Practical Electro-plating

Bedell

L. A. Pandick

PRACTICAL

ELECTRO-PLATING

A guide for the electroplater, giving complete instructions for the arrangement of the shop, the installation of the plant, polishing, plating, buffing, and lacquering.

WITH 110 ILLUSTRATIONS

BY

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1912

THIRD EDITION

INTRODUCTION

It has been the author's aim in compiling this work to instruct the operator, in a practical manner, in the art of electro-plating and metal finishing.

The work illustrates and describes the necessary articles, states what they are used for, and how to use them.

The work in arrangement and classification differs entirely from any work previously published on this subject. It first describes the general shop arrangement, then, beginning with the installation of the dynamo, goes through the complete electrical equipment in the order in which it should be set up and connected, following with other necessary equipment and information in regular order. This will be found of particular advantage to the beginner.

Taking in the electro-deposition of the standard commercial metals, formulæ are given for making and operating various plating solutions, dips, and pickles, as well as the manner in which they should be maintained and renewed.

The information given has been carefully obtained from reliable experts of long and varied experience.

Many thanks for valuable information on the subject are especially due the following: John T. Daniels, E.E., and Willis R. King, Electro-plating Expert.

THE AUTHOR.

CONTENTS

ELECTRO-PLATING

Electro-plating.—Electro-plating is the art or process of depositing or plating metals with an electrolyte medium, by the aid of an electrical current; the combination of the two causing decomposition of one element which is deposited on the other.

Common Electrical Symbols and Terms, with their Meaning.

D. C.	Direct current. The only current used for electro-plating purposes.
V.	Volts, represent the current pressure or force.
A.	Amperes, represent the volume or quantity of current.
W.	Watts = V. × A.
K. W.	Kilowatt = W. ÷ 1000.
E. M. F.	Electro-motive force or voltage.
P. or +	Positive pole or line conducting current from dynamo.
N. or —	Negative pole or line conducting return current to dynamo.
H. P.	Horse power; 1 H. P. = 746 watts.
R. P. M.	Revolutions per minute.

Anode. Source of supply from which the metallic deposit is obtained.

Cathode. The article to be plated or deposited upon.

Generator. A machine that converts mechanical into electrical energy.

Motor. A machine that converts electrical into mechanical energy.

Ammeter. An instrument for indicating the volume or quantity of current.

Circuit. The path in which the current flows.

Ground. The connection of any part of an electrical current with the earth, either by fault or intent. A ground is used in some circuits for economy, but is to be avoided in electro-plating circuits.

Neutral. A conductor used for convenience and economy through which the current may flow in either direction.

Potential. The difference of electrical conditions.

Rheostat. A current regulator.

Short circuit. A path of little or no resistance, connecting positive and negative conductors.

Voltmeter. An instrument for indicating the current pressure or force.

LIST OF ARTICLES COMPRISING A COMPLETE ELECTRO-PLATING PLANT

PLATING PLANT

Dynamo.
Rheostat for field regulation.
Countershaft.
Copper wire for main line.
Connections for main line.
Tanks for solution.
Brass rods for tanks.
Rod connections for tanks.
Connecting wire for tanks.
Rheostats for tanks.
Voltmeter.
Ammeter (not always necessary).
Wood tank for water, 2 compartments, unlined, with overflow and outlet pipe.
Wood tank for acid, lead lined (not always necessary, jars may often be used).
Iron tank for potash.
Wood tank for hot water with overflow and outlet pipe.
Chemical stoneware jar for acid dip.
Chemical stoneware jar for cyanide dip.
Steam sawdust box (not always necessary).

PLATING SUPPLIES

Solution, or material for solution.
Anodes.
Anode hooks.
Hydrometer, 0–20, for solutions.
Hydrometer, 0–70, for acids.
Slinging wire.
Kostico or XXX lye.
Cleaning compound.
Scrubbing brushes.
Potash brushes.
Cyanide of potash, C. P.
Powdered pumice, F. F.
Litmus paper.
Boxwood sawdust.
Sawdust brushes.
Dipping baskets.

