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Introduction

Electroplating is a method of covering objects with a thin layer of metal. Discovered by Michael Faraday in the 1830's it has enjoyed enthusiastic development and application in many areas of industry, and touches our everyday lives in many ways.

This manual and our kits, have been designed to help the smaller operation obtain a professional finish, with fairly basic plating techniques. Of the thousands of different methods and formulae available today, we have chosen several which fit the 'keep it simple' philosophy! The entire manual revolves around our 'electroplating in miniature' systems, no references are made to large commercial set ups, unlike other manuals. These things are deliberately NOT mentioned to avoid confusing you with irrelevant material.

Many of our customers have started off with our kits, mastered the basics of plating, then furthered their education and gone on to set up larger commercial operations. We are happy that they do this, as it is proof positive that they are able to obtain sufficient technical know-how and practical expertise from these smaller operations.

This version of The Complete Plating Manual has many new additions. Its overall format may look similar to the previous edition, **but please follow every step carefully, as many procedures have been improved and altered**. We have also tried to keep each plating procedure's setup and operating notes together, so you should not need to keep referring back to different sections. There are many new photographs to help you visualize each setup, along with the original CAD drawings and diagrams from version one. Some of the procedures will not apply to you, if you don't have the relevant plating kit. All our chemicals are pre-weighed and mixed, so do not concern yourself with knowledge of chemistry.

We have also taken great care to ensure we are using the safest available routines, but the new plater should, never the less, look to his personal safety as he starts to use these systems, for all chemicals are toxic. Because our systems use such minute quantities of chemicals on such an occasional basis, there are usually no problems concerning government departments. However, please note the new sections that discuss waste disposal and chrome emissions.

Many of the chemicals we incorporate into our systems are ordinary household products, such as bleach, Soft Scrub, Ammonia, Hydrogen Peroxide, and Muriatic acid. You will occasionally be required to purchase some of these materials to supplement the operation of the kits. These chemicals are quite safe, if used correctly, and are not considered dangerous goods. They do not even pose special disposal problems.

The actual process of plating is very simple, and once a kit is set up, a novice plater can experience the pleasure of seeing the plating taking effect within 5 to 10 minutes.

We will provide you with a comprehensive system and a good technical backup service, and you should visit our web page at **www.caswellplating.com** for updated support. Our policy is to strive for continual improvement in procedures and techniques, which will result in a continual update of this manual. By sticking to our methods rather than the dozens of others out there, we can easily trouble shoot any problems you may encounter.

Our new PRS (Problem Resolution System) is now available on our web page for problem solving of technical issues. Simply log on to www.caswellplating.com, look for 'support' then 'PRS'. Your username is 'support', the password is 'plater'. This system keeps a log of all activities, as we progress through troubleshooting your problems. It is continually being updated, and answered usually two or three times a day. The service is free to bona fida customers. Please see page 166 for further details.

If you have any questions or problems, please let us know. We probably have the answer, and if we do not, we know where to find it!

And remember - PLATING IS MORE ART THAN SCIENCE - and - PRACTICE MAKES PERFECT!

The Principals of Plating

Electroplating is the depositing of positively charged metal particles (ions) moving through a solution by electricity, attracting them onto an object that has been given a negative charge.

Using the immersion plating technique, the object to be plated (the cathode) is connected to the negative (-) side of the battery, giving it the negative charge, and a metal plate usually made of the plating metal (the anode) is connected to the positive (+) side of the battery, giving it a positive charge.

Positive ions flow from the anode toward the object being plated, through the plating solution (the electrolyte), and are deposited onto the surface of the object. The longer the system is left on, the thicker the resulting plate will be.

Commercial platers usually 'TRIPLE' chrome plate steel in the following manner:-

Strike coat of Cyanide Copper	For bonding
Acid Copper Plate	For hi-build filling
Nickel Plate	For the corrosion resistance
Chrome Plate	For the color and protection of the nickel

The cyanide strike coat is an inexpensive method of providing a fast bond for the Nickel, but as it is only a very thin layer it has to be built up with the acid copper.

Acid copper can plate layers up to 1/4" thick, given time, and as it is a soft metal, it can be polished to give a beautiful luster. This is the stage where the commercial platers spend their time to get the 'show quality chrome' finish we all know.

The Nickel Plate is the hard protective layer, and is really the 'guts' of a chrome plate. It is this nickel you usually see peeling from an old bumper. As this is a hard metal, it is more difficult to polish or burnish, and so it is essential that all blemishes and repairs are done before this stage.

Nickel, given time and the elements, will dull down, giving a flat almost leaden look. It can often easily be brought back to life with a little chrome polish, but it is for this reason that chrome is applied.

Decorative Chrome plate is a very thin layer of plate. It can be applied directly to many metals, but it is extremely porous and will allow the part to rust through in next to no time. Only by providing adequate under layers of copper and or nickel, will this be avoided.

Our New Triple Chrome Kit offers a set up similar to the commercial plater, except that we use a strike coat of FLASH COPPER instead of the cyanide copper. FLASH COPPER will bond to almost all the same materials that a cyanide copper plate will. The obvious advantage is that FLASH COPPER is much safer.

Our New Triple Chrome Plate Procedure is:-

FLASH COPPER	15 minutes	
Acid Copper Plate	15-30 minutes	- only if repairs are needed.
Nickel Plate	30-45 minutes	
Chrome Plate	2 - 4 minutes	

Often, a nickel plate can be applied without the underlying copper plates. This will work particularly well on steel.

In many situations the nickel plate will be quite adequate, so no further plating will be needed. There are many combinations of plate that can be used. There seems to be no real set rules, except that, if it works, do it! Our most successful customers experiment a little!

A simpler and effective alternative to real Chrome plating, is to use Copy Chrome. This can be applied directly to steel, copper, brass and bronze, so it will also go over FLASH COPPER. When more difficult metals such as lead and pot metal need to be plated, FLASH COPPER can be applied as the 'primer' and then Copy Chrome applied over.

Brush Plating is a technique which allows you to plate a small area on a part without immersing it in a tank. This is especially useful for doing touch ups, or gold plating, where the solution is expensive.

Electroless Plating is a chemical reaction of the part and the solution, usually heated, which plates the part extremely evenly. This technique is very useful for small parts,

Practice makes Perfect. The best platers keep notes! Recording your successes and failures is the best way of learning, and practice really does make perfect. If it isn't working, you are probably doing something wrong! Check your procedures with the manual and try again. If you can't fathom it out, make a note of what you did and then give us a call. We can usually fix it quickly! We suggest that you start off with some scrap metals for your first efforts. Short lengths of copper pipe are great for practicing on. Save each piece so that you can apply another plate to it when you set up the next tank.

If it isn't working, you are probably doing something wrong! Check your procedures with the manual and try again. If you can't fathom it out, make a note of what you did and then go to our web site and use the PRS support system. We can usually fix your troubles quickly using this system!

Try some different finishes like wire brushing, emery sanding, bead blasting or buffing and polishing. Practice your buffing skills on these bits of pipe, then plate all of them! You will immediately discover the benefits of good preparation, and then understand that 'show quality finishes' have little to do with the actual plating. It's all in the prep

Your first plating job can be plating your tank bars. A good nickel plate applied to these copper pipes will dramatically reduce any corrosion forming on them.

This version of our manual is going to have a notation against different kits, denoting the skill level required. Rated 1= easy , 10 = very difficult

You should start off using ONLY ONE KIT AT A TIME. If, for example, you have a TRIPLE CHROME KIT, don't set up all the tanks, because you'll be tempted to flit amongst the processes. It is imperitive that you master ONE SKILL at a time. DO NOT progress to another kit until you are quite satisfied you are producing good plating.

We suggest, that with a Triple Chrome kit, you set up the nickel tank first and learn that process. Once mastered, the other kits will be muich easier to understand.

Select some pieces of copper pipe and plate them. Try different finishes, sand blasting, polished, wire brushed, just dirty, etc. and see what they come out like. Buff the finish vigorously, to see it improve (hopefully) and to see if it is well bonded.

Safety Procedures

The major problem with any larger plating operation is the emission of fumes from the tanks during the plating process. Fortunately, we do not have to deal with this in the same way as the commercial platers, due to our 'miniature' systems.

In the case of nickel, copper, Copy Cad, Copy Chrome and zinc plating, the fumes are hardly noticeable, and do not pose any major health risk. However, the chrome, SP Degreaser and de-plating tanks do give off unpleasant, and potentially dangerous fumes. These need to be considered and controlled.

We suggest you manufacture a small fume hood and/or install a fan system to move the fumes away from yourself. An ideal ready made inexpensive hood is a kitchen stove fume hood. The use of a respirator is also advisable.

Our Chrome kits have a fume control system. This comprises of a bag of plastic balls and an EPA compliant mist suppressant which is mixed into the Chrome Activator.

The plastic balls are placed in the chrome tank, and they float on the surface of the chrome. The Chrome Activator is also added to the tank. The mist suppressant in the Activator is a commercial 'oil' which fills the gap between the balls. The combination of these two items, virtually eliminates all fumes from the tank. The balls also hold the heat in. Additional balls may be purchased for use in the pickling tanks.

The actual chemicals themselves are all toxic! None of our systems contain cyanides. All products have a special set of safety and material safety data sheets. Most of the other chemicals are either acids or alkalis, either type will burn skin and blind eyes if the proper precautions are not taken.

You should use goggles, gloves and an apron while using your plating operation.

Acid Spills
Keep a box of Sodium Bicarbonate (Baking Soda) handy. Sprinkle on the spill to neutralize the acid. Then mop and flush.

Disposal of chemicals (for more details see- Waste Disposal & Emmissions)
Most plating chemicals contain heavy metals. They should not be flushed down drains, even in small quantities.
To dispose of chromic acid solution, you may purchase a small Chrome Neutralizer kit from us. Simply add all the contents of the kit to your chromic acid and allow it to work. Then you may pour the solution down the drain. The sludge at the bottom of the tank should be placed into a plastic container and handed in at any 'transfer station' where you would dispose of household paint. Do not 'flush' this sludge. It is a heavy metal.
When you finally dispose of the other chemicals, you should evaporate off as much water as possible, place the remaining sludge in a plastic container, and take it to a 'transfer station', telling them what the chemical is. They will usually dispose of it for you at no charge, considering the small quantity, preferring to do this than let them be flushed!
In the case of spent SP Degreaser this is only a caustic solution and is drain safe, so can be flushed into a sewer system.
Spent acid solutions from the preparation tanks can be used to clean up concrete or neutralized with baking soda. Ask the supplier of these materials for correct disposal procedures.

Some DON'Ts

Don't pour water into any acid, it can heat up and sometimes explode. Pour acid into water.
Don't come in contact with Chromic Acid. It will burn, stain and is a dangerous material if not treated with respect.
Don't think you can get away without taking safety precautions! You can't!
Don't leave the lids off your tanks when not in use. They WILL get knocked over!

Material Safety Data Sheets
(MSDS) are available on all products. The most common ones are printed at the rear of this manual

Setting up a Workshop

Although we have shown a complete workshop here, it is NOT necessary to go to these lengths, you can plate from one tank at a time quite easily!

Here is an example of a neat setup, where the entire operation has been enclosed in a home made cabinet. The top has an exhaust system build in, and there are even glass doors to enclose the operation. Note how the tanks are sunk into the worksurface.

Top left hand shows a power supply, which is connected to the bus bars running along the back of the unit. Operating notes/reminders are pinned on the back wall.

Tank heaters are located on the left and right sides when not in use.

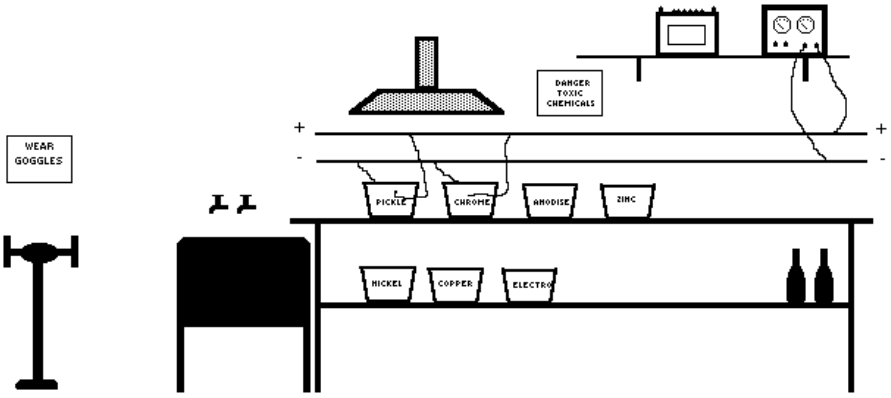
As you will be using acids, alkalis, water etc. and doing surface preparation to various metals with grinding and polishing tools, you will be making some mess and a few smells. We recommend you find a place where you can set up that has a good concrete floor, preferably painted with an epoxy, has some cross ventilation and running water. The kitchen is NOT a good idea!

Plenty of workbench area is a must. You might have up to 4 plating tanks set up at any one time, and will need more space to lay objects out etc.

Set your workbench next to a sink if possible, and tilt the bench so it drains into the sink. Minor spills can be flushed away easily. Some of our customers have purchased 'seconds' kitchen work tops as benches. They have even cut holes in them to recess the tanks.

Find a free area for your buffing equipment. This needs to be away from the plating tanks, as the dust and small metals particles dispelled into the air, can settle in the tanks and spoil your solutions. Your buffing machine can be mounted on the edge of a bench with one wheel hanging over the side. This allows the part, if caught, to drop fairly harmlessly we hope, to the floor. Alternatively, you could construct a pole stand and mount the motor on that.

You will need some good lighting for the workshop, as you will need to inspect your work thoroughly. The area should be heated to about 68-72 deg. F.



Setting Up A Workbench

Depending on the size of your kit, you need to make a suitable workbench. Ideally, it will be close to a sink and a water supply, and the surface could even be tilted to drain into the sink.

A framework of 2" x 4" timbers, is ideal for most triple chrome plating operations. The 2 & 4 gallon setups could be set at your waist height, but larger tanks would need to lower to make it easier to lift the heavier parts in and out of the tanks.

Customers may install a plywood or Formica type surface. Do not use particle board as the liquids will disintegrate it very rapidly.

The air pump and gang valve are installed on the pegboard (top left) Bus Bars are attached to the pegboard by drilling and bolting. Note:- two bus bars running across pegboard.

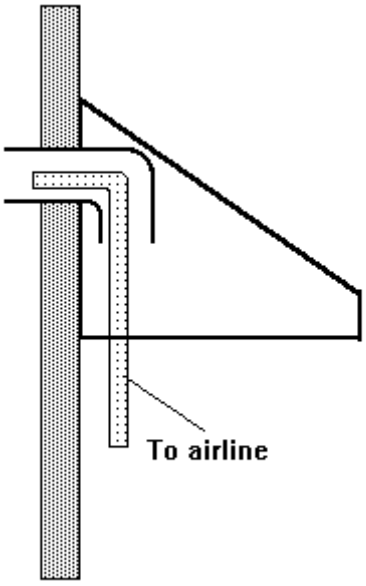
The actual work surface should be strong enough to withstand weights of 200 lbs+(16 gallon kits contain about 150 lbs per tank, so build a STRONG framework and place these tanks on top of the work surface). Do not cut the holes too close to the edges of the board. The plating tanks should fit snugly into the cut hole, resting on the lip around the edge. Ensure the fit if fairly tight.

Additional tanks may be stored on the lower shelf

Storing the chemicals when not in use

None of our chemicals are damaged by freezing, however if the tanks freeze they may crack open, and give you a real mess to clear up when they thaw. So we suggest you store them in a heated area. Ensure the lids are secure on each tank and mark the tank with an indelible marker, denoting the contents.

If you intend storing the chromic acid from the chrome plating tank, for a long period, say 2 years or more, we suggest you transfer the product to a glass container. This acid will very slowly attack the plastic tank, and may cause you an unpleasant clean up job.



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Making a fume hood

For the occasional plater, a fume hood may be an extravagance, and the problems of occasional fumes can be dealt with by simply opening a window and placing a fan by the offending tank, or simply wearing a respirator with acid gas cartridges.

There are a number of options for a fume hood. Normally, hoods will not be necessary for nickel and copper plating, as the fumes generated are very minimal from these processes, but from the De-greasing, De-plating and Chrome plating tanks some sort of control is almost vital.

A simple hood can be made from plywood, and coated with a bituminous or epoxy paint. Or the use of a range hood from a cooking stove could be a 'ready made' solution. The fan motors in these will usually not last too long, as the acid fumes will attack the windings. The best arrangement is to rig up a simple ventura blower, using an air line or a vacuum cleaner exhaust, as pictured above.

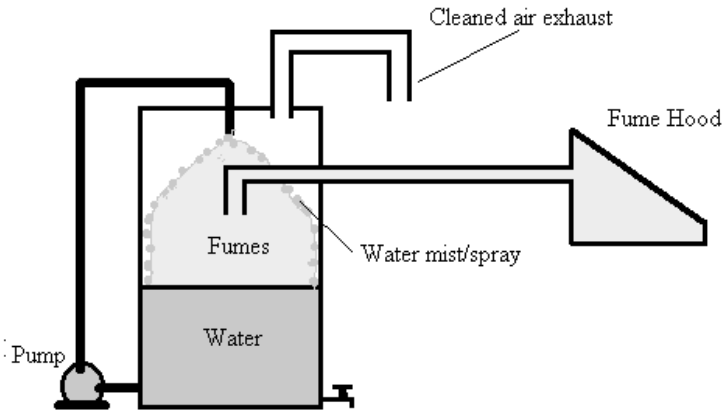
Set the hood about 1 foot above the tanks. You can usually get two of our tanks under a range hood. We don't envisage you having many more than 2 tanks running at any one time, so there is no need to make a huge contraption.

Make a hole through to an outside wall, or place your exhaust pipe through a window.

Using some 4" plastic pipe make up an arrangement as shown in the diagram.

Make a hole in the bend of the pipe large enough for you to insert your air line or vacuum exhaust pipe.

When the air line/vacuum is switched on the force caused by the ventura principal will suck all the fumes out through the larger pipe. There are no moving parts and the system is therefore fairly foolproof!



Air Scrubber Unit

See the section on Zero Emissions

You may also consider constructing a simple 'scrubber unit' to clean the air from your fume hood. Depending on the size of your operation, you can make this set up from something as small as a 5 gal pail to a 55 gal plastic drum

You will need a small water pump, preferably with an all plastic housing and impeller. The pump is there to circulate water around the tank. As the water is introduced back into the tank it must be made to spray out in all directions as a fine mist. It is this curtain of mist that traps airborne particles of acid, ' scrubbing' the air clean as it passes through the curtain.

The acid is contained in the body of water at the bottom of the tank. Very occasionally, you will need to remove this water, evaporate it down by placing our heaters in it, and saving the sludge or concentrate in a small plastic container. You may them dispose of this at your local transfer station. Even a busy shop may not have to do this more than once every year or so. Remember to top up the water level periodically, as it will evaporate off fairly quickly. Adding a couple of boxes of Baking Soda to the water will neutralize the acid as it enters the system.

Bus Bars

You may wish to mount two lengths of 1/2" copper pipe along the back wall of the bench. Space them about 6" apart, and mount them on wooden blocks using the 'u' shaped straps designed for plumbing. These are your 'BUS BARS' and carry the power from your battery to the various tanks. They allow you to connect to a power unit saving a 'spaghetti' mess of wires. Remember to get alligator clips large enough to clip onto the copper pipes.

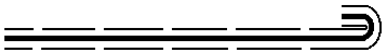
Paint both ends of the top bar RED, and the bottom bar BLACK. You may like to nickel plate these bars to stop corrosion forming on them. This could be your first plating job.

Note. In the picture left the bottom two bars are the bus bars

The Agitator

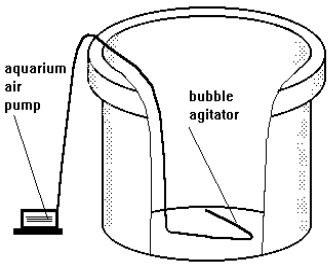
During the plating operation a small quantity of hydrogen gas is formed on the work piece. If this is not removed, the plate forms around the bubbles leaving tiny craters. One simple method of removing these is to simply shake the tank bar every few minutes. Agitation also keeps the temperature of the tank even and the chemicals well mixed. The use of compressed air is the conventional method of doing this. Once set up the system can be left unattended.

TO MAKE A SIMPLE AGITATOR .



Cut a length of aquarium air pipe and punch small holes in the last 9" of it. Space them about 1" apart. They should be large enough to let fairly big bubbles through. You do not want a fine mist as this will simply add to the problem. This can be best achieved using a small nail to punch through the plastic.

Cut a length of plastic coated wire about 9" long. Stretch and melt the plastic over the ends, so they are sealed. Insert the wire into the air pipe where you punched the holes. Bend the wire or tie off the end. This gadget can now be dropped into the tank and shaped to suit any work piece. The bubbles should float up around the part, gently agitating it, or at least knocking off the hydrogen bubbles.



Here is a larger tank with a zig zag pipe system across the bottom.

This air agitator can easily be made from ½" pvc plumbing pipe and elbows.

To allow air to escape, use a small hack saw and cut slots across the pipe at 2" intervals down its length, The cut should be made so that it just make a small hole in the pipe. Once treated, the system should be placed back into the tank with the cut slots FACING DOWN. The tank need to be place on a level base to ensure even exiting of the air.

Anodes & Cathodes

Supplied in each kit is a set of metal plates which can be either a cathode or an anode. The plates are called anodes when they are used in a plating tank, and cathodes when they are used in a de-plating tank. Anodes are always connected to the (+) positive side of a power unit, and cathodes to the (-) negative side.

The anodes we supply are of very pure quality. Substituting, particularly copper, is tempting but can result in low quality copper being introduced into the bath, which can cause contamination of the solution and disbonding of subsequent layers of plate.

Nickel Anodes 4" x 6"

Nickel anodes are supplied either singly, or in a set of 2, each with a special bandage. The bandages should be wrapped around the anode, to make an envelope and secured with a rubber band. This prevents the oxide that forms during plating from falling into the solution and contaminating it. The other types of anodes do not usually require this treatment. Note how the bottom of the bandage is folded up and then secured. Always remove the anodes from the tank after plating. Rinse and dry them to store.

Copper Anodes 4" x 8" (High Phosporous)
Supplied singly, or in a set of 2, with anode bandage. As of January 1997, we have changed our policy on anode bandages for copper, and they will be added to each pack of anodes. Install the bandages in the same manner previously described for nickel plating. Anode bandages in copper provide a smoother, higher quality plate. Always remove these anodes from the tank after plating. They will deteriorate rapidly if left in the tank.
Pictured right, the anode and bandage, with a strip cut to make the tank hanger.

Chrome Anodes 12" x 12"

These larger plates are used as anodes for chrome plating. The chrome is derived from the solution and not from the anode, so these plates are a permanent fixture. They are a specially made alloy of lead and antimony.

Chromic acid will attack the anode. forming a yellow layer of lead chromate. This acts as an insulator and prevents the anode from functioning properly. Anodes must be removed from the tank, immediately after plating and cleaned with a Scotchbrite pad in fresh water to remove this film. Dry and store the anode ready for the next usage.

Chrome anodes need to be affixed to a heavier wire than all other types of anode, due to the much larger current requirement of the plating operation. To affix the anode to a thicker wire (such as jumper cables), bare approx. 2" section of the wire and roll a corner of the anode around it. Hammer flat to secure. The anode can be hung into the tank, using the wire as its positioning support. Alternatively, use jumper cable clips to secure the anode to the tank wall and make the connection.

PEROXIDING CHROME ANODES. As an option for chrome anodes, you may wish to treat them to prevent the build-up of 'lead chromate' This yellow coating prevents the correct function of the anode. It usually occurs if the anodes are left in the solution for long periods without regular cleaning.

Make up a solution of 15% sulfuric acid (battery acid) and 85% distilled water. Clean the anodes with wire wool, and connect anodes to a dc power supply, one to the negative and one to the positive. Adjust the current to obtain approx 5amps per sq foot of anode surface area. Maintain current for 15 minutes.

Reverse the polarity and repeat the process for 15 minutes.

Finally, reverse the polarity once more, and repeat the process for 15 minutes.
A dark brown coating will form on the anodes, indicating the prescence of lead peroxide. This layer will prevent the formation of the lead chromate whilst still allowing the current to flow.

Installing the anode/cathodes

It is imperitive that you do not allow any connecting wires/clips etc. to be immersed into the plating solution. Any such foreign objects will be dissolved by the plating action, and the result will be a contaminated electrolite.

To ensure that ONLY THE ANODE is dissolved, cut a strip down one side of the anode, about 1/4' in. Do not completely sever the strip from the anode, stop cutting about 1/4" from the end. This strip can now be bent 180 degrees to make the hanger and contact for the anode.

Drop the anode into the solution, and bend the top of the strip over the lip of the tank. You may now use an alligator clip to attach your power line to the anode. Attach a second wire from this anode to any other anodes.

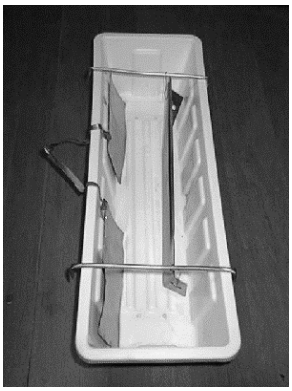
Anode Positioning.

Most items can be plated in our round tanks with an anode either side. In larger round tanks several anodes may have to be placed around the circumference. The effectiveness of an anode placement is something you will learn by experience, but as a general rule, try to keep the anode at least 3" away from the article being plated and no more than 9" away. When chrome plating, remember that chrome has poor throwing power, so anodes should be evenly placed around the object.

For long objects, several anodes may have to be placed along the length of the tank.

Objects with recesses may not plate effectively in the recessed corners. To overcome this, you may need to place the anode closer to the recess and actually form it to conform to the recess.

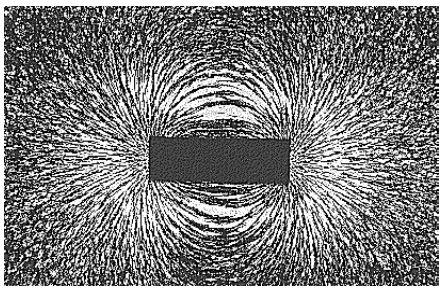
To reach difficult areas, you may need to make a cut in an anode edge and bend a strip upwards, so that it can be pointed into the recessed area. This technique is especially useful for plating inside tubes. See the section on HARD CHROME PLATING, for specific anode design.



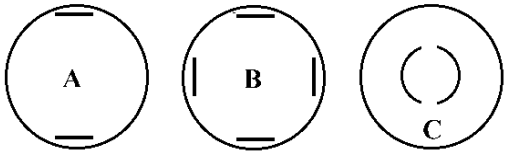
In the picture, left, a long object is required to be plated on one side only. Both anodes have been placed on one side, facing the part. Their strips are joined together ready for the positive terminal from the power supply to be attached.

If both sides were to be plated, anodes would be placed on either side of the part, which would be centralized in the tank.

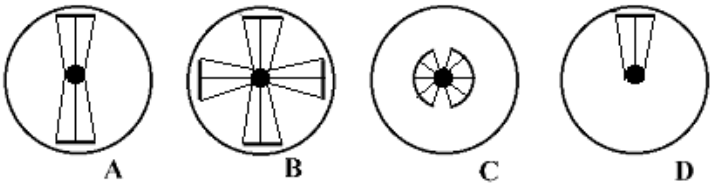
Left. The two tanks bars have the part suspended on copper wire. If the part were to be plated on both sides, additional anodes should be placed opposite the existing ones.



Anodes give out 'Lines of Force' similar to a magnetic field. These lines travel in almost straight lines form the anode to the part, but, like magnetic force fields they will bend slightly. So an object being plated which is facing only ONE anode, will generally only the side facing the anode plated. Because the 'Lines of Force' bend, some of the back edge of the part may also get plated. This phenomonen will vary from part to part, also depending which type of plating you are doing. Generally, zinc plating will almost plate all the back side of a part, whilst chrome will not, as it has poor 'throwing power'.



Here are several configurations of anode placement. Tank C shows the anodes hung centrally in the tank, and bent around to keep their surface equidistant from the part. This is especially useful when chrome plating a small part. If the anodes were left in the A tank position, the distance from the part would be so great that the 'chrome anode would be unable to 'throw' the power across to the part, resulting in a patchy, or non existant plate. The anodes in tank C could also be made into a complete tube, with the part hung in the center.
The configuration in tank B could be used when the part has many 'nooks and crannies', ensuring the 'Lines of Force' come from many directions.

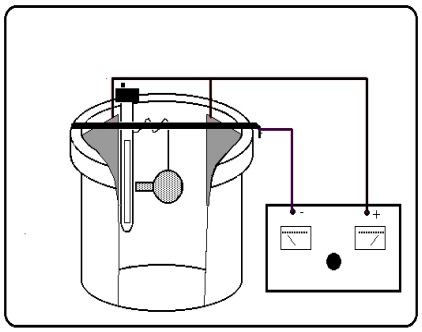


Here left, the lines of force are shown. Note in A that the areas directly opposite the anodes get more lines of force, so get plated heavier. Whereas the 'sides' of the part get much less.

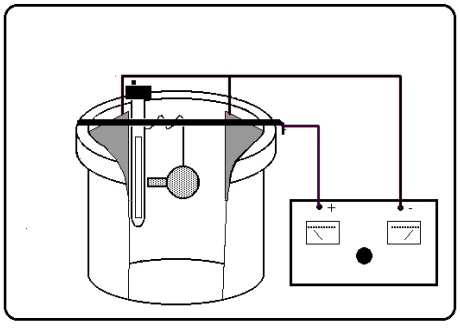
In tank D, note that the lines of force are only attracted to one side of the object, so the side 'in shadow' from the anode doesn't get plated.

GP Plates 8" x 8" (General Purpose Plates) Used for Anodizing, Stripping.
In these instances the plates are called cathodes, and are wired to the negative side of the power unit. They may be attached to wire in exactly the same way as the chrome anodes. If the tank is to be stored for any length of time, it is advisable to remove the anodes/cathodes, wash & dry them and store them separately.

Making up the tanks
There are two basic types of tanks;
A. PLATING B. DE-PLATING.



A. PLATING TANKS are used for applying the various metals to the objects. One type of tank will only plate one type of metal, therefore you will have several tanks for triple chrome plating, where the requirement is to copper, nickel then chrome plate. The metal plates used in these tanks to supply the plating metal are wired to the positive side of the power source and are, in this instance, called the ANODES. The part to be plated is wired to the negative side of the battery and is called the CATHODE.
The negative CATHODE attracts metal from the positive ANODE.

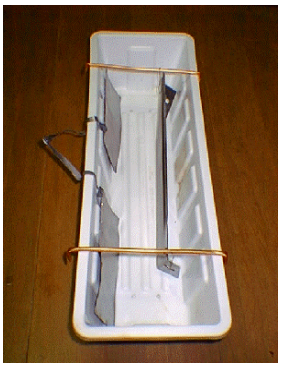


B. DE-PLATING TANKS are used for:-
1. removing old plate
2. anodizing aluminum
3. dissolving rust
4. electric etching

These tanks are set up in exactly the same way as the plating tanks, except that they are wired up IN REVERSE.
So you end up - DE-PLATING.

Our previous policy was to bolt the anodes/cathodes to the side of the tank, but now we prefer to cut a strip along the long side of the anode and use this as the hanger. This enables the anode to be placed deeper into the solution, with no fear of contamination from the hanger.

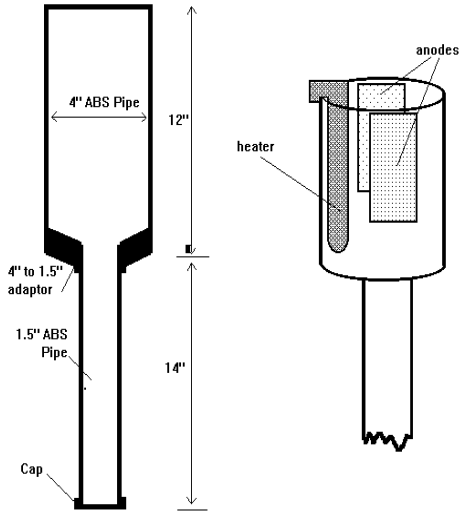
Plating long objects.



As our tanks are cylindrical in shape, this can cause some problems when plating longer objects. Most objects can be half plated, then turned in the tank and the other half plated. Where there is a join mark, this can be buffed out leaving no signs of its existence. Pictured right is a plastic window box. Note how the anodes are placed on one side only. In this instance, only one side of the object needs plating. More anodes would be needed to plate both sides, or the object could be turned and the process started over for the other side.

THE WORONKO PLATING CHAMBER

This ingenious tank was developed by Mr. Henry Woronko, a customer of ours.



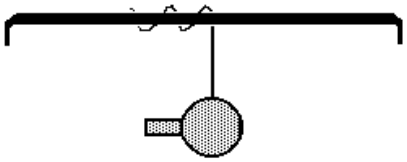
The set up is extremely simple and inexpensive to make, and can plate parts up to 6 feet long, if adapted.
Once the tank is assembled, it should be wrapped in fiberglass, or pipe insulation and covered with plastic sheet to protect it from the splashing chemicals.
Seal it with duct tape. This will keep the temperature constant which is a major consideration when chrome plating.

Increase the solution's recommended temperature by 20 deg. F when using this set up, as the larger and cooler part will drop the temperature as it is introduced to the system. This particularly applies to chrome plate.
All our procedures can be used in the tank, de-plating, anodizing, and all other plates. Ensure you rinse the tank thoroughly between changes! If you chrome plate, make a special tank, specifically for the purpose, and do not use it for any other type of plating, otherwise you will contaminate your solution.

The Woronko Plating Chamber is operated by hanging the long thin part into the fatter area of the chamber, and held there until that section of the piece is plated. As soon as there is sufficient plate, the piece is lowered, so the plated are now drops into the lower, thinner section of the tank. The process is repeated until the entire item is plated. There will be no 'tide marks' or bumps in the plate using this technique. Extra long items could be plated down one half, then turned around and plated from the other end.

MAKING A TANK BAR

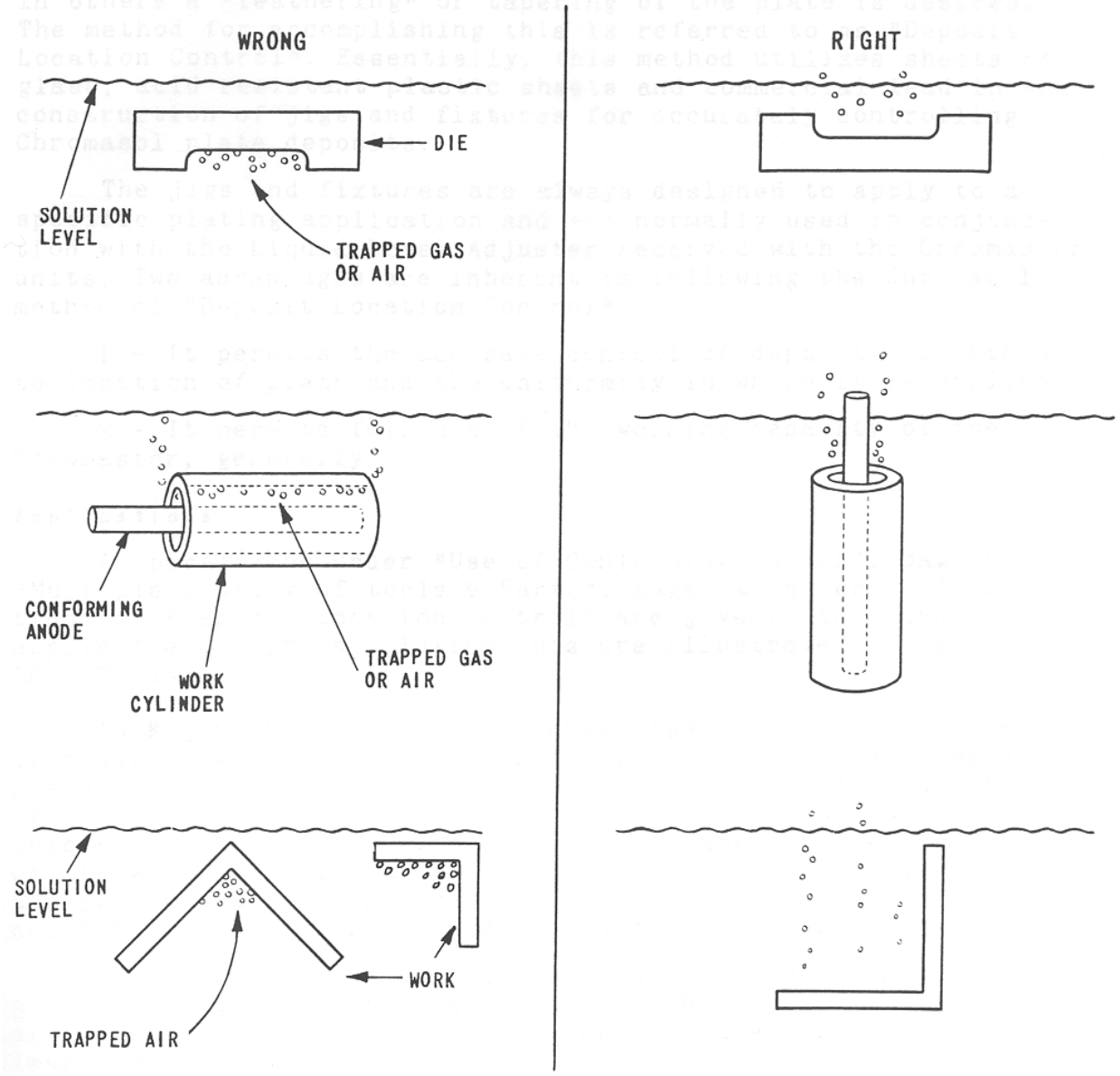
Using a hammer, flatten about 1.5" of each end of a 1/2" x 14" copper pipe. On our 1 & 2 gal plating kits, use a 1/4" diameter pipe. On the 16 gal kit, use a 1" pipe. Bend the ends at 90 degrees, so that they fit over the outside edge of the tank. These bars will be used to suspend parts in the tank.



For most applications, simply wrapping the wire from the part around this tank bar several times is sufficient. However, to ensure good electrical contact, you may wish to drill several holes along the length of the pipe and insert some brass bolts & secure with nuts. The part's wire can then be affixed to these bolts and locked into place with another nut.

Keep the bar clean by occasionally scrubbing with wire wool. This ensures a good electrical contact. You may plate the bar with a nickel plate to reduce corrosion. Use these tank bars as your first plating job!

If you are going to hang really heavy articles in a larger tank, cut a steel reinforcing bar, and coat it with epoxy paint, then insert it inside your copper pipe. This will dramatically increase the tank bars holding capacity.



Positioning workpieces to avoid trapped gasses will save many a spoilt plating job. If a trapped gas is present, this expells the plating solution, and so the area will not plate.

Heating the Plating Solutions

Almost all our kits have a heater supplied with them. Depending on the size of the tank, the heater will be either 100 watts, or 300 watts. These heaters have been specially designed to work in our plating tanks.

The heaters are submersible. However, in some of our smaller kits, they may be too large to operate like this, so we suggest that you hang them from the side of the tank. 2 sucker clips are included for this. Alternatively, you may make a loop of plastic coated single strand wire that fits around the neck of the heater and then bend the ends over the tank edge to make a hook.

The glass tube is very fragile. It may break if tapped or dropped. It will also crack if thermally shocked. This can occur when the heater is hot and a quantity of water is added to the tank If the heater is completely immersed, you are unlikely to cause thermal shock to it by adding water to the tank, but if any portion of it is above the water line, then you could damage the glass. It is advisable therefore, to only add water to the tank when the heater is cold. Do not remove the heater when it is hot. Do not place large objects in the tank quickly, as the rise in liquid level may crack the glass.

To further prevent damage to the glass, we have supplied a length of Poly-net to encase the glass tube. Stretch the net over the glass & secure with a twist of plastic coated wire or a plastic tie.

To set the heater adjuster to the optimum temperature of your tank, turn the heater dial to its mid range position and then immerse it into the solution. Monitor the temperature after approx 1 hour, and make adjustments accordingly. If the heater does not bring the temperature up high enough, remove the cover and undo the screw holding the dial. On some models, you'll see a small groove on the underside of the dial. There is a raised nipple on the head of the heater and this runs in the groove. The groove does not go all the way around the dial, stopping you from continually turning the dial to raise the temperature. You may either lift the dial over this stop, or simply drill out or cut out the stop, allowing free and continual movement of the dial. Most models have already had this modification carried out.

Do NOT swap your heaters from one type of plating tank to another. Small quantities of solution lodge under the dial cap, and this WILL contaminate different solutions.

ENSURE YOU REMOVE YOUR HEATER FROM THE CHROME PLATING TANK AFTER USE. Once you have set your dial temperature for your chrome tank, you may like to remove the dial cap, dial and head of the heater, fill all the voids with silicone rubber and then replace everything. This will ensure no damage is done by the aggressive action of the chrome plating solution. It also prevents small quantities of chrome being removed from the tank when you remove the heater for storage.

If you decide not to completely immerse your heater, you may hang it from the edge of the tank by making a wire holder and hook, (see left). This can be adjusted to let the maximum amount of the glass be immersed.

Another way of bringing a tank to its operating temperature quickly, is to remove a saucepan full of liquid and bring it to a near boil on a hotplate, then return it to the tank. Always use a ceramic lined vessel for heating solutions; otherwise, you may contaminate them.

Some solutions work better with high temperature settings, such as SP Degreaser, and often an aquarium heater simply will not bring larger quantities of liquid to the near boil.

By transferring the liquid to a metal can, it can be placed over a gas or electric burner and brought to temperature. If you are using the liquid with low voltage to strip plating, then you can simply clip the wire to the tank, using the entire metal surface of the container as your anode/cathode.

An excellent vessel for heating liquids to higher temperatures is an inexpensive 'crock pot', available from any good hardware store. It has a lid and a thermostat control. The one pictured here holds 2 gallons of liquid quite comfortably, and has a non-stick lining. Do not 'Electrostrip/clean' using low voltage power in these vessels, because if the thin lining has been damaged, the chemicals and low voltage will rapidly attack the aluminum pot. This vessel is ideal for 'hot soaking' parts in SP Degreaser.

Insulating the plating tanks.

Simply by taping an insulating material around the side and the bottom of your plating tanks, you can rapidly decrease the amount of time required to warm up the solution from cold, and particularly in the case of chrome plating, attain a higher temperature using only aquarium heaters. However, if you intend to use direct heat, such as a gas burner, then some consideration to the flammability of the insulating material must be given.

There are several suitable materials for this. Many hardware stores sell an aluminum foil combined with a bubble wrap especially for insulating domestic water heaters. It comes in various widths and is very inexpensive.

There are several sizes of 'Bubble Wrap' packaging material available at many 'office supply stores'. Even a layer of corrugated cardboard covered with plastic sheet (to keep it dry) will make a huge difference.

The inclusion of mist control balls to any plating tank, will also hold in the heat. We only ship these with chrome and anodizing kits, so they may need to be ordered separately.
In the picture here, a mist suppressant is also being added.

Double Boiler - an alternative way of heating

The use of the 'double boiler' technique can often be a simple yet fast way of bringing a plating tank solution to a higher temperature than the 'aquarium type' of heaters supplied.

Using any steel vessel as the outer jacket, place a wire trivet or cake stand in inside and drop in the plastic plating tank. Fill the jacket with fresh water, to about 1 or 2 inches below the top. You need to allow some room for bubbling etc.

The plastic tanks do tend to insulate somewhat, so it is advisable to find the thinnest plastic container to increase heating speed. Place a lid on the tank during heating to conserve heat.

Almost any configuration of tank can be designed, with a variety of external heating sources, which can be thermostatically controlled.

Ceramic Lined Tanks.

An alternative to using plastic tanks are the porcelain or ceramic lined vessels now available. (As supplied in CASWELL Electroless plating kits). These allow plating to be done in the tank, while being heated on either an electric or gas burner. The ceramic coating is a complete electrical insulator, so anodes may be hung in the normal manner. Periodic checks must be made to ensure the ceramic coating is not damaged in any way. If you do find any damage, this may be repaired by cleaning with steel wool, then daubing a small amount of two part epoxy resin over the area. (Gas Tank Sealer works well)

Heating larger kits

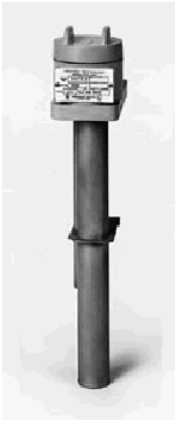
Larger tanks, such as the 16 gal kit, may be heater with commercial quality heater such as the ones shown here.

The section containing the heater may be made of quartz, titanium or stainless steel, depending on which chemical it is heating.

These heaters come with a thermostat control and a probe which is inserted into the solution. They operate on 110 volts.

A typical 16 gal Triple Chrome Plating kit contains:

2 x 1000 watt Titanium Heaters
1 x 1000 watt Quartz Heater with guard
1 x 1000 watt Stainless Heater
4 Control Boxes



SOME THINGS YOU MIGHT NEED

You will need to collect some articles before you can start plating. We suggest you read the entire book before trying to collect these items, to determine your requirements for each procedure.

For general requirements -

A candy or aquarium thermometer
Distilled Water (not mineral water)
Rubber gloves (kitchen type, not latex)
Goggles
Plastic Apron
Alligator clips
Red & black Plastic Coated copper wire.
Stirring sticks, preferably plastic or wood, NOT metal!
Muriatic Acid (or hydrochloric Acid -this is swimming pool or concrete cleaner) 1 gal
Swimming Pool water test kit, (for checking pH of your water supply)
Sulfuric Acid (battery acid 1.26 baum)approx. 1/2 gal
Acetone or lacquer thinner 1 gal (for oil & grease removal)
Bare copper wire, approx. 18g. Heavier gage for Chrome plating.
Some spare plastic containers.
Aquarium heater (Supplied with most kits)
14" lengths of 1/2" copper pipe - to make TANK BARS. One for each tank
A respirator with ACID GAS cartridges
1 box of Baking Soda, for neutralizing acid spills.
Magnifying glass, for inspecting your work.

THE POWER SOURCE

There are many choices of power source, all of them being able to cope well with most applications. All our kits, except Chrome and Copy Cad, will work well from a car battery or a battery charger. Even a cheap 2 amp trickle charger will plate surfaces of up to 30 square inches, which is sufficient for many of the small parts likely to be plated in our operation. If you decide to use a rectifier, you need not be concerned at to how you are going to control the power, as these units have built in rheostats. But, if you want to use a simple control, without the use of these more expensive units, then you will need to control the power with either a rheostat or light bulbs. Please see the section on 'Controlling the Power'.

The 25 amp & 60 amp Rectifier.

Powered by 110 volts, these rectifiers will plate continuously all day long. They are ideal for the smaller workshop with a higher output.

The 25 amp rectifier will plate up to 20 sq. inches of chrome, but will admirably cope with all other plating tank requirements.

We suggest that this machine is your best choice. If you require to plate occasional larger parts with chrome, then set up large batteries and the salt water rheostat system, as this is more cost effective than purchasing the 250 amp rectifier.

The 60 amp machine is capable of plating smaller items with chrome up to approx. 50 sq. inches in total surface area.

The 250 amp Plating Rectifier

This unit will plate chrome parts up to approx 200 sq. inches in surface area. It is not suitable for chrome plating small parts less than 20 square inches, or for any other type of small item plating, because the lower end of the 'tuning' range is simply not fine enough to give you an accurate result. For these parts use the 25 amp rectifier.

The only disadvantage of rectifiers, is their cost. For the occasional plating job, the initial cost may be prohibitive. So, an alternative low cost method is to use light bulbs to control a battery. See the next section on “Controlling the Power”.

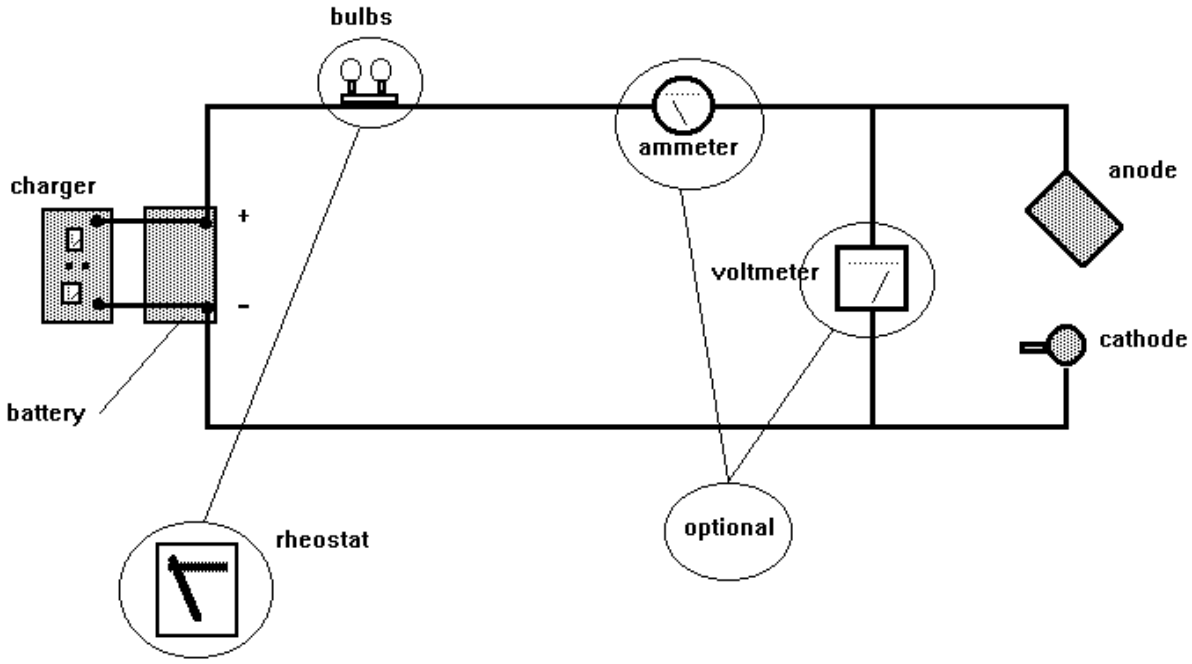
The 6 & 12 volt Battery

Giving pure 'ripple free' DC current, these batteries are the obvious preferred choice of power source, and are able to supply high amperage for a short duration, ideal for chroming small parts.

As the usual current requirement is 2-6 volts for most plating jobs, it is preferable to use a 6 volt supply. By using 12 volts, we have more difficulty in disposing of the additional heat. Much larger rheostats are required. So, it makes more sense when designing your system, to use the correct voltage in the first place. 6 volts is our preferred voltage output for all power sources.

The Battery charger

Often they come with their own ammeter, and a variety of settings. Some of the larger ones will give outputs of up to 300 amps, but the voltage needs to be reduced to plate effectively. On smaller operations, a charger can be effectively controlled using light bulbs, or a salt water rheostat.
The 'ROBBER' principle may also be employed effectively to control the output. (See the section on 'Controlling the Power'.



Here is a typical setup showing charger backing up a battery, ammeter and voltmeter in the correct positions, and a bulb rack which can be replaced with a suitable rhoestat (salt water is an option). The battery & charger can be replaced with a rectifier.

Combining battery & charger for chrome plating

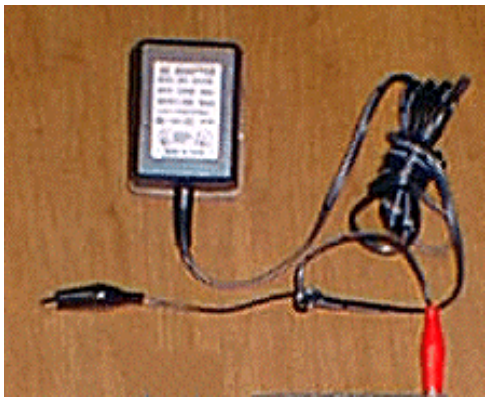
If you are chrome plating larger parts up to approx. 200 square inches, we suggest you use a combination of battery and a larger battery charger. Use a battery with a high cranking amps rating, such as a marine deep cycle trolling battery or a ready made 6 volt battery from a golf cart.

You should couple the charger to the battery and then draw your current from the battery.

Unlike plating other metals, chrome plate will not form unless there is sufficient power. The part will just sit in the tank bubbling away all day until you increase the power.

If you are plating larger parts and not getting the chrome to deposit, place a second battery in parallel. Additional amps will be provided in this manner.

Power for very small items



We have introduced a new PLUG 'N PLATE power pack to our COPY CAD system.

This unit supplies 1.5 volts @ 300milli amps (ma). As the requirement for Copy Cad, gold, zinc etc is 1.5 v @ 25 ma per sq. inch of surface area, then this unit will plate up to 12 sq. inches. (It will actually plate up to about 16 sq. inches in practise)

Using the 'ROBBER' technique, see the section 'Controlling the Power', very precise plating can be achieved on smaller articles. This unit is much preferred by us than using small batteries, as the output from these varies tremendously as the battery wears out. However, batteries may still be used, as follows:-

When you are plating very small items, such as a nut & bolt, or a washer, with a zinc, nickel, COPY CAD or copper plate, a smaller control system will be required. As bulbs, rheostats and most rectifier units will not reduce the current from a six or 12 volt battery sufficiently, you can use a simple flashlight 1.5 volt battery as your source. You can connect the battery directly to the anode without a bulb or resistor in the circuit. We have found that an AA type battery will plate an item up to 5 square inches in surface area beautifully with any of the systems mentioned above. If you have a very small article, use an older ' flat' battery. If the color of the plate is dark, then use a smaller, flatter, battery. This is a great way of using up those old batteries!

The Arc Welder

This is not our preferred choice of power unit, never the less it will work well providing you make some following modifications. Most arc welders supply 24 volts output and very high amperages, the latter being ideal for chrome plating. However, this voltage is generally too high, and needs to be reduced.

By setting a 2:1 step down transformer in the line between the main 120 volt circuit and the charger, you will drop the input voltage to 60 volts. Therefore the output voltage will be 12 volts, a more acceptable figure for our purpose. We suggest you control the current at the source because it is more economical to get a mains step down transformer, than a 24 volt, 300 amp setup.

Alternatively, if you have a 220 volt Arc Welder, this can be wired to a 110 volt supply, which will reduce the output by half.

Consult a qualified electrician for this work.

This system can produce dangerous currents to the tank, if the modification is incorrectly carried out.

This work is beyond the scope of this manual.

Controlling the Power

If you are using a Rectifier, controlling the power will be a straightforward job of dialing up the amount required, depending on the size of the part to b e plated, and the amperage requirement. For example, nickel requires 1 amp per 15 square inches of surface area. So, a 45 sq. in. piece will need - 3 amps.

If you are using a battery or battery charger as your power supply, these units have no power control, and if you were to hook them up directly to the part and the anodes, plating would be fast and furious as the as the current virtually shorts across the tank. Of course, you would probably ruin the part too! To control this power, (to 'slow' it up) we have to place some resistance in the line. This can be done by using either light bulbs, or a rheostat. Whilst the bulbs may look a little amateurish, they really do an excellent job of plating, and should not be underestimated! If you decide on obtaining a rheostat, we have provided OHM's law below, to enable you to work out the resistance YOU require. We cannot do this for you here, because we don't know what you are plating. If you have any difficulty in doing this, get in touch with us and we'll be pleased to help.

For controlling large currents, as used in Chrome Plating, you may wish to use the Salt Water Rheostat (See this section). It is an economical unit to construct and is very reliable.

Most applications will use a 6 volt supply.

Choosing the right bulb

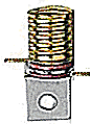
You will use different size bulbs depending on the surface area of the part to be plated.

You need to consider the size of the largest part you are likely to plate when you construct your bulb rack. If you are only plating an odd item, you may not even want to bother with making a rack, just simply plug in a bulb and place the bulb holder into the circuit.

These 6 volt bulbs & sockets may be obtained from any motorcycle outlet, lawnmower repair, golfcart repair, & Radio Shack.

6 volt 100 ma bulb RADIO SHACK product # 272-1142

6 volt 250 ma bulb RADIO SHACK product # 272-1130

Threaded Bulb Base RADIO SHACK product # 272-360
Or # 272-357 

Radio Shack Part # 272-357

Most of our plating tanks, except chrome, zinc & Copy Cad, draw roughly the same amount of amperage, 1 amp plates approx. 16 sq. in.

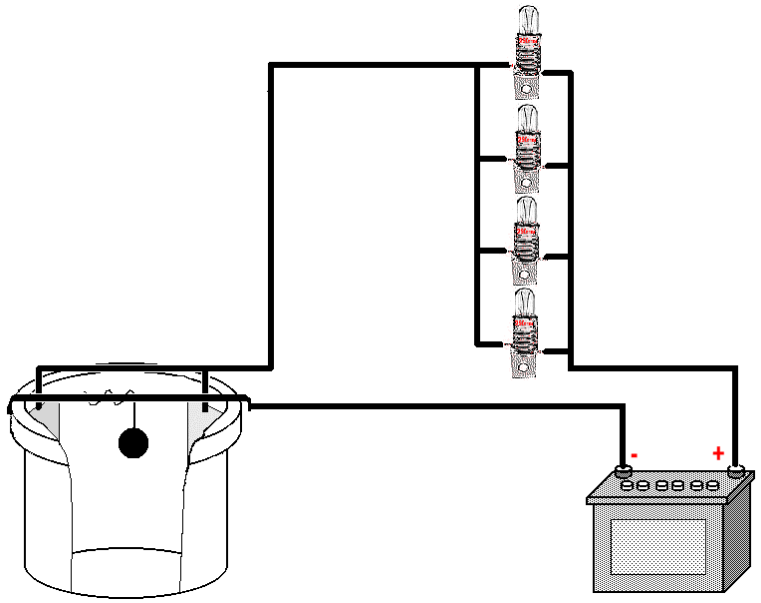
Here are two bulbs manufactured by United States Hardware Manufacturing Inc. Washington, Pa 15301

1. Product # RV 371B 12 volts 15 watts = 1.25 amps
2 Product # RV373B 12 volts 50 watts = 4 amps

These bulbs fit into a standard household bulb holder. You will need to use a 12 volt battery/charger. They are ideal for controlling the power to a chrome tank when plating mid sized parts.

Here is the setup for a typical bulb control system. There is no need to use an ammeter, because you already know the current draw from the bulb rating.

To increase the amount of current, simply add more bulbs



As an example, say we wanted to plate 90 sq inches of nickel. Nickel requires 1 amp per 15 or 16 sq inches. Therefore 90/15 = 6 amps.

This larger current could be obtained by using 24 x 250 ma bulbs, or by going to a 12 volt system and using 6 a 4 amp RV bulbs. Don't forget that you can use either 12 volt or 6 volt power supplies, but the bulbs must be rated for the same voltage.

Chrome plate draws 1 amp per square inch of surface area, which is much more than the other processes.
As an example, lets imagine you were plating 24 sq inches of surface area. Then you would need to place 6 x 4 amp bulbs into the circuit.

For a better understanding of this procedure, go to www.caswellplating.com/flash/bulbcontrol.swf

There are many combinations of bulbs that can be used.

You could add many more larger bulbs to control even a chrome plating operation.

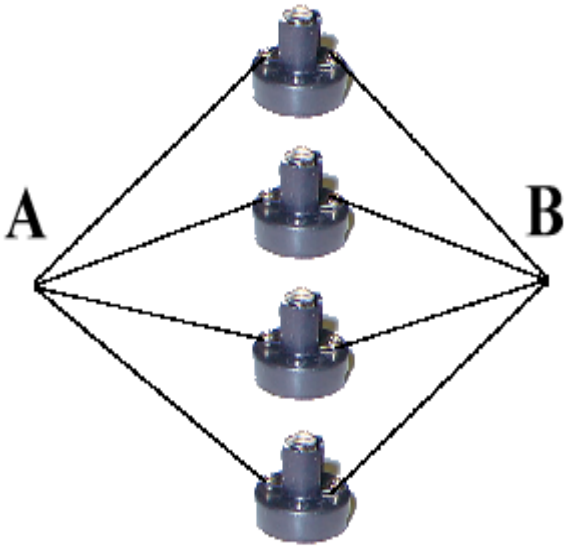
Check the bulb rating, and remember that amps = watts/volts

So, as long as you have the voltage and the wattage of the bulb, its pretty easy to calculate how much power it will draw.

eg: 12 volt bulb rated 15 watts = 12/15 = 1.25 amps

On larger parts you should use the SALT WATER RHEOSTAT.

Making a bulb holder



A bulb holder rack can be made from any small box, wooden or plastic. Radio Shack sell some inexpensive boxes ideal for this purpose.

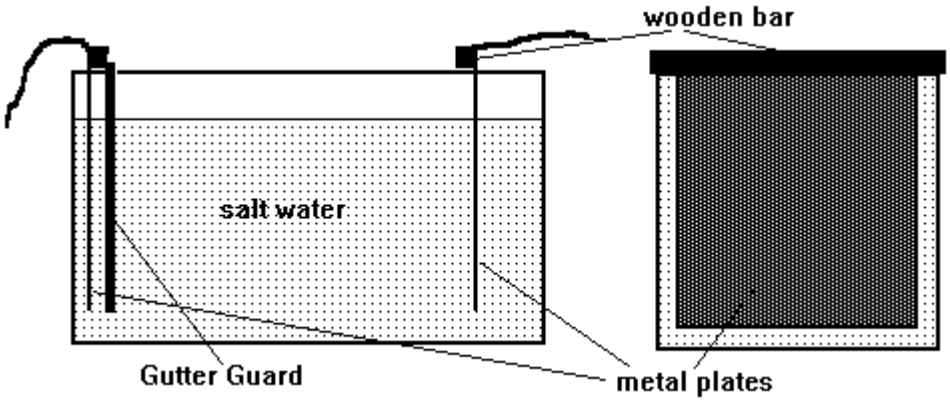
Once you have determined the maximum size of part you are likely to plate, you can then obtain the necessary amount of bulb holders.

