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### The Sacrifices of World War II in the Plating Industry -A Reflection in Light of the Covid Pandemic

Introduction by James H. Lindsay NASF Technical Editor Fenton, Michigan, USA

Eighty years ago this month, our involvement in World War II began with the attack on Pearl Harbor. It was the existential crisis for the 20<sup>th</sup> century, for America and the world. Virtually everyone was impacted by the events of that global conflict as the nation mobilized for the four-year struggle.

Eighty years later, the ongoing Covid pandemic may well be considered the existential crisis for the 21<sup>st</sup>, although another eight decades remain in the century and global climate matters may or may not make the pandemic look like small potatoes. Nonetheless, both the war and the pandemic drastically changed everyday life for almost everyone. From employment arrangements to supply chain problems as a result of the pandemic, the surface finishing industry has been severely affected, and normalization of our businesses is still in the future.

While the saga of the pandemic has yet to play out, it is worthwhile at this juncture to look back and see how the surface finishing industry was affected by the war effort. It was drastic, and indeed many of the sacrifices made exceeded the harsh measures that have been endured with the pandemic.

In 1942, the American Electroplaters' Society held its 30<sup>th</sup> annual convention in Grand Rapids, Michigan. This was the first convention after Pearl Harbor and America's entry into World War II. Our covert efforts to help the Allies in Europe had become overt and the war expanded to the Pacific theater as well. The entire focus of the nation was on victory, and both civilian life and industry required major sacrifices.

What follows here are three papers, comprising the first educational session, dubbed the "Victory Session," of the 30<sup>th</sup> AES Convention held on June 8, 1942, at the Pantlind Hotel in Grand Rapids, Michigan. Due to the wonders of talented stenographers, the published proceedings were verbatim, including the introductions as well as the discussions which followed the three presentations:

- "The Present Situation in The Electroplating Industry as Regards Government Restrictions and Government Business" by William McCord
- "Military Applications of Electroplating" by William Blum
- "Conservation Program of The War Production Board" by Harvey A. Anderson





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### The Present Situation in The Electroplating Industry as Regards Government Restrictions and Government Business

by William McCord

Technical Editor's Note: The paper begins with introductory remarks by Chairman Maurice R. Caldwell.

The first Educational Session of the 30th Annual Convention of the American Electroplaters' Society, held in the Ballroom of the Pantlind Hotel, Grand Rapids, Michigan, was called to order at ten o'clock by the President of the Grand Rapids Branch, Maurice R. Caldwell, who presided as Chairman of the meeting.

Chairman Caldwell: I believe we are ready to begin our first Educational Session. This morning session was designed, as you notice, to include the various representatives from Washington with whom we all work so much these days. We think we have three outstanding speakers this morning, representing the industry in Washington, and I am sure they will be able to give you as much information as anyone can. I believe it will be advisable to have all three of the papers presented before we open the meeting for discussion.

Our first speaker is Mr. William "Bill" McCord, whom most of you know. He has been very active in the Society for years and has been technical advisor with the McCord Radiator Manufacturing Company in Detroit for approximately 30 years. Several months ago, he was appointed to his present position in Washington as Chief of the Electroplating Durable Goods Branch of the War Production Board.

At this time Mr. McCord will speak to us on "The Present Situation in the Electroplating Industry as Regards Government Restrictions and Government Business."

Mr. McCord: I dislike very much to read a speech, but I am going to ask your indulgence, for two reasons: One is that, as some of you fellows may know, I have been a trifle busy in the last couple of weeks and I really haven't had a chance to memorize it, and the other reason is that for the first time in my life, what I say has to have approval in advance . . . There are faces in the audience grinning at me - they know perfectly well that when anyone puts me on a platform, I am a pretty wordy sort of a guy, and I am liable to go off on all sorts of tangents . . . The result is that just to be absolutely sure that I am going to stick to the text, I am going to read it exactly as I wrote it.

I may say parenthetically that this had to be written about three weeks ago and that in some slight respects, perhaps I would not have said precisely what I am saying today, if I had been writing it yesterday.

It may strike you as entirely unnecessary and even redundant to have a speaker start an address with the statement that this country is at war, but if you had handled the quantities of interviews and correspondence which I have since Pearl Harbor in which it was evident that this fact was making no particular impression, you would understand why I start in this manner.

I reiterate, this country is at war. It is not merely at war; it is at war to prevent you from becoming a slave. There has been altogether too much disposition to take the attitude: "Oh yes, we are at war and oh yes, we must win the war but that has nothing to do with me, personally." The hell it hasn't! Maybe you are willing to spend the rest of your life with a gestapo agent showing you where to dig, but I certainly am not.

We must win this war, and we must win it, regardless of what it may cost any individual either in money, life or property. That is a serious statement and its implications are not pleasant. However, it is a fact which we must all face squarely. Our choice is between winning, no matter what the cost may be to us individually, or virtual slavery.

The trouble is that too many individuals have refused to recognize that there is no alternative choice. They want to win the war, but at the same time they do not want the winning to cost them anything in any way. It can't be done. We are all going to take it in the solar plexus. The severity of the blow may not be equal in all cases, and probably will not, but if anybody thinks he personally is going to entirely escape it, he is the world's greatest optimist.





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We are going to send millions of young men out to do battles for you and for me, and perhaps lose their lives in the attempt. They do not want to die or be maimed for life any more than you do. It is not entirely impossible that before this is over that men sitting in this audience before me today may be lying dead in unnamed graves on foreign battlefields. That is not a pleasant picture, but it is one that should be carried in the minds of all of us at all times and taken into consideration whenever a question is raised which involves some personal sacrifice.

We are going to win this war. The American people will not fail when it comes to a showdown. We have been accused of being pampered and soft, but gentlemen, there is no better soldier on earth than the American makes when the necessity arises. He has vim, dash, fire and intelligence but above all he has guts. Our history is comparatively short, but it is full of that fact. Valley Forge, the Alamo, Pickett's Charge at Gettysburg, San Juan Hill and going into the Argonne without artillery preparation while French and British generals stood aghast. But above all gentlemen, the heroic defense of little handfuls of men at Wake Island and the Bataan Peninsula stand out. If we are getting soft, we must have been awfully hard before.

These men are not going to have died in vain. I don't suppose there is an American living who has not made a silent resolve that sometime, somehow, someway, we will make the Japs sorry they ever heard of Wake Island or the Philippines.

We have the manpower, and it is the right kind of stuff to do the job. If this were just back in the times of the Crusades when opposing armies lined up, and each individual picked out somebody on the opposite side that he thought he could lick, and they went to it with a multiplicity of more or less personal combats, we would probably end this thing in a hurry.

But modern war is not won that way. Individual battles are won by tanks, airplanes, guns and ammunition, and the commander who has the preponderance in those respects generally comes out on top.

In other words, individual battles are largely won behind the lines. The goods have to be produced and they have to be transported to the places where they can be used to advantage.

In order to produce the vast quantities needed for modern warfare, it requires raw materials, and particularly metals, in previously unheard of quantities. Some of the astronomical figures which I have heard casually mentioned by representatives of our armed forces have made me fairly dizzy. When anyone begins to count in billions, my mind refuses to grasp it and I think that would be the case with most laymen.

We have always had a more or less smug self-complacency that this country was the one most blessed with natural resources, and that we could always get anything we wanted.

It is difficult for anyone to change his viewpoint in that respect. However, we are in for a rude awakening. The plain facts are that we haven't enough copper, we haven't enough aluminum, we haven't enough nickel, we haven't enough chrome, we haven't enough cadmium, we haven't enough tin, we haven't enough rubber, we haven't enough wool, we haven't enough steel, and a lot of other materials. About the only things in which we really have any great surplus are gold, silver, cotton and wheat. So far, we have enough lead and zinc.

We are by no means the land of abundance that most of us thought we were. Even where we have the ores, such as in the cases of aluminum, copper and steel, we lack sufficient facilities for converting them into form in which they can be used. But in some very important cases we haven't the raw materials, such as tin, rubber, and chrome. There is no use disguising the fact that those deficiencies are going to hurt.

When we are faced with the fact that there is not sufficient material of any given kind to meet all needs, there is no option left but to use what materials are needed for war purposes, and then if there is any left over to use that to the best possible advantage in other ways.

I don't suppose there is a single soul in this room that would take issue with that general statement.

The trouble is that when the application of the general principle hits anyone personally, that too many of us forget it, and think only of the personal angle. I can understand the feeling to some extent, and there is an element of justification. I am perfectly





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ready to admit that I think a lot of people have material in their possession which they should not have. It is a little difficult in some cases to understand how they have so much. However, those stocks are being frozen as fast as located, and they will be taken away from them.

