experiment Station.) Med. 8vo. Pp. 47, with 31 illustrations. 1935. Urbana, Ill.: Engineering Experiment Station, University of Illinois. (50 cents.)
- Non-Ferrous Metals.** *Collected Papers on the Working of Non-Ferrous Metals*. [In Russian.] Pp. 72. 1934. Moscow, Leningrad, and Swerdlowsk: Metallurgisdat. (Rbl. 1.10.)
- Obraszow, A. W. *Rolling*. Part III. [In Russian.] Pp. iv + 188. 1934. Leningrad, Moscow, and Swerdlowsk: Gos. nausch-techn. isd. po Tschernoi i zwetnoi metallurgii. (Rbl. 2.60.)
- Oxford University.** *Abstracts of Dissertations for the Degree of Doctor of Philosophy*. Volume VI. Pp. 303. Oxford: Clarendon Press. (3s. 6d.)
- Paris**, —. *Contribution à l'étude des alliages ternaires*. Pp. 94. 1935. Paris: Gauthier-Villars et Blondel La Rougery. (25 francs.)
- \*Paterson, Clifford C. *The Electron Liberated: Its Industrial Consequences*. Med. 8vo. Pp. 20, with 1 illustration. [1935.] London: The British Science Guild, 6 John St., Adelphi, W.C.2. (1s.)
- Perlin, I. L. *The Drawing of Non-Ferrous Metals and Their Alloys*. [In Russian.] Pp. 324. 1934. Moscow, Leningrad, and Swerdlowsk: Metallurgisdat. (Rbl. 4.25.)
- Pittsburgh, University of.** *Abstracts of Theses, Researches in Progress, and Bibliography of Publications. The Graduate School*. Volume X. (University of Pittsburgh, Bulletin 31, No. 1.) Pp. 676. Pittsburgh, Pa.: University of Pittsburgh.
- Pokrowski, J. M., and M. N. Snamenski. *Treatise on the History of Metallurgical Technique*. [In Russian.] Pp. 287. 1934. Moscow: Isdatbjuro Mosk. gornogo Inst.
- \*Preston, G. W. *Cadmium-Copper: Its Importance as an Overhead Transmission Line Conductor Material*. 6 in. × 8½ in. Pp. 16, with 5 illustrations. (Copper Development Association Publication No. 11.) 1935. London: Copper Development Association, Thames House, Millbank, S.W.1.  
[Reprinted from *Elect. Rev.*, 1935, Mar. 15.]
- \*Preston, G. W. *Steel-Cored Copper Conductors*. 6 in. × 8½ in. Pp. 17, with 3 illustrations. (Copper Development Association Publication No. 10.) 1935. London: The Copper Development Association, Thames House, Millbank, S.W.1.  
[Reprinted from *Electrician*, 1935, Feb. 22.]
- \*Schmid, E., und W. Boas. *Kristallplastizität mit besonderer Berücksichtigung der Metalle*. (Struktur und Eigenschaften der Materie. Eine Monographiensammlung. Begründet von M. Born und J. Franck. Herausgegeben von F. Hund und H. Mark.) Demy 8vo. Pp. x + 373, with 222 illustrations. 1935. Berlin: Julius Springer. (Geh., R.M. 32; geb., R.M. 33.80.)
- \*Scriabine, I. *Les matériaux constitutifs de l'appareillage chimique: leur résistance à la corrosion*. Med. 8vo. Pp. 100, with 23 illustrations in the text. 1934. Paris et Liège: Ch. Béranger. (20 francs.)