POLISHING PLANT

Lathes.
Column.
Countershaft.
Glue heater.

POLISHING SUPPLIES

Leather-covered wood wheels.
Union canvas wheels.

Bull-neck wheels.
Walrine wheels.
Felt wheels.
Muslin buffs.
Cotton flannel buffs.
Bristle wheels.
Tampico wheels.
Scratch brushes.
Turkish emery (various grades).
Glue, XXXX flake.
Glue brushes.
Emery paste.
F. F. composition.
Crocus composition.
Tripoli composition.
Buffing composition, XXX.
Essex lime composition.
Hard rouge.
Lump pumice stone.
Many other articles illustrated and described in the following pages will be found very useful but not always necessary.

SECTION 1

A COMPLETE ELECTRO-PLATING PLANT

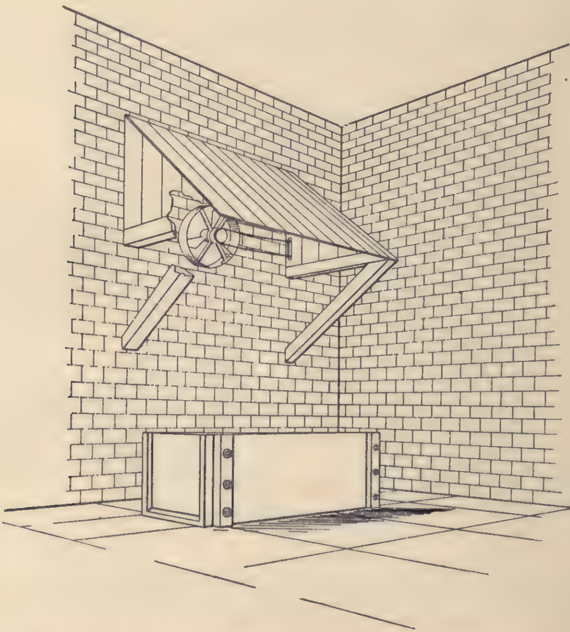
PART 1.—THE PLATING ROOM

If possible have this on the ground floor and where it will receive the best light and ventilation; both are essential to good work. The room must be provided with facilities for obtaining a plentiful supply of fresh running water and live steam, as much of the work in plating is in preparing the article by scouring, dipping, and rinsing, and, with convenient facilities for doing this, the cost is reduced and better work accomplished.

The Floor.—The best and most satisfactory floor for a plating room is one constructed of concrete or cement, having suitable gutters arranged at the sides of the room, these to drain into a screen-covered catch basin properly connected with the sewer by a good sized tile pipe and trap.

The waste water from the tanks can then be carried off through the gutters, thereby saving considerable expense in piping.

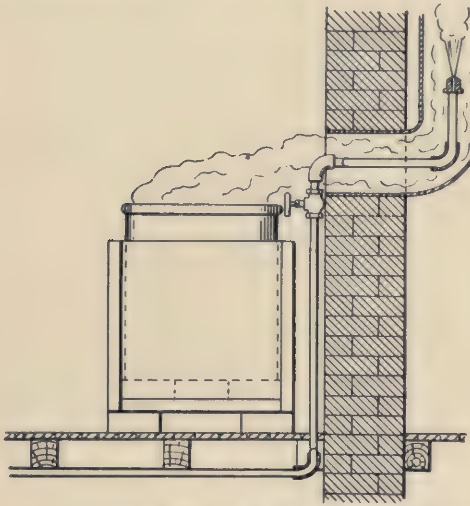
The floor may then at any time be cleaned by flushing with a hose.



Arrangement of Dipping Tank Hood, and Exhaust Fan.

Another and cheaper method of constructing a plating room floor is by the use of good quality heavy tar paper having the edges well lapped, the seams and top of the paper then to be well coated with asphaltum and given a good sprinkling of coarse sand, while hot.

Wood gratings made of narrow strips about one inch high placed in front of each tank will be found



Arrangement of Steam Exhaust for Acid Fumes.