Individuals who are asked to forego use of critical materials in their own production see surplus stocks in the hands of others, and naturally they are skeptical.

I suppose that at least once a day I am asked in confidence whether these supposed shortages are just somebody's crazy figures. If I succeed in nothing else today, let me get the true picture about that over to you.

This picture has been changing so fast that today's figures mean nothing tomorrow. The situation is analyzed in the light of events as they then appear, and then something like the fall of Singapore occurs, and the picture is completely changed in a thousand different ways. The figures on which you were given information are just plain screwy, in view of developments.

The military demands of the United States have increased by leaps and bounds. I don't suppose that anybody on earth can possibly be sufficiently well informed and sufficiently wise to accurately foretell what will actually be required by the United States alone in the year 1943. In addition to that we have become the arsenal of the whole United Nations. Will Russia next year be able to produce as much in war materials as she is now doing? Will England? Or will we have to take over those additional burdens? We hope not, and have no such expectations but in the last analysis nobody can answer with any authority.

So when I say to you that the shortages are real and not the figment of anyone's imagination, that is probably an understatement. Let's run over them.

 Aluminum: Not enough for a long time to come.

 Rubber:
 Not enough and with poor chance that synthetic will arrive in time.

 Copper:
 Not enough and with little or practically no chance there ever will be.

 Tin:
 Not enough and with little or practically no chance of betterment.

 Chrome:
 Very tight, however, the Montana ores may provide sufficient chromic acid by the end of this year although this does not help ferrochrome materially.

 Cadmium:
 Not nearly enough to take care of war demands and many specifications have had to be changed.

 Nickel:
 Not nearly enough and with practically no hope that there ever will be.

That does not leave very much for any plater except war work.

He would still have gold, silver, lead and zinc with which to plate for civilian usage.

So far, we still have plenty of gold, silver, and lead. We also have been able to meet all demands in zinc.

You have gold and silver for ordinary usage and not much else. Immediately the cry is raised that they are too expensive. Now get this point. We haven't a free market. Prices are pegged and they are pegged on a relationship which existed before the war. This is no indication of what their relationship would be if a free market existed. It is entirely artificial at this time without taking into effect the changes caused by the war. I sincerely believe that if a free market existed, and all the opposing elements were allowed to compete for each individual metal, that you would be surprised to find that a pound of nickel or tin would probably command a higher price than a pound of gold or silver. We need and can use the nickel or tin, but we have a great surplus of gold and silver for which we have no immediate need.

Our ideas regarding values are so fixed that it is extremely difficult for us to appreciate this change. It is not that gold and silver have become less valuable but that due to extraordinary circumstances, tin and nickel have become infinitely more valuable. So when you are told that you cannot use what seems to you an inconsequential amount of tin or nickel or something else, you just stop and ask yourself whether you would want to use it, if you had to pay the pound price of gold. Furthermore, when you consider gold or silver as a covering, do not do it with the old relationship in your minds, but with the realization that actually you may be using a cheaper metal than nickel or tin. This is the economic side, but the really important one is that your country needs that nickel or tin, and if you are going to remain a free man, that they must use it.





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Perhaps you are not as constricted regarding civilian usage as you think you are, provided you will get over some of your preconceived ideas regarding values, but you are still pretty constricted. Unfortunately dollar values still exist, and I recognize that people who buy things pay in dollars and they will not buy, if the article costs too much, according to their former sense of values. So while you may be able to use some gold and silver, where formerly it was not even considered, particularly as time goes on and the demand for any kind of goods increases, necessarily its usage will be limited.

In other words, you may continue to do a little plating in special fields for Civilian Consumption, but it will not be of any great magnitude. Gold, silver, zinc and lead plating may even become more popular than in the past. However, nobody will get rich on the amount that will be done for civilian purposes.

That leaves war work. I am not going into any detailed discussion of the particular applications of plating in military usage. Dr. Blum and I have worked together in that respect and he will discuss the particular applications. However, I do want to point out the over-all picture as I see it.

In the first place, the plating trade is lucky. As soon as I sit down, about a hundred men will jump to their individual feet and say, "What do you mean lucky, when my plant is shut down?" The statement still stands. Individually, you may be unfortunate, and that may continue without much hope for you, but the fact remains that the plating trade as a whole is lucky. They have lots of work to do, and will continue to have it for the duration.

I can point out plenty of industries to you that were told to stop entirely their former system of manufacture and to go out and find something to do for war purposes. Nobody has told you to stop plating. They have told you that you cannot plate with certain metals for certain purposes, but so long as you stay away from those prohibited areas, you can continue to plate. Also there is a very large volume of war plating to be done, and if you are able to get enough of it, you can continue your previous type of manufacturing without essential change, as was necessary with so many industries.

Now that distinctly does not mean that every individual plater is going to be able to go along just as he always did and have plenty of work. There simply is not enough work to go around and when there isn't enough for everybody, someone is bound to get hurt.

I have been trying for months to get an accurate picture into my own mind, as to just what percentage will remain in the plating business and what will have to go out of it, and I am frank to confess that I still do not know.

In order to arrive at that percentage two facts have to be known that as far as I can discover are known only to God. The first one is just how much war plating is there going to be. I have already told you that today's figures mean nothing tomorrow as far as totals to be produced are concerned. Added to that is the difficulty that articles which are specified for a plated finish today may not be so specified tomorrow. They are coated with a given metal, and the supply of that metal becomes inadequate or progressively tighter, and it becomes necessary to find places where it can be eliminated. Specifications are changed and something else is substituted. Vice versa, some material becomes scarce and another material is substituted but the latter material has to be protected against corrosion, so a plate is added. The steel cartridge case is a good illustration of this.

The picture changes rapidly. All I can say has to be in very general terms and subject to change without notice. However, I think I am safe in the following generalizations:

- 1. There will be a very considerable volume of war plating that will continue to be done.
- 2. The total volume of this has increased rather than diminished as time went on due to both increase of amounts required of specific articles, and also to the addition of plating to articles not previously so coated.
- 3. Our belief is that this tendency toward increase rather than decrease is apt to continue although this can by no means be any surety.

However, we do not know just how much war plating there is to be and in the very nature of things, never can know. Neither do we know just how much plating capacity there is in this country. Neither do you, and neither does anyone else. We probably have as good information on the subject as exists, but it is a long way from accurate.





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Not knowing either the demand or the capacity for meeting it makes it a trifle difficult to give in percentage the amount of plating capacity that will be used for war work. However, I am going to give you a guess figure.

My best guess is that there will be about 50% as much plating as prior to the war, but if anybody tries to make me substantiate it, I will immediately retire from the field, because I do not know how I arrived at the figure any more than I know why an article when first seen costs about \$5. I probably would not be far wrong, but I have no knowledge of the mental process by which I arrived at the figure. It can only be a guess, but it is probably a pretty good guess.

However, that does not mean that everybody is going to do 50% as much business. It is not as simple as that. Some platers will have 100% and others will have none. There are all kinds of factors involved. Some plating plants are set up with equipment that is not readily adaptable to anything but the plating of the particular article for which it was designed. The chances of finding a war article to which it can be converted are pretty slim. In addition, most plating will be done by sub-contractors working for some manufacturer who holds a prime contract for some article which requires plating. Naturally if you happen to be located in a territory in which there are not prime contracts placed which require plating your chances of securing any plating business would not be very good. On the other hand, you might be located where the number of contracts placed are in excess of the capacity to plate. There will be no uniformity about it.

The third factor is that most jobs are going to be volume. That would seem to indicate that small platers would probably find it pretty difficult to secure any of this business. I still think that the cards are stacked against them, but I have been rather surprised to find individual cases of rather small platers who are actually running 30% to 50% of former capacity on war orders. In fact, I have known some of them to be so enthusiastic that they wanted to increase capacity.

Another factor in the situation is that a considerable part of the 50% will be made up of plating in a form that could not be handled in an ordinary plating plant with ordinary equipment. For instance, there are 24 tin-plating plants going in for electro-tinning instead of hot tin-dipping commercial tin plate. My best judgment is that there will be a great deal more pre-plated sheet used than formerly. This is a specialized game that cannot be handled with ordinary equipment. In addition, there is bound to be a certain amount of equipment go in where it did not exist before to take care of special requirements on production lines, or where adequate facilities are not available in the district.

When all this is deducted from 50%, our best judgment is that not more than 35% to 40% of the equipment used will be actually employed.

That may be considered as not particularly alluring but I remind you that even if only 35% of former equipment finds employment that this is infinity times zero, which is the amount allotted to many industries. Again I say, you are lucky.

