THE NEW ZEALAND INSTITUTE of CHEMISTRY

INC.

INDUSTRIAL CHEMICAL PRIZE ESSAY

1945

By M. FIELDES, M.Sc., A.N.Z.I.C.

WRIGHT & CARMAN, Ltd.
177 VIVIAN ST. WELLINGTON.

TABLE OF CONTENTS

I. Introduction

II. The Pre-War Importance of Electroplating Overseas

III. Electroplating in New Zealand

IV. The Effect of the War on New Zealand Electroplating

V. Modern Trends in Electroplating:
1. Equipment
2. Surface Preparation
3. Improved Plating Baths

VI. New Developments:
1. New Metals
2. Alloy Deposition
3. New Applications
4. Surface Treatments
   (i) Anodising
   (ii) Surface Treatment by Immersion
5. Electrolytic Polishing

VII. Possible Adverse Developments

VIII. Post-War Prospects

IX. Post-War Development

X. Suggested Plans for the Industry

XI. Proposed Methods of Assisting the Industry

XII. Summary:
1. Review
2. Conclusions

A Review of the Electro-Plating Industry in New Zealand

By M. Fieldes, M.Sc., A.N.Z.I.C.

(Dominion Laboratory, Department of Scientific and Industrial Research, Wellington)

—//—

I. INTRODUCTION

In the metal finishing industry the processes of electroplating and surface treatment are employed for three main purposes. A surface coating may be applied to a basis metal to improve its resistance to wear and corrosion, to modify the properties of the metal at its surface to make it suitable for special purposes such as reflectors and electrical contacts, or to improve its appearance.

New Zealand conditions differ so much from those of large industrial units like Great Britain and America that special consideration must be given to the development of the electroplating industry in this country. In spite of the impetus given to engineering by the war, New Zealand, because of its isolation, its small population and its position as essentially a primary producing country, will never become highly industrialised, but there is an increasing tendency for this country to become self-sufficient in the minor secondary industries and there will be a growing demand for electroplating.

The electrodeposition of metals has in recent years reached an advanced stage of scientific development. Strict attention must be given to the process itself, the constitution of the bath and the thickness, adhesion, protective value and physical properties of the deposit if the best finish is to be obtained. As the increasing complexity of the method is revealed it becomes obvious that the factors affecting the deposit require precise technical control.

It is important to consider to what extent scientific control and the introduction of newer methods can assist New Zealand electroplating, and this paper is intended to review the industry in the light of local conditions and to indicate in broad outline its prospects for future development.

II. PRE-WAR IMPORTANCE OF ELECTROPLATING OVERSEAS

Electroplating methods were first employed in 1838. From that time onwards the plating process was developed as an art mainly concerned with the deposition of copper, silver, gold and nickel, and for many years there were no fundamental changes in technique. In the twenty-five years prior to the present war, however, many important advances were made, and by 1940 methods had been developed for the electrodeposition of most of the metals available commercially.

Copper was among the most extensively used. Electrodeposition of copper from acid baths was employed in electroforming. Thin films of copper were used to increase the adhesion of subsequent coats, for obtaining oxidised finishes and to prevent deposition by immersion as in the case of nickel plating zinc alloys. Heavier layers were used to give localised protection to ferrous metals during case hardening, and also as a basis for nickel and chromium plating. The Rochelle salt bath was widely used and a high efficiency cyanide bath was just being introduced.

Nickel was used to protect steel, brass and zinc alloys and bright nickel plating had recently been introduced as an undercoat for decorative chromium. Chromium coatings were also employed commercially on account of their hardness, reflectivity and resistance to atmospheric corrosion.

Zinc, tin, lead and cadmium were being electroplated on steel to protect it from corrosion. Zinc as a cheap efficient protective coating where appearance was unimportant was already being used for continuous processing of strip steel and wire from the acid zinc bath. Tin was also being strip plated and was widely used in the food industry and as a basis for soldering. Lead plating on steel was employed principally for corrosion protection against non-oxidising acids, while the more expensive cadmium was used in thin coats chiefly as an attractive protective finish on steel and copper alloys for interior fittings.

Silver continued to be applied extensively to base metals for tableware and decorative articles and was finding increasing use for reflectors, electrical contacts and other special purposes.

Because of its price gold plating was limited to a few specific uses such as jewellery, laboratory apparatus, electrical contacts and infra-red reflectors.

A number of alloy plating processes were already firmly established and others were being developed.

III. THE GROWTH OF THE ELECTROPLATING INDUSTRY IN NEW ZEALAND

The growth of the electroplating industry in New Zealand has been slow. This is chiefly because of the absence of large scale mass production in this country, and although the electroplating generally has followed the trends of overseas practice the range and nature of local plating has been restricted, and in many cases the industry has not kept pace with modern developments. Electroplating has, however, played an important part in the Dominion's economy and made valuable contributions to our wartime production.

