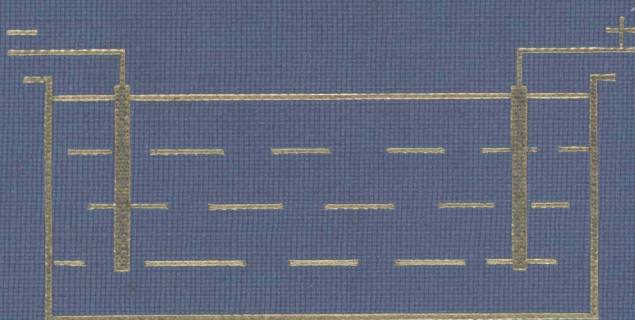


*Introductory*  
**ELECTROPLATING**



by E.A.OLLARD

# INTRODUCTORY ELECTROPLATING

An intermediate handbook of principles and  
practice in electroplating and related  
processes for students and general readers

*by*

ERIC A. OLLARD A.R.C.S., F.R.I.C., F.I.M., F.I.M.F.

*Consultant*

*Past President, Institute of Metal Finishing*

*Past Examiner in Electrodeposition, City & Guilds of London Institute*

ROBERT DRAPER LTD

TEDDINGTON

1969

## COPYRIGHT NOTICE

© E. A. Ollard, 1968

All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of Robert Draper Limited.

*Printed in Great Britain*

*by Clare o' Molesey Ltd, Molesey, Surrey*



## About the Author



MR. E. A. OLLARD was educated at St. Edward's School, Oxford and the Royal College of Science, South Kensington. After an absence of some four years with the Navy during the 1914-1918 war he obtained his A.R.C.S. in chemistry and then undertook a post-graduate course in metallurgy at the Royal School of Mines.

In 1920 he spent a year in a rolling mill and then turned over to electro-deposition, which has been his absorbing interest ever since. Some four years were spent in the Research Department of Metropolitan-Vickers Ltd. (as it was then) in Manchester and then seven years with the Gramophone Company Ltd. of Hayes, Middlesex.

During most of the last war he was with Cruickshanks Ltd. in Birmingham, a leading British electroplating supply house, and he contributed much to the technical development of his Company during that period.

At the end of the war he left Birmingham to take up the post of Electro-deposition Advisor with the British Non-Ferrous Metals Research Association in London. This position brought him into further contact with electroplating shops varying greatly in size, scope, manning and equipment and gave him a splendid opportunity to carry out the type of work which appeals to him most, namely, the investigation and solution of practical problems in the plating industry involving both processes and plant. Many firms in this country have reason to be glad of Mr. Ollard's advice which was always based on a thoroughly down-to-earth approach to the problem of obtaining quality finishes efficiently and at realistic cost within the limitations imposed by human nature

and permissible capital expenditure. After nine years he left the B.N.F. to become an active Director of Atlas Plating Works Ltd., a large trade plating firm in the London area carrying out an exceptionally wide range of electroplating processes, and also a Director of C. H. Rumble Ltd. who manufacture gramophone records.

Early in 1967 he retired from Atlas Plating Works Ltd. though he retains his Directorship of C. H. Rumble Ltd. and he now also acts as a General Consultant to the electroplating industry.

Mr. Ollard has had a distinguished career within the electroplating industry. Although he has not travelled widely, his name is known and respected in all parts of the world. He became a member of the Electrodepositors' Technical Society (now the Institute of Metal Finishing) when it was founded in 1925. He presented its second paper—on the subject of chromium plating, something which was very new in 1926—and he became its fourth President (1935-1937). Since that time he has served on its committees in various capacities over many years and he has always been one of its most staunch supporters.

Two particular interests have been in standard specifications and in education and training within the electroplating industry. The first led Mr. Ollard to serve on various committees of the British Standards Institution and he has been concerned with the drafting of a number of plating specifications. The second prompted him to become the Examiner in Electrodeposition to the City and Guilds of London Institute, which position he held for some years, and also to write a book 'Elementary Science for Electroplating Students and Foremen', first edition 1961, second edition 1965, third edition 1969, published by Robert Draper Ltd. This book has the express purpose of helping foremen and others to acquire that knowledge of basic electroplating science which they need before they can take an intelligent part in meetings of technical societies, read technical articles and books and attend specialised courses of instruction which will help them to be more useful employees and to better their positions. He has also written a book, primarily for maintenance and supervisory staff, entitled 'Installation and Maintenance in Electroplating Shops' which was published by Robert Draper Ltd. in 1967.