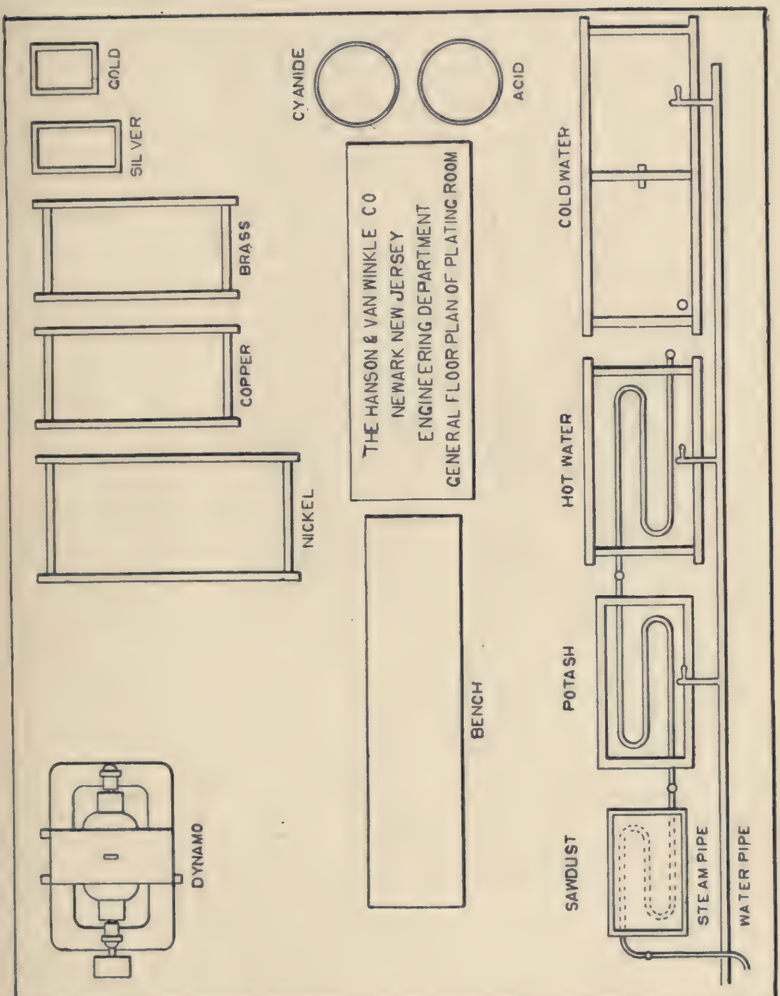
very useful in keeping the operator's feet from the wet and dampness caused by the drippings from the tanks.

Dipping Tank Ventilation.—A large wooden hood arranged directly over the dipping tanks, and connected to a chimney flue or through a window sash by a square wooden flue made of boards, will be found of great benefit to the operator by carrying off the acid fumes. The hood and flue should be coated both inside and out with acid proof paint.