Now let's correct a very popular misconception about how war business can be secured. The War Production Board buys nothing, and no government agency buys very much plating as such. Various agencies of the government, such as the War Department, the Navy, the Maritime Commission, etc. buy finished articles which may require plating in whole or in part.

Your individual plant may be equipped to furnish some finished article complete and thus utilize your plating equipment. In that case, pick out the specific article which you feel that you can handle, and apply either to Washington or to the nearest local branch of the War Production Board, and they will tell you how to secure the necessary information in order to bid when such goods are to be bought.

However, let me stress that the first thing to do is to pick out the article that you want to make and are equipped to make. Too many manufacturers seem to think that all they have to do to get government business is to write a letter to Washington, saying that they want some business. They will probably be just about as successful pursuing that type of salesmanship as they would have been to have picked out some manufacturer before the war and asked the purchasing agent what he wanted to buy without any indication of what they had to offer. Selling is selling regardless of the customer. The main distinction is that the various agencies of the government do not have to be sold on the advantages of buying. They are anxious to buy provided they can secure articles to suit their purposes.





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But if you have only a plating plant with no other facilities, you have only one option. Your business, if you are to get it, must come as a sub-contractor from manufacturers in your home territory, who hold prime contracts covering articles which require plating. Your local offices of the War Production Board may be able to help in that respect, by telling you of contracts that are placed in your vicinity but in the main, the way you will get it is by leg-work among neighboring manufacturers. You never got business before by writing letters to Washington, or by sitting and waiting for it to drop into your lap, and you will not get it now. You will get it by shagging it. Of course, it is entirely possible that no orders requiring plating will be placed in your vicinity, and if that happens, pick out manufacturers possessing other facilities which you do not possess, and persuade them to bid on articles which require plating and which they would otherwise be equipped to make. In other words, pool your resources in the territory and get business that individually none of you could handle.

However, we again warn you that there cannot be expected to be enough plating to use more than about one third of previous plating capacity so that the odds are about two to one against you individually. The live ones will probably get the business, the others will get nothing.

This is the situation in regard to plants, but individually you are platers. The prospects for platers are better than for equipment. In other words, while perhaps only one third of existing equipment will be used, as the production total will probably be about 50%, the chances of continuing employment in the same field would appear one in two instead of one in three.

This covers what you might do. Let's see what you cannot do. We will run over the present restrictions on the plating of various metals individually. Gold, silver, lead and zinc have no restrictions as to usage, provided you can secure the materials. The same is true of cadmium but as the supply of cadmium is inadequate even for war alone, the chances of securing it for any other purposes are practically negligible. Tin falls into a similar category. There are no direct prohibitions against its use by plating, and as a matter of fact due to the ability to control thickness more closely by plating than by hot tin dipping it is probable that its usage by plating will actually increase in total rather than decrease. However, due to its extreme scarcity, it would be practically impossible to secure raw materials except for extremely essential purposes.

Likewise, the plating of chrome is unrestricted so far as we know, except for vending machines. In other words, if you can procure chromic acid, you can apply it directly to any base metal provided the part is not going into a vending machine. While the supply of the basic chromite is exceedingly limited in a general sense, due to the ability to secure low-grade ores, and the lessening of demand for chromic acid for composite coatings, it is our judgment while this cannot be entirely final that there will be adequate supplies for all who want to apply chrome directly to the base metal. But as soon as an under-coating is desired for the chrome, the condition changes.

I do not need to tell anybody in this audience that anyone who is plating nickel is breaking the law, and I am putting it badly that way, because it should be. He is not only a slacker from a patriotic standpoint but he is sticking out his neck in addition. You cannot use nickel as an undercoating for chrome, or for any other purposes, except virtually by special permission. We have about two-thirds enough nickel for this year's demands and it is not going to be wasted, just because somebody wants to. It is known that there is bootlegging but they will catch up with it.

The situation in copper is more complex. The M-9-c Order prohibited plating with copper where the purpose was primarily decorative. Most plates where copper was employed had two purposes. One was corrosion resistance and the other was decoration. Which was the primary purpose? You and I know that in most cases it was decoration, or you would have used zinc which would have given you far better corrosion resistance. However, a lot of platers virtually ignored the order on the ground that they were doing it primarily for corrosion resistance. They were not very honest about it. However, I want to correct any misconception that may exist about the future. We haven't anywhere near enough copper for purely military needs and under those circumstances the usage of copper for plating except for really essential purposes will not be permitted. Do not make plans on that basis.

There are other metals such as rhodium and indium. It is entirely possible that such metals may come into more general use, limited of course by amounts available. An acute general metal shortage exists and under those circumstances, it is likely that usage will be made of any metal that is available.





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In conclusion, let's sum up a little. Plating for civilian usage will be curtailed, but there is and will probably continue to be a considerable volume of war plating. Prospects for individual platers vary exceedingly. Some will prosper while others will go bankrupt. There is nothing fair about that but it is an unavoidable condition of war. There is nothing fair about war. It is not fair that just because I happen to be 54 years old and have already lived most of my life in a condition of luxury that would have made the old Roman Emperors green with envy, should stay home while young chaps with all their lives before them are sent out to toil and sweat in foreign jungles and perhaps lose their precious lives. War just isn't fair in any way, and if you happen to be one of the unfortunates, you will simply have to chalk yourself up as one of the casualties. We recognize that this is cold comfort. Nobody is going to award you any posthumous medals or send any gold stars to your mothers, but you are a casualty of war just as surely as the boy that gets in the way of a Jap shrapnel.

This industry depends upon metals, and there aren't enough metals for war purposes, so there are bound to be casualties, and the fact that there are going to be casualties cannot be allowed to interfere with the winning of the war.

We are not going to let MacArthur down. We are not going to let the Chinese down. We are not going to let the Russians down, but above all, we are not going to send out our kids to be slaughtered because somebody did not want to change his occupation or was trying to hold onto money that he never would have had, except for the system of freedom which we are all fighting to preserve.

We have a job to do. We are all equally responsible. It is my job and it is your job. Our individual welfare does not count until the job is done. Let's forget personal fortunes for the time being and stop petty bickering. If we all put our shoulders to the wheel, with the one idea paramount of keeping the wagon rolling, we will get this thing over in a hurry. Nothing can stop us. And then I would like to talk to this society again. I can be just as optimistic, as I have been pessimistic today and the picture I have in my mind of the eventual future of the plating business can only be expressed in superlatives.

I thank you.





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### Military Applications of Electroplating

by

Dr. William Blum\*

Technical Editor's Note: The paper begins with introductory remarks by Chairman Maurice R. Caldwell.

Chairman Caldwell: We will follow right through and have Dr. Blum's paper. Dr. Blum, I am sure, needs no introduction . . . Dr. Blum.

Dr. William Blum (U. S. Department of Commerce, National Bureau of Standards, Washington, D. C.) : Mr. Chairman, Members of the American Electroplaters' Society:

My speech was also censored, but I cannot read a paper. I am not sure whether I know how to read. What I have to say officially is in the record that Miss Marquardt has, and anything else you hear, I did not say.

### I. Introduction

The purpose of this paper is to summarize typical important military applications of electroplating. It is based largely upon a list compiled by W.W. McCord and the author, and published in the *A.E.S. Review* for March, 1942. However, since the preparation of that list, the situation has changed with respect to certain metals, especially nickel and tin.

No effort will be made to discuss all the items on that list or to give detailed specifications. Many of these uses are still in the experimental stage, and subject to the restrictions of military developments and metal shortages. It is hoped that the compilation and distribution of this information will be advantageous to the military departments and to the electroplating industry. The unprecedented scale of the present war has brought about shortages of many metals normally employed in the construction and coating of articles for both civilian and military use. The consequent curtailment of many industries has caused a great reduction in the use of electroplating. Efforts are being made by the War Production Board to foster the application of existing plating facilities and personnel to meet essential military needs.

#### **II. The Metal Situation**

The present shortage of metals affects their military as well as their civilian uses. The supplies of nickel, copper, tin, lead, zinc, cadmium and chromium are so limited that for each metal it is necessary to meet in sequence, (a) the most critical military uses, (b) the less critical military needs, (c) essential civilian requirements, and finally, if any metal remains, (d) the normal civilian uses. As was predicted in my address last year (published in the *AES Review* for July 1941), the necessary changes in the base metals have brought about certain increased uses of plating. Plain carbon steel has been extensively substituted for aluminum, brass, nickel-brass (nickel-silver), zinc-base die-castings and stainless steel. In practically all these applications, the steel must be protected against corrosion. For such protection, plated metal coatings have certain advantages. For example, their thickness can usually be controlled more closely than by hot-dipping, and strategic coating metals can thereby be conserved. A good illustration is the increased use of tin plated steel as a substitute for hot-dipped tin-plate.