There are about thirty plating works in New Zealand, located mainly in the four centres. Many of these are job-plating works but some are connected to small engineering workshops and to a certain extent control the production of the articles they plate. In addition there are throughout the country many firms producing manufactured articles, which provide solely for their own plating requirements.

Very few plating shops have been specially designed and built for the purpose of plating. This condition is common to most New Zealand industries. Workshops are established in whatever accommodation is available, and with growing staff and equipment they become increasingly inadequate.

Although many of the firms are controlled by men with wide experience both in this country and overseas, very little technical control has been employed because of the small scale of the industry. As a result of the absence of demand few facilities exist for the training of electroplating technicians.

There is a tendency to regard the appearance of the finished article as the criterion of successful plating, and to this end other more important properties are frequently sacrificed. The main properties necessary for a plated article that is to give lengthy service are adequate adhesion, ductility and uniformity, and freedom from defects such as porosity, cracks, blisters and inclusions. Deficiency in these properties becomes apparent with thicker coats, so that in order to obtain good appearance under poor operating conditions thickness is sacrificed. Articles treated in this way cannot give satisfactory service. If the metal finishing industry is to perform its proper function in the post-war economy of the Dominion, New Zealand platers must be prepared to examine their processes and products critically with a view to supplying finishes that will bring credit to the industry.

IV. THE EFFECT OF THE WAR ON NEW ZEALAND ELECTROPLATING

Wartime conditions created shortages of cadmium, chromium, copper, nickel and tin and their use for civilian electroplating was curtailed and prohibited. In overseas countries this restriction and the growth of wartime industries in new localities resulted in a redistribution of the plating industry and the closing down of some shops dependent mainly on civilian requirements. In New Zealand, however, demands for military purposes and essential undertakings were sufficient to keep all shops working to capacity. In Wellington alone the number of articles plated for purely military purposes ran into many millions.

New standards of plating required by military specifications and the exacting demands of some wartime industries emphasised the need for fuller technical control and progress along modern lines. In New Zealand control in certain cases was specified for the preparation of the basis metal, the constitution and operation of the bath and for the thickness and properties of the coating. Although in some instances such specifications were merely used as a guide, in others they were fairly strictly adhered to and enforced by routine inspection. It is probable that in the future plating to specification will become the rule rather than the exception.

The war also resulted in closer collaboration between the engineering and the plating industries. The two industries are so interdependent that the fullest co-operation is desirable, and although their relation is not yet entirely resolved a stimulus has been given which will assist them to settle down into their true relative position in the post-war period.

V. MODERN TRENDS IN ELECTROPLATING

1. Equipment

Power plant in a modern plating works must be more flexible than that employed in the older type of shop. New baths permit the use of higher current densities and new methods may require a greater range of voltage. The tendency to plate to standard thickness, and in particular to deposit thick coats such as heavy nickel and abrasion resistant chromium, requires the use of baths for extended periods and increases the total load on the rectifying supply. Further demands may be made by the introduction of electrolytic degreasing and polishing.

Motor generator sets for direct current supply in plating works have a number of disadvantages. These include exposure to corrosive fumes, noisy and dusty operation, the nuisance of moving parts, unreliability for continuous full load duties owing to heating and sparking, inefficiency at reduced loads and lack of flexibility.

Modern metal rectifiers overcome most of these deficiencies. The selenium type of rectifier supplied from a tapped auto-transformer makes possible wattless control of plating current over wide ranges and is free from all the disadvantages mentioned. Metal rectifiers can be supplied in units for general purposes or specially designed for a particular job. They have the additional advantage that the units may be readily coupled in series for high voltage requirements or in parallel for high current loads. Their increased overall efficiency may reduce power costs to less than a quarter, and this factor offsets their higher capital costs.

Rectifiers therefore tend to replace motor generator sets for low voltage plating. For higher voltages in the neighbourhood of sixty volts, such as are required for chromic acid anodising, the initial cost of metal rectifiers is at present high compared with motor generators, which may therefore still be preferred.

In recent years the importance of proper agitation and the removal of suspended matter from plating baths has been fully realised. Effective methods have been devised for combined agitation, filtration and purification of the electrolyte by continuous circulation through filters. For mass production fully automatic methods of plating have been greatly improved and yield excellent, uniform coatings. Such methods involve heavy capital outlay and are not likely to be introduced in this country, but continuous filtration may be found desirable in many cases and semi-automatic control will definitely be justified.