- \***Seely, Fred B.** *Resistance of Materials*. Second Edition. Med. Svo. Pp. xii + 436, with 383 illustrations. 1935. New York: John Wiley and Sons, Inc. (\$3.75); London: Chapman and Hall, Ltd. (18s. 6d. net).
- \***Shipowners, Shipbuilders, and Marine Engineers.** *The Directory of Ship-owners, Shipbuilders, and Marine Engineers, 1935*. Thirty-Third Edition. Demy 8vo. Pp. 812 + 71. 1935. London: The Directory Publishing Co., Ltd., 33 Tothill St., S.W.1. (20s. net.)
- Size love, Oliver J.** *Platers' Guide Book. 1935 Solutions Edition*. 4th revision. Pp. 64 + 10. New York: Metal Industry Publishing Co. (Gratis to subscribers to "Metal Industry" (U.S.A.) and "Platers' Guide.")
- Stanford University.** *Abstracts of Dissertations for the Degree of Doctor of Philosophy and Doctor of Education, with the Titles of Theses Accepted for the Degrees of Master of Arts and Engineer, 1933-1934*. Volume IX. (Stanford University Bulletin, 1934, No. 178.) Pp. 192. Stanford University, Cal.: Stanford University.
- Tartakowski, W. J.** *The Determination of Metallic Magnesium, Magnesium Oxide, and Magnesium Fluoride in the Products of Electrolytic Extraction of Metallic Magnesium*. [In Russian.] Pp. 16. 1934. Moscow, Grosny, Leningrad, and Nowossibirsk: Gos. nausch.-techn. gorno-geol.-neft. isd. (K. 65.)
- \***Turner, C. A. P.** *Elasticity, Structure, and Strength of Materials Used in Engineering Construction*. Med. 8vo. Pp. xv + 416, with numerous illustrations. 1934. Minneapolis, Minn.: C. A. P. Turner, 342 Builders' Exchange. (\$6.00, post free.)
- \***U.S. Department of Commerce, National Bureau of Standards.** *Standard Samples Issued or in Preparation by the National Bureau of Standards*. (Supplement to National Bureau of Standards Circular C 398.) Med. 8vo. Pp. 11. 1935. Washington, D.C.: Government Printing Office.
- Universities Bureau of the British Empire.** *The Year-Book of the Universities of the British Empire, 1935*. Cr. 8vo. Pp. xxxi + 1057. 1935. London: G. Bell and Sons, Ltd. (15s. net.)

#### NEW PERIODICALS.

- Metal Treatment.** No. 1. (Spring 1935.) Industrial Newspapers, Ltd., 49 Wellington St., Strand, London, W.C.2. Published quarterly. 1s. per copy.
- World Survey.** Volume 1, No. 1. (April 1935.) Published under the auspices of the World Power Conference. Percy Lund Humphries and Co., Ltd., 12 Bedford Sq., W.C.1. Published monthly. 5s. net. per copy. [Contains the International Power and Fuel Bibliography.]
- Zapiski Institutu Khenii, Vse. Ukrain'ska Akademia Nauk.** (Memoirs of the Institute of Chemistry, All-Ukrainian Academy of Sciences.) No. 1 (1934). All-Ukrainian Academy of Sciences, Kiev, Ukraine. Rbl. 3.50 per issue.
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## XXIV.—BOOK REVIEWS

(Continued from pp. 192-196.)

**Handbuch der Metallphysik.** Herausgegeben von G. Masing. Band I: *Der Metallische Zustand der Materie.* Erster Teil, Lief. 2: *Grundlagen des metallischen Zustandes. Physikalischen Eigenschaften.* Von G. Borelius. Pp. 181-496, with 166 illustrations. 1935. Leipzig: Akademische Verlagsgesellschaft m.b.H. (R.M. 27.)

I remember reading, in one of Leacock's thrillers, of a detective seated in his consulting room with a *bucketful* of cocaine and a dipper at his elbow. Well, that is the sort of lavish manner in which information relating to the physical properties of the metals and alloys is provided in this volume. This field has been intensely cultivated during the last 30 years or so, and the literature of the subject is very extensive and widely scattered. A summary of this literature has been long overdue and here at last is exactly what is required. Dr. Borelius, the author of this section of Volume I, discusses volume, pressure, magnetic and thermal characteristics of metals and alloys, electrical conduction, thermoelectricity, the effects of a magnetic field, optics and electronics of metals, and the electronic theory. The various matters are critically discussed; in general, references are given to all work of importance in the various subjects; outstanding papers are examined in very considerable detail. The total number of papers referred to amounts to many thousands, and the whole has been assembled to make very interesting reading.