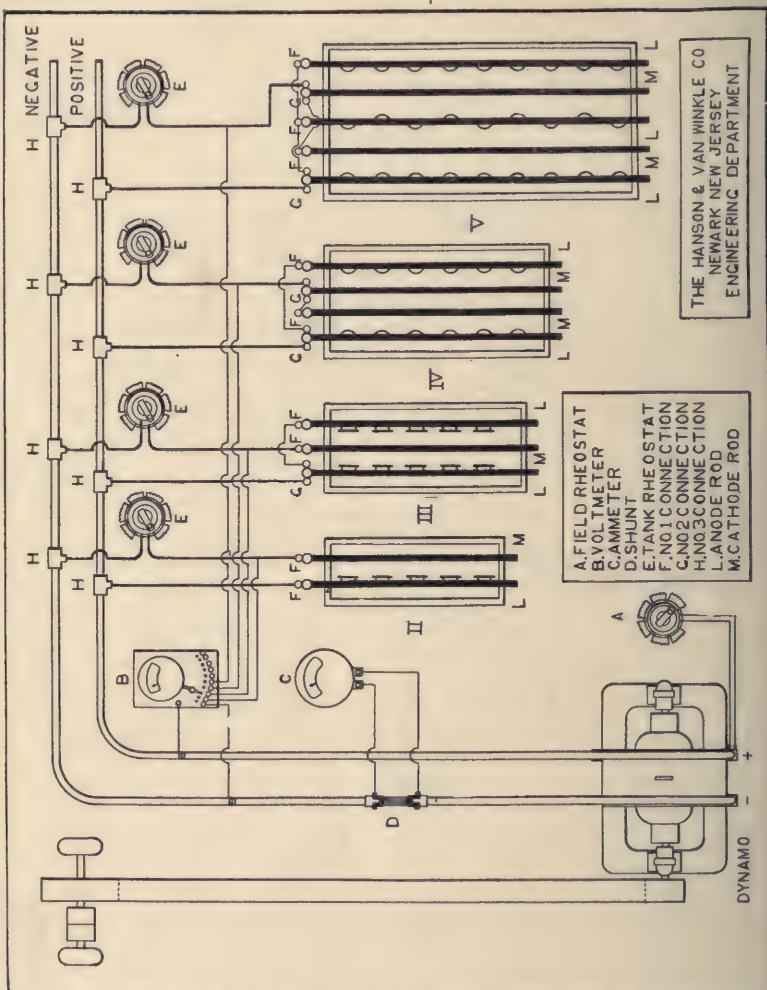
A small exhaust fan should be placed under the hood at the entrance to the outlet in a manner similar to the sketch. This may be driven by a small round belt. The forced draught created will keep an ordinary sized room free from steam or acid fumes.

Equally good results can be obtained by using a steam pipe in place of the fan. The pipe should be arranged to exhaust into the outlet flue; this will create a good draught, which will carry off all vapors or fumes.

The steam pipe should be given a very heavy coating of acid proof paint to keep it from rusting.



General Floor Plan of Plating Room.



Method of Connecting Dynamo, Tanks, and Instruments. Two-wire System

PART II.—ELECTRICAL EQUIPMENT

DYNAMOS

The dynamo or battery may well be termed the heart of all electro-plating operations, as either is absolutely necessary to generate the electrical current required in the plating solution tanks.

Batteries at the present time play a very small part in these operations. This is due to the many improvements in construction of modern dynamos and to the reduction in cost of the machines and running expense.

The dynamo consequently is the first and most important article to be considered when selecting material for an electro-plating plant, and should be purchased from a reliable manufacturer. Avoid experimenting with some odd or unknown dynamo that can be bought for a small sum, as it is almost sure to prove a source of trouble and expense.

A first-class modern dynamo possesses the following important features and should be selected accordingly:—

One that is not overestimated in capacity rating.

One that is noiseless in operation.

One that will give a steady flow of current.

One in which the current can be easily controlled.

One that will not require constant attention.

One that will not spark.

One having interchangeable parts.

One that is sufficiently large to do the work required in the various solution tanks and still have some energy to spare so that at any time, when an increase in business may warrant, one or more tanks may be added in the circuit without the necessity of buying a new machine.

A rapid deposit depends on certain well-known conditions, viz., the density of the solution, the distance between anode and cathode, but primarily on the maintenance of the electro-motive force at a certain strength continuously. A properly constructed compound-wound dynamo will maintain the initial voltage without drop, that is, the voltage being set by means of the field rheostat, one piece or a number of tanks full of work can be deposited without either rise or drop in voltage, this factor remaining constant under all conditions, and with the solution at proper density uniform results in the same space of time can always be obtained.

Standard electro-plating dynamos are constructed varying in capacity from 50 to 6,000 amperes, with a current pressure of $4\frac{1}{2}$ to 6 volts to operate on the two-wire system, this being the one most commonly used. These may be furnished either compound or shunt wound, or with fields wound for separate excitation.