Use single filament bulbs & sockets wherever possible, as this is easier to set up. If you are electronically inclined, you will soon understand how to wire up double filament bulbs in parallel, thus saving on bulbs.

Mount the sockets in the box and solder a connecting wire to each bulb socket casing linking them all together. Run this wire to a bolt mounted on the box. This is your power terminal A

Join all the wires together and mount them on a bolt which is secured to the box. This is your other power terminal B. To test the box, connect both terminals to your battery and plug in the bulbs. They should all light brightly.

Making a salt water rheostat



A simple rheostat can be an excellent inexpensive addition to a miniature plating workshop. The following design works well for controlling 10 amps -100+ amps.

Obtain a suitable plastic container as a tank, approx. 10" x 15" x 10" deep.
Cut 2 sheets of copper. galvanized sheet metal, brass or lead to fit on one side of the tank. The thickness of the sheet is not important, so long as it is fairly rigid.

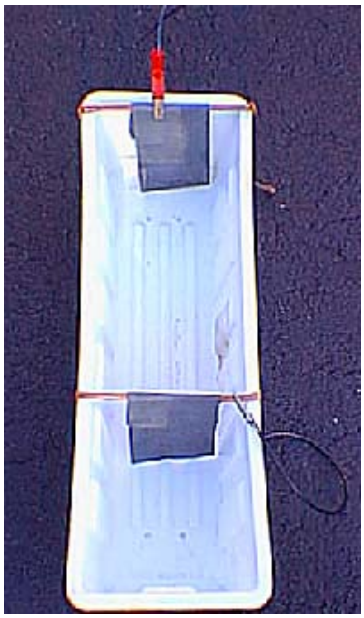
Attach a piece of wooden batten to the top edge of both pieces of metal with screws. The batten should be long enough to rest across the tank top, so as to suspend the plate into the liquid.

Attach a wire to each sheet, making sure you have a good electrical connection. One wire from one plate should connect to the positive side of your battery, the other to the anodes.

You may fix one plate to the side of the tank so that it does not move. Also secure a large piece of plastic rain gutter mesh. This will stop the two plates touching each other and shorting out.

Salt water rheostats are ideal for one off, short run setups. Their disadvantage is that the water heats up and so the resistance changes. This problem can be reduced by making a larger tank, so the greater quantity of water takes

longer to heat, or by cooling the water by a simple heat exchanger made from a coil of garden hose placed in the bottom of the tank, with cold water running through it



To operate:- Fill the tank with fresh water. Pour in approx. 1 pound of salt, and stir to dissolve. You may alter the concentration of salt to achieve different results. By adding more salt you will increase the amperage range.

Experiment to obtain the range you require.

Slide the moveable plate to alter the resistance. The further apart the two plates are the less current flow will occur. If you discover during your operation, you do not have enough resistance from the salt water rheostat, simply remove some of the salt water and replace with fresh, thus decreasing the conductivity.

In the picture, left, lead sheet has been used for the plates. This has been wrapped over a short length of copper tubing. The tank is a plastic window box.

During continual use, the water temperature in the tank may rise and this will effect the resistance. You may have to make an occasional adjustment to maintain the same setting during long plating episodes with high amperages.

Controlling the Power From a PLUG 'n PLATE Power Pack
Or any a/c adapter

To best demonstrate the 'robber' principal, we are going to use thePlugNPlate kit instructions. Of course, you could use a battery charger, providing you know the amperage output, and adapt this method to almost any other situation.

Most parts requiring plating with COPY CAD are fairly small, so this power pack is designed to provide enough power to plate up to 15 sq. inches of surface area.

The output of the Power Pack is 300 ma (milli amps). The requirement for Copy Cad plating is 25 ma per square inch. Therefore, this unit will plate 300/25 = 12 sq. ". (In practice, it will actually plate a little more, about 15 sq. inches)

If the part to be plated were exactly 12 sq. inches, then it would simply be placed into the plating tank and connected to the negative Power Pack connector. The Anode would be connected to the positive connector, and plating would commence. The 300ma output would match the surface area, and no further adjustment would be necessary.

However, not all parts are going to be exactly 12 sq. inches, so we must 'rob' some of the power from the Power Pack. This is achieved by placing more surface area in the tank to be plated. As the output from the Power Pack is constant, we must adjust the surface area being plated to match the output. Too much current on the work piece will result in a dark, rough plate, and too little current will give us a patchy plate.

Let's assume we want to plate a part having a total surface area of 5 sq. inches. As the output from the Power Pack is for 12 sq. inches, we need to add enough surface area to make up the difference (12-5=7). This simple addition of surface can be accomplished in two ways.

1. Add more parts to be plated, until you have 12 sq. inch total surface area.

2. Add a 'ROBBER' to the parts to be plated.

You may use almost anything that has a surface area of 7 sq. inches, but that would be somewhat wasteful, so, a simple robber needs to be made from part of the anode supplied with the kit.

Cut a strip from the long side of the anode, which is 1" wide, and mark it off in 1 inch increments. This 'ROBBER' has a total surface area of 16 sq. inches.

Place the ROBBER into the Plating solution, so that 3.5" is immersed. (That gives you a total immersed surface area of 7 sq. inches) and then bend the ROBBER over the tank bar, ensuring it has good electrical contact. Now, you have 5sq" of part to , and 7sq" of ROBBER, making a total of 12 sq", so you should achieve optimum plating capability. The ROBBER may be used late as an anode, so no product is wasted.

Calculating Electrical values (For those who are technically inclined)

OHM'S LAW
This law expresses the relation in an active electric circuit of current, voltage and resistance. These three factors are always present in such a circuit. Its general statement is as follows:

"In an active electric circuit, the Amperes are equal to the voltage divided by the resistance"

In other words:-

1. The Amperes are equal to the volts divided by the resistance A=V/R

2. The Volts are equal to the Amperes multiplied by the resistance V=AxR

3. The Resistance is equal to the Volts divided by the Amperes R=V/A

4. The Amperage varies directly with the Volts and inversely with the Resistance.

5. The Resistance varies directly with the Volts and inversely with the Amperage.

6. The Volts vary directly with the Amperage and with the Resistance.

Resistance = Ohms = R

This law is the fundamental principle in most electric calculations., so, as long as you know 2 figures in the above equations, you can easily work out the third figure.

WATTS

The power value or Watt is calculated by multiplying the AMPS by the VOLTS:-

W = AxV or V = W/A or A = W/V

6 volts x 100 amps = 600 watts, 100 volts x 6 amps = 600 watts, 12 volts x 100 amps = 1200 watts
or 600 watts divided by 100 amps = 6 volts etc
A FINAL WORD ABOUT POWER

A simple way of explaining what we are trying to achieve by controling power, is to compare our battery and wires as to a water reservoir and pipeline.

The battery (or power supply, such as a rectifier) is our reservoir. The deeper the reservoir, the more pressure we have at the bottom of the reservoir (where we draw off the water) The water pressure is VOLTAGE in our electrical circuit.

Imagine we have a huge pipe, say 4 feet diameter, at the bottom of our reservoir, and we leave it open. It wouldn't take too long to empty that reservoir. In the case of the battery, if we had a very fat wire, such as a jumper cable, it wouldn't take too long to empty the battery if we 'opened' (or grounded) that wire.

Now imagine we have a 1/2" open pipe from our reservoir and we leave just that one open. Its going to take a LONG time for that reservoir to empty. This is a thin wire. Too much pressure from the reservoir can actually burst this pipe, (or melt your thin wire)

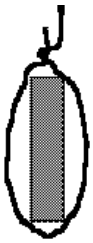
In the first example, we need a fair amount of that pressure, but we don't need the volume of water (flow or amps), so we need to place a valve in the line. If the valve is adjustable, we now have a 'rheostat' and we can control exactly how much water we let down the pipe.

Experience tells us that certain types of plating need specific voltages and amperages to plate nicely, so it is extremely important to control these flows of current.

There are two thing to consider; is the pipe strong enough, and do we have the right valve (or rheostat) to correctly control the current?

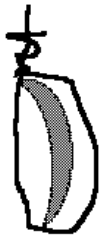
Once this principal is mastered, controlling the power is relatively easy

Wiring Up the Parts



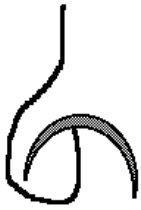
Brass wire is probably the best to use, but is more difficult to obtain. It does not oxidize as quickly as copper or steel. We have always used copper wire with no adverse effects, 10-20 gauge wire is ideal. For chrome plating use a fairly heavy gauge, and/or double it up, as this procedure uses high amperage, which may melt a thinner wire.

Do NOT use steel wire - or copper coated steel wire - it will NOT conduct properly!



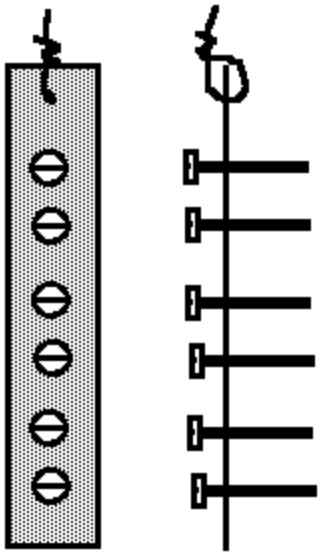
When ANODISING, only use ALUMINUM or TITANIUM wire from the tank bar to the part. The wire needs to be SECURELY fixed to the part, otherwise it receives an insulating coat of anodize and then no longer conducts, so the part will not receive any more power, and the process ceases.

Each part needs to be carefully examined to find a suitable place where a wire can be attached, so that it may be hung from the tank bar. There is a good possibility that every place a wire touches the part, the plating process will leave a mark. So, if there is an underside it will always be better to fix to this.



Wire the part so that only the edges are touched, bending the wire away from flat surfaces. Alternatively, parts can be suspended from hooks made from wire, so only the point of the hook is touching the part. (See diagram).

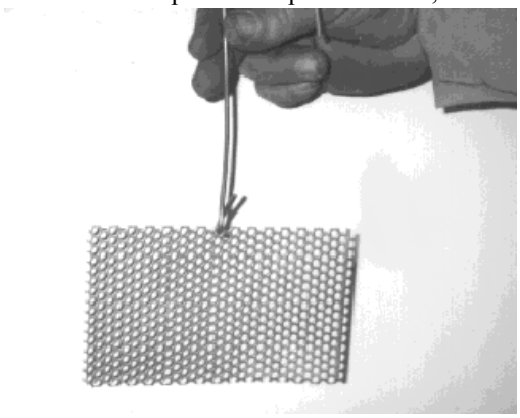
Running wires through an existing hole will often eliminate wire marks.



Another technique is to frequently move the wire to another location; i.e., spin the part, so that the touch point is lessened to any particular point.

Occasionally it will be inevitable that you leave an odd wire mark. This can usually be buffed out with a little care.

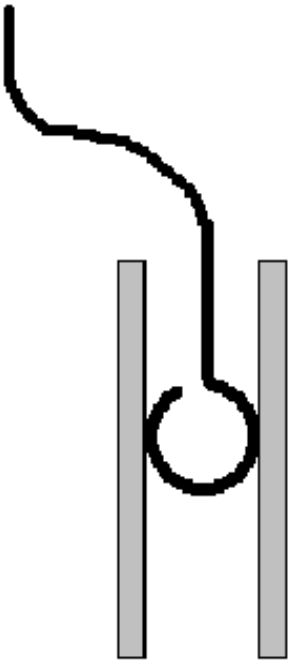
Some small parts can be strung on a wire with plastic beads separating them, and then plated all at the same time. Other small parts such as screws or bolts can be fixed into holes drilled into a thin sheet of brass, copper or steel and plated as one, or fixed on to a piece of expanded metal, see below).



If only the heads of bolts require plating, screw them into a metal sheet and immerse just the heads in the liquid. Alternatively, you could wrap a wire around the thread and then suspend each bolt from the tank bar into the solution, so that just the head is immersed.

A small plastic basket, such as those found in dishwasher to hold flatware, makes an ideal receptacle for plating some small parts. Weave bare copper wire in and out of the latticework in every direction, along the bottom and sides of the basket. Fix one wire to come up the handle so that it can make a connection with the tank bar. Small parts can be thrown into this basket, knowing that they will make contact with the wire and therefore become conductive. The basket can occasionally be shaken so that the plate is applied evenly.

For some hollow objects, where the inside will not get plated, you can use a spring clip (figured below) to hold and connect the part whilst it is being plated.



When chrome plating, you will need to make these wires from very thick single strand wire, and may even need to run several wires to the one object to ensure enough current is conducted. With these stiffer single strand wires, you can make hooks that will hang from the tank bar. By stripping the insulation from only the ends, you can make hooks that do no get clogged up with plating, and may be used over.

All fastenings to the parts need to be secure, especially when dealing with higher currents and in processes such as Chrome plating and Anodizing.

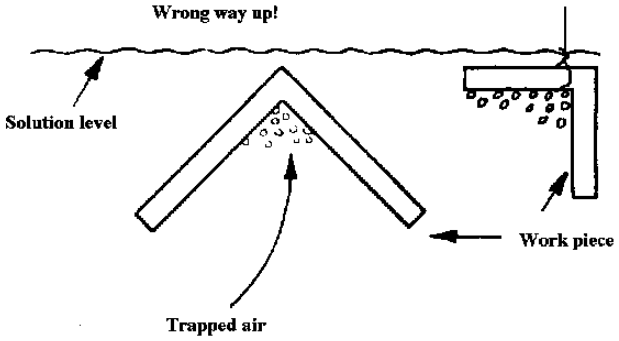
Which ever method you use, make sure you roughly calculate the total surface area of all the parts, and adjust your current controls (bulbs or rheostats) accordingly.

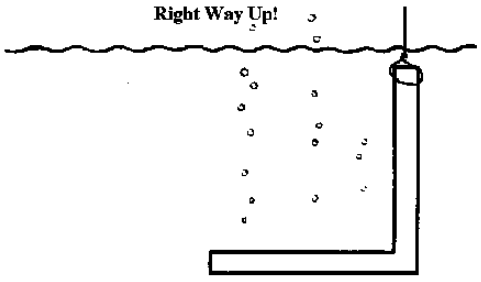
Estimating Plate Thickness

The section of wire that is immersed into the solution can be used as a good indicator of the thickness of the applied plate. Simply measure the wire thickness before plating commences and again afterwards, using a micrometer.

Hydrogen and Air Entrapment

You should give some consideration to the problem of trapped bubbles when hanging the parts in the tank. Hydrogen bubbles form during all plating processes and if they are allowed to collect, they form a gas pocket which displaces the solution and stops the exposed area from plating. Air can also be trapped during immersion. Always make sure the parts are hung to avoid this.





Repairing Pitted Metals

Steel, Copper, Brass. Bronze, Nickel

First, the part must be thoroughly cleaned, preferably by bead blasting and/or electrostripping to remove rust. If the surface has very minor pitting (orange peel texture) then this can usually be filled using a copper plate. Important - On steel, don't forget to prime the steel with nickel or Flash Copper first.

The use of copper plate to repair pits

Apply theBright Acid copper plate, and then flat down with a fine wet & dry paper using a sanding block. Repeat the process until the pits are completely filled with copper. Then buff and polish and finish with a nickel and/or chrome plate. (see below)

If the pits cannot be filled with copper, use a paste grade solder paint, which can be applied with a brush to the surface prior to heating. This allows a thin layer of solder to be applied making the application of larger quantities of stick solder easier, if required, for filling deeper pits. Steel, copper, brass, and nickel can all be repaired this way.

After any soldering soak the part in hot SP Degreaser to remove any flux.

Filling shallow pits & scratches using copper plating

This technique is ideal for a substrate with many shallow pits of approx. 1/16" depth.

The pitted part should be first plated with a 'strike coat' of Flash Copper (1) for approx. 15 minutes. This layer of nickel is not effected by acid and ensures the part is completely protected from the acidic copper solution.

A heavy layer of copper is applied (2), usually for at least 30 minutes. Periodic checks should be made to ensure the plate is smooth. If not, remove and sand lightly, taking care not to damage the Flash Copper 'strike' coat. If your part is pot metal and you do sand through to the pot metal, you will have to 'strike' coat the part again with Flash Copper Alternatively, you could 'touch up' this area using the BRUSH PLATING technique. Flash Copper solutions will brush plate, as long as you use a copper wand.

Once a heavy layer is applied, this can be sanded smooth (3). We have found that it is easier to apply the plate in several layers, sanding lightly between layers. This ensures the copper is removed from the high spots, and left in the pits.

A final layer of copper is applied (4), and then buffed lightly to a high polish. Do not get the part too hot during buffing, or you may make the plate blister.

Finally, the part is returned to the nickel plating bath and plated for 15 minutes (5). The part may be chrome plated immediately after this nickel plate.

Filling pits using solder

Apply a 15 minute 'strike' coat of Flash Copper, then a 15 minute plate with Bright Acid copper .

Apply a paint coat of Plumb-Loy the area to be repaired, then melt in the solder, by either using a small blowtorch or a heavy duty soldering

iron. The area must be heated sufficiently to allow the solder to flow into the hole, yet not hot enough to make the copper plate disbond. Fortunately, Plumb-Loy melts much easier than stick solder, but the could also be used in many situations.

Finally, sand down the solder, ensuring you do not go through the Flash Copper 'strike' coat, and Bright acid copper, then nickel plate directly over. Ensure that you return the part to the degreasing bath to remove flux before the final plate.

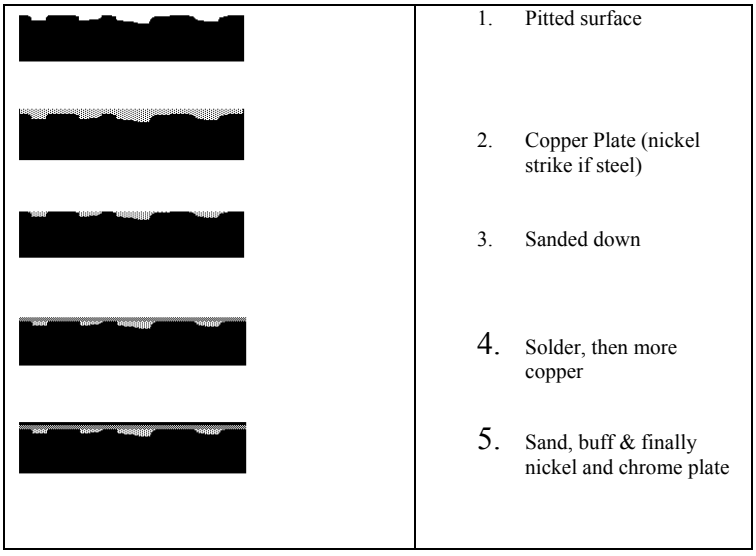
The Repair and Replating of Pot Metal (or Zinc Die Casting)

Pot Metal is probably one of the worst things to repair and replate. The metal varies tremendously in its consistency, the foundry seemingly blending whatever metals (usually zinc and a little aluminum) they had available on the day. This, coupled with the fact that the zinc corrodes quickly when exposed to the elements, can make the product seem almost impossible to repair.

Pot metal has always been a major problem for the average restorer to repair, as it can't be welded, brazed or soldered with conventional materials..

Commercial platers use a cyanide copper 'strike' coat then plate with acid copper. The cyanide is, of course, a product that many don't wish to handle. So, the only route has been to send pot metal parts out to a professional restorer, usually at great expense.

UNTIL NOW!!! Because FLASH COPPER substitutes cyanide copper systems, doing exactly the same thing but without the dangers. Now you can plate directly onto metals such as pot metal, pewter, lead and steel with copper. For more information, see the section on FLASH COPPER.



Zinc is a poor choice for a casting. It is readily attacked by acidic situations, as can easily be demonstrated by dropping an eye dropper droplet of battery acid on a cleaned area of a casting. The zinc will start to 'fizz' & bubble' as the zinc is destroyed. Aluminum does not do this, so this is a good way of testing for Pot Metal.

On first examination, an old pot metal part that has been chrome plated will have the characteristic blistering all over it. It would appear that if these blisters were sanded down, the part would be in a good enough condition to replate, but, unfortunately, this is often not the case. These tiny blisters in the chrome plate are just the tip of the iceberg, for when they are examined closely with a magnifying glass, one can see quite deep holes filled with corrosion. This corrosion grows with a tremendous force, pushing the plate from the surface and forming the blisters.

There are many reasons why pot metal corrodes in this way. Poor initial surface preparation. Contaminants in the actual metal. Thin plating being porous and letting the elements through to attack the zinc. The casting itself seems to be porous, holding in moisture like a sponge.

In old pot metal, the corrosion that forms a hole in one area effects the surrounding, seemingly good, area of the metal, making it difficult to plate.

The best way to deal with these defective areas is to bead blast the surface, then inspect it thoroughly for dark spots in the pits. These dark areas are oxides formed by the corrosion. The must be removed. Either re-blast the part, or get a small drill and gently drill out the corrosion until you find bare, clean metal. On no account proceed to plating until this problem has been resolved.

Now you have a choice of repair options.
You can use Pot Metal Solder and make repairs to the bigger holes ,
or
you can plate with FLASH COPPER, the n BRIGHT ACID COPPER, then use Plumloy solder, and then overcoat with FLASH COPPER. You will need to make a determination of which method you prefer depending on your own skill levels.

Preparing the surface

Pot metal has many impurities in it, and the older it gets the worse the part can become. Many castings are porous and absorb water. This can cause many problems during repair, especially during soldering.

Pre-repair heat treatment

In order that the part be cleansed of these impurities and any possible moisture, it should be placed in an oven and baked as follows:-

15 mins @ 150 deg F this gradual increase eliminates any warping/stress etc.
15 mins @ 300 deg F
15 mins @ 450 deg F

At this higher temperature you will find that SOLDER-IT pot metal solder will fuse to the surface easily. A blow torch may be needed to heat the part a little more. Let the heat travel to the solder, do not directly torch the solder as you will burn off the flux and it won't stick properly.

If the repairs are extensive, you may wish to hang the already hot part over a hot plate while you work on it. If you allow it to cool too much, no amount of localized blow torch heat will bring the part up to the correct temperature and you risk damaging the part.

If the part has deep pitting it is usually best to drill out the entire area, ensuring that the corrosion is completely removed. If any is left it will cause a black streak in the plate. This procedure can be likened to drilling and filling a tooth, only less painful! A Dremel tool is ideal for this work. As you are going to completely fill this hole with solder, you can wiggle the drill around a little to undercut the hole, improving the strength of the repair. Sometimes the hole may have to be made right through the part. A piece of tightly crumpled aluminum foil is placed behind the hole when the solder is run in, stopping it from flowing right through. This can be removed after cooling.

Once the part has been successfully repaired, the entire surface needs to be cleaned and polished in the normal way to accept a plate.

Pot Metal has large quantities of zinc in it, which form oxides on the surface of the metal. These have to be removed to allow the FLASH COPPER plate to bond correctly. As this metal does not like the acid in the Electro-strip tank, a procedure which could damage the part if overdone, we should consider these other ways to rid the surface of these contaminants. Abrade with emery paper, Sand blast, Britex or Scotchbrite wheels

Pot Metal should NOT be introduced into the regular Nickel Plating tank, which is acidic and may damage the Pot Metal part.

Removing Old Plate From Pot Metal

The sand blasting technique may be employed to remove CHROME PLATE. Alternatively, a Scotchbrite Pad as a buffing wheel, or a Britex Wheel will do a good job on most parts.

Remember, NO OTHER PLATE WILL STICK TO CHROME- YOU MUST REMOVE IT!
DO NOT USE ACID TO REMOVE THIS PLATE.

Care is taken to avoid burning off the flux.

Underneath the chrome is nickel plate, you will see the yellowish color of the nickel as you remove the chrome. If the surface of this plate is undamaged, it may be left as it will accept a new plate, but you will probably find it is easier to sand blast all the plate off.

Soldering is a skill. You need to practiceif you have not done this before.

This preheated door handle is about to have the SOLDER-IT solder applied. The part will be heated close to the repair, to bring the part up to solder melting temperature.

Casting A New Part

Another alternative to trying to repair a part is to use the original as a pattern, and cast a new piece using a castable, platable metal. The CASWELL Foundry - in miniature has been developed to produce high quality reproduction parts which can easily be plated with any of our plating kits. Badly pitted parts can be filled with car body filler (Bondo etc.), then sanded and shaped back to the original profile.

The sand casting technique is thousands of years old, and is extremely simple to do, providing you have the right equipment - and know how! We have provided all the main ingredients in this kit to get you started within a matter of hours.

This manual cannot devote enough space to this extensive subject, so we have included the instrucions in each kit, in the form of the famous book 'How to Cast Small Metal Parts', by Bill Cannon. He carefully explains how to make a furnace, in less than one hour, using a metal container, (which is included in the kit) and an old hair drier, or blower. The furnace can be run on propane gas from a barbecue, or charcoal. You will need to obtain 7 fire bricks and a bag of refractory cement from a local fireplace store.

The ingots of CASWELL metal supplied are high quality, low temperature melting (650^0F), and non corroding. It will accept any of our plating systems. High quality detail will be reproduced using this metal. Replacement ingots can be purchased separately.

A special, high quality PETRO BOND mold sand is supplied. The fine mesh size of the sand allows for sharp definition of detail to be obtained from the original. This material is blended with special oils which make it bond together when compressed.

A complete novice can set up the entire operation, and produce professional parts on his first attempt!

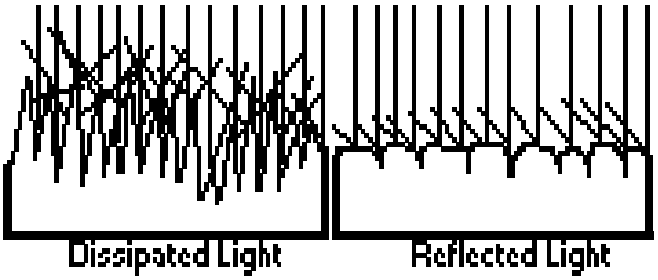
Complicated shapes and designs can be cast, and many examples are shown in the handbook.

Pictured above, a door handle being used as a pattern In the sand mold

Buffing & Polishing

Buffing and polishing using wheels and 'compounds' is somewhat like using wet and dry sanding paper, only much faster. Instead of using 'elbow grease' you will be using the power and speed of an electric motor.

The edge, or face, of the wheel is the 'sanding block', which carries a thin layer of 'compound' which is the sandpaper. Varying types of wheel are available, and the different grades of compound are scaled similar to sandpaper. The compounds are made from a wax substance which has the different abrasive powders added to it. When this hard block is applied to the edge of a spinning buffing wheel, the heat from the friction melts the wax, and both wax and abrasive are applied in a thin slick to the face of the wheel.



The objective of buffing and polishing is to make a rough surface into a smooth one and, of course, each work piece will be in a different condition, so will need different procedures. Imagine the surface magnified thousands of times, it will look like jagged mountains and valleys. By repeated abrasion, you are going to wear down those mountains until they are old, soft, rolling hills! Then they will not *dissipate* the light, but *reflect* it. It is the reflection that makes the buffed part appear shiny.

Tricks of the Trade

Repairing small dents.

Sand the inside of the part with emery paper. This will show you exactly where the dent is.
Using a piece of end grain wood as a block, gently beat out the dent with a hammer.

Cleaning your buffing wheels.

Take the blade from an old rough cut log saw, or large hacksaw, and cut it about one foot long.
Wrap several layers of duct tape around each end to make a handle similar to a bicycle handlebar grip.

Offer the jagged blade to the edge of the spinning wheel, and work it across the face until the wheel looks bright and fluffy once more. This action, done periodically, will remove entrapped metal particles, which could scratch a more delicate part.

Eliminating 'Swirl' Marks

Swirl marks caused by buffing in the final stages can easily be removed by wetting the part with a damp cloth, then dusting with a powder such as:- Whiting, Talcum Powder or Corn Starch, then buff on your wheel again until the swirls disappear.

One Wheel for one compound

Applying different compounds to the same wheel only causes problems, because you end up with a mixture of abrasive surfaces, and metal deposits left over from the more abrasive operation. These microscopic particles only scratch the surface, destroying any benefit gained by the finer compound.

APPLICATION OF THE BUFFING COMPOUNDS

The actual compound does the work, not the buffing wheel.
Compounds are made from a mixture of fine abrasive fillers and a sort of greasy wax. The compound is melted, by friction heat, as the bar is pressed to the revolving wheel. This applies a thin layer of abrasive, 'glued' onto the cloth wheel, making it similar to an emery paper, only much faster!

Do not apply the compound (see right) after the workpiece, or on its own. This wastes material and is much less efficient.

By applying the material before the workpiece, you actually use the workpiece to force the compound into the buff. This is much less wasteful, more efficient and will actually speed up your buffing times.

Apply small quantities of compound, by approx. 1/2 - 1 second applications to the wheel.

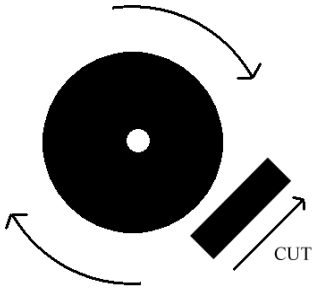
Buffing & Polishing Machine

Buffing and polishing machines can be mounted on a bench or a pedestal.
These motors are especially made for buffing, grinding and polishing. They operate at 3450 rmp. And come in various sizes, depending on the job requirement. The one shown left is the 3/4hp Caswell Buffer. A 2hp model is also available.

A bench grinder can easily be converted to a buffing machine by the use of shaft extenders.

Remove the guards and slide the extender over the shaft and tighten the two grubs screws. You may need to turn the shaft extender a quarter turn and retighten after running the machine, to ensure the shaft is running true. Shaft extenders are made with right and left hand threads., so you need one of each for a bench grinder.

CUT AND POLISH MOTIONS

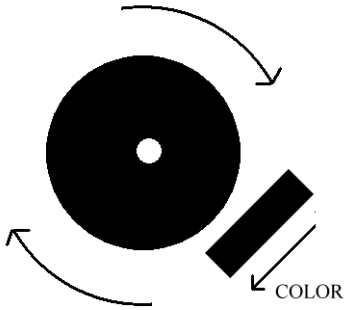


There are two basic buffing motions you should use.

1. ***CUT MOTION*** gives you:-

SMOOTH SURFACE, SEMI-BRIGHT & UNIFORM

The workpiece should be moved AGAINST the direction of the wheel, using a MEDIUM to HARD pressure.



2. ***COLOR MOTION*** gives you:-

BRIGHT, SHINY & CLEAN SURFACE

The workpiece should be moved TOWARD the direction of the wheel, using a MEDIUM to LIGHT pressure.

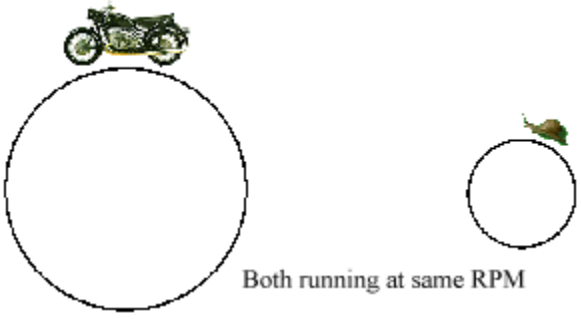
BUFFING SPEED AND PRESSURE

The correct pressure must be applied to the workpiece to provide the best finish economically and safely.

Inadequate pressure will give NO buffing action

Excessive pressure will cause the buffing wheel to slow down or actually collapse. This can also result in burn marks on the workpiece.

BUFF RUNNING SPEEDS



For best results your wheel should maintain a surface speed of between 3600 & 7500 Surface Feet Per Minute. (SFPM). The higher your speed, the better and quicker your results.

Formula for calculating surface speed of wheel in SFPM.

SFPM = 1/4 x diameter of Wheel x RPM (revs of spindle per min.)
Therefore an 8" wheel @ 3600 RPM =2 x 3600 = 7200SFPM.
Spindle speeds can be increased by a step pulley on a motor shaft.

For the workshop where only the occasional piece of work needs to be buffed, an economic alternative to purchasing a special machine is to simply adapt a bench grinder. Whilst this does not have the extended shaft, it can still do a formidable job.

All the guards need to be taken off and the grinder mounted on the edge of a workbench. This will allow access to the wheel from many angles.

DISCLAIMER - Buffing machines can be dangerous. We accept no liability for their use/misuse or for accidents caused by the removal of guards.

Alternatively, a small used washing machine motor can be used. With access to a lathe, a simple pointed taper can be made to fit over the shaft. Then the buffing wheels can be rammed on to the point. On smaller pieces, an electric drill with one of our shank mounted buffs will do an excellent job.
Some of our customers have even placed a large hand grinder in a vice, then changed the grinding wheel for a buff. These machines usually have very high speeds with good power, so they should be considered as another option.

Whenever you are making up something to do a buffing job, your prime consideration should be your safety.

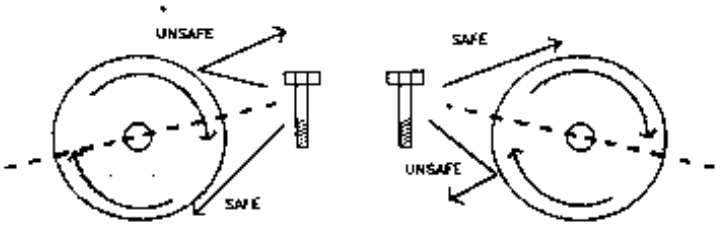
If the buff pulls the piece from your hands, you should consider where it is likely to go. Remember it will be traveling at a fair speed, so no one should be in its way!

Is the machine mounted safely? It will have to stand a fair amount of abuse, so make sure it is WELL fastened down.

SAFETY FIRST

There are two distinct areas on a buffing wheel -
THE UNSAFE AREA which is rotating towards the workpiece.

THE SAFE AREA which is rotating away from the workpiece.



The division of these two areas is marked with the dotted line on the above drawings.
The workpiece must only be applied to the area of the buff that is rotating AWAY from the workpiece.

You should ensure that you are completely aware which area is which, otherwise you could have a serious accident. Objects being thrown away from a buffing wheel can be traveling at very high speeds, which can result in some very unpleasant and potentially deadly accidents!
When buffing parts have sharp corners, edges or hooks, they should be offered to the wheel with the edge flowing away from the buff, so the part does not catch.

Operators should ALWAYS wear SAFETY GOGGLES, APRON and GLOVES.

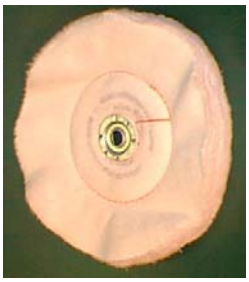
THE SPIRAL SEWN WHEEL

Spiral sewn wheels are the workhorse of most buffing and polishing jobs. Because the ply's of cotton cloth are sewn together spirally, the wheel becomes much harder and more pressure can be exerted on it. This is especially useful when 'cutting' the metal.
The faces of these wheels are pre-raked to accept compound immediately.
These wheels are dependable and long wearing.

THE LOOSE COTTON WHEEL

The main purpose of a loose cotton wheel is to polish and cut in a similar manner to the Spiral sewn wheel, except that this wheel, not being tightly stitched together, will 'mush' or collapse, allowing the cotton to get into awkward places more easily. If you have an object with fine details and awkward crevices, then this is the wheel to use.

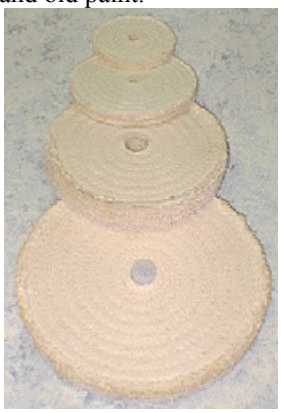
THE CANTON FLANNEL WHEEL



Canton flannel is very soft, and this wheel is loosely stitched, so the layers of cloth flare out to give a wide angle ultra smooth polishing surface.
Generally used with the BLUE compound, this wheel can be used on the most delicate items such as silver and gold plate. This wheel should not be contaminated with any other compound.

THE BRIGHTEX WHEEL

Brightex wheels are constructed from a type of material, impregnated with a fine abrasive powder. The resulting combination being very flexible, yet very aggressive.
Brightex wheels remove rust, paint, scratches, minor blemishes and old paint.
A 'featherlite' touch is required with these wheels, unlike an ordinary buffing wheel. Heavy pressure will result in premature wear of the wheel.



The blisters found in chrome plate, particularly on pot metal, can be flattened with this wheel. Substrates take on a satin or flat finish, which should then be buffed with Emery and a Sisal wheel, followed by White or Tripoli on a cotton wheel.

THE SISAL BUFFING WHEEL

Sisal is a slender, hard, cellular strand of fiber that has demonstrated its great strength and tough resiliency in the form of binder twine, cord & rope for many years. These qualities, along with its natural abrading and grease absorbing characteristics, provide an ideal buffing wheel fabric.

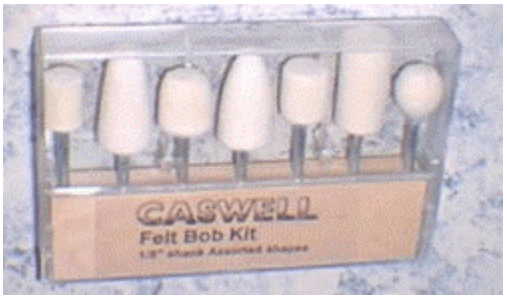
Sisal buffing wheels will provide both polishing and cutting action. They will remove stretcher strains, orange peel, polishing wheel grit lines, light die marks, etc.To effect a fast cut, use a sisal wheel with the Black Emery compound.

CYLINDER FELT BOB

The face of this 2" diameter bob is normally used on larger flat surfaces. All the compounds can be used on this bob, as well as the special Glass Polishing Kit powder, which is mixed with water to make a slurry.

ASSORTED FELT BOBS

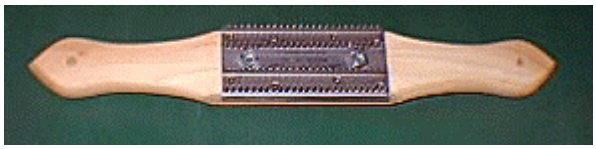
These bobs are used for areas where the larger buffing wheels won't reach. Use on a fast air tool, electric drill, e grinder or 'Dremel' type tool. The bobs are constructed from a medium hard felt. Use with all types of compound. Larger size bullet shapes are available.



THE ARBOR ADAPTER

These adapters are designed to be used in electric and air drills. They have 1/4" shafts, and can hold 4" and 6" wheels. Ideal for use when cleaning and polishing items actually on the vehicle.

THE BUFFING WHEEL RAKE



This simple tool will revitalize a clogged up buffing wheel. Offer the jagged blade to the edge of the spinning wheel and work it across until the wheel looks bright and fluffy. This action, done periodically, will remove entrapped metal particles which could scratch a more delicate part.
Alternatively, you could use an old hacksaw blade, with the ends wrapped in duct tape to make a simple rake.

NYLON ABRASIVE WHEELS The next best thing to a sand blaster and will last up to 10 times the life of a wire wheel!

Will not puncture skin and does not shed bristles - unlike dangerous wire wheels

Ideal for: Scratch brushing aluminum and other metals for decorative finishes Removes paint, corrosion, weld scale, rust & weld mrks from steel Gently removes paint and varnish from wood. Sands wooden moldings, railings, turnings and banisters Removes cement from tiles, stone and brick mortar Prepares fiberglass, rubber, and all plastics for adhesive application. Frosts glass.
3" wheels - ideal for use with a small hand drill.

Repairing Small Dents

Sand the inside of the part with emery paper. This will show you exactly where the dent is. Using a piece of end grain wood as a block, gently beat out the dent with a hammer. Resand then repeat the process until the sanding looks even.

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Swirl marks caused by buffing in the final stages can easily be removed by wetting the part with a damp cloth, then dusting with a powder such as:- whiting, talcum Powder or Corn Starch, then buff on your wheel again until the swirls dissapear.

One Wheel For One Compound

Applying different compounds to the same wheel only causes problems, because you end up with a mixture of abrasives and metal deposits left over from the more abrasive operation. These microscopic particles scratch the surface, destroying any benefit gained by the finer compound.

ELECTRIC MOTOR & BUFFING WHEELS SIZES

Motor Size	4"	6"	8"	10"
1/6 hp	1"	.5"	-	-
1/4 hp	1.5"	1"	.5"	-
1/3 hp	2.5"	2"	1"	-
1/2 hp	3"	2.5"	2"	1"
3/4 hp	4.5"	3.5"	2.5"	2"

Generally speaking, you will start off with a course abrasive compound, then change to a medium compound and finally a fine compound, just as you would using sandpaper.

There are different types of wheels and these have different effects on the compound they are used with. For example, the SISAL wheel is a course 'rope like' fiber, which frays out to make a sort of brush. These fibers have a very beneficial effect on scratched and rougher surfaces, almost stroking them smooth. When used with a course 'EMERY' compound, they 'cut' the metal down very rapidly. You could use this compound on a SPIRAL SEWN wheel and it would work, but the job would take much longer because the softer SPIRAL SEWN wheel is not going to thrash the metal so aggressively.

As you progress through the buffing compounds, you will change your buffing wheel, ending up using the softest polishing wheel, the CANTON FLANNEL with the least abrasive BLUE or RED compound which only polishes, it has no cutting action.

So, depending on the job in hand, you will determine which abrasive compound and wheel you are going to use first, then step down through the stages until YOU are satisfied with the results.

GREASELESS COMPOUNDS

Greaseless Buffing compounds may be applied to almost any cloth buffing wheel, (sisal, spiral sewn cotton & loose cotton) turning it into a tough flexible grinding wheel. The roughest casting edges can quickly removed. These materials do an excellent job of leveling highly contoured surfaces quickly.

Caswell Inc carries 4 grit sizes, 80, 120, 180, and 240.

These compounds are rubbery and are heavily applied to any of the harder buffing wheels. (ie: not ‘loose’ or ‘canton flannel’) Their cutting capabilities are similar to the equivalent grit emery papers, only the surface of the wheel is travelling much faster, so the job is completed quickly.

Greaseless compounds should be used for rough cut down work, then followed with the conventional compounds.

After use, store the compound in a sealed ZIPLOK bag, to retain moisture. If the bar becomes rock hard, simply add several spoonfuls of water to the ZIPLOK bag and re-seal. In a day or so, the bar will have re-absorbed the water, and softened again.

	Plastics			Silver, Gold (plated and solid) and very thin plates			Nickel and Chrome Plate			Copper, Brass, Aluminum, Pot Metal and Other Soft Metals			Steel and Iron			Stainless Steel		
Buff Type	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Sisal										X			X			X		
Spiral Sewn								X			X			X			X	
Loose												X			X			X
Canton Flannel						X			X									
String	X	X	X															
Compound																		
Black										X			X			X		
Brown											X							
White								X				X		X				
Blue	X	X	X			X			X						X			
Green																	X	X
Red						X			X						X			

Buffing Wheel And Compound Recommendations

BLACK = Emery Compound, a course abrasive material for removal of scratches, pits, paint, rust etc.

BROWN = Tripoli compound used for general purpose cut and color on most soft metals.

WHITE = Blizzard compound, used for color and final finish of harder metals, has a cutting action.

RED = Jeweller's Rouge, designed to polish without any cutting action. Safe on thin plates. Use on its own wheel.

BLUE = A dryer, almost greaseless wheel - designed to polish without any cutting action. Safe on thin plates. Use on its own wheel.

GREEN = Used exclusively for cut & color of Stainless Steel.

THE THREE BUFFING STAGES

A = Rough Cut To Remove Scratches
B = Final Cut & Initial Polish*
C = Final Polish (or luster)
* - At Stage B, you should first use your wheel with a cutting action, then finish with a color action. See the page on Cut & Color.

Preparing your Solutions

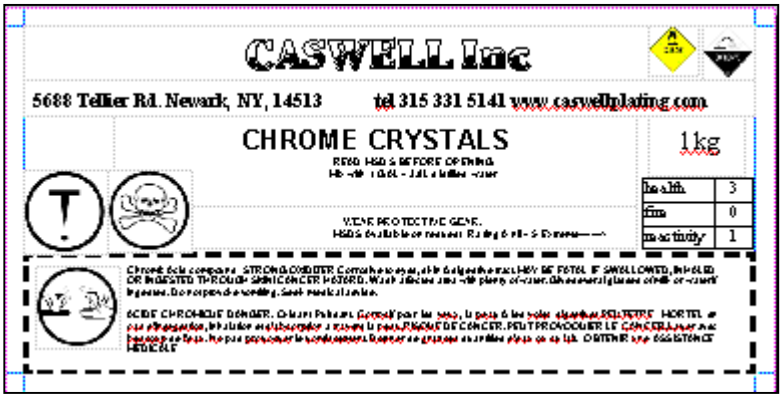
The following symbols will appear on all product labels where appropriate

CORROSIVE POISON TOXIC FLAMMABLE REACTIVE

MAKE SURE YOU UNDERSTAND THESE SYMBOLS BEFORE USING CHEMICALS!

All the plating and de-plating solutions are fairly easy to prepare providing you follow these simple rules.

Always used distilled or de-ionized water. (Not mineral, tap, well or spring water). You may use water from a dehumidifier, air conditioner, clean snow or clean rain water.



Read the instructions on the labels on each packet of chemicals.
LABEL INSTRUCTIONS SUPERCEDE MANUAL INSTRUCTIONS SO IF IN DOUBT, ALWAYS FOLLOW THE LABELS. See right for a typical label.

Measure out any additions, such as battery acid in the copper and chrome tanks, before you add them to the tank. It is far better to check them over twice before adding them, than try and rectify the addition of too much acid later. (There is an old carpenter's saying, "Measure twice, cut once!".)

Rain water.
You can collect rain water from a downspout during a storm. Let the first few gallons pass by, as this will probably contain contaminants from dust settled on the roof. Filter through a coffee filter paper. Then check for acidity with a simple aquarium pH test kit. These cost approx.. $1.50 in Walmart. They contain a small vial and a bottle of test solution. pH is determined by the color comparison chart. As long as the water falls in the neutral range, it will be quite suitable for electroplating tanks.

Always use plastic or glass stirrers & containers. Warm the water before adding crystals, this aids them in dissolving.

ALWAYS POUR ACIDS INTO WATER, NOT VICE VERSA.

Rinse everything off after use, to avoid cross contamination. Even the smallest amount of chrome introduced into a nickel tank can ruin it! Wear safety equipment, goggles, gloves, and apron. As soon as you have made up your solutions for the first time, you should mark the level of the liquid on the tank wall. You will need to refer to this line, when evaporation of the water takes place, at which time you will need to add more water.

If you add too much water, you can always remove it by evaporation. Heating the liquid will cause the chemicals to stay, and only the water to evaporate off. Evaporate down to your original mark. You may wish to periodically strain all your solutions through a coffee filter to removes sludge and debris. Add activated charcoal to the bottom of the filter. This will remove many contaminants.

SP Degreaser

TO MAKE SP Degreaser
Add DISTILLED WATER to the tank
Add 8oz SP Degreaser powder to each gallon of water. Keep to this ratio for larger quantities.
The crock pot pictured right, is ideal for presoaking small parts. The **SP Degreaser** solution may be placed in the 2 gal metal pot with no detrimental effect, and the liquid can even be brought to a boil for those very stubborn parts.

Any metal container will do for the **SP Degreaser**. You could heat the solution by placing on a gas or electric burner.

Ideal operating temperature is between 140 -210 deg F.

Using the SP Degreaser

The **SP Degreaser** tank can be used for two different reasons:-

1. SOAK

By soaking a greasy part in this solution for a period of time the caustic **SP Degreaser** will break down oil and grease.

2. DIP

A quick dip in the solution, usually after the part has been immersed in an acid, will neutralize the surface, and kill any remaining acid, which could cause dis-bonding problems.

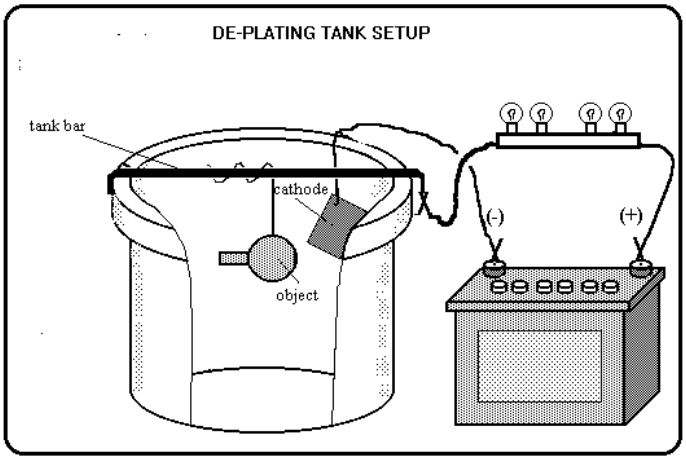
Rinse the part in fresh hot water and proceed immediately to plating. Do not allow the part to dry. Keep it suspended in fresh warm water whilst waiting for the plating bath.

As soon as the effectiveness of the SP Degreaser is diminished, dispose of the product by dumping into a drain, and replace with a fresh batch.

The use of SP Electrocleaner (now SP DEGREASER) using an electrical current for 'Electrocleaning' has been discontinued as a recommended technique.

Acid Pickles

There are 3 types of acid pickles, which can be used for 3 different procedures. The section concerning the various plating procedures will tell you which ones to use and when. All these techniques will destroy either corrosion or old plate, the electro-stripping usually being faster and more dramatic. When there are only thin, delicate layers of plate or corrosion, soaking is preferred.



We do not supply the Muriatic (hydrochloric) acid or Sulfuric (Battery) acid, required to make up these solutions.
Muriatic acid can be purchased from almost any hardware store, as a concrete cleaner. Sulfuric acid (Battery acid @1.27 SPECIFIC GRAVITY, or 33% concentration) can be purchased from any NAPA Auto Parts Store. Pure (98%) can be diluted to this by adding one part of acid to 2 parts of water. Make sure you add the acid to the water, not the other way around, otherwise it may explode in your face! All references to battery acid in this manual refer to 33% diluted sulfuric acid @ 1.27sg.

1. DIPPING.
The part is momentarily dipped into the solution.

2. SOAKING
When the Operating Procedures call for a soak, this means the part should be hung from a wire and immersed into the solution. No electric current is used. Soak times are posted in the Operating Procedures section. These chemicals usually operate faster when warmed to between the 140-180 deg. F range. However they will work as low as 70 degrees. .

3. ELECTRO-STRIPPING .
The introduction of an electric current through the part, dramatically increases the depletion of rust and old plate.

The relevant solution is introduced to a de-plating tank and the part suspended on a wire from the tank bar. The tank plates (cathodes) are wired to the negative side of your power unit and the tank bar to the positive. By varying the resistance, using bulbs or your rheostat, you can control the degree of de-plating taking place.

WARNING! Always pour acid into water, NEVER POUR WATER INTO ACID!

1.Weak Pickle # 1 *Used for mild etching prior to plating.*

TO MAKE PICKLE # 1 :-

To 20 parts Fresh Water ('parts' means a measure of volume of i.e.: pint or quart or gallon)
Add 1 part of Muriatic Acid. Store in a plastic lidded container. Mark with a CORROSIVE label.

A soak in the tank with the Muriatic acid PICKLE # 1, for between 15 minutes to 1 hour, will remove most rust from steel. This has the advantage of getting into the pores where sand blasting won't reach, but takes forever to eat through thick rust. So it is better to blast off the rust, than soak in Pickle.

Electro-strip using PICKLE # 1
Once the part has been thoroughly soaked in the pickle, it should be removed, rinsed and then gently brushed with a steel wire brush to remove the encrusted lumps, which should fall off fairly easily. If they don't, return to the bath for another soak.

Finally, they should be wired up to the Tank Bar and given a 5-30 second Electro-strip charge. This will ensure the surface is completely clean and ready for plating. Rinse in fresh water, then a 2 second dip in the SP Degreaser bath to neutralize the acid. Rinse, then proceed to plating.

2.Medium Pickle # 2 ***Rust Remover & De-plater***

TO MAKE PICKLE # 2 :-

To 2 parts fresh tap water
Add 1 part Muriatic (or hydrochloric) acid.

Rust can be removed by soaking in this solution.
Store in a lidded plastic container when not in use. Mark container with a CORROSIVE label.

De Plating using acid pickles

Stripping off old plating is a fairly easy procedure using the Electro-stripping tank and either sulfuric or Muriatic acid. However some care should be taken not to go too far and damage the part.

CHROME AND CADMIUM PLATE STRIPPING USING PICKLE # 2

Removes chrome and cadmium plate if the part is simply immersed in this solution for between five minutes and one hour. To speed up the process you suspend the part from the TANK BAR via a copper wire and connect the cathode plates to the negative side of your battery/charger. Connect the tank bar to the positive side of your battery/charger. The chrome/cadmium will now de-plate itself. A milky white residue will form over the part. This can be washed off with fresh water.

THIS IS A VERY RAPID PROCESS, SO BE WATCHFUL THAT YOU DO NOT GO TOO FAR AND START TO DISSOLVE THE PIECE COMPLETELY.

We prefer that you use ANODIZE & CHROME STRIPPER to remove chrome plate. This system is less harmful to the base metal. See the Chrome Plating Section for further details.

3.Strong Pickle # 3 ***Nickel Activator and Nickel Stripper***

TO MAKE PICKLE # 3:-

To 1 part DISTILLED WATER.
Add 2 parts of BATTERY ACID. Allow to cool.
Add 1 more part of BATTERY ACID
Add 2oz Glycerin per gal of solution. (Optional -prevents etching.)

Glycerin can be obtained at drug stores, in the skin care section. The solution may be warmed to approx. 110 deg F for best operation. Store in a lidded plastic container. Mark with a CORROSIVE label.

NICKEL PLATE STRIPPING using PICKLE # 3

Nickel plate is best removed with PICKLE # 3, using a current in the de-plating tank. Set up the de-plating tank in the same manner as for chrome de-plating, but fill the tank with PICKLE # 3. Nickel de-plating should only take 1 to 5 minutes.

Rinse the part in fresh water then return to the SP Degreaser for a few seconds. This neutralizes any remaining acid. Rinse the part thoroughly and proceed to plating immediately.

You may find that some areas have not de-plated completely, or you may wish to de-plate a specific area on a part. To accomplish this without returning the part to the tank where there is a risk of overstripping and ruining the piece, then make up a stainless steel brush plating wand (see Brush Plating) and connect the wand to the NEGATIVE side of your power supply, and the part to the POSITIVE side. Dip the wand in the respective stripping solution and apply it to the effected area. This is an extremely useful tool, especially for stripping chrome from parts prior to plating. (See GOLD BRUSH PLATING techniques)

Pickle # 3 may also be used to 'activate' an old nickel surface. Immerse the part for 15-30 seconds in the solution, or use a swab to brush it over the part.

New - PICKLE # 4 An alternative to Pickle # 2
For stripping rust from steel & also activates zinc, pot metal, lead, 60/40 solder, copper & its alloys.
No unpleasant fumes. More moderate action, less pitting.
This system is ideal for the preparation of lead work such as bullets, sun catchers, lead came, etc

PICKLE # 4 is a general-purpose metal activator and de-oxidizer containing fluoride and is used at room temperature on steel, copper, brass and zinc.
PICKLE # 4 is a free flowing mixture of dry acids and is more convenient and safer to use than liquid mineral acids. It does not produce the undesirable fumes given off with strong acids. It is dissolved in water and used at ambient temperatures to remove light to medium surface rust from steel and to activate steel surfaces prior to blackening with Black Oxide blackening solutions. Heavily rusted surfaces may require elevated temperatures of 150°F to 170°F. No venting required when used at ambient temperatures. It is used following the water rinse after cleaning the steel surfaces with SP DEGREASER

PICKLE # 4 is more moderate in its action on steel surfaces than mineral acids and produces a uniformly active surface.

PICKLE # 4 is also used to activate zinc-plated surfaces, die cast zinc surfaces, copper and copper alloy surfaces prior to blackening, oxidizing, antiquing, chromating or other finishing.

PICKLE # 4 solutions must be contained in acid-resistant tanks and containers. Polypropylene, polyethylene, PVC or rubber-lined steel are suitable. If heaters are required they must be glass or Teflon coated.

Metal	Action	Makeup & Use
Steel	activation	8 oz/gallon 30 to 60 second immersion
	rust removal	16 to 32 oz/gallon 2 to 10 minutes immersion
Copper and its Alloys	deoxidizing	8 to 16 oz/gallon 30 to 60 seconds immersion
Plated and die cast zinc Lead/lead solder	deoxidizing	4 to 8 oz/gallon 30 seconds to 2 mins immersion

Residual PICKLE # 4 solution must be removed with a thorough cold-water rinse prior to further finishing. The strength of the solution is maintained by small periodic additions of PICKLE # 4 salts. The solution is dumped only when its effectiveness is diminished by accumulation of metals, dirt, oil, etc.

Introduction to Plating Procedures

The following pages show the various plating set ups and procedures. You should use these pages in conjunction with the particular surface preparation methods and the METALS CHART (at the rear of this book). By doing this, you will be able to make a determination of exactly what you want to do.

There may be several ways to plate the same part. For example, a steel bolt in good condition may be nickel plated and polished to look like chrome, or it could be chrome plated on top of a nickel plate.

On each Plating Procedure page you will find a box showing you the settings for temperature and current, and the diagram at the foot of each page shows exactly how the system should be set up.

On some metals you may be instructed to apply a 'strike' coat. This is a thin layer of metal, applied as a primer to the main plate you wish to apply. It usually only takes a few minutes to apply. See the METALS CHART.

For example, our Bright Acid Copper plate cannot be directly plated to steel, it will not bond. So you need to apply a thin layer of FLASH COPPER first (this is the 'strike' coat), then apply the Bright Acid Copper to the nickel. You would be applying the copper plate (a filler) to enable you to carry out repairs to the steel. If there were no repairs to make, you would not need the 'strike' coat, so you would simply nickel plate, then maybe, chrome plate the part.

Example of a plating procedure, on a pitted steel part.

Degrease in the SP DEGREASER
Rinse
Pickle in PICKLE # 1
Rinse
FLASH COPPER for 10-15 mins (Strike)
Rinse
BRIGHT ACID Copper Plate for 30 + mins
Rinse
Solder any pits, Sand down
Buff with Emery & Sisal Wheel
Degrease in the SP DEGREASER
Rinse
FLASH Copper Plate for 15 mins
Rinse
Buff to a high quality shine cotton/brown bar
Degrease in the SP DEGREASER
Rinse
Nickel Plate for 45 mins
Buff with cotton wheel & White bar
Degrease with SP DEGREASER
Rinse
Chrome Plate
Buff with Canton wheel and Blue bar
Apply Collinite Metal Wax

Rinsing is a very important step. It MUST be done thoroughly.

METALS CHART

The following chart gives you an overall concept of which metals can be plated with each kit, and the steps required.

Gold (not shown) should only go over a nickel or tin plate

Silver (not shown) should only go over a copper, nickel or tin plate.

A copper plate is considered a base metal, and so can be plated with nickel, copy chrome or tin

Nickel plate is considered a base metal, so can be plated with chrome, copper, tin, zinc, Copy Cad, Copy Chrome, gold & silver

Zinc & Copy Cad are acid sensitive, so must be plated with Flash Copper prior to being plated with Reg Nickel or Bright Acid Copper.

Substrate	**SP Degreaser**	**Pickle**	**Strike Coat**	**Flash Copper**	**Bright Copper Plate**	**Regular Nickel Copy Chrome**	**Chrome Plate**	**Anodize Aluminum**	**Zinc Plate**	**Yellow Chromate**	**Copy Cad**	**Tin**
Aluminum	5-15 secs	#3 10-40 secs	Zincate Then Flash Copper	optional	After Flash Copper	15-60	3 mins	See Anodizing section				
Iron Steel	15-60 secs	#1 or 2 as required	Reg Nickel 10 mins Or Flash Copper	optional	as required	15-60 mins	3 mins		15-30 mins	5-30 secs	15-30 mins	15-30 mins
Stainless Steel	15-60 secs	#2 as required	Stainless Steel Activator		as required	15-60 mins	3 mins					
Pot Metal Zinc Die Cast	30-60 secs	None	Flash Copper or Zinc/Copy Cad	yes	as required		3 mins		15-30 mins		15-30 mins	
Brass Copper Bronze	as required	#1 or #2 1-5 mins	copper 10 mins		as required	15-30 mins	3 mins					15-30 mins
Nickel	15-60 secs	#3 15 secs		optional	as required	5-15 mins	3 mins		15-30 mins		15-30 mins	15-30 mins
Chrome		#2 to strip chrome										
Plastic			conductive powder	Yes	as required	15 mins	2 mins					
Lead		Pickle # 4		Yes		yes	yes					
Pewter		Pickle # 4		Yes		yes	yes					

The WATER BREAK TEST

Also recognised as ASTM-F-22

This test is probably one of the most important procedures in any plating operation.

Make sure you carry out this test after doing all the preparation work, including degreasing and etching in pickles.

To pass the test water will sheet off the part rather than bead

Take a cleaned and dried part and set it in a vertical position.

Use a spray bottle containing distilled water.

Spray the part two to three times from at least 6" away.

If the part is clean and free of oily residue, the water spray should sheet off.

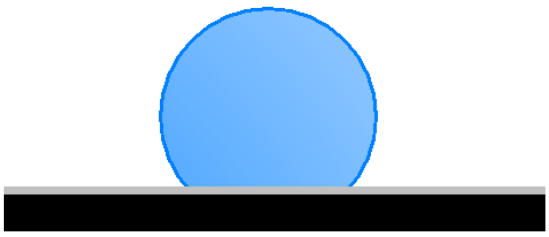
If some oily residue remains, the water will tend to bead on the part

Repeat the cleaning process until the part passes the test.