All interested in the physics of metals or metallurgical physics will find this book one they will wish to possess. It is very well printed on good paper, the illustrations are clear, and the book is well bound. There was a dyspeptic who concluded a review with the remark that he had found no errors, but he had no doubt there were some. There are a few, very few in the book, e.g. S. H. Livens for G. H. Livens (p. 509). There is one misprint about which I would particularly remark as a variant of it occurs so often in English and French literature. The correct name of that great German physicist, the founder of the firm of Zeiss, is Abbe (pronounced Ab). In English and French literature it usually appears as Abbe. Here on p. 223 it appears as Abbee. A mere trifle in a book of such outstanding merit as this.

—J. S. G. THOMAS.

**Die Praktische Werkstoffabnahme in der Metallindustrie.** Von Ernst Damerow. Med. 8vo. Pp. vi + 207, with 280 illustrations. 1935. Berlin: Julius Springer. (R.M. 16.50; geb. R.M. 18.)

The great majority of books dealing with the strength and testing of metallic materials are concerned mainly with the scientific rather than the practical aspects of the subject. The object of the present one on practical acceptance testing and inspection is to deal with the question mainly from the point of view of the relevant specifications, and to attempt to dispel suspicion as between the two parties concerned—manufacturer and user.

The first half of the book describes the types of test most commonly used for acceptance purposes, viz. tensile (including extensometer tests for the determination of proportional limits and moduli), tensile at elevated temperatures, hardness, notched-bar, &c. Directions are given for the carrying out of these tests, and the best positions from which to take test-pieces indicated. Much space is devoted to the many types of bend test, and to tests intended to establish the forging qualities of materials. The testing of some special materials and components such as chains, springs, cast iron, welded joints, and case-hardening, is briefly treated. The next section is devoted to rough workshop methods of test, including the differentiation of types of steel by the sparks emitted in grinding.

The effects of impurities and defects on the properties of metals and the alteration of the latter by heat-treatment are described, and the volume concludes with an account of some testing machines and their calibration or checking. The book is well illustrated with diagrams and microphotographs, and a useful feature is the inclusion, in a pocket at the end, of a series of 9 tables giving in diagrammatic form the requirements of the principal specification authorities for many materials.

Whilst it is natural that the emphasis should be on German practice, this emphasis has here been carried rather too far. For instance, the 15 types of notched-bar test-piece illustrated do not include the standard Izod specimen. The space devoted to fatigue is scarcely commensurate with its importance, but this is perhaps a criticism rather of acceptance testing practice than of the book. The few words on the bearing of statistics on testing might usefully have been expanded. Low temperature annealing of wrought-iron chain is said to be not only useless but harmful, a statement entirely disproved both by research and practical experience in this country. Apart from these defects, this book should prove a useful work of reference to those interested in the testing of materials from the practical point of view.—D. G. SOPWITH.

**A Study of Crystal Structure and Its Applications.** By Wheeler P. Davey. (International Series in Physics.) Med. 8vo. Pp. xi + 695, with numerous illustrations. 1934. New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd. (45s. net.)

Professor Davey has written a most comprehensive and readable text-book, which will be widely consulted and used in the laboratory. He has covered the usual ground with great thoroughness, describing both the technique and the interpretation of X-ray crystal analysis, and the book is amply illustrated with diagrams and charts for computation. An appendix contains particulars of all the 230 space groups, and of the kinds of configuration which can be obtained from each. The theory of space groups and of atomic and molecular structure factors is fully treated. In addition to these features, however, which are usual in works on X-ray analysis, there are interesting chapters on the growth of crystals and on internal transformations in solid solutions, subjects which do not usually find a place in crystallographic works, but which are of present interest to metallographers. The existence of a mosaic structure in crystals is regarded as established, and its consequences are discussed. These chapters form a valuable survey of the present position on matters which are still the subject of controversy.