## P R E F A C E

THE INSTITUTE of Metal Finishing has recently commenced to award a Metal Finishing Technicians Certificate to candidates who successfully pass the requisite examination. The syllabus for this examination has been published and a number of technical colleges are running courses based on this syllabus. However, students need books and at the present time there does not appear to be any one book which covers the whole subject. In addition, many of the books that do exist are of rather an advanced nature which may present difficulties to the student.

It was felt, therefore, that a book covering the whole syllabus of this examination would be useful, and it is the object of this book to cover this syllabus in such a way that anyone who has an elementary knowledge of chemistry, physics and mathematics should be able to understand the subject.\*

It should be pointed out, however, that the object of taking the certificate to be any one book which covers the whole subject. In addition, many of the in writing the book this matter has been kept in mind and a certain amount of additional matter, not actually required by the syllabus, has been incorporated to give the student the necessary knowledge which he will require when he actually takes charge of a plating shop. To this extent, therefore, this book has also been written for the general reader who requires a sound knowledge of basic electroplating and related techniques before proceeding to more advanced or more specialised reading matter. It is presumed that most readers will be actually employed in the electroplating industry and, therefore, a certain amount of plating shop phraseology has been used as the author believes it is better to write a book in a language which the reader is likely to understand rather than in exact scientific English with which he may not be familiar (in spite of the inclusion of English in the syllabus for the Advanced Metal Finishing Technicians Certificate !). Again references to other works have not been incorporated because the author does not believe that the reader will need to consult them at this stage.

---

\* Students without this elementary knowledge will need to take an introductory course in these subjects and may usefully consult the book 'Elementary Science for Electroplating Students and Foremen' by E. A. Ollard, published by Robt. Draper Ltd., Teddington.

It should be pointed out that this is an introductory text book only and that a great deal of matter has been purposely omitted. A second volume of a more advanced nature is in preparation and will satisfy the needs of those who wish to study the subject further.

*London,*  
*September 1968*

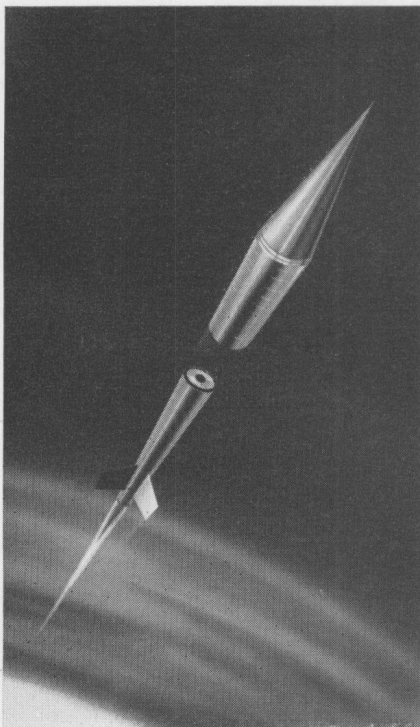
E. A. OLLARD



## plating with precious metals

Long association and extremely close co-operation with the plating industry has enabled Engelhard to offer a range of precious metal plating solutions to meet most industrial requirements.

Many years of experience in this highly specialised field is available to Engelhard customers through a team of technical service engineers. Literature will be sent on request.



This is the Skylark research vehicle constructed by the British Aircraft Corporation. One of its tasks is to measure electron density in the ionosphere. The nose cone contains sensitive equipment which includes a module gold plated with an Engelhard solution. Gold plating ensures efficient and reliable electrical bonding at a radio frequency of 39 Mcs. The module was prepared by the Electron Physics Department of the University of Birmingham

**ENGELHARD**

S A L E S   L I M I T E D

**Chemical Division**

Valley Road Cinderford Gloucestershire Telephone: Cinderford 2181 Telex: 43274



# ELECTROPLATING & METAL FINISHING

During the whole of its 21 years of publication **ELECTROPLATING & METAL FINISHING** has been able to claim a readership widely international in scope for the simple reason that it has always kept itself in the forefront of technical progress and at the same time has anticipated possible applications of modern metal finishing techniques to industrial trends.