Alternatively, apply several drops of distilled water to the cleaned surfaces.

If the surface is inadequately cleaned, the spherical form of the drop is largely retained, and the surface must be cleaned once more.

If the water runs on the treated surface, then wetting has been satisfactory and the part is ready for plating.



Oil/dirt film makes water bead up

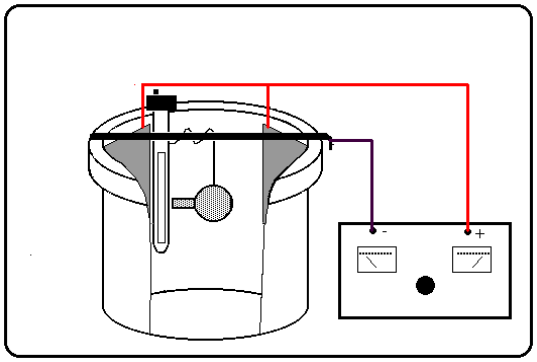
No oil/dirt film allows water to cover part

Bright Acid Tin Plating Process

Ideal for model Tin-ware Trains, Antique Tin-ware, Cooking Utensils, Electronics, Buss Bars, Tools and much more

Tin is a very commonly used metal for the protection of steel. It is used extensively in the food trade because of its non-toxic qualities. Tin is a bright, shiny material, and has excellent soldering capabilities, making it ideal for all electrical connection applications.

Caswell's Tin Plating kit will plate directly over, copper, steel, brass, bronze. Other more 'difficult' metals such as pot metal, will require a coat of FLASH COPPER first.



TANK TYPE	Plating
SOLUTION TEMP RANGE deg F	65-80 opt =72
AIR AGITATION	NO
PLATING TIME (MINS)	20-30 mins
ANODE	Tin
ANODE BANDAGE	no
VOLTS SHOWING ON VOLTMETER	1-4
MILLI-AMPS REQUIRED PER SQ "	0.10
FUME HOOD	no
USE AS A STRIKE COAT	no

Average thickness is typically 0.0002-3" (0.10" in 10 mins)

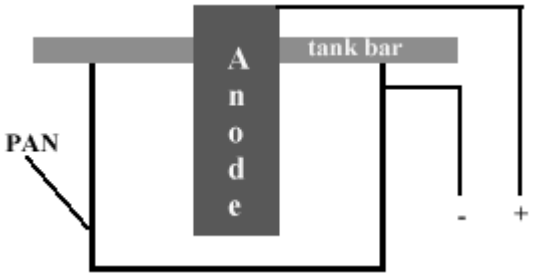
Setup involves mixing 3 quarts of battery acid into 6 quarts of distilled water, then adding one unit of Tin Concentrate. Double these quantities for the 4 gal kit.

The Caswell Tin Plating System is a stable bath, which deposits a leveled, brilliant plate with excellent soldering capabilities. It has a wide operating range in regard to concentration and operates well with low tin concentration.

Do not use air agitation, as the bath will froth violently due to the wetting agents used.

Copper Cook ware is often lined with tin. Usually molten tin is 'hand wiped' into the cleaned pot. However, lining can be done quite easily by the following electroplating technique.

Clean the inside of the pot thoroughly with an abrasive cleaner such as Soft Scrub. Buff and polish to an acceptable shine. Fill the pot to the brim with pickle # 2 and let soak until the entire inside is a pink color.
Rinse thoroughly in hot water.
Fill the pot to the brim with Tin Plating solution which has been preheated approx 80 degrees.
Make a suitable tank bar from PLASTIC or some other NON CONDUCTOR



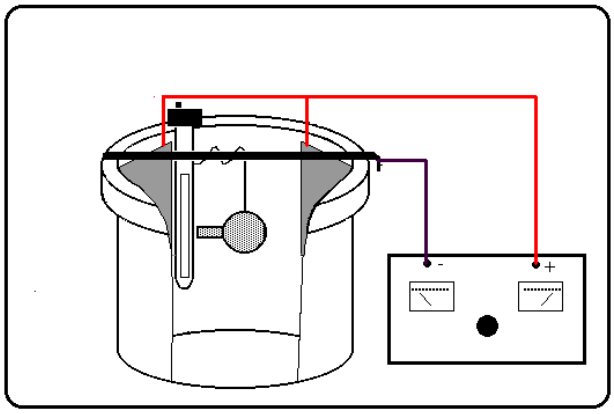
Connect the positive wire from your power supply to the Tin Anode, and the negative to the cooking pot. Then plate in the normal manner. The pot should keep the liquid around the optimum operating temp of 72 deg f, especially if the start up temp is raised to 80, as previously suggested.

Regular Nickel & Copy Chrome Plating

Copy Chrome is a nickel cobalt alloy. The kit is the same formula as regular nickel, except that there is an addition of cobalt salts. These salts make the plate a 'bluer' color, and harden the finish. Other than that, the system is identical, so to conserve space in this manual we are using the same instructions for both set-ups.

TANK TYPE	Plating
SOLUTION TEMP RANGE (Deg F)	105-115
AIR AGITATION	yes
PLATING TIME (Mins)	15-60
ANODE	Nickel
ANODE BANDAGE	Yes
VOLTS SHOWING ON VOLTMETER	1.5 - 6
AMPS REQUIRED PER SQ. INCH	0.05 - 0.06
FUME HOOD	no
USE AS A STRIKE COAT	yes
SYSTEM plates at the rate of 1/1000" per hour	
pH	3.5 - 4

TO MAKE UP the Regular Nickel or Copy Chrome SOLUTION.



The chemicals are supplied pre weighed and ready to mix into distilled water. Take note of the mixing ratios marked on the bags.

Heat the required amount of distilled water to approx. 170 deg. f. This will aid the chemicals to dissolve.

Add the required amount of DISTILLED WATER to the tank. See the label on the bag.
Add the bag of Regular Nickel or Copy Chrome CRYSTALS.

Stir the solution regularly as it cools, with a plastic or wooden stirrer.

You may have some chemicals settle to the bottom of the tank. They will eventually dissolve, although this may take some days.

Nickel & Copy Chrome solution is like a good wine, it gets better with age. Leave the solution overnight to 'age' before using. There is no need to check the pH with litmus paper, as per our old instruction manuals.

Operating the system

For best results, you should have an air supply/agitator blowing bubbles into the tank. Regular Nickel & Copy Chrome plating is prone to forming little pin pricks in the surface unless you do this. Hydrogen bubbles are formed during plating and these stick to the plated surface. The plating then forms around the bubble, making a small crater on the surface. These are very unsightly and difficult to remove. Air agitation removes the bubbles and supplies fresh solution to the plating surface. It will also make a smoother plate.

After plating with nickel or Copy Chrome, buff the part to a high shine using a spiral sewn wheel and white compound, then soak in hot SP Degreaser to remove buffing greases etc.

For a decorative finish plate for approx. 15-20 mins.
For a tough corrosion resistant finish plate for 60 minutes.
Only nickel & Copy Chrome plating has the following peculiarity:-

DO NOT REMOVE THE PART ONCE PLATING HAS STARTED.

You will interrupt the process causing the succeeding layer of plate to delaminate. If any interruption occurs, activate the surface by swabbing the surface with PICKLE # 3 on a cotton swab.
Rinse the part in fresh water, then return to the plating tank to finish the application.

For a high quality finish on brass, copper & bronze, apply a copper plate first, buff, then nickel or Copy Chrome plate. However, nickel or Copy Chrome will plate successfully directly to these metals.

For a flat finish on steel, sand blast with fine abrasive, then plate, do not polish before plating, only after to remove dull gray. The Regular Nickel finish can be made to look like Cadmium or a "Butler Nickel" used on Model A Fords.

To make nickel look like a cadmium plate sand blast the part to a dull flat finish, then nickel plate. Finish by scrubbing with wetted scouring powder such as VIM or Comet. You will get better results from our COPY CAD kit.

To make nickel look like the Butler Nickel finish, plate with the amperage turned up slightly and the temperature down. Clean up with scouring powder.

Use nickel plate as a 'strike' coat onto steel, prior to plating with copper. Acid copper systems such as ours, will NOT plate directly to steel or zinc, so they need to be covered with an 'inert' layer prior to plating. Either type of nickel system will act as this protective layer, preventing the acid from damaging the steel or zinc.

DO NOT PLACE POT METAL, OR ANY TYPE OF ZINC/PLATED SURFACE IN REGULAR NICKEL OR COPY CHROME SOLUTION. The zinc from the pot metal will react with this more acidic solution, which will become contaminated and ruin any further work. However, steel is not effected by this product and can be directly plated with it.

As soon as you have completed nickel plating, proceed immediately to chrome plating, if required Copy Chrome will not require Chrome plating, as it is the finished job.

The shiny appearance of Regular Nickel or Copy Chrome plate can be enhanced by several factors.

1. Buffing and polishing PRIOR to plating, is by far the most important factor.

2. The addition of brighteners to the solution. NICKEL/COPY CHROME BRIGHTENER ADDITIVE should be added at the rate of 1 fl oz per gallon of solution when the system begins to lose brightness. These brighteners are in the initial mix of nickel solution. If the system is 'cleaned' by filtering through a charcoal filter (see troubleshooting), then additional brightener MUST be added to bring back the original plating conditions.

3. Buffing and polishing AFTER plating,

4. Protecting the surface by applying Collinite Metal Wax.

Nickel & Copy Chrome Plating Troubleshooting

Problem	Cause	Remedy
No deposit	No current (or gassing from part)	Check all electrics
Plate peels off or blisters	1. Poor preparation 2. Inadequate cleaning	Check part with 'waterbreak' test. Acid etch part. Check SP Degreaser is OK. Chrome in nickel, if so, dump solution. On porous metal (Pot Metal) sand blast, Flash Copper, then Bright Copper & or nickel plate.
Pitted Plate and Orange Peel effect	1. Impurities in solution 2. Hydrogen bubbles formed on part	Strain though coffee filter with 1/2 of 'activated charcoal' in bottom. Add more Nickel Brightener. Add 1-3 teaspoon of HYDROGEN PEROXIDE per 2 gals of nickel solution to reduce pitting Alter air agitation. Make air flow/bubbles larger, or use manual agitation of the part.
Rough Plate	1. Amps too high 2. suspended particles in solution 3. pH too high or low	Reduce current 1 amp = 15 sq" Filter solution (no charcoal) Adjust Ph to within 3.5- 4.5
Black streaks or dark deposits (esp. on low spots)	Zinc, lead or copper in solution (Especially zinc plate)	Plate out onto a dummy corrugated cathode. Zinc contaminants may show as alternating dark & lights areas. Air agitation must be on. Adjust pH to 3.5 - 4.5
'Burnt' Plate	Too much current	Lower the amperage Raise the bath temperature
Haze on the plate	Excess Hydrogen Peroxide	Heat solution to 190 deg F, then filter using charcoal. Replace brightener
Bright plate on high areas only	Insufficient Brightener	Add Nickel/Copy Chrome Brightener
Bright plate except very low spots	Too much Brightener	Remove by filtering through charcoal, then replace
Dull plate	1 Insufficient Brightener 2. Part not polished properly	Add brightener Strip the plate off and re-polish, or plate with copper, polish the copper and then re-plate.

Electroless Nickel & Krome Plating

Acid Nickel Process: 5-7% phosphorus

These instructions now cover the Nickel and the Krome kits. Electroless Krome is a nickel/cobalt alloy, harder and bluer than nickel. Where these instructions refer to Electroless Nickel, this also means Electroless Krome. The only difference in the kits is the part A component, which, in the case of Krome, has the cobalt additive. You may use parts B & C for either type of plating, as they are completely interchangeable.

Electroless nickel/krome plating requires no anodes, power supply or electrical connection of any kind. The process simply involves mixing together some solutions, heating them to just off the boil, and then immersing the part to be plated. An auto-catalytic electrochemical reaction takes place and the nickel is evenly deposited all over the part being plated. The thickness of the plate will depend on the duration of immersion. To stop the reaction, the part is removed from the solution, which is allowed to cool before storing for later reuse.

Commercial electroless nickel platers usually employ full time chemists to make additions to the solution. This is a time consuming activity for a small operation and is not cost effective. Our system is designed around the KISS - 'Keep It Safely Simple' principal, so you will not have to 'titrate' and mess around with this technicality. We have developed a straightforward way of estimating the nickel depletion of the bath, and fresh additions can easily be made to prolong the life of the solution. The procedure is much like balancing your chequebook.

The brightness of the plate will, to some extent, depend on the degree of polish existing on the part. The higher the shine initially, the brighter the plate. Surfaces requiring shiny finishes should be done in fresh batches of solution, otherwise they may have to be buffed to obtain a high gloss. The duller finishes resemble cadmium or Butler nickel, so are of great value to most vehicle restorers. Numerous variations can be achieved by changing the surface finish prior to plating.

Electroless nickel plating is not new, it has many applications in industry. Because the system plates evenly over all areas of the part, even down tubes and holes, it is frequently used for firearms and small hand tools. It is ideally suited for coating extrusion dies to assist in mould release and protection of the surface. For the motorcycle restoration enthusiast, electroless nickel has a great application for evenly plating the air cooling fins on many engine blocks, particularly older Indians and Harleys.

Fortunately, electroless nickel is a fairly safe material, nevertheless, there are heavy metals (nickel) in the solution and this should not be disposed of carelessly. Our kits have a special system included to 'plate out' the excess nickel, rendering the rest of the solution harmless, enabling you to dispose of down a drain, or as per your local regulations.

The system consists of 3 main ingredients, parts A, B & C.

Mix parts A & B with distilled water to make up the initial solution. As this is depleted of nickel, further additions of part A and part C are made to keep the solution stable and plating brightly.

Getting Started!

To provide the optimum protection for each article, the thickness of the nickel plate needs to be considered. The thicker the requirement, the longer the part is plated.

Application	**Plate Thickness**	**Plating Time** in minutes
Indoor items, decorative etc.	0.25 thou	15
General use, hand tools, guns, nuts & bolts, brackets etc	0.5 thou	30
Marine, motorcycle, car or outdoor fittings	1 thou (25 micron)	60

The table below shows how much surface area, at a given thickness, can be plated with 1 litre of solution before the nickel needs to be replenished with a small quantity of parts A & C concentrates. Failure to replenish the solution will result in the plate becoming dull and the bath eventually becoming out of balance and unusable.

BATH SIZE in Litres	**Surface Area Plated**	**Thickness in 1/1000"**	**Time in minutes**	**MAXIMUM LOAD At any one time In square inches**
1	15	1	60	30
1	30	0.5	30	30
1	60	0.25	15	Use a larger tank
4	60	1	60	120
4	120	0.5	30	120
4	240	0.25	15	Use a larger tank
12	180	1	60	360
12	360	0.5	30	360
12	720	0.25	15	Use a larger tank

Where it states 'Use a larger tank' in the examples shown above, you may plate the given quantity, but will need to do this in two batches. E.g., You wish to plate 720 sq. inches of parts @ 0.25". Therefore, you would need to split the load into two parts, equalling 360 sq. inches each, plate one load for 15 minutes, and then plate the other load. If the part itself were 720 sq. inches, make up a larger tank (say 24 litres) to accommodate this. In practice, the occasional large part will plate quite successfully in a somewhat overloaded tank, at the risk of having to dump the solution afterwards.

Example.

Lets imagine several parts, which need to plating for general use (such as a gun). This would require a plate of approx. 0.5 thou. (half a thou.)

To achieve this, they would need plating for 30 minutes. The total surface area of these parts is 10 square inches. The bath is capable of plating 30 square inches at 0.5 thou, (See table above) so three batches of the same sized parts could be plated before replenishing the bath. Therefore, the bath is 1/3rd depleted.

The next job is a large part, 15 square inches, which needs plating for outside use. It requires 1 mil, so must be plated for one hour. The existing bath only has sufficient chemical left to plate this for 40 minutes, because we just used 1/3rd of it. Therefore, the bath will need to be replenished during the plating process. Electroless nickel baths should be replenished at 30 minute intervals, if the part is likely to consume more than 15 square inches @ 1/1000" thick.

As this bath will have consumed 1/3 of the nickel, and needs a 'full load of 15 sq." @ 1/1000") to complete the job, we must add more nickel.

Therefore, the nickel replenishment is made 2/3rds of the way through the 1-hour plate job.

Failure to do this will result in the plate becoming duller and the solution deteriorating, until it can no longer be satisfactorily replenished.

NICKEL REPLENISHMENT

The Nickel Bath Replenishment is a straightforward matter of adding more nickel from the Concentrate Part A, with and addition of Concentrate Part C.

If you have used the bath several times, you should keep a note of the time, surface area etc. using the following log sheet. A blank form is at the back of this leaflet.

Each Litre of initial made up solution will plate 15 square inches @ 1/1000 in 60 minutes before the bath needs replenishing.

To provide us with a simple way of logging the usage of the bath, we are going to award each litre of new solution with 'Nickel Credits'. These are the sum of the square inches multiplied by the time in minutes.

A 1liter bath has a total Nickel Credit of 15 x 60 = 900. Enter the 900 in the Nickel Credits column, and, just like balancing a chequebook account, enter the final balance in the balance column. (But- this is an account you cannot overdraw!)

***** The 1.6 litre bath has a total Nickel Credit of 25 x 60 = 1500. Enter the 1500 in the Nickel Credits column.

If you were making up a 4 litre kit, the answer would be - 4(litres) X 15 x 60 = 3600

Surface Area in Square inches	**Time In minutes**	**Nickel Credits**	**Balance Of Nickel Credits**
Initial solution total credits for 1 litre in Nickel Credits Column 15 x 60 = 900 (UK/ Euro see *)		***+900 (1500)***	***900 (1500)***
10	***30***	***-300***	***600 (1200)***
Replenish		***+900 (1500)***	***1500 (2700)***
15	***60***	***-900***	***600 (2100)***

Using our previous example, we can now log the plating bath usage.
In the first line, the total credits for the bath is entered = 900
The second line shows a part with surface area of 10 sq. being plated for 30 minutes, depleting the credits by 300.

The next line shows the bath replenished. This is because the next part, being 15 sq." & requiring 60 minutes plate, will over-deplete the remaining credits (and remember, you cannot overdraw this account).

So before this happens, we have to add more nickel, which may be done during plating, and should be added gradually in several small amounts over the plating period.

REPLENISHING THE NICKEL PLATING BATH with Part A & Part C

As soon as your chart shows you have depleted the bath, add the quantities of part A & C, as shown below for your sized bath. These quantities will never change.

The replenishment solution makes up to the original load of the bath.

Tank Size In litres	**Nickel Credits**	**Addition of Part A In millilitres**	**Addition of Part C In Millilitres**
2	1800	30	60
1.6 (UK)	**1500**	**25**	**50**
4	3600	60	120
12	10800	180	360

You may add the replenishment solutions at any time. After a wait of approx. 20 seconds, to allow the solution to warm up to it operating temperature, top up the solution to the original waterline with DISTILLED WATER.

CONVERSION TABLE			
Fluid Ounces	**Millilitres (cc)**	**Teaspoons**	**Tablespoons**
1	30	6	2

You may make as many as 15 additions of replenishment to the bath.
Your additions will be noted on your 'Nickel Credits' form.

After this, you should dispose of the solution and make a fresh bath with parts A & B.

The 2 (& 1.6 UK) litre kit has enough product for approx. 2 replenishments**,** the 4 litre kit = 11 replenishments, and the 12.5 litre kit = 7 replenishments. These varying amounts are due to the packaging sizes available.

A note on bath replenishment.

During the process of plating, a quantity of water will evaporate from the tank.
Additions of DISTILLED WATER must be added periodically to maintain the correct dilution of the solution.

Make a note of the waterline when you first make up your solution.
To make an addition, first, IF REQUIRED, add a quantity of REPLENISHMENT SOLUTION, then top up wth distilled water.

It is always advisable to add small amounts of both frequently, say every 5 minutes, as this will keep the bath from cooling, and becoming unstable.

NICKEL CREDIT FORM

Surface Area in Square inches	Time In minutes	Nickel Credits	Balance Of Nickel Credits
1 litre tank = 15 1.6 litre tank = 25 4 litre tank = 60 12 litre tank = 180	60 60 60 60	900 1500 3600 10800	

Set-up and Operation of the Kits

INITIAL SETUP MIX

Tank Size In litres	Part A In millilitres	Part B In Millilitres	Distilled Water In Millilitres
1	50	150	800
4	200	600	3200
12	600	1800	9600

The 1 Litre KIT

The 1 Litre Kit can be mixed up as follows:-

Add 3.5 tablespoons (50ml) of Concentrate part A to the tank.

Add one bottle (150ml) of Concentrate part B.

Top up the tank with 800ml DISTILLED water.

If an enamelled vessel is available and the coating is not damaged it can be used. If you have a saucepan with a non-stick lining that is not damaged you can use it with out a problem. You can also use glass lined or Pyrex bowls and even plastic containers in a larger pot with water around to heat the plating liquid.

Cut a piece of sheet metal or expanded mesh cut larger than the base of a Pyrex plating tank to use as a heat diffuser.
Place this onto the electric heating element or gas ring. Place the tank on top of the heat diffuser. Heat the solution to the boil and then heat on low or simmer at 195 deg F.

Suspend the previously cleaned parts on cotton or string from a wooden bar and allow to plate for the required time, stirring occasionally.
With small parts, you may simply deposit them gently in the bottom of the flask. During the plating procedure, stir them around every 5 minutes with a wooden stick. Flip flat objects over to expose the underside.

Remove the parts and rinse. Store the liquid for use again.

THE 4 & 12 LITER KITS

Operating the 4 & 12 Litre Regular Kit

YOU MUST NOT PLACE PLATING SOLUTION DIRECTLY INTO A STEEL TANK. Our tanks are supplied with a ceramic coating, which prevents the nickel from plating it.

4 Litre Kit
Place the tank onto the heating element.
Add 200 ml of Concentrate part A to the tank. Add 600 ml of Concentrate part B to the tank. Finally add 3.2L (3200ml) of DISTILLED water.

12 Litre Kit
Place the tank onto the heating element. Using the measuring cup, add - 600 ml of Concentrate Part A, 1800 ml of Concentrate part B, 9.6 litres of DISTILLED water.

Place the lid on top of the plastic liner and heat the solution until it just begins to boil and then turn down the heat to allow it to simmer without bubbling. This will maintain a temperature of 195 deg F. Using a piece of wooden dowel as a bar, suspend the parts to be plated into the solution and allow to plate for the recommended time. If the parts are very small, deposit them onto the bottom of the tank, and stir them around about every 5 minutes.

It is VITAL that you periodically check the water in the outer tank and add small amounts to compensate for evaporation. If this boils dry you will ruin the plastic liner and your solution.

After plating, filter the solution through a coffee filter and return to the tank.

GENERAL ELECTROLESS NICKEL PLATING INSTRUCTIONS

Important. Any part made which contains copper; i.e. copper, brass, bronze, must be 'activated' by physically touching the part with a piece of steel for several seconds (5-30). Alternatively, the part may be suspended on a STEEL wire, which will activate the nickel/krome plating process. You should see the steel rod/wire bubbling gently. When the copper part begins to bubble, it has accepted the reaction and will continue to plate successfully.

Chemical Disposal Procedure

Add enough household ammonia to make the plating solution turn blue Heat to 170 deg f. Using 1 steel pad per litre of solution, immerse them into the solution.

Add the END concentrate at the rate of 20 ml per litre of solution. (20ml will do the UK kit)

Heat the bath to 190-205 deg F approx. 1-2 hours until the solution turns water white.
The solution is now drain safe and can be disposed of.

Tank Size In litres	**Quantity of Steel Pads**	**END** In millilitres
1	1	20
1.6 UK / Euro	2	20
4	4	80
12	12	240

The 4 and 12 litre Kit

Contains:-

1 x 4 (or 12) litre Stainless Steel Tank and Lid
1 unit Electroless Nickel Part A
1 unit Electroless Nickel Part B
4 units Electroless Nickel Part C
1 unit END Plate Out Solution
Plate Out Wire Pads
Measuring Cup.
Instructions

Electroless Nickel Plating Troubleshooting

Problem	Cause	Remedy
No deposit	No current (or gassing from part Incorrect solution ratio Copper alloy not activated	Incorrect bath temperature, increase temp Dump solution and make up fresh batch Touch copper alloys with steel rod for 5-60 seconds until part starts to gas
Plate peels off or blisters	1. Poor preparation 2. Inadequate cleaning3. Organic or metallic contamination 4. Improper zincating of aluminium	Check part with 'waterbreak' test. Acid etch part. Check SP Degreaser is OK. Rework the part through the cleaning process Dump solution and make a fresh bath. Etch zincate off in mild acid, and re-zincate in fresh solution.
Pitted Plate	Impurities in solution Copious evolution of hydrogen gas	Dump solution and make up a fresh bath Surface are being plated should be reduced. If tank walls are gassing, they may be being plated. Clean tank
Rough Plate	Contamination of loose particles i.e.: dust nickel. Contaminated water used Particles of metal or soil on work	Filter solution through a doubled coffee filterDiscard solution and make up new batch using DISTILLED water Improve cleaning and rinsing process.
Dark deposits (esp. on low spots)	Zinc, lead or copper in solution	Plate out onto a dummy corrugated cathode. Zinc contaminants may show as alternating dark & lights areas. Air agitation must be on Adjust pH to 3.5 - 4.5
Streaks in Deposit	Gas streaks from position of work Poor agitationPoor rinsing & or cleaning Metal & organic contamination Low surface area	Reposition work occasionally Agitate occasionally Improve cleaning and rinsing process Dump solution and make up fresh batch Increase the number of parts being plated
Poor corrosion/chemical resistance	Metallic contamination	Dump solution and make up fresh batch
Dark to black deposits	Metallic/organic contamination (usually caused by old zinc plate Bath imbalance	Dump solution and make up fresh batch Soak part in weak solution of muriatic acid to remove old zinc plate
Poor wear resistance	Low heat treatment temperature &/or short time	temperature and time cycle should be adjusted
Laminar deposits	Poor temperature	Keep temp within range
Frosted deposits	Low work load Metallic/organic contamination	Increase work load Dump solution and make up fresh batch
Poor Adhesion on Aluminium	Metallic/organic contaminationImproper surface preparation Improper zincate or other pre-treatment Improper heat treatment Re-oxidation	Dump solution and make up fresh batch Improve cleaning and rinsing process Replace zincate bath heating time and temperature should be corrected Reduce transfer time from zincate to nickel
Dull or matte deposit	bath more than 25% usedMetallic/organic contamination Poor quality substrate Low temperature	Make up fresh batch -or- buff the part to a shine solution and make up fresh batch Improve polishing etc Correct the temperature
Poor coverage, edge pullback & frosted edges	Improper cleaning &/or rinsing Metallic/organic contamination	Improve cleaning and rinsing process Dump solution and make up fresh batch
Plating solution turns white	Solution is depleted	Solution may be contaminated with alkaline drag in. Dump solution
Plating solution turns grey	Solution is decomposing	See above. Prevent drag in. Dump solution

Zincate Instructions

Process for Plating Aluminum

Aluminum forms an oxide the moment it is exposed to the air. This presents a problem when plating it, as the oxide prevents the plate from sticking. By using the Zincate process as a preplate dip, you chemically remove the oxide layer and at the same time, apply a layer of zinc. The zinc protects the aluminum from further oxidizing until it is ready to be plated. As the part is lowered into the plating tank, the zinc is etched away by the solution and plating proceeds onto a clinically clean surface.

Procedure for Zincating

Bead Blast clean the part to remove all heavy oxides and contaminants.

Buff and polish to the required shine. The part should then be thoroughly degreased in CASWELL SP Degreaser.

Make up a solution of Zincate by adding 25% by volume of the concentrate to a plating tank (Pyrex , plastic etc.) and fill with distilled water. i.e.:- Add 250 ml of Zincate, then top up to 1 liter mark with distilled water.

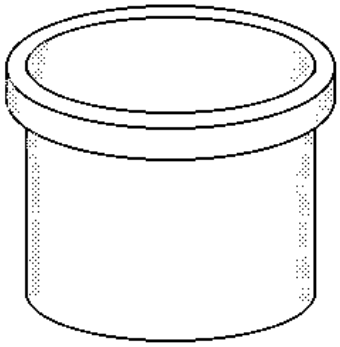
Heat the solution to 75 deg f. An aquarium heater will do this quite easily.

Immerse the part in the solution for 15 sec. to 2 minutes. NO MORE! Immersion time will depend on the alloy, zincate condition and temperature. If the alloy reacts violently with the solution, then shorten the time immersed. If no reaction is visible, then immersion times can be extended.

A uniform gray appearance is usually a sign of a properly zincated surface, however there are cases where a dark, slightly streaked surface is acceptable. As the Zincate solution is depleted, there will be a noticeable increase in the gassing. You can replenish the solution by adding about 10% of the Zincate concentrate, or simply make up a fresh batch.

Rinse the part and prepare for Nickel Plating in our Regular Nickel (with anodes & power supply), Electroless Nickel kit, Copy Chrome or Copper kit.

Stainless Steel Activator for a Nickel Plate



Stainless Steel must be etched and then plated with a 'strike' coat of a special nickel before it can be plated conventionally.

Prepare the part by buffing and degreasing in the normal manner.

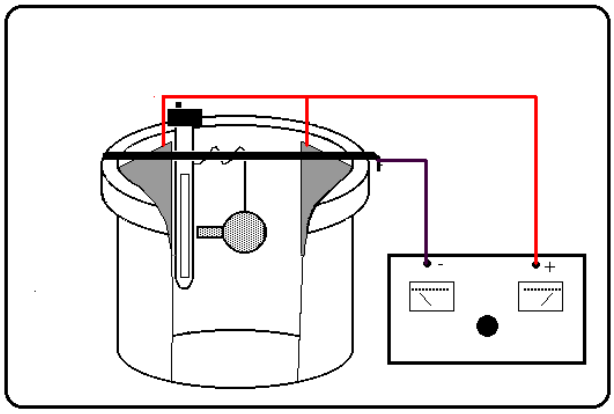
Immerse the part in the STAINLESS STEEL ETCH solution for 10 seconds at room temperature. (approx 70 deg f)

Rinse in fresh water.

Unless you are going to be doing a quantity of stainless steel, you can use the regular nickel plating tank setup. Remove the regular nickel solution and set aside, rinse the tank, then pour in the STAINLESS STEEL ACTIVATOR .

Plate for 1 minute at room temperature (approx. 70 F) in the STAINLESS STEEL ACTIVATOR solution @ 1 amp per 15 square inches of surface area. Remove the solution from the tank, rinse the tank, and set the solution aside for re use.

The part can now be given the REGULAR NICKEL PLATE, once that set up is re-installed in the tank.



Stainless Steel Etch & Activator Solutions

Two solutions are required to activate STAINLESS STEEL prior to nickel plating.

1. Stainless Steel Etch

Use a 3 gal plastic pail as a container.

Add 1 gal of DISTILLED WATER.
Add 1 gal MURIATIC ACID

Warning! Always add acid to water, not water to acid!

The solution is now ready for use.
Use at room temperature.

2. Stainless Steel Activator

Use a 3 gal plastic pail as a container.

Add 1 Gal DISTILLED WATER
Add 1 pint of MURIATIC ACID
Add 1 bag (2lbs) STAINLESS STEEL ACTIVATOR crystals

Stir thoroughly to dissolve.
Allow 4 hours to age before use.

FLASH COPPER Plating

TANK TYPE	plating
SOLUTION TEMP RANGE (optimum)	(Deg F) 120
AIR AGITATION	yes
PLATING TIME (Mins)	5-15
ANODE	copper
ANODE BANDAGE	yes
VOLTS SHOWING ON VOLTMETER	1-6
AMPS REQUIRED PER SQ. INCH	0.05 - 0.1
FUME HOOD	no
USE AS A STRIKE COAT	yes

Plates onto, LEAD, POT METAL, STEEL, PEWTER, ZINC, BRASS, ZINCATED ALUMINUM, ELECTROLESS NICKEL, AND COPPER
Eliminates the use of cyanide strike coats, Pot Metal Primer on Zinc, nickel strike on steel prior to copper plating.
Ideal for 'priming the lead on fishing lures, and sun catchers, prior to plating with Nickel or Copy Chrome.
Increases the bond of acid copper, nickel and Copy Chrome to all substrates.

FLASH COPPER is a unique alkaline electrolytic copper plating process with covering and throwing powers greater than cyanide copper.

FLASH COPPER is an outstanding pre-plate copper strike for bright nickel, acid copper, tin and solder plates. It is an excellent heat treat stop off plate and EMI shield. It is also an excellent decorative finish for buttons, rivets, lighting fixtures and builders' hardware. The copper plate can be readily blackened or oxidized for a variety of attractive antiqued finishes. There are no carbonates to be treated. It contains no strong chelators. It is supplied as a liquid concentrate, which is diluted with water.

FLASH COPPER produces a fine grained, smooth, dense and ductile copper deposit, which is nonporous and has excellent bonding properties. The throwing and covering power of the non-cyanide process is superior to cyanide processes. This is especially evident in barrel plating. It has uniform low current density distribution with excellent micro-throw.
The grain is smaller than cyanide copper, which increases the density of the deposit. This density provides excellent heat treat stop off and masking properties. The fine-grained FLASH COPPER deposit under nickel/chrome improves the overall corrosion resistance and helps to throw the nickel farther into the low current density areas.
FLASH COPPER produces a softer and more ductile deposit than cyanide or acid copper. The soft deposit imparts improved adhesion and corrosion resistance and greatly improved resistance to thermal shock.
It has a high deposit purity and hence no out-gassing with subsequent brazing, soldering or vacuum operations.

FLASH COPPER is simple and inexpensive to use because it replenishes the copper in solution by dissolving the copper anode and here again it is a unique product with only one maintenance additive.

The kit contains PICKLE # 4, a new product that replaces the use of flouroboric acid for etching lead and solder. The pickle can also be used on most other metals.

Making up the FLASH Copper Plating Solution
2 gal kit4 gal kit
FLASH COPPER Part A3 qts6 qts
FLASH COPPER Part B1 qt2 qts
FLASH COPPER Part C1pint2 pints
Pour all ingredients listed above into tank

Distilled WaterRefill all containers with distilled water and add to tank. So, add an equal amount of water to chemicals.

To obtain maximum bonds, all metals to be plated must be thoroughly cleaned and degreased.
Lead and pewter must be immersed in PICKLE # 4 for 2 minutes to remove the oxide layers.
See Bright Acid Copper for setup details.

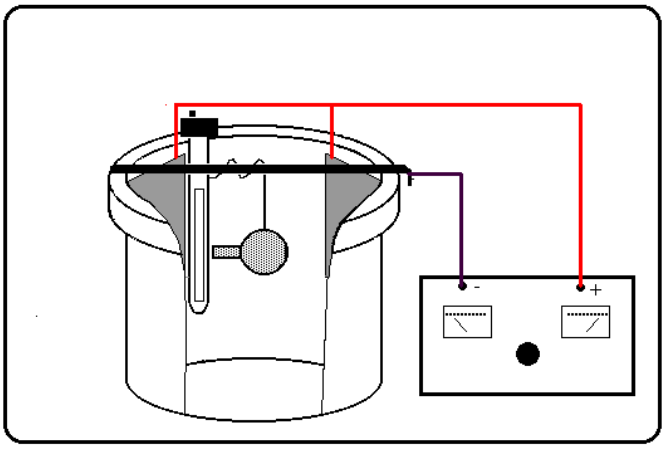
BRIGHT ACID Copper Plating

TANK TYPE	plating
SOLUTION TEMP RANGE (optimum)	(Deg F) 75
AIR AGITATION	yes
PLATING TIME (Mins)	5-360
ANODE	copper
ANODE BANDAGE	yes
VOLTS SHOWING ON VOLTMETER	1-6
AMPS REQUIRED PER SQ. INCH	0.05 - 0.1
FUME HOOD	no
USE AS A STRIKE COAT	no

Copper plating can be used for several operations. This soft metal can be applied in thick layers that can be sanded, soldered and polished to a high shine, making its use somewhat like a high build filler paint coat. It may also be used to 'electroform' articles in various ways, and to 'bronze' non-conductive items such as leaves and baby shoes.

Making up the Copper Plating Solution

Add DISTILLED WATER to the tank. See Copper Crystals bag for ratios. Bags are marked with water quantities (Approx 1.5 lbs of Crystals per gaL of water)



Add 12oz battery acid to 1 gal distilled water, then add ½ bottle (2oz) of New Copper Brightener.
Add the Copper Crystals

Plate a piece of scrap brass or copper about 15 sq. ins surface area for approx. 1 hr with 1 amp. This will expel any impurities from the solution.

Our acid based Copper Plating System is designed to apply heavy layers of copper which can be sanded, soldered and/or burnished. It will only plate directly onto copper, brass, bronze, Copy Chrome and nickel .

Do NOT attempt to plate steel, pot metal or aluminum without first applying a 'strike' coat of the appropriate metal. See the METALS CHART for more information

The finished setup, ready for plating.

To apply a more even layer over rough surfaces, we have found it is best to remove the part from the tank and sand down with wet & dry paper, then return to the tank for more plate. This gives a more even plate than trying to apply all the copper at once. Buffing between layers will also help to produce a high quality finish.

Copper will plate quickly, and if left too long will grow nodules & coral like trees on the part, which are fairly hard to remove. Agitation and a lower current will reduce the amount of buffing required.

You may remove the part from the tank frequently, with no adverse effects to the successive layers of plate.

Although the average plating time is 15-20 minutes, copper may be plated for several hours if a really heavy layer is required. For a finer, denser plate, increase the tank temperature using the aquarium heater, and reduce the amperage.

If the copper plate looks dark and is rough, or has a layer which rubs off, you will need to reduce the amperage during plating. Ideally, the color of good copper plate is a 'salmon pink'

Copper Plating Troubleshooting

Problem	Cause	Remedy
No deposit	No current (or gassing from part)	Check all electrics
Pitted Plate and Orange Peel effect	Impurities in solution	Plate a dummy for 30 mins. If no improvement, filter solution through activated charcoal placed into a coffee filter, then replace the Brighteners (You will have to order new brighteners)
Rough Plate	1. Amps too high 2. suspended particles in solution 3. pH too high or low	1. Reduce current 2. 2. Filter solution through a coffee filter (No charcoal) 3. Dump solution and make a new batch Check anode bags are not torn etc.
Dark deposits (esp. on low spots)	Zinc, lead etc. in solution	Plate a dummy for 30 minutes.
'Burnt' Plate	Too much current	Reduce current, check solution temperature and reduce if needed.
Cloudy depisits on the plate	1. Poor cleaning/rinsing 2. Organic contamination 3. High temperature 4. Low agitation	1. Improve cleaning/rinsing 2. Filter solution through activated charcoal placed into a coffee filter, then replace the Brighteners (You will have to order new brighteners) 3. Adjust temperature 4. Improve air agitation
Dull plate	1. Too much amperage 2. Part not buffed enough	1. Reduce amperage 2. Buff and re polish
Plate Peels or Blisters off	1. Current too great 2. Surface too hot when buffed 3. Poor surface preparation 4. Plated onto steel	1. Reduce amperage 2. Reduce pressure on Buffing wheel 3. Improve technique 4. Prime steel with nickel before copper plating
Plate peels or blisters off when applied to nickel base	1. Nickel has ozidized 2. Insufficient cleaning 3. Too much power whilst plating	1. Prior to plating swab nickel base with battery acid, then rinse. 2. Reappraise cleaning methods – use Soft Scrub etc 3. Reduce amperage.

Plating Plastics & Non Conductive Materials

Plastic, being a non-conductor, has to be made conductive for a plate to adhere to its surface. The process used to do this commercially is too complex for a 'one off' scenario, so we have included several different techniques here.

CONDUCTIVE POWDER

Mix a small quantity of CONDUCTIVE POWDER with some ACETONE and swill it around to wash the powder. This removes the protective additive.

Pour away the liquid and spread out the powder to dry out thoroughly.

1 level spoonful of any suitable plastic adhesive, with 2 spoonfuls of fresh ACETONE or M.E.K. Add 1 level spoonful of cleaned CONDUCTIVE POWDER. Mix thoroughly. The adhesive should be compatible with the type of plastic. Many plumbing pipe adhesives are suitable, such as PVC or ABS plastic adhesives. You may also use this technique with any clear lacquer, epoxy or varnish, providing your use a compatible solvent and keep the ratios of binder (epoxy/adhesive etc.) to powder to solvent. 1:1:2

Connect wires to the part to be plated, in order to conduct electricity to the part for plating. It is important that you do this PRIOR to coating, to enable the coating to make contact with the wire.

Using a fine brush, brush this thinly onto the surface of the plastic.

Dust the surface with CONDUCTIVE POWDER and allow to thoroughly dry.

Wash the part in warm water to remove any excess powder.

An alternative method is to use the same mix, but apply a couple of thin coats with a small spray gun/air brush, allowing it to dry between coats. There is usually no need to dust the article with Conductive Powder after spraying.

Some plastics can be softened when they are immersed in a solvent such as lacquer thinner, acetone or MEK. This presents another simple way of applying a conductive surface to the part. Wait until the surface of the plastic has e sufficiently softened, so that it is slightly tacky to the touch. Using a pepper pot, sprinkle the copper dust over the part until it is completely covered, and then set aside to allow the solvent to dry out of the plastic. The powder will be glued to the soft plastic surface sufficiently enough to make the part conductive.

Make sure that you pre-wash the powder in the same solvent to remove the preservative, then lay it on some paper to dry. The powder will be clumped together, but this can easily be broken up using a fork.

Another technique, involving coating the part with CASWELL SEALER (a nitrocelloluse lacquer) and then spraying with copper powder and thinners, is outlined in the Bronzing Baby Shoe section of this manual.

CONDUCTIVE SPRAY PAINT Fast Drying - Lacquer based

For use on fragile non-conductive materials prior to copper plating.

Instructions

Attach a copper wire to the item, to conduct the electric current. Shake the canister vigorously for at least two minutes. Pour the liquid into the spray gun (air brush etc) and check for copper sediment in the original container and if present, remix the solution until all copper sediment is suspended in the solution. You may add up to 5% acetone or lacquer thinner to aid spraying with an air-brush.

Spray a light mist coat onto the part, and allow to dry for at least 5 minutes (@ 68 f min).

Spray a second heavier coat, at about 12" from the object, ensuring you spray up to and over the copper plating wire. Allow to dry for at least 15 minutes.

Clean painted surface with a mild abrasive cleaner such as 'Soft Scrub'. This will remove a small amount of the resin in the paint film, exposing more of the conductive powder.

CONDUCTIVE SPRAY PAINT

Specifically formulated to be used in an air brush or spray gun onto leather, wax sculptures, glass, molded clay, ceramics, leaves, baby shoes, gifts and difficult to plate metals such as pot metal.

To improve plating capability, you may also dip in Caswell "Tin Plate" solution for 1 minute, then rinse in fresh water.

Plate the part @ 1 volt for approx 30 minutes, then increase to 1.5 - 2 volts for whatever time you require. Parts will plate @ approx. 1/1000" per hour.

Once plated with copper you may polish lightly, then nickel and/or gold plate.

CONDUCTIVE BRUSHING & DIPPING PAINT

Water based - no fumes -environmentally friendly. For use on fragile non-conductive materials prior to copper plating, such as: leather, glass, molded clay, ceramics, leaves, roses, insects, baby shoes, wooden objects, gifts and difficult to plate items with fine details

Attach a copper wire to the item, to conduct the electric current. Shake the container vigorously for at least two minutes.

Dipping.

Dip the object to be plated into the paint and then shake gently to remove excess moisture. Hang upside down to drip dry. If the coating appears heavy or 'lumpy', use a fine soft paint brush to even out the film.

After about 5 minutes, check to see if any drips have formed on the bottom of the object and gently remove them with a soft paint brush. Allow to dry for at least 2 hours.

Apply a second coat using the same technique, then leave to dry for at least 8 hours prior to plating

Brush Application

Using a fine, soft paint brush, apply a thin coating with smooth strokes. Hang to dry for at least 12 hours.

A second application should not be necessary. To improve plating capability, you may also dip in Caswell "Tinning" solution for 1 minute, then rinse in fresh water. If any areas do not change color in the 'Tinning' solution, then re apply the conductive paint to those areas with a soft, fine paint brush.

Plate the part @ 1 volt for approx 30 minutes, then increase to 1.5 - 2 volts for whatever time you require. Parts will plate @ approx. 1/1000" per hour. Once plated with copper you may polish lightly, then nickel and gold plate.

System does not exceed maximum VOC 350g/l VOS 2.9 pounds per gal

SILVER NITRATE TECHNIQUE

The following technique is useful when fine detail of the original is required. Items such as leaves, insects, cloth, intricate moldings, as well as larger items may be treated this way.

The part must be capable of being 'wetted' evenly as this is an immersion process. Some items may need to be dried out first, such as plants. Place them in a jar with silica gel, or potassium carbonate for several days.

Make up a solution of:-

- 1/4 oz Silver Nitrate - available at photography supply stores.
- 5 oz rubbing alcohol - available at drug stores
- 5 fl oz distilled water

Brush, spray or dip the part in the solution, and allow it to dry. The silver nitrate now needs to be converted to silver sulfide to make it a conductive surface.

Place about 2 fluid oz of Caswell Bronzer solution into a glass vessel. .

Hang the part on a thread into the container.

In a well ventilated area, pour 1 fluid oz of battery acid solution into the Bronzer solution.

Immediately cover the container. Obnoxious fumes are emitted.

The fumes will then convert the coating to a conductive surface.. After 5 minutes, remove the item and proceed to plating with copper.

BRONZING BABY SHOES

BABY SHOES - Replace laces if worn. Wash the shoe and laces separately in detergent and allow to dry. Tie the laces, and allow them to fall naturally Glue them into position using a hot melt glue gun. Glue the tongue into position. Cut off any frayed stitching etc.
To aid in sinking the shoe, you may pour some plaster-of-paris into the toe. This will also help the shoe keep its shape. Allow to thoroughly dry. Affix plating wires to the shoe. You could put a couple of wood screws in the sole and heel of the shoe and also use the shoelace holes. The more wires the better conductivity you'll get.

Immerse the shoe into the mixed CASWELL SEALER for 30 minutes, stirring occasionally to remove any entrapped air bubbles in the toe area. CASWELL SEALER comes in concentrated form. 1 quart of sealer must be mixed with 2 quarts of LACQUER THINNERS (not supplied) before use. Make a shoe rack by hammering several 4" nails into a small plank of wood. Invert the shoe over the nail and allow it to drain and thoroughly dry for about 4-8 hours.

Dip the part into CASWELL SEALER momentarily, and allow to dry, then repeat. Mix a 4oz bottle of CASWELL CONDUCTIVE POWDER into a quart of LACQUER THINNERS. Thoroughly stir. Contents will settle so make sure you thoroughly stir each time you use this material. Do NOT add any SEALER to this mix. Spray CONDUCTIVE POWDER mix all over the shoe, avoiding runs, to provide an even coverage. The coating should extend into the shoe as far as possible. Allow to dry. Make sure the wires are well coated; otherwise you will not conduct power to the surface of the shoe.

To aid the plating procedure, you may dip the object to be plated in CASWELL TINNING SOLUTION. This coats the entire part with a thin layer of tin, which aids in even plating coverage. The part should be dipped into the solution for approx. 30 seconds, then rinsed in fresh water. This procedure is optional. Use only if you are experiencing difficulties in obtaining even coverage of the copper plate. Suspend the shoe from the tank bar, which should already be wired to the power unit, and immerse in the copper plating tank. The shoe should immediately start plating. The average baby shoes will measure approximately 25-30 square inches so should be plated at the rate of (1amp per 20 sq ") 2-3 amps.

Plate for approximately 1 hour. Remove and inspect. Sand/emery any rough spots. Continue plating for about 3-5 hours, checking periodically for any rough spots, which should be sanded smooth. Smooth cloths and leather will have different appearances. Rinse the part off, then polish lightly and then proceed to the section in this book, ANTIQUE AND BLACKENING TECHNIQUES, for a choice of antiquing finishes, or plate with nickel and/or gold.

If plating with nickel, gold or silver, then the part needs to be polished to a high shine, to give best effect. Brush the shoe with steel wool or a soft buffing wheel and compound to remove the antiquing oxides and expose the copper on the high spots. Finally dip into CASWELL SEALER and rack to dry.

PLATING GLASS TABLEWARE

GOLD & & SILVERING GLASS

GOLD & SILVER PLATING

A typical example of plating on glass is the gilding or silvering of drinking glasses. The following technique should only be considered for better quality glassware.

1. Firstly an enamel of lead borate is prepared as follows:-
2. Dissolve a small quantity of LEAD ACETATE into a quantity of hot distilled water.
3. Dissolve and equal amount of SODIUM TETRABORATE in to a quantity of hot distilled water.
4. Mix the two solutions together. As they are mixed, a white precipitate will form immediately. Filter this through a coffee filter to remove the water and then dry the white precipitate. Heat this in a small crucible, until it melts, then pour it into cold water to granulate it.
5. Dry the granules and then pulverize them. This is LEAD BORATE
6. Depending on which metal you wish to plate, either add 2 parts of SILVER or GOLD dust to one part of the LEAD BORATE (Copper dust could be used, but please bear in mind that the copper color could be seen in the underside of the glass)
7. Add a small quantity of OIL of LAVENDER, enough to make the mix thick enough to handle nicely on a fine paintbrush.

Applying the coating

Apply a heavy coat of the enamel, and allow to dry for a day.

Small designs and the rims of drinking glasses can be fired over the flame of a hand torch if done carefully. The part must be brought to a dull heat, at which point the enamel fuses. Allow the object to cool very slowly to avoid cracking.

Scratch brush the surface slightly and dip in a cyanide solution. Continue to plate with whichever metal you require. Brush plating techniques will work well here.

SILVERING GLASS

To silver glass, you need to make up TWO solutions:

1. Bring one pint of distilled water to a boil and add 25 grains each of SILVER NITRATE and POTASSIUM SODIUM TARTRATE.
2. Allow to boil for 5 minutes, then cool, and add enough distilled water to make up for the evaporation loss.
3. Dissolve 32 grains of SILVER NITRATE in 4 oz of distilled water. Add AMMONIIA, drop by drop, stirring slowly The solution will become cloudy, then clear.
4. Add 32 grains of SILVER NITRATE and 12 oz of distilled water, then filter through a coffee filter.

All this work must be carried out using DISTILLED WATER and in glassware. Store the solution in DARK bottles, where it will keep indefinitely.

To make the silvering solution, mix equal parts of these two solutions together.

The glass must be scrupulously clean. A good cleaning technique is to clean the surface with 'SOFT SCRUB', which is a kitchen work surface cleaner with fine abrasive in it. (Or any similar product that does not scratch glass)

Swab with nitric acid, rinse with fresh water, then rinse with distilled water.

Pour the silvering solution over the wettened surface.

CLEANING SILVER

To clean silver, place a sheet of aluminum (kitchen foil is ok) into a shallow tray and fill with warm water.

Add 2-4 tablespoons of BAKING SODA (sodium Bicarbonate) and stir in to dissolve.

Place the tarnished silver article into the tray, so it is lying on and touching the aluminum.

The black sulfide will be reformed into silver in a matter of seconds.

Rinse off the part, dry thoroughly, and polish with Collinite Wax.

Chrome Plating

Chrome plating has, until now, been one of those mystical arts that is followed around by all sorts of tales, regarding the difficulties of doing the job, yet in fact, the process is no more difficult than any other plating procedure. The most common 'tale of woe' is that of safety and disposal of the chemicals, and we will address both of those topics now.

In all kits containing chrome, we have provided a commercial chemical safety blanket and fume control balls, to virtually eliminate fumes from the plating tank. Providing you wear gloves, have adequate ventilation (a backup fume hood or respirator), and practice good housekeeping, you will have no problems.

To check that the tank is not emitting fumes during its operation, simply hold a sheet of white paper horizontally about 6" from the surface., for about 30 seconds. On removal, the sheet should be clean, with no brown stains. Iit is stained, add more Mist Suppressant.

Read the MSDS at the back of this manual.

We are dealing with very small quantities of chemical compared to the plating shops, so the problems of disposal are almost non-existent. The chromic acid has such a large amount of real chrome in it, that it usually takes several years for most of our customers to use it up, so, it is infrequently disposed of. We now have a new 'chrome disposal kit' which you add to your old chrome to 'neutralize it', after which you can flush it down a drain.
Providing you follow the instructions explicitly, we believe any danger in the usage of these chemicals will be minimized and much satisfaction will be derived from your efforts.

Safety First
During chrome plating, the vigorous bubbling action around the work-piece can send large quantities of pure chromic acid mist into the air unless proper procedures are taken. This mist is dangerous, carcinogenic and very unpleasant to breathe in, so certain measures MUST be taken before starting to plate. All of our chrome plating systems are supplied with Chrome Mist Suppressant, a chemical foam which is poured into the chrome tank. This, along with the mist control balls, makes a 'blanket' over the chrome, preventing most of the fumes/mist from escaping. See the section on safety procedures for more details. Read the MSDS at the back of this manual.

If you inadvertently get a quantity of the acid on your skin, (chromic acid will stain your skin a 'nicotine' yellow), carry out the procedure outlined in the material safety data sheet. To remove the stain, gently rub the affected part with a bleaching scouring powder like VIM or COMET. This will also remove some stains on work surfaces etc.

Always- always - wear gloves, an apron, respirator and goggles when handling chromic acid.

Chrome plating uses much more power than all other forms of plating, so consideration has to be given for a source of power adequate to bring the plating tank up to the 'operating window' requirements. Usually smaller items are easily plated from a car battery, (up to 50 square inches in surface area) but larger items, say up to 200 square inches, require planning and organizing of the power source. See the section on Power Requirements.

Most people fail to get a good chrome plate simply because they fail to appreciate the HUGE difference in power requirements from all other forms of plating. The chrome tank is also deceptive to watch, as it bubbles much more vigorously than the other tanks, so it appears that everything is working well, yet no plate appears. Operators simply need to turn up the power to get the tank into the 'operating window'!

There are two type of Chrome Plating:
1. Decorative Chromium Plating

2. Hard Chrome Plating
The application for each procedure is different. Decorative chrome is usually applied in a very thin layer, over a nickel plate, taking only 2-4 minutes to plate, and Hard chrome is applied straight to the base metal at the rate of .75 to 1.2 mil per hour of plating. We can use the same chemical and tank for these different procedures, but have to alter the concentration by evaporating or adding water, this will be explained later in this section.

1. Decorative Chromium Plating can be likened to a 'clear coat' on a paint job. It is a very thin layer of a bluish hue metal, which is applied over a nickel plate, the nickel plate being 'the paint job'. Chromium has very poor corrosion resistance as, if applied on its own, it is very porous. It has a cracked, porous appearance when examined under a microscope. Nickel, on the other hand, is very corrosion resistant, but it tends to slowly lose its shine unless polished occasionally. By applying chrome over nickel, we obtain the best of both worlds, high corrosion resistance and longevity of shine. To distinguish nickel from chrome you should look for the yellowish/gold hue of nickel and the bluish tint of chrome.

Decorative Chromium is applied in an extremely thin layer over nickel, approximately 1/100th the thickness of a hair, or 0.000001". This procedure takes only 2-4 minutes, unlike most other plating techniques, but there are several real differences in the application, such as the high current and accurate temperature requirement.

2. Hard Chrome Plating is applied to certain surfaces requiring a very tough wear resistant coating, such as hydraulic cylinders on earth moving equipment, where dust and debris can scratch untreated steel rams, causing the seals to leak.

Worn shafts of all sizes can be rebuilt successfully using this technique.
It is possible to build up from 0.09" to 1/8" by hard chroming then regrinding to the correct diameter. Because the chrome is so hard, it cannot be turned to size, but must be finished on a lathe equipped with a tool post grinder or on a center-less grinding machine.

Suitable applications are: water pump shafts, crankshafts, kingpins, tie rod ends, valves, tappets, camshafts, axle shafts, master cylinder insides, piston pins, saw blade teeth, drill bits, etc. Parts which have been finished by hard chroming, will be superior to the original because they will have better wear and lower friction properties.

When used as a bearing surface, chrome must be micro finished and will then provide a coefficient of friction lower than any other metal when used against steel, iron, brass, bronze, Babbitt or aluminum alloys. Do not use chrome against chrome. Because chrome is much harder than case hardened steel, you now have the perfect set-up for long wearing working surfaces.

Consideration needs to be given to mating surfaces, e.g. on camshafts only the journals should be rebuilt, not the lobes. If the chrome were to be in contact with the hard steel of the tappet, it would probably score it.

Most metals can be hard chromed, e.g.:- steel, stainless, bronze, brass.

NB. High stress load items such as crankshafts need to be baked in an ordinary oven for 3 hrs. @ 375 deg F to remove any hydrogen formed during plating. This will otherwise cause 'hydrogen embrittlement'. See the section on Hydrogen Embrittlement.

Plating the Dummy

Make up a piece of sheet metal, approx 5" x 5" and corrugate it in 1" sections. Punch a hole in one corner to enable you to hang this in the plating tank.
Prior to any chrome plating operation, set this 'dummy' in the tank and plate it for 15 minutes at 60 amps. (If you have a smaller setup, reduce the size of the dummy and the amperage.) This will warm up the tank, and remove any impurities from the solution.
Regular use of the dummy, prior to chrome plating will ensure quality work. You may re use the dummy.

Making up the NEW Decorative Chrome Solution

We have made a major improvement to our DECORATIVE CHROME PLATING system. This new formula has a much wider operating range than the previous system, making the system more tolerant of temperature and amperage.

The NEW DECORATIVE CHROME PLATING system is not suitable for HARD CHROME applications. You must use the original Hard Chrome formula to do this job – see below for instructions.

The DECORATIVE CHROME PLATING system comes with a 24 oz pack of chrome crystals and an 8 oz bottle of CHROME PLATING CATALYST. This catalyst contains everything needed to run the system, including the EPA compliant MIST SUPPRESSOR, sulfuric acid and catalyst. You only need to add 1 gal of distilled water to the Chrome Crystals and the catalyst.

For the NEW Decorative Chrome Plate
Add 1 US gal of DISTILLED water to the tank**.**
Add 1 x 8 oz bottle of CHROME PLATING CATALYST
Add 1 24oz can of DECORATIVE CHROME CRYSTALS

****

The following instructions show how to convert a hard chrome plating solution into the older version of decorative chrome solution. This older system has a more narrow operating range than our new decorative chrome system, and is no longer recommended.

Make up the tank initially for hard chrome and mark the liquid level, which uses the more concentrated solution., then add more water to dilute the solution for decorative chrome, and mark the new level. Most people will be using decorative chrome, but if hard chrome is required, simply evaporate off the water until the water level reaches the hard chrome mark. You can move from one method to another by adding or taking away water.

TO MAKE one gallon of OLD FORMULA DECORATIVE CHROME SOLUTION.

Mark the existing Hard Chrome Water line with an indelible marker. You will need this point later.

(If you are making up larger quantities than a 1gallon system, multiply the figures below proportionally.)

Add another 2 .5 pints of DISTILLED WATER for every can of Chrome Crystals you previously added

In the case of our 4 gal kit example, you would therefore need to add 4 x 2.5 pints (10 pints) of DISTILLED WATER. (Do not add any extra battery acid or chrome crystals)

Finally, add the Chrome Mist Suppressant and the Fume Control Balls. Your tank is now ready for use.

Mark the liquid level on the tank with a permanent marker - 'DECORATIVE CHROME LINE'
From time to time, the solution should be topped up to this line with distilled water, to compensate for evaporation loss. Store in a lidded container in a locked cupboard.

To evaporate the water off, add a number of heaters to the tank and set their thermostats on high. This should take 2 - 4 hours to evaporate.

The system will operate at the setting for the new decorative chrome plating solution.

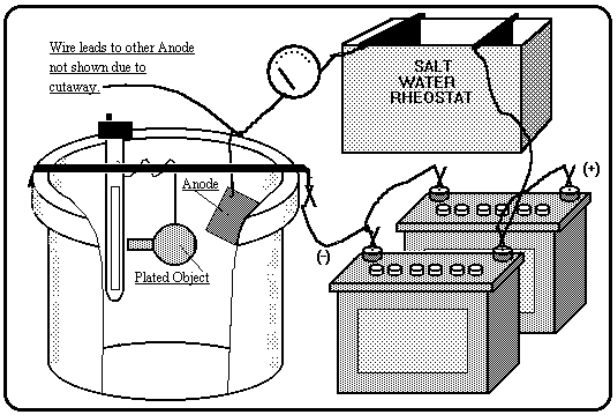
****

Operating The NEW Decorative Chrome System.

Before you start to use this system, make sure you have adequate ventilation, and a fume control system in place.

The operating parameters of decorative chrome are much more restrictive than any other type of plating. We suggest that you do some trials using clean copper tubing to gain some experience. The difference in the color of the copper and the chrome finish makes it easy to ascertain if you have been successful.

TANK TYPE	Plating
SOLUTION TEMP RANGE (Deg F)	105- 115
AIR AGITATION	NO
PLATING TIME (Minutes)	1-3
ANODE	12" x 12" GP Plate
ANODE BANDAGE	NO
VOLTS ON VOLTMETER	3-12
AMPS REQUIRED PER SQ INCH	1.0 – 1.5
FUME HOOD	YES
USE AS STRIKE COAT	NO



The main factors to consider are temperature and amperage. Usually, if these are correct, then the part will plate almost instantly. If no plate has occurred within 2 minutes, re-appraise the situation and make adjustments. Chrome plating consumes HUGE amounts of current compared with all other types of plating. Your setup will require thicker wires to cope with this extra current. Usually jumper cables will accommodate most setups. If any wires get hot, then increase their size. The use of an ammeter to monitor amperage is highly recommended. This should be placed between the rheostat and the anodes –see diagram above.