In dynamos over 2,000 ampere capacity, it is advisable to use the separately excited type, a shop current being used for the excitation of the fields.

Motor generator sets are especially recommended as they may be located at the most convenient points in the shop, without regard to the location of line shafts. Trouble with the long line shafts occasionally results in stopping all of the machinery. With the electric drive, trouble at one point does not interfere with the operation of the dynamo in another part of the shop.

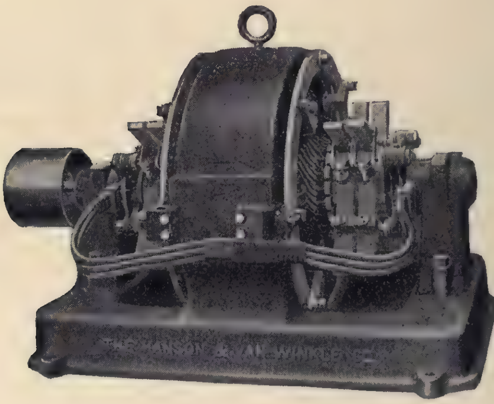
Belting and shafting may be dispensed with, resulting in better light, less dirt and oil. The noise of belts running at high speed, as well as the danger of injury from them, is avoided.

The friction loss due to long heavy shafting is avoided, and the operating expense stops with the motor. This friction loss, especially when the shafting is slightly out of line, represents a large percentage of the total power delivered by the engine.

It is considered good practice to work generators to their maximum capacity, and with the direct connected outfit the full capacity of the generator is always at the command of the operator, night or day, without reference to the rest of the shop. It has been demonstrated in many instances that the output of the plating dynamo has been increased when direct connected to the motor.

METHOD OF CONNECTING DYNAMOS, TANKS, AND INSTRUMENTS

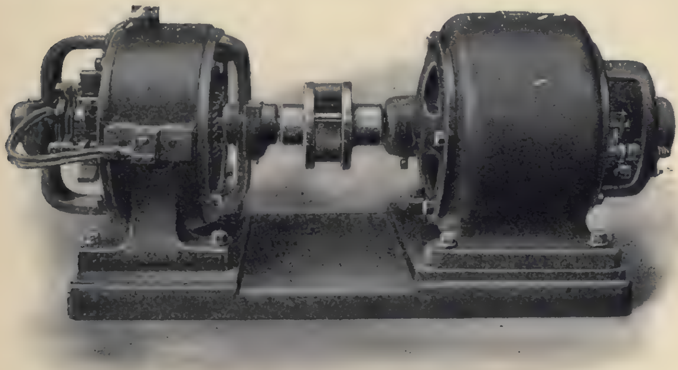
TWO-WIRE SYSTEM



A Compound-wound Multipolar Dynamo.

Dynamos.—All modern plating dynamos unless otherwise ordered are generally compound wound.

This method of wiring is particularly desirable in the smaller sizes, as this peculiarity in winding enables the operator to adjust the voltage to some definite point (which is done by the use of a field rheostat), when no further hand regulation is necessary; for with a fairly uniform speed the voltage will remain constant, whether one piece of work is placed in the tank, or the same is loaded to the full capacity of the machine.



A Motor Generator Set.

Motor Generator Sets.—The dynamo description also applies to the generators of motor generator sets. These sets can be furnished with motors operating on either direct or alternating current.

For instructions, management of dynamo, see Section 12.

Placing.—It is very important that the dynamo or motor generator set be properly placed and where it is easy of access. It should not be exposed to moisture or to the dust and dirt from the polishing room.

Cleanliness is a necessity. A well-ventilated machine will do more work with less wear than one unfavorably placed.

Foundation.—The smaller sized dynamos may be placed on rigid wooden frames; they may also be attached to the side wall or suspended from the ceiling. The larger sizes should be placed on brick or concrete piers, as it is very important that all vibration be reduced to a minimum. Care must be taken to see that the machine is perfectly level and that it is accurately lined up with the driving pulley of the countershaft.