Known all over the world today as **THE METAL FINISHING TRADE'S JOURNAL** it is as widely read in Detroit, Moscow, Australia, India, Peking and Tokyo as in the U.K. and other countries in Europe, where it is accepted as a leading authority covering an increasingly important field.

Month by month **ELECTROPLATING & METAL FINISHING** deals with every aspect of the finishing of metals and metal products, anodising, galvanizing, polishing, phosphating, plating on plastics, colouring, spraying, chromizing, organic finishing, corrosion resistance, pickling, vitreous enamelling and other aspects of the industry.

Special features apart from **COMMENT** include original and exclusive articles by experts in the U.K. and overseas as well as an invigorating monthly **SPOTLIGHT** commentary on current topics and industrial trends. Readers are kept up to date with illustrated articles on new processes and equipment and application stories and, last but not least, personal news of those engaged in various branches of metal finishing and allied fields at home and overseas.

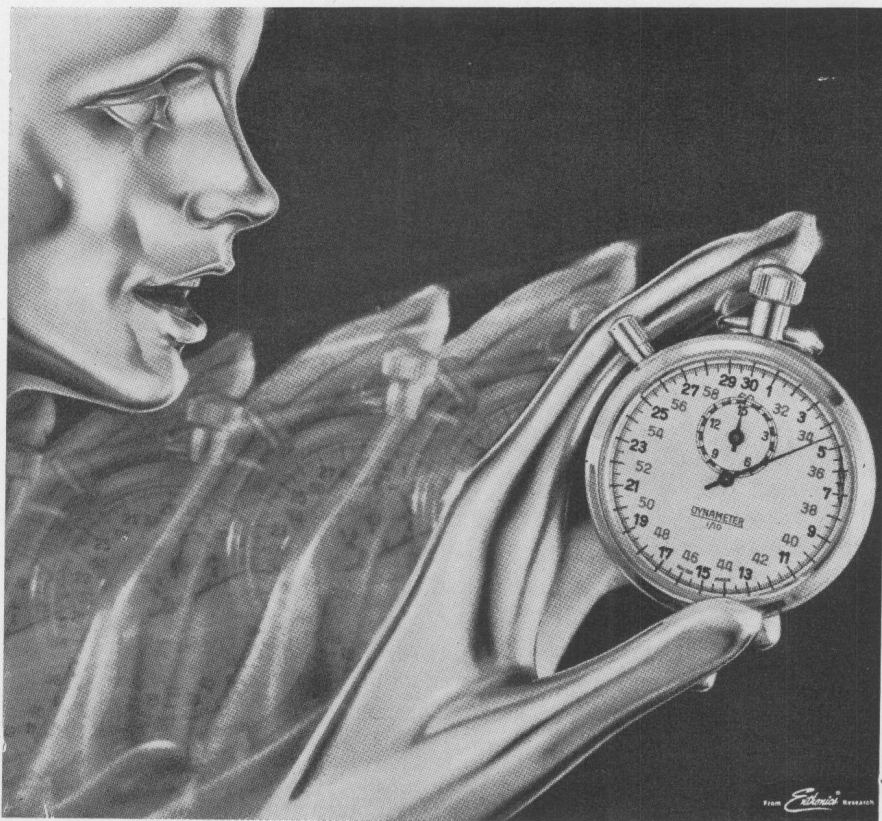
## *SUBSCRIPTIONS*

Remittances to the Accounts Department,  
46 Chancery Lane, London W.C.2.

U.K. and Ireland		U.S.A.	Elsewhere	
One Year	£3.5.0d	One Year	\$13.00	One Year £4.10.0d
Two Years	£6.5.0d	Two Years	\$24.00	Two Years £8.10.0d
Three Years	£9.5.0d	Three Years	\$35.00	Three Years £12.10.0d (post free)

Published by **THE NORTHERN PUBLISHING CO LTD.**

**157 Hagden Lane, Watford WD1 8LW**



## Electroless Nickel Plating Record-Breaker: New, High-Speed ENPLATE<sup>®</sup> NI-415

**In speed:** a deposition rate of 0.7 mils per hour at 190 degrees Fahrenheit.

**In economy:** low production costs range from 6/- to 8/- to deposit a mil of electroless nickel per square foot of surface.

**In quality:** Enplate NI-415 liquid concentrates are made and quality-controlled to the highest purity standards.

**In stability:** Enplate NI-415 all but eliminates costly decomposition.

**In convenience:** Enplate electroless nickel has been especially designed to yield easy maintenance of solution.

And take your pick of the superlative physical properties of the electroless nickel coating, excellent solderability, lubricity and hardness . . . outstanding resistance to corrosion, erosion, wear and abrasion.