A 25 amp rectifier will plate approx 15- 20 square inches of decorative chrome. This will replace the two batteries, the salt-water rheostat and the ammeter in the above diagram. Any items larger than that will require a larger power source. The most economic way of doing this for plating occasional items is to use one or two large 12 volt batteries, and control them with a salt water rheostat.

Chrome has poor throwing power, so don't place a small object into a large tank, without placing it close to the anodes. If needs be, reshape the anode around the part. (See Hard Chroming instructions for ideas on anode placement). You may only decorative chrome plate onto a GOOD, polished shiny nickel plate.

Each time you start up the chrome tank, plate a large piece of clean scrap metal for about 2 minutes. This 'charges' the tank and removes any impurities. With larger items, it is advisable to immerse them in hot water prior to plating. This brings their temperature up to the plating bath tank temperature, and therefore does not chill the solution, which would probably drop it to below its optimum operating range.

Chromium is deposited from the solution, not from the anodes. If you intend to plate hundreds of items, it may be advisable to take a specific gravity reading of your solution. Later, as the bath is depleted of chrome, you may add small quantities of chromic acid crystals to maintain the reading. Alternatively, as there is enough chrome to plate 200+ sq feet per gallon, you may wish to simply dispose of the solution and make up another batch, thus ensuring you have a fresh bath.

Chromic acid does not rinse well from parts. You can assist the rinsing process by using a squeeze/spray bottle filled with distilled water. Spray the water over the part and catch the runoff in your chrome distilled water tank.

Avoid getting chromic acid in your other plating tanks, as it will ruin them. If the plate is unsatisfactory, you may remove it without damaging the underlying nickel plate, by swabbing with Muriatic acid. Lightly buff the part prior to re-applying the chrome.

GENERAL HARD CHROME PLATING INSTRUCTIONS

The following instructions apply to all cases of Chrome plating with the exception of non-ferrous metals special alloys and mirror surface finishes in which cases the stripping operation should be omitted.

DO NOT STRIP NON-FERROUS METALS IN Chrome solution.

See Chart on "Rate of Deposition" and "Current Densities" following these instructions.

Before plating make sure your power is switched off and any rheostat control is turned to low.

1. Estimate the square inches of the work surface area to be plated.

2. Attach cleaned work securely to tank bar, being careful not to touch the surface to be plated.

3. Locate work in the approximate center of tank and raise or lower the liquid level adjuster so that the bottom of the work rests on the adjuster platform. Ensure solution level is approximately 1/8" above the top of the surface to be plated. Then, tighten work arm screw.

4. Set your power supply in the "STRIP" position (Anode wired to negative), and turn the power on. Adjust current to one amp. per sq. in. of surface to be plated and maintain this current value for approximately 10 seconds.

5. Reverse the wiring so that the anode is wired to the positive, or is in the "PLATE" position and increase current to one amp per sq. in. of surface to be plated. Plate work at this current for one minute. Next, increase current to 2 amps. per sq. in. of surface to be plated and maintain this current until the desired thickness of Chrome plate is attained.

IMPORTANT: All timing calculations referred to by "Rate of Deposition Chart" are based on 2 amps. per sq. in. current density and timing required for the desired deposit thickness should start when plating at 2 amp. per sq. in. current density starts.

6. After the required time interval has elapsed, reduce current density to equal 1 amp. per sq. in. and change terminals to 'reverse plate'. Allow work to remain in bath for 10 seconds and switch off the power supply.

7. Remove work and rinse it thoroughly in clean water.

DEVELOPMENT OF HARD CHROME SOLUTION

Hard CASWELL Chrome plating solution has been developed specifically for use by the metal working industry, for the purpose of extending the life of cutting tools and wear parts. The simplicity and economy of operation makes it possible for the average machinist and tool engineer to accomplish industrial CASWELL Chrome plating within the confines of his own shop and without previous plating experience or knowledge.

This is possible because:

1. CASWELL Chrome Plating solution requires no periodic chemical analysis and adjustment.

2. CASWELL Chrome plating is fast. The standard rate of deposit,(.002 in. per hr.) at a current density of 2 amps per sq. in. remains constant during the full life of the plating bath. Average plating time in most cutting tool applications is 3 minutes in which time a thickness of CASWELL Chrome plate .0001 in. is deposited.

3. Operation is simple and economical. The average cost of plating is approximately 7 mils, per square inch, per .002 in. deposit.

4. CASWELL Chrome solution operates at room temperature (65 to 90F).

In general, a 300 to 400 per cent increase in cutting tool life is not unusual with the application of CASWELL Chrome plate.

The hardness of Hard Chrome plate depends on several factors including the characteristics, finish and hardness of the base metal. The term "hard" Chrome is a misnomer since all electro deposited CASWELL Chrome is hard. The hardness of Hard Chrome plate ranges from 650 to 850 Bhn.

The hardness factor in industrial Hard Chrome plating is not as important in its practical application as some believe. In fact, the association of the term "hard" with industrial Hard Chrome plating is misleading and therefore responsible for a great amount of misconception and misapplication.

More important to the efficient performance of cutting tools and wear parts are the other properties of Hard Chrome plate, such as the low coefficient of friction, resistance to seizure, high heat and corrosion. These factors and only these factors determine the efficiency of cutting tool and wear part performance.

The hardness of the Hard Chrome deposit is incidental in this case.

As an example, a cutting tool manufacturer does not process his cutting tools to their maximum possible hardness. Instead, he lowers the hardness of the tool to obtain toughness, wearing ability and resiliency and to reduce the brittleness of the tool, a condition extremely detrimental to good tool performance. The same is true of CASWELL Chrome plate since the same principles and reasoning apply. "Hard", brittle Hard Chrome plate is not the answer to increased tool performance.

The Importance of Base Metal Finish and Preparation (Prior to Plating)

Basically, the smoother the base metal surface of the tool or wear part to receive CASWELL Chrome plate, the greater the efficiency in performance.

Since excessive friction is the prime reason for excessive tool wear and breakage, Hard Chrome plate cannot be expected to increase the efficiency of the tool or part if the cause for excessive friction has not been removed before plating.

To reduce friction and heat in the practical application of the tool or part and thus eliminate the cause of most tool failure, it is recommended that the tool or part be finished or polished to as good a base metal finish as is practical from an economical standpoint -- and in all cases, before applying Chrome plate.

CASWELL Hard Chrome plate will follow the exact surface characteristics of the base metal; thus, the smoother the base metal surface -- the better the wearing qualities of the plate. This diagram shows a comparison between smooth and rough base metal finishes and the hazards associated with plating over a rough base metal surface.

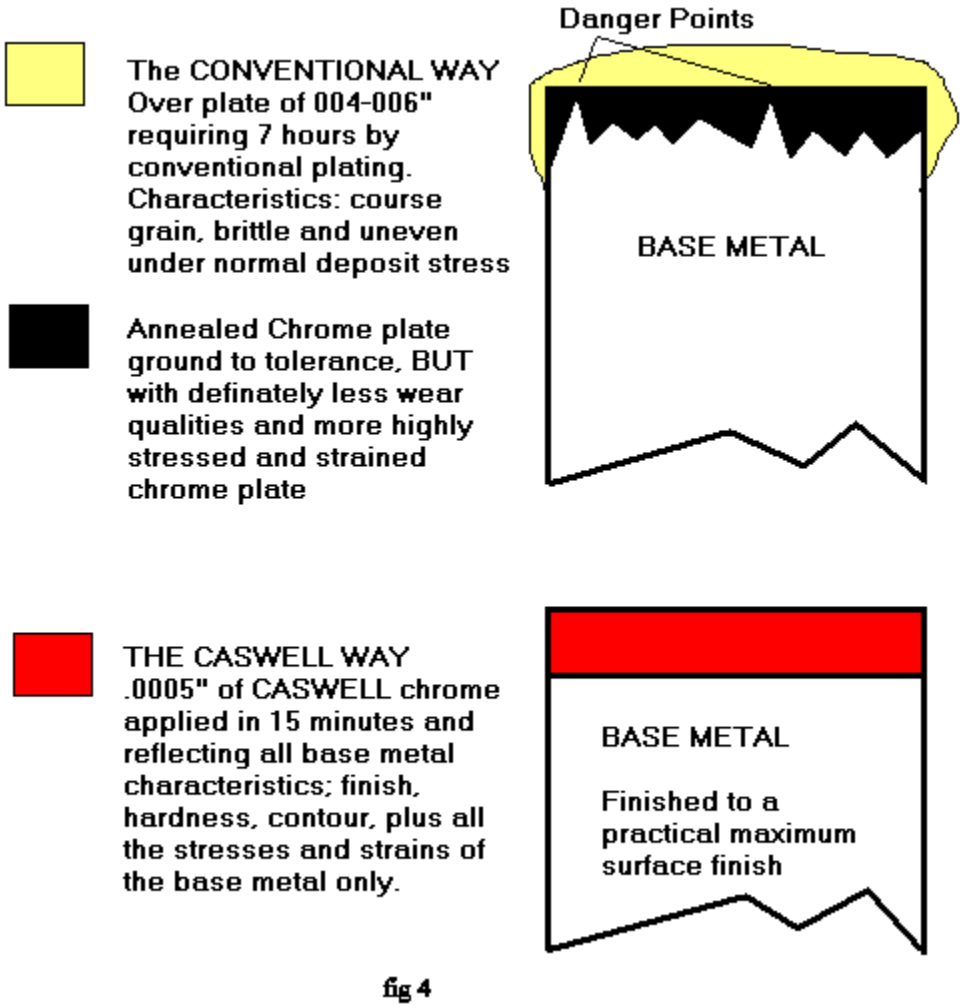


fig 4

Contrary to some thinking, a rough base metal finish does not provide a better bond between the base metal and the plate.

In effect, rough base metal surfaces can be likened to grinding marks, shown below, which set up friction and subsequently grind through the chromed surface.

Reasons for Tool Failure

For maximum tool performance,
rough grind marks should be removed
prior to plating by lapping or polishing

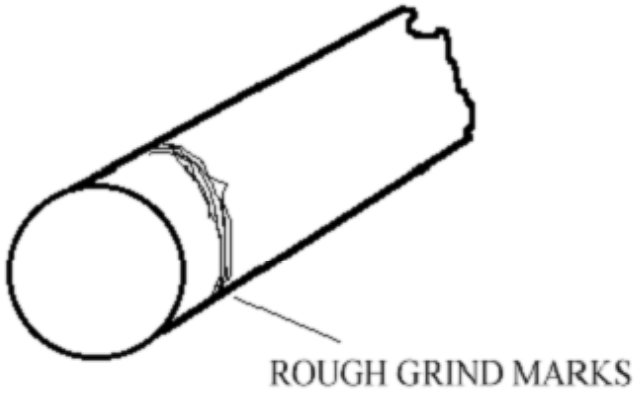


fig 5

Tool finishes normally supplied by most cutting tool manufacturers can be considered sufficient finish for the application of CASWELL Chrome plate.

The following precautions for the prevention of faulty Chrome plating should be observed:

1. Oil Impregnation.

Tools and parts which in their normal application, work in coolant oil, are subject to a certain amount of oil impregnation dependent on the type of steel used.

Depth of oil impregnation will range from .010 to .020 inches, and it is necessary that this oil be removed prior to plating.

This condition can ordinarily be rectified by immersion in carbon tetrachloride or by use of standard commercial degreasing methods. In extreme cases, however, it is recommended that the tool or part be heated to a temperature of 300 to 350 degrees F for a period of approximately two hours. The recommended cleaning and plating procedure should then be followed.

2. Highly Stressed Metals.

High stress and strains created by the natural forming and processing of any tool or part has the tendency to localize when subjected to exterior strains or forces.

In the electro-deposition of chrome, the CASWELL Chrome plate is deposited under stress. For this reason, in the plating action, the stresses and strains localize at the surface of the base metal. At times, this condition is difficult to recognize with the naked eye (in many instances not until the part has been plated). Plating will reflect and magnify base metal surface defects. These may be in the form of heat checks or fractures.

High stresses and strains are more likely found in tools and parts of the higher hardness range (50 to 60 Rockwell C). Should there be doubt as to the existence of high stress and strain in any tool, it is recommended that the tool or part be normalized or stress relieved prior to plating. In the case of heat checks, it is necessary to grind the tool or part below the checked surface of the base metal to a point where a true and unchecked base metal surface is reached.

3. Improperly Cleaned Surfaces

A. Care should be taken to eliminate the possibilities of oil or grease coming into contact with the base metal surface to be plated. Avoid excessive handling of the tool or part.

B. Plating operation should be located in plant areas relatively free from oily or corrosive atmospheres. Parts must always be clean and free of oil, dirt and grease before plating.

C. Tools and parts should be plated immediately after cleaning to prevent oxidation and air impurities from contaminating the cleaned work surface. See "Cleaning Instructions Prior to Plating"

4. Defective Surfaces

A. Oxides - Ferrous metals such as industrial steels and cast iron are subject to oxidization as a result of heat treating, grinding or other surface treatments. Manufacturers of some cutting tools and parts purposely apply commercial oxides for the purpose of protection, appearance and color.

All of these oxides must be removed prior to plating either by mechanical or alkaline chemical cleaning. In the case of the manufacturer of cutting tools it is possible to obtain tools without this surface oxide applied, the natural steel finish being more applicable to plating procedure.

After the removal of oxides the recommended plating procedure should be followed, see GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92).

B. Carbonization - Carbonization occurs as a result of chemical and/or electrical action in which the carbon in high carbon steels particularly, is attracted or drawn to the surface of the base metal. This can be recognized by a mottled or gray-black surface smudge.

Immersion of the part in certain acids or excessive reverse current (stripping) in plating solutions are the prime reasons for the formation of this surface smudge. In the CASWELL Chrome bath a ten second reverse current (or strip) is recommended to eliminate this plating hazard.

In cases where this condition is apparent the smudge must be removed by mechanical means (see "Cleaning Instructions Prior to Plating"

5. Hydrogen Impregnation - Hydrogen Embrittlement

A. Hydrogen Impregnation - Hydrogen impregnation is a term used to designate the presence of hydrogen gas, which has penetrated into the porous structure of the base metal or part.

Prior to plating hydrogen impregnation occurs only as a result of acid pickling or cleaning of the base metal tool or part. Penetration of the base metal by this gas is a direct cause of hydrogen embrittlement brought about by the sealing or locking in of the hydrogen gas by various surface finishes. Embrittlement rarely occurs in un-pickled or unplated tools or parts.

B. Hydrogen Embrittlement - Deposited CASWELL Chrome plate has the tendency to lock in or seal hydrogen gas in the grain structure of the tool or part. In all cases, it is not until this seal or CASWELL Chrome plate is applied that the formerly inert gases become active - thus causing embrittlement in the grain structure of the base metal.

Due to this action, fractures may be created either, in the base metal, and/or the CASWELL Chrome itself. The chance for hydrogen embrittlement of the base metal part or tool will increase with the deposition of heavy deposits of CASWELL Chrome plate since the greater thickness provides a tighter seal and a lesser chance for the gas to escape. This is a problem long associated with conventional Chrome plating processes.

The possibility of CASWELL Hard Chrome plate producing hydrogen embrittlement is remote. To date no evidence of hydrogen embrittlement has been found in CASWELL Chrome plated tools or parts as a direct result of the CASWELL Chrome process.

Should the unplated part or tool be hydrogen impregnated, because of acid pickling or cleaning methods, this hydrogen should be removed or driven from the base metal before plating. This is accomplished by baking the tool or part for approximately one hour at 350 degrees F. prior to plating. After baking the recommended CASWELL Chrome cleaning and plating instructions should be followed. If this precaution is not observed hydrogen embrittlement may occur.

6. Failure to Follow Recommended Plating Procedures.

Many faulty plating jobs are simply caused by failure to follow the recommended plating procedures for CASWELL Chrome plate. Due to the characteristics of the Chrome solution, it is imperative that the CASWELL Chrome plating procedure be followed explicitly. Refer to "GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92)"

CASWELL Chrome Plate Is No 'Cure-All"

Cutting tools that are chipped, heat checked or worn well below useful tolerance or otherwise damaged in general, cannot be restored by the application of light, or even heavy, Chrome deposits. In the case of wear parts, CASWELL Chrome plate is often applicable for salvage purposes, but the surface preparation of the base metal should equal the surface finish found on new tools or parts. After sufficient surface preparation, deposits of chrome plate can then be applied. Disregard for this precaution, however, will only nullify or lower the effectiveness of CASWELL Chrome plate.

Heavy versus Light Deposits of CASWELL Chrome Plate

In all cases, the lighter deposits (.0001 to .0005 in.) of CASWELL Chrome plate are recommended on cutting tools. The reason being Chrome plate, in its lighter deposit, reflects all the base metal characteristics; finish, hardness and contour and so retains all the toughness and resiliency of the base metal. As a further contribution to the efficiency of the tool or part CASWELL Chrome plate reduces friction, has high heat resistance and reduces galling and seizure tendencies.

Conversely, cutting tools with heavy deposits of CASWELL Chrome plate as well as conventional chrome plating (.002 in. or more) operate under reduced efficiency and hazards of chipping. The base metal characteristics are lost with the heavy deposits and the working surfaces of the tool takes on the undesirable characteristics of chrome itself in its coarse and brittle state. In all cases, including wear parts, the lighter deposit is more to be desired.

Another reason for the objection to heavy deposits of CASWELL Chrome in cutting tool applications is the necessity for regrinding the tools to size after plating. Besides being a costly and time consuming operation, it has been established that ground chrome plated surfaces lose a large percentage of their wear resistant qualities brought about by the regrinding of the tool.

Where tool and wear parts are not subject to extreme pressures, shock and impact, heavy deposits of Chrome plate are applicable. Applications of heavy chrome deposits however should be limited to salvage applications as in the case of plug gages, pistons, shafts and bearing surfaces.

The problems associated with heavy deposit plating are numerous and special care should be exercised in all heavy plating applications. Most common are the following:

1. Excessive build-up on sharp corners and inverted angles
2. Treeing
3. Peeling, cracking and chipping
4. Poor adhesion.

THE PRINCIPLES OF CASWELL Hard Chrome PLATING

The Theory

Each square inch of anode surface area, is the source of a given number of "lines of action" which are responsible for the deposition of CASWELL Hard Chrome plate on the surface of the tool or part to be plated. The "lines of action" can be assumed to travel in a straight line (shown here) from the anode surface to the work surface or cathode.

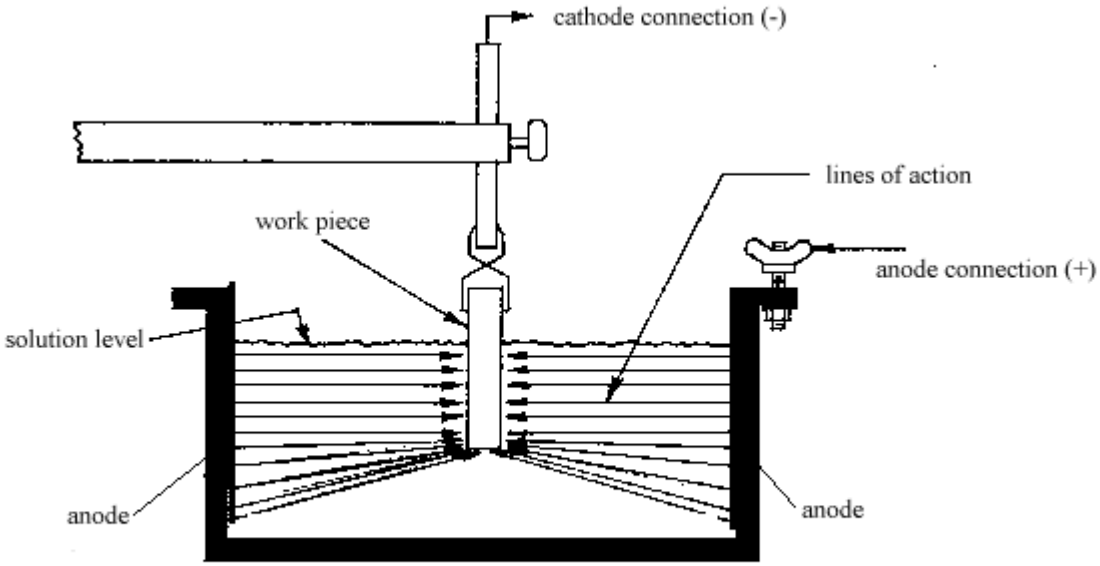


fig 7

Direction and control of the "lines of action" is necessary to the success of the plating job, as to the uniformity of deposition and the elimination of excessive build-ups. Without this control, the uncontrolled "lines of action" overlap the parallel "lines of action" thereby producing undesirable buildups as shown here.

Directional control of these "lines of action" is actually obtained by the elimination of those not needed to accomplish the plating job. This elimination is achieved by insulating the surface areas of the work from certain portions of the tank or anode surface with nonconductive and acid resistant materials as in the case of the liquid level adjuster.

Thickness of deposit is controlled by time of immersion in the plating bath at a recommended current density rate with the solution at ambient room temperature. The recommended plating current (amperage) is determined by approximating the square inch surface of the work area where plate is desired and allowing 2 amperes for each square inch of work area to be plated. See Rate of Deposition

The Liquid Level Adjuster

In order to maintain close tolerances and avoid excessive build up of CASWELL Hard Chrome plate on certain points or work areas of the piece, directional control of the ″lines of action" is required. Notice in Fig 7 (above) that the parallel (horizontal) and non-parallel "lines of action" concentrate at the lower portion of the work. This results in excessive buildup of CASWELL Hard Chrome plate at the lower end of the work as shown in Figure 8 below

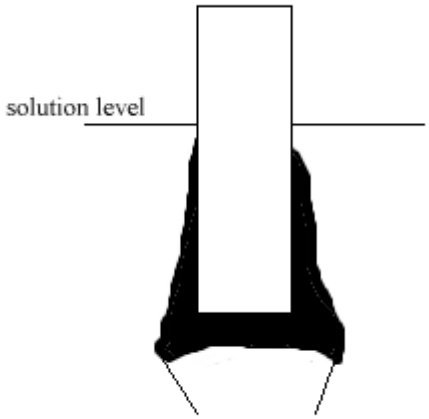


fig 8

A simple and convenient method of alleviating this condition is by the use of a device known as the Liquid Level Adjuster. A typical design is shown here. The entire device is made from Plexiglass.

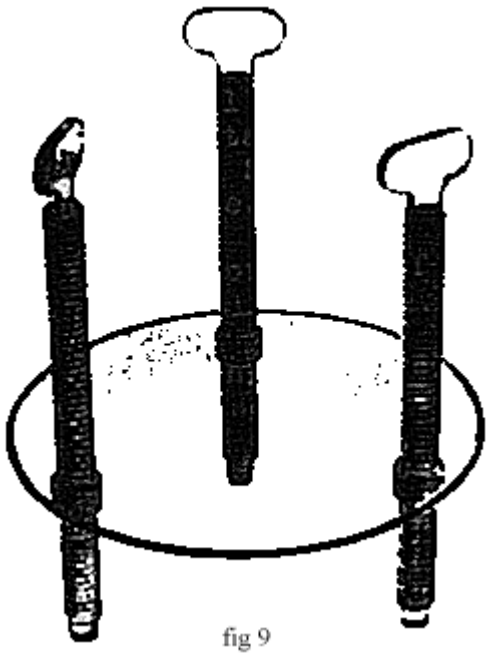


fig 9

The platform of the adjuster may be raised or lowered by means of turning the threaded plastic rods. Notice in Figure 10, that the liquid level adjuster platform has been located in correct position for this particular application. In most cases, the work piece should rest on the adjuster platform while plating.

Accordingly, the liquid level adjuster platform eliminates the undesirable (or non-parallel) "Lines of Action" without which, this directional control would produce the undesirable effects of uneven deposit and excessive build-up as shown in Figure 8.

However, by the correct positioning of the liquid level adjuster platform (see Figure 10), the desired result is obtained as illustrated in Figure 11

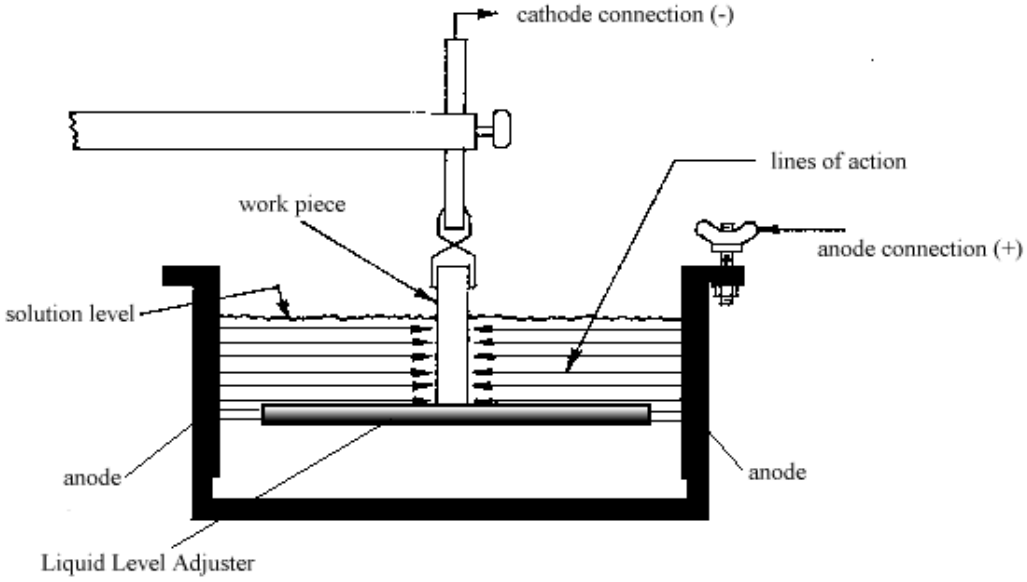


fig 10

.Parts and tools may be plated (individually) by this method to accurate dimensional tolerance. For multiple quantity plating of tools or parts to a critical dimensional tolerance. see under "Multiple Plating of Tools or Parts".

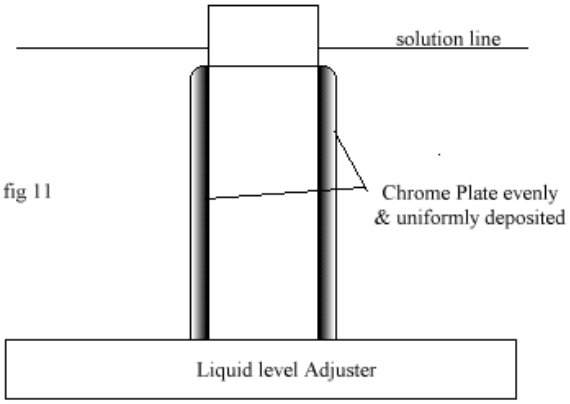


fig 11

PREPARING CASWELL HARD CHROME SOLUTION

Preparation of Solution

To make approx ¾ gal of CASWELL Hard Chrome Solution:

Add 5.5 US Pints (16 fl oz) of DISTILLED WATER to the tank.

Add 1 can of CASWELL Chrome Crystals to the water. (1kg)

Add 30 milliliters (1 fl oz. or approx 3 teaspoons of BATTERY ACID

To make up larger quantities, multiply the figure accordingly.

Therefore a 4 gallon setup would need 22 pints (4 x 5.5) DISTILLED WATER.

4 cans of CASWELL Chrome Crystals (4 x 1kg)

120 milliliters (4 fl oz or 12 teaspoons) of BATTERY ACID

Evaporation. Water loss by evaporation takes place in the mixed Caswell Hard Chrome solution as a result of contact with the atmosphere. It is recommended that solution level be checked daily and the necessary amount of water added each day to maintain the original level. Daily evaporation loss is small, but may be minimized by keeping the plating tank covered when not in use. To avoid damage to glass heaters, only raise the level when they are cold.

Contamination. Caswell Hard Chrome solution is designed to minimize the effects of contamination. Non-ferrous metals such as brass, bronze, copper and zinc., etc., if allowed to remain in the solution for long periods of time, either being stripped, or not electrically connected may cause contamination of the Caswell Hard Chrome, thereby reducing the efficiency of the solution or shortening its effective life. DO NOT STRIP NON-FERROUS METALS (Brass, copper, bronze, etc.) in Caswell Hard Chrome Solution.

See procedure for cleaning and plating non-ferrous metals.

Your Caswell Chrome setup should be located where atmosphere is free of heavy dust or oil mist. If the solution is covered with an oil film, the oil will tend to cling to the tool or part when. It is immersed into the solution and cause plating failures.

Temperature Caswell Hard Chrome solution is designed for operation at room temperature (65-90F). In cases where the room temperature drops, lowering the temperature of the Caswell Hard Chrome solution to below 65F, the solution must be brought up to plating temperature before use. For optimum results, set your tank heater thermostats to approx 80 F

In some cases of production plating where long and continuous plating operations are necessary (8 hours or more continuously), the temperature of the solution may exceed 90F, particularly when plating at maximum capacity. When the solution temperature exceeds 90F, the characteristics of the bath change with respect to rate of deposit and

chrome properties. This can be overcome by enlarging the plating tank and supplying more volume of Chrome solution.

Exhaust Requirements All Chrome plating units should be operated in well-ventilated rooms. Chromic Acid fumes are toxic. However, with the inclusion of the MIST SUPPRESSANT, you should experience NO fumes or mist when operating this system.

To periodically check for emission of fumes, hold a flat sheet of white paper about 6" above the tank for about one minute of a plating run. If the sheet is stained brown, you should shut the operation down, until you obtain more MIST SUPPRESSANT from CASWELL Inc.

Depletion of Solution

Caswell Hard Chrome solution does not require adjusting or balancing throughout its entire plating life.

CHEMICALS, OR OTHER INGREDIENTS, SHOULD NEVER BE ADDED TO CHROME in an attempt to increase the effective life or operating efficiency of the solution. Additives may greatly decrease the life and operating efficiency of the solution.

Normally, the depletion of the Caswell Hard Chrome plating solution can be recognized when a dense chrome deposit is no longer obtained and a powdery non-adherent deposit is obtained instead. When this happens, a new charge of Caswell Hard Chrome solution should be utilized. The exhausted solution should be discarded and the tank replenished with a fresh charge of Caswell Hard Chrome solution. .

Siphoning of Caswell Hard Chrome Solution

When the plating solution is depleted, it can readily be removed from the plating tank by siphoning as shown below. Flexible acid resistant plastic tubing should be used for the hose connections to the glass loop and T-shaped glass tube as well as the rubber bulb. Repeated compression of the rubber bulb starts the siphoning cycle. After emptying the tank, the rubber bulb should be washed thoroughly in water to remove the excess solution and thus prevent the bulb from deteriorating.

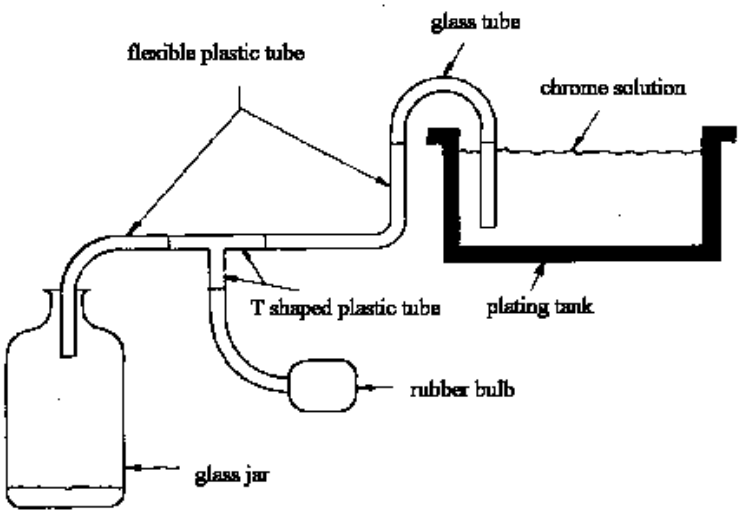
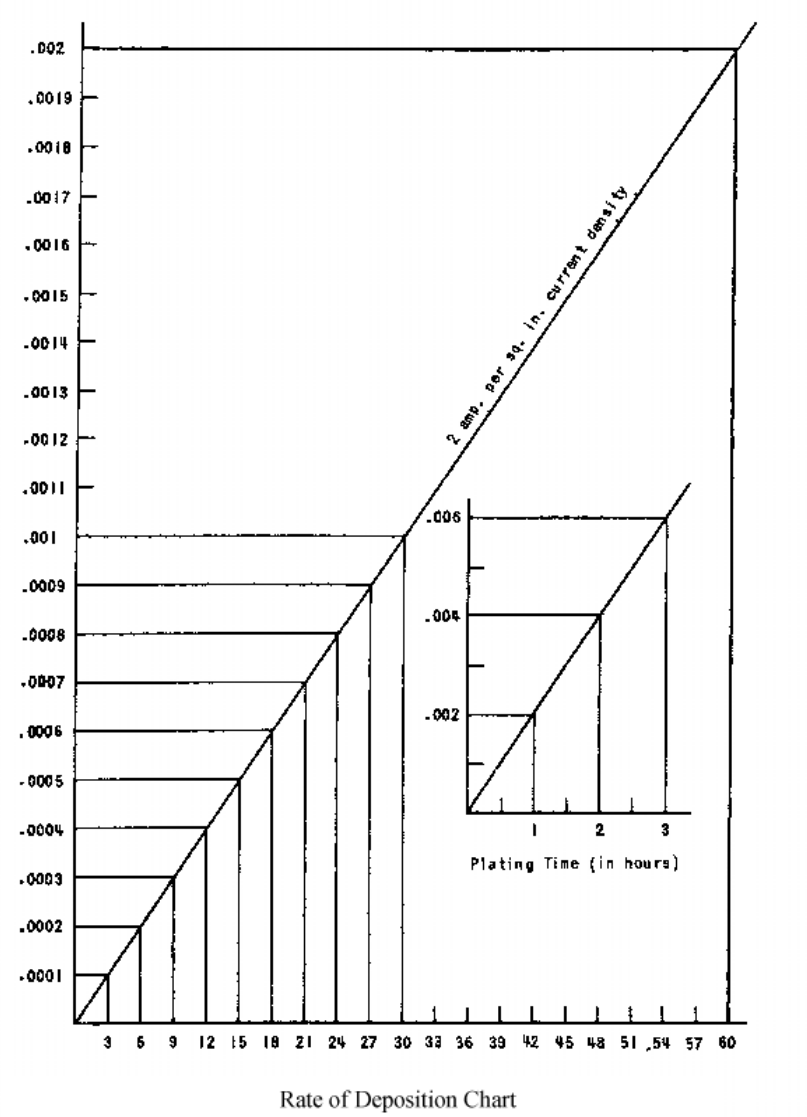


fig 6

RATE OF DEPOSITION CHART



Rate of Deposition Chart

Values given are based on the recommended current density of 2 amps per sq. in.
Solution temp 80 deg f

fig 3

The Rate of Deposition Chart illustrates the thickness of Chrome plate deposited on the surface of the base metal in any given time, based on the recommended current density of 2 amps. per sq. in. For example, should you want to increase the diameter of a plug gage by 0.001", approximately 15 minutes plating time at the standard current density of 2 amps. per sq. in. would be necessary in order to deposit .0005" on the surface of the plug gage.

In the GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92), notice that an initial plating action (after stripping) is based on a current density of 1 amp. per sq. in., and that the instructions call for this lower current density to be maintained for 1 minute, after which the current density is then increased to the higher rate of 2 amps. per sq. in.

IMPORTANT -

ALL TIMING CALCULATIONS REFERRED TO IN THE RATE OF DEPOSITION CHART ARE BASED ON THE 2 AMP PER SQ.IN.

CURRENT DENSITY AND TIMING REQUIRED FOR THE DESIRED DEPOSIT THICKNESS SHOULD START WHEN THE 2 AMP.PER SQ.IN.CURRENT DENSITY STARTS.

Current Densities

Current density is defined as the amperage (current) applied to one sq. in. of surface to be plated with your setup.

Tools and parts are always plated at the current density of 2 amps. per sq. in. As an example of how to arrive at the proper ammeter reading for tools or parts to be plated, assume a cutting tool with 5 square inches of surface to be plated. During plating, the ammeter would be set to read 10 amps. (After the initial stripping and plating procedure has been followed) the ammeter reading would remain at 10 amps until the desired deposit thickness is attained.

USE OF CONFORMING ANODES

Since each plating job represents a slightly different problem, and because of the many applications for Caswell Hard Chrome plate, no one case example can be given that will cover all plating applications. The recommended procedure for a shallow recess die for example, might be entirely different from that of a deep recessed die. For this reason the subsequent paragraphs will describe the fixtures or setups and the use of conforming anodes for several different applications as a general guide.

The plating principles of jigs or fixtures described in the following pages may be applied in the case multiple plating applications, that is, where more than one part or tool is plated at one time. See "Multiple Plating of Tools & Parts"

Shallow Recess Dies

In the treatment of the work piece, shown in Figure 18 the die rests on a sheet of lead bent to an L-shape in order to make good electrical contact and afford simplicity in jigging. At the bottom of the die the sheet lead is brought flush with the surface where plate is desired, in order to provide uniformity of plate and eliminate buildup of chrome on the lower edge, in effect increasing the surface area at the lower edge of the die. The top surface of the die is also shielded with sheet lead (flush with the face) for the same reason.

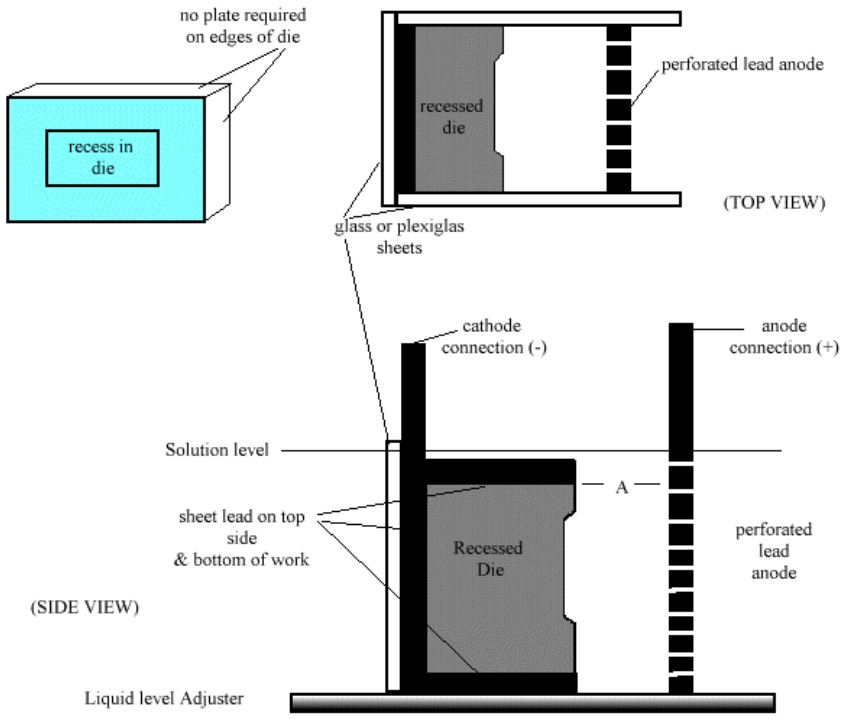


fig 18

Chromic acid resistant plastic sheets encase the rear and sides of the die to control ionization of the "lines of action". Note that the plastic sheets extend from the face of the die to the sheet lead anode or flat plating tank side, affording better "line of action" control. "A" distance of anode to work surface may be 2 to 4 inches in most cases.

The assembled jig or fixture rests on the Liquid Level Adjuster Platform and the platform is lowered into the Caswell Hard Chrome solution to a point where the solution level is 1/8th inch above the work piece.

Direct connection is made to the conforming anode from the power source.

Work should be cleaned thoroughly prior to plating as outlined "Cleaning Instructions Prior to Plating" and plated following the GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92)

In Figure 19, again the application is a shallow recessed die, but a case where gases may become trapped because of the change in the work surface contour of the die. Note the sharp corners or inverted angles present in this application: necessitating the different arrangement and positioning of this die in direct contrast to the one shown in Figure l8. Where sharp corners or inverted angles are involved in any plating application, the possibility of entrapped gases exists. See section on "Trapped Gases"

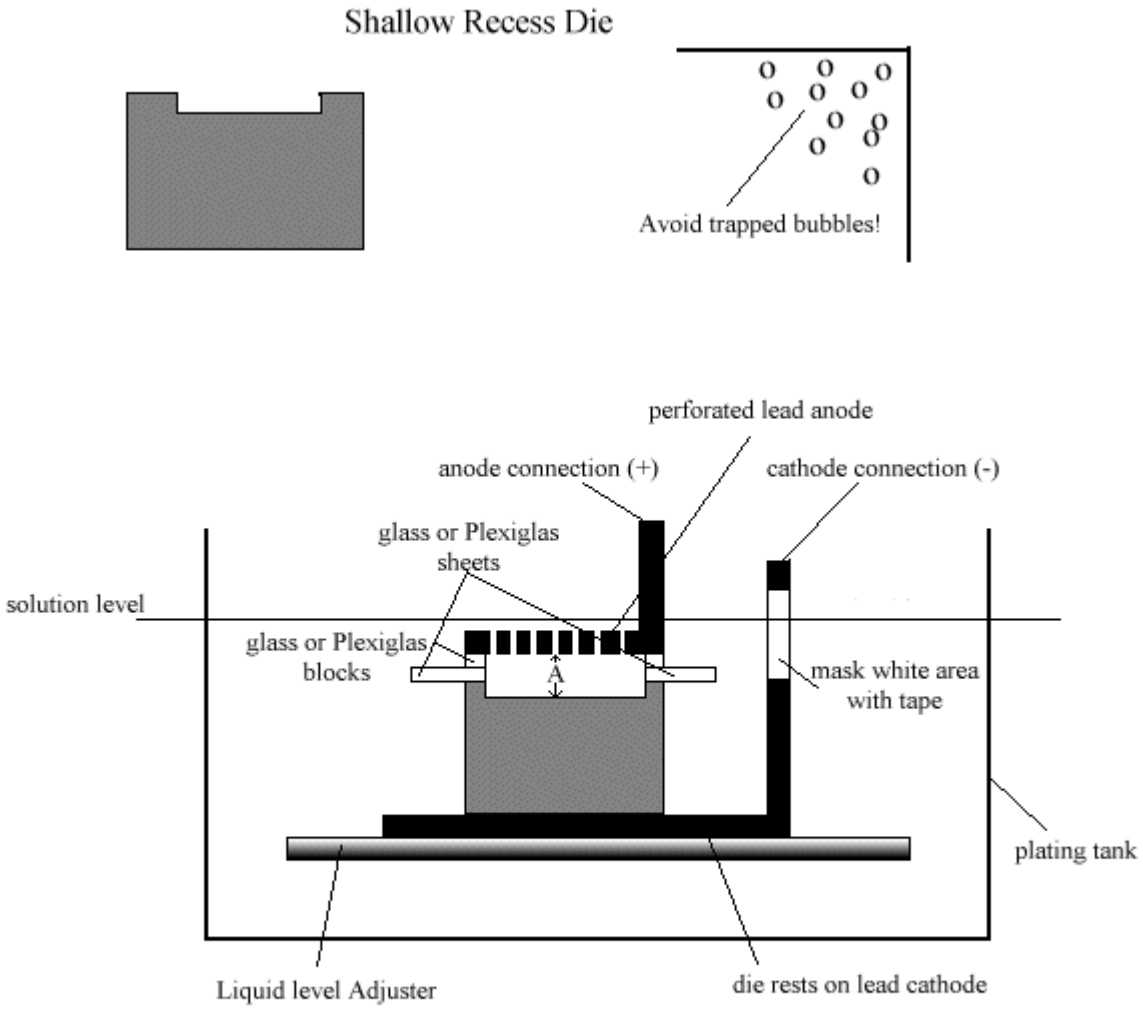


fig 19

The die in this case rests on its back with the surface to be plated facing upward thus allowing the gases formed to escape freely. Note that the conforming anode is perforated to further allow the escape of generated gases.

"A" distance of anode from cathode may be 1" in the case of small dies and 2", in the case of larger dies. Glass or acid resistant plastic blocks are used to control this distance.

The jig or fixture used in Figure 16 is again different from the previous illustration. The cathode is again a sheet of lead (on which the work rests), L-shaped to provide good electrical contact. Note that a portion of the vertical extension of the lead cathode is masked or insulated with acid resistant tape so as not to attract "lines of action" to that portion of the cathode opposite the anode.

Glass or sheets are used in this application to further control the "lines of action". In the case of a small die or work piece, Figure 16, the plastic sheet should extend approximately 4 inches beyond the edge of the work piece. On larger work or dies, the plastic sheet should extend to the walls of the plating tank, completely insulating the work piece from current action below the level of the plastic sheets.

The fixture or jig is assembled on the Liquid Level Adjuster Platform and lowered into the solution so that the solution just covers the perforated lead, conforming anode. Direct connection between power source and perforated lead anode is made. Cathode is similarly connected with cathode terminal. General cleaning and plating instructions apply.

Deep Recess Dies

A conforming anode is used in deep recessed die applications also. As shown in Figure 20, the perforated conforming anode should follow the contour of the surface to be plated and in most cases be equidistant from the work surface. "A" distance can be 1 to 2 inches in most deep recess applications.

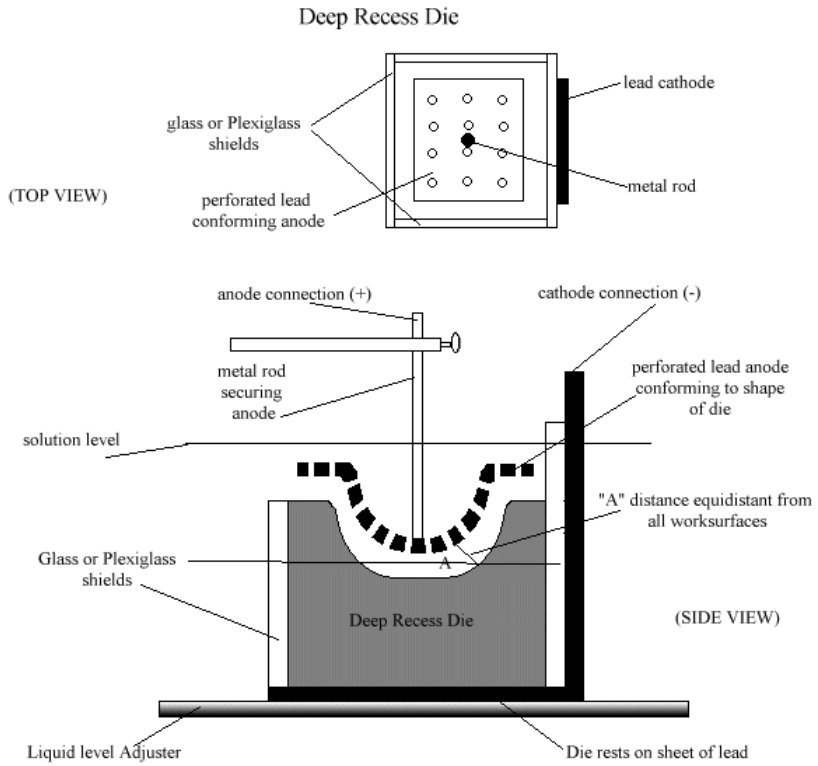


fig 20

The conforming anode in this example is required to properly distribute the "lines of action" in the deep recess of the work, eliminating the chances for un-plated areas and promote uniformity in thickness of deposit. Note that this

work piece is positioned in the plating tank with the surface to be plated facing upward (perforated anode is used), thus reducing the hazard of entrapped gases. See "Trapped Gases"

The fixture in Figure 20 is, in effect, a plastic box which is open at both ends and resting on a piece of sheet lead; U-shaped so that the die rests on the horizontal portion of the sheet lead U serving as the cathode connection. In this way the work piece makes contact by pressure of the die weight alone. The lead cathode is connected directly with the cathode terminal on the power source.

The perforated conforming anode, in Figure 20, rests on plastic blocks controlling the "A" distance of the anode from the cathode. The anode in this case, may be held in position by the use of acid resistant tape or clamps. The anode is perforated to affect the release of generated gases rising from the work piece and is connected directly to the anode terminal on the power source.

This jig or fixture for ease in handling can be assembled on a bench before being lowered into the Caswell Hard Chrome solution. The jig should rest on the Liquid Level Adjuster Platform and the solution level (as illustrated) may be 1/8th inch above the work surface. This method will produce a feathered edge around the outer edge of the surface being plated.

Note in the illustrations, the conforming anode is a greater distance from the work surface opposite the outer edge of the die to produce a featheredge. Should positive uniformity of deposit on all surfaces of the die be required (eliminating the feather edge), the anode should be equidistant from the work surface at all points and the solution level raised to cover the conforming area of the anode.

General cleaning and plating instructions apply.

CLEANING INSTRUCTIONS PRIOR TO PLATING*

Surfaces to be plated must be clean and free from rust and scale.

To clean work prior to plating, the following general procedure will be sufficient in most cases:

1. Degrease work surface thoroughly using a commercial vapor degreaser, acetone or lacquer thinner.

2. Scour all the surfaces with 'Soft Scrub Household Abrasive Cleaner' or Vim or Comet.

3. Rinse work thoroughly in clean water and plate immediately.

DO THE WATER BREAK TEST. Continuous water films are a good indication of properly cleaned surfaces. Immerse work in water and look for an even distribution of water film on the surface to be plated. Droplets or surfaces where water will not adhere will indicate an oily surface not suitable for plating.

Commercial oxides and those resulting from nitriding of tools or parts and/or other stubborn surface impurities can be most effectively removed by immersion in a solution of 25% (by vol.) muriatic acid for 15 minutes followed by a cold water rinse before plating.

Another recommended means of removing stubborn surface impurities is by use of a liquid hone (wet blast or vapor blast). Various grit sizes are used to obtain the desired finish; 100, 400 and 1200 grit are recommended for rough, medium and fine finishes, respectively. CAUTION: Care must be taken not to destroy cutting edges or fine base metal finishes by too prolonged or severe treatment. A cold water rinse should follow before plating.

Extremely fine base metal finishes found on mold cavities, draw dies, etc. requires that special cleaning procedures be followed so as not to damage the mirror-like finish. Stripping or severe etching procedures are not recommended.

In most cases these surfaces are free from stubborn surface impurities and require simply degreasing followed by immersion in SP Degreaser.

Afterwards the surface should be given a cold-water rinse.

Protecting Cleaned Surfaces

If for any reason, the already cleaned work surface cannot be plated immediately after cleaning, immersion in SP Degreaser will prevent oxidation of the cleaned surface. The work can then remain in the atmosphere up to periods of an hour or less. When ready for plating, parts should be rinsed in clean water and plated.

PLATING MILLING CUTTERS FLAT PLATES & DRILLS

PLATING DRILLS & TAPS**.** Figure 12 shows the arrangement for plating a single drill or tap. After cleaning, the drill or tap should be located in the approximate center of the tank and immersed in the solution to cover the surface to be plated.

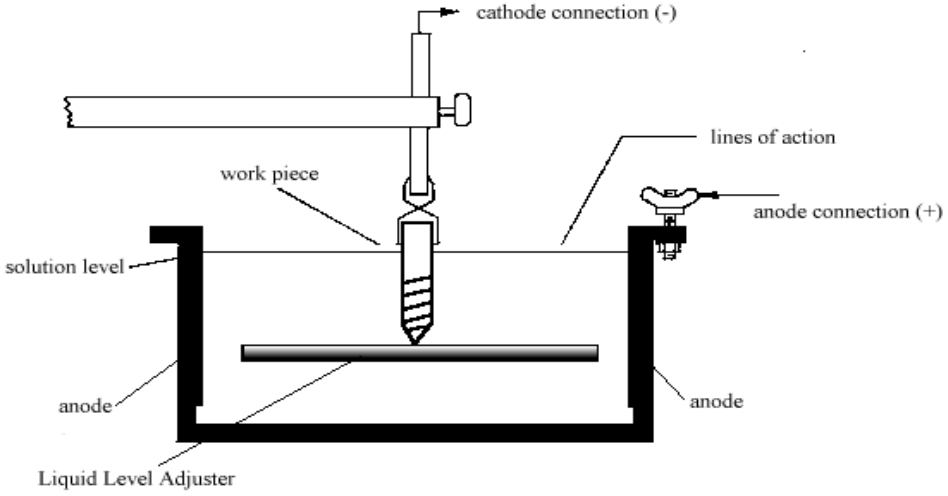


fig 12

Next, the liquid level adjuster platform should be positioned so that it just touches the point of the drill or tap. Then the GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92) should be followed.

PLATING FLAT PLATES**.** When plating thin flat plates such as small dies or parts, the set-up illustrated in Figures 13 & 14 are recommended. In this application, the sheet lead cathode is cut out and the piece to be plated is pressed tightly into the sheet of lead.

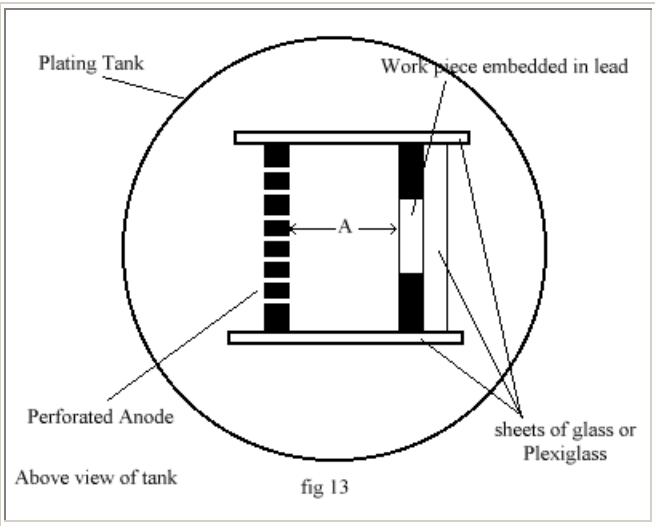


fig 13

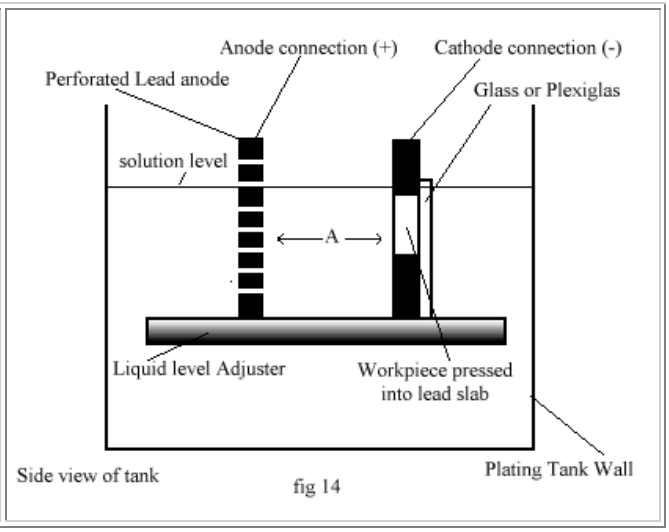


fig 14

Sheets of glass or acid resistant plastic form a fixture for positioning the lead sheets and for controlling the "lines of action". To allow circulation of solution the sheet lead anode should be perforated with holes. The "A" distance from anode to cathode should be a minimum of two inches. On larger work areas requiring higher plating amperage, the "All" distance should be increased to approximately four inches. When determining the area and plating amperage, the area of the piece plus the lead cathode surface facing the anode should be calculated rather than the area of the piece alone.

PLATING MILLING CUTTERS

The recommended method for plating milling cutters is shown in Figures 15 & 16.

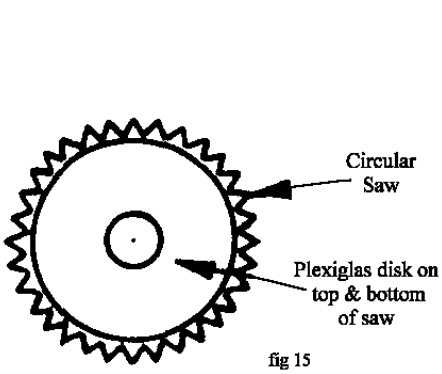


fig 15

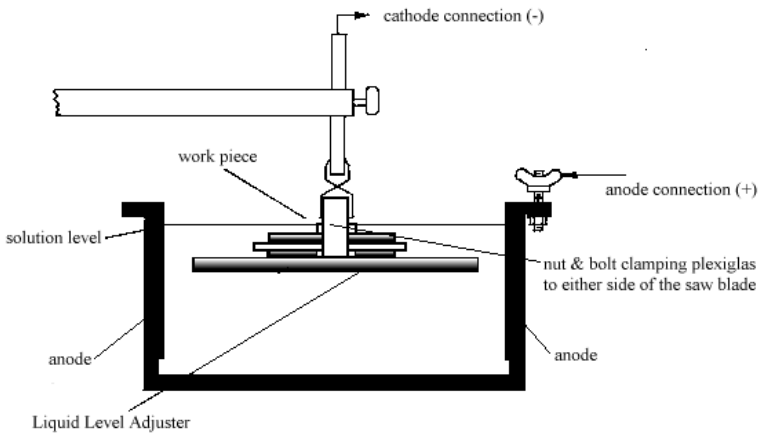


fig 16

Thin glass or acid resistant plastic discs are placed on top and bottom of the cutter in the approximate center of the plating tank. Solution level should be 1/8" from the top surface of the teeth.

Excessive plating amperage may cause the sharp teeth to become burned and may result in a non-adherent flaky deposit. To avoid this condition, the area of the surface to be plated should be determined using the following formula:

OUTSIDE DIAMETER OF CUTTER x 3.2 x THICKNESS OF TEETH, assuming the cutter O.D. measures 5" and is 1/8" thick, then the area becomes: 5 x 3.2 x 1/8 = 2 sq. in.

The plating amperage or current (based on a 2 amp. per sq. in. current density) is twice the area or 4 amperes.

HARD CHROME PLATING MULTIPLE PARTS

(Jigs and Fixtures Anode Control)

When Caswell Hard Chrome plating two or more pieces of work simultaneously in a plating unit, some scheme must be employed for:

1. Controlling the "lines of action" properly to obtain uniform deposit.
2. Securing and holding work pieces in their correct position relative to each other and the plating tank or anode.
3. Making good electrical contact between cathode fixture or jig and each piece to undergo plating.

In multiple plating as in the plating of a single work piece, GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92) should be applied.

General Recommendations

The following recommendations should be observed in all multiple plating operations:

Overloading Care should be exercised so as not to attempt to plate more square inches of surface area than that allowed by the maximum capacity of the power source. The ratio of 2 amps per square inch of TOTAL surface area must be adhered to. Inaccurate estimation of surface areas in square inches is frequently the cause of plating failures. See Ammeter settings for taps and twist drills based on pre-calculated current densities in relation to the square inch surface of various sizes. As a further guide to the calculation of surface area in square inches refer to:- Formulas for Determining Area

Good Electrical Contact. If good electrical contact is not made to each work piece in the multiple plating application, the parts making poor contact will not receive Caswell Hard Chrome plate at an equal rate of deposition and finish may be spotty or even remain unplated.

Positioning Work in Plating Tank. In multiple plating, one of two procedures may be used depending on the degree of accuracy and uniformity of plate required.

MULTIPLE PARTS PLATING TO NON CRITICAL DIMENSIONS

Where dimensional accuracy is not critical, the methods given in Figures , 23, 24, 25, 26 &27 may be applied.

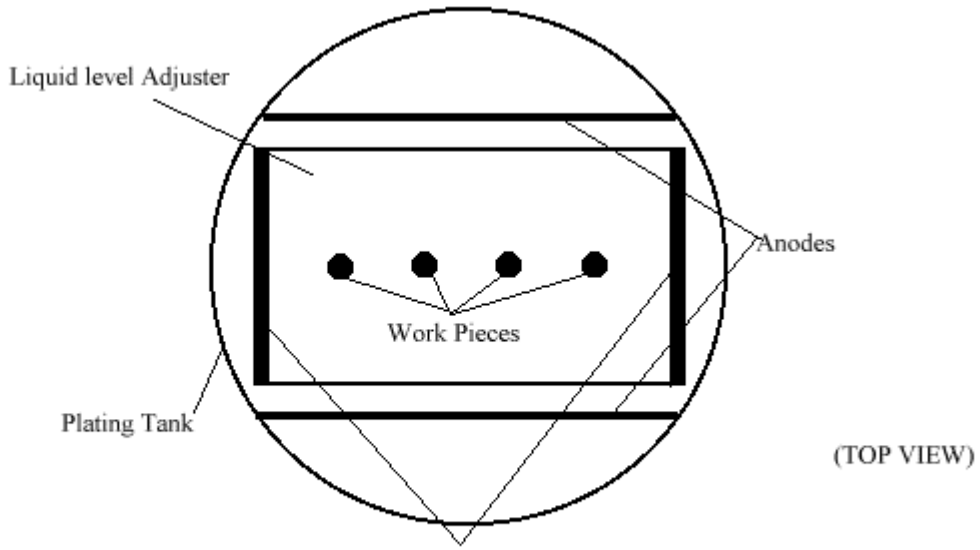


fig 21

.

In Figures 21, 22 & 23 for example, the procedure for plating a number of twist drills or similar objects is shown positioned in a straight line. Note that the Liquid Level Adjuster Platform is positioned to control the horizontal "lines of action" and that the distance between each tool or part ("A" dimension in Figs 22 & 23) should be equidistant from each other or no closer than the maximum nearness as specified in Table 3.