2 Surface Preparation

Metal surfaces are treated prior to plating for three main purposes. First, polishing is necessary because the thin electrodeposited coats necessarily have the same general surface as that of the basis metal. Secondly, modification of the micro-structure of the basis metal may be required as its physical condition influences the properties of the plated coat, and thirdly, thorough cleaning is required to remove grease, dirt, corrosion product and residual chemicals which would cause poor adhesion and pitting of the plate.

The surface condition of the basis metal is determined by the processes to which it has been subjected. Certain mechanical treatment—such as excessive working—may result in poor adhesion. It is now recognised that preliminary etching is frequently required to obtain an adherent coating. Etching may be by simple immersion or by anodic treatment.

For the efficient removal of grease and dirt there is an increasing tendency to employ electrolytic treatment and vapour and solvent degreasing. The use of the latter has, however, been restricted during the war through the shortage of trichlorethylene and allied solvents.

3. Improved Baths

Recent improvements to plating baths have been principally in the direction of increased efficiency and in the use of brightening agents.

Progress has been hindered by the fact that chemical theory does not adequately cover the behaviour of concentrated aqueous electrolytes. As plating baths normally contain a number of constituents in relatively high concentration, for the present at least, advances must be made largely by trial and error.

The high efficiency copper cyanide bath developed by Du Pont is an example of a modern bath in which improved efficiency enables satisfactory coats to be obtained in reduced time. High current densities, high temperature and agitation are employed, and brightener and anti-pit substances are included in the bath as "addition agents."

"Addition agents" is a general term covering a wide variety of empirically selected and often secret substances which when added in small quantities to plating baths improve the properties of the plate. Bright plating baths of this nature have recently found extensive use for depositing cadmium and zinc coats of improved appearance and for nickel plating where they eliminate buffing prior to applying decorative chromium.

In general, the operation of improved rapid baths containing addition agents is more complicated and demands greater technical skill.

VI. NEW DEVELOPMENTS

1. New Metals

The development and application of new metal coatings has been governed by the availability of the metals concerned. The rapid advances made in electroplating in the past few decades have been largely due to the increased number of metals being produced on an industrial scale, and it is reasonable to anticipate similar advances as still further metals become available commercially. Manganese, recently produced in large quantities by electrolysis, may be mentioned as a metal which may shortly find uses in electroplating coatings.

Tin and lead are the most important of the metals that have only recently been electroplated on a large scale. Tin coatings give protection to steel by virtue of their covering power and not by sacrificial corrosion as is the case with zinc. The conventional hot-dipping process applies coats of varying thickness, and in obtaining adequate cover much tin is wasted. In 1935 a continuous process was developed for plating sheet steel from an acid tin bath. On account of the uniformity of the deposit, electrotinned steel uses only one-third of the tin required by the hot-dipping method. To ensure even distribution and obtain a shiny appearance similar to dipped tin, the strip plated steel is subjected to a continuous heating process, sometimes by high frequency electrical treatment, which melts the tin and causes it to flow. By 1943 electrolytic processes for tin plating were consuming about fifty per cent. of the world's tin production.

Until recently it has been customary to apply lead coatings by a hot-dip process in lead alloyed with a small proportion of tin. There is, however, an increasing tendency to employ electroplated lead. Lead is resistant to non-oxidising acids and atmospheric corrosion, and electrodeposited lead is superior to the hot-dipped coat, as it is less porous and can be stamped without distortion. Lead coatings on steel have been used as a substitute for cadmium and zinc, which are more expensive and in considerable demand. Lead is also extensively used to protect metals in contact with chemicals such as brine and sulphuric acid, in plating parts of storage batteries and in barrel plating of nuts and bolts. The most satisfactory electrolyte is lead fluoborate, which is prepared from basic lead carbonate, hydrofluoric acid and boric acid. Because of the risks entailed in its preparation, lead fluoborate is now made up in concentrated solution for supply to the plater.

Rhodium is another of the newer electrodeposited metals whose use developed greatly during the war. This metal has a number of superlative qualities. It is more resistant to tarnishing than platinum, has a very high melting point, is particularly hard, has good electrical conductivity, and when polished is highly reflective.

Prior to the war rhodium was used to a small extent as a flash coating on expensive silver plate to prevent tarnishing and improve reflectivity. Its use for this purpose was limited by its price, about four times that of gold. During the war it was used to coat electrical contacts as its hardness, conductivity and low contact resistance made it excellent for critical low voltages switches. It was also deposited, usually on top of silver, to form the reflecting surface of metal base mirrors in military instruments required to withstand heat and shock.

Platinum and palladium can both be successfully plated and resemble rhodium in their properties, but since for most purposes they are excelled by the latter their use has been limited. They are, however, cheaper, and have been used for electrical contacts and protective coats on laboratory equipment.