For full information on new Enplate NI-415 Electroless Nickel Plating, contact.

# PERNIX ENTHONE

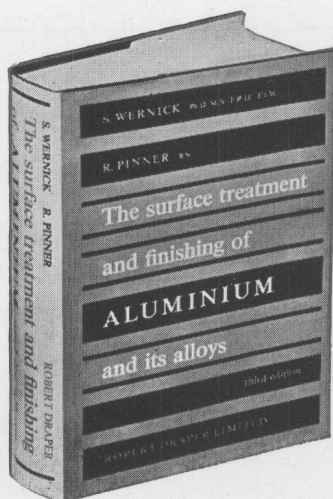
PERNIX ENTHONE LIMITED CHANTRY ROAD KEMPSTON BEDFORDSHIRE Telephone KEMPSTON 3541 Telegrams ENTHONICS BEDFORD

# Surface Treatment and FINISHING OF ALUMINIUM and its Alloys

By **S. Wernick**, Ph.D., M.Sc., F.R.I.C., F.I.M.  
and **R. Pinner**, B.Sc.

3rd Ed. August 1964 xxxii + 792 pp. 143 tables  
292 illustrations 1154 references

Price £8. 12s. 6d. (\$24.75) Post free



## Chapter

1. General Notes on Properties, Corrosion and Protection of Aluminium and its Alloys
2. Mechanical Surface Treatments and Finishes (polishing, scratch brushing matt and satin finishing, high lighting, blasting, embossing, barrelling, vapour blasting, contouring by shot peening, etc.)
3. Electrolytic and Chemical Polishing (theory, mechanism, Brytal, Alzak, Battelle, Alupol, Phosbrite, Alubril, E. W., Kaiser, General Motors and other industrial processes, drag-out, solution regeneration, reflectivity and durability of bright anodized aluminium, bright anodizing in the car industry, micrographic applications, etc.)
4. Cleaning and Etching (including washing machines, bright dips, etching for designs, etching before electroplating, chemical contouring (chemical milling), cleaning before and after welding, etc.)
5. Chemical Conversion Coatings (chemical oxide coatings, M.B.V., E.W., L.W., Pylumin, Alrok, Alodine (Alcrom) and Iridite processes, phosphating, applications in organic finishing, architecture, tubes, etc.)

## Chapter

6. Anodizing: General and Theory (types of anodizing processes, applications, the barrier layer, porosity, forming voltage, breakdown voltage, cell dimensions, etc.)
7. Decorative and Protective Anodizing (industrial sulphuric, chromic, oxalic, sulphamic, phosphoric, malonic, mellitic, and sulphasalicylic acid processes, Peintal, barrier-type and other processes, manual and automatic plant, barrel, wire and strip anodizing, jigs, solution control, etc.)
8. Architectural Anodizing (base metal, choice of finish, special anodizing processes, maintenance cleaning, organic coatings, assembling anodized architectural parts, pre-anodized strip, etc.)
9. Hard Anodizing (processes and equipment, suspension arrangements, stopping-off, honing and grinding etc., properties and applications of hard anodic oxide coatings, etc.)
10. Colouring (organic, inorganic and solvent dyestuffs, processes, faults, opaque coatings, multi-coloured effects, photographic processes, etc.)





**Offer a unique combination of technical expertise and practical experience to the field of electroplating processes and equipment.**



*The new complete plating department at the Canning Research Laboratories*

Canning Developments in the field of metal finishing are backed by extensive research and development facilities and an unrivalled technical service.

To keep in touch with the latest developments, ask for your name to be included on our mailing list.

**W. CANNING & CO. LTD. BIRMINGHAM, 18.**

BRANCHES: WATFORD · SHEFFIELD · GLASGOW    ASSOCIATED COMPANIES: AUSTRALIA · NEW ZEALAND · INDIA · SOUTH AFRICA · SPAIN

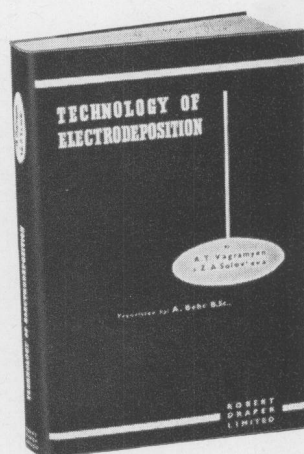
# Technology of ELECTRODEPOSITION

Mechanical and Physical Properties of Electrodeposits and Factors Affecting Their Control; Thickness Distribution; Fundamental Plating Theory; Surface-active Materials; Alternating Current; Alloy Plating.