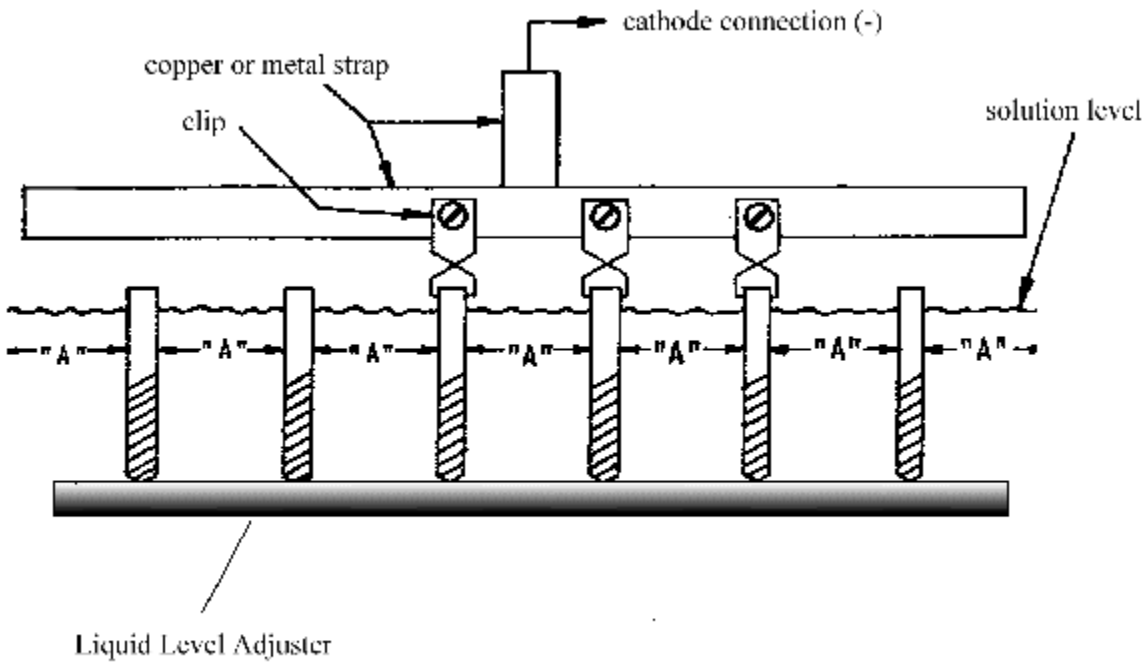


fig 22

(Side View)

TABLE 3 Recommended Spacing for Multiple Plating.

Diameter or size of work * (in inches)	"A" Dimensions (in inches)
up to 1/4	2
3/8 to 1	4
1.25 to 2	6

*NOTE In applications where the dimension of the work is over 2", follow procedure as outlined in Figures 21 and 22.

Square or Rectangular Objects

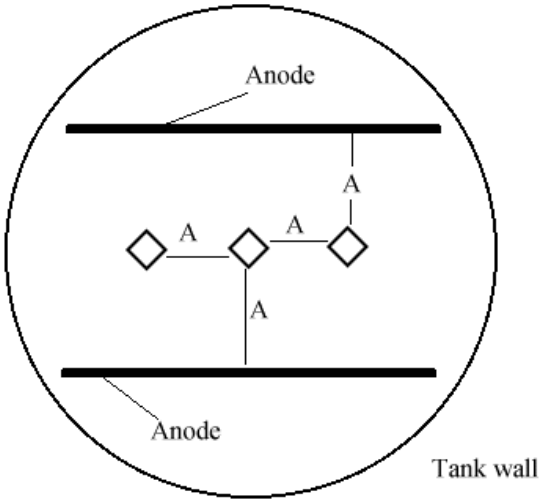


fig 23

When plating multiple objects square or rectangular in cross-section, the parts or objects should be arranged in the supporting jig or fixture so that the flat planes of the work do not face each other. See Figure 23

.

Figure 26 shows a simple method for racking or jigging tubular objects in single or multiple plating applications.

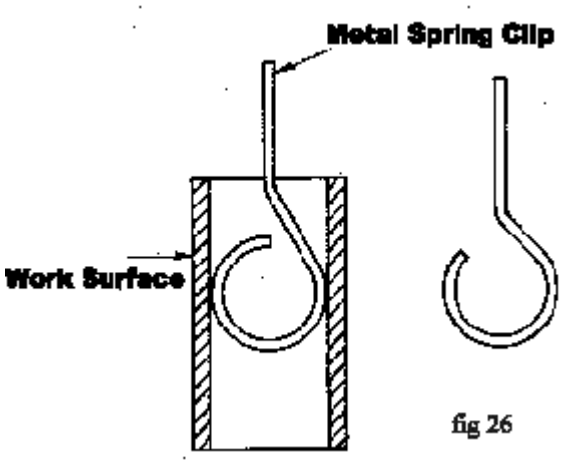


fig 26

Small Tools or Parts - (Figures 24 & 25) shows how several small tools or parts may be plated utilizing the full power capacity of the Caswell Chrome Plating unit. The sheet of lead electrically connected to the ends of the plating tank, divides the plating tank forming two plating compartments. In effect, allowing a greater number of small tools or parts to be plated at one time.

Caution, only commercial lead sheet free from antimony, tin and bismuth may be used for the dividing partition in this application. Do NOT use Caswell Chrome Anodes.

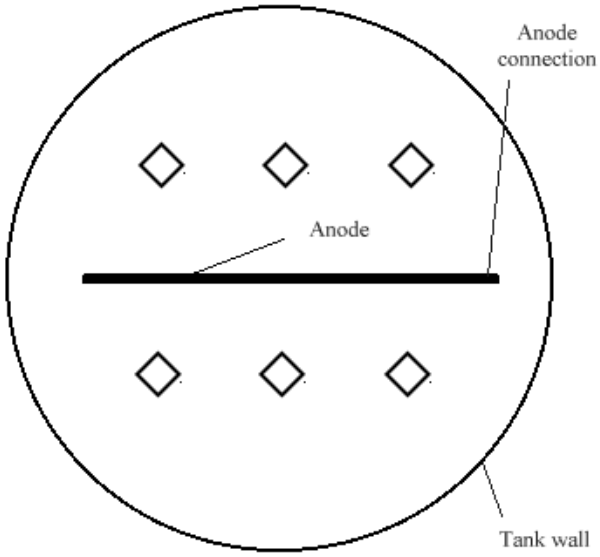


fig 24

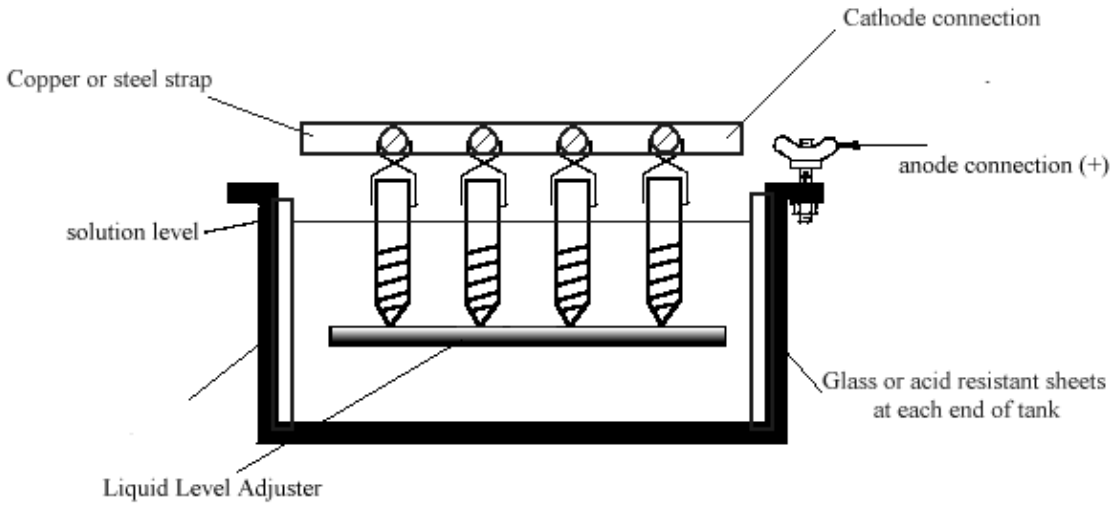


fig 25

MULTIPLE PLATING TO CRITICAL DIMENSION TOLERANCES

As in the case of inspection gages and parts of extreme close tolerance, it is necessary to Hard Chrome plate with more exacting control when plating a number of parts at one time. Figure 21, and 22, suggests a jig or fixture for plating a number of pin type plug gages at one time where the dimensional tolerance is normally critical. The same principle will apply to other tools or parts in the same dimensional category.

To plate the assembled fixture, as shown in Fig 27, it must rest within the plating tank on the Liquid Level Adjuster Platform. The Liquid Level Adjuster is then adjusted to bring the solution level to a point 1/8" above the top of the gage as in Figure 22.

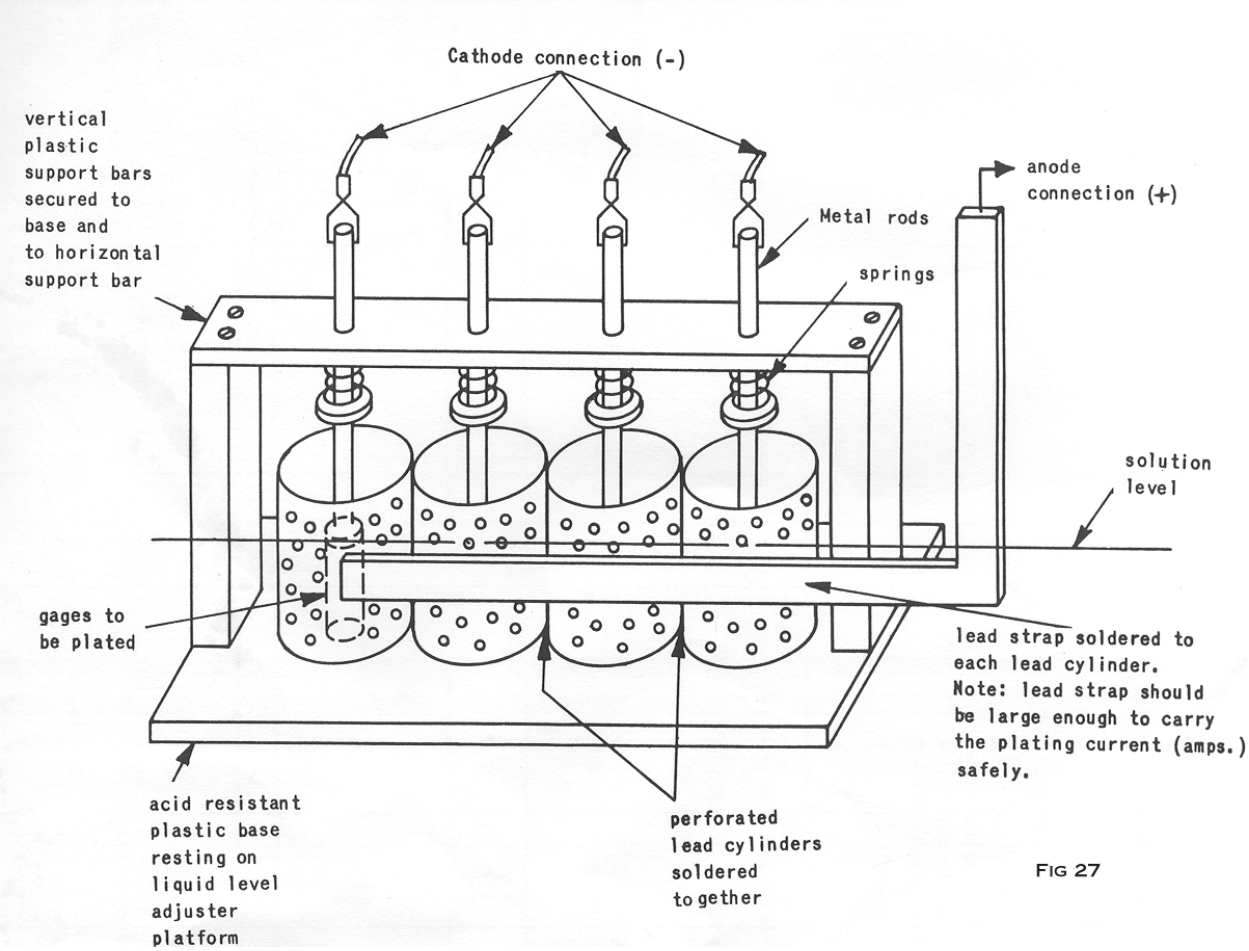


FIG 27

The gages are positioned equidistant from the inside walls of the perforated lead cylinders by means of a series of small plastic plugs. The spring held metal rod must have sufficient pressure to make good electrical contact with the lead washer and consequently the work.

NOTE: THE GENERAL HARD CHROME PLATING INSTRUCTIONS (P 92) ARE FOLLOWED IN MULTIPLE PLATING APPLICATIONS.

NOTE: See the "Rate of Deposition" chart, for determining plating time in relation to the Hard Chrome deposit required.

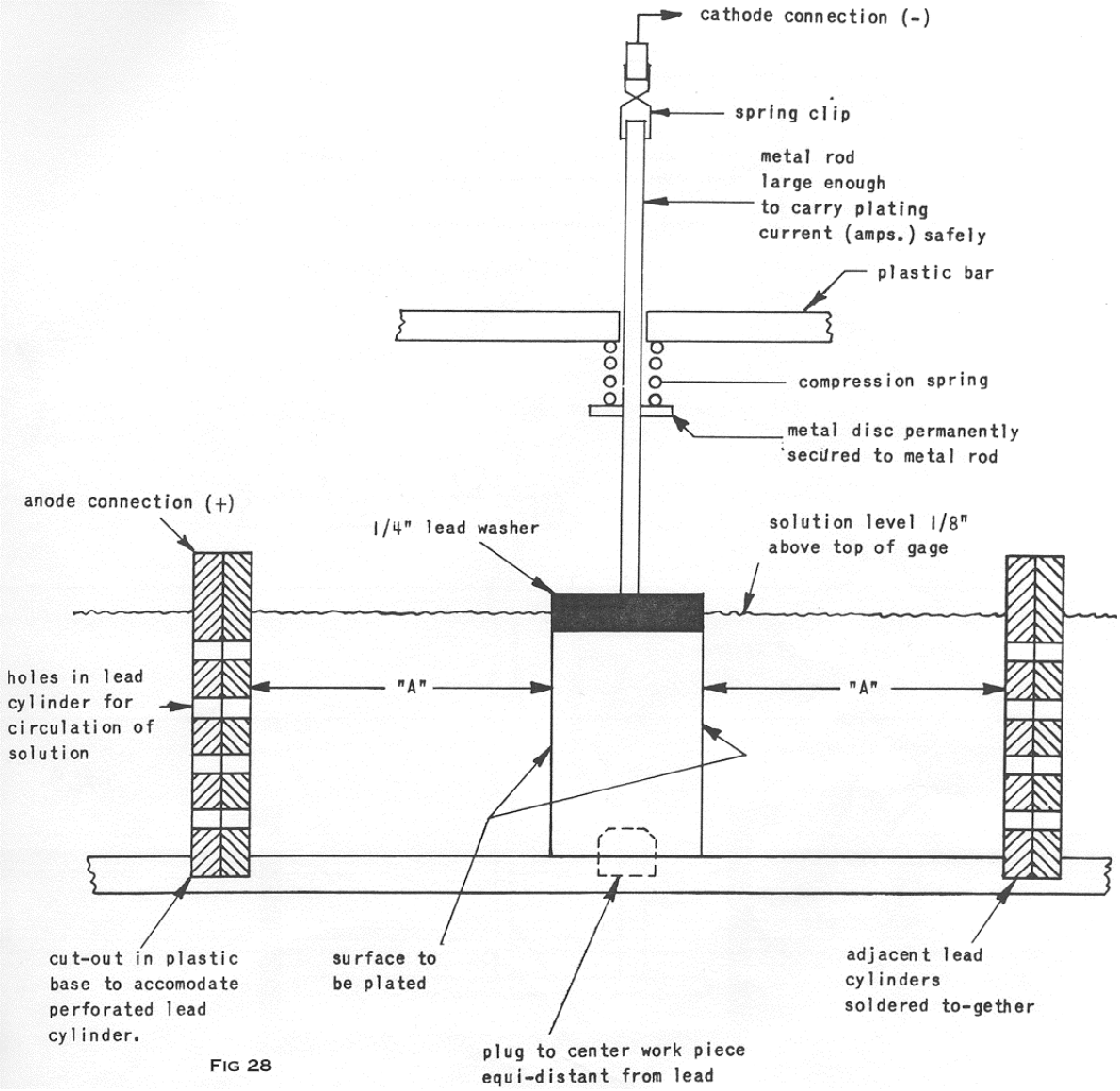


Fig 28. Fixture for multiple plating pin type plug gages.

See fig 27 for complete fixture.

INSIDE DIAMETER PLATING

Satisfactory inside diameter plating depends on several factors including the type of material, shape and size of the internal anode as well as the location of the internal anode with respect to the work surface.

Internal Anode Material

A lead rod or steel drill rod will be found most suitable for use as the internal anode in most applications involving circular shapes. Lead in the form of sheet or rod cut to the desired shape and length is also useful as an internal anode, where odd shaped surfaces must be plated, i.e., mold cavities, stamping dies, etc. It is imperative that lead be used in all applications requiring lead anodes, internal, conforming or otherwise. Steel anodes should not be used for prolonged plating operations, for more than 30 minutes continuous plating time. Copper or brass anodes should never be used.

Shape of Internal Anode

Figure 17 shows a cross-sectional view of typical internal anodes used in plating various inside work surfaces. Where the inside surface of the tube is perfectly cylindrical, an internal anode circular in cross section as shown in Figure 17A should be used. Oval shaped work surfaces require an oval shaped anode, Figure 17B for even deposition of plating.

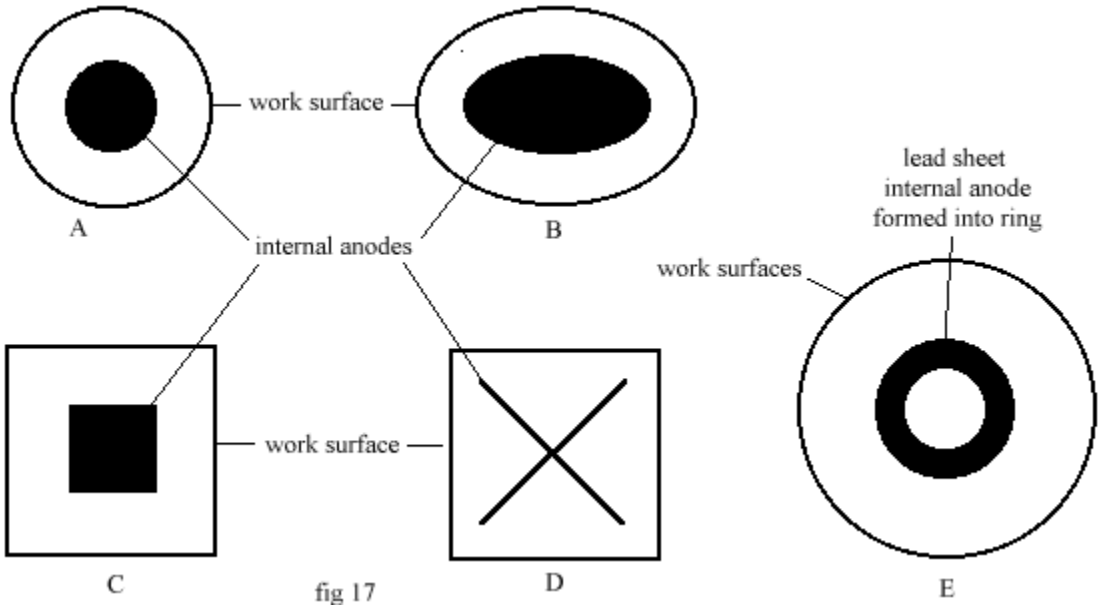


fig 17

For square or rectangular inside surfaces, anodes shown in Figure 17C or 17D may be used. For dimensional build-up and close tolerance applications a square internal anode, Figure 17C, should be used. For light deposits where tolerances are unimportant the X - shaped anode, Figure 17D will be satisfactory.

When plating large internal surfaces, that is, over 7 inches in diameter, the arrangement shown in Figure 17E is recommended. For these applications, the sheet lead internal anode is formed into a ring or tube.

The lead tube should be perforated to provide adequate circulation of solution during plating.

Size of Internal Anodes when Plating Inside Diameters

The size of internal anodes will depend on the inside diameter of the work. Internal anode should always have sufficient cross section area to handle the current flow safely. Table 2 makes recommendations for the diameter size of internal anodes in relation to the work piece I.D.:

The greater the cross-sectional area of the internal anode is, the more current it can handle. Excessive temperature rise (heating) of the internal anode or the anode leads indicates that the cross-sectional area of the anode or lead is too small.

The following table makes recommendations for sizes of internal anodes in relation to the work piece I.D.

TABLE 2 - Size of Internal Anodes for Plating Inside Diameters

Work I.D. (in inches)	Solid Rod Internal Anode O.D. (in inches)	Work I.D. (in inches)	Sheet Lead Ring Internal Anode O.D. (in inches)
1/4	1/32	7	3
1/2	1/16	8	4
3/4	1/8	9	5
1	1/8	10	6
2	1/4	11	7
3	1/2	12	8
4	3/4	13	9
5	1	14	10
6	2	15	11

CAUTION - For good contact, make sure that the anode lead is clamped securely to the internal anode.

Location of Internal Anode

To obtain even deposition of Hard Chrome plate on the work surface, the internal anode should be equidistant from the surface to be plated. Using a cylindrical tube as an example, if the anode is off center with respect to the tube diameter, the tube surface closest to the anode will receive a heavier deposit than the opposite surface of the tube.

Jigs made of glass, Lucite, or other acid resistant plastic, may be used for supporting the internal anode and the work in the plating solution. The internal anode should be held securely in place to prevent it from touching the work. This is sometimes accomplished by drilling a recess hole in an acid resistant plastic jig or base holding the work. If the anode does touch the work accidentally during operation, a short circuit occurs which may cause serious damage, that is, the work surface may be burned because of arcing.

Circulation and Level of Solution

Regardless of the length of the work, provision should be made for free-circulation of plating solution over the entire work surface. Jigs, where used, should not block the top or bottom of the work cylinder or tube. This may be accomplished by positioning the work on an acid resistant plastic fixture, which is drilled to allow free circulation of Caswell Hard Chrome solution through the plastic base. In general, the plating solution level should be about 1/8" above the top of the work surface to be plated.

Cathode Leads Cathode leads, like lead anodes, must have sufficient capacity to handle the current flow safely. Wire leads, as well as clips or connection clamps, that are undersize (insufficient current carrying capacity) will overheat. Suggested American Wire Gauge Sizes for 20 amp, 50 amp 250 amps are 12, 8 and 0 respectively. Smaller sizes may be used where currents are below maximum rating of the unit.

Constructing Jig or Fixture for Plating Inside Diameters

1. Construct jig or fixture, being careful to drill sufficient number of holes in the fixture base to allow free circulation of Caswell Hard Chrome solution over the area to be plated.

2. Clean work thoroughly as discussed under "Cleaning Instructions Prior to Plating"

3. Insert work piece in jig, being sure that the steel or lead internal anode conforms to the work surface, and is centered equidistant from all sides of the work surface area. Work should slip fit into the plastic base and be held securely in position. Cathode clamp should be designed to permit good electrical contact, construction similar to hose clamp construction is recommended.

4. Set fixture and work piece assembly approximately in the center of the liquid level adjuster platform, and lower into Caswell Hard Chrome solution to the point where the solution level is 1/8th inch above the work surface to be plated.

5. Disconnect anode terminal link from the plating tank.

6. Connect the anode to anode-terminal (+). Be sure internal anode holds center of the I.D.

7. Connect one end of the cathode terminal lead securely to the cathode terminal (-) and the other end to the cathode clamp attached to the work piece.

8. Follow GENERAL HARD CHROME PLATING INSTRUCTIONS

DEPOSIT LOCATION CONTROL

In some Hard Chrome plating applications certain surfaces of the tool or part must remain unplated while in others, a "feathering" or tapering of the plate is desired. The method for accomplishing this is referred to as "Deposit Location Control". Essentially, this method utilizes sheets of glass, acid resistant plastic sheets and commercial lead in the construction of jigs and fixtures for accurately controlling chrome plate deposits.

The jigs and fixtures are always designed to apply to a specific plating application and are normally used in conjunction with a Liquid Level Adjuster. Two advantages are inherent in following the method of "Deposit Location Control":

1 - It permits the accurate control of deposition, both to location of the plate and the uniformity in which it is applied.
2 - It permits full use of the working capacity of the system.

AppIications.

In the sections under "Use of Conforming Anodes", and 'Multiple Plating of Tools & Parts", several illustrations of "Deposit Location Control" are given. Other examples applicable to typical plating jobs are illustrated, Figs. 29, 30, 31 and 32

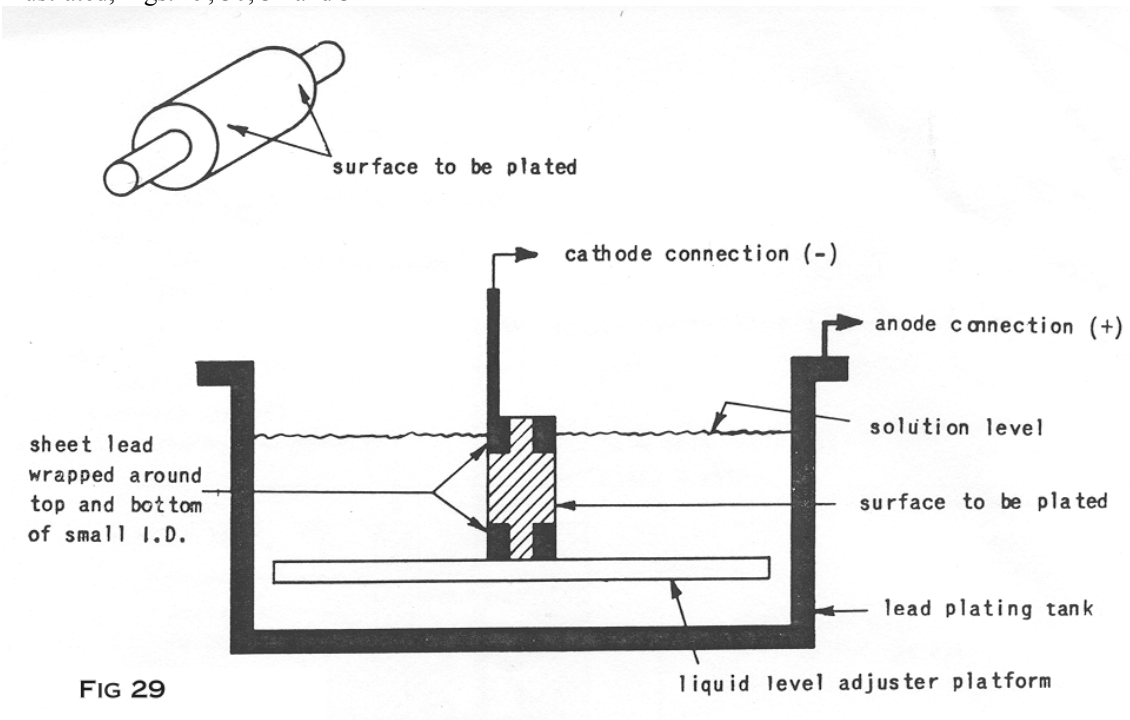


Fig 29 Shows a method of Hard Chrome plating the large O.D. of a two step gage.

In Figure 29 for example, sheet lead is used in conjunction with the work for two reasons. Firstly, the lead sheets prevent Hard Chrome plate from being deposited on the small O.D. of the work piece. Secondly, the lead sheets assure uniform thickness of deposit on the work surface area or the large O.D. of the work. In calculating the total area for determination of the proper plating amperage, the area of the sheet lead on top and bottom of the work should be added to the work surface area.

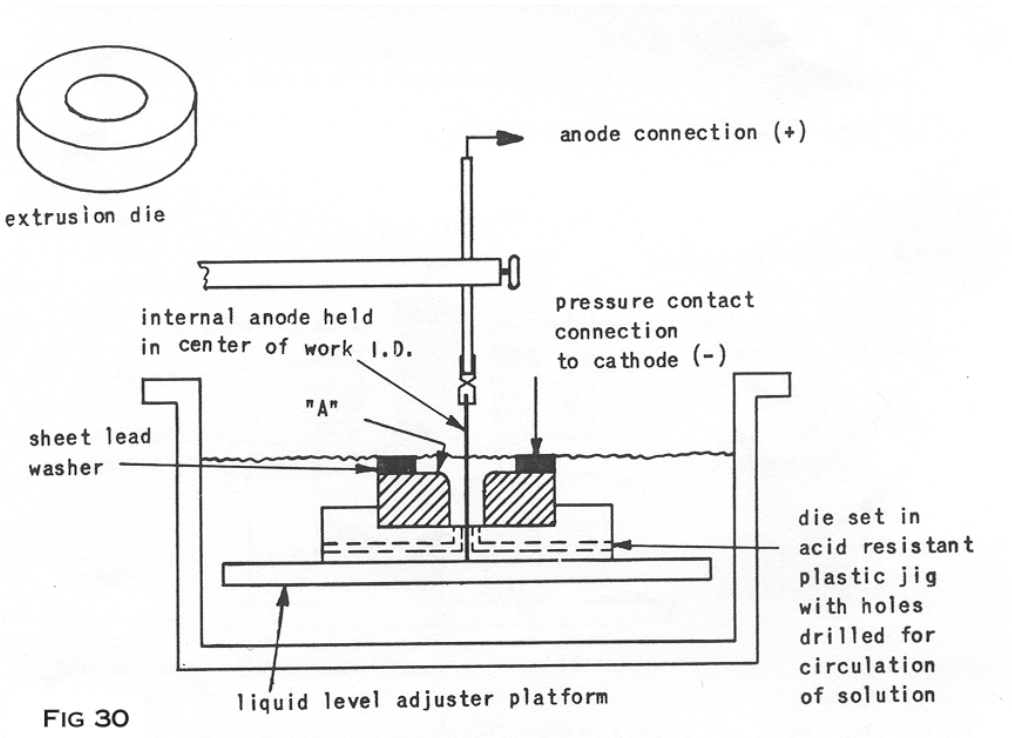


Fig 30 Shows an arrangement for Hard Chrome plating the ID of an extrusion die, where the plate must feather out to top surface at 'A'. The use of the sheet lead washer makes it possible to deposit Hard Chrome plate on the top surface of the die. The chrome, in this case, feathers or tapers in toward the lead washer.

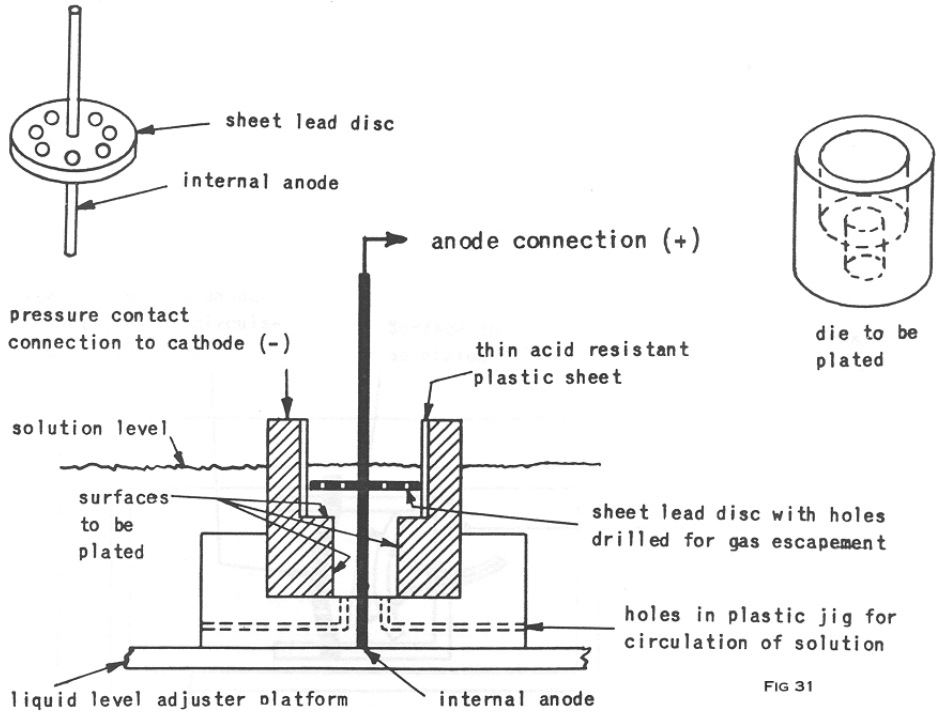


Fig 31 Shows a fixture for Hard Chrome plating both the I.D. & the horizontal surface of a die. The thin acid resistant plastic sheets prevent the Hard Chrome plate from being deposited on the large I.D. The lead sheet disc is used for depositing plate on the horizontal surface area or shelf area perpendicular to the inside diameters.

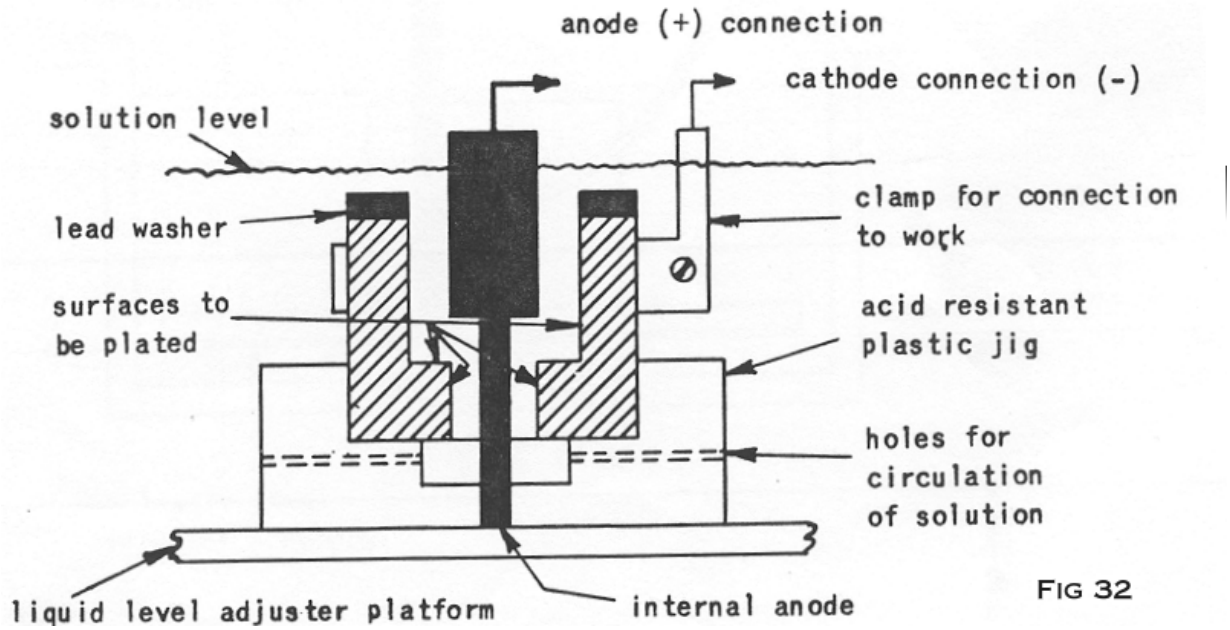


Fig 32. Arrangement for simultaneously Hard Chrome plating small and large I.D. of a work-piece

Figure 32 is similar to the one given in Figure 31,except the large and small inside diameter require Hard Chrome plate. The size of the internal anode should be based on the values shown in the table shown in the 'Inside Diameter Plating' section.

A perforated lead conforming anode, Figure 33, is used in conjunction with plastic jig to obtain a uniform deposit on the surface of the plate.

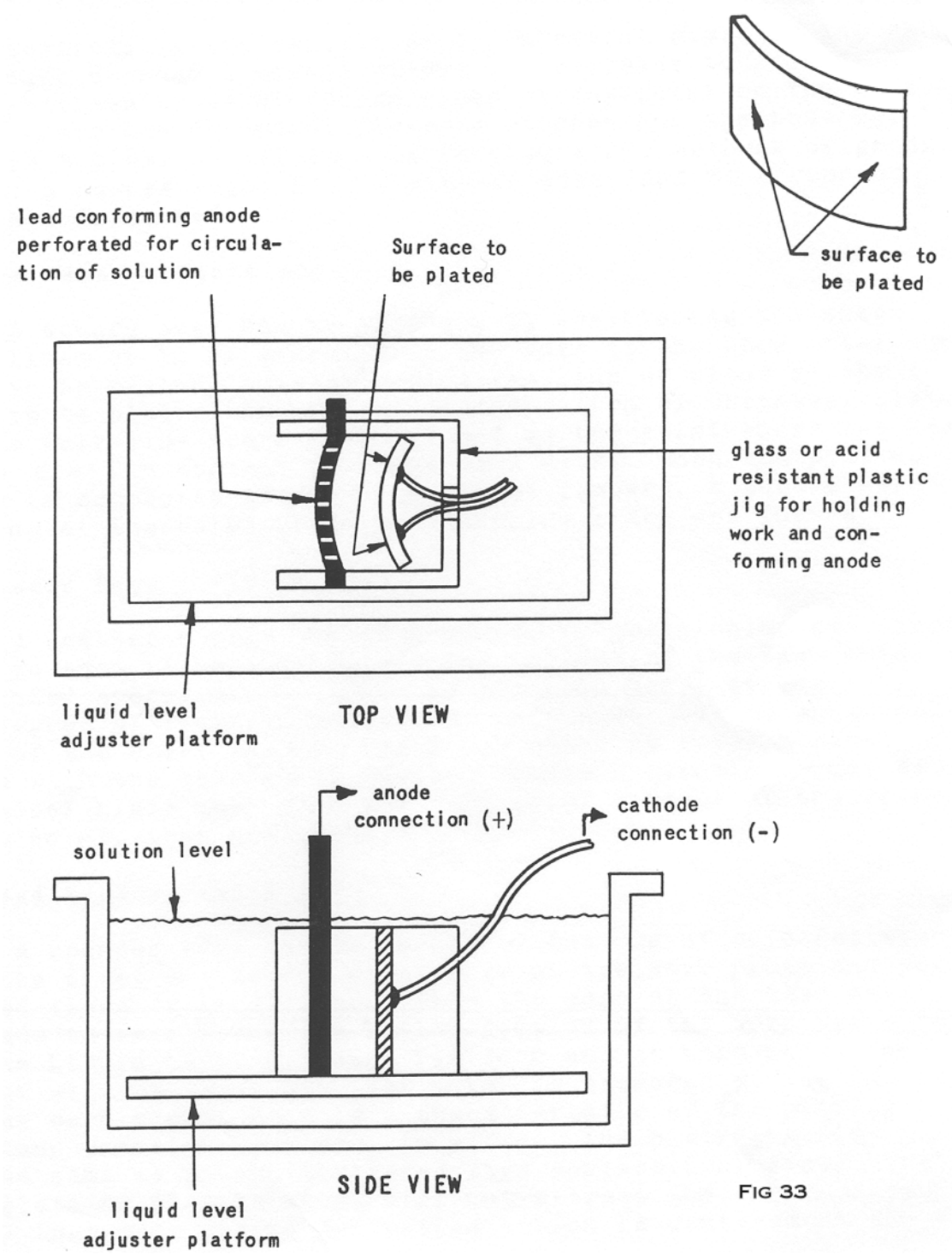
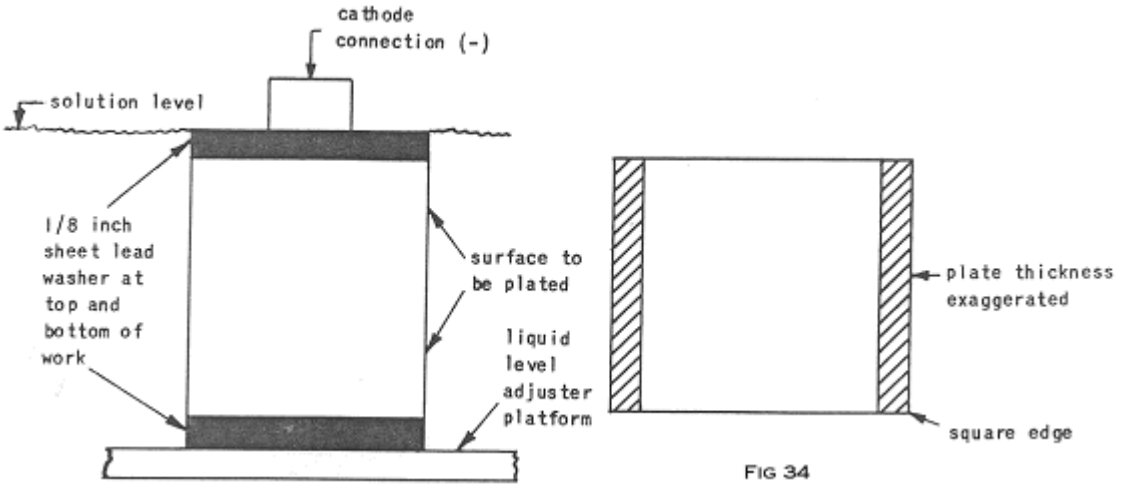


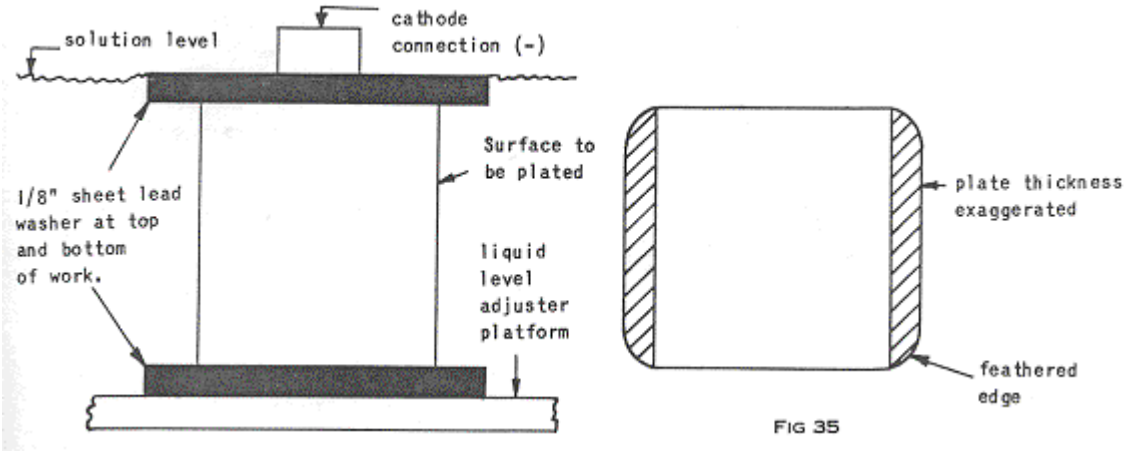
Fig 33. Conforming anode used for even deposition of Hard Chrome plate on the surface of an electroplate.

Controlling the deposition of Hard Chrome plate by the recommended Hard Chrome method allows the operator to produce three various types of finish edges at any point on the work piece where the Hard Chrome plate is stopped and the base metal surface begins. As illustrated in Figures 34, 35 & 36, methods of producing 1) a square edge, 2) a feathered edge, and 3) a rounded edge are explained.



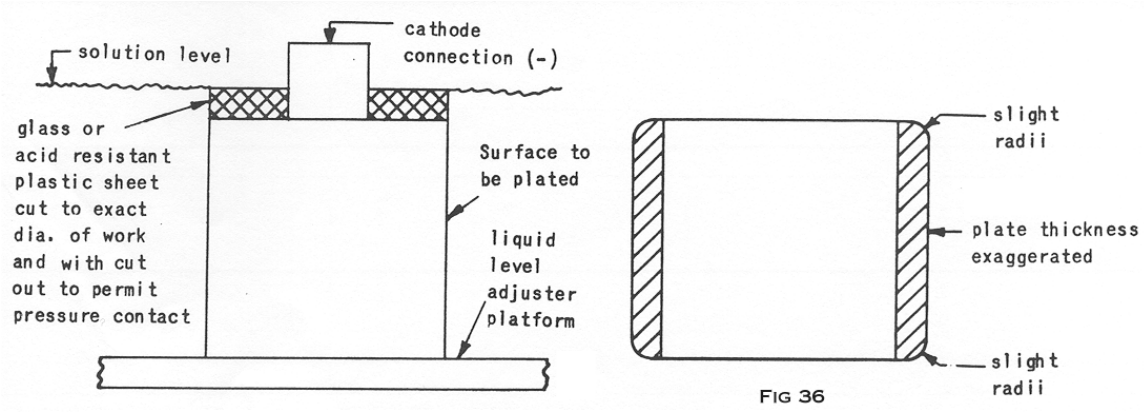
Square Edge - Figure 34

A square edge can be produced by positioning the sheet lead flush or in alignment with the edge of the base metal surface to be plated, thus extending the line or plane of the surface to be plated. In the actual deposition of Hard Chrome plate, a fine hair-line crack is developed at the point where the lead sheet come in contact with the base metal. When the plating cycle is completed and the lead sheet removed, a square edge remains at the point where the hairline crack was formed.



Feathered Edge - Figure 35

A feathered edge can be produced by positioning the sheet lead so that it extends beyond the surface of the base metal to be plated approximately 1/16" or slightly more, depending upon the degree of feathering desired. In effect, the extended portion of the sheet lead at the point where it forms a right angle with the base metal surface, draws a certain amount of Hard Chrome plate away from the base metal surface at the right angle point, thus producing a feathered edge.



Rounded Edge *Figure 36*

A rounded edge can be formed by the use of acid-resistant plastic sheet cut to the exact size of the work piece and positioned flush or in alignment with the edge of the base metal surface to be plated. The bottom portion of the work piece rests on the Liquid Level Adjuster Platform and at this point the radius will be less than that which is produced at the top edge of the work piece. This is a characteristic of the plating action and cannot be avoided. In effect, the plating action here is the same as in the feathered edge application, except that the glass or plastic sheet will not attract the chrome deposition, thus more chrome deposition action is centered at the edge of the work piece.

Note: In all the illustrations and examples referred to in the preceding paragraphs on "Deposit Location Control", the use of masking tape, stop-off lacquers and plastic coatings have been limited to minor usage in the coating of the cathode surface. In the construction of jigs and fixtures, masking tape can sometimes replace clamps as a method of holding the plastic sheets or anodes in proper position.

FINISHING AFTER HARD CHROME PLATING

Buffing

To improve the luster on parts that require that type of finish, parts may be buffed lightly using a soft felt, or cloth wheel with the addition of commercial buffing and polishing compounds. In many cases, the parts may be hand rubbed, using a damp cloth dipped in levigated alumina. Where low micro inch finishes (2 to 10 micro inch) are required, commercially accepted polishing methods should be applied.

Grinding and Lapping

In some instances, it is necessary to salvage parts that are excessively worn or uneven. In this application, the parts should be machined lapped or ground to a smooth, even surface before plating.

Refer to the paragraph entitled "The Importance of Base Metal Finish Prior to Plating", page 92.

If the thickness of deposit required is too great, and the tolerance is too close to permit plating to size, the part may be plated over-size and the part, finished to size by lapping or grinding.

Lapping is preferred since the grinding of a chrome plate surface is known to seriously reduce the wear resistant qualities of the chrome.

INTERRUPTED CHROME PLATING CYCLES

If the plating cycle is interrupted by power failure, blown fuses or for other reasons, the following procedure is recommended in order to continue plating after correction of the electrical or other troubles:

Work should remain positioned in the plating tank, and it should not be removed from the solution.

A stripping current at 1 amp. per sq. in. should be applied to the work piece for 10 to 30 seconds, depending on the already attained deposit thickness. The heavier the deposit of chrome, the longer it takes to strip.

After stripping, the plating cycle should be continued in the normal manner as outlined in the "GENERAL HARD CHROME PLATING INSTRUCTIONS (p 92),"

Undersize Deposits -- Occasionally, when plating to dimensional tolerance, the work may be removed from the plating tank and upon measurement, be found to have less plate thickness than required. This may be caused by failure to calculate surface area correctly or failure to apply the proper current.
The work can be brought up to size by:

1. Rinse work in clean water and check for size. Avoid contamination of plated surface; DO NOT HANDLE OR TOUCH PLATED SURFACE.

2. Re-calculate work surface area and determine plating current. Determine the plating time required to bring work up to size (see Rate of Deposition Chart)

3. Re-immerse the work in plating bath and plate according to the "Recommended Plating Instructions". No cleaning procedure is needed prior to re-immersion in the plating bath if the work surface has not become contaminated or oxidized.

Note: Before re-immersing in the solution, make sure that the temperature of the work piece is equal to or higher than the solution temperature. If the temperature of the work is considerably below that of the solution, the deposited chrome has a tendency to laminate and the added deposit may be chipped or flaked off easily.

Oversize Deposits -- In general, for close tolerance work, oversize deposits (.0005" and below) the condition may be rectified by lapping the work piece to size. Applications where the over deposit is greater, only one alternative remains--grinding.

Heavy deposits of Hard Chrome should not be removed by stripping in the Hard Chrome bath.

PROCEDURE FOR REMOVAL OF CHROME PLATE

The method best suited for removal of chrome deposits depends on the thickness of deposit, and the base metal material. Under normal circumstances, that is, starting with a new tool or part thoroughly cleaned as recommended, chrome plate removal after using the Caswell Hard Chrome System, is seldom necessary because of the close control obtainable over the deposit. In those instances where a poor finish caused by improper cleaning etc., it is essential that all the chrome be removed and that the work be re-cleaned before re-plating. In addition, if the work received by the Chrome operator has been previously plated with conventional industrial chrome or has been returned after use for re-plating with Chrome, the work should be processed to remove all traces of chrome before re-plating. Subsequent paragraphs will deal with removal of heavy and light deposits from ferrous and nonferrous metals.

Removal of Chrome Plate from Industrial Steel.

Light Deposits. Light deposits of Chrome Plate (up to .002") can be removed by stripping in Chrome solution. This may be accomplished by following Steps 1 to 4 under GENERAL HARD CHROME PLATING INSTRUCTIONS page 92, except, maintain the stripping current of 1 amp. per sq. in. At the first signs of a constant bubbling action at the work surface or when an abrupt drop is observed in the reading of the ammeter, stripping should be terminated. The work should then be removed from the solution for examination. If after inspecting the work surface and the chrome is not removed, the work should be re-immersed and stripped until all signs of chrome have disappeared. Because Chrome plate is removed by stripping at a rate considerably faster than it is deposited, extreme caution should be exercised when stripping chrome.

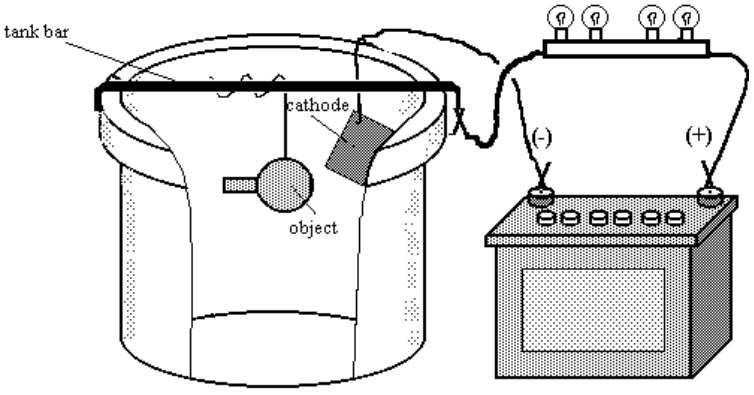
Heavy Deposits. Heavy deposits of Chrome plate (.002" or more) are stripped conveniently using electrolysis. Some acids will remove chrome deposits, but the user is cautioned against application of acids for chrome removal from industrial steels, because of the harmful effect time may have on the base metal. The Chrome unit's direct current output is used as a source of power when using alkaline cleaners.

A good alkaline cleaning solution is prepared with 5-6 oz. ANODIZE & CHROME STRIPPER added to one gallon of water. This solution may be used at room temperature but, the stripping time is slower. Heating the alkaline solution to a Temperature of 160^{o} F, considerably increases the rate of chrome removal. The brush plating technique is ideal for use with this solution, especially for decorative chrome plate removal.

A typical set-up for stripping Chrome plate electrolytically using ANODIZE & CHROME STRIPPER solution is shown here.

The recommended procedure is as follows:

DE-PLATING TANK SETUP



1. Connect the piece to be stripped to anode (positive) connection of your power unit, and immerse work in Anodize & Chrome Stripper Solution .

2. Connect the GP Plates to the negative terminal of your power supply.

3. Adjust current until a current density of 1/2 to 1 amp. Per. sq. in. is obtained. Maintain this current density for approximately five minutes.

6. Remove work and inspect to see if all chrome has been removed. If not, repeat cycle as outlined previously.

7. Water rinse work and clean work according to recommended CLEANING INSTRUCTIONS PRIOR TO PLATING P 108. The part is then ready for plating.

Note: The above procedure is recommended for the removal of heavy Chrome deposits (.002" or over), which have been deposited over nickel. CAUTION: EXCESSIVE STRIPPING ON THE BASE METAL AFTER CHROME HAS BEEN REMOVED IS NOT RECOMMENDED. THIS APPLIES PARTICULARLY TO HIGH CARBON STEELS. A PERIODIC FIVE MINUTE INSPECTION OF THE WORK SURFACE IS HIGHLY RECOMMENDED. (It is usually better to leave the nickel plate intact, and plate over it with copper.)

Removal of Chrome Plate from Non-Ferrous Metals (Brass, Bronze, Copper or Nicke1)

Light and Heavy Deposits -- Either concentrated or diluted hydrochloric acid can be used for removal of Chrome plate from brass, copper or nickel. In this case, no electrical current is necessary, only immersion in the acid is required.

Concentrated Hydrochloric Acid is recommended for the removal of Chrome plate from brass, bronze, copper and nickel.

Concentrated Hydrochloric Acid is always used at room temperature, the work being immersed in the solution for sufficient time to remove all the chrome deposit.

Diluted Hydrochloric Acid Solution, consisting of 1 pint of Hydrochloric Acid, slowly and carefully added to 1 gallon of water, can also be used if desired. The rate of chrome removal using the diluted solution may be increased by increasing the temperature of the solution. Usually, Hydrochloric Acid solutions are heated to approximately 125 deg F. Use acid-resistant containers and keep them covered.

CAUTION: Extreme care should be exercised in the mixing of the Hydrochloric Acid Solution. ALWAYS ADD THE ACID TO THE WATER SLOWLY AND CAREFULLY.

Chrome Plating Troubleshooting

Problem	Cause	Remedy
No deposit. No gassing	No current (or gassing from part)	Check all contacts. Check power source.
No deposit. Work is gassing	Reversed polarity	Anodic work piece. reverse polarity
No deposit. Work is gassing	Too much acid in solution, from previous bath	Discard solution. Check & improve rinsing
No deposit. Work is gassing. Brown stains	Insufficient sulfuric acid in solution.	Add 1/2 teaspoon of battery acid, and try again.
Deposit dull or milky	Temperature &/or current balance incorrect	110f = 0.8 amps per sq". 125f = 1.45 amps per sq" Raise temp & amps for more current
Dull spots	finger prints etc. passive nickel plate rinsing problem	Clean off prints with talc, or lime Activate by dipping in muriatic acid check rinse water, use distilled water
Low throwing power	hydrogen gas is trapped Temperature &/or current balance incorrect Work is shielded from anode	Agitate the part to release gas 110f = 0.8 amps per sq". 125f = 1.45 amps per sq". Raise temp & amps for more current Move the part to a more prominent position
Pitting	surface contaminated or bubbles sticking	Improve surface cleaning
Burnt looking plate	Temperature &/or current balance incorrect. Current too high	110f = 0.8 amps per sq". 125f = 1.45 amps per sq" reduce amps or use a dummy (add more parts) to 'rob' current
Rough Deposit	amps are too high Smuts on work. suspended matter in tank	reduce amps or use a dummy (add more parts) to 'rob' current Brush off smuts. Filter solution through a double coffee filter. remove all sludge from tank bottom
Poor adhesion of Chrome plate	poor surface preparation	Check cleaning,check for oil or grease in bath. Remove old chrome before plating. Etch nickel plate prior to chrome
Partial Plate on high spot &/or edges.	Insufficient current	Clean anodes by wire wool/brush. Check anode/cathode ratio adequate, and anode distribution is even. Check sufficient power form source. Remove anodes from tank when not in use.
Irridescent color on dry chrome plate	insufficient power, or insufficient rinsing	110f = 0.8 amps per sq". 125f = 1.45 amps per sq". Raise temp & amps for more current Improve rinsing and drying procedures

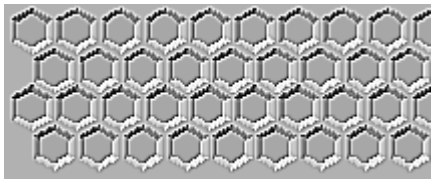
ANODISING ALUMINUM

The process of anodizing is, chemically speaking, rather complicated, but in practice is extremely simple.

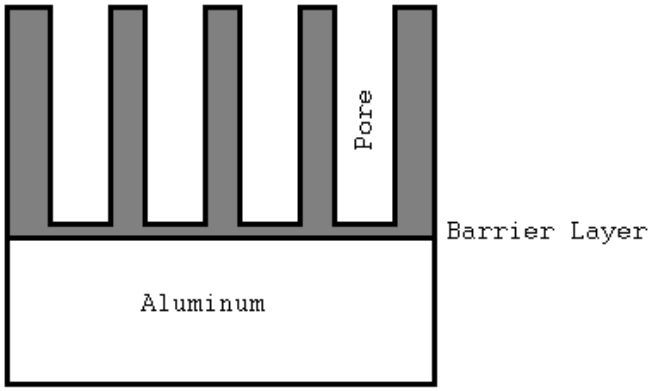
The process involves placing aluminum in an electrolyte, weak sulfuric acid, and passing a low voltage current through it. The aluminum part is connected to the positive (anode) side and the negative side is connected to a cathode made of lead. This causes the aluminum to oxidize, similar to steel rusting, with the net result of a very hard, tough abrasion resistant protective coating being formed. An interesting 'quirk' of this process is that the film formed looks like honeycomb, and has 'tubes' growing up from the aluminum. These tubes conveniently allow color dyes to flow into them

For the technically inclined, the surface of the aluminum actually grows a layer of aluminum oxide on itself, which is then transformed into aluminum hydroxide (anodize) and finally hydroxide monohydrate. The whole anodize layer is non conductive. The hydroxide is microscopically porous which allows it to absorb dyes. This layer looks somewhat like a honeycomb, as can be seen from this photo, magnified some 40,000 times.

The 'barrier layer' at the base of the pores is thin enough to pass some current, even though the complete layer is non-conductive, so the honeycomb structure continues to grow, as long as current is flowing through the system.



Looking from above



Cross section

Aluminum can be processed in a number of ways to achieve different effects. It may be highly polished to look like 'chrome', brushed with a wire wheel or Britex Wheel to provide a 'scratch brushed' finish, or even bead blasted to provide a 'satin' look. All of these processes would be done prior to anodizing, and the surface may, be sealed without dying.

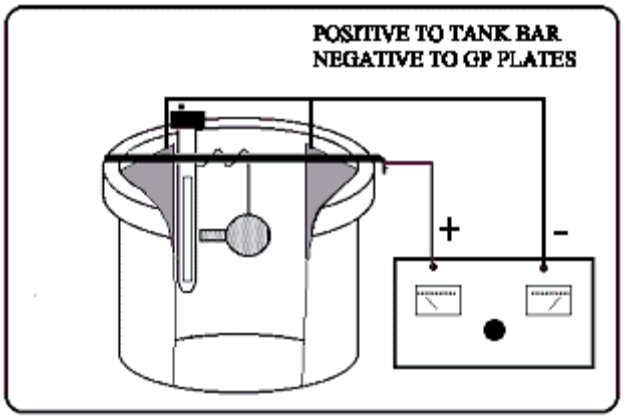
Most types of aluminum can be anodized using this process. The purer grades of the metal will produce a better finish. Silicon & manganese alloy components tend to retard the process somewhat, however experimentation with different types of alloys will give the operator an idea if the process is suitable for a particular application. The anodized surface can always be removed!

The most exciting part of aluminum anodizing, is without doubt, experimenting with the amazing array of colors and effects one can produce, with a little practice and skill. The metal can be pretreated in a variety

of ways, polished, scratch brushed etc., the anodize film grown, and then the colors applied prior to sealing the anodize surface, permanently locking the colors into the metal.

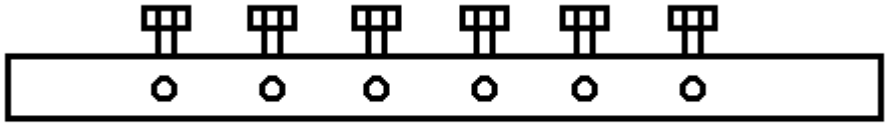
Setting up the Anodizing Tank

Wiring up the parts.

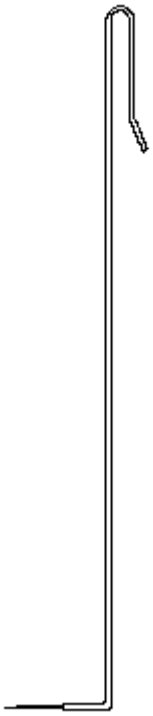


Anodizing requires special attention to wiring up the pats, because only aluminum parts can be placed into the solution, so the actual wire, or rack, must be made of this, or titanium. Consequently, the aluminum also is anodized. If a connection is poor, then the anodize film grows on the wire, where it is touching the part, and an insulating barrier is formed, preventing further film growth.