At present, almost the only metals used in plating that are not abnormally scarce are silver and gold. The supplies of chromium, zinc and lead are less critical than those of nickel and copper, but are subject to restrictions. From certain examples to be cited, it is evident that for the less critical military requirements, expediency demands that plated products be used that may not be entirely satisfactory. In each case it is necessary to select the best products that can be made from the available materials, in the hope that they will prove fairly serviceable. The specifications are subject to frequent revision in the light of experience. Persons who expect to engage in this type of plating, usually through primary military contractors, must therefore be sure to obtain the latest pertinent specifications.

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#### III. Ordnance

1. Guns

### (a) Gun barrels

Chromium plating has been used for years to increase the wear resistance of the rifling on gun barrels. It is now being applied successfully to the interior of large-caliber guns, but has not thus far found much application to small-caliber guns such as machine-guns.

In certain cases, chromium is being plated on the outside of water-jacketed guns to protect them against corrosion. Nickel would probably be equally effective but is less available and less easily applied than chromium.

#### (b) Gun mounts

Chromium plating has proved very satisfactory on rollers and circles of gun mounts to protect them against both corrosion and wear.

### (c) Building-up

A minor but often very important use of plating on guns is to bring up to dimensions some part of a large casting or forging. When the latter is of such shape or size that it can be conveniently handled, chromium, nickel or iron may be applied. Practically, it is often more convenient to deposit copper from a cyanide bath, which has a cleaning action on the steel, and does not corrode the latter where it may be splashed.

#### 2. Ammunition

### (a) Steel cartridge cases

The present shortage of copper and zinc arises largely from the enormous consumption of brass in the manufacture of cartridge cases. Steel cartridge cases were made by U. S. arsenals during the last war, but were not manufactured in quantity till 1941. In the large-scale tests now in progress in this country on the production and use of steel cartridge cases, two applications of electroplating are involved. Copper is usually plated on the steel blanks to furnish "lubrication" of the drawing dies. To protect the outside against corrosion, plated coatings of copper, zinc, or brass may be used. If any of these plated coatings proves satisfactory for this purpose it will result in very extensive demands upon existing plating equipment and personnel. The amounts of copper or zinc thereby used in plating represent a very small proportion of what would otherwise be used to manufacture the cases from brass.

#### (b) Deposited copper driving-bands

Experiments are now in progress upon the deposition of copper driving bands on steel shells, instead of using the swaged bands made from copper tubing. The latter type of band involves grooving and possible weakening of the steel shell. Electrodeposition of the copper without grooving would reduce the consumption of copper and possibly strengthen the shell. Because the copper band may have to be as thick as 0.035 inch, high current densities will be very desirable in order to reduce the time of deposition. If this method of producing driving bands is adopted, it will also demand very extensive plating facilities.

#### (c) Fuse parts

Practically all the steel parts of fuses must be plated to protect them against corrosion. Cadmium plating is most commonly specified, because of its good protection against marine exposure, and because the cadmium coatings are usually very smooth and therefore more readily meet the close dimensional tolerances. Because the present and prospective supplies of cadmium are not adequate for all military requirements, it is probable that zinc plating may be accepted for the less critical fuse parts.

#### (d) Ammunition containers

A large proportion of the loaded ammunition must be shipped in sealed metallic containers to exclude moisture. For this purpose, steel sheets preplated with zinc, copper or lead may be used. The zinc furnishes the best protection against corrosion, the copper is most easily soldered, and the lead most easily painted. Bonderized painted steel may also be used.





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#### 3. Tanks

Because of the sturdy construction of armored tanks, little application is made of protective metallic coatings. When rubber treads were employed, the steel tracks were usually brass plated to increase the adhesion of the rubber.

#### **IV.** Aeronautics

Because of the weight economy and consequent low factors of safety on aircraft, prevention of corrosion is very important. Resistance to wear of moving parts is also essential. Electroplated coatings have found many applications for both purposes.

#### 1. The Power Plant

#### (a) Engine parts

The extreme hardness of deposited chromium naturally led to many efforts to use it to reduce wear on moving parts. It was then found that under certain conditions the chromium coating reduced the fatigue resistance of the steel and caused structural cracks and failures of stressed parts. While this adverse effect of chromium is somewhat reduced by the use of relatively low current densities of deposition, it is not desirable to apply chromium coatings to engine parts that are highly stressed. There are therefore not

many present applications of chromium on the aircraft engines.

It has been reported that nickel plating is used abroad on certain parts of aircraft engines to insure close fit of stationary members. The moderate hardness and ductility of nickel probably account for this use.

On those aircraft parts that are to be selectively hardened, copper plating is used to protect against case-hardening and tin plating against nitriding.

One of the most interesting applications of plating is upon aircraft bearings. In certain cases, a relatively thick silver coating is applied, followed by a layer of lead and a very thin film of indium. When the composite coating is heated, the indium alloys with the lead to form a surface layer that resists attack by the lubricants. For certain bearings, lead plating alone is applied, which is especially useful during the run-in period.

Many of the manifolds are now made of heat-resistant alloys containing nickel and chromium. Use of plain steel with thick nickel coatings has been suggested as a means of conserving nickel. Nickel, chromium and iron plating are sometimes used to salvage worn or undersized parts of aircraft.

#### (b) Propellers

When chromium was applied to steel propeller blades to protect them against abrasion, some failures were attributed to the embrittling effect of the chromium, especially on the edges, where the current density is highest during the plating. Nickel plating may prove more effective, even though it is not as hard as the chromium.

#### 2. Aircraft Fittings

#### (a) Brass and steel parts

In order to prevent accelerated corrosion of aluminum that may come into contact with brass or steel parts, the latter are usually plated with cadmium. A zinc coating would furnish even more protection to the aluminum, but is itself more subject to corrosion in such a combination, and hence does not last as long as the cadmium.

When the only requirement is the protection of steel against corrosion, cadmium coatings are preferred, especially for marine exposure. Here again, scarcity of cadmium may necessitate the use of zinc coatings (which in a marine climate are fully equal to cadmium) or of phosphate-treated and painted coatings on less critical steel parts.





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### (b) Aluminum parts

Electroplating has not been applied to any appreciable extent upon aluminum aircraft parts. These are commonly anodized in either chromic acid or sulfuric acid. The latter process may be carried out with plating equipment, including the 12-vo!t generators.

### (c) Magnesium alloys

While it is possible to plate nickel upon magnesium, the coatings do not furnish good protection against corrosion. Both chemical and electrochemical treatments are employed to produce protective coatings on magnesium alloys.

#### V. Marine Construction

#### 1. Marine Fittings

The widespread use of hot galvanized coatings on iron and steel parts of ships is based on the good protection furnished by zinc against salt-water corrosion of steel. The necessity of substituting steel for brass on many marine fittings has increased the use of zinc coatings. In certain cases, where very thick coatings are not required, zinc plating has been substituted for hot galvanizing in order to save zinc.

#### 2. Marine Engines

Chromium plating the cylinder liners on marine engines has been found advantageous. The process in which the surface of the chromium is anodically etched to produce a porous surface is reported to be especially suitable for this purpose.

#### VI. Illumination

Preparation of reflecting surfaces by electroplating permits the application of various metals with the desired optical and chemical properties. Silver has the highest reflectivity (about 95%) in the range of visible light, but is subject to tarnish, especially in an atmosphere containing sulfur compounds. Its use is therefore limited to sealed reflectors or protected reflecting surfaces. The use of baked synthetic lacquers to protect the silver against tarnish is being investigated.

Rhodium has a reflectivity of about 75% and is resistant to sulfur tarnish. In spite of its high cost (about \$125 per troy oz.) thin rhodium coatings are extensively applied to searchlight reflectors.

Chromium, with a reflectivity of about 65%, is sometimes used on floodlight reflectors. To obtain adequate protection of the underlying steel against corrosion, it would be desirable to apply nickel under the chromium. As the present nickel shortage prevents this use, the steel reflectors are likely to be plated with copper, and then with either silver or chromium.

Preplated steel or brass sheets may be used as flat mirrors, for example, in camps and ward rooms, or for rear-vision on airplanes. Chromium coatings are usually satisfactory.

One very important application of electrodeposition is the electroforming of large searchlight reflectors. This process was devised in 1898 by Sherard Cowper-Coles, and has been developed in recent years by the Bart Reflector Co. By this method, 60-inch reflectors are reproduced, largely by copper deposition, and are finally plated with rhodium. Production of such reflectors by iron deposition is under investigation.