**By A. T. Vagramyan and  
Z. A. Solov'eva**

Moscow 1961 Translated by A. Behr  
Published 1962 398 + xiv pp. 233 Figs.

Price 90/- (\$12.75) Postage 2/6 (50c.)



42 Tables.

## CONTENTS (abridged)

### Chapter

- Methods of studying the rates of electrode reactions.
2. Surface-active materials in electroplating.
3. Plating with alternating, pulsating or reversing current, (equipment, effect on deposit).
4. Alloy plating (methods of adjusting deposition potentials, effect of substrate, plating chromium, tungsten and molybdenum alloys)
5. Brightness (determination, factors influencing brightness, bright plating).
6. Hydrogen absorption (methods of studying, effect of metal, pH, current density, temperature).
7. Mechanical properties; internal stress (determination, factors affecting, causes); hardness (effect of c.d., temperature, electrolyte,

### Chapter

- surface-active materials, a.c. and pulsating currents, ultrasonics); brittleness (effect of c.d., electrolyte, treatment time, storage time).
8. Adhesion (methods of determining, factors affecting, relation between brightness changes and adhesion, application to copper-on-copper, zinc-on-aluminium, chromium-on-aluminium and nickel).
9. Porosity (methods of studying, factors affecting).
10. Current and metal distribution, covering and throwing power (methods of studying, effect of shape and size of tank, shape of electrodes, inter-electrode distance, position of electrodes, improving distribution, metal distribution in copper, zinc and chromium plating).

Critical survey of the world's literature, supplemented by original Russian work, on the electrodeposition process, the principal properties of electrodeposits and their dependence on operating conditions, substrate surface and plant design, and methods of investigation. A book for the man who is required to produce electrodeposits of consistent or controlled characteristics.

It is No. 2 in the RD Translation Series.

"Very interesting book with some excellent passages of information".—*Product Finishing*.

**ROBERT DRAPER LTD.**

KERBIHAN HOUSE 85 UDNEY PARK ROAD TEDDINGTON  
MIDDIX. Telephone 01-977 2207

11. Sealing (hot water, steam, dichromate, waterglass, nickel-cobalt acetate, nickel sulphate, lead acetate, sodium sulph-antimonate, molybdate, tannin, etc., combined sealing and dyeing, effect of sealing on lightfastness, heat resistance, etc., control of sealing baths, etc.)
12. Properties and Testing of Anodic Oxide Coatings (specific gravity, thickness, porosity, adhesion, hardness, abrasion resistance, flexibility, corrosion resistance, sealing efficiency, electrical properties, reflectivity and image clarity, thermal properties, tensile strength and fatigue effects)
13. Plating on Aluminium. A: General Notes; Direct Plating Methods; Etching Processes; Plating over Anodic or Chemical Oxide Coatings
14. Plating on Aluminium. B: Zinc Immersion Processes
15. Plating on Aluminium. C: The Vogt Process (including Ore's variation and the B.N.F. modification)
16. Plating on Aluminium. D: Hard Chromium; Immersion Tin, Copper and Silver; Chemical and Carbonyl Nickel; Properties, Tests, Applications and Specifications of Plated Aluminium
17. Organic Finishing (brushing, spraying, roller, dip, barrel, centrifugal and flow coating, pre-painted aluminium strip, primers and etch primers, finishing paints, clear lacquers, lacquer simulations of other finishes, sealing compounds, luminous paints, applications in architecture, air and space-craft, domestic appliances and collapsible tubes, marine applications, etc.)
18. Vitreous Enamelling (enamels, processes, defects, tests, architectural applications, etc.)
19. Metal Spraying (spraying onto aluminium, protection of aluminium alloys by sprayed aluminium, etc.)
20. Vacuum Coating.
21. Appendix: Composition and Properties of major British and U.S. Aluminium Alloys: Specifications  
Author and Subject Indexes