Thin aluminum wire may be obtained from almost any garden center/hardware shop. This is ideal for wiring small parts, as long as you make sure you twist the wire on very tightly. You may also like to ensure a good connection by placing a 'Bull Dog' type clip over the wire.



An aluminum tank bar, using hex head bolts to secure the wire rack



Ideally, the tank bar should also be made of aluminum. This will avoid any corrosion problem, which may arise from the acid attacking a copper tank bar. A solid bar of aluminum could be used, and for the engineering inclined, this could be drilled with holes to accommodate the needle, which could be secured with hex head bolts, tapped into the block.

An alternative technique to wire is to use knitting needles. By removing the top of the needle and bending it into the shape needed, it can be forced into a slightly smaller hole, using the needle's tapered point as a wedge.

Aluminum knitting needles are usually anodized, and as this is an insulator, the anodize must be removed, either by sandblasting, abrading with emery paper, or stripping in the anodize stripper. If stripping, leave the needle in the stripper until all the color has gone, usually about 3 minutes. Some needles are coated with lacquer, so you may have to abrade this off.

Knitting needles (see left) are usually made of harder material and so, when the taper is forced into the hole, it slightly enlarges the softer aluminum, ensuring a tight fit. Soft wire will actually decrease in size if pushed into a work-piece, which is harder than itself, thereby shrinking it, and causing a loose connection.

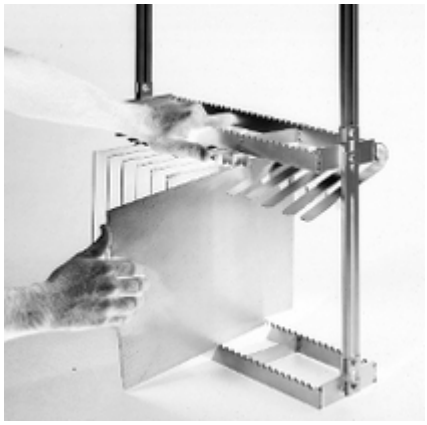
There is a host of different types of Titanium grips and racking clips available. Titanium is actually better than using aluminum, as it is not anodized in the process, saving you the job of stripping your racks after each operation.

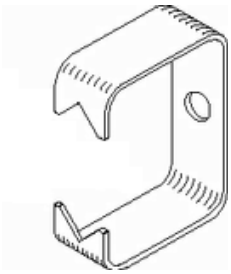
Servi-Sure Inc are suppliers of these racks.

www.servisure.com

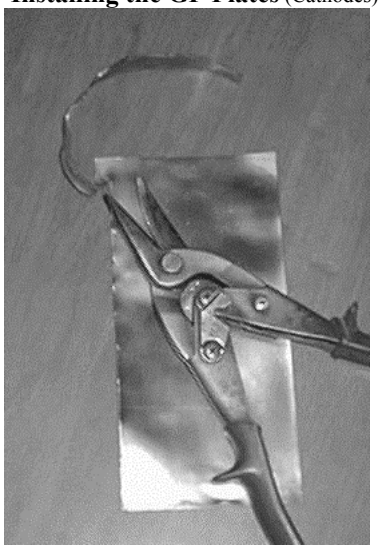
2020 W. Rascher Ave., Chicago, IL 60625
Phone: (773) 271-5900, Fax: (773) 271-3777,

Email: racks@servisure.com





Installing the GP Plates (Cathodes)



The anodizing system uses 2 GP plates 8" x 12" as cathodes. (The actual part being anodized becomes the anode). To install these into the tank, see page 11 & 12 for anode/cathode installation procedures.

The GP Plates should be occasionally cleaned using wire wool or Scotchbrite type material.

Remove the plates from the solution when not in use.

TANK TYPE	De-Plating
SOLUTION TEMP RANGE deg F	65-80 opt =72
AIR AGITATION	yes
ANODIZING TIME (MINS)	7-10
CATHODE	GP Plates
ANODE BANDAGE	no
VOLTS SHOWING ON VOLTMETER	12-24
AMPS REQUIRED PER SQ. INCH	0.1 - 0.15
FUME HOOD	Yes
USE AS A STRIKE COAT	No

The Power Supply and Power Requirements.

Unlike other plating procedures, where the amperage has to be controlled with a resistor or a bulb, anodizing draws only whatever current it needs from the power supply. This makes the power supply problem somewhat easier, and inexpensive battery chargers, or car batteries may be employed. The main consideration is, will the power supply output enough power for the time it takes to successfully anodize something?
Therefore, a small battery charger, having a limitless source of power (the mains) can successfully anodize anything up to its amperage rating at the rate of 0.15 amps per sq. inch of surface area of the part. A 12 volt battery, however, will anodize much larger parts.

a. Battery chargers

Battery chargers do a really good job of anodizing., whereas they are not quite as good for electroplating.

Set the charger to the 12 volt position. If you have 'fast charge' positions, such as 30 or 50 amps, do not use these, as the charger is not designed to operate at these outputs for long periods, and it will cut out.
If you have a 2 amp. charger, it will only be able to output enough current to anodize a part up to 20 sq. inches (2 amps divided by 0.1 amp per sq.inch)
If you have a 10 amp. charger, this will anodize up to 100 sq. inches (10 amps divided by 0.10 amp per sq.")
Therefore, the Caswell 25 amp rectifier will, in theory, deal with up to 250 sq. inches.

b. Batteries.

A 12 volt car battery is capable of giving out relatively large amperages, for a reasonable length of time. There is certainly enough power in a fully charged car battery to anodize a large part for at least an hour.

It is advisable to purchase an ammeter to measure the current flow when using a battery. This should be placed between the positive terminal of the battery and the GP Plates (Cathode)
Normally, the current draw will be less than the capability of the battery, so no problems will occur, but on smaller parts, you may have to insert a bulb or two to restrict and control the current.

c. **Rectifiers.**

Rectifiers are the ultimate in anodizing. Variable controls, voltage and amperes dials, allow you to fine tune your anodizing efforts. This can be especially useful when dying, as the minor variations can effect pore size of the anodize, which may interfere with the acceptance of the dye.

Setting up the Anodizing Solution

TO MAKE UP THE ANODIZING SOLUTION

The battery acid bath (electrolyte) should be made up as follows:-

A reliable source of high quality battery acid can be obtained from NAPA AUTO STORES
See **www.napaonline.com** for a store near you.

Using a plastic container mix up the following solution:-

Add battery acid to water - stirring constantly. Do not add water to acid!
Battery Acid is a mix of Sulfuric Acid and water 33% acid 66% water.
Specific Gravity = 1.26

For general purpose anodizing:-

Add 3 quarts of distilled water
Add 2 quarts of battery acid

For Hard surface anodizing:- This is specialized and not normally used.
Add 4 quarts of distilled water
Add 2 quarts of battery acid

For dyeing anodize-

Add 2 quarts of distilled water
Add 2 quarts of battery acid

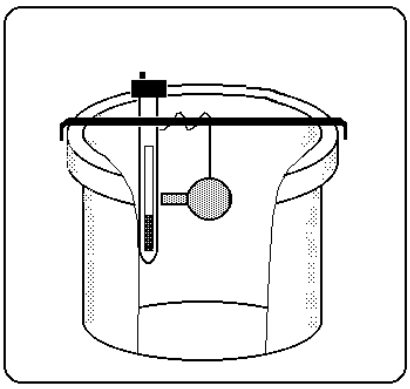
Multiply these amounts if you wish to make a larger tank.

All these solutions operate at 70-75 deg F (20-25 deg C)

Add the Fume Control Balls. These help reduce fumes, hold in the heat and reduce evaporation.

Add one teaspoon of Anodize Fume Control per 2 gals made up anodizing solution.
You will need to add more of this occasionally, if you begin to notice an odor during operation.

Aluminum De-Oxidizer & De Smut.



Aluminum De-oxidizer is a concentrated, easy to use liquid material designed to deoxidize and de-smut aluminum prior to anodizing, bright dipping and chromating. Aluminum De-oxidizer is non-chromated, yet offers performance comparable to or better than most chromate bearing products. The product is especially useful on certain types of aluminum alloys found on Japanese motorcycles, which have a certain amount of zinc in them. The prescence of zinc makes the casting smut as soon as it enters the anodizing tank. Pre-dipping with Aluminum De-oxidizer reduces this problem.

PRODUCT FEATURES
No chromate disposal problems.No heat required.

EQUIPMENT
Tank: HDPE Plastic tanks
Agitation: Continuous air agitation is recommended to increase effectiveness.

OPERATING PARAMETERS

Concentration:Mix 1 qt (1 liter) of Aluminum De-oxidiser with 2 gallons water
Temperature: 70-110°F Optimum 100 deg f
Immersion time: 1-3 minutes
Water: De-ionized or distilled

SOLUTION MAKEUP
Before making up or replenishing the working solution, refer to the Material Safety Data Sheet for protective safe handling measures.
1. Fill tank 2/3 full of water.
2. Add required amount of Aluminum De-oxidizer to the water with mild agitation.
3. Add water to operating level and mix again.
4. Adjust heater to 100 deg F

To prevent excessive heat generation and spattering, never add water to Aluminum De-oxidizer. Always add Aluminum De-oxidizer to water. Add in small amounts over the entire surface of the solution with mild agitation.
Dip the parts into the solution for 1-3 minutes, rinse in fresh water, then immediately proceed to anodize the part.

Operating the Anodizing System.

1. **Check the part for cleanliness**. After thoroughly preparing the part, by bead blasting, polishing etc. ensure it is completely degreased by using the 'water break test'. Simply run water over the part, if the water sheets evenly, then the part is clean. If it 'balls up' or spots, then it needs further cleaning. At this point, the part should already be wired up to the tank bar. This will prevent you from handling it.

2. **Caustic Etch**. Dip, for a few seconds only, into a room temperature solution of Caustic Soda (Sodium Hydroxide or Lye) This is usually sold under the brand name "Red Devil". Add 6 oz per gal of water. This operation may be ignored, especially if you have a highly polished part, as the etching action will dull the finish slightly. However, the part MUST pass the 'water break test'. Rinse the part.

3. **Anodizing De-Oxidizer** Dip the part for 1-3 minutes into the pre-mixed solution at 100 deg F. See the section on Aluminum De-oxidizer.

4. **Rinse**, thoroughly in fresh water. Agitate the part, and if necessary, spray with water to rinse chemical from hard to reach areas. A shower hose attached to a faucet is a great idea.

5. **Anodizing the Part**. Place the pat into the tank, and connect the tank bar to the positive side of your power supply. Make sure the negative wire is connected to the GP Plates (cathodes). Switch on the power. You should see small bubbles moving around between the part and the GP Plates.

   Genral Duration of Anodizing.
   - Jewelry 15 minutes
   - Small hand tools, implements etc. 30 minutes
   - Motorcycle parts subject to road abrasion 60 minutes

   Anodize film forms at the rate of 2-3 minutes per 0.10 mil oxide coating thickness. 24 microns = 1 mil

   Remember: Parts requiring deep colors will require longer anodizing times – experiment.

   Remove the part from the tank and rinse off in distilled water - thoroughly.

6. **Acid Neutralizer.** Make up a tank of 1 gal distilled water and 1/2 lb baking soda, as your neutralizer tank. Before proceeding to dying, the part must be completely ridden of acid; otherwise, this will cause you problems. Acid dragged from the anodizing tank into the dye tank will cause streaking and blemishes. It will also eventually alter the dye's color. After neutralizing, rinse in fresh or distilled water.

7. **Dying**. (If a clear anodize is required, skip this part). It is important to try to dye the part as quickly as possible after growing the anodize film, otherwise the pores will begin to close up, and the dye will not be able to penetrate quite so effectively. Dying techniques are covered in a separate section. Rinse in fresh water.

8. **Fixing (or sealing**) Using the porcelain steel container supplied with the kit, place 1 or 2 gals of water, depending on what will cover the part, and add 1 oz per gallon of ANODIZING SEALANT POWDER, and bring to the boil on any heat source, such as a gas or electric burner. Then place the anodized part into the tank, using the tank bar as the suspension support. Boil for 2-3 minutes per 0.10 mil oxide coating thickness. 24 microns = 1 mil Wipe the parts dry and immediately apply a mineral oil (WD40 etc) with a soft cloth.

9. **Polishing.** You may polish the part using a loose cotton buffing wheel and either a white or blue buffing compound. Be sure to take care, the anodize film is not very thick. You could damage it.

Dying the Anodize

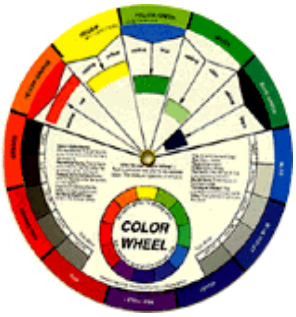
The dying of anodized aluminum is probably one area where artistic creativity can really come to the fore. Limited only by your imagination, parts can be dyed in many ways and colors, to create amazing results. The application of the dye can be done in several ways: simple immersion for a single color, multi immersions for two or three tone effects, air brush painting, silk screen, splash dying etc. etc.

Code	*Color name*
DYERB9	Red Bordeaux 2R
DYEY9	Yellow 4A
DYEB9	Blue 4A
DYEV9	Violet 3D
DYEBLK27	Black HBL
DYEGR9	Green SCG
DYEGO9	Gold S (Simulates Gold Plate)
DYET9	Turquoise PLWN
DYEGRY9	Grey BL
DYEOD9	Olive Drab
DYEBR9	Brown GL
DYEO9	Golden Orange

Here, we hope to address all of these techniques, but your best way of getting the most from this process is to EXPERIMENT!

Caswell Inc now carries a range of professional dyes. For a color sample, please visit our web site @

http://http://www.caswellplating.com/anodizedye.htm

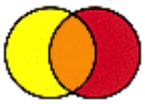


These dyes can be mixed together to create a host of different colors. The dyes are in concentrated liquid form, a 4oz bottle makes up 2 gals of ready to use dye. To make up different colors, we suggest that you make up the colors to the correct dilution first, then take a quantity of each dye and blend them together.

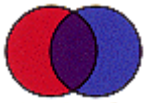
A color wheel is supplied with all anodizing kits.
The use of a color wheel will give you a good concept of what to expect when dying.

What Does the Color Wheel Do?

The Color Wheel shows how the three primary or parent colors (the only colors that cannot be made by mixing two others) relate to each other. The wheel clearly illustrates the results of color mixing. For example, equal amounts of two primary colors (red, yellow, or blue) create secondary colors (orange, green, or purple).


Yellow + Red = Orange

Blue + Yellow = Green


Red + Blue = Violet

Anodizing dyes are transparent, so this means you can 'overlap' colors, just as in the diagram above. The dye colors also mix well, which allows plenty of variety in 'mix 'n match' dying. When over-dying, consideration must be given to the color wheel, red and yellow = orange, blue and yellow = green etc. These colors are adjacent to each other on the wheel. However, if you try to dye across the wheel, eg: yellow & violet, or blue and orange etc, you will get only shades of brown. Dying green over red gives you black or brown.

Anodize the aluminum at 72 deg F for 30 minutes @ 12 - 18 volts @ 14 amps per sq foot or 0.1 amp per sq inch. This will yield a film thickness of approx 12 microns. When using a battery charger, simply make sure that the rating is higher than this, and the anodizing process will draw what it needs. After thorough rinsing, immerse the part in the dye at a temperature of 140 deg F for 15 minutes. Finally, seal by hanging the part in a steam bath for 30+ minutes

COLOR MIXING

You have some choices when it comes to creating new colors.

- **A. You can premix the dyes.** This involves some experimentation to get exactly the right color.
- **B. You can over-dye.** Starting with the lightest color, simply dip the part in, rinse off, then dip into the next color, and so on. Using this technique, you can easily see exactly what is happening, and you don't waste your original colors by premixing.
- **C. Toning a dye color.** Various shades can be created by dipping the colored anodize into a black dye.
- **D. Shades of color.** The duration of dipping time will lighten or darken the overall color of the dye.

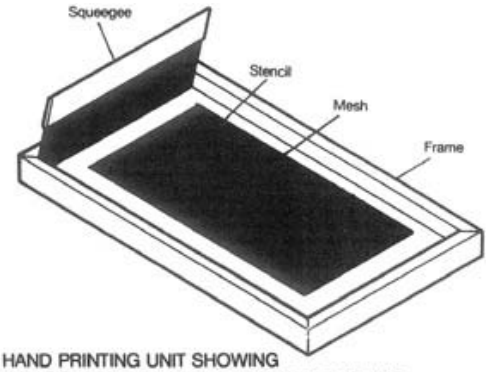
COLOR APPLICATION

There are an almost infinite number of ways you can apply dye to anodized surfaces.

- Immersion.
  - Full immersion to produce one solid color
  - Partial Immersion to produce two or more colors
  - Over dying by immersion.

- Direct Application
  - Air Brush (see right)
  - Paint Brush
  - Syringe
  - Eye Dropper
  - Sponge
  - Splash or spill over
  - Silk Screen
  - The dye may need to be thickened. This is accomplished using the following materials:

Water 1000 parts
Corn Starch 75 parts
Tapioca Starch 25 parts
Gum Tragacanth 225 parts



HAND PRINTING UNIT SHOWING
4 BASIC COMPONENTS OF SCREEN PRINTING.

Add this mix @ 20% to 80% of the dye depending on the consistency required.
There is a huge potential for silk screen work in the decoration of aluminum for road vehicles. In particular, the motorcycle and Hot Rod enthusiasts would love to see the large areas of aluminum, such as side covers, with more permanent decoration. By using a silk screen process, and starting with the lighter colors, several colors could be screened over the aluminum, to create full color logos etc. Pastel dyes could be used as a background color. A good example would be a side cover from a Harley motorcycle. Dip it in the gold dye first, then screen on the orange of the Harley logo, and finally screen on the black element of the logo. The part would need to be set in a jig of some sort, to ensure the logo colors are printed in the correct places. A little 'Imagineering' and a small production run could easily be set up.

MASKING OFF

There may be areas where you want the original color of the metal to show through, yet total immersion would spoil the effect, or you may want to create patterns in the over dye or subsequent colors. To prevent dye from affecting these areas, a number of 'masks' can be used, such as: masking tape, Avery Labels, clear contact paper, rubber cement, grease pencils, etc. Liquid masks can also be applied using a simple silk-screen process. Grease pencils will be removed in warm water. Check the melting point of the pencil.

REMOVING DYE

You may find that a mistake has been made on your work-piece, perhaps the color is wrong, whatever the reason, you have to remove some, or all, of the dye. As long as the part has NOT been sealed, most dyes will easily be removed by immersing in household bleach. We've found that our black dye (the most dense color) whites out in about 1 minute with a splash of bleach. Rinse the part thoroughly afterwards in room temperature water (not hot, or you will start to seal the anodized surface). You may apply the bleach with a brush, or a cotton swab, or you may even fully immerse the part.
MAKE SURE YOU DO NOT ACCIDENTALLY DROP BLEACH INTO ACID, (e.g. the anodize tank), AS THIS CREATES DANGEROUS FUMES!

If the part has been sealed, then you can immerse it in ANODIZE STRIPPER to remove all the dye along with the anodize film. Of course, after doing so, you'll have to re-anodize the part.

SEALING THE ANODIZE WITH ANODIZING SEALANT
High Temperature Sealant. (Do not confuse this with a room temperature system which will allow some colors to leach out.)

Any lined vessel may be employed for sealing.
Ceramic lined or stainless steel cooking pots are ideal.
Do NOT use aluminum, as it causes problems.
Always use distilled water, as ordinary water may leave mineral deposits on/in the film.

Anodizing Sealant is a nickel acetate compound for sealing anodic coatings on aluminum. Anodizing Sealant is a fine flowing greenish powder, readily soluble in water. It is specifically formulated with a pH regulator and an agent to help minimize smut. Anodizing Sealant is suitable for clear anodize and offers increased weather and light-fastness on coatings dyed with aluminum dyes.

OPERATING PARAMETERS

Make up a solution of 1 oz per Anodizing Sealant to 1 gal of distilled water - or 7.5 grams per liter
Time:5 to 30 minutes depending on anodize thickness (2-3 minutes per 0.10 mil oxide coating thickness) 24 microns = 1 mil. (The anodize film will grow at the rate of 0.10 mil every 3 minutes of anodizing.)
Temperature:202-210°F
pH:5.5 to 6.0
Water:Deionized or Distilled water

CONDITIONS FOR USING ANODIZING SEALANT

Tank:Sealant solution should be contained in a non-metallic or ceramic lined steel tank.

pH: pH adjustments will not be necessary unless acetic or alkaline compounds are carried over into this sealing bath. Then acetic acid (to lower pH) or ammonia (to increase pH). Acetic acid is difficult to come by, and it is preferable to discard the bath, especially as it has a limited shelf life anyway.

Rinse: Before sealing, a thorough rinse is necessary to remove any foreign substances. After sealing, the work should be thoroughly rinsed at once, as is normal in nickel acetate sealing, before it is dried.

Filtration

Filtration clears the bath of precipitates with interfering action. Filter through coffee filters after each use.

Maintenance: Bath life is 14-60 days dependent upon operating conditions and bath upkeep.

BATH TURBIDITY

Freshly prepared nickel acetate sealant baths are clear green solutions. In use they become contaminated by precipitates and grow cloudy. If not removed, these contaminants can form deposits on the sealed surface. The effect can be due to the following: High pH (at pH values above 6.0, nickel acetate may be converted into soluble nickel hydroxide), hard water and entrained impurities.

The following measure can be taken to minimize this affect: Maintain pH value of 5.7 ± 0.3, through rinsing of anodized, dye or un-dyed work prior to sealing to prevent possible introduction of contaminants and filtration to clarify the bath and to prevent surface deposit formation

BATH REPLENISHMENT

As mentioned the bath life will range from 14-60 days. This is due to contamination of the sealing bath and decrease in the active substance. A decrease on preventing smudging and an increase in smut may be noticed. Thus even when the bath concentration is strengthened regularly, the Anodizing Sealant must be replaced from time to time.

BATH CONSUMPTION

The consumption of Anodizing Sealant is calculated from the amount absorbed by the anodic film, the amount carried out of the bath and the amount of active ingredients inactivated by the introduction of foreign substances. Below is the average consumption of Anodizing Sealant per unit area of sealed surface:

Absorption by the film0.4 g/m2
Amount carried off.3 g/m2
Consumption for strengthening additions7.0 g/m2

STRIPPING THE ANODIZE FILM

Mix up a solution of 4-6oz of Anodize & Chrome Stripper with 1 gal of water. Add the powder slowly to the water.

Dip the anodized part into the solution for between 20 seconds and 10 minutes, depending on the thickness of the existing anodize film.

Rinse off the part thoroughly in fresh water.

Test for anodize film (see below) and if present re-immerse.

Ideally, the solution should be at approx 70 deg f plus. The hotter the solution, the more rapidly the anodize film will be stripped.
Solution temperature range is 70-150 deg f.

Use only plastic vessels, not aluminum as this material is extremely corrosive to this metal.

TESTING FOR ANODIZE FILM CONTINUITY

Anodize film in non-conductive, whereas the actual aluminum is not.
It is therefore relatively easy, using a multimeter, to determine if we indeed have grown an anodize film.
Set any multimeter to the 1000 ohm setting.

Place the black and red probes on the aluminum in different places. The needle on the multimeter dial will swing over if there is NO anodize film. If you have grown an adequate film, then the multimeter will not register at all.

Some Interesting Points about Anodized Aluminum.

Anodized aluminum has a very durable surface that is unaffected by weather and many chemicals
The surface will resist high temperatures, even a blowtorch, for short periods.
Many other types of dye may be used with varying effects, fabric dye, leather dye, water-based ink, felt tip pens etc.

Anodized films are usually measured by their intended operation:

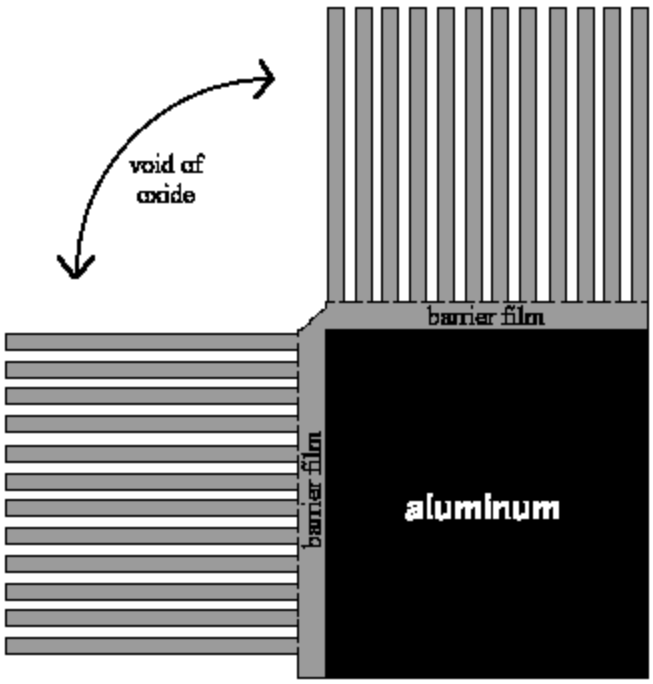
Interior or unexposed articles	0.1 - 0.2 mil (mil = 1/1000")
Auto Trim	0.2 - 0.4 mil
Architectural or construction	0.8 -1.0 mil

Once a part has been anodized, it cannot be reshaped, and any great degree of flexing will cause the anodize film to crack.

Sharp edges can create problems, because the anodize pores grow out at right angles to the metal. On the example here, the corner area is almost completely void of pores. This will show up when dying.

Consideration needs to be given to this phenomenon, and sharp edges should be rounded over.

Pore diameter and barrier film thickness will vary depending on the voltage and the electrolyte temperature. Different alloys will also have different effects. Pore size is related to voltage, higher volts means larger pores. This can sometimes have adverse effects on dying, because the pores are too large and the dye runs out.



TROUBLESHOOTING ANODIZING

FAULT	PROBABLE CAUSE	REMEDY
Decrease in depth of color	Bath contamination Dye used up	Improve rinsing Extend dying time Replace bath
Color depth changes in a production run	Anodizing film is inconsistent	Improve conditions to ensure constant procedure
Color differences	Irregular current in anodizing procedure Different alloys	Clean contacts Dye only similar alloys
Darker edges	Irregular current density and heat building up film	Reduce current/heat Lower dye temp and dye for longer period
Large cloudy areas	Anodizing temp not uniform	Increase air agitation
Pale spots	Oily Uneven wetting of the parts when dying impurities Local overheating by polishing Gas bubbles on anodize pores	Add 2 drops liquid detergent Immerse in the wet state only. Agitate the parts in the dye bath. Re-anodize -briefly Agitate parts. Increase air agitation.
Dark Spots	Over heavy dyeing, superficially attached particles	Reduce dying temp & extend dying time. Clarify dye bath by filtering.
Dull &/or chalky dye (probably won't wipe from surface.	Inadequate anodize, too soft. Current free suspension in anodize. Coating attacked by low anodize bath pH.	Reduce anodize temp/time &/or acid concentration. After switching off current, remove parts & rinse off. Increase PH to 4.
Opaque & dull coating, removed by wiping.	Excess of hydrolysed aluminum.	Replace dye bath. Acid dip part prior to dying to dissolve & clear aluminum.
Surface pitting & soft coating	Part to close to the cathode	Increase tank size &/or move part further away

ANALYSING DYING PROBLEMS

Questions to ask	Main Reasons parts fade:
1. What dye was used? 2. What was dye-bath concentration, ph and temperature? 3. What was the oxide coating thickness? 4. How long was the part dyed? 5. What sealant was used? At what concentration, temperature, pH and time? 6. Were the parts cleaned, etched and deoxidized prior to anodizing? 7. Does the faded part have exposure to light from a window? 8. Does the part get hot?	1. Wrong type of dye used. 2. Parts not dyed long enough. 3. Oxide coating to thin. 4. Poor sealing. 5. Parts exposed to high temperatures. 6. Interior parts were dyed with wrong type of dye and placed by a window. 99% of the time, the cause is dye time (too short), poor sealing and too thin oxide coating. Please remember, just because a dye may have a good rating for lightfastness, it does not mean that it will have an unlimited life expectancy.

SULFURIC ACID ANODIZING

Sulfuric acid anodizing produces oxide coatings with excellent corrosion and wear resistance. It is also the basis for most decorative coloring finishes on aluminum in use today. The information on anodizing listed below relates to standard anodizing (type II) parameters.

Sulfuric acid (free)165-225 g/l	Aluminum content 5-15 g/l
Current density 12-15 amps./ft. sq.	Voltage 15-25 volts
Current D.C.	Temperature 70°-72°F
Time10-75 minutes	Oxide thickness 0.10-1.0 mil.

The direct current sulfuric acid process is preferred because it produces a coating with optimum properties for dyeing with organic dyes and inorganic colorants.

In the adsorptive dyeing of anodic coatings, the final shade is not determined by the dyeing process alone, but to a great extent by the properties of the anodic coating structure, which are determined by the anodizing parameters.

Deviation from standard anodizing conditions

Standard Parameter	Deviation from standard	Difference in intensity of dyeing
Sulfuric acid concentration	higher	deeper
	Lower	paler
Aluminum concentration	higher	alter coating structure
	Lower	slightly paler
Current density	higher	paler
	Lower	deeper
Temperature	higher	deeper
	Lower	paler
Time	longer	deeper
	Shorter	paler
Oxide thickness	thicker	deeper
	Thinner	paler

Sulfuric Acid Concentration

Most conventional sulfuric acid anodizing is carried out using electrolyte concentrations ranging from 165-225 g/l free sulfuric acid. An increase in the sulfuric acid concentration intensifies re-dissolution of the coating, producing a pore structure of greater average diameter allowing dyeings of greater intensity. It is most important to maintain the free sulfuric acid concentration within narrow limits to ensure successive dyeings of equal intensity.

Aluminum Content

Experience has shown that the presence of small amounts of aluminum in the electrolyte is advantageous. The dye adsorption capacity decreases when the aluminum content is below 5 g/l, but remains constant at higher concentrations. Aluminum content above 15 g/l lead to irregularities in the anodic coating. It is good practice to keep the aluminum between 5-15 g/l.

Current density

The standard current density is carried out 12-15 A/Ft 2. An increase in the current density decreases the porosity of the anodic coating and thus the dye adsorptive capacity is lower since the metal is exposed for a shorter time to the dissolution action of the sulfuric acid. At very high current density, burning of the parts can be caused by high current flow at local areas and overheat the parts.

Voltage

The voltage is given by the anodizing parameters and the type of alloy being anodized. It usually will range between 12-25 volts.

Temperature

Standard anodizing temperature for sulfuric acid anodizing (type II) is 70°-72°F. A higher temperature increases the dissolution of oxide and limits the amount of anodic thickness attainable, but results in a more porous or softer films with a higher capacity of dye adsorption. However, as the pore size is increased, sealing becomes more difficult and more dye will bleed during the sealing process.

Anodizing Time and Coating Thickness

Anodizing time can range from 10-75 minutes with an anodic coating thickness in the range of 0.10-1.0 mil. The anodic thickness is dependent on the current density and the time left in the anodizing solution. The current density needed can only be calculated in plant production. The anodic thickness increases with increases in time.

Rinsing After Anodizing

Thorough rinsing after anodizing is important to remove all acid residues clinging to the work. Insufficient rinsing can result in the drag-in of the electrolyte into the dyebath causing uneven dyeing, streaks discoloration, and/or dyebath contamination. Double rinsing is recommended with at least one of the rinse tanks with overflow.

TITANIUM ANODISING

For reference only

Any electrolyte will do: phosphoric, coca-cola, sulfuric
Colors are achieved by varying oxide thickness.

Colors are achieved thru refraction of light on titanium surface.
The color changes with the voltage rather than amperage.
Clean parts in 25%-30% nitric with 2-4 oz/gal HF

1-8 volts	yellow
9-12 volts	brown
13-20 volts	maroon
21-25 volts	blue
26-35 volts	green
36-45 volts	gold
46-50 volts	rose
70 volts	purple/fuscia

BRUSH PLATING with PlugNPlate
(power pack is 4.5v DC @ 300ma)

The following solutions are available for use with PlugNPlate adapters

Solution	Size	Wand
Nickel	8oz	Stainless
Copper	8oz	Copper
Copy Chrome	8oz	Stainless
Brass	4oz	Brass
Gold	4oz	Stainless
Silver	4oz	Stainless

Gold, silver and brass are also supplied in 1 pint bottles. Nickel, Copy Chrome and Copper should be purchased from our standard price list as 1 gal 'crystal' packs. The same solution for tank plating is used for brush plating. Larger quantities of Brass may be purchased by the liter.

General Setup

The PlugNPlate power supply for Brush Plating has two terminals. The red plug is designed to fit into the open end of the plating wand. Sometimes this may be a little loose, but this can easily tightened by placing the plug into the wand, then gently squeezing the wand case with a pair of pliers, until the fit is tighter.

The black alligator clip must be attached to the work-piece. The blade of the wand must be wrapped with the bandage in such a way that no metal is showing. This should be done as if the bandage was being applied to a cut in the tip of a finger. The end of the bandage should be secured by a rubber band of a small piece of sticky tape.

The PlugNPlate power supply should be plugged into a 110 volt power outlet. Make sure the two terminals are not touching, as this will short out the unit, causing irreparable damage.

Making up your brush plating wands.
Clean off the metal blade with some steel wool, then wrap a cotton ball around it. Cover with the bandage supplied, wrapping the entire metal area carefully, ensuring NO METAL is showing.
Secure with a rubber band. The wand should now look like a huge Q-Tip. Plug the red plug into the end of the wand.
Occasionally, oxides will build up on the plating wand blade. These should be removed with a wire brush or emery paper.

Surface preparation
All surfaces must be highly polished and thoroughly cleaned, with no corrosion. This can best be achieved by buffing and polishing.

Brush Plating Procedure

Pour a small quantity of plating solution into an eggcup sized plastic container. (The actual lid of the plating solution will do). Firstly, dip the clean wand into the entire bottle. Hold onto the bottle, otherwise it WILL tip over. Let the solution thoroughly soak into the bandage. This should take about 30 seconds.

Proceed to brush plate the area to be treated, using soft strokes, (somewhat like stroking a cat). Do not stop in any one place, otherwise 'burning' will occur. You should plate at about 1 sq. inch per minute. After a few seconds, you will find that the plating is no longer proceeding as quickly. This is because all of the metal has been used up from the solution contained on the wand. Dip the wand in the smaller amount of solution (in the eggcup), and NOT in the main bottle. Harmful oxides build up during brush plating, and repeated dipping of the contaminated wand will spoil many of the solutions. You may repeatedly dip your wand into the smaller amount of solution.

If the plating has black streaks, speed up the wand action and press down harder. A few more passes over the blackened area will clean it up. This is especially prevalent with silver plating. To improve the finish of a repair to a silver plate, we recommend a final clean/polish of the entire surface of the part with SILVERSMITH or SILVERPLATER solution.

Technical Tip. Place the solutions (in a glass container) in a microwave, and heat on high for approx 30 seconds before plating, to attain approx 140 deg f.. At the same time, place the part to be plated into hot water. When warm, proceed with plating. The additional heat will dramatically improve plating speed.

BRUSH PLATING WITH COPY CHROME

Copy Chrome is a nickel alloy, harder than nickel and with a blue tint like chrome. It should be plated directly to the metal, and does not need an underlying layer of nickel plate like a normal chrome plate. Because of its extra hardness, it is important to ensure the part is highly polished prior to plating, as this finish is harder to buff than nickel.

Gold Emblem Plating using PlugNPlate

The system must be applied to a nickel or buffed copper plate surface.

To plate emblems requires a two step process:-

1. Stripping. Removing the existing chrome.

- Attach a plating wand to the NEGATIVE side of your power pack. You can clip the alligator clip inside the end of the wand, ensuring electrical contact with the metal. Press the positive terminal plug to the work piece.
- Make up a stripping solution of 1 level spoonful of CASWELL ANODIZE & CHROME STRIPPER or SODIUM HYDROXIDE or Lye, to 9 spoonfuls of water, in a plastic container.
- Pour a small quantity of the stripping solution into a plastic cup. Use only this liquid, and the original solution will stay fresh.
- Saturate the wand with the stripping solution.
- Stroke the wand slowly & gently over the work piece. The wand's cotton will turn yellow as the chrome comes off.
- The work piece will change color slightly as the chrome is removed.
- To ensure all the chrome is off, apply fresh cotton and bandage to the wand, then dip in fresh solution and lightly repeat the process. If no yellow appears on the wand, then the part is successfully stripped.
- Rinse the part in fresh water.
- To remove chrome faster, you may attach the wand to a 12 volt power supply, rather than use the PlugNPlate adapter.

2. Plating. Applying the gold plate.

- Attach a plating wand to the red plug on the PlugNPlate adapter.
- Pour a small quantity of Gold solution into a plastic cup. Use only this liquid, and the original solution will stay fresh.
- Saturate the wand with Gold solution. Stroke the wand slowly & gently over the work piece.
- Initially you may increase the wand speed slightly, then, as the gold color forms, slow the speed down to build up a thicker layer of gold.
- The gold will become visible after 30 -60 seconds for 1-2 square inches of treated area.
- Repeat the gold application to increase the gold's durability.
- Finally, wash with detergent, and rinse with water.
- You may polish the metal with a proprietary metal polish. We recommend Collinite Metal Wax, as this has a very mild abrasive in it, which cleans off brush plating smut marks and at the same time waxes and protects the plate. Use sparingly on silver and gold plate.

Additional tips for Brush Plating

Always check that the bandages are in good condition. Worn areas may allow the wand to touch the work piece, causing a short circuit and burning the work piece.

The gold wand bandage will become soiled with a green substance after plating. The degree of this will depend on plating action and time.

Dark spots or streaks that occur during the gold plating may be from brushing too slowly.

Remove and wash all bandages after use. Dispose of cotton ball.

Plate only articles that are in good condition. Gold plate will NOT cover imperfections, such as scratches and pits.

Plating larger objects can be more difficult than small ones. Practice your technique on the smaller objects first.

Some objects may actually be covered with a type of chrome paint or lacquer. Test the piece first by checking that it is conductive, using a multi-meter.

Trying to match existing gold supplied by another company is difficult as shades vary.

An application of a lacquer, or polyurethane, over a plated item will increase its wear, reduce water spotting and enhance the gold's color.

DIP PLATING with PlugNPlate

Sometimes it is much easier to simply dip the part into the solution to plate it, especially if it is small with lots of detail. The PlugNPlate power supply and plating wand can easily be used for this procedure.

Pour all of the plating liquid into a small wide necked container, such as a glass.
Place the plating wand into the solution and clip it to the side of the glass with a clothes peg.
Attach the work-piece to the negative alligator clip and suspend the part into the solution.

The degree of plating will depend on several factors:

1. **The amount of anode** (plating wand) immersed in ratio to the size of the part. The larger the part, the more surface area of the wand should be immersed. (Too much wand will make the plating appear smutty or dark).

2. **The distance of the anode from the work-piece.** Being too close will cause similar problems to #1.

3. **The temperature of the solution.** Generally, the warmer they are, the better they plate, and the less current you need.

4. **The duration of plating time.** This will depend on which plating kit you are using. Gold should only be plated until the color is right. Copper should be plated until the thickness is adequate, especially if you are using it to build up an area. Nickel and Copy Chrome should be plated for at least 5 minutes. Silver, being a soft metal, should be treated somewhat like gold, but make sure you have enough plating on the part to enable it to withstand polishing etc.

5. **Silver will often plate a dark smutty color.** This will polish off, but you can reduce this by plating with a very small amount of the wand immersed, or by using the Copy Cad PlugNPlate power supply. A final treatment using a sparing amount of Collinite Metal wax will also clean the smut and leave a wax protective film, which will reduce tarnishing. Swishing the part through the solution as it plates will also dramatically reduce the smutting problem.

Silver PlugNPlate kits are supplied with a 1.5 volt power supply and a spare banana plug. Replace the red alligator clip with the banana plug for brush plating.

With silver and gold Plug N Plate systems, you may substitute the wand for a small piece of silver or gold. This will enhance the life of the solution. (Do NOT use plated items as the anode, they MUST be made of solid silver or gold. (The anode must be held so that the wire connection is out of the liquid, otherwise the wire will dissolve and contaminate the solution)

Note the clothes peg holding the plating wand to the side of the glass.

Rub on Silver Plating

SILVERSMITH & SILVERPLATER
Articles that are normally silver plated include: flatware, tableware, ornaments, jewelry and headlight reflectors on older vehicles.

Using no electrical power at all, both SilverPlater and SilverSmith are applied with a small piece of cloth (chamois leather is ideal) and by gently rubbing the part to be plated, the pure silver is deposited from the liquid onto the part. The friction sets up static which deposits the silver. This material is ideal for any item, which has worn and tarnished silver plate, which is usually patchy in the high wear areas. The action of rubbing activates a mild cleaner which removes existing tarnish and dirt, and then lays down a layer of silver onto the cleaned metal.

Silver plate naturally tarnishes and is easily worn away the by repeated cleaning. Using SilverPlater or Silversmith as a cleaner actually adds more silver to the part each time you clean, so it will never wear through again. If you have trouble in getting a plate to appear, simply warm the bottle of SilverPlater and the part, by immersing them in a pail of hot water. Dry the part, and then continue to apply the solution. The heat will dramatically increase the plating activity.

You cannot apply SilverPlater & Silversmith to Pot Metal or Steel. Ideally they should be applied over a nickel plate, but can be applied over copper, brass, bronze, nickel, zinc and existing silver. If the original plate is worn below any of the base plates, exposing steel or pot metal, you should brush plate those areas with a nickel plate before re-silvering.

It is very important that you wash the part in hot water, immediately after the application of SilverSmith or SilverPlater, otherwise the residual chemicals will tarnish the silver.

SilverPlater is a milder version of the product containing NO cyanide; anyone can purchase it. The application will take a little longer than using Silversmith, rubbing from some 30 seconds to 1 minute before the plating becomes apparent. Silversmith contains cyanide, and is forbidden in domestic households by Federal Law. We can only ship this to registered businesses. It works in exactly the same way as SilverPlater, but much faster, 10-20 seconds. We recommend this product to commercial setups, especially for flatware and headlight reflectors.

The use of SilverSmith or SilverPlater as an overall cleaner after using the PlugNPlate silver brush plater, will help blend in areas that have been repaired using the brush on PlugNPlate system. The latter will lay down heavier layer of silver much faster than the rub-on technique.

At typical repair technique would be to:

- Clean the area using ‘Soft Scrub’ the kitchen cleaner
- Polish the worn area, using a buffer with jewelers rouge or blue compound & a soft wheel.
- Apply a heavy layer of silver plate using the PlugNPlate brushing technique to the damaged area.
- Apply SilverSmith or Silver plater to the entire workpiece, blending in the repair.
- Apply a coat of Collinite Fleetwax, or any carnuuba wax product.
- Polish with a very soft cloth.

Silverplater contains Silver Nitrate which is poisonous.

SilverSmith contains a small amount of cyanide -which is extremely poisonous. Read the product labels for full instructions.

SILVER PLATING KITS

Caswell Silver is a new type of alkaline cyanide free silver plating solution that will plate over nickel, sterling silver, gold, rhodium, copper, brass and bronze. The system will provide uniform color consistency and even coverage.

The solution is supplied ready for use and must not be diluted.

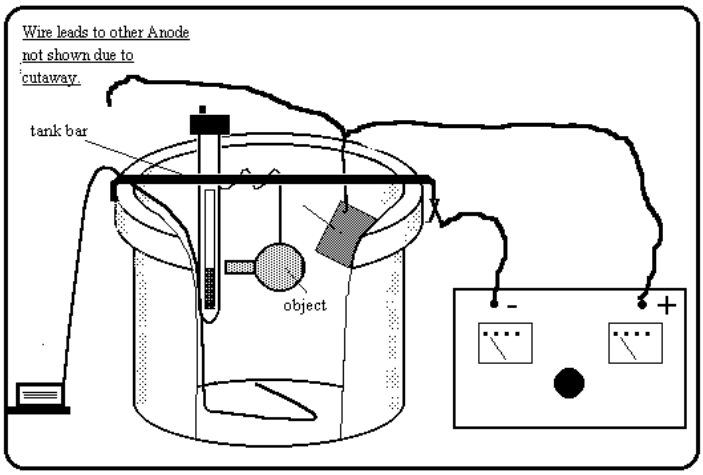
Once the initial tank is setup, mark the liquid level on the side of the tank. Use this level to occasionally top up the level with distilled water.

Stainless steel anodes may be used, but this will rapidly deplete the solution of silver. Silver anodes are preferred. To connect a silver anode to the power supply, solder a length of SILVER SOLDER WIRE to one end of the anode. This will enable you to place the entire anode into the solution, with no fear of contamination from the connecting power wires. The latter are usually copper and this WILL dissolve into the solution, causing contamination, if the wire is submerged.
Start plating at approx 1 volt and increase to 2-3 volts depending on the size of the part.

It is important when silver plating to realize what type of finish is required on the part. If a highly polished surface is required, the part must be buffed to a high shine before plating. If a matt finish is required, then the part should be beat blasted or buffed with something like a Britex wheel.

TANK TYPE	Plating
SOLUTION TEMP RANGE (Deg F)	75
AIR AGITATION	yes
PLATING TIME (Mins)	1-5
ANODE	Silver or stainless
ANODE BANDAGE	yes
VOLTS SHOWING ON VOLTMETER	1.5 - 3
AMPS REQUIRED PER SQ. INCH	0.007 - 0.003
FUME HOOD	no
USE AS A STRIKE COAT	no

Silver anodes should be suspended in the tank in a similar manner to all other anode types, by snipping a small strip and using this as the hanger. Due to lower voltages etc. you may make this fairly thin in the interests of economy. After the anode is used up, these strips may be used as a wand for brush plating silver.
After silver plating, rinse the part thoroughly in distilled water and dry completely with a hair drier or air line.



Lacquer or wax the part to prevent tarnishing, or use Silversmith or Silverplater, to maintain the shine.

Worn areas on antiques etc. may be built up with silver before tank plating, by using the PlugNplate silver setup and locally plating these defective areas. Clean off any smut before finally plating in the tank setup.

Alternatively, a strip cut from a silver anode may be attached to the positive side of a 1.5-3 volt power supply. Wrap a strip of bandage over the end, then dip into the tank silver solution,

then connect the negative wire to the part being repaired. Brush over the area with soft, even strokes until the silver is restored. Plating the entire piece will then give a more even layer of silver.

SILVER PLATING TROUBLESHOOTING

Problem	Cause	Remedy
Parts not plating	Poor connections	Check all wiring
Parts turn dark grey or black	Power supply is reversed. Current is too high	Positive must go to anode Reduce amperage
Parts turn hazy, cloudy or dark	Current is too high Temperature is too high Solution is used up	Reduce current Reduce solution temperature Discard and replace
Parts are dark and not plated	Current too low Not plated long enough Solution is old	Increase amperage Increase plating time Discard and replace solution
Parts have a yellow or orange tint	Amperage too high	Lower amperage

24 ct GOLD TANK PLATING KITS

Caswell 24ct Gold is a new type of alkaline cyanide free gold plating solution that will plate over nickel, sterling gold, gold, rhodium, copper, brass and bronze. It is preferred that copper alloys are given a strike coat of nickel. The system will provide uniform color consistency and even coverage.

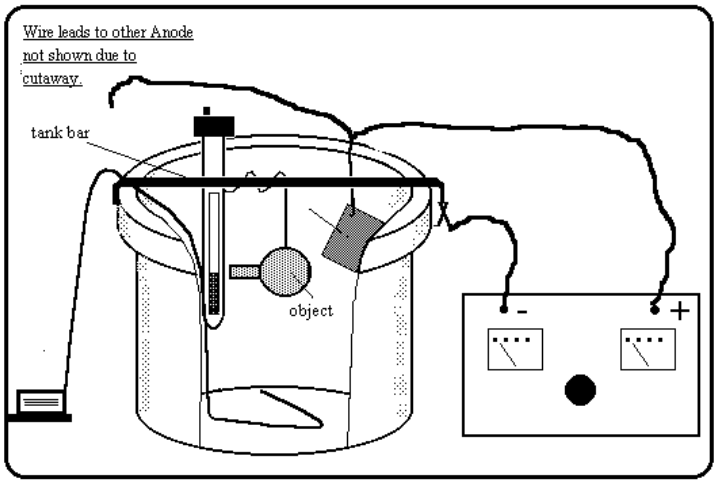
Once the initial tank is setup, mark the liquid level on the side of the tank. Use this level to occasionally top up the level with distilled water. The solution is supplied ready for use and must not be diluted.

Stainless steel anodes are used, to reduce the cost of using large gold anodes. The investment in replacing solution is less expensive than purchasing a large gold anode, especially for the larger items, where a 1:1 anode to work piece ratio is preferred. If scrap gold (not gold plate) is used, the solution life will be extended.

It is important to ensure that the operating temperature of the solution is maintained at 140 deg f.

The heater will take approx 2 hours to raise the temperature from 70 deg f to 140 deg f. To reduce the wait, we suggest transferring about 1 quart of solution to a plastic container, heating it to about 180 deg f in a microwave oven, then returning it to the tank. Once the temperature is reached, adjust the heater until the red light goes out. This will set the heater to maintain the 140 deg temperature.

TANK TYPE	Plating
SOLUTION TEMP RANGE (Deg F)	140
AIR AGITATION	Optional
PLATING TIME	30-60 seconds
ANODE	Gold or stainless
ANODE BANDAGE	no
VOLTS SHOWING ON VOLTMETER	2-4
AMPS REQUIRED PER SQ. INCH	0.003 - 0.007
FUME HOOD	no
USE AS A STRIKE COAT	no



Start plating at approx 2 volts and increase to 4 volts depending on the size of the part.

It is important when gold plating to realize what type of finish is required on the part. If a highly polished surface is required, the part must be buffed to a high shine before plating. If a matt finish is required, then the part should be beat blasted or buffed with something like a Britex wheel.

The anodes should be suspended in the tank in a similar manner to all other anode types, by snipping a small strip and using this as the hanger. After gold plating, rinse the part thoroughly in distilled water and dry completely with a hair drier or air line.

Lacquer or wax the part to maintain the shine. VHT Clear Lacquer provides an excellent thin coating for protection.

Worn areas on antiques etc. may be built up with gold before tank plating, by using the PlugNplate gold setup of *FastGOLD* and locally plating these defective areas. Clean off any smut before finally plating in the tank setup.

24 ct GOLD PLATING TROUBLESHOOTING

Problem	Cause	Remedy
Parts not plating	Poor connections	Check all wiring
Parts turn dark grey or black	Power supply is reversed. Current is too high	Positive must go to anode Reduce amperage
Parts turn hazy, cloudy or dark	Current is too high Temperature is too high Solution is used up	Reduce current Reduce solution temperature Discard and replace
Parts are dark and not plated	Current too low Not plated long enough Solution is old	Increase amperage Increase plating time Discard and replace solution
Parts are too 'rich' in gold color.	Amperage too high	Lower amperage Plate for a shorter time

***Fast*GOLD**
For Professional Quality Brush & Pen Platers

Designed to eliminate the dangerous cyanide process from brush plating, ***Fast*GOLD** is the obvious choice of professional gold brush & pen platers. The product will work with all types of brush & pen plating machines, giving superior results to most cyanide products.

***Fast*GOLD** is a new type of alkaline cyanide free gold plating solution that will plate over nickel, sterling gold, gold, rhodium, copper, brass and bronze. It is preferred that copper alloys are given a strike coat of nickel. It will not plate onto pot metal, any zinc alloy, zinc plate or steel, unless previously primed with nickel. The system will provide uniform color consistency and even coverage. In the case of chrome-plated items, the chrome must be removed to expose the nickel plate, before plating with gold.

Surface preparation
All surfaces must be highly polished and thoroughly cleaned, with no corrosion. Buffing and polishing can best achieve this.

Use ***Fast*GOLD** directly as supplied, alternatively make a gel by mixing in the thickening agent Cabosil. If using the latter, it is advisable to dampen the wand bandages with fresh water to initially aid absorption and conductivity.

TANK TYPE	N/a
SOLUTION TEMP RANGE (Deg F)	room
AIR AGITATION	no
PLATING TIME	30-60 seconds
ANODE	Gold or stainless
ANODE BANDAGE	yes
VOLTS SHOWING ON VOLTMETER	4-10
AMPS REQUIRED PER SQ. INCH	Depends on m/c
FUME HOOD	N/a
USE AS A STRIKE COAT	no

Brush Plating Procedure

Always decant a small amount of solution/gel into a separate container for actual usage. This will avoid inadvertently contaminating the solution with anything the bandage may pick up from the plating operation. Dip the wand in the smaller amount of solution and NOT in the main bottle. You may repeatedly dip your wand into the smaller amount of solution.

Proceed to brush plate the area to be treated, using soft strokes, (somewhat like stroking a cat). Do not stop in any one place, otherwise 'burning' may occur. You should plate at about 5-10 sq. inches per minute. After a short while, you will find that the plating is no longer proceeding as quickly. This is because all of the metal has been used up from the solution contained on the wand., so re-apply more product to the wand.

If the plating has dark spots, speed up the wand action and press down harder. A few more passes over the darkened area will clean it up.

To plate car emblems, see the section **Gold Emblem Plating using PlugNPlate**

***Fast*GOLD may be used with PlugNPlate kits**

BLACK OXIDIZING OF STEEL

This 'room temperature' Black Oxidizing system is a new technology in the blackening process, often known as 'Parkerizing'. Developed by a company specializing in hot blackening processes to eliminate the hazards and fumes from their process, this method is rapidly gaining favor with all types of metal finishers. Although Black Oxide does not provide the degree of protection given by plating, it does serve an important role in metal finishing. Ideally suited for nuts and bolts, where any increase in dimension would ruin the part, this process is used in many vehicle restoration applications. The system is also ideal for hand tools, subject to knocking, where a plated surface would simply chip off.

TO MAKE THE BLACK OXIDE SOLUTION

Pour 1/2 US Gal DISTILLED WATER into a plastic container.
Add 8 fl oz Black Oxide Concentrate (blue liquid).
(For larger quantities, keep the water and concentrate in the same ratio)

Leave for 30 minutes to age.

TANK TYPE	Dipping
SOLUTION TEMP RANGE (Deg F)	60-140
AIR AGITATION	no
DIPPING TIME (Mins)	3-10
ANODE	no
ANODE BANDAGE	no
VOLTS SHOWING ON VOLTMETER	none
AMPS REQUIRED PER SQ. INCH	none
FUME HOOD	no
USE AS A STRIKE COAT	no

Soak the part in SP DEGREASER for at least 5 minutes. Rinse in fresh water, or if not available, a good hot detergent solution.

Remove all rust using PICKLE # 1 or sand blast. Rinse in fresh water.

Immerse the part in the BLACK OXIDE CONCENTRATE for between 2-10 minutes. If the part is not suitably blackened, lightly brush with a soapy steel wool pad, rinse and re-immerse. As an alternative, you may wish to Electro-strip the surface for 20 seconds. See the section on Electro-stripping. A brown smut over the part is indicative of being immersed for too long. Clean off the smut with steel wool etc. and re-immerse for a shorter period.

Dip or brush the part in PENETRATING SEALANT ensuring it is thoroughly saturated. Soak for approx. 5 minutes. Shake off excess material and allow to dry. Both solutions may be used repeatedly.
To speed up the blackening process, warm the BLACK OXIDE CONCENTRATE to approx. 140 deg. f.
The degree of blackening will vary depending on the type of steel and the time immersed.

The BLACK OXIDE CONCENTRATE forms a whitish sludge, which sinks to the bottom of the tank. This is harmless to the process, but may be removed by periodically straining through coffee filters.

The rich black color will not occur until you seal the surface with PENETRATING SEALANT.

Oil the part in the normal manner using the PENETRATING SEALANT. Alternatively, you may lacquer the part with a flat clear lacquer.

For a more durable finish, plate with Copy Cad or Zinc, then use the Zinc Balckener process. This does add dimensional thickness to the part.

The Old Fashioned Way of Blackening Steel

A member of the fur trapping fraternity forwarded to us this ancient, but extremely effective method of blackening steel.
It is so simple and effective; we felt the technique was worth sharing. Originally, this technique was used to protect steel traps from rusting.

One can almost imagine a fur trapper, alone in the backwoods, accidentally discovering that an old metal bucket, absent-mindedly left under a walnut tree in the fall, became full of dropped walnuts and rainwater. This 'soup' had a strange blackening effect on the metal bucket, which had not rusted. The technique for removal of rust using wood ashes could have easily been similarly discovered. These two simple concepts were used together to give the backwoodsman some low technology corrosion resistance.

> *"As I recall the old method was to use a large wash tub, these held some 12 to 15 gallons. I use a metal 55 gallon barrel. The traps were first boiled in water and wood ashes, about a 4 to 1 ratio of water to ashes. This formed a mild lye solution, which removes rust. Traps are rinsed after they come out to remove loose rust.*
>
> *The hulls are gathered and smashed, these are the thick outer husks that cover the walnut when it first drops from the tree. I collect and save these in 5 gallon buckets, the walnuts are an extra bonus. I use 5 gallon of hulls in 40 to 45 gallons of clean water.*
>
> *After the hulls start to simmer, I add the traps 1 dozen at a time. Let them stay for at least half an hour then lift out. Hang them from the rim with a heavy wire.*
> *After the first batch, you adjust the time in the water by how dark they get. The longer the darker. I have a French-fry basket on a pipe I use to dip out the hulls as I go. When the color starts to lighten dip out the old hulls and add more.*
> *The color will last several weeks if not waxed and forever, well almost, if waxed."*
>
> *Wayne Langman*
> *Langman's Wildlife Services, Indiana*

The spent solution can also be used to tan hides and as a wood stain.

Soak the cleaned hide in the liquid, as you would any other tanning solution.

To stain wood, paint on or rub on with a soft cloth, then seal with a polyurethane.

COPY CAD & ZINC PLATING INSTRUCTIONS

Zinc and cadmium plating are somewhat unlike most other types of plating in that they are sacrificial to underlying steel. Over time, the coating gives up its life to protect the underlying metal from rusting. As this happens, the coatings develop a dullness, which eventually turns to a whitish powdery surface. This is the 'rust' of zinc, an oxide. When the life of the zinc/cadmium is over, the part will begin to rust. If these types of sacrificial coatings damaged, a scratch as an example, the coating forms a protective film of oxide over the scratch, preventing it from rusting. This is unlike other types of plate, such as nickel, where the edge of the damaged coating would begin to rust, and it would eventually get under the nickel and push it away from the steel.

Life expectancy of these coatings may be pre-determined by the thickness of the coating. However, a given thickness in one situation may last much longer in a less harsh environment.

Cadmium and Zinc plates do not cope well with acid environments, and premature accelerated action may take place, reducing the life of the coating. This can be reduced by 'chromating' the parts, or treating with a lacquer etc.

When considering removal of old cadmium plates, consider that the metal removed is highly toxic. It is very inadvisable to remove this using abrasive means, which may produce an airborne breathable dust.

The operating instructions for Copy Cad and Zinc plating kits are the same, except that Copy Cad does not use Brightener and the surface is prepared to provide a dull flat finish.

To achieve the flat dull gray look of Copy Cad or cadmium, treat the surface to provide a dull finish immediately before plating. Either bead blasting, or cleaning with the nylon abrasive wheel, which is included in all Copy Cad kits, best achieves this. Mount the wheel on a bench grinder or fast electric drill. Copy Cad does NOT use any brightener, as this addition to the solution will produce a bright shiny surface, which is undesirable.

The Zinc plating kit requires that the surface be reasonably shiny before plating. Light buffing and polishing will provide an adequate pre-plate surface. Add ZINC BRIGHTENER to the plating solution to maintain the bright shiny appearance of the zinc plate.

Copy Cad & Zinc Plate will also accept numerous chromates, which allows you to color the finish. A popular color for cadmium and zinc is a golden yellow. This can be achieved with our Yellow Chromate system. Immerse the plated part in the chromate solution. When the desired color is reached, remove the part and rinse in distilled water

The 1 gal kit will plate a total of approx. 10-15 square feet of surface area, before the anode completely dissolves. The 2 gal kit will plate 15-30 sq. ft.

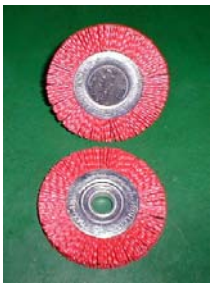
When plating cast iron with Copy Cad or Zinc, it is advisable NOT to soak the parts in acid pickle, but bead blast them instead.

SURFACE PREPARATION for COPY CAD

The most important part of Copy cad plating is to achieve a dull 'flat' even finish to the metal prior to plating. Any shiny areas will make the Copy Cad plate shinier, which will look more like a zinc plate.

There are several ways to achieve this 'flat' finish.

A Nylon Abrasive wheel (supplied in the Copy Cad kit)

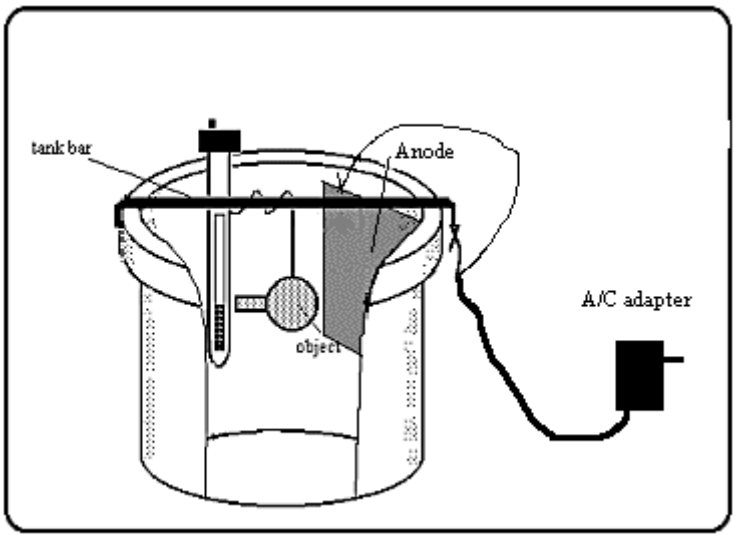


A Britex wheel. A cool running wheel made of an abrasive 'cloth' impregnated with a fine abrasive aggregate. Leaves a fine satin scratch brushed effect.