#### **VII.** Communications

The military applications of radio, telephone and other signaling equipment involve the use of the same types of plated coating as are employed on similar civilian equipment. The shortages of nickel and cadmium have necessitated substitutions of copper and zinc coatings on many of these parts.





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### VIII. Attire and Personnel Equipment

With normal metal supplies, brass was always used for buttons, buckles and insignia on uniforms, and for gas-mask fittings. The "coloring" of the brass, *e.g.*, by black nickel plating, usually followed by lacquering, was done chiefly for appearance, because brass is resistant to corrosion. The necessary substitution of steel for such parts has involved the use of coatings which will furnish protection against corrosion under severe conditions, including the laundering and sterilization of the clothing. Chemical treatments are used to produce phosphate or oxide coatings which increase the adherence of the lacquer coatings. Thus far, plated coatings have not been extensively applied to this type of equipment.

#### IX. Mess Equipment

Aluminum and stainless steel are the preferred metals for cooking utensils and tableware but are not available for this purpose. The efforts to replace these metals with plated steel have been handicapped not only by the shortage of certain metals (especially nickel), but also by the rapid changes in their availability. Specifications have been changed to meet new conditions before there was an opportunity to thoroughly test the preceding requirements, much less the new proposals. Many of the latter involve untried combinations, or procedures that are admittedly inferior but are the best available at the time.

#### 1. Tableware

The use of plain-carbon steel instead of the customary nickel-silver for flatware introduced many new problems of corrosion. Experience with plated steel auto parts showed that good protection can be obtained with about 0.001 inch of copper plus nickel, followed by a thin chromium coating. Some tableware of this type was produced for military use until the shortage of nickel prevented.

Experience with hot-tinned or tin-plated steel tableware shows that the process can be cheaply applied and that the products yield fair service. The present shortage of tin has precluded this use on a large scale.

As previously indicated, silver is one of the few metals now available. Long experience with silver-plated steel knife blades and handles shows that fair service may be obtained, even though corrosion of any exposed steel is accelerated by the silver. Such articles do not usually have a life equal to that of companion pieces consisting of silver-plated nickel-silver. Accelerated tests indicate that even a thin layer of nickel prior to the silver will increase the corrosion resistance, but nickel is not available for this purpose. Present plans therefore call for a relatively thick silver coating directly on the steel, or over a copper flash.

One difficulty in predicting the serviceability of such equipment under severe conditions is the lack of an accelerated test that will yield significant results in a short period. The salt spray test, which is most extensively employed, is a measure of the porosity of noble-metal coatings on steel. If pores are thereby detected, it merely shows that at such points the steel is subject to corrosion, but does not indicate whether such corrosion will occur rapidly in some other environment, or whether the products of corrosion will be extensive or objectionable. Conversely, if pores are absent, it still must be determined whether in service the metal coating will be rapidly attacked or abraded, with consequent exposure of the steel.

Other porosity tests such as the ferroxyl, boiling-water, and moisture-condensation tests are apparently not more conclusive than the salt spray. It is planned at present to eliminate the salt spray and other accelerated tests from the specifications, but to make sufficient tests on delivered equipment to determine whether any correlation exists between these results and those of actual service.

The same considerations apply to the plating of steel mess trays and mess kits, with the additional facts that a silver coating is relatively soft, and its cost would be prohibitive on the large areas involved. To prevent scratching by the cutlery, it is proposed to apply a relatively thick chromium coating (*e.g.*, 0.00015 inch) directly on the steel. Such coatings are somewhat porous and not as protective as if a nickel layer were also present, but they deserve a trial in service.





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### 2. Cooking utensils

It is difficult to produce adequately protective plated coatings on steel cooking utensils without the use of nickel. Available information on chromium coatings directly over steel or over copper on steel indicates that they are unlikely to protect against corrosion by the food constituents, including salt and organic acids. Steel heavily plated with copper and silver may be fairly satisfactory but would be expensive for large vessels. In certain cases, enameled utensils may be used, and in other cases uncoated steel or cast iron, which will be cleaned of rust at intervals.

### X. Medical Supplies

Under normal conditions, steel surgical and dental instruments are plated with nickel (about 0.0005 inch) and chromium (about 0.00002 inch). Such instruments usually yield good service under severe conditions, including frequent sterilization, and occasional contact with corrosive compounds.

The shortage of nickel and the W.P.B. order against any civilian nickel plating raised the question as to whether silver-plated surgical instruments might be employed for both military and civilian use. The considerations are similar to those involved in silver-plated tableware, but are complicated by the very severe conditions in using surgical instruments, and the importance of having them at all times in practically perfect condition. Many dental instruments come into contact with amalgams, which are likely to attack silver; and with phosphoric acid (in cements), which will rapidly attack any exposed steel. Tests are now in progress to determine to what extent the nickel plating of surgical instruments is essential to their proper performance. Even with the great demands for nickel it may be found necessary to allocate to this industry at least a part of the small amount of nickel (about 3000 lb. per month) normally used in plating surgical and dental instruments.

### XI. Miscellaneous Applications of Plating

To the extent that cantonments, hangars, dwellings and munitions plants are built by or for the government, hardware and plumbing and lighting fixtures will be required. These supplies will be subject to about the same restrictions as those for civilian consumption. In general, steel or cast iron will be used extensively in place of brass. Zinc plating the steel will be adequate for many purposes. The net result will be to utilize at least a small part of the normal plating facilities of the above industries.

It is probable that a fair proportion of the existing plating facilities and personnel can be employed in the production of military supplies, including munitions and other essential equipment. Some of these uses will involve little or no change in plating equipment or methods, while others may require radical conversion. Just as with other industries, the survival of the plating industry will depend upon its ability to meet essential military and civilian needs.





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### **Conservation Program of The War Production Board**

by

Harvey A. Anderson

Technical Editor's Note: The paper begins with introductory remarks by Chairman Maurice R. Caldwell.

Chairman Caldwell: Our third paper is by Mr. Harvey A. Anderson, Chief, Conservation and Substitution Branch, Bureau of Industrial Conservation, War Production Board, Washington, D.C. Mr. Anderson is probably more or less new to us, so I will give a short history of his accomplishments. He has been with the Bell Telephone Company and the Western Electric Company for around 21 years and I understand that previous to that he has worked for the Bureau of Standards in Washington.

Right now, Mr. Anderson has a real job in Washington and is a very busy man. Under his Department, as he will explain, comes practically every material that is on shortage, or being followed by the government as being curtailed here and there, so I am sure Mr. Anderson will be very interesting to listen to, as he speaks to us on "Conservation Program of the War Production Board."

Mr. Harvey Anderson: Coming as the third speaker of a group of people down in Washington, I am unable to give the recorder an opportunity to know in advance what I am going to say, because I could not know until I had heard what our other WPB speakers had to say. I will try to find a few spots that have not been covered in these excellent talks that we have had.

This morning, as I came through my birthplace, a few miles south of here, I realized that at least from the standpoint of age, I would be qualified to be one of the trio of oldsters that the Chairman is handling this morning, because in a couple of years it will be 50 years since I started life down here in Plainwell, a few miles south.

This is my second war in Washington . I went down by request in April 1941, to help out on the problem of die castings and have been asked to continue on down there with the manifold materials conservation problems which have arisen.

It looked to us a year or so ago as though the problem down there would not be much worse, this war, than it was in the last war. Then it was largely a case of trying to find the best material for each purpose. Today it is a case of trying to find the most suitable material which is available. It makes us all feel small.

I am reminded of a story of an occurrence in Washington about a week ago. They just got a new Chief of the Iron and Steel Branch down there - Reese Taylor . . . He came from Los Angeles, where he was the president of the Union Oil Company - to take the place of C.E. Adams. Mr. Taylor, by the way, is an old steel man - he had been in the oil game just a few years . . . Reese is one of these big boys, about 6'4", weighs 250 pounds . . . He was in the other day, talking to Sidney Weinberg, the assistant to Mr. Nelson, and he started in with all the vim and vigor which is so characteristic of him, telling how he planned to remake the Iron and Steel Branch, correct all the deficiencies he thought existed there, simplify the whole job.

After he had gone on a little while, Sidney interrupted him and said, "Reese, you're a pretty big man, aren't you?"

"I guess so."

"How tall are you?"

"6'4"."

Sidney said, "You're big in every way . . . How much do you weigh?"

"250 pounds."

"Well," he said, "You know how big C.E. Adams is?"

"He is a small fellow - about 5-1/2' tall, weighs about 140 pounds, I guess."