#### WORLD OPINIONS

- U.S.A.** "One of the most valuable compilations available to the metal finisher . . . No other source in the English language can even remotely compare with it in scope . . . a 'must' beyond question"—Metal Finishing'.
- Gt. Britain.** "An up-to-date survey that all concerned with aluminium and metal finishing generally will need to have at hand".—Dr. T.P. Hoar in the 'Journal of the Royal Institute of Chemistry'.
- Germany.** "Not only the chemist but also the engineer and designer will find it of great value . . . Industrial processes are described in such detail that in general it is unnecessary to study the original sources"—Prof. E. Raub in 'Metalloberfläche'.
- Italy.** "A book which is absolutely essential on all technical aspects"—F. Sacchi in 'Alluminio'.

#### ROBERT DRAPER LTD.

KERBIHAN HOUSE 85 UDNEY PARK ROAD TEDDINGTON  
MIDDLESEX. Telephone 01-977 2207



# *The modern* **ELECTROPLATING LABORATORY MANUAL**

Wide-ranging and comprehensive guide to all aspects of the plating chemist's normal duties. Includes tests for production processes and deposits, water, effluents, etc.; identification of finishes, metals and plastics; laboratory plating tests and trouble shooting; metallurgy and metallography in the plating laboratory; and a good selection of tables.

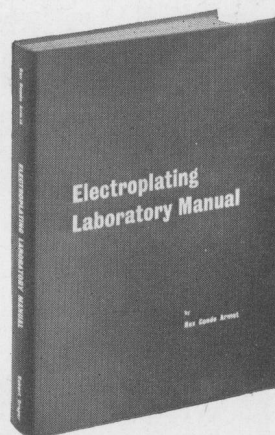
**by Rex Armet**

(Asst. Chief Chemist, Wm. Bate Ltd.)

Published December, 1965.

382 + xx pp 91 illus. 49 tables, 116 refs.

**Price 118s. (\$17.50) Post free**



## **CONTENTS**

(abridged)

### Chapter

1. Identification of finishes and base metals.
2. Identification of plastics.
3. Sampling of solutions.
4. Control tests for anodizing and ancillary solutions (polishing solutions, dye baths, etc.)
5. Brass plating solutions.
6. Cadmium plating solutions.
7. Chromium plating solutions.
8. Copper plating solutions.
9. Gold plating solutions.
10. Indium plating solutions.
11. Lead plating solutions.
12. Nickel plating solutions.
13. Silver plating solutions.
14. Tin plating solutions.
15. Zinc plating solutions.
16. Trade effluents.
17. Water.
18. Notes on E.D.T.A.
19. Notes on chromatographic analysis.
20. Use of thioacetamide and Murexide.

### Chapter

21. Laboratory plating tests and trouble shooting.
22. Mechanical, physical and electrical properties of electrodeposits and anodic oxide coatings.
23. Thickness tests.
24. Corrosion resistance.
25. Current instrumentation and supply.
26. The metallurgical microscope and its use in the electroplating laboratory.
27. Ferrous metal structure.
28. Heat treatment of steel.
29. Aluminium and its alloys.
30. Copper-base alloys.
31. Nickel alloys.
32. Zinc-base diecasting alloys.
33. Titanium, zirconium, niobium and semi-conductors.

### Tables.

### Bibliography.

### Index.

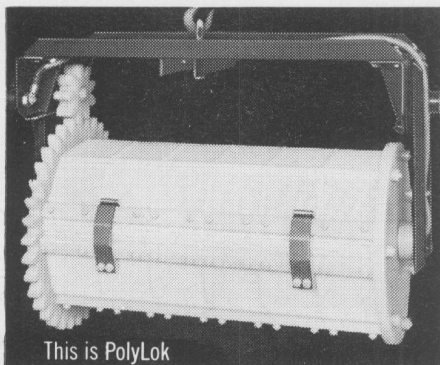
This book aims to provide the chemist concerned with the control of production plating, anodising, passivating and similar processes with all the information he will normally wish to have at his finger tips other than that which is already covered by Langford's 'Analysis of Electroplating and Related Solutions'. It therefore includes rapid control tests for main and ancillary solutions, water and effluents, laboratory plating tests for control purposes, 'trouble shooting', chemical, mechanical, physical and electrical tests on electrodeposits, checking plating rectifiers, the identification of finishes, metals and plastics, a section on metallurgy and metallography in the plating laboratory and a selection of tables designed to be of immediate value to the plating chemist.