Bead Blasting. Using a fine glass bead, this cleaning technique surpasses all other for the right effect.

SURFACE PREPARATION for ZINC PLATING

Most commercially zinc plated items will not have had too much preparation done to them. They will not have been highly polished, merely cleaned well. Usually the steel is fairly clean and new, so it has a certain shininess to it. The parts may be polished or left without any work. The overall end result will vary depending on the final surface preparation. The additional of ZINC BRIGHTENER to the solution will make them plate shinier than COPY CAD, even on a dull flat surface.



SETTING UP THE SYSTEM

Pour the Copy Cad or Zinc Concentrate into the tank and add the appropriate amount of hot distilled water.

1 bottle (1 pint) Copy Cad & Zinc Concentrate = 1 gal water

For larger quantities, keep the ratios of concentrate and water the same.

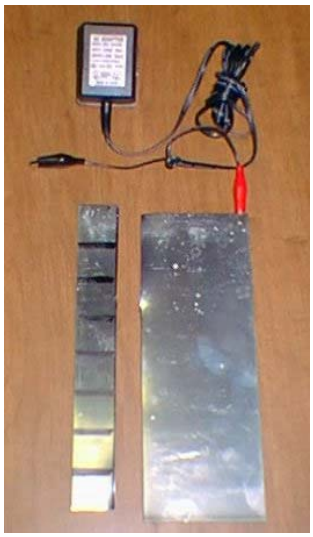
Stir with a plastic or wooden stirrer and allow to cool.

FOR THE ZINC PLATING SYSTEM ONLY – add 2 teaspoons of ZINC BRIGHTENER

Copy Cad anodes are 8" x 4". Cut them in half and hang on opposite sides of the tank if you are using the 1 gal kit. This is especially helpful if you are plating on both sides of your work. Make sure you connect both anodes together with a wire.

Install the heater and tank bar.

Both systems work better with air agitation, but this is optional. This addition will certainly improve the brightness of the zinc plate, and give a 'whiter' appearance to Copy Cad.



The A/C Adapter, (supplied with the kit) is rated at 1.5 volts @ 300ma.

The power requirement for both Copy Cad and Zinc is 25 milliamps (ma) per square inch of surface area, so this adapter will plate 300/25 = 12 square inches. (It will actually plate about 16 square inches)

If you have larger parts than this, you will need to reconsider you power supply. Radio Shack sell A/C adapters rated 1.5 volts @ 700ma, so these larger adapters will plate 700/25 = 28 square inches. You may use power supplies up to 3 volts, but this higher voltage will make the system plate faster and the end result will be a darker, rougher plate.

For even larger items, such as carburetors, you will probably need a variable power supply, such as the 25 amp rectifier.

To set up the power source, see the chapter entitled 'The Power Source', and the section "Controlling the Power From a PLUG 'n PLATE Power Pack"

The robber technique explained there works exceptionally well with A/C adapters, giving you fine control, especially over small parts.

Plate a dummy piece of metal for about 30 minutes to purify the system, prior to plating your first work piece. (You will only need to do this again, if you think the solution is contaminated)

OPERATING THE COPY CAD & ZINC PLATING SYSTEMS

When adjusting the amperage, keep an eye on the bubbling effect from the plated part. This should have a small amount of bubbles, an 'effervescence', coming from it. If the plating solution froths, turn down the current. You will need to turn off the air agitation to view these bubbles.

TANK TYPE	Plating
SOLUTION TEMP RANGE (Deg F)	60-90
AIR AGITATION	yes
PLATING TIME (Mins)	5-15
ANODE	zinc
ANODE BANDAGE	no
VOLTS SHOWING ON VOLTMETER	1-3
AMPS REQUIRED PER SQ. INCH	0.02
FUME HOOD	no
USE AS A STRIKE COAT	yes

Guide to plating times;
plate small items for approximately 5 minutes,
larger items 15-30 minutes.

Remember, the thicker the plated coating, the longer it will last.

Timing is everything. Smaller nuts, washers and bolts can be done with excellent results in 8-12 minutes, while larger ones can take up to 15-20 minutes. By watching the bubbles and the reaction rate of the part being done, one notices that the bubbles or foam begins to dissipate once the process is almost finished. By removing the part and dipping into fresh water, you can check the texture of the finish.

The finish can vary from a flat silver cad colour to a shinny almost chrome finish.
This is the result of bead blasting verses cleaning material with a fine grinder pad. Bead cleaning is recommended as your finish will be true to the cad finish.

Problem	Cause	Remedy
No deposit	No current (or gassing from part)	Check all electrics
Plate peels off or blisters	Poor preparation Inadequate cleaning High current	Improve all cleaning aspects Check part with 'water-break' test. Acid etch part. Check SP Degreaser is OK. Lower current
Blackish discoloration	Impurities in solution (copper or cadmium)	Plate a dummy for 20 mins.
Rough Plate	Amps too high Suspended particles in solution	Reduce current 25 milliamps per sq " surface area. Filter solution (no charcoal)
Overall haze	Low brightener Poor cleaning Inadequate agitation	Make one brightener addition Improve cleaning Increase air agitation
'Burnt' Plate (Dark grey)	Too much current	Lower the amperage Raise the bath temperature
Slow plating speed	Low zinc level Weak pickling solution	Increase anode surface area Make up new pickle solution
Bright plate on high areas only	Insufficient Brightener Insufficient current	Make one brightener addition Increase amperage
Bright plate except very low spots	Too much Brightener	Remove by filtering through charcoal, then replace
Dull or blotchy plate	Insufficient Brightener Part not polished properly Poor cleaning	Add brightener Strip the plate off and re-polish, or plate with copper, polish the copper and then re-plate. Improve all aspects of pre-clean.
Blistering	Poor cleaning or pickling Metallic contamination High current Low zinc level	Improve pretreatment Plate a dummy for 30 minutes. If unsuccessful, dump solution and make a new mix. Lower current Increase anode surface area
Black fingerprints on plated parts	Body acids attack freshly plated zinc	Refrain from touching freshly plated parts with fingers for at least 4 hours. Use a light abrasive cleaner to remove marks.
Patchy plate, plating thickly and erratically. Lumpy and shiny	Low in chemical concentrate.	Add more Zinc Concentrate until problem dissapears.

Chromate Processes

Chromating is a process used primarily on zinc plating, zinc die casting (pot metal), and cadmium plating. Golden 'cad' is really a cadmium plate that has been ‘chromated’ with a yellow chromate.

Zinc and cadmium are plates/metals which are readily attacked by mild acids, and will deteriorate rapidly, even if daubed lightly with tomato ketchup! To 'harden' the plate it is placed in a mild solution of special acid (Yellow Chromate or Drab Olive Green). This slightly attacks the plate, oxidizing it. The oxide forms a tough corrosion resistant crust, which protects the softer zinc or cadmium metal.

Chromates will only work on zinc die cast (pot metal), or parts previously plated with zinc, cadmium or Copy Cad. Prepare the part for chromating by zinc or 'Copy Cad' plating steel, or bead blasting pot metal. The plate needs to be in excellent condition, fresh and bright, otherwise defects will occur in the treatment. Do not handle the parts with your bare hands prior to dipping, as you will leave body oils in the form of fingerprints, which will show up on the finished item.

Old pot metal, (probably 25 years +) these parts need to have fresh metal exposed without any oxidation present. To achieve this on carburetors, blast clean with baking soda and then rinse off in fresh water before dipping. If the result is blotchy, then blast clean again, and zinc plate the part to provide an even, fresh layer of zinc over the part.
NB. Baking Soda dissolves in water and will therefore not clog any important carburetor ports.

When using any of the following processes, it is important that the parts are rinsed thoroughly aftr and that they are allowed to dry overnight before handling.

1. Iridescent Yellow Chromate Process has an 'oily' look to it, with ripples of yellows, blues and greens. It is commonly found on brackets, brake boosters and carburetors.

The Yellow Chromate Crystals are acidic! Make sure you read the labels and MSDS before use!

a. YELLOW IRIDESCENT FINISHES.
Add 1 gal of DISTILLED WATER to a plastic tank
Add 1 oz of CHROMATE CRYSTALS.

b. DEEP YELLOW - BRONZE FINISHES
Add 1 gal of DISTILLED WATER to a plastic tank
Add 2 oz of CHROMATE CRYSTALS.

Using the Iridescent Yellow Chromate

Raise the temperature of the solution to 80 deg. F using your immersion/aquarium heater.

Hang the part from a copper wire and immerse in the solution for 30 seconds (or until the correct color is achieved) swirling it to agitate. Remove and rinse in fresh water (Failure to do this will result in the part continuing to darken beyond the desired color). Set aside and air dry using a small fan.

Variations on the amount of chromate crystals will achieve different effects. Less chromate will produce a light brass color and more will produce a dark bronze. Experiment!

When the process seems to no longer work effectively, add more crystals to the solution, or discard and make up a new batch. The latter is preferable if you are trying to achieve a constant result.

Store the unused liquid in a glass container, in a locked cupboard.

2. Olive Drab Green Chromate Process

Olive Drab Green Chromate is a single dip process consisting of two components. Olive Drab #1 & Olive Drab #2. The color is usually found on carburetors. The system is specifically designed to provide a Olive Drab Green color to previously zinc plated parts as well as pot metal. .The chromate system only works on zinc metal (pot metal), zinc plate or cadmium, so all parts should be either manufactured from pot metal , coated with zinc or cadmium plate. The system may also be used on 'Copy Cad' plate. The finish has performed well in salt spray tests.

Handling Olive Drab Concentrate
Both these chemicals are corrosive. Wear gloves and face protection before opening and during use.

Preparation of the Olive Drab Dip

In a plastic pail (HDPE preferred) place 2 gallons of distilled water.

Pour in all of the Olive Drab # 1
Pour in all of the Olive Drab # 2

Mix the solution carefully, avoiding splashing. The solution is now ready for use.

Using the Olive Drab Green system.

Raise the temperature of the Olive Drab Green solution to 80 deg F, using your immersion/aquarium heater.

Hang the part from a copper wire and immerse in the solution for 30 seconds (or until the correct color is achieved) swirling it to agitate. Remove and rinse in fresh water (Failure to do this will result in the part continuing to darken beyond the desired color). Set aside and air dry using a small fan.

Problem	Cause	Solution
Dull streaks/bare spots	Poor rinsing after plating	Increase rinsing/agitation
Bronze to reddish color	Temperature too high	Lower Temperature
Olive color too iridescent	Solution too weak	Evaporate off some water
Dull powdery film, not adhering	Rinse of air drying too hot	Adjust to 120 deg F or less
Poor corrosion resistance	Temp. of drying is over 160 deg F. Leaches out chromate	Reduce temperature Reduce temperature
Poor dye absorption	Immersion time in dye too short Dye temperature too low Chromate film too thin	Increase immersion time Increase temperature Increase dip time

Zinc & Copy Cad Blackener

Zinc & Copy Cad Blackener is a black conversion finish for zinc die cast and zinc plated surfaces. It operates at room temperature (70 deg F) and produces a dense black finish which is hard and uniform, with no rub-off. When sealed with Penetrating Sealer or a wax product, it can be used as a direct replacement for black chromates or black oxides, with comparable appearances and corrosion resistance, and higher hardness. The system affords much better corrosion resistance than the Black Oxiding system, as the underlying Zinc or Copy Cad plate gives cathodic protection to the steel.

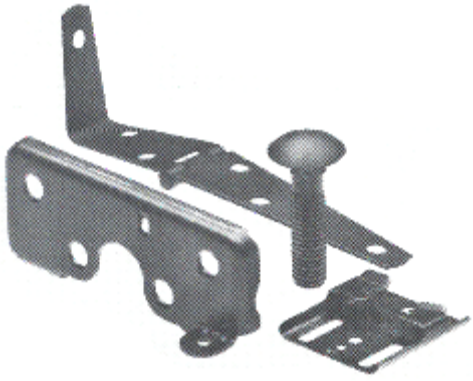
Zinc & Copy Cad Blackener contains no chromates and generates no hazardous fumes.

Preparing the solution.
Use ceramic lined metal tanks, or any plastic container.
Mix 1 part of the concentrate to 9 parts of distilled water. (1 pint Zinc & Copy Cad Blackener, to 9 pints water, etc)

Surface Preparation
Parts that are freshly plated with Copy Cad or Zinc plate may be moved directly to the Zinc & Copy Cad Blackener system, after rinsing in fresh water.

Older zinc die castings (pot metal) should be blast cleaned with either glass beads or baking soda to remove the oxide layer. Some parts may not blacken evenly. In this situation, blast off the defective coating, then 'etch' the metal by immersing in a solution of 5% battery acid and 95% distilled water for 60 seconds. Thoroughly rinse in fresh water, then repeat the blackening process.

To blacken the parts, simply immerse in the made up solution until uniformly black. The immersion time will depend on the bath temperature. Agitate the parts to remove air bubbles etc.



Rinse the parts in fresh water and allow to dry. Do not handle the parts for at least 1 hour.

Seal the surface with any of the following products.

Penetrating Sealer (from the Black Oxide system)
WD40
Collinite Metal Wax
Any other wax.

Bath Maintenance.

The black coating is the result of a chemical reaction between the concentrate and the zinc surface. Chemical activity is gradually diminished with use, but it may be restored to the desired strength by periodic small additions of the concentrate.

When not in use, cover the tank to avoid water evaporation. The active ingredients do not evaporate.

Zinc Plating Bright Dip

As an option, dip the plated part for a few seconds into a solution of 1% sulfuric acid (battery acid) and rinse in distilled water

ANODIZE & CHROME STRIPPER

STRIPPING ANODIZE FILM

Mix up a solution of 4-6oz of Anodize & Chrome Stripper with 1 gal of water. Add the powder slowly to the water.

Dip the anodized part into the solution for between 20 seconds and 10 minutes, depending on the thickness of the existing anodize film. The solution may also be brushed on.

Rinse off the part thoroughly in fresh water.

Test for anodize film (see below) and if present re-immerse.

Ideally, the solution should be at approx 70 deg f plus. The hotter the solution, the more rapidly the anodize film will be stripped.
Solution temperature range is 70-150 deg f.

Use only plastic vessels, not aluminum, as this material is extremely corrosive to this metal.

STRIPPING CHROME PLATE

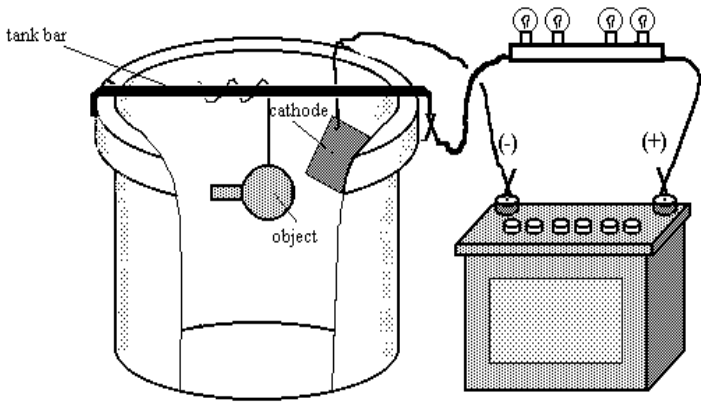
There are two techniques for removing chrome plate.

- Acid strip using a solution of 2 parts (by volume) of Muriatic (hydrochloric) acid and 1 part water. This chemical will strip decorative chrome by immersion, but the process will speed up considerably if the electro-strip process is used. The underlying nickel plate will also be stripped, but at a slower rate.

- ANODIZE & CHROME STRIPPER. This is an alkaline stripper, requiring current. It will strip the decorative chrome from a part, but not adversely effect an underlying nickel plate.

Some acids will remove chrome deposits, but the user is cautioned against application of acids for **hard chrome** removal from industrial steels, because of the harmful effect time may have on the base metal. The Chrome tank's direct current output is used as a source of power when using ANODIZE & CHROME STRIPPER..

DE-PLATING TANK SETUP



The solution is prepared with 5-6 oz. ANODIZE & CHROME STRIPPER added to one gallon of water. This solution may be used at room temperature but, the stripping time is slower. Heating the alkaline solution to a Temperature of 160^{o} F, considerably increases the rate of chrome removal. The brush plating technique is ideal for use with this solution, especially for decorative chrome plate removal.

A typical set-up for stripping Chrome plate electrolytically using ANODIZE & CHROME STRIPPER solution is shown here.

The recommended procedure is as follows:

1. Connect the piece to be stripped to anode (positive) connection of your power unit, and immerse work in Anodize & Chrome Stripper Solution .

2. Connect the GP Plates to the negative terminal of your power supply.

3. Adjust current until a current density of 1/2 to 1 amp. Per. sq. in. is obtained. Maintain this current density for approximately five minutes.

6. Remove work and inspect to see if all chrome has been removed. If not, repeat cycle as outlined previously.

7. Water rinse work and clean work. The part is then ready for plating.

Note: The above procedure is recommended for the removal of heavy HARD Chrome deposits (.002" or over), which have been deposited over nickel. CAUTION: EXCESSIVE STRIPPING ON THE BASE METAL AFTER CHROME HAS BEEN REMOVED IS NOT RECOMMENDED. THIS APPLIES PARTICULARLY TO HIGH CARBON STEELS. A PERIODIC FIVE MINUTE INSPECTION OF THE WORK SURFACE IS HIGHLY RECOMMENDED. (It is usually better to leave the nickel plate intact, and plate over it with copper.)

Light and Heavy Deposits -- Either concentrated or diluted hydrochloric acid can be used for removal of Chrome plate from brass, copper or nickel. In this case, no electrical current is necessary, only immersion in the acid is required.

CAUTION: Extreme care should be exercised in the mixing of the Hydrochloric Acid Solution. ALWAYS ADD THE ACID TO THE WATER SLOWLY AND CAREFULLY.

ANTIQUING OXIDIZERS

All the products listed below are supplied in 16 oz bottles.
The key to success with all these oxidizers is to experiment with temperature and time of immersion. Ideally the solutions should be at 65-75 deg F.

After producing the desired color, a variety of methods can be used to expose the underlying colors. Buffing the oxide off using wire wheels, cotton wheels with compound, or simply scratch cleaning with steel wool will give pleasing effects. Experiment!
Matt, clear lacquers and Collinite metal wax will seal the surface

Code	Description	Application
A01	**Tiffany Green** The original solution for the 'greening' of the copper components of Tiffany lamps.	Apply the solution, undiluted, with a soft paintbrush. Allow the reaction to work on the copper overnight. You may also apply a matt clear lacquer to seal the surface.
A02	**Bronze & Blackening Solution** For use on Copper, brass and Silver. Varying the solution strength and the time of immersion can produce an almost infinite range of shades.	Mix 1-2 fluid oz of Concentrate to 1 gal water depending on degree of effect required. Use at room temperature. Dip item into solution for 5-10 seconds, longer for darker effect. Rinse to stop coloring effect. For the 'French Grey' effect on silver, scratch-brush or buff the high spots to expose the underlying silver. Add 1 fl oz household ammonia per gal of solution to preserve the mixed solution
A312	**Chocolate Brown** Produces a chocolate brown to antique brown finish on copper and brass.	Mix 15% concentrate with 85% water. Use as a dip at room temperature.
A313	Black & Brown Oxidizer Blackens silver and nickel and browns copper and brass	Mix 15% concentrate with 85% water. Use as a dip at room temperature.
A316	**Verdi Green** On brass and copper	Mix 15% concentrate with 85% water. Use as a dip at room temperature.
A325	**Pewter Blackener** For pewter only	Mix 15% concentrate with 85% water. Use as a dip at room temperature.

Plating Lead, Pewter and Stained Glass Objects

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Stained Glass Objects

Remove all excess flux, dirt, grease and glue by cleaning/washing pieces thoroughly. We recommend using a dishwasher and skipping the dry cycle.

Glass containing leaded/iridescent can cause the glass to be plated, and it can contaminate the plating tank.

Copper foil and other types of wires can also be plated. If using copper foil, be sure that you use enough solder or reinforcing wire to insure a strong product. Tinning over the copper foil ensures a stronger bonding of the glue.

Lacquered items, such as instruments, bows and other attachments, will plate poorly or won't plate at all. These small items, as long as they aren't plastic, may be stripped prior to plating.

Well-soldered joints will help stained glass pieces to hold their shape when plating.

Lead Came, pewter and 60/40 solder are normally difficult to plate, unless the metals are pretreated. The dull oxide layer that quickly forms after cleaning must be removed prior to plating. To achieve this, the lead work must be cleaned, (dishwasher etc) and then polished to a high shine using a metal polish. Ensure no waxes are left on the work piece.

To prepare lead or pewter items such as fishing lures, these need to be polished. The use of a vibratory tumbler is ideal to obtain a high shine on the lead work. Items should be freshly cast, and free from heavy oxides. No washing is necessary, as no soldering using fluxes etc. has been carried out.

To remove any oxides, make up a solution of **Pickle # 4**, at the rate of 4 to 8 oz/gallon and immerse for 30 seconds to 2 mins.

Rinse the parts off in distilled water and proceed immediately to plating them.

Plate the parts for a minimum of 15 minutes with Flash Copper.

To gold plate, we suggest you apply gold onto a nickel plate.The latter may have already been plated over a copper plate, so this becomes a 3 step process. A nickel plate using regular nickel will take directly to the prepared metals. Gold plating lends itself to the brush plating technique, as it plates quickly. The gold plating solution is also relatively expensive, so making up ‘immersion plating tanks’ can become cost prohibitive. Brush plate the gold on until the part achieves the correct color. Over plating simply wastes gold. You may wish to lacquer the gold finish to protect it from wear.

Finally, wax and polish the parts with Collinite Metal Wax.

Brass Tank Plating

Cyanide Free Brass Plating

Caswell Brass is a unique cyanide-free alkaline brass plating system which plates a true 70/30 yellow-green plate directly onto steel and bright nickel plated surfaces. It contains no strong chelating agents making it very environmentally friendly. It is used as a bright brass flash over nickel plating process. It is the preferred system for heavy brass plating which will be antiqued (oxidized and relieved). It may also be used for decorative heavy brass if the surface is burnished or buffed and colored with a wheel to remove the slight haze and reveal the true rich brass color for lamp parts, hardware and plumbing fixtures.

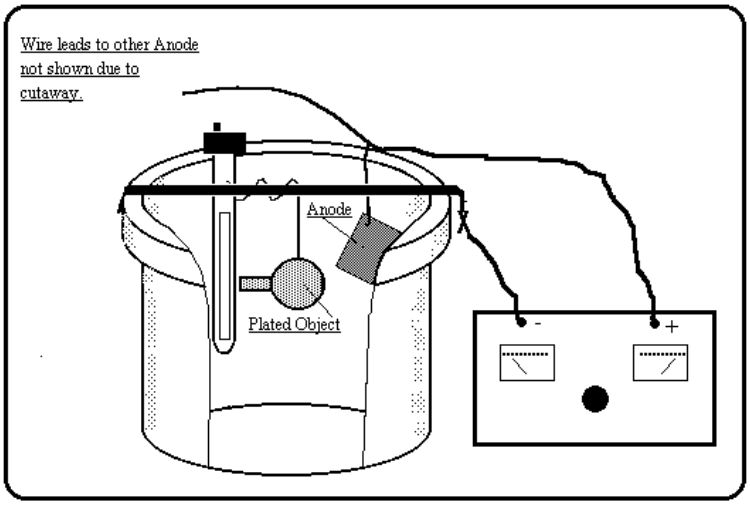
TANK TYPE	Plating
SOLUTION TEMP RANGE (Deg F)	80
AIR AGITATION	yes
PLATING TIME (Mins)	5-15
ANODE	Brass
ANODE BANDAGE	Yes
VOLTS SHOWING ON VOLTMETER	1-4
AMPS REQUIRED PER SQ. INCH	0.01 – 0.30
FUME HOOD	no
USE AS A STRIKE COAT	no
Anode/Cathode ratio1:1	

Zinc die-castings must receive a strike plate of Pot Metal Treatment. Zinc plated steel must have the zinc removed by soaking in a 5% muriatic acid etch, followed by bead blasting or buffing.

Caswell Brass is supplied as a ready-to-plate solution which includes all components except **Caswell Brass** brightener. When making 10 gallons of solution 9.5 gallons of **Caswell Brass A** and 0.5 gallons of **Caswell Brass B** are required.

Potassium Hydroxide Control

Potassium hydroxide (KOH) is used in the solution for conductivity, anode corrosion and it aids in the control of the color of the brass deposit. If the pH is too low, copper will deposit in the low current density area. This can be corrected by a simple addition of KOH (the 45% liquid is the most convenient for adjustments) to raise the pH. The pH must be checked frequently and maintained between 13.0 and 13.5 if satisfactory results are to be obtained. It must be checked at least daily and every four (4) hours with very heavy production.



Due to the high pH of the **Caswell Brass** plating solution, thorough rinsing of the alkaline film is necessary before antiquing, buffing, burnishing or lacquering.

Caswell Brass plating solution is alkaline (potassium hydroxide) and can cause severe burns. Do not get in eyes, on skin or clothing. Wear eye protection (glasses, goggles, full face shield), rubber gloves and apron when preparing solutions and making additions to the solutions. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. For eyes, call a physician.

Manufacturing Guilding Foils

Using an electroforming technique, the manufacture of thin foils such as a gold foil used in guilding, can easily be accomplished with the copper plating kit.

These foils can be glued onto any nonconductive surface to achieve numerous effects. As an example, a copper foil could be made, then glued, using plastic adhesive, to a car dashboard component. Then the entire component could be placed into a nickel or Copy Chrome tank, and plated. Alternatively, the copper foil could then be gold plated, making a gold foil for use in guilding picture frames or other art objects.

The Copper Plating kit should be set up with one anode on one side of the tank. This is connected to the positive side of your power supply.

The other copper anode supplied with the copper kit, or a piece of brass sheet of similar size should be thoroughly cleaned & polished, then painted with a solution of potassium sulfide (liver of sulfur - available in any drugstore). The surface will turn a dark color. This coating provides a surface to the sheet that renders it conductive, but prevents the plating from adhering.

This sheet is then hung on the opposite side to the anode and connected to the negative side of your power supply. The normal copper plating currents/amps are applied.

After approximately ten minutes, remove the sheet, rinse, then gently polish the surface with a light buffing compound. Using a razor blade, make a cut about 1/4' in from the edge of the sheet and gently peel the foil from the sheet to produce your first copper foil.

If you require a gold, silver or nickel foil, you could plate these metals onto the polished copper prior to removal from the sheet. In the case of gold, this could even be applied to the copper with a brush plating wand. Silver could be applied using SILVERPLATER or SILVERSMITH rub on solutions.

You may wish to experiment with different thicknesses of foil. (This depends on the length of time you plate the copper on)

DISPOSAL OF ELECTROLESS NICKEL, KROME & POT METAL PLATING SOLUTION

Add enough household ammonia to make the plating solution turn blue
Heat to 170 deg f
Using 1 steel pad per liter of solution, immerse them into the solution
Add the END concentrate at the rate of 20 ml per liter of solution.
Heat the bath to 190-205 deg F approx. 1-2 hours until the solution turns water white.
The solution is now drain safe and can be disposed of.

Tank Size In liters	**Quantity of Steel Pads**	**END** In millilitres
1	1	20
4	4	80
12	12	240

SAFETY PRECAUTIONS: Always provide ventilation, safety clothing and eye protection when treating wastes.

Adding acids to alkalis, or vice versa, is dangerous. Drain waste treatment residue when water use is at a maximum so that effluents are diluted to the greatest possible extent

DISPOSAL OF ACID BATHS

Plating pickle tanks are normally made of either muriatic or sulfuric acid. Both of these tanks can be neutralised in several ways. Muriatic & sulfuric acids are good concrete cleaners. Muriatic acid is specifically sold for the purpose, so you can clean up an old floor with it prior to painting.

Wear an acid gas respirator and have plenty of ventilation, then pour the acid onto the floor and scrub with a brush. There will be a violent reaction for a few seconds as the acid works on the concrete. The alkalinity of the concrete will neutralise the acid which can then be safely hosed away.

Check with your local authorities if you are using large quantities as there may be some regulations regarding limits on spent acids into drains. Alternatively, slowly pour quantities soda ash, sodium bicarbonate, limestone, or lime, until acidity is neutralized, then dispose of the remaining liquid.

Disposal of Sludge, waste concentrate.

Set aside a separate lidded plastic containers and place all sludge, residues etc. in them. Mark the container as TOXIC waste, with the name of the chemical. You may also add a box of Baking Soda to neutralize any acid. Dispose of this at your local 'transfer station' or any waste management company where they will take small quantities of household chemicals, in accordance with local regulations.

CHROMIC ACID FUME EMMISSIONS

Fume suppressants are wetting agents, also known as surfactants and are used to reduce mist produced during chrome plating. Due to the high current used, relatively violent bubbling occurs during plating, causing small particles of the chromic acid to become airborne. They function by reducing surface tension, and this eliminates the airborne bubbles.

The EPA recognizes the use of fume suppressants for decorative chromium platers and chrome anodizers. The surface tension must be below 45 dynes/cm. If chrome platers are successful in meeting this surface tension requirement, they are not required to perform emissions testing to demonstrate compliance with emission standards.

In a nutshell, this means that as long as you have applied the 'Fume Suppressant' supplied with the kit, you are automatically meeting this requirement, and do not need to test for it. We actually supply twice as much

chemical as required. The installation of the Fume Control Balls also reduces the mist rising from chrome tanks, so you have approximately 3 times more protection than the requirements.

Depending on the size of your tanks and the frequency of use, you may need to periodically check the effectiveness of your mist suppressant. This is an EPA requirement, and is good for your health.

We suggest that you test your tank every time you use it by holding a sheet of white paper horizontally over the top of the tank during a plating operation. Keep the paper about 4" above the surface. Hold it there for about 30 seconds, then remove it and inspect the underside. If the paper is clean, no further action is required. If the paper is stained brown, then the Fume Suppressant system is failing. This is not an official test, but it does give you an early indication that something is wrong.

At this point, you may wish to carry out the monitoring required by the EPA, which is to test the surface tension of the solution using a device called a Stalagmometer. (These are available for rental from Caswell Inc) This is a special calibrated glass tube, which indicates the efficiency of the system. The requirement is that if the test fails, then you must add more Mist Suppressant. You could however, report in your log that the test failed, without actually carrying it out, and then simply add another dose of fume suppressant. This would bring you into compliance once more.

Monitoring frequency is detailed in40 CFR Subpart N 343(c)(6).

Staggered time frequency is written in the regulation. Refer to 40 CFR §63.343(c)(5)(ii).

Abstract:

The hard chromium electroplating industry has been affected by numerous air quality regulations on both the state and federal levels. In 1995, the U.S. Environmental Protection Agency promulgated its National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks. Under these standards, facilities that perform industrial or functional chrome plating must demonstrate that chromium emissions do not exceed acceptable limits, and must satisfy monitoring, record-keeping and reporting requirements. Various chemical and mechanical strategies for air pollution control exist to accomplish these goals. This report evaluates the use of control technologies and fume suppressants to extract, recover or suppress chromium emissions before venting the exhaust air to the atmosphere.

For more information on chrome emissions, please visit the websites @

http://www.cdphe.state.co.us/ap/chromium/html/index.html
http://arbis.arb.ca.gov/toxics/atcm/chroatcm.htm
http://www.nysefc.org/tas/sbap/fact%20sheets/work%20standards.htm

Decorative chrome plating operations that use fume suppressants as the control technology are proposed to be permanently exempted from Title V permit requirements. Contact the State EPA for the other sources.

Report from the United States Environmental Protection Agency

EPA-453/F-95-001 March 1995

Office of Air Quality Planning & Standards (MD-10)

New Regulation Controlling Air Emissions from Chromium Electroplating and Anodizing Tanks
In November 1994, the U. S. Environmental Protection Agency (EPA) issued national regulations to control air emissions of chromium from chromium electro-plating and anodizing tanks. The regulation appeared in the January 25, 1995 edition of the Federal Register [volume 60, beginning on page 4948]. The regulation affects all facilities performing hard and decorative chromium electroplating and chromium anodizing, regardless of size. Over 5,000 facilities are affected nationwide.

Why is EPA regulating electroplating and anodizing tanks?

The Clean Air Act (CAA), as amended in 1990, directs EPA to regulate emissions of 189 toxic chemicals, including chromium compounds, from a wide range of industrial sources. EPA is regulating emissions of chromium from electroplating and anodizing tanks to meet the requirements of the CAA. The hexavalent form of chromium is highly toxic and strongly suspected of causing lung cancer. Less is known about the cancer risk of the trivalent form of chromium, but it can accumulate in the lungs and may decrease lung function after continuous exposure.
Hard chromium electroplating operations deposit a thick layer of chromium directly on a base metal to provide wear and corrosion resistance, low friction, and hardness (for hydraulic cylinders, industrial rolls, etc.). Decorative chromium electroplating operations deposit a thin layer of chromium on a base metal, plastic, or undercoating to provide a bright finish and wear and tarnish resistance (for bicycles, auto trim, tools, etc.). Chromium anodizing operations form a chromium oxide layer on aluminum to provide corrosion and wear resistance (for aircraft parts, architectural structures, etc.). Except for the trichrome decorative process, which uses the trivalent form of chromium, all other electroplating processes use the hexavalent form of chromium.
Chromium electroplating and anodizing tanks are one of the largest sources of chromium emissions. Over 5,000 facilities with chromium electroplating and/or anodizing tanks exist in the United States; many are located in small shops (using one plating tank) that are within close proximity to residential areas. EPA estimates that full compliance with its new regulation will result in a reduction of about 173 tons of chromium emitted into the air annually, or about a 99 percent reduction from today's levels.

How does the new EPA regulation affect you?
The regulation affects all facilities that use chromium electroplating or anodizing tanks, regardless of size. How you are affected depends on the size and type of shop (hard, decorative, or anodizing) you have and the technique that you use to reduce emissions. Decorative chromium electroplating operations must be in compliance with the regulation by January 25, 1996. Hard chromium electroplating and chromium anodizing operations must comply by January 25, 1997. In general, the regulation requires:

- Emission limits
- Ongoing monitoring
- Work practice standards
- Recordkeeping
- Initial testing
- Reporting

These requirements are summarized below. Also, EPA has published a guidebook entitled "A Guidebook on How to Comply with the Chromium Electroplating and Anodizing National Emission Standards for Hazardous Air Pollutants" (EPA-453/B-95-001) that provides a more detailed explanation of the regulation.

The information in this fact sheet is intended for general reference only; it is not a full and complete statement of the technical or legal requirements associated with the regulations. Local and government regulations are continually changing. Please contact your local EPA office and local authority for further details. You will find both offices friendly and helpful.

PROBLEM RESOLUTION SYSTEM

We suggest that wherever possible, you use the PRS SUPPORT SYSTEM on our web page to troubleshoot and resolve technical support problems. Look for' support', then click on 'PRS'. Please do not use the system for non technical difficulties.

The PRS system asks basic questions, as you can see below, All communications between you and our technical support people are logged. We can trace the history of the problem and resolve it as quickly as possible. We also use this information to update our plating manual.

Over the next few months, PRS will be expanded to become more automated and interactive, as many of the problems customers encounter are similar and fairly straightforward to resolve.

We have also engaged the services of many of our suppliers technical support departments. As our range of products expands and more and more plating procedures come into play, suppliers expertize becomes invaluable. Sometimes your problem will be forwarded directly to their technical department, ensuring you get the very best of support.

We suggest that wherever possible, you use the PRS SUPPORT SYSTEM on our web page to troubleshoot and resolve technical support problems. Go to http://www.caswellplating.com/support.htm, login using:

Login: support
Password: plater

then login to PRS using your Caswell Inc. login name. Please do not use the system for non technical difficulties.
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Here is a typical report:-

Problem Report Number 52

Status: pending
Date Submitted: November 02, 2002
Submitted By: Jim

The original problem report follows:

Product: Read Key	nickel
Base Metal:	steel
Amperage:	1
Voltage:	4.5
Temperature:	80
Duration:	15
Area:	15
Power Source:	rectifier
Surface Prep:	Blast cleaned, polished, etched.
Problem:	The plating seems to be rather dull and dark looking What have I done wrong?

Solution 1 :

It looks like your temperature is too low. Change it to 105-110 deg f and try again.

Prepared: 4/23/98

Edited: 01/26/03

Telephone: (315) 597-5140
Emergency: (315) 597-5140
CHEMTREC: (800) 424-9300

Product Name: POT METAL PRIMER A
Product Code: ALZA1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

SECTION II - HAZARDOUS INGREDIENTS

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Hypophosphite	7681-53-0	50	ne	ne

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.260
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = 7.0
Appearance/Odor = Clear, colorless liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heat
Incompatible Materials - Strong oxidizing agents. Strong acids.
Decomposition Products - Thermal decomposition may evolve toxic phosphine gas, oxides of phosphorous and various phosphoric acids.

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: Thermal decomposition may release phosphine gas.

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal burns.
Carcinogenicity - none 1 . NTP? - No. IRAC? - no. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/23/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL
4336 Route 31 Palmyra NY 14522-9719
Telephone: (315) 597-5140
Emergency: (315) 597-5140
CHEMTREC: (800) 424-9300

Product Name: Pot Metal Primer Part B
Product Code: ALZB1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfamate*	133770-89-3	10	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				
Ammonium Hydroxide*	1336-21-6	5	ne	ne

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.2
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = 10.0
Appearance/Odor = Clear, Dark Blue Liquid with ammoniacal odor.	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heat
Incompatible Materials - Cyanides, Water reactive materials
Decomposition Products - Thermal Decomposition will form oxides of nickel & sulfur.

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal burns.
Carcinogenicity - Group 1 . NTP? - Yes. IRAC? - Yes. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/23/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**Black & Brown Oxidizer**
REGULATED IDENTIFICATION	DOT PROPER SHIPPING NAME Corrosive Liquid NOS (Hydrochloric Acid, Selenious Acid)
	SHIPPING ID NUMBER UN 1760 NA - - - DOT HAZARD CLASS Corrosive

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
7440-50-8 as Cu	Copper Acid Salt of Section 313	< 2	1.0mg/m^3	1.0mg/m^3	No
7783-00-8	Selenious Acid Section 313	< 2	1.0mg/m^3	1.0mg/m^3	No
- - - -	None listed in 29 CFR 1910.1200	- - -	- - - -	- - - -	- - -
- - - -	Water & other non-hazardous, non-listed or non-reportable materials	96	- - - -	- - - -	- - -

KNOWN HAZARDS UNDER 29 CFR 1910.1200					
	YES	NO		YES	NO
CORROSIVE MATERIAL	X		SKIN HAZARD	X	
FLAMMABLE MATERIAL		X	EYE HAZARD	X	
PYROPHORIC MATERIAL		X	TOXIC AGENT	X	
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN	X	
COMBUSTIBLE LIQUID		X	LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM		X

HIMS - HAZARD SIGNALS			
HEALTH	2	FLAMMABILITY	0
REACTIVITY	0	PERSONAL PROTECTION	C
0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe			

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Chemical goggles. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of any eye injury.
	RESPIRATORY Wear a NIOSH approved respirator appropriate for the vapor or mist at the point of use.
	GLOVES Rubber
	OTHER Long sleeved shirt, trousers, rubber safety shoes, rubber apron.
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Preferred to maintain emissions at point of use below the PEL.
PRECAUTIONS	HANDLING & STORAGE Keep in closed container in a dry, well-ventilated area away from incompatible materials. Wash thoroughly after handling. Containers, even those that have been emptied, will retain product residue and vapors. Always obey hazard warnings on container, as if they were full.
	OTHER Avoid contact with eyes, skin and clothing.

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Section 4. Emergency Response Data

FIRE	EXTINQUISHING MEDIA Water spray, dry chemical, CO_2 or alcohol foam. Do not use direct water stream.
	SPECIAL PROCEDURES Fire fighters should wear self-contained breathing apparatus and full protective clothing.
	UNUSUAL HAZARDS May produce toxic selenious fumes.
	EYE: Immediately flush with lots of running water for 30 minutes, lifting the upper and lower eye lids occasionally. Get immediate medical attention.
EXPOSURE FIRST AID	SKIN: Immediately flush skin with lots of running water for 30 minutes. Remove contaminated clothing and shoes, wash before reuse. Get immediate medical attention.
	INHALATION: Remove to fresh air, give artificial respiration if not breathing. Get immediate medical attention.
	INGESTION: If conscious, immediately induce vomiting by giving 2 glasses of water and sticking a finger down the throat. Get immediate medical attention. After person has vomited have them drink milk, water or solution of 1 tsp/1qt. Sodium Bicarbonate in water. Do not give anything by mouth to an unconscious or convulsing person.
SPILLS ---------- **RQ= 436#**	STEPS TO BE TAKEN Wear acid resistant gloves, rubber boots and eye protection. For small spills, mop or wipe up and dispose of in DOT approved waste containers. For large spills, contain by soil or other absorbent material and carefully neutralize with soda ash or lime. Flush area with water. CO_2 will be given off if soda ash is used. Keep non-neutralized material out of sewers and surface waters. Comply with regulations for spill reporting.
	WASTE DISPOSAL METHOD Consult appropriate federal, state and local regulations for disposal. Empty containers are subject to same regulations.

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT None		°F - - - -		°C - - - -	METHOD USED: - - - -
STABILITY	STABLE	X	CONDITIONS TO AVOID: None			
	UNSTABLE		HAZARDOUS DECOMPOSITION PRODUCTS: Reactions with organics and strong reducing agents can produce volatile organoselenides or hydrogen selenide.			
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:	

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: It is an eye irritant, causing redness and watering. Breathing mists can cause nose and throat irritation. Garlic odor to breath, headaches, dizziness, difficulty breathing. Ingestion will result in metallic taste, garlic odor to breath, nausea. It is not a primary skin irritant, however, it can produce redness of skin and slight edema on prolonged contact.

PRIMARY ROUTES OF ENTRY

☐ INHALATION ☒ INGESTION

☐ SKIN ABSORPTION ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 220°F	SPECIFIC GRAVITY: 1.045	VOLATILE COMPONENTS Water
pH= 1.22	VAPOR DENSITY (AIR=1) Approx. equal to water	EVAPORATION RATE (Water =1) Approx. = 1
SOLUBILITY IN WATER Complete	WILL DISSOLVE IN Water	
APPEARANCE Light blue solution		MATERIAL IS: LIQUID ☒ POWDER ☐
ODOR Characteristic		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS: **Caswell Inc 4336 Rte 31 Palmyra NY 14522**

Date Prepared or Revised May 25, 2000		EMERGENCY TELEPHONE NO. 315 597 5140

Prepared: 4/23/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**Black Oxide Concentrate**
REGULATED IDENTIFICATION	DOT PROPER SHIPPING NAME Corrosive Liquid N.O.S. (Phosphoric Acid, Selenious Acid)
	SHIPPING ID NUMBER UN 1760 NA DOT HAZARD CLASS CORROSIVE

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
7783-00-8	Selenious Acid Section 313	<3.5	0.2 mg/m^3	0.2 mg/m^3	NO
7664-38-2	Phosphoric Acid Section 313	2.0	1.0 mg/m^3	1.0 mg/m^3	NO
7440-50-8 as Cu	Copper, Acid salt of Section 313	<3.0	1.0 mg/m^3	1.0 mg/m^3	NO
7697-37-2	Nitric Acid Section 313	<2.0	2.0 ppm	2.0 ppm	NO
- - - -	Water & other non-hazardous, non-listed or non reportable materials.	89.5	- - - -	- - - -	NO

KNOWN HAZARDS UNDER 29 CFR 1910.1200					
	YES	NO		YES	NO
CORROSIVE MATERIAL	X		SKIN HAZARD	X	
		X	EYE HAZARD	X	
PYROPHORIC MATERIAL		X	TOXIC AGENT	X	
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN	X	
COMBUSTIBLE LIQUID		X	LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM	X	

HIMS - HAZARD SIGNALS			
HEALTH	2	FLAMMABILITY	0
REACTIVITY	0	PERSONAL PROTECTION	C
0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe		STABILITY	

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Chemical Goggles. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of an eye injury.
	RESPIRATORY Wear a NIOSH approved respirator appropriate for the vapor or mist at the point of use.
	GLOVES Rubber
	OTHER Long-sleeved shirt, trousers, rubber safety shoes, rubber apron
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Preferred to maintain emissions at point of use below the PEL.
PRECAUTIONS	HANDLING & STORAGE Keep in closed container in a dry well-ventilated area away from incompatible materials. Wash thoroughly after handling. Containers, even those that have been emptied, will retain product residue and vapors. Always obey hazard warnings on container, as if they were full.
	OTHER Avoid contact with eyes, skin and clothing.
INCOMPATIBILITY	MATERIALS TO AVOID Cyanides, organic solvents, strong reducing agents.

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Section 4. Emergency Response Data

	EXTINGUISHING MEDIA Water spray, dry chemical, CO_2 or alcohol foam. Do not use direct water stream.

FIRE	SPECIAL PROCEDURES Fire fighters should wear self-contained breathing apparatus and full protective clothing.
	UNUSUAL HAZARDS May produce toxic selenious fumes.
EXPOSURE FIRST AID	EYE Immediately flush with lots of running water for 30 minutes, lifting the upper and lower eye lids occasionally. Get
	SKIN: Immediately flush skin with lots of running water for 30 minutes. Remove contaminated clothing and shoes. Wa
	INHALATION: Remove to fresh air. Give artificial respiration if not breathing. Get immediate medical attention.
	INGESTION: If conscious, immediately induce vomiting by giving 2 glasses of water and sticking a finger down the thro have them drink milk, water or solution of 1 tsp./1 qt. Sodium Bicarbonate in water. Do not give anything by mouth to an
SPILLS ---------- **RQ= 335#**	STEPS TO BE TAKEN Wear acid resistant gloves, rubber boots and eye protection. For small spills, mop or wipe up and contain by soil or other absorbent material and carefully neutralize with soda ash or lime. Flush area with water. CO_2 wil out of sewers and surface waters. Comply with regulations for spill reporting.
	WASTE DISPOSAL METHOD Consult appropriate federal, local regulations for disposal. Empty containers are subjec

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT °F NONE		°C	METHOD USED:	
	STABLE		X	CONDITIONS TO AVOID: Unstable with high heat.	
	UNSTABLE		C	HAZARDOUS DECOMPOSITION PRODUCTS: Reactions with organics and strong reducing agents can produce volatile organoselenides or hydrogen selenide.	
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: It is an eye irritant, causing redness and watering. Breathing mists can cause nose and throat irritation. Garlic odor to breath, headaches, dizziness, difficulty breathing. Ingestion will result in metallic taste, garlic odor to breath, nausea. It is not a primary skin irritant. However, it can produce redness of skin and slight edema on prolonged contact.

PRIMARY ROUTES OF ENTRY

- ☐ INHALATION
- ☒ INGESTION
- ☐ SKIN ABSORPTION
- ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 212°F	SPECIFIC GRAVITY: 1.049	VOLATILE COMPONENTS Water
pH= 0.72	VAPOR DENSITY (AIR=1) Approx. equal to water	EVAPORATION RATE (water =1) Approx. = 1
SOLUBILITY IN WATER Complete	WILL DISSOLVE IN Water	
APPEARANCE Light Blue Solution		MATERIAL IS: LIQUID ☒ POWDER ☐
ODOR Characteristic		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS: **Caswell Inc 4336 Rte 31 Palmyra NY 14522**

Date Prepared or Revised: January 26, 2003		EMERGENCY TELEPHONE NO. 315 597 5140

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Brass Plating Solution
Product Code: BRBP59
DOT Description:Corrosive Liquid, n.o.s (Potassium - Caustic)
DOT Label: Corrosive
Hazard Class:8
Subsidiary Hazard:na
Packing Group: II
UN #:UN1760

SECTION II - HAZARDOUS INGREDIENTS

HAZARD RATINGS:Health - 3
Fire - 0
Reactivity - 0
Protection - C

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M3)
Copper, Basic Salt Of;*	7440-50-8 as Cu	<1	1.0	1.0
Caustic Potash 1910.1200	1310-58-3	<11	2.0	ne
Water & Other Non-Hazardous, non-listed or non reportable materials		88		

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 230 F	Spec Grav (H20=1) = 1.28
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = Complete	PH = 13.0-13.5
Appearance/Odor = Musty odored liquid	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - none
Incompatible Materials - None
Decomposition Products - none

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = naw	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact may cause severe burns and irritation. Destructive to skin tissues contacted and produces severe burns. A latent period may exist between exposure and sense of irritation. Inhalation causes irritation of the respiratory tract. Ingestion may cause severe and permanent damage to mouth, throat and stomach..
Carcinogenicity - No . NTP? - No. IRAC? - No. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water or milk. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide and materials that react with sodium hydroxide.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 7/7/99

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**Chocolate Brown Antiquing Oxidizer**
REGULATED IDENTIFICATION	DOT PROPER SHIPPING NAME Corrosive Liquid NOS (Phosphoric Acid, Selenious Acid)
	SHIPPING ID NUMBER UN 1760 NA - - - DOT HAZARD CLASS Corrosive

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
7664-38-2	Phosphoric Acid Section 313	< 3	1.0mg/m^3	1.0mg/m^3	No
- - - -	None listed in 29 CFR 1910.1200	- - -	- - - -	- - - -	- - -
7440-50-8 as Cu	Copper, Acid Salt of Section 313	< 4	1.0mg/m_3	1.0mg/m_3	No
- - - -	Water & other non-hazardous, non-listed or non-reportable materials	93	- - - -	- - - -	No

KNOWN HAZARDS UNDER 29 CFR 1910.1200					
	YES	NO		YES	NO
CORROSIVE MATERIAL	X		SKIN HAZARD	X	
FLAMMABLE MATERIAL		X	EYE HAZARD	X	
PYROPHORIC MATERIAL		X	TOXIC AGENT	X	
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN	X	
COMBUSTIBLE LIQUID		X	LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM		X

HIMS - HAZARD SIGNALS			
HEALTH	2	FLAMMABILITY	0
REACTIVITY	0	PERSONAL PROTECTION	C
0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe			

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Chemical goggles. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of any eye injury.
	RESPIRATORY Wear a NIOSH approved respirator appropriate for the vapor or mist at the point of use.
	GLOVES Rubber
	OTHER Long sleeved shirt, trousers, rubber safety shoes, rubber apron.
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Preferred to maintain emissions at point of use below the PEL.
PRECAUTIONS	HANDLING & STORAGE Keep in closed container in a dry, well-ventilated area away from incompatible materials. Wash thoroughly after handling. Containers, even those that have been emptied, will retain product residue and vapors. Always obey hazard warnings on container, as if they were full.
	OTHER Avoid contact with eyes, skin and clothing.
INCOMPATIBILITY	MATERIALS TO AVOID Cyanides, organic solvents, strong oxidizing agents.

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Section 4. Emergency Response Data

FIRE	EXTINQUISHING MEDIA Water spray, dry chemical, CO_2 or alcohol foam. Do not use direct water stream.
	SPECIAL PROCEDURES Fire fighters should wear self-contained breathing apparatus and full protective clothing.
	UNUSUAL HAZARDS May produce toxic selenious fumes.
EXPOSURE	EYE: Immediately flush with lots of running water for 30 minutes, lifting the upper and lower eye lids occasionally. Get immediate medical attention.
FIRST AID	SKIN: Immediately flush skin with lots of running water for 30 minutes. Remove contaminated clothing and shoes, wash before reuse. Get immediate medical attention.
	INHALATION: Remove to fresh air, give artificial respiration if not breathing. Get immediate medical attention.
	INGESTION: If conscious, immediately induce vomiting by giving 2 glasses of water and sticking a finger down the throat. Get immediate medical attention. After person has vomited have them drink milk, water or solution of 1 tsp/1qt. Sodium Bicarbonate in water. Do not give anything by mouth to an unconscious or convulsing person.
SPILLS	STEPS TO BE TAKEN Wear acid resistant gloves, rubber boots and eye protection. For small spills, mop or wipe up and dispose of in DOT approved waste containers. For large spills, contain by soil or other absorbent material and carefully neutralize with soda ash or lime. Flush area with water. CO_2 will be given off if soda ash is used. Keep non-neutralized material out of sewers and surface waters. Comply with regulations for spill reporting.
RQ= 9778#	WASTE DISPOSAL METHOD Consult appropriate federal, state and local regulations for disposal. Empty containers are subject to same regulations.

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT None		°F - - - -	°C - - - -	METHOD USED: - - - -
STABILITY	STABLE	X	CONDITIONS TO AVOID: None		
	UNSTABLE		HAZARDOUS DECOMPOSITION PRODUCTS: Reactions with organics and strong reducing agents can produce volatile organoselenides or hydrogen selenide.		
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: It is an eye irritant, causing redness and watering. Breathing mists can cause nose and throat irritation. Garlic odor to breath, headaches, dizziness, difficulty breathing. Ingestion will result in metallic taste, garlic odor to breath, nausea. It is not a primary skin irritant, however, it can produce redness of skin and slight edema on prolonged contact.

PRIMARY ROUTES OF ENTRY

☐ INHALATION ☒ INGESTION

☐ SKIN ABSORPTION ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 220°F	SPECIFIC GRAVITY: 1.055	VOLATILE COMPONENTS Water
pH= 1.68	VAPOR DENSITY (AIR=1) Approx. equal to water	EVAPORATION RATE (Water =1) Approx. = 1
SOLUBILITY IN WATER Complete	WILL DISSOLVE IN Water	
APPEARANCE Light blue solution		MATERIAL IS: LIQUID ☒ POWDER ☐
ODOR Odorless		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS Caswell Inc 4336 Rte 31 Palmyra NY 14522		
Date Prepared or Revised: May 25, 2000		EMERGENCY TELEPHONE NO. 315 597 5140

Prepared: 7/7/99

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**CHROME MIST SUPPRESSANT**
REGULATED IDENTIFICATION	DOT PROPER SHIPPING NAME Cleaning Compound NOI Liquid
	SHIPPING ID NUMBER UN - - - - NA - - - - DOT HAZARD CLASS Non-Hazardous

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
	None listed in Section 313	- -	- - - -	- - - -	- - - -
112-34-5	Diethylene glycol monobutyl ether 1910.1200	8	25 ppm	25 ppm	NO
70225-15-9	Fluorchemical surfactant	8	0.1 mg/m^3	0.1 mg/m^3	NO
	Water	84	- - - -	- - - -	NO

KNOWN HAZARDS UNDER 29 CFR 1910.1200					
	YES	NO		YES	NO
CORROSIVE MATERIAL		X	SKIN HAZARD		X
FLAMMABLE MATERIAL		X	EYE HAZARD		X
PYROPHORIC MATERIAL		X	TOXIC AGENT		X
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN		X
COMBUSTIBLE LIQUID		X	LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM		X

HMIS - HAZARD SIGNALS			
HEALTH	0	FLAMMABILITY	0
REACTIVITY	0	PERSONAL PROTECTION	C
0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe			

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Safety glasses. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of an eye injury.
	RESPIRATORY None
	GLOVES Rubber
	OTHER Long sleeved shirt and trousers.
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Not required
PRECAUTIONS	HANDLING & STORAGE Keep in closed container. Wash thoroughly after handling.
	OTHER Avoid contact with eyes, skin and clothing.
INCOMPATIBILITY	MATERIALS TO AVOID Strong acids, strong oxidizers

Section 4. Emergency Response Data

FIRE	EXTINGUISHING MEDIA CO_2, Dry chemical, water spray
	SPECIAL PROCEDURES None
	UNUSUAL HAZARDS None
EXPOSURE FIRST AID	EYE: Flush eyes with large amounts of water for at least 15 minutes. See a physician if irritation persists.
	SKIN: Wash skin with soap and water.
	INHALATION: Move subject to fresh air.
	INGESTION: If swallowed, dilute by giving a glass of water. See a physician. Never give anything by mouth to an unconscious person.
SPILLS ---------- **RQ=** No Limit	STEPS TO BE TAKEN Wear eye protection. Dike and contain spill with sand or earth. Transfer liquid to container for recovery or disposal. Flush cleaned area with water. Keep spills and cleaning run-off out of municipal sewers and open sources of fresh water.
	WASTE DISPOSAL METHOD In accordance with local, state and federal regulations. Liquid cn be incinerated. Dike material to land fill.

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT None		ºF - -	ºC - -	METHOD USED: - -
STABILITY	STABLE	X	CONDITIONS TO AVOID: None		
	UNSTABLE		HAZARDOUS DECOMPOSITION PRODUCTS: None		
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: Possibly irritating to eyes. Possibly irritating to skin with repeated or prolonged contact.

PRIMARY ROUTES OF ENTRY

☐ INHALATION ☐ INGESTION

☐ SKIN ABSORPTION ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 212°F	SPECIFIC GRAVITY: 1.025	VOLATILE COMPONENTS Water
pH= 5.7	VAPOR DENSITY (AIR=1) Approx. equal to water	EVAPORATION RATE (water =1) Approx. = 1
SOLUBILITY IN WATER Complete	WILL DISSOLVE IN Water	
APPEARANCE Clear, Colorless Solution		MATERIAL IS: LIQUID ☒ POWDER ☐
ODOR Slight odor of carbitol		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS: **Caswell Inc 4336 Rte 31 Palmyra NY 14522**

Date Prepared January 26, 2003		**EMERGENCY TELEPHONE NO.** 315 597 5140

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: CHROME CRYSTALS
Product Code: CHRC1G
DOT Description:Chromium Trioxide, Anhydrous
DOT Label: Oxidizer, Corrosive
Hazard Class:5.1
Subsidiary Hazard:8
Packing Group: II
UN #:UN1463

HAZARD RATINGS:Health - 3
Fire - 0
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Chromic Acid*	7738-94-5	60-100	0.05	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = decomposes	Spec Grav (H20=1) = 2.7
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = 196 deg C
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 62.5%	PH = 0.2 - 2.0 depending on concentration
Appearance/Odor = odorless dark red powder	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - materials below
Incompatible Materials - This product is a strong oxidizing agent. It may react with easily oxidizable/combustible materials especially at elevated temperatures. Both in dry form and in solution this material may violently react with organic materials. Keep away from heat, hydrogen sulfide gas and protect from moisture.
Decomposition Products - Thermal decomposition produces chromic oxide (Cr2O3), other oxides of chromium which may be hazardous and oxygen. Oxygen increases the fire hazard.

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus. UNUSUAL FIRE HAZARDS: May act as an oxidizing agent to initiate or sustain a fire involving organic matter or other easily oxidizable material. Fire may produce irritating or poisonous gases. Runoff from fire fighting can cause pollution. Dike fire control water.

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - May be fatal if inhaled, swallowed or absorbed through skin. Dry or wet chromic acid is corrosive to eye and skin tissue. Contact of very small quantities of dust or mist with the eyes can result in severe burns. Inhalation of dust or mist can cause damage to the mucous membranes, perforation of the nasal septum, and irritation of the respiratory system. Skin contact can cause severe burns, external ulcers and ulceration of broken skin. Can be absorbed through the skin and cause systemic poisoning. Repeated skin contact leads to sensitization dermatitis with inflammation and ulcers that heal slowly. Inhalation may cause painless ulceration, bleeding, perforation of the nasal septum accompanied by a nasal discharge and hepatitis. Can also cause conjunctivitis, tearing, erosion, and discoloration of teeth. May alter genetic material.
TARGET ORGANS - Kidneys, lungs, liver, nerves.
Carcinogenicity - Group 1 (known carcinogen). NTP? - Yes. IRAC? - Yes. OSHA Regulated? - Yes. Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: SEEK IMMEDIATE MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT (*PHYSICIAN - Read this MSDS. An effective treatment has been shown to be immediate administration of 5-10 grams of ascorbic acid (dissolved in water) by mouth or intravenously followed by 1000 mg three times a day for 14 days*). INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling. OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL Inc.Telephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Copper Anode
Product Code: CUANOD20
DOT Description: Not Regulated
DOT Label: None
Hazard Class:None
Subsidiary Hazard:None
Packing Group: None
UN #:None

HAZARD RATINGS:Health - 0
Fire - 0
Reactivity - 0
Protection -

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Copper	07440-50-8	> 99	1	--

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg C) = 4703 deg F	Spec Grav (H20=1) = 8.92
Vapor Pressure (mm Hg) = N/A	Melting Point (deg F) = 1981 deg F
Vapor Density (Air=1) = N/A	Evaporation Rate = N/A
Solubility in H20 = N/A	PH = N/A
Appearance/Odor = REDDISH, LUSTROUS, MALLEABLE METAL	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - None
Incompatible Materials - None
Decomposition Products - None

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = None	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: None

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - May cause irritation. Avoid contact with eyes, skin and clothing.
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: EYES: Immediately flush with fresh water for at least fifteen minutes. Hold eyelids apart during irrigation. SKIN: Flush immediately with fresh water for at least fifteen minutes. Remove and wash contaminated clothing before reuse. INHALATION: Immediately drink a large quantity of water, milk or egg whites. SEEK MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)

PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 3/2/99

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL Inc.Telephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Copper Conductive Powder
Product Code: CCP9
DOT Description: None
DOT Label: None
Hazard Class:n/a
Subsidiary Hazard:none
Packing Group: n/a
UN #:n/a

HAZARD RATINGS: Health - 1
Fire - 1
Reactivity - 0
Protection - B

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Copper*	7440-50-8	99	--	1
Stearic Acid	57-11-4	<1	--	--

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = -n/a	Spec Grav (H20=1) = 8.5
Vapor Pressure (mm Hg) = n/a	Melting Point (deg F) = n/a
Vapor Density (Air=1) = n/a	Evaporation Rate = n/a
Solubility in H20 = n/a	PH = n/a
Appearance/Odor = Copper Colored Powder	

Section IIII - REACTIVITY DATA
Chemical Stability - Deliquesecent
Conditions to Avoid - Heat, Sparks
Incompatible Materials - Strong Oxidants
Decomposition Products - None

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - Use CO2, dry powder, foam. Use NIOSH approved SCBA.
UNUSUAL FIRE HAZARDS: None.