The use of indium as an electroplated coat has developed in the last few years. This metal has a low melting point and resists tarnishing. It is deposited on parts of internal combustion engines, particularly silver-lead bearings in aircraft, to give increased protection against wear, marine atmosphere and attack by the acids present in lubricating oils. In coating steel a thin coat of copper or silver is followed by lead plating. Indium deposited as a final layer is diffused into the undercoats by low temperature heating. It is an attractive finish resembling silver in its whiteness.

2. Alloy Deposition

Alloys produced by codeposition of metals cathodically have virtues similar to alloys produced by other means. Alloys are usually denser and harder than their constituent metals and may excel them in other desirable properties. In recent years the attention of the metallurgist has been directed towards alloys whose production by normal means is difficult or impossible, and considerable progress has been made in the fields of codeposition and powder metallurgy. Alloys may be deposited with uniform structure and fine grain size, and the fact that they may be produced at low temperature gives the method unique possibilities.

Brass and bronze plating have been used for many years for decorative purposes, to match a basis metal with solid brass or bronze and to obtain adhesion between rubber and steel. Bright nickel plate is obtained in Great Britain by codeposition of nickel and cobalt. The resulting coat is harder and more resistant than coatings of the individual metals. A wide range of other alloys have also been electrodeposited successfully in recent years.

The deposition of white bronze or speculum metal, an alloy containing sixty per cent. copper and forty per cent. tin, has been perfected during the war, and although, as with many other processes, details are not generally available at present, this alloy should prove very suitable as a coating for reflectors since it is non-tarnishing, hard, and comparable with silver in reflective properties.

The use of electroplated alloys for bearing metals is an important application of codeposition in engineering. Bearing metals made thus require little finishing, are produced at temperatures which do not affect the basis metal and have fine grain and uniform structure. Typical alloys for this purpose including silver-lead-indium, silver-cadmium, lead-tin and lead-copper yield for particular purposes the desired combination of hardness and freedom from friction. A further engineering application of codeposition is for the preparation of alloy powders for powder metallurgy.

Newer methods of alloy plating requiring critical control are likely to become important in post-war plating in New Zealand.

3. New Applications

Technical developments in industry are greatly assisted by electroplating. In planning the manufacture of a new type of article it is possible to choose for its construction a material that will give adequate structural strength and economy of production and rely on subsequent plating to obtain the desired surface properties. Demands of this nature sometimes require modified plating methods.

The extensive use of aluminium and its alloys in industry has inevitably led to a demand for electroplated aluminium. Early attempts to accomplish this by preliminary removal of the oxide film were unsuccessful. Aluminium can now be satisfactorily plated by first forming an anodically oxidised layer upon which, after modification in dilute hydrofluoric acid, deposits of most metals may be formed by normal plating processes. By this method aluminium and its alloys are coated with copper to permit soldering, brass to give adhesion to rubber, silver for high frequency conduction, cadmium for protection and nickel and chromium to obtain resistance to wear and burning in Diesel engines.

While the use of nickel and chromium for decorative plating was restricted in wartime, the application of these metals in much thicker layers of heavy nickel and hard chromium was extended and found uses in this country. On account of its resistance to abrasion hard chromium has been widely used for building up machine parts, plating gauges and precision moving parts, lining moulds for dies and many similar purposes. When engine cylinders and piston rings are chromium plated to prevent wear special attention must be paid to the porosity of the deposit which determines its capacity to hold lubricant. Porous chrome is produced by plating a coat somewhat thicker than that required and then reversing the current. In the reversal process the surface is broken up, and after subsequent honing yields the oil retaining, porous structure required.

An increased interest in plating on zinc and zinc alloys has arisen owing to the extensive use of zinc base alloys for the mass production of die-castings. Interior house fittings of this alloy are commonly nickel plated for protection and appearance. Since nickel tends to deposit on zinc by immersion the zinc surface is either flashed with copper before nickel plating or else a modified nickel bath is used permitting cathode potentials at the zinc high enough to prevent it from going into solution. Unless such measures are taken a satisfactory nickel coat is not obtained. Zinc base die casting has been widely used in New Zealand for the manufacture of war material, and the machinery acquired for this purpose will be available for peacetime production so that there is certain to be a demand for the electroplating of die cast articles in this country.

The development of automatic continuous plating of strip steel has resulted in a demand for electrotinned sheet, particularly by the canning industry. Strip plating is also extensively used for zinc coating wire and sheet steel. It is possible that the method will find applications for the deposition of other metallic coatings.

Satisfactorily plated sheet steel can be stamped into many shapes and forms. This method of obtaining plated articles possesses obvious advantages over a procedure in which the articles are formed first and subsequent plating involves handling great numbers of small articles.