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Sidney said, "You know, C.E. Adams was your size when he came to Washington." (laughter)

It does take the measure of a man down there. It is a job that is bigger than any of us. It is a job that cannot be handled from Washington. It is a job that necessitates the cooperation of all you people that are so capable of working independently in this country.

The group that I am associated with down there, the Bureau of Industrial Conservation, attempts to serve a staff function in channeling scarce materials into the avenues where they will be of the most value in the war effort.

We had several conservation groups in OPM a year ago and last fall Mr. Nelson drafted Mr. Rosenwald (Lessing Rosenwald, former chairman of Sears-Roebuck) to correlate the various conservation activities. He pulled in various groups, so that now we have a Specifications group under C.L. Warwick of the American Society of Testing Materials. They have the problem of studying the Army and Navy Specifications and attempting to eliminate wherever possible all inconsistencies, all requirements which are not essential or cannot be met with the materials at hand and, as far as possible, to try to get government organizations to buy from uniform specifications.

Howard Coonley, the Chairman of the Walworth Company, heads a Simplification Branch, which, as its name implies, is attempting to foster reduction in the number of varieties, sizes, shapes and colors that result in increased inventory, increased consumption of material and less availability for war purposes.

They have succeeded in making reductions in a great variety of things, bringing down the number of colors of dyes in hosiery, number of sizes, and shapes of glass containers, and a variety of other activities in the direction of simplification, carrying on in cooperation with the Bureau of Standards, which has been handling the simplification work for a number of years.

Then there is a Salvage Branch headed by Paul Cabot, which is attempting to bring out into useable channels all of the inactive critical materials, which are laying around the country. It is divided into four sections: (1) General Household Salvage, which had some connection with the unfortunate aluminum drive, bungled by our friend, the "Little Flower" from New York, because he would not allow the scrap dealers to take the very essential part which they must play in any salvage program. Our salvage group went out after paper, a campaign which, as you know, has been so successful that temporarily we have gotten quantities of scrap paper in excess of the paper mills' and paper box manufacturers' requirements.

They are going out after old metals with such success in the case of steel, that, last week, for the first time in many months, there was not a single open hearth furnace in America that was down because of lack of scrap. That has been an accomplishment which the discouraged and pessimistic people said could not be done, that we would have shut-downs, but a very effective job has been done in bringing in the old metals.

The little town I come from, in Illinois, put on a campaign a couple of weeks ago. One Sunday the men of the village got out and collected old scrap metals and rubber. In a town of 6,000 people, in one Sunday, they were able to bring in over 70 tons of scrap material. The country is full of this, and we can get it out if all of us do our part. Today the rubber campaign needs special emphasis and special co-operation.

Then they are going after old rags which can be used to good advantage and also including in their campaigns now, fats and greases and bones, where the glycerine is so needed.

Then there is another group in the salvage branch which has to do with (2) Industrial Salvage. They went to airplane plants last summer, getting them to classify their aluminum scrap, so that instead of selling the aluminum alloys out the back door, they are being returned to the original fabricators to be reworked and made into new, strong alloys. Classification of scrap is the secret of the whole program.

In connection with industrial salvage, it is interesting to note that one steel company which was pessimistic about the shortage of scrap, and which had never been accustomed to do anything on its own part to increase its flow of scrap, felt they were going to run short. Our Industrial Salvage section suggested to them that they see what they could do to help themselves. As a result of considerable prodding, they went out, searched their plant, and found 125 carloads of obsolete scrap within the boundaries of





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their own plant. That is an example of the way in which self-help often will solve the problems that face you. Just as Mr. McCord told you. It must be the method of solution in your case.

Then there is another salvage group that is working on the (3) Automobile Graveyards. They started in in Maryland and there they were so successful that the number of junk cars that were brought back for remelting into steel exceeded the total number of cars that the preliminary survey had indicated were available in all the junkyards of the state.

The method that is being followed is to give the junk yard owners 30 or 60 days to strip the cars down and get out the nonferrous metals and anything that is useable. At the end of that time, if they have not done their job and are not ready to sell their junked cars, our people walk in and take them over. You may recall seeing newspaper accounts of such requisitions. We have to get that scrap and if dealers expect to hold it for a source of income in their old age, they are due for a reawakening!

There is a (4) Special Projects Salvage Section which is attempting to get all of the old rails from the abandoned railroads and the steel from old bridges and old buildings. Many of these projects are tied up with legal restrictions and they have to be cleared, so that they can be wrecked. A bridge in Maryland was secured in that manner, and some of the old remaining tracks of the Boston-Westchester - a couple of streaks of rust have been pried loose so that they can go back and be melted. All over the country large amounts of these obsolete utility and governmental properties are being made available for salvage purposes.

The fourth one of the branches in the Bureau of Industrial Conservation is the Conservation and Substitution Branch, with which I am associated. We, as the Chairman has indicated, have contact with a large variety of materials, all the way from iron, steel and ferrous alloys, to rubber, textiles, paper and other non-metallics.

The whole attempt all the way through is to see if the materials which are scarce for military needs can possibly be replaced with something else that is satisfactory for civilian needs, or something else which is satisfactory for the less essential military needs.

Essentially, there are only three reasons why the War Production Board issues orders; in the first place, because the materials are needed, in the second place, because the manpower is needed, and in the third place, because the facilities, including transportation, are needed. One of those three reasons is or should be the guiding consideration in every case of the issuance of an order.

Now, of course, if we were able to be foresighted enough, these orders would come out in a logical sequence and in time so that it would not dislocate industry nearly as much as has been necessary with the volume of orders that has been issued recently.

Just last week this book on priorities reached my desk (holding up a copy) . . . this represents in very fine type the list of P, L, M, E and S orders which the WPB has put out in its short period of life.

It is an enormously complicated job, but throughout the whole thing, certain objectives are apparent.

For instance, last summer we sent to the War and Navy Department a list of critical materials and told the War and Navy Department, "If you don't design downward to the less scarce materials, there are going to be shortages for military needs, irrespective of civilian requirements."

That list still holds fairly good, with magnesium at the top, a metal which is relatively scarce still, but is going to be an extremely abundant material.

For many years, the only source of magnesium in this country was a plant up here in Michigan. The Dow Chemical Company subsequently put in new plants at Freeport, Texas, where they are getting increasing amounts of magnesium from sea water - an inexhaustible reservoir; natural gas, seashells and sea water are practically the only raw materials that are required. Magnesium production is increasing rapidly because, luckily, the British authorized construction of a plant down there long before we got into the war. There is also a new magnesium plant built at Las Vegas, New Mexico, another in California, and a new plant is going up in the Pacific Northwest. The sum total of magnesium production will be increased 60-fold over what it was before the war.





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Magnesium will be an abundant material and something it behooves you all to learn more about to be prepared for the post-war period, but magnesium is not yet available in quantities that are needed for war purposes. We are way behind the Germans . . . electron metals were more abundant there in the last war than magnesium metals were here at the beginning of this war. Eventually this country will catch up.

Aluminum has already been discussed. We are in much the same position on that, except that the expansion that had taken place before the war provided us with a larger quantity, amounting last fall to about 70 million pounds of aluminum a month and it is going to go up until we will have a capacity of over 2,000,000 000 pounds a year. However, that amount of aluminum is not available yet and aircraft needs practically every pound of new aluminum we have.

There has been some loose talk about a surplus of aluminum; that is not a true surplus. The apparent surplus that exists has been due to failure of the fabricating facilities to keep up with the ingot production. There is some shortage of production capacity in sheet and extruded forms and forgings, but that is rapidly being rectified. With the contemplated expansion of the aircraft program, the aircraft demands for early 1943 will still be ahead of the aluminum production.

Nickel has also been referred to. The International Nickel Company spent some 35 million dollars last year to increase the output of nickel by 50 million pounds, but the output has not kept up anywhere near to the increased demand. The requirements from our Allies have gone up. New Caledonia, which was a source of a small part of our nickel, is being held by the Allied troops, but the conditions for shipping are not at all favorable. The nickel situation is so tight it is becoming necessary to take nickel out of armor plate, an application which is certainly a primary combatant use. You must realize that when nickel is taken out of armor plate and out of superstructures on board ship, there is no excuse for any claim that the use of nickel is necessary for plating except for military applications.

The potential tin shortage was not fully realized nor anticipated before the Pearl Harbor catastrophe, but practically all of our supply of tin came from the Dutch East Indies and Malaya and was smelted over in England. Today we have just gotten into operation a new tin smelter at Texas City, Texas, which has a limited capacity. It was originally designed for 1500 tons a month, which is a mere bagatelle when you realize we consumed over 110,000 tons of tin in this country last year. We call tin an irreplaceable metal . . . we have some stockpiles, thanks to the buying of the RFC, but not nearly enough. Part of the blame is due to the international tin cartel. What we use in tin we cannot expect to replace in any considerable per cent for several years.