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Irritation to the mucous membranes and phaynx, nasal perforation, eye damage, dermatitis.
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: EYES: Immediately flush with fresh water for at least fifteen minutes. Hold eyelids apart during irrigation. SKIN: Flush immediately with fresh water for at least fifteen minutes. Remove and wash contaminated clothing before reuse. INHALATION: Immediately drink a large quantity of water, milk or egg whites. Do not induce vomiting. SEEK MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424 9300
NY 14522-9719

Product Name: COPPER CRYSTALS
Product Code: CPRC1G OR CPRC2G
DOT Description: Environmentally Hazardous Substance, Solid, n.o.s., (Cupric Sulfate) Marine Pollutant
DOT Label: Class 9
Hazard Class:9
Subsidiary Hazard:none
Packing Group: III
UN #:UN3077

HAZARD RATINGS: Health - 2
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Copper Sulfate Pentahydrate*	7758-98-7	75	ne	ne
Copper*	7440-50-8	25	ne	ne

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = -5 H2O @150 deg C	Spec Grav (H20=1) = 2.284
Vapor Pressure (mm Hg) = 7.3 MgHg @ 25 degC	Melting Point (deg F) = -4 H2O 110 deg C
Vapor Density (Air=1) = ne	Evaporation Rate = ne
Solubility in H20 = 22.37 @ 0degC,117.95@100C	PH = ne
Appearance/Odor = Blue Crystals or Powder, Odorless	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - None when product remains dry. Solutions are corrosive to mild steel.
Decomposition Products - If heated above 1100 deg F sulfur dioxide may be released

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: Sealed containers may rupture when heated due to release of water from metals. Material is acidic when dissolved in water, contact with magnesium metal may evolve hydrogen gas. Anhydrous salt will ignite hydroxylamine if present. Fire may produce irritating or poisonous gases. Runoff from fire fighting can cause pollution. Dike fire control water.

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Corrosive. Causes eye damage and irritation to the skin and mucous membrane. Harmful or fatal if swallowed. Do not get in eyes, on skin or clothing. Copper Sulfate is emetic, and has seldom been fatal. prolonged over ingestion might increase liver copper content.
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: EYES: Immediately flush with fresh water for at least fifteen minutes. Hold eyelids apart during irrigation. SKIN: Flush immediately with fresh water for at least fifteen minutes. Remove and wash contaminated clothing before reuse. INHALATION: Immediately drink a large quantity of water, milk or egg whites. SEEK MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: COPPER PLATING SOLUTION
Product Code: NKCUBP20
DOT Description: Environmentally Hazardous Substance, Solid, n.o.s., (Cupric Sulfate) Marine Pollutant
DOT Label: Class 9
Hazard Class:9
Subsidiary Hazard:none
Packing Group: III
UN #:UN3077

HAZARD RATINGS:Health - 2
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Copper Sulfate Pentahydrate*	7758-98-7	75	ne	ne
Copper*	7440-50-8	25	ne	ne

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = -5 H2O @150 deg C	Spec Grav (H20=1) = 2.284
Vapor Pressure (mm Hg) = 7.3 MgHg @ 25 degC	Melting Point (deg F) = -4 H2O 110 deg C
Vapor Density (Air=1) = ne	Evaporation Rate = ne
Solubility in H20 = 22.37 @ 0degC,117.95@100C	PH = ne
Appearance/Odor = Blue Solution, Odorless	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - None when product remains dry. Solutions are corrosive to mild steel.
Decomposition Products - If heated above 1100 deg F sulfur dioxide may be released

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: Sealed containers may rupture when heated due to release of water from metals. Material is acidic when dissolved in water, contact with magnesium metal may evolve hydrogen gas. Anhydrous salt will ignite hydroxylamine if present. Fire may produce irritating or poisonous gases. Runoff from fire fighting can cause pollution. Dike fire control water.

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Corrosive. Causes eye damage and irritation to the skin and mucous membrane. Harmful or fatal if swallowed. Do not get in eyes, on skin or clothing. Copper Sulfate is emetic, and has seldom been fatal. prolonged over ingestion might increase liver copper content.
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: EYES: Immediately flush with fresh water for at least fifteen minutes. Hold eyelids apart during irrigation. SKIN: Flush immediately with fresh water for at least fifteen minutes. Remove and wash contaminated clothing before reuse. INHALATION: Immediately drink a large quantity of water, milk or egg whites. SEEK MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: COPY CHROME CRYSTALS
Product Code:CCHRC2G
DOT Description:Environmentally Hazardous Substance, solid, N.O.S (Nickel Sulfate)
DOT Label: Miscellaneous
Hazard Class: 9
Subsidiary Hazard:none
Packing Group:III
UN #:UN3077

HAZARD RATINGS: Health - 3
Fire - 1
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfate*	10101-97-0	70-80	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				
Cobalt Sulfate Heptahydrate*	10124-43-3	20-30	0.02	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = ne
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = ne	PH = na
Appearance/Odor =Dark Red and Green Crystals, odorless	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - na
Decomposition Products - when heating in air, toxic SO2/SO3 gas can be formed. Other toxic fumes and metal oxides may be present during decomposition

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - eye contact causes irritation, skin contact causes irritation and may cause sensitization or allergic reactions resulting in chronic eczema or "nickel itch" Inhalation causes irritation of the mucous membrane.
Carcinogenicity - Group 1 & 2B . NTP? - No. IRAC? - Yes. OSHA Regulated? - No.
Symptoms of exposure: above Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELL Inc.Telephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: SP DEGREASER
Product Code: SPED18
DOT Description: Not Regulated
DOT Label: None
Hazard Class:None
Subsidiary Hazard:None
Packing Group: None
UN #:None
Chemical Family Mild alkaline detergent

HAZARD RATINGS: Health - 1
Fire - 0
Reactivity - 0
Protection -

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
None considered hazardous				

TCSA STATUS:
All components of this product are on the US TCSA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212	Spec Grav (H20=1) = 1.09
Vapor Pressure (mm Hg) = N/A	Melting Point (deg F) = 32
Vapor Density (Air=1) = N/A	Evaporation Rate = N/A
Solubility in H20 = Complete	PH = 9.0 -10.0
Appearance/Odor = white powder	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Heat above 1000 deg F.
Incompatible Materials - Strong Acids, Water Reactive Materials
Decomposition Products - None

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = None	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: None

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - May cause irritation. Avoid contact with eyes, skin and clothing.
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: EYES: Immediately flush with fresh water for at least fifteen minutes. Hold eyelids apart during irrigation. SKIN: Flush immediately with fresh water for at least fifteen minutes. Remove and wash contaminated clothing before reuse. INHALATION: Immediately drink a large quantity of water, milk or egg whites, then dilute vinegar, lemon or orange juice. Do not induce vomiting. SEEK MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - None required.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS KROME CONC A
Product Code: ELKRA1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 2
Fire - 1
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfate*	7786-81-4	45	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.34
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = 3.5
Appearance/Odor = Clear, green liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heat
Incompatible Materials – cyanides, strong alkalies
Decomposition Products - Thermal decomposition will form oxides of nickel and sulfur.

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: Thermal decomposition will form oxides of nickel and sulfur.

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation and may cause sensitiziation or allergic reactions resulting in chronic eczema or “nickel itch”. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal burns.
Carcinogenicity – Group 1 . NTP? – anticipated as nickel compound. IRAC? - Yes. OSHA Regulated? – Yes, Subpart Z.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS KROME CONC B
Product Code: ELKRB1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Hypophosphite	10039-56-3	25	ne	ne
Ammonium Hydroxide	1336-21-6	1	Ne	Ne

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.180
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = 5.5
Appearance/Odor = Clear, colorless liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - none
Incompatible Materials – none
Decomposition Products - none

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: none

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal irritation.
Carcinogenicity – No . NTP? – no. IRAC? - no. OSHA Regulated? no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/29/99

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS KROME CONC C
Product Code: ELKRC1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Hypophosphite	10039-56-3	30	ne	ne
Sodium Hydroxide*	1310-73-2	2	2	2

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TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = ne	Spec Grav (H20=1) = 1.195 to 1.205
Vapor Pressure (mm Hg) = ne	Melting Point (deg F) = na
Vapor Density (Air=1) = ne	Evaporation Rate = ne
Solubility in H20 = ne	PH = 5.4 to 5.8
Appearance/Odor = Clear, colorless liquid	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heat
Incompatible Materials – Strong oxidizing agents. Strong acids.
Decomposition Products - Thermal decomposition may evolve toxic phosphine gas, oxides of phosphorus and various phosphoric acids.

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.

UNUSUAL FIRE HAZARDS: none

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal irritation.
Carcinogenicity – No . NTP? – no. IRAC? - no. OSHA Regulated? no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS NICKEL CONC A
Product Code: ELECA1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 2
Fire - 1
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfate*	7786-81-4	45	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.34
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = 3.5
Appearance/Odor = Clear, green liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heat
Incompatible Materials – cyanides, strong alkalies
Decomposition Products - Thermal decomposition will form oxides of nickel and sulfur.

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: Thermal decomposition will form oxides of nickel and sulfur.

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation and may cause sensitiziation or allergic reactions resulting in chronic eczema or “nickel itch”. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal burns.
Carcinogenicity – Group 1 . NTP? – anticipated as nickel compound. IRAC? - Yes. OSHA Regulated? – Yes, Subpart Z.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS NICKEL CONC B
Product Code: ELECB1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Hypophosphite	10039-56-3	25	ne	ne
Ammonium Hydroxide	1336-21-6	1	Ne	Ne

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.180
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = 5.5
Appearance/Odor = Clear, colorless liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - none
Incompatible Materials – none
Decomposition Products - none

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.

UNUSUAL FIRE HAZARDS: none

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal irritation.
Carcinogenicity – No . NTP? – no. IRAC? - no. OSHA Regulated? no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/29/99

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS NICKEL CONC C
Product Code: ELECC1L
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Hypophosphite	10039-56-3	30	ne	ne
Sodium Hydroxide*	1310-73-2	2	2	2

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = ne	Spec Grav (H20=1) = 1.195 to 1.205
Vapor Pressure (mm Hg) = ne	Melting Point (deg F) = na
Vapor Density (Air=1) = ne	Evaporation Rate = ne
Solubility in H20 = ne	PH = 5.4 to 5.8
Appearance/Odor = Clear, colorless liquid	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heat
Incompatible Materials – Strong oxidizing agents. Strong acids.
Decomposition Products - Thermal decomposition may evolve toxic phosphine gas, oxides of phosphorus and various phosphoric acids.

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: none

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal irritation.
Carcinogenicity – No . NTP? – no. IRAC? - no. OSHA Regulated? no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/23/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: ELECTROLESS NICKEL END
Product Code: ELECEND
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
None				

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = 1.2
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = completely miscible	PH = na
Appearance/Odor = Clear, colorless liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - none
Incompatible Materials – none
Decomposition Products - none

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: none

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal irritation.
Carcinogenicity – No . NTP? – no. IRAC? - no. OSHA Regulated? no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

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MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL Telephone: (315) 597-5140
4336 Route 31 Emergency: (315) 597-5140
Palmyra CHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Gas Tank Sealer A
Product Code: GTS1750
DOT Description:Consumer Commodity
DOT Label: ORM-D
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 3
Fire - 1
Reactivity - 1
Protection - G

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Acrylate Inhibited With 100PPM Ether Hydroquinone	15625-89-5		None	None
Reaction Products Of Epichlorohydrin	25068-38-6		None	None

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 200	Spec Grav (H20=1) = 1.1
Vapor Pressure (mm Hg) = 1.0 @ 356F	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = Negligible	PH = na
Appearance/Odor = Low viscosity liquid – Clear Amber	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid – Avoid Excessive heat or open flames
Incompatible Materials – Can react vigorously with strong oxidizing agents, stong acids or peroxides, copper, iron, rust and strong bases.
Decomposition Products - CO^2, Aldehydes, acids. Reaction with some curing agents can generate large amounts of heat
Hazardous Polymerization: May Occur

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES – Foam, alcohol foam, CO2, Dry Chemical, water fog. Do not enter confined fire area without full bunker gear including a positive pressure NIOSH approved self-contained breathing apparatus. Cool all fire exposed containers with water.
UNUSUAL FIRE HAZARDS: High temperatures and fire may cause rapid and uncontrolled polymerization which can result in explosion and violent rupture of storage vessel.

Flash Point = 200F	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact may cause injury that may persist for several days, redness and tearing may accur. Skin contact may cause irritation or allergic skin response, redenning or blistering may result from prolonged exposure. Inhalation of heated vapors can cause irritation to the nose, throat or mucous membranes. At saturation concentrations (0.2mg/L) this product is practically nontoxic. Ingestion may cause damage to mucous membranes and digestive tract. May cause nausea or other similar response. LD50 = 9.6g/kg
Carcinogenicity - No . NTP? - No. IRAC? - No. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure – respiratory conditions or other allergic response.
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water or milk. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL – Wear respirator and protective clothing. Absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in cool, dry. well ventilated areas.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

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MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Gas Tank Sealer B
Product Code: GTS1750
DOT Description:Consumer Commodity
DOT Label: ORM-D
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 2
Fire - 1
Reactivity - 0
Protection - G

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Diethylenetriamine	111-40-0		1ppm	1ppm
Bisphenol A *	80-05-7	15	None	None
Benzyl Alcohol	100-51-5		None	None

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TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 401-631	Spec Grav (H20=1) = 1.0
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = Negligible	PH = na
Appearance/Odor = Amber clear liquid with amine odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid – Avoid contact with open flames and all sources of ignitions and sparks.
Incompatible Materials – Avoid contact with strong oxidizing agents, mineral acids and epoxy resins in uncontrolled amounts.
Decomposition Products - CO, CO2, NOX
Hazardous Polymerization: Will Not Occur

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES – Foam, alcohol foam, CO2, water fog. Do not enter confined fire area without a self-contained breathing apparatus. Cool all fire exposed containers with water.
UNUSUAL FIRE HAZARDS: None

Flash Point = 200F	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards – Will cause burns to skin and eyes. High vapor concentrations can cause severe irritation to the eyes Inhalation of high concentrations of vapor can cause irritation to the respiratory tract, nausea and dizziness. Ingestion may cause severe damage to mucous membranes
Carcinogenicity - No . NTP? - No. IRAC? - No. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure – respiratory conditions or other allergic response.
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water or milk. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL – Wear respirator and protective clothing. Absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in cool, dry. well ventilated areas.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

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MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELL Inc.Telephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Cerium Glass Polishing Kit
Product Code: GPK10
DOT Description: Not Regulated
DOT Label: None
Hazard Class:None
Subsidiary Hazard:None
Packing Group: None
UN #:None

HAZARD RATINGS:Health - 2
Fire - 0
Reactivity - 0
Protection -

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Cerium Oxide	1306-38-3	60-100	--	--

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = N/A	Spec Grav (H20=1) = 1-1.7
Vapor Pressure (mm Hg) = N/A	Melting Point (deg F) = N/A
Vapor Density (Air=1) = N/A	Evaporation Rate = N/A
Solubility in H20 = NIL	PH = N/A
Appearance/Odor = Tan to yellow powder	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - None.
Incompatible Materials - None
Decomposition Products - None

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = None	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: None

Section VI - HEALTH HAZARD DATA
Routes of Entry - inhalation
Health Hazards - EYE:CONT W/DUSTS MAY BE ABRASIVE & IRRIT TO EYES & MAY CAUSE BURNING, TEARING & REDNESS. SKIN:THERE IS INSUFFICIENT INFO AVAILABLE ON THIS MATL TO PREDICT POTENTIAL FOR HARMFUL EFTS FROM SKIN CONT/ABSORPTION. STUDIES BY OTHER EXPOS ROUTES SUGGEST A LOW DEGREE OF HAZ. INHAL:WHILE (EFTS OF OVEREXP)
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: hlth haz:this material has a low degree of tox, brthg high conc of dusts may cause hdch & naus. Prlngd overexpos to dusts may result in bronchitis (lung inflamm). Ingest:this matl has a low degree of tox by ingestion.
Medical conditions aggravated by exposure - persons with preexisting skin disorders may be more susceptible to effects of this material.
FIRST AID: eyeseyes:if irrit/redness from expos to dusts dev, move victim away from expos & into fresh air. If irrit/redness persists, seek md attn. For direct cont, hold eyelids apart & flush w/clean water for at least 15 min. Seek md attn. Skin:if matl comes in cont w/cuts, scratches/abrasions, immed flush affected area(s) w/lrg amts of water. If irrit/redness dev, seek md attn. Inhal:if irrit of throat and mouth delevops drink large quantities of water. Seek medical attention. Seek medical attention in the event of any accidental exposure to this product.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/17/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Nickel Anodes
Product Code: NKANOD20
DOT Description:N/A
DOT Label: Not Regulated
Hazard Class:N/A
Subsidiary Hazard:N/A
Packing Group: N/A
UN #:N/A

HAZARD RATINGS:Health - 3
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M3)
Nickel*	7440-02-0	31-100	1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TCSA STATUS:
All components of this product are on the US TCSA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 1453 deg F	Spec Grav (H20=1) = 8.90
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = 2647 deg F
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = not soluble	PH = na
Appearance/Odor = bright silver metal	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Strong Acids
Incompatible Materials - na
Decomposition Products - None

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - eye contact causes irritation, skin contact causes irritation and may cause sensitization or allergic reactions resulting in chronic eczema or "nickel itch" Inhalation causes irritation of the mucous membrane.
Carcinogenicity - Group 1 . NTP? - Yes. IRAC? - Yes. OSHA Regulated? - No. Z List? - No.
Symptoms of exposure: above Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: REGULAR NICKEL CRYSTALS
Product Code: RNC1G OR RNC2G
DOT Description:Environmentally Hazardous Substance, solid, n.o.s., (nickel sulfate)
DOT Label: Class 9
Hazard Class:9
Subsidiary Hazard:none
Packing Group: III
UN #:UN3077

HAZARD RATINGS:Health - 3
Fire - 1
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfate*	10101-97-0	70-80	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				
Nickel Chloride Hexahydrate*	7718-54-9	10-20	0.1	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = 2.07
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 62%	PH = na
Appearance/Odor = green crystals, odorless	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - na
Decomposition Products - when heating in air, toxic SO2/SO3 gas can be formed

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - eye contact causes irritation, skin contact causes irritation and may cause sensitization or allergic reactions resulting in chronic eczema or "nickel itch" Inhalation causes irritation of the mucous membrane.
Carcinogenicity - Group 1 . NTP? - No. IRAC? - Yes. OSHA Regulated? - No.
Symptoms of exposure: above Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: NICKEL PLATING SOLUTION
Product Code: NKCUBP20 or NKBP11
DOT Description:Environmentally Hazardous Substance, solid, n.o.s., (nickel sulfate)
DOT Label: Class 9
Hazard Class:9
Subsidiary Hazard:none
Packing Group: III
UN #:UN3077

HAZARD RATINGS:Health - 3
Fire - 1
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfate*	10101-97-0	70-80	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				
Nickel Chloride Hexahydrate*	7718-54-9	10-20	0.1	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = 2.07
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 62%	PH = na
Appearance/Odor = green solution, odorless	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - na
Decomposition Products - when heating in air, toxic SO2/SO3 gas can be formed

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - eye contact causes irritation, skin contact causes irritation and may cause sensitization or allergic reactions resulting in chronic eczema or "nickel itch" Inhalation causes irritation of the mucous membrane.
Carcinogenicity - Group 1 . NTP? - No. IRAC? - Yes. OSHA Regulated? - No.
Symptoms of exposure: above Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

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MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: OLIVE DRAB CHROMATE #1
Product Code: ODK27
DOT Description:Consumer Commodity
DOT Label: ORM-D
Hazard Class:
Subsidiary Hazard:
Packing Group:
UN #:

HAZARD RATINGS:Health - 3
Fire - 1
Reactivity - 1
Protection - H

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Chromic Acid*	7738-94-5	20-50	0.05	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				
Acetic Acid	64-19-7	20-50	10ppm	10ppm

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TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = 1.28451
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = < 1	Evaporation Rate = Slower than n-Butyl Acetate
Solubility in H20 = 62.5%	PH = na
Appearance/Odor = Dark Orange Liquid	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - materials below
Incompatible Materials - This product is a strong oxidizing agent. It may react with easily oxidizable/combustible materials especially at elevated temperatures. Both in dry form and in solution this material may violently react with organic materials. Keep away from heat, hydrogen sulfide gas and protect from moisture.
Decomposition Products - Thermal decomposition produces chromic oxide (Cr_2O_3), other oxides of chromium which may be hazardous and oxygen. Oxygen increases the fire hazard.

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus. UNUSUAL FIRE HAZARDS: May act as an oxidizing agent to initiate or sustain a fire involving organic matter or other easily oxidizable material. Fire may produce irritating or poisonous gases. Runoff from fire fighting can cause pollution. Dike fire control water.

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - May be fatal if inhaled, swallowed or absorbed through skin. Dry or wet chromic acid is corrosive to eye and skin tissue. Contact of very small quantities of dust or mist with the eyes can result in severe burns. Inhalation of dust or mist can cause damage to the mucous membranes, perforation of the nasal septum, and irritation of the respiratory system. Skin contact can cause severe burns, external ulcers and ulceration of broken skin. Can be absorbed through the skin and cause systemic poisoning. Repeated skin contact leads to sensitization dermatitis with inflammation and ulcers that heal slowly. Inhalation may cause painless ulceration, bleeding, perforation of the nasal septum accompanied by a nasal discharge and hepatitis. Can also cause conjunctivitis, tearing, erosion, and discoloration of teeth. May alter genetic material.
TARGET ORGANS - Kidneys, lungs, liver, nerves.
Carcinogenicity - Group 1 (known carcinogen). NTP? - Yes. IRAC? - Yes. OSHA Regulated? - Yes.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: SEEK IMMEDIATE MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT (*PHYSICIAN - Read this MSDS. An effective treatment has been shown to be immediate administration of 5-10 grams of ascorbic acid (dissolved in water) by mouth or intravenously followed by 1000 mg three times a day for 14 days*). INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.
Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling. OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: OLIVE DRAB CHROMATE #2
Product Code: ODK27
DOT Description:Consumer Commodity
DOT Label: ORM-D
Hazard Class:
Subsidiary Hazard:
Packing Group:
UN #:

HAZARD RATINGS:Health - 3
Fire - 2
Reactivity - 0
Protection - SG

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Formic Acid*	64-18-6	40-70	5ppm	5ppm

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = 1.13
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = < 1	Evaporation Rate = na
Solubility in H20 = na	PH = 0.50 – 1.0
Appearance/Odor = Sharp Odored Clear Liquid	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - flame
Incompatible Materials – oxidizing agents or strong alkalis
Decomposition Products – Carbon Monoxide

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: None

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Inhalation can cause irritation of the respiratory system. Skin contact can cause irritation. Eye contact can cause irritation.
Carcinogenicity -None. NTP? - No. IRAC? - No. OSHA Regulated? - No. Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL – Neutralize with dilute base and absorb on an inert material such as clay or sawdust. WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling. OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from flames, alkalis and cyanide.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**Penetrating Sealer**
REGULATED	DOT PROPER SHIPPING NAME NA-Combustible Liquid N.O.S. (Naptha) UN-Petroleum Distillates N.O.S. (Naptha)
IDENTIFICATION	SHIPPING ID NUMBER UN 1268 NA 1993 DOT HAZARD CLASS Combustible Liquid (NA) /Flammable Liquid (UN) **NA = North America**

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
- - - -	None in section 313	- -	- - - -	- - - -	- - - -
8052-41-3	Stoddard solvent 1910.1200	< 79	*	*	No
8042-47-5	Mineral oil 1910.1200	< 8	5mg/m^3	5mg/m^3	No
- - - -	Non-hazardous, non-listed or non-reportable materials	13	- - - -	- - - -	- - - -
			*=100ppm	ACGIH TWA	
			200ppm	STEL	
			500ppm	OSHA TWA	

KNOWN HAZARDS UNDER 29 CFR 1910.1200

	YES	NO		YES	NO
CORROSIVE MATERIAL		X	SKIN HAZARD	X	
FLAMMABLE MATERIAL		X	EYE HAZARD	X	
PYROPHORIC MATERIAL		X	TOXIC AGENT (low)	X	
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN		X
COMBUSTIBLE LIQUID	X		LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM	X	

HMIS - HAZARD SIGNALS

HEALTH	1	FLAMMABILITY	2
REACTIVITY	0	PERSONAL PROTECTION	C

0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Chemical goggles. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of an eye injury.
	RESPIRATORY Respiration protection is not required under normal use. Use NIOSH/MSHA-approved respirator where mist or spray may be generated.
	GLOVES Impervious gloves, such as natural or butyl rubber should be used.
	OTHER Long sleeved shirt, trousers, chemically resistant shoes, and rubber apron. Eye wash and shower should be nearby. Wash contaminated clothing.
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Use adequate local exhaust to maintain emissions at point of use below the PEL when mist or spray may be generated.
PRECAUTIONS	HANDLING & STORAGE Keep containers tightly closed in a cool, dry, well-ventilated area away from sources of ignition. Use good personal hygiene practice. Empty containers retain residue and vapors and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind or expose such containers to heat, flame, sparks or other sources of ignition; they may explode and cause injury.
	OTHER Avoid contact with eyes, skin and clothing. Avoid breathing mist or spray.
INCOMPATIBILITY	MATERIALS TO AVOID Oxidizing agents, strong acids, and strong bases.

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Section 4. Emergency Response Data

FIRE	EXTINGUISHING MEDIA Dry chemical, CO_2 or a universal type foam.
	SPECIAL PROCEDURES Use of a SCBA is recommended for fire fighters. Water spray may be useful in minimizing vapors and cooling containers exposed to heat and flame. Avoid spreading burning liquid.
	UNUSUAL HAZARDS This material will burn, but will not ignite readily.
EXPOSURE FIRST AID	EYE: If irritation or redness from exposure to vapors develops, move victim away from exposure and into fresh air. Immediately flush with lots of running water for 30 minutes, lifting the upper and lower eye lids occasionally. Washing eyes within several seconds is essential to achieve maximum effectiveness. Get immediate medical attention.
	SKIN: Remove contaminated clothing. cleanse affected area(s) thoroughly by washing with mild soap and water. It irritation or redness develops and persists, seek medical attention.
	INHALATION: If irritation of nose or throat develops, move victim away from source of exposure and into fresh air. If symptoms persist, seek medical attention. If victim is not breathing, artificial respiration should be administered. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention.
	INGESTION: Aspiration hazard: Do not induce vomiting or give anything by mouth because this material can enter the lungs and cause severe lung damage. If victim is drowsy or unconscious, place on the left side with head down. Do not leave victim unattended. Seek medical attention.
SPILLS	STEPS TO BE TAKEN Stay upwind and away from spill. Keep all sources of ignition away form spill. Wear chemical goggles, butyl gloves, respirator, and chemical resistant shoes. If indoors, ventilate area of spill. Keep out of drains, sewers or waterways. Use sand or other inert material to dam and contain spill. Do not flush area with water. Comply with regulations for spill reporting.
RQ= 34#	WASTE DISPOSAL METHOD Consult appropriate federal, local regulations.

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT 126°	°F - - - -	°C	METHOD USED: TCC		
STABILITY	STABLE	X	CONDITIONS TO AVOID: None			
	UNSTABLE		HAZARDOUS DECOMPOSITION PRODUCTS: Carbon Monoxide, Carbon Dioxide			
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:	

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: This material may cause irritation to eyes, skin and respiratory system. Direct contact with liquid or vapor may cause stinging, tearing and redness of eyes. Prolonged or repeated contact may cause redness, burning and drying and cracking of the skin. May cause irritation of the nose, throat, and signs of nervous system depression (e.g. fatigue). Pre-existing lung disorders may be aggravated. If swallowed, may cause irritation of the digestive tract and signs of nervous system depression. This material can enter lungs during swallowing and cause lung damage.

PRIMARY ROUTES OF ENTRY

☒ INHALATION ☐ INGESTION

☒ SKIN ABSORPTION ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 350-410°F	SPECIFIC GRAVITY: 0.790	VOLATILE COMPONENTS Stoddard solvent
pH= N.A.	VAPOR DENSITY (AIR=1) 1.2 @20°C	EVAPORATION RATE n-butyl acetate 0.13
SOLUBILITY IN WATER Negligible	WILL DISSOLVE IN N.A.	
APPEARANCE Amber liquid		MATERIAL IS: LIQUID ☒ POWDER
ODOR Characteristic		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS: **Caswell Inc 4336 Rte 31 Palmyra NY 14522**

Date Prepared or Revised: January 26, 2003		**EMERGENCY TELEPHONE NO.** 315 597 5140

MATERIAL SAFETY DATA SHEET

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

B/OX 325

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**Pewter Blackening Oxidizer**
REGULATED IDENTIFICATION	DOT PROPER SHIPPING NAME Corrosive Liquid N.O.S. (Nitric Acid, Fluoboric Acid)
	SHIPPING ID NUMBER UN 1760 NA - - - DOT HAZARD CLASS Corrosive

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
7697-37-2	Nitric Acid Section 313	< 6	2.0 ppm	2.0 ppm	No
16872-11-0	Fluoboric Acid	< 20	2.5 mg (F)/m^3	2.5 mg (F)/m^3	No
7440-50-8 as Cu	Copper, Acid salt of Section 313	< 2	1.0 mg/m^3	1.0 mg/m^3	No
- - - -	Water & other non-hazardous, non-listed or non-reportable materials	72	- - - -	- - - -	No

KNOWN HAZARDS UNDER 29 CFR 1910.1200					
	YES	NO		YES	NO
CORROSIVE MATERIAL	X		SKIN HAZARD	X	
FLAMMABLE MATERIAL		X	EYE HAZARD	X	
PYROPHORIC MATERIAL		X	TOXIC AGENT	X	
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN		X
COMBUSTIBLE LIQUID		X	LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM		X

HMIS - HAZARD SIGNALS			
HEALTH	2	FLAMMABILITY	0
REACTIVITY	0	PERSONAL PROTECTION	C
0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe			

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Chemical goggles. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of an eye injury.
	RESPIRATORY Wear a NIOSH approved respirator appropriate for the vapor or mist at the point of use.
	GLOVES Rubber
	OTHER Long-sleeved shirt, trousers, rubber safety shoes, rubber apron.
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Preferred to maintain emissions at point of use below the PEL
PRECAUTIONS	HANDLING & STORAGE Keep in closed container in a dry, well-ventilated area away from incompatible materials. Wash thoroughly after handling. Containers, even those that have been emptied, will retain product residue and vapors. Always obey hazard warnings on container as if they were full.
	OTHER Avoid contact with eyes, skin and clothing.
INCOMPATIBILITY	MATERIALS TO AVOID Alkalis, oxidizing or reducing materials, cyanides, sulfides or combustible materials.

Section 4. Emergency Response Data

FIRE	EXTINGUISHING MEDIA Water spray, dry chemical, CO_2 or alcohol foam. Do not use direct water stream.
	SPECIAL PROCEDURES Fire fighters should wear self-contained breathing apparatus and full protective clothing.
	UNUSUAL HAZARDS Extinguish all nearby sources of ignition since flammable hydrogen gas will be liberated from contact with some metals.
EXPOSURE FIRST AID	EYE: Immediately flush with lots of running water for 30 minutes, lifting the upper and lower eye lids occasionally. Get immediate medical attention.
	SKIN: Immediately flush skin with lots of running water for 30 minutes. Remove contaminated clothing and shoes, wash before reuse. Get immediate medical attention.
	INHALATION: Remove to fresh air, give artificial respiration if not breathing. Get immediate medical attention.
	INGESTION: Do not induce vomiting. If conscious, give lots of water. Get immediate medical attention. Do not give anything by mouth to an unconscious or convulsing person.
SPILLS ---------- **RQ= 1,633,333#**	STEPS TO BE TAKEN Wear acid resistant gloves, rubber boots, eye protection and NIOSH approved respirator. For small spills, mop or wipe up and dispose of in DOT approved container. For large spills, contain by diking with soil or other non-combustible absorbent material and carefully neutralize with soda ash or lime. Provide adequate ventilation to dissipate the Co_2 gas. Keep material out of sewers, storm drains, surface waters and soil.
	WASTE DISPOSAL METHOD Consult appropriate federal, state and local regulations for disposal. Empty containers are subject to same regulations.

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT None		ºF - - -	ºC	METHOD USED: - - -
STABILITY	STABLE	X	CONDITIONS TO AVOID: None		
	UNSTABLE		HAZARDOUS DECOMPOSITION PRODUCTS: May liberate boron trifluoride and hydrogen fluoride. Thermal decomposition liberates toxic, corrosive fumes of nitrogen oxide and hydrogen nitrate.		
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: Vapors, mists and liquid are extremely corrosive to respiratory tract, eyes, skin, mouth and throat. If inhaled, a burning sensation, coughing and wheezing may occur. Eye contact may severely damage eyes and could cause blindness. Will severely burn and irritate skin. If swallowed, will burn tissues, cause nausea, vomiting and collapse. Systemic fluoride poisoning and potentially fatal hypocalcemia may occur.

PRIMARY ROUTES OF ENTRY

☐ INHALATION ☐ INGESTION

☐ SKIN ABSORPTION ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 222°F	SPECIFIC GRAVITY: 1.18	VOLATILE COMPONENTS Water
pH= < 1	VAPOR DENSITY (AIR=1) Approx. equal to water	EVAPORATION RATE (water =1) Approx. = 1
SOLUBILITY IN WATER Complete	WILL DISSOLVE IN Water	
APPEARANCE Light blue		MATERIAL IS: LIQUID ☒ POWDER ☐
ODOR Characteristics		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS: **Caswell Inc 4336 Rte 31 Palmyra NY 14522**

Date Prepared or Revised May 25, 2000		**EMERGENCY TELEPHONE NO.** 315 597 5140

Prepared:12/26/02

Edited: 1/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: POT METAL NICKEL CRYSTALS
Product Code: PMNC1G OR PMNC2G
DOT Description:Environmentally Hazardous Substance, solid, N.O.S., (Nickel Sulfate)
DOT Label: Class 9
Hazard Class:9
Subsidiary Hazard:None
Packing Group: III
UN #:UN3077

HAZARD RATINGS:Health - 1
Fire - 1
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Sulfate*	10101-97-0	25-30	0.1	1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = ne
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = ne	PH = ne
Appearance/Odor = green crystals, odorless	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - na
Decomposition Products - when heating in air, toxic SO2/SO3 gas can be formed

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - eye contact causes irritation, skin contact causes irritation and may cause sensitization or allergic reactions resulting in chronic eczema or "nickel itch" Inhalation causes irritation of the mucous membrane.
Carcinogenicity - Group 1 . NTP? - No. IRAC? - Yes. OSHA Regulated? - No.
Symptoms of exposure: above Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared:12/26/02

Edited: 1/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL
Telephone: (315) 597-5140 Emergency: (315) 597-5140
4336 Route 31
Palmyra CHEMTREC: (800) 424-9300
NY 14522-9719

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

Product Name: STAINLESS STEEL ACTIVATOR
Product Code: SSACT2G
DOT Description:Consumer Commodity
DOT Label: ORM-D
Hazard Class:ORM-D
Subsidiary Hazard:none
Packing Group: none
UN #:none

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Nickel Chloride*	7718-54-9	60-100	0.1	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = 1.57
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = ne	PH = ne
Appearance/Odor = green crystals, odorless	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - na
Incompatible Materials - na
Decomposition Products - when heating in air, toxic SO2/SO3 gas can be formed

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus. UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - eye contact causes irritation, skin contact causes irritation and may cause sensitization or allergic reactions resulting in chronic eczema or "nickel itch" Inhalation causes irritation of the mucous membrane.
Carcinogenicity - Group 1 . NTP? - No. IRAC? - Yes. OSHA Regulated? - No.
Symptoms of exposure: above Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

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Prepared: 4/17/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: TINNING SOLUTION
Product Code: TINSOL1Q
DOT Description:SULFONIC ACID
DOT Label: Corrosive
Hazard Class:8
Subsidiary Hazard:n/a
Packing Group: II
UN #:UN3205

HAZARD RATINGS:Health - 3
Fire - 0
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sulfonic Acid				

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 230 deg F	Spec Grav (H20=1) = n/a
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = n/a
Vapor Density (Air=1) = 1	Evaporation Rate = na
Solubility in H20 = infinite	PH = n/a
Appearance/Odor = cloudy yellow liquid	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - materials below
Incompatible Materials – May react with cyanides, sulfides, and strong alkaline materials
Decomposition Products – n/a

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus. UNUSUAL FIRE HAZARDS: Thermal decomposition may release sulfer dioxide and sulfer trioxide.

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Threshold Limit Value 2mg/m^3
INGESTION
Irritation and corrosive burns to mouth, throat, stomach. May cause death or permanent injury. Get medical aid at once. Do NOT induce vomiting. If concious, give large quantities of water and several glasses of milk of magnasia or aluminum hydroxide gel. If spontaneous vomiting occurs, keep airways clear.
Oral LD50 = 6200mg/kg
INHALATION Causes severe irritation of upper respiratory tract, coughing, sneezing, salivation, and difficulty in breathing. Immediately move victim to fresh air, keep warm and quiet. If breathing has stopped, start artificial respiration at once. Oxygen should be administered. Contact Physician immediately.

SKIN CONTACT. Irritating to tissue. May cause permanent skin damage. Flush copiously for 15 minutes with water, wash with soap and plenty of water. Remove contaminated garments and wash before reuse or discard them. Seek medical attention at once.

EYE CONTACT. May cause irritation corneal burns and conjunctivitus. Severe or permanent damage or blindness may result. Within 1st 60 seconds, flush eye for 15 minutes with water while holding eyes open. Obtain medical treatment at once. Repeat procedure for 15 minutes while waiting for medical help.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL – Ventilate well. Prevent spread of spill. Neutralize slowly and carefully with soda ash, lime, or sodium bicarbonate. Cover with sand and sweep into a plastic container.

WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling. OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide. Do not flush to sewer.

HANDLING & STORAGE keep away from cyanides, sulfides & oxidizers, strong alkaline materials. Store in dry cool place. Place in tightly closed containers.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.
SPECIAL Empty containers must never be used for any other purpose.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this in**formation.**

Prepared: 4/17/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Section 1. Identity of Material

PRODUCT NAME OR NUMBER	**Verdi Green Oxidizer**
REGULATED IDENTIFICATION	DOT PROPER SHIPPING NAME Corrosive Liquid N.O. S. (Ammonium Hydroxide)
	SHIPPING ID NUMBER UN 1760 NA - - - - DOT HAZARD CLASS Corrosive

Section 2. Hazard Specifications

Section 313 Supplier Notification: This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372 or other hazards under 29 CFR 1910.1200.

CAS NUMBER	CHEMICAL NAME	% BY WEIGHT	PEL=	TLV=	CARCINOGEN
7664-41-7	Ammonia Section 313	< 10	25 ppm	50 ppm	No
7440-50-8 as Cu	Copper, Acid Salt of Section 313	< 3	1.0 mg/m^3	1.0 mg/m^3	No
- - - -	Molybdenum Trioxide Section 313	< 5	5mg/m^3	5mg/m^3	No
- - - -	Water & other non-hazardous, non-listed or non-reportable materials	82	- - - -	- - - -	- - - -

KNOWN HAZARDS UNDER 29 CFR 1910.1200					
	YES	NO		YES	NO
CORROSIVE MATERIAL	X		SKIN HAZARD	X	
FLAMMABLE MATERIAL		X	EYE HAZARD	X	
PYROPHORIC MATERIAL		X	TOXIC AGENT		X
EXPLOSIVE MATERIAL		X	HIGHLY TOXIC AGENT		X
UNSTABLE MATERIAL		X	SENSITIZER		X
WATER REACTIVE MATERIAL		X	REPRODUCTIVE TOXIN		X
OXIDIZER		X	BLOOD TOXIN		X
ORGANIC PEROXIDE		X	NERVOUS SYSTEM TOXIN	X	
COMBUSTIBLE LIQUID		X	LUNG TOXIN		X
COMPRESSED GAS		X	LIVER TOXIN		X
IRRITANT	X		KIDNEY TOXIN		X
			RESPIRATORY SYSTEM		X

HMIS - HAZARD SIGNALS			
HEALTH	2	FLAMMABILITY	0
REACTIVITY	0	PERSONAL PROTECTION	C

0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES Chemical goggles. It is generally recognized that contact lenses should not be worn when working with chemicals because they may contribute to the severity of an eye injury.
	RESPIRATORY Wear a NIOSH approved respirator appropriate for the vapor or mist at the point of use.
	GLOVES Rubber
	OTHER Long sleeved shirt, trousers, rubber safety shoes, rubber apron.
VENTILATION	GENERAL MECHANICAL Yes
	LOCAL EXHAUST Preferred to maintain emissions at point of use below the PEL.
PRECAUTIONS	HANDLING & STORAGE Keep in closed container in a dry, well-ventilated area away from incompatible materials. Wash thoroughly after handling. Containers, even those that have been emptied, will retain product residue and vapors. Always obey hazard warnings on container, as if they were full. Vent container frequently and more often in warm weather to relieve pressure.
	OTHER Avoid contact with eyes, skin and clothing.
INCOMPATIBILITY	MATERIALS TO AVOID Acids, oxidizing materials and oil/combustible materials.

Section 4. Emergency Response Data

FIRE	EXTINGUISHING MEDIA Water spray, dry chemical, CO_2 and alcohol foam.
	SPECIAL PROCEDURES Fire fighters should wear self-contained breathing apparatus and full protective clothing. Cool fire-exposed containers with water spray. Use water spray to knock down vapors.
	UNUSUAL HAZARDS Thermal decomposition may produce ammonia and oxides of nitrogen.
EXPOSURE	EYE: Immediately flush with lots of running water for 30 minutes, lifting the upper and lower eye lids occasionally. Get immediate medical attention.
	SKIN: Immediately flush skin with lots of running water for 30 minutes. Remove contaminated clothing and shoes, wash before reuse. Get immediate medical attention.
FIRST AID	INHALATION: Remove to fresh air, give artificial respiration if not breathing. Get immediate medical attention.
	INGESTION: Do not induce vomiting. If conscious, give lots of water. Get immediate medical attention. Do not give anything by mouth to an unconscious or convulsing person.
SPILLS	STEPS TO BE TAKEN Wear alkali-resistant gloves, rubber boots, eyes protection and a SCBA for large spills or a full facepiece air-purifying cartridge respirator equipped with ammonia filters. For small spills, mop up or wipe up and dispose of in DOT-approved waste container. For large, spills, contain by diking with soil or other non-combustible absorbent material and carefully neutralize with dilute Hydrochloric Acid. Keep out of sewers, storm drains, surface waters and soil.
RQ= 8500#	WASTE DISPOSAL METHOD Consult appropriate federal, state and local regulations for disposal. Empty containers are subject to same regulations.

Section 5. Physical Hazard Data

FLAMMABILITY	FLASHPOINT None		°F - - - -		°C	METHOD USED: - - - -
STABILITY	STABLE	X	CONDITIONS TO AVOID: Heat, sparks and open flames			
	UNSTABLE		HAZARDOUS DECOMPOSITION PRODUCTS: Ammonia gas and oxides of nitrogen.			
HAZARDOUS POLYMERIZATION	MAY OCCUR		WILL NOT OCCUR	X	AVOID:	

Section 6. Health Hazard Data

EFFECTS OF EXPOSURE, SIGNS AND SYMPTOMS: Vapors, mists and liquids are extremely corrosive to the nose, throat, mucous membranes, eyes, skin and mouth. If inhaled, irritation, coughing, chest pain, and chemical pneumonitis may occur. Breathing high concentration may result in tissue damage and death. Eye contact may severly damage the eyes which may be permanent and cause blindness. Skin contact will burn the skin and maybe destroy surrounding tissue. If swallowed, it will burn tissues, cause abdominal pain, nausea, vomiting and collapse plus can cause death.

PRIMARY ROUTES OF ENTRY

☒ INHALATION ☐ INGESTION

☐ SKIN ABSORPTION ☒ SKIN OR EYE CONTACT

Section 7. Physical and Chemical Properties

BOILING PT= 215°F	SPECIFIC GRAVITY: 1.03	VOLATILE COMPONENTS Water & Ammonia
pH= 10.69	VAPOR DENSITY (AIR=1) N/A	EVAPORATION RATE (=1) N/A
SOLUBILITY IN WATER Complete	WILL DISSOLVE IN Water	
APPEARANCE Dark blue solution		MATERIAL IS: LIQUID ☒ POWDER ☐
ODOR Ammonia		

Section 8. Manufacturer Data

FIRM'S NAME & MAILING ADDRESS: **Electrochemical Products Inc. 17000 Lincoln, New Berlin, WI 53151**		
Date Prepared or Revised May 25, 2000		**EMERGENCY TELEPHONE NO.** 315 597 5140

Tinning Solution

Prepared: 4/17/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELLTelephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: YELLOW CHROMATE CRYSTALS
Product Code: YCHR5G
DOT Description:Corrosive Solids, oxidizing, N.O.S. (contains Chromic Acid)
DOT Label: Corrosive, Oxidizer
Hazard Class:8
Subsidiary Hazard:5.1
Packing Group: II
UN #:UN3084

HAZARD RATINGS:Health - 3
Fire - 0
Reactivity - 1
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Chromic Acid*	7738-94-5	60-100	0.05	0.1
CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN				

***THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.**

TCSA STATUS:
All components of this product are on the US TCSA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = decomposes	Spec Grav (H20=1) = 2.7
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = 196 deg C
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 62.5%	PH = 0.2 - 2.0 depending on concentration
Appearance/Odor = odorless dark red powder	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - materials below
Incompatible Materials - This product is a strong oxidizing agent. It may react with easily oxidizable/combustible materials especially at elevated temperatures. Both in dry form and in solution this material may violently react with organic materials. Keep away from heat, hydrogen sulfide gas and protect from moisture.
Decomposition Products - Thermal decomposition produces chromic oxide (Cr2O3), other oxides of chromium which may be hazardous and oxygen. Oxygen increases the fire hazard.

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: May act as an oxidizing agent to initiate or sustain a fire involving organic matter or other easily oxidizable material. Fire may produce irritating or poisonous gases. Runoff from fire fighting can cause pollution. Dike fire control water.
Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - May be fatal if inhaled, swallowed or absorbed through skin. Dry or wet chromic acid is corrosive to eye and skin tissue. Contact of very small quantities of dust or mist with the eyes can result in severe burns. Inhalation of dust or mist can cause damage to the mucous membranes, perforation of the nasal septum, and irritation of the respiratory system. Skin contact can cause severe burns, external ulcers and ulceration of broken skin. Can be absorbed through the skin and cause systemic poisoning. Repeated skin contact leads to sensitization dermatitis with inflammation and ulcers that heal slowly. Inhalation may cause painless ulceration, bleeding, perforation of the nasal septum accompanied by a nasal discharge and hepatitis. Can also cause conjunctivitis, tearing, erosion, and discoloration of teeth. May alter genetic material.
TARGET ORGANS - Kidneys, lungs, liver, nerves.
Carcinogenicity - Group 1 (known carcinogen). NTP? - Yes. IRAC? - Yes. OSHA Regulated? - Yes. Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: SEEK IMMEDIATE MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT (*PHYSICIAN - Read this MSDS. An effective treatment has been shown to be immediate administration of 5-10 grams of ascorbic acid (dissolved in water) by mouth or intravenously followed by 1000 mg three times a day for 14 days*).
INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention.
INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water. Seek immediate medical attention.
Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling. OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/17/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL Inc.Telephone: (315) 597-5140
4336 Route 31Emergency: (315) 597-5140
PalmyraCHEMTREC: (800) 424-9300
NY 14522-9719

Product Name: Zinc Anode
Product Code: ZNANOD20
DOT Description: Not Regulated
DOT Label: None
Hazard Class:None
Subsidiary Hazard:None
Packing Group: None
UN #:None

HAZARD RATINGS:Health - 0
Fire - 1
Reactivity - 2
Protection -

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Zinc	7440-66-6	90-100	10	--

TCSA STATUS:
All components of this product are on the US TCSA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg C) = 1666 deg F	Spec Grav (H20=1) = 7.14
Vapor Pressure (mm Hg) = N/A	Melting Point (deg F) = 788 deg F
Vapor Density (Air=1) = N/A	Evaporation Rate = N/A
Solubility in H20 = N/A	PH = N/A
Appearance/Odor = Silver Metal	

Section IIII - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - None
Incompatible Materials - None
Decomposition Products - None

Section V - FIRE AND EXPLOSION HAZARD DATA

Flash Point = None	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: None

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - May cause irritation. Avoid contact with eyes, skin and clothing.
Target Organs - none.
Carcinogenicity - Not listed. NTP? - No. IRAC? - No. OSHA Regulated? - no.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: EYES: Immediately flush with fresh water for at least fifteen minutes. Hold eyelids apart during irrigation. SKIN: Flush immediately with fresh water for at least fifteen minutes. Remove and wash contaminated clothing before reuse. INHALATION: Immediately drink a large quantity of water, milk or egg whites. SEEK MEDICAL ATTENTION IN THE EVENT OF ANY ACCIDENTAL EXPOSURE TO THIS PRODUCT.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - shovel into drums for disposal. Liquids should be contained, absorbed with inert absorbent such as vermiculite, sand or soil then shoveled or swept into a sealed container.
WASTE DISPOSAL METHOD - As recommended by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - ventilate area well
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - No bare skin when handling this product. Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Prepared: 4/17/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
MANUFACTURER: CASWELLTELEPHONE: (315) 597-5140
4336 ROUTE 31EMERGENCY: (315) 597-5140
PALMYRACHEMTREC: (800) 424-9300
NY 14522-9719

PRODUCT NAME: ZINC PLATING SOLUTION
PRODUCT CODE: ZNC2G
DOT DESCRIPTION:NOT REGULATED
DOT LABEL:
HAZARD CLASS:
SUBSIDIARY HAZARD:
PACKING GROUP:
UN #:

HAZARD RATINGS: HEALTH - 2
FIRE - 0
REACTIVITY - 0
PROTECTION - NA

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS	CAS #	WEIGHT %	TLV(MG/M3)	PEL(MG/M)
ZINC CHLORIDE*	7646-85-7	15	1	1
AMMONIUM CHLORIDE*	12125-02-9	85	10	NE

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
ALL COMPONENTS OF THIS PRODUCT ARE ON THE US TSCA INVENTORY.

SECTION III - PHYSICAL DATA

BOILING POINT (DEG F) = NE	SPEC GRAV (H20=1) = NE
VAPOR PRESSURE (MM HG) = NE	MELTING POINT (DEG F) = NE
VAPOR DENSITY (AIR=1) = NE	EVAPORATION RATE = NE
SOLUBILITY IN H20 = NE	PH = NE
APPEARANCE/ODOR = WHITE POWDER, ODORLESS	

SECTION IV - REACTIVITY DATA
CHEMICAL STABILITY - STABLE
CONDITIONS TO AVOID - STABLE UNLESS HEATED
INCOMPATIBLE MATERIALS - ACIDS, ALKALIS, NITRATES
DECOMPOSITION PRODUCTS - AMMONIA AND HYDROGEN CHLORIDE GASES

SECTION V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - USE AVAILABLE AGENT
UNUSUAL FIRE HAZARDS: WEAR NIOSH APPROVED SELF CONTAINED BREATHING APPARATUS

SECTION VI - HEALTH HAZARD DATA
ROUTES OF ENTRY - INHALATION, INGESTION
HEALTH HAZARDS - BREATHING DUST MAY IRRITATE THE NOSE AND THROAT AND CAUSE COUGHING AND CHEST DISCOMFORT. INGESTION CAN BE HARMFUL. MAY IRRITATE MOUTH, ESOPHAGUS, STOMACH ETC. MAY CAUSE SKIN IRRITATION. MAY IRRITATE AND BURN EYES.
CARCINOGENICITY - NA. NTP? - NA. IRAC? - NA. OSHA REGULATED? - NA.
SYMPTOMS OF EXPOSURE: NA MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE - NA
FIRST AID: INHALATION - MOVE PERSON TO FRESH AIR. CALL PHYSICIAN IMMEDIATELY. EYES - FLUSH IMMEDIATELY FROM EYES FOR 15 MINUTES WITH WATER. SEEK MEDICAL ATTENTION. SKIN - WASH AFFECTED AREA WITH PLENTY OF SOAP AND WATER. SEEK MEDICAL ATTENTION. INGESTION - IF SWALLOWED, DO NOT INDUCE VOMITING. GIVE LARGE QUANTITIES OF WATER. SEEK IMMEDIATE MEDICAL ATTENTION.

SECTION VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - WEAR PROTECTIVE CLOTHING. CONTAIN SPILLS WITH INERT ABSORBENT. RECOVER MATERIAL INTO A CHEMICAL WASTE CONTAINER.
WASTE DISPOSAL METHOD - AS RECOMMENDED BY LOCAL, STATE AND FEDERAL AUTHORITIES (REGULATIONS REGARDING DISPOSAL VARY FROM TOWN TO TOWN)
PRECAUTIONS - WEAR PROPER PROTECTIVE CLOTHING WHEN USING THIS PRODUCT. WASH THOROUGHLY AFTER HANDLING.
OTHER PRECAUTIONS - STORE AWAY FROM INCOMPATIBLE MATERIALS

SECTION VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - USE NIOSH APPROVED RESPIRATOR IF VAPORS ARE EXCESSIVE.
VENTILATION - LOCAL
PROTECTIVE GLOVES - RUBBER
EYE PROTECTION - SAFETY GOGGLES, FACE SHIELD.
OTHER PROTECTIVE EQUIPMENT - RUBBER APRON, RUBBER BOOTS, COVERALLS.
WORK/HYGIENIC PRACTICES - WASH THOROUGHLY AFTER HANDLING, LAUNDER CLOTHES.

NA = NOT APPLICABLE NE = NOT ESTABLISHED

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Zinc Crystals

Prepared: 4/23/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION

Manufacturer: CASWELL
4336 Route 31
Palmyra
NY 14522-9719

Telephone: (315) 597-5140
Emergency: (315) 597-5140
CHEMTREC: (800) 424-9300

Product Name: Zincate Concentrate
Product Code: ZINC1L
DOT Description:Consumer Commodity
DOT Label: ORM-D
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 3
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Hydroxide*	1310-73-2	65	2	2
Sodium Gluconate	524-07-1	2	na	na
Zinc Oxide*	1314-13-2	<10	10	5

*THIS PRODUCT CONTAINS SUBSTANCES WHICH ARE DEFINED AS TOXIC CHEMICALS UNDER, AND SUBJECT TO THE REPORTING REQUIREMENTS OF, SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) OF 1986 AND 40 CFR 372.

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = na	Spec Grav (H20=1) = 1.425 to 1.465
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = na	PH = 13.5 to 15.5
Appearance/Odor = Yellow liquid	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - none
Incompatible Materials - Materials that react with Sodium Hydroxide, Acids
Decomposition Products - none

Section V - FIRE AND EXPLOSION HAZARD DATA

SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: na

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact may cause severe burns and irritation. Destructive to skin tissues contacted and produces severe burns. A latent period may exist between exposure and sense of irritation. Inhalation causes irritation of the respiratory tract. Ingestion may cause severe and permanent damage to mouth, throat and stomach..
Carcinogenicity - No . NTP? - No. IRAC? - No. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately. EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention. SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, DO NOT induce vomiting. Give large quantities of water or milk. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanide and materials that react with sodium hydroxide.
Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

Zinc Crystals

Prepared: 4/23/98

Edited: 01/26/03

MATERIAL SAFETY DATA SHEET

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELL 4336 Route 31PalmyraNY 14522-9719
Telephone: (315) 597-5140
Emergency: (315) 597-5140
CHEMTREC: (800) 424-9300

Product Name: ZINC & COPY CAD BLACKENER CONCENTRATE
Product Code:
DOT Description:Not Regulated
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - B

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Sodium Molybdate	7631-95-0	<10	5mg/m3	ne
Sodium Chlorate	7775-09-9	<5		

TSCA STATUS: N/a

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = >212F	Spec Grav (H20=1) = 1.053
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = <1	Evaporation Rate = <1
Solubility in H20 = 100% at 70F	PH = 7.5- 8.0
Appearance/Odor = Clear, pale yellow liquid. No Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid – none known
Incompatible Materials - Strong reducing agents.
Decomposition Products - Thermal decomposition may evolve noxious chlorine gases

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available.

UNUSUAL FIRE HAZARDS: None

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

Section VI - HEALTH HAZARD DATA

Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal burns.
Carcinogenicity - none 1 . NTP? - No. IRAC? - no. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed, induce vomiting. Give large quantities of water. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town). For small quantities, flush with copious amounts of water.
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELL 4336 Route 31PalmyraNY 14522-9719
Telephone: (315) 597-5140
Emergency: (315) 597-5140
CHEMTREC: (800) 424-9300

Product Name: Gold Plating Solution
Product Code:
DOT Label: na
Hazard Class:na
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 1
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
Potassium Ferrocyanide	14459-95-1	<10%	ne	ne

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = 212F	Spec Grav (H20=1) = n/a
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = na
Solubility in H20 = 100% at 70F	PH = na
Appearance/Odor = Amber/green liquid, slight Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid - Excess Heating to decomposition after evaporation.
Incompatible Materials - Strong acids.
Decomposition Products - Sodium Bisulfite vapors less than 2%. Sodium bisulfite in solution.
Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available. Fire fighters should protect themselves from exposure with protective clothing and self-contained breathing apparatus.
UNUSUAL FIRE HAZARDS: n/e

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation. Inhalation causes irritation of the respiratory tract. Ingestion may cause gastrointestinal burns.
Carcinogenicity - none 1 . NTP? - No. IRAC? - no. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Call physician immediately.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention. INGESTION - If swallowed,, give large quantities of milk. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES
IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town)

PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION - Use NIOSH approved respirator if vapors are excessive.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

MATERIAL SAFETY DATA SHEET

Flash Point = na	Flammable Limits = na
Lower Flame Limit = na	Higher Flame Limit = na

SECTION I - PRODUCT IDENTIFICATION
Manufacturer: CASWELL 4336 Route 31PalmyraNY 14522-9719
Telephone: (315) 597-5140
Emergency: (315) 597-5140
CHEMTREC: (800) 424-9300

Product Name: Silver Plating Solution
Shipping Name Inorganic Liquid
Product Code:
DOT Label: na
Hazard Class:Non Hazardous Liquid NOS
Subsidiary Hazard:na
Packing Group: na
UN #:na

HAZARD RATINGS:Health - 2
Fire - 0
Reactivity - 0
Protection - na

SECTION II - HAZARDOUS INGREDIENTS

Ingredients	CAS #	Weight %	TLV(MG/M3)	PEL(MG/M)
None				

TSCA STATUS:
All components of this product are on the US TSCA Inventory.

SECTION III - PHYSICAL DATA

Boiling Point (deg F) = n/a	Spec Grav (H20=1) = 1.23
Vapor Pressure (mm Hg) = na	Melting Point (deg F) = na
Vapor Density (Air=1) = na	Evaporation Rate = as water
Solubility in H20 = 100% at 70F	PH = na
Appearance/Odor = Amber/green liquid, slight Odor	

Section IV - REACTIVITY DATA
Chemical Stability - Stable
Conditions to Avoid – Reacts with acids
Incompatible Materials - Strong acids.
Decomposition Products - None expected

Section V - FIRE AND EXPLOSION HAZARD DATA
SPECIAL FIRE FIGHTING PROCEDURES - any available.
UNUSUAL FIRE HAZARDS: none

Section VI - HEALTH HAZARD DATA
Routes of Entry - skin, ingestion, eyes, inhalation
Health Hazards - Eye contact causes irritation. Skin contact causes irritation. Inhalation causes irritation of the respiratory tract.
Carcinogenicity - none 1 . NTP? - No. IRAC? - no. OSHA Regulated? - No.
Symptoms of exposure: above
Medical conditions aggravated by exposure - na
FIRST AID: INHALATION - Move person to fresh air. Not sever enough to cause permanent injury.
EYES - Flush immediately from eyes for 15 minutes with water. Seek medical attention.
SKIN - Wash affected area with plenty of water. Remove contaminated clothing. Seek medical attention.
INGESTION - If swallowed,, give large quantities of milk of magnesia or water. Do not induce vomiting. Seek immediate medical attention.

Section VII - PRECAUTION/PROCEDURES

IN CASE OF SPILL - absorb with inert material
WASTE DISPOSAL METHOD - As recommenced by local, state and federal authorities (Regulations regarding disposal vary from town to town). Small quantities may be flushed with copious amounts of water.
PRECAUTIONS - Wear proper protective clothing when using this product. Wash thoroughly after handling.
OTHER PRECAUTIONS - Store in well ventilated areas. Keep away from cyanides.

Section VIII - SPECIAL PROTECTION
RESPIRATORY PROTECTION – Not normally required.
VENTILATION - local
PROTECTIVE GLOVES - Rubber
EYE PROTECTION - Safety goggles, face shield.
OTHER PROTECTIVE EQUIPMENT - Rubber Apron, rubber boots, coveralls.
WORK/HYGIENIC PRACTICES - Wash thoroughly after handling, launder clothes.

na = Not Applicable ne = Not Established

While the information and recommendations given are believed to be accurate, CASWELL makes no warranty, express or implied, and assumes no liability with respect to use of this information.

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