**ROBERT DRAPER LTD.**

KERBIHAN HOUSE 85 UDNEY PARK ROAD TEDDINGTON  
MIDDX. Telephone 01-977 2207

# EFCO HAVE GOT PLATING COSTS OVER A BARREL!

Meet the Efco PolyLok Barrel.



This is PolyLok

And suddenly all other plating barrels are out of date.

It's lower priced for a start. Stronger, too. The polypropylene panels—8" x 6"—key together to make up a side—the sides join by simple rod and hinge method. So barrels are easily assembled in a range of standard sizes. Cuts maintenance bills, too—you pay only to replace a small panel... and you can fit it yourself.

Most important, PolyLok cuts plating costs. Why? Because the polypropylene panels

have rectangular holes (made possible by injection moulding) and these provide an increased open area. This leads to increased electrical conductivity.

And that leads to increased current for the same voltage.

Result: plating speed goes up, output goes up... only the costs go down.

**POLYLOK**

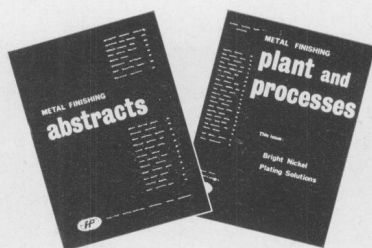
(patents applied for)

More details from  
Electro-Chemical Engineering Co. Ltd., Sheerwater, Woking, Surrey.



Electro-Chemical Engineering Co. Ltd., are the sole licensees of the Udylite Corporation for the manufacture and distribution of Udylite equipment and processes in the territories, and through the exclusive Efco-Udylite distributors, as follows:- **AUSTRIA**- Dr. Steiger & Felsenstein, Grm.b.H. Vienna. **AUSTRALIA**- Automatic Plating Equipment Co. Pty. Ltd., Melbourne. **BELGIUM**- Etabs. R. Corbiere, S.A. Brussels 9. **DENMARK**- J. A. Wallin, A/S. Copenhagen. **FINLAND**- Oy Kontino AB, Helsinki. **FRANCE**- Societe Continentale Parker, S.A. Paris. **GERMANY**- Friedr. Blasberg, Gm.b.H. Solingen. **HOLLAND**- Plating-Chemie N.V.'s-Hertogenbosch. **ISRAEL**- A. Normand Limited, Tel-Aviv. **ITALY**- Industria Metalchimica, Ing. A. & F. Stein, Milan. **NEW ZEALAND**- Automatic Plating Equipment (N.Z.) Ltd., Auckland. **NORWAY**- H. A. Johansen, Oslo. **POLAND**- Polcomex S.A. Warsaw. **SOUTH AFRICA**- Chemical Services (Pty) Ltd, Johannesburg. **SPAIN**- Instituto Electroquimico S.A. Barcelona. **SWEDEN**- A. B. Tudor, Stockholm. **SWITZERLAND**- A. Reymond et Cie, Bienne.

*Your complete  
guides to  
Metal Finishing*



## **Metal Finishing ABSTRACTS**

A complete bi-monthly survey of the metal finishing literature of the world covering over 850 technical journals from 52 countries, patents from Great Britain, U.S.A., U.S.S.R., Germany, Switzerland, France, Belgium, Canada and Japan, standard specifications, special reports, new books and translations. Classified under twenty section headings. Also available on filing cards.

**Annual Subscription :**

Surface Mail £15 (\$42.00). Air Mail £18 (\$50.00).

**Combined rate for both journals ordered together :**

Surface Mail £20 (\$56.00). Air Mail £24 (\$68.00).

## **Metal Finishing PLANT & PROCESSES**

A bi-monthly survey of all new products and processes, plant and chemicals, on an international scale presented in 20 classified sections similar to M.F.A. Each issue also includes a Process Guide devoted to a particular group of finishing processes (e.g. bright nickel plating processes, electrophoretic paints, pretreatment processes, etc.) or a Plant Guide devoted to an individual group of commercially available products (e.g. vapour degreasers, vibratory finishing units, airless spray painting equipment, etc.). Also available on filing cards.

**Annual Subscription :**

Surface Mail £8 (\$23.00). Air Mail £9.10.0d (\$27.00).



**FINISHING PUBLICATIONS LTD.,**

17 Cranmer Road, Hampton Hill, Middx.  
Telephone 01-979 7559