Speed.—The dynamo must be run at the speed marked on the name plate, otherwise it is impossible to obtain proper results. The speed should be tested with an accurate speed indicator.

In most instances where complaints have been made that the dynamo did not work properly, it has been found by investigation that the above instructions were not carried out, or that the dynamo had been run from a power of variable speed, often caused by a frequent slipping of belts.

The armature should revolve in the direction which would cause the commutator to run from the brushes and not toward them.

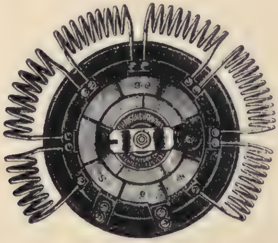
Belting.—When possible place the dynamo in such a position that a slanting belt can be used and so that the underside of the belt does the pulling. The length of belt to use for the best results is one that would allow for about 10 to 15 feet between the centers of dynamo and driving pulleys.

Terminals.—The main line terminals of a dynamo are necessarily constructed of a size suitable to carry the entire ampere output of the dynamo, consequently the main line wires should be of a size exactly to fit the holes made in terminals.

Positive terminal is marked + or P.

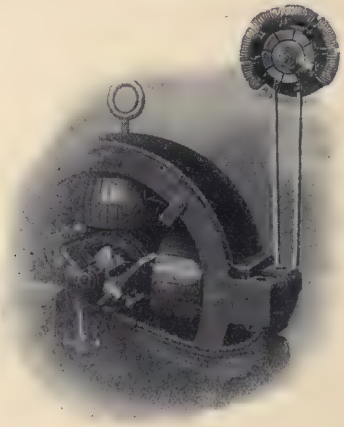
Negative terminal is marked — or N.

Field Rheostat.—A rheostat is *necessary* in the field of the dynamo, where it will control the voltage along the entire line of connection, enabling an initial current pressure to be maintained, while the tank rheostats further reduce this current to the proportions needed at the place required.



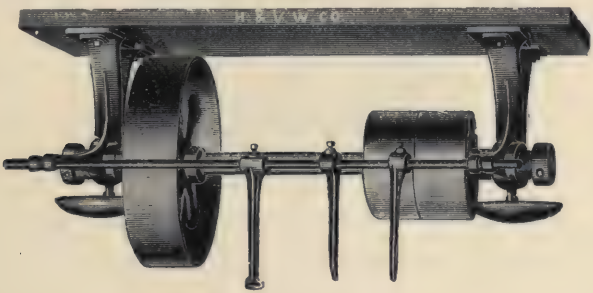
Field Rheostat.

Connect the rheostat in the field by copper wires which exactly fit the terminals made to receive them.



Rheostat in Field of Multipolar Type Dynamo.

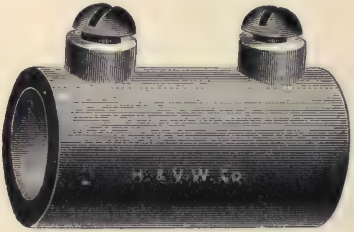
Place the rheostat not more than three feet from the dynamo and within easy reach. It may be fastened on a suitable wooden frame, or on the side wall. When starting the dynamo turn the rheostat lever to the weak point until the dynamo has obtained full speed, then shift the lever gradually toward the strong point until the proper voltage has been obtained as indicated by the voltmeter.



Countershaft.—Dynamos should always be driven from a countershaft as they are then under better control of the operator, and in case of accident can be quickly stopped without injury.

Main Line.—Bare copper wire is used for this purpose, the voltage being so low that there is no danger of leakage. For the main line or leads, only pure copper wire or rod should be used and this must be sufficiently large to carry the entire ampere output of the dynamo. The size required can be determined by the size of the dynamo terminals or by reference to the table on page 50.

Main Line Connections.—When it is necessary to splice or piece the main line, it can easily be done by using No. 4 connections of proper size.



No. 4 Connection.

Main Line Location.—When possible place the main lines along the side wall about the height of the operator's head. They will then be out of the way, and it will also be easier to arrange the instruments where needed.