Owing to the difficulty experienced in this country in obtaining replacement parts for machines manufactured overseas there is a field for the application of electroplating in the salvage of worn parts. Nickel chromium and iron can be used for this purpose. Another use of iron plating is made possible by the development of plastic moulding. The manufacture of steel dies can be simplified by preparing a prototype of easily worked material upon which the moulds can be built up by electroforming with thick deposits of iron.

4. Surface Treatment

In addition to cathodic deposition of metals there are ever-increasing numbers of processes for surfaces treatment of metals. Some of these employ electrolysis and others merely chemical treatment by immersion, but in either case they are of considerable interest to the plater as they come within the scope of the operations carried out in the plating shop.

(i) **Anodising.** By far the most important electrolytic process of surface treatment is the anodic oxidation of aluminium and its alloys. Enormous quantities of aluminium have been used for aircraft production and other military purposes. Aluminium will soon be in plentiful supply and available for many peacetime applications.

The anodising process is carried out by making an aluminium article the anode in a bath usually of chromic or sulphuric acid. Anodic oxidation occurs and the article is coated with a transparent film of oxide.

Aluminium in ordinary use is protected by a thin film formed by atmospheric oxidation. The thicker film produced by electrolysis increases this protection and has other valuable properties. For maximum protection the film is sealed by hydrating the oxide in boiling water or by boiling in potassium dichromate. The sealed layer forms a satisfactory base for subsequent waxing, oiling or painting.

Prior to sealing the anodic coating is highly absorptive and can readily be dyed. Aluminium articles coloured in this manner are peculiarly attractive, and as fast shades of all colours can be produced it is certain that this process will be widely used for decorative purposes. As die casting is well established here and is applicable to aluminium alloys, there are good prospects for the production of coloured aluminium in New Zealand.

Aluminium is light, readily shaped and highly reflective when polished. Reflectors made of shaped aluminium polished by special processes are protected from stain and tarnish by a transparent anodic film.

The oxide film may be sensitised by absorbing silver halides and photographs made on it by the ordinary process. The importance of such reproductions lies in their permanence. Their base is metal, the image formed within the pores is fast and, after sealing, resistant to abrasion.

The hardness of particles of aluminium oxide is well known. For this reason anodising is used for protecting moving parts—such as bearings and pistons—from abrasion.

The use of an anodic film to make possible electroplating of aluminium has already been described, and other uses include its application to reveal flaws in manufactured articles and for a number of electrical purposes utilising its insulating and dielectric properties.

Protective coatings can also be applied on magnesium by the anodic process, although the protection afforded is not comparable with that given by anodic films on aluminium. Post-war supplies of magnesium will be plentiful, however, and there will be definite uses for anodised magnesium.

(ii) **Surface Coating by Immersion.** Surface coatings applied by immersion are employed for the same general reasons as electrodeposited coatings. Chemical processing may give results not obtainable electrolytically or provide an adequate alternative finish by a method which is simpler or more economical to operate. Thus to increase the corrosion resistance of aluminium it is possible to form an oxide coating by chemical treatment in dichromate solutions. For certain purposes this treatment is an alternative to anodic oxidation, although it has a limited range of usefulness. Magnesium and its alloys may also be protected by alternative chemical or electrolytic processes and films of chromium salts applied by immersion to zinc or cadmium surfaces inhibit corrosion by contact with water and form a base for protective organic coats.

The use of phosphate coatings for iron, steel and zinc surfaces is well known. The early method of treating in dilute solutions of phosphoric acid known as Coslettising has given way to accelerated modern methods, the best known of which are Parkerising, Bonderising and Spra-Bonderising.

The Parkerising process applies a rust-proof coating to iron and steel articles. The phosphate layer produces little dimensional change and, being porous, may be stained black and sealed with suitable oils for further protection. Bonderising is used to provide ferrous metals, zinc and zinc alloys with a rust-proof base for subsequent lacquering and painting, while Spra-Bonderising is a recent modification using a rapid spray treatment for continuous processing methods which may be used in conjunction with strip plating of sheet steel with zinc.

A matt black oxide finish can be obtained on ferrous metals without great dimensional change by treatment in hot alkaline solutions. Oxide finishes can be oiled to increase their protection and provide a satisfactory base for paints and varnishes. They have been used as dull finishes for military purposes and as thin coats on precision gauges so that undue wear will be revealed by the appearance of the underlying steel.

The war created a considerable demand for black non-reflective surfaces. The dazzling reflection from the aluminium alloy or aircraft propellors was overcome by anodising and black dyeing, while black nickel plating was used to overcome reflection in other cases. Satisfactory immersion methods exist for blackening copper, brass, zinc, cadmium, nickel and steel.

The colouring of metals for decorative purposes introduces another field which is of importance to the electroplater. Typical examples are the production of bronze and antique finishes of various shades on brass and copper plated articles.