We have about four detinning plants in this country, a couple in New Jersey, one in Pittsburgh, one in San Francisco and approval has been given for the construction of six additional detinning plants. The danger is that with a reduction in the amount of tin on tin plate for tin cans we will lose the chief source of raw material for the detinning plants. The maximum permissible tin coating was reduced from 1.65 pounds per base box to 1¼ and the can people are going as rapidly as possible to ½ pound electrolytic coat and even cutting out tin plate entirely on a great many containers. I notice that dog food is coming out now with no tin; they are using paper. Dog food alone took one billion tin cans last year, and oil took one-half billion tin cans. Most similar items are prohibited now for packaging in tin, so that there is going to be a decreasing amount of raw material for the detinning plants. It causes the WPB serious concern as to whether or not to take critical materials for the construction of detinning plants when the source of raw material is being cut off.

Then copper, which has been referred to. The predictions on that become more pessimistic every time you hear them. The Army and Navy requirements are going up, even with the substitution of steel cartridge cases for brass. Our naval requirements are constantly increasing and the picture on the sources of supply is not comfortable.

A new open pit mine just came into production in Arizona in January. They spent some 35 million dollars down there to produce 75,000 tons of copper per year from low grade ore. With that increase and with the bonus which the RFC has arranged to pay the high cost producers over the copper ceiling, we are still unable to increase the supply here to anywhere near what we need. We are faced today with a very serious condition in the reduction of imports. About one-third of our copper ore came from Chile; bottoms today are tight; a lot of ships that formerly touched at South American ports and came up with ore in their holds, today are making a rapid turn-around from Australia and going back to the Pacific Coast to load up with supplies for MacArthur and his forces in the Far East.





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As a consequence, we are getting less and less copper in from South America, just as we are getting less bauxite in from British and Dutch Guiana because of the sinking of our ships over on the other side of the Panama Canal.

Those five metals are and bid fair in the next few months to be available in inadequate quantities for military and associated essential civilian demands - such things as construction of military facilities and provision of defense housing.

The zinc and lead pictures are a little bit better, although the situation on high grade zinc is not nearly as optimistic as was predicted last fall. Last month only 15% of the total lead went into the "kitty" which is allocated by the WPB. The balance still was being shipped out to customers by the suppliers without full control. One of the objectives of the Conservation and Substitution Branch at this time is encouraging the use of lead in place of the other more critical metals.

The steel situation is becoming increasingly bad. I spoke before the Air Conditioning and Refrigerating Congress in Chicago a couple of weeks ago and a number of people came up to me after the meeting and said, "Why should we not use brass as a substitute for steel, because we can get the brass and we cannot get the steel."

Well, that situation was referred to by Mr. McCord. Our inventory and requisition operations have not worked out as fast and as adequately as they should have. We need all of the copper and copper alloys including the scrap for strictly military needs and will need them for many months. The mere fact that somebody has some of that scrap is no excuse for using it for non-essential applications and certainly not for substituting it for iron and steel. Although the deliveries are slow in iron and steel, we have some 80 million or more tons of steel and only about two million tons production of aluminum and copper. The difference in estimates of annual production of iron and steel is as great as total production of aluminum or copper will be next year. You have to keep your proportions straight or you cannot reason satisfactorily with a local condition where there may be a little excess of brass in the hands of some user temporarily.

The announcement was made in the papers recently that some of this steel expansion is going to be given up, because of the fact that critical materials which are required to build new facilities will have to be taken away from the construction of shipping and guns and planes and tanks today. Today is when we need these things. As Mr. Nelson put it, we have to use the "silver months" to maximum advantage.

I am not going to go into the other non-ferrous materials, alloy and plating materials, because they have been adequately covered, but I want to say a word more about silver. I have been pretty close to that deal down there. We have been trying our best to get a set-up whereby silver will be available for unlimited use in industry. You recall the announcement in the paper that we got the approval of the Treasury and RFC to the use of 40,000 tons of silver as a substitute for copper in bus bars in the new aluminum and magnesium plants. That represents a non-deteriorating use, where we can return it to the Treasury Department after the war and it will be equally as valuable and there will be no appreciable loss involved.

Today we import about 3500 tons of silver a year and we produce domestically about 2500 tons. The treasury offers to buy the foreign silver at  $35\phi$  a troy ounce, but actually, industry is now paying  $35\%\phi$ , so the treasury is not buying much foreign silver. However, the treasury is obligated to buy all silver of domestic origin at 71¢ a troy ounce and it is not permitted to sell any silver until silver bullion either attains a certain ratio to the gold holdings, which is fantastic, or until silver passes the price of \$1.29 a troy ounce, which is its monetary value. It is unfortunate that adequate silver is not available for industry when we know, for instance, that we can substitute solder containing around 2% silver, balance lead for 40%-60% and 50%-50% tin-lead solder.

We have adequate silver in the vaults up at West Point, which cannot be used because of the legal restrictions. We estimate that approximately 8,000 tons of silver could be used annually in industry as a replacement for critical metals in war equipment if there were no legal restrictions.

Reference has been made to the use of gold for plating. Several weeks ago, I visited the California Institute of Technology and Dr. Clark showed me some work he had done a couple of years ago in connection with a silver investigation, namely, plating a few millionths of gold on top of silver. The suggestion has been made by some people that the gold would diffuse into the silver and the resulting alloy would not have the nobility of the gold. That was found not to be the case. Even when samples were given what he called the egg test, *i.e.*, boiled with ground, hard-boiled egg, and baked at 1100° and 1200°F., there was no





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tarnish apparent and even two years after the time that these specimens had been prepared and tested, the gold still was visible there in a form which indicated it had real merit as a protection from tarnish of the silver.

That is one of the things that is being considered along the lines Dr. Blum suggested for surgical instruments. I was in the office of the Under-Secretary of the Treasury some time ago asking for the loan of silver and he said, "When are you going to come back and ask us for our gold?" I said, "You will be surprised - we have already got plans for it." In a country that is wholeheartedly all-out for the war, we ought to find economical uses for as much as possible of our gold and I solicit your help.

One thing that I have not heard mentioned this morning is a coming development which is going to have some real value. That is the application of chromium plating on silver. It is being done satisfactorily and will be discussed at further length here in this meeting. Mr. Hogaboom of our staff is prepared to give some of the information which has been developed by the Underwood-Elliott-Fisher people and it looks very promising.

From the standpoint of the electro-tin deposition, we are doing the best we can to foster the utilization of the tin plating facilities of the shops of the type in this vicinity prior to the availability of the strip plating that the steel mills are putting in. The indications are promising that some work will be done, but of course, it is more expensive and there is considerable resistance. The steel companies would rather put in their strip plating lines.

Today the anomaly exists for the can manufacturers that black plate seems to be the neck of the bottle, rather than the tin which has been allocated for coatings. However, every possible pound of tin should be saved, and considerable quantities could be saved by using these batch plating methods that are available in your plants with relatively small changes.

These things move slowly. We have an enormous organization, but we are doing our best to help you out. I want to close by stating again that there are only three reasons why orders are issued: We need the materials, need the manpower, or we need the facilities and if any one of those three necessitate changes in American industry in order to win this war, and win it speedily, I know every one of you is willing to make the necessary sacrifices.

Thank you! (applause)





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# Technical Discussions at the AES 30th Annual Convention Victory Session

**Technical Editor's Note:** *The discussion begins with remarks by Chairman Maurice R. Caldwell after the presentation of the three papers.* 

Chairman Caldwell: We have about ten minutes, or longer, if necessary, for a discussion period. Are there any questions?

Dr. K. Schumpelt (Baker & Company, Inc., Newark, NJ): The speakers we have heard today discussing materials which can be had and materials which should be replaced have not mentioned the one metal which today still is available and regarding which no government restrictions have been announced; this metal is palladium, one of the metals of the platinum group, and in its properties, very similar to nickel.

The color as well as the hardness of palladium are almost identical with that of nickel.

Mr. Anderson: How much palladium have you got?

Chairman Caldwell: Dr. Blum, can you officially answer that?

Dr. Blum: I would rather Dr. Schumpelt would tell us and add to the picture the availability and approximate price of plating.

Dr. Schumpelt: The price of palladium at present is about \$24.00 per ounce. There is no reason to believe that the price should not be fairly stable because the amount of metal available is rather large. During the past ten or twenty years, palladium has been accumulating due to increased production of Canadian nickel ores which contain an appreciable amount of platinum metals, particularly platinum, palladium and rhodium. So far, no commercial or industrial applications for palladium have been found big enough to make a dent in the accumulated stock. I have no definite figures regarding the total amount available, but I can say it is rather large.