When it is necessary to place the main lines in the center of the room they should run perpendicularly from the dynamo terminals to a height sufficiently great to allow plenty of head room for the operator, then horizontally for the desired length.

The main lines may be supported by grooved wooden brackets, porcelain cleats, or porcelain knobs.

Tanks for Plating Solutions.—Tanks for plating solutions are made of several kinds of material, the kind required depending upon the kind and quantity of solution to be used. The regular tanks are:—

Wood tanks lined with prepared tank lining.

Wood tanks, lead lined.

Enameled iron tanks.

Plain iron tanks.

Steel riveted tanks.

Earthenware tanks.

Glass tanks or jars.

When possible place the first tank not more than about 10 feet from the dynamo, taking care that enough working space for the operator is left between the first and the succeeding tanks. The small sized tanks may be placed on benches or frames so they will be at a convenient height.

Wood Tanks Lined with Prepared Tank Lining.—These may be used for all of the so-termed cold plating solutions, and if necessary they may be fitted with a loop of lead steam pipe, in order to take the chill off the solution during cold weather. The pipe entering and returning from the tank should be insulated from the heating system with insulating joints. Care, however, must be taken that the solution does not become too hot, as this will cause the lining to run to the bottom of the tank. In no case should the temperature exceed 120° F.

Wood tanks are generally used when it is necessary to operate large plating solutions; they serve a very

Wood Tank.

important part in the plating shop, and too much care cannot be given in selecting them.

The tanks should be purchased from manufacturers of supplies who make a specialty of this line, as they employ skilled mechanics and use only the very best lumber. Tank making is a special branch of the carpenter trade, and is in a class by itself, as the amateur tank maker may soon discover.

Beware of homemade tanks, the best of them are very unreliable. Many platers believe they can save a few dollars by making their own tanks, but will not think so when they go to the shop some morning and find that the solution has leaked out on the floor and possibly on the machinery and tools in the shop below, thereby causing considerable damage.

The best tanks are made of selected kiln-dried cypress of 2 or 3 inch stock, with carefully fitted joints, and are held together by numerous stout iron bolts.

Wood tanks can be bought in all shapes and sizes to suit requirements. They are generally made of lumber 2 inches thick, excepting the very large sizes, when 3 inch stock is used.

Tanks have two specifications to be considered, the size or shape (length, width, and depth) in inches and the capacity in gallons. When calculating the number and length of rods to use on a tank as well as the number and length of anodes for same, it is necessary to know the size in inches, and when calculating for a solution it is necessary to know the capacity in gallons.

When purchasing a tank state the length, width, and depth in inches.

To find the capacity of a tank in gallons, multiply the length by the width and this product by the depth, then divide by 232, this being the number of cubic inches contained in one gallon.

Always allow at least 6 inches between the lowest point of the largest work and the bottom of the tank.

Wooden tanks should never rest on the floor, but on stringers, in order to protect the bottom from the wet and from becoming rotten.

When shipments are made to near-by points, the manufacturers generally send the tanks lined and ready for use; lined tanks should be kept filled with clean water until needed. This will aid greatly in preserving the lining.

When tanks are to be shipped to any great distance it is advisable to have them sent unlined, as the lining is liable to become injured in transit.

Tank Lining.—When wood tanks are shipped unlined, sufficient prepared tank lining should be sent with them, this to be applied by the plater.

Directions for Lining Wooden Plating Tanks with Prepared Tank Lining.—The tanks must be thoroughly dry and free from grease or the lining will not adhere.

Tighten all bolts and nuts before beginning operations.

The best results may be obtained in lining wooden plating tanks by using specially prepared tank lining. Melt this in an iron or tin vessel over a slow fire until it becomes very thin. It is then applied to the tank by using a whitewash or similar brush, working rapidly while hot. It is a good plan to first paint the joints with the lining and while it is hot place over them strips of cheese cloth or muslin; then go over the entire surface giving a thin, even coating. After this is done heat some clean sand (sea sand preferred) and sprinkle this freely over the lining. The sand while hot should then be rolled in by using a small hard-wood or iron pipe roller. This hardens the lining and will aid greatly in preventing its running in hot weather.