Although work on the structure of liquids and amorphous substances is described, the examples of persistence of nuclei in liquids are confined to non-metallic substances, except for a reference to the work of Goetz on bismuth, and the problem of the Beilby layer is not mentioned. It is true that this problem has been best attacked by the method of electron beam diffraction, and this method, a most valuable auxiliary to that of X-rays, is not dealt with. In view of the similarity of technique and the theoretical relations between the two methods, this subject should certainly be included whenever the book passes into a second edition. The chapter on solid solutions includes an account of work on Widmanstätten structures and a discussion of the mechanism of solid diffusion. The metallurgist will find much that is suggestive in these chapters. The style and printing are excellent.—C. H. DUNCAN.

**Les Matériaux constitutifs de l'Appareillage Chimique : Leur résistance à la Corrosion.** Par I. Sriabine. Med. 8vo. Pp. 100, with 23 illustrations in the text. 1934. Paris et Liège: Ch. Béranger. (20 francs.)

The author justly describes his little volume as "cet aperçu succinct des matériaux de l'appareillage chimique." The first chapter, dealing with general principles governing the choice of materials, provides an excellent example of sound sense and terse expression, and would in itself entitle the volume to a place on the bookshelf of every chemical engineer. Questions of price, mechanical properties, and thermal conductivity receive due consideration, as well as the subject of corrosion, which, it is pointed out, affects not only the life of a chemical plant, but also the purity of the product, whilst sometimes, owing to the catalytic activity of metallic compounds, it may cause unexpected reactions to make their appearance in the process. Recognition is given to the fact that the course of corrosion varies greatly with the conditions, that the behaviour of a fully immersed specimen is little guide to resistance to water-line conditions, and that oxygen, which stimulates the attack upon many materials, depresses that upon others.

The portions of the book dealing with individual materials are less uniform in quality. Of necessity, the author takes his experimental data from a number of different sources, and these are not all equally reliable; statements regarding the good resistance of certain materials appear unduly optimistic. There are some useful diagrams indicating the manner in which corrosion rate varies with concentration or other conditions. The chapter devoted to non-ferrous metals, 23 pages in length, contains short sections dealing with lead, aluminium, zinc, cadmium, magnesium, copper, nickel and its alloys, chromium, cobalt, tin, silver and the precious metals. Much of the book is devoted to ferrous metals or to non-metallic materials. —U. R. EVANS.

**Essentials of Metalworking. A Text-Book for Schools and Shops.** By Edward Berg and Bristol E. Wing. Post 8vo. Pp. 160, with 141 illustrations. 1934. Peoria, Ill.: Manual Arts Press (\$1.32); London: B. T. Batsford, Ltd. (6s. 6d.).

This is a very elementary text-book of a type which is too common. Much space is devoted to detailed descriptions of steel rules and spanners, whilst the only applications of 18:8 steel, which the authors could think of, are cutlery(!) and automobile trimmings. Monel metal receives better treatment, for, in addition to "sinks, table-tops, cafeteria equipment," the student is told that there are "other purposes." The book appears to be free from the usual "howlers," but is also free from sense of proportion. The binding, printing, and illustrations are excellent.—H. W. G. HIGNETT.



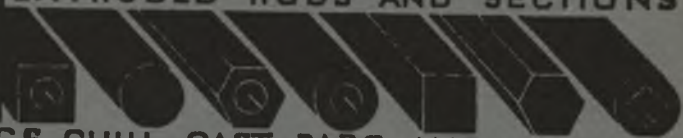
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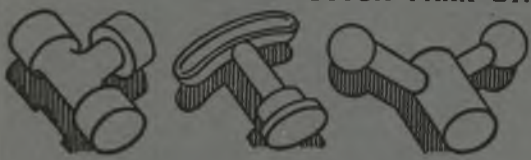
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