5. Electrolytic Polishing of Metals

The anodic treatments of metals for degreasing and for oxidation of aluminium have been mentioned. Anodic treatment can also be used for etching ferrous metals prior to plating and has of recent years attracted much attention because, by the use of suitable baths, many metals and alloys can be electrolytically polished.

During electrolysis, the ions discharged at the anode will react with it, if this is chemically possible. The products of such anodic reaction accumulate in the immediate neighbourhood of the anode and may create an electrical layer of high resistance compared with the bulk of the electrolyte. If this occurs at a rough surface the current is concentrated on points projecting beyond the polarising layer and such points are preferentially attacked. This results in a smooth or polishing action on the metal of the anode.

A great deal of attention has been paid to the use of anodic polishing for preparing metallographic sections for microscopic examination because it eliminates the tedium of mechanical polishing and the process does not produce surface distortion. Suitable baths for this purpose have already been obtained for many metals and other methods are constantly being published.

Industrially the method has been successfully used for polishing nickel, stainless steel and aluminium. A process for polishing nickel at high current density in an electrolyte consisting of 73 per cent. sulphuric acid has been patented in Great Britain. Sulphuric acid and phosphoric acid baths have been extensively used for stainless steel and a patented British process is employed for the final polishing of aluminium for reflectors.

For commercial use the method can possess many advantages. Considerable skill is required to polish satisfactorily by mechanical methods, whereas once a suitable electrolytic method is evolved its operation is relatively straightforward. In anodic polishing increasing surface area does not affect the polishing time, surface distortion is avoided and polishing is accomplished with very little loss of metal.

Possible disadvantages are that high current densities similar to those used in chromium plating may be required, making heavy demands on the rectifying equipment. The methods need fairly close control and some difficulties occur with articles of intricate shape. Thus with stainless steel the polishing is less in deep recesses while with nickel, although polishing is fairly even over the whole surface, trouble may occur if the original coating is thinner in the recesses owing to poor throwing power of the plating bath. These difficulties are offset by the fact that mechanical polishing of intricately shaped articles is often impossible.

The advantages of electrolytic polishing appear to be far greater than its disadvantages, and it should find favourable applications in this country. It is likely, too, that with the increased attention being paid to this method overseas new processes may soon be developed for the anodic polishing of other metal surfaces.

VII. POSSIBLE ADVERSE DEVELOPMENTS

There are a number of industrial methods which come into more or less direct competition with electroplating. Among these may be mentioned the production of protective and decorative finishes by painting, varnishing, lacquering and enamelling, the application of metallic coatings by engineering methods and the die casting of plastic articles.

Although there is considerable competition between the paint industry and electroplating, to a certain extent the two fields are complementary. Electroplating methods are used for the surface treatment of metals to secure adhesion of subsequent organic finishes and increase their durability, while on the other hand organic coats are frequently employed by the plater for protection of plated articles. Where the two methods conflict the ultimate choice will be that which gives most satisfaction in practice. In its own field electroplating has advantages as it is capable of producing coatings of guaranteed properties—a fact that should be fully utilised by the plater to ensure against loss of work to a rival industry.

Much the same considerations apply to competition from engineering methods of appliyng metal coatings. The advantages of plating over hot-dipping have been discussed. Metal finishes are also obtained by heating articles in powdered metal. Typical of the latter process is the method of Sheradising for obtaining coats of zinc, cadmium-zinc and chromium on brass and steel and Calorising for applying heat resistant aluminium coats to copper, copper alloys and steel. Recently developed methods of metal spraying also have advantages for specific purposes. There should be no fear of these methods usurping the functions of electroplating if the latter industry maintains a reputation for high quality finishes.

The mass production of die cast plastic articles has introduced a new field which may take some business away from the electroplater. Plastic material may be preferred to metal because it is light and a poor conductor of heat and electricity, but it is generally inferior to metal in mechanical strength and in appearance. In order to imitate the appearance of ordinary plated articles processes have been developed for electrodepositing metal on non-conducting material. This process of galvano-plastics has been extensively used in Germany where shortage of metal compelled manufacturers to use plastic substitutes. There are good prospects for the introduction of this practice in New Zealand. Electroplating may also be of use to the plastics industry in the electroforming of dies by iron plating and in applying hard chromium finishes on the surface of moulds and dies, which greatly increases their useful life.

The advantages to the engineer of working with pre-plated sheet metal have been mentioned. The capital cost of automatic plant for strip plating is high and it is unlikely that such plant will be justified in this country so that the supply of electroplated sheet metal from overseas may seriously affect local industry. Where the use of pre-plated sheet is practicable an added advantage is that the engineer can be sure of the quality of the finish on his work before it is started, a consideration that would be particularly attractive to a firm that had put up with unsatisfactory or unreliable finishing by the plater.