Mr. Anderson: I would like to say that I have had considerable experience with palladium in my position with the Bell Company; in precious metal welded contacts in telephones, we have found palladium a quite satisfactory substitute in a number of instances for gold-silver-platinum contacts. It is not as hard as some of the other platinum group metals and it does not have quite as good characteristics from a non-sparking standpoint for current carrying contacts, but it does have a lot of possibilities. I think the Bell System is one of the larger users of palladium for industrial purposes.

Dr. Schumpelt: Another thing about palladium which should be of interest to the plater is the fact that a palladium bath is available which can be operated on the same basis as for instance, a nickel or silver bath. Once the electrolyte is made up the metal is replenished from the palladium anode. Anode and cathode efficiencies are practically 100%.

Very recently a palladium bath has been put in operation to plate surgical instruments and parts of dental apparatus which up to now had been nickel and chromium plated. As far as these instruments were made of steel, a silver plate has been applied before the palladium.

Chairman Caldwell: Thank you for giving us that information. Are your questions answered properly? Do you wish any further answer on that?

Dr. Schumpelt: No, I don't want any. I just wanted to bring palladium to the general attention as a metal still available without restrictions.

Chairman Caldwell: Are there any further questions you would like to ask these gentlemen? Mr. Hogaboom, do you have something to add to this discussion?

Mr. George B. Hogaboom (War Production Board, Washington, DC): Mr. Anderson spoke about a new development - chromium plating on silver. I am pleased to report that such a process is now perfected and the plating is being done on a commercial basis.





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The method of operation was developed at the research laboratory of Underwood Elliott Fisher, under the direction of R.M. Woodward and John G. Poor.

I have seen the process in operation and have had some surgical instruments made of steel silver plated, buffed and chromium plated. The silver is deposited directly on the steel and after the silver is buffed, the chromium is plated on it without any undercoat, that is, directly on the silver.

The final finish is identical in appearance to that of a nickel-chromium coating.

The salt spray life is equal to the nickel-chromium coatings when the two deposits are of the same thickness.

This process opens up a new field and will assist materially in the conservation of nickel which is one of the most strategic metals in production of war goods.

The Underwood Elliott Fisher Company and their research staff is to be congratulated upon developing the process and also especially for their offering this process to the government for the production of such important products as surgical instruments.

Chairman Caldwell: Thank you, George. I have one question in writing here, which I will read. It is presented by Mr. Oliver E. Auer, Engineer Board, Corps of Engineers, U.S. Army, Fort Belvoir, Virginia: "The Engineer Board, Specifications Section, Fort Belvoir, Virginia, is very desirous of finding out about the extent of facilities for plating of large threaded parts, also of pieces with interior threads, with openings of more, with zinc or cadmium." Dr. Blum, could you answer that?

Dr. Blum: Yes, I think it is an example of the sort of contact that is needed and yet which has to be handled individually. In other words, at Fort Belvoir, in connection with the searchlight plant there, they want inside threading of bolts and nuts with zinc and cadmium. I think there must be many electroplating plants that could handle that work satisfactorily. The best way would be for the plants to direct inquiry to Fort Belvoir, Virginia, for details as to what is wanted.

Mr. W. M. Phillips (General Motors Corporation, Detroit, Michigan): I have a question of this sort to ask:

There are a great many plating solutions in the United States that have valuable metals in them. Along with others, we have been trying to get information as to what to do with them - whether to recover the metals, and if so, how, and how it is going to be paid for. I wonder if any of these gentlemen can tell us what to do with these solutions? In other words, we have 300,000 gallons of nickel containing about 10 ounces of nickel per gallon which makes about 200,000 pounds of nickel that is not helping to win the war.

Mr. McCord: Have you been in touch with the Copper Section of the Inventory Requisition Branch?

- Mr. Phillips: Yes.
- Mr. McCord: What did they tell you?
- Mr. Phillips: Nothing.

Mr. McCord: In general, I cannot answer it. That subject has been debated down there off and on now for about three months and I was hoping they had given the answer, because I am frank to say I do not have any. Of course, there have been a half-dozen methods suggested as to possible ways of getting part of the nickel out of the solution. Maybe you don't know this, but the Section is limited to what they can pay per pound. They have a distinct upper limit and I personally do not feel that nickel can be recovered at the price which is their upper limit - that is my own personal judgment on it - I don't know whether they have ever succeeded in getting a directive that would allow them to pay a price which I would feel would be necessary from your standpoint in order to cover your cost. I don't know what you figure, but I know what I figure on the thing and any method that I can think of would be considerably above the price they would be empowered under their original directive to pay for that recovered nickel.

I think that is the basis of the whole trouble. I have not talked with them for several weeks, but the last I knew they were more or less stymied, and I wondered whether anything had happened in the meantime of which I was not informed.





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Mr. Phillips: One idea that was suggested was to evaporate the solution and then roast the impure nickel sulphate to nickel oxide, then find some use for the oxide - I don't know what. The other one was to deposit as much of the nickel out of the solution as we could on anodes and then throw the rest of it down the drain. Those two methods seem to me to verge on the practical.

Mr. McCord: I think both of them are, but on the other hand, I still think that it is probably the price angle in there that is the deterrent factor, because they had a complete directive when they were set up that said they could not pay more than so much per pound and I don't think that so much per pound would, on either of those methods, get you out with a whole skin.

Mr. Phillips: All we are interested in is getting the nickel back into the war effort and what we want to do is, of course, just break even if we can.

Mr. McCord: Naturally, but you do want to break even.

Dr. Blum: A third possibility that has been discussed is the precipitation of the nickel from the solution by sodium carbonate. The nickel carbonate could then be converted to oxide or other forms. The statement has been made in one of the discussions that some of the processes of making synthetic rubber will demand an amount of nickel for catalysts that would use all of the nickel solutions and all of the nickel salts that are available in the country.

Dr. Edwin M. Baker (University of Michigan, Ann Arbor, Michigan): If you wish to recover all the nickel present in nickel plating solutions, I believe the best method is to evaporate the solutions to dryness, and to send the resulting crystallized salts to a central plant to be calcined to the oxide and reduced to nickel powder. The principal impurity in the nickel should be iron, which would not be objectionable if the nickel was used for making alloy steel.

However, the nickel present in plating solutions, purchased as salts, represents a cost of about  $65^{\circ}$  per pound of nickel. New electrolytic nickel is priced at something over  $32^{\circ}$  per pound. The cost of evaporating the solutions, of reducing the salts to metallic nickel, and of freight must be subtracted from the  $32^{\circ}$  figure to give the net return, which would be at most only a small fraction of the original  $65^{\circ}$  cost.

The recovery of this nickel in plating solutions must be justified almost wholly on the basis of contributing to the war effort, as the economics of the situation indicates that the plating plant would be better off financially to retain the solutions (or evaporated salts obtained from them) for post war plating.

Mr. Austin F. Fletcher (Brewer Titchener Corporation, Binghamton, New York): I would like to ask Dr. Blum if he would enlarge on the reference to embrittlement of chrome plated parts of airplanes when they come under stress. I was wondering just what he meant.

Dr. Blum: It is well established that when certain hardened heat-treated steel parts are chromium plated and then subjected to alternating stress, their strength in alternating stress, in other words, their resistance to fatigue, is decreased. The explanation of that behavior is not simple. The easiest explanation is that the chromium has a very hard surface, and therefore if in the bending or stressing of that part a crack starts in the chromium (and chromium is ordinarily brittle), then that crack is likely to extend through to the underlying metal. As an illustration, some years ago some paper manufacturers asked us about the chromium plating of the brass Foudrinier wire that is used in the paper mills. At that time, we tried chromium plating directly on the brass wire. When that wire had a fairly heavy coating of chromium on it, you could snap it in your fingers; but if you dissolved the chromium off, the brass was just as flexible and ductile as before. This shows that the chromium plating had not made the brass itself brittle but it had made the structure brittle. In other words, if a crack started on the surface, it was likely to extend through. That is a very simple explanation of a much more complicated phenomenon. It is a fact that in aircraft engines they must be very careful about the application of chromium to certain parts, because it is likely to reduce the resistance to fatigue and cause fractures afterward in service.

Chairman Caldwell: If there are no further questions, let's give these three fellows from Washington a rising vote of thanks.

... The audience arose in a unanimous vote of thanks and appreciation. ... The meeting then adjourned, at twelve-ten o'clock.