VIII. POST-WAR PROSPECTS

It is almost certain that New Zealand will experience an increasing demand for electroplating in the post-war period. With the return of manpower, industry will be called upon to remedy wartime shortages and contribute to some extent to the reconstruction in devastated countries. Housing schemes will require increased production of plated interior fittings and the demand for decorative and luxury plated articles that has perforce accumulated over a period of years will bring further business to the plater.

Conditions are not favourable for the establishment of heavy industries in New Zealand and the post-war development of secondary industry can best be directed toward the production of articles required in large numbers for local consumption. The standard of living in this country has steadily improved, and when materials again become available there will be a great demand for consumer articles such as radios, washing-machines, vacuum cleaners and refrigerators which are particularly suitable for small scale mass production methods such as casting, moulding and stamping. Light industries developed to supply these needs will result in the increasing use of metal finishing processes.

Post-war boom in industry overseas may result in continued shortages of materials for some years. It is therefore reasonable to expect that restrictions on decorative plating will only gradually be lifted. Even more essential work may be held up for some time.

In the transition period the plater should find an opportunity to gauge the scope of his future operations and make his plans accordingly.

IX. POST-WAR DEVELOPMENT

During the last five years it has been difficult to obtain new equipment, and the deterioration of existing plant, together with the accumulation of capital that would normally have been expended, are additional factors which provide possibilities for progressive firms to reorganise their works. To take full advantage of recent advances careful consideration should be given to improved types of equipment available, the design of its accommodation and the possibility of introducing new methods of finishing.

The wartime demand for surface coatings produced to military specifications has been mentioned. In overseas countries there is a growing tendency to produce metal finishes to specification, and standardising bodies such as the American Society for Testing Materials have already issued a number of tentative specifications stating the minimum requirements for particular purposes. The introduction of such standards is obviously desirable and, if specifications were laid down by the New Zealand Standards Institute, metal finishes complying with them would bear the New Zealand Standard Mark as a guarantee of quality from the plater to the consumer.

There is an increasing tendency for engineering works to install their own plating equipment. As most plating works are largely dependent on factory orders, if this main source of revenue dwindles the small plater may find it difficult to continue unless he can build up an engineering side to his own business. Closer association of the engineer and the plater is desirable as consideration of the plating process may influence the selection of materials of construction, and full co-operation between the two enables the plater to produce the desired finish.

X. SUGGESTED PLANS FOR INDUSTRY

Progress in the electroplating industry in this country must be based on increased scientific control, an enlightened attitude through knowledge of modern developments overseas, technical training of operators and co-operation and exchange of ideas between firms.

Existing methods of plating control are rudimentary. Some simple tests can be carried out according to the instructions of firms supplying plating material, but control is largely empirical based on the experience of the plater. Because of the many variables involved, such methods inevitably result in decreased life of the bath and inferior quality of the finish. As an example may be mentioned the provisions recommended for the control of one proprietary nickel bath widely used in this country. The pH may be adjusted by means of a comparator if available and the specific gravity by a hydrometer. Should the bath be unsatisfactory after these adjustments, bottles are provided in which samples of electrolyte can be sent overseas for analysis. Apart from the disadvantage of the delay that this would incur, such analytical results would be of doubtful significance because of the possibility of changes in the bath pending their arrival.

The use of proprietary methods and materials makes the plater very dependent on the manufacturer. One cannot belittle the advantages offered by a large firm specialising in the production of plating requirements. Such institutions take the responsibility for the quality of their products and support research laboratories which make valuable contributions to the industry as a whole. On the other hand, the necessity for maintaining a standard product makes frequent changes in formulae undesirable, and makers of proprietary products may be slow to adopt improvements. The New Zealand plater, remote from the source of his material, can obtain limited technical help from local agents and is at a serious disadvantage when trouble occurs unless he is in a position to investigate the problem himself.

Scientific methods of control employed by trained technicians with a reasonable knowledge of the electrolytic process should result in increased efficiency and flexible methods which can be adapted to take advantage of the proved results of modern research.

In this country there is a tendency for the experienced plater to keep the details of his processes to himself or his immediate family. At present operators pick up their knowledge in a haphazard fashion and only one instance is known in Wellington of an employee apprenticed to the trade. Other industries have long recognised the fallacy of such reticence. With minor exceptions the details of plating procedure are available in technical literature for whoever cares to read, and a progressive works making proper use of published information can readily improve on techniques based on the experience of a single individual.

Scientific control of plating has a scope beyond the mere choice and maintenance of bath constitution. Important factors are the choice of materials for constructing baths and the control of temperature, agitation, purification and filtration. Current density, electrode distribution and efficiency, and the physical properties of the deposit, should also be controlled.

Details of the methods by which such control can be achieved are freely published in the literature on the subject, and considerable ingenuity has been employed in devising reliable tests. An interesting method for the control of plating baths is the use of the Hull cell. The method has been described in technical papers of the American Electroplaters' Society. By plating on to a test plate for a short period in a small experimental cell containing a sample of the electrolyte, information about the constitution and operation of the bath is obtained, and the effect of improvements suggested by the test may be tried on a small scale before making changes to the whole bath. The cell is available commercially and the method should prove of value to the New Zealand plater.

The desirability of an association of electroplaters to discuss problems and exchange ideas is evidenced by the success of such institutions overseas. Representatives of many of the most successful firms are prepared to discuss and publish details of their work through societies such as the Electrodepositors' Technical Society of Great Britain, the Electrochemical Society of America, the American Electroplaters' Society, and others to whose publications the writer is indebted for ideas incorporated in this paper. The establishment of a New Zealand society or a New Zealand branch of an overseas society might well have an important influence on the local industry.

XI. SUGGESTED METHODS FOR ASSISTING THE NEW ZEALAND ELECTROPLATING INDUSTRY

Plans for the technical training of electroplaters and the institution of scientific control have not been suggested without some appreciation of the difficulties involved. Fortunately the facilities for technical education in this country are good, and it is certain that if workers in the industry could demonstrate by their demand that such training was needed the technical colleges would be prepared to provide night classes for those working in the daytime and a systematic approach for day students who wished to make electroplating their occupation. A special section for training in Applied Chemistry has recently been started at Canterbury University College, and here again, if the demand were present, men could obtain advanced education in practical and theoretical aspects of plating to enable them to undertake scientific control in the works. The efforts of a platers' society could be of great assistance in organising technical education for workers in the industry.

In a small country like New Zealand it is not possible for most works to equip laboratories with expensive scientific equipment sufficient to cope with all the problems that may arise. The presence of scientifically trained men in the industry, however, permits them to see the problems needing attack, and if they themselves are not sufficiently equipped they are entitled to expect assistance from government departments with modern facilities provided by the taxpayer. This fact has recently been recognised in the setting up of a Manufacturers' Research Committee as a section of the Department of Scientific and Industrial Research and by the provision of a library service to manufacturers by the Department of Industries and Commerce.

During the war a considerable amount of assistance was given to plating firms engaged on essential work by the Dominion Laboratory through the Controller of Munitions and other departmental offices. It is to be hoped that government assistance will be continued post-war and extended along lines designed to make the industry more efficient.

The mechanism for such assistance would be determined by government policy, but one can point to the success obtained in similar circumstances by the appointment of a research officer. An electroplating research officer employed by the government would make a special study of plating and be prepared at the request of the platers to use government facilities to investigate problems and provide information.

Any proposal for the assistance of an industry cannot be effected without co-operation from that industry, but there is clearly a case for planned government help to the plating industry. Were such a scheme undertaken it would be well to consider the ultimate formation of an Electroplaters' Research Association to be supported and directed partially at least by the members. A number of research institutions of this nature, including the Leather Research Association and the Wool Manufacturers' Research Association, to mention but two, have been established with government help and conferred great benefits on their respective industries. A similar organisation for the assistance of electroplaters would undoubtedly make valuable contributions to the electroplating industry.

XII. SUMMARY

1. Review

In planning the development of the electroplating industry in New Zealand it is necessary to consider its relation to the plating industry overseas and the opportunities and limitations of secondary industry in this country.

Up till now the local plating industry has been restricted in its scope and for economic reasons unable to employ the full range of existing finishing methods.

The war resulted in a big demand for military finishes and restricted decorative plating. In recent years new coatings and new methods of surface treatment have been introduced, many of which may find post-war applications in the New Zealand industry.

A post-war boom in electroplating is likely when materials again become readily available for the manufacture of consumer articles. Engineering methods, such as die casting and moulding with suitable metal finishing, may well supply the local market with luxury articles demanded by improved standards of living.

With the expansion of the industry the plater will have an opportunity to reorganise his works on modern progressive lines with increased technical control and plating to specification.

2. Conclusion

There are good prospects for the post-war growth of the New Zealand electroplating industry. Competition from other industries may be met by fully utilising the versatility of the plating process and by exploring the possibility of new applications.

Progress and development will depend predominantly on keeping up with modern trends and the wise use of scientific control and properly trained workers.

Government assistance to the industry is desirable. This might well be accomplished in the first instance by appointing a research officer and ultimately by the formation of a research association.

WRIGHT & CARMAN, LTD. 177 VIVIAN ST. WELLINGTON