Care must be taken while melting the lining that it does not become too hot or come in contact with the fire, as it will readily ignite. It is safer to melt this in the open and not in the shop.

If at any time the lining becomes uneven it can be smoothed down by using a hot flatiron.

Tanks or tubs that are to be used for acid dips or pickles should be lined both inside and outside, but not sanded, as the action of the acid would soon destroy the sand.

About five pounds of prepared tank lining will cover one square yard.

Wood Tanks, Lead Lined.—These tanks, while the most expensive, make the best possible containers for all plating solutions, either cold or hot. If cold solu-

Iron Tank.

tions are to be used, it is better to have the lead coated with prepared tank lining. These tanks are particularly recommended for silver and acid copper solutions.

Enameled Iron Tanks.—These may be used with all solutions, either cold or hot, excepting acid or acid solutions, for the reason that the action of the acid will quickly destroy the enamel. They are particularly adapted for use with gold and silver solutions.

Plain Iron Tanks.—These may be used for cyanide solutions, either cold or hot, excepting gold, silver, galvanizing, acid copper, or nickel solutions, but when lined with prepared tank lining they will serve the same purpose as the wooden tanks.

The plain and enameled iron tanks are generally made with an overhanging flange of about one inch. A good plan for supporting these is to make a frame of boards about 6 inches wide, built on edge, on which the tank flanges may rest. Suitable legs of the desired height can then be fastened to the frame.

When fitting anode and cathode rods on iron tanks, they must be insulated from the tank. This may be done by using wooden strips placed across the ends of the tanks, or by fitting a small piece of rubber hose over the rods.

Steel Riveted Tanks.—These may be used under the same conditions as the plain iron tanks.

Earthenware Tanks.—These may be used for all solutions, either cold or hot, but care must be taken while heating the solutions to do so gradually in order to prevent the tank from cracking.

When used for hot solutions it is safer to arrange the tank in a steam-heated water jacket or bath.

Glass Tanks or Jars.—These may be used for all solutions and are particularly adapted for use with small gold and silver solutions. If a hot solution is to be used it should be heated gradually in order to prevent the glass from cracking.

When heating solutions contained in glassware they should be placed on a sand bath (an iron pan containing sand) as they may be heated more evenly in this manner, and if the glass should then crack the solution will be caught in the pan, or the jars may be placed in a hot water bath.

Agate Ware Vessels.—For very hot solutions, excepting acid solutions, a good quality, one-piece, agate ware vessel is recommended.

Tank Rods.—Heavy brass tubes are generally used as tank rods for all ordinary electro-plating purposes. The tensile strength of the hollow formation makes the tubes sufficiently rigid to support the necessary weight and the wall of the tubes is thick enough to carry the necessary current. If these rods should not prove to be sufficiently rigid they can be stiffened by inserting a piece of common iron pipe or rod.

For very small tanks, solid brass rods about 5-16 inch in diameter are generally used. These have holes drilled through them near the ends to receive the connecting wire, which is held in place by a thumbscrew fitted in the end of the rod.

Plating tanks, depending on the size, shape, and requirements, are regularly fitted with brass rods in the following manner:—

Anode rod +, work rod —.

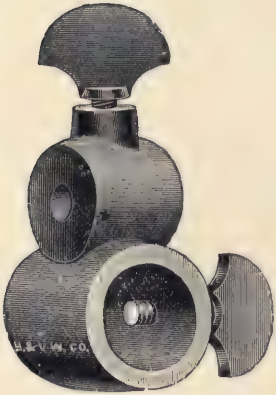
Two-rod tank,	1 anode rod,	1 work rod.
Three-rod tank,	2 anode rods,	1 work rod.
Four-rod tank,	2 anode rods,	2 work rods.
Five-rod tank,	3 anode rods,	2 work rods.

See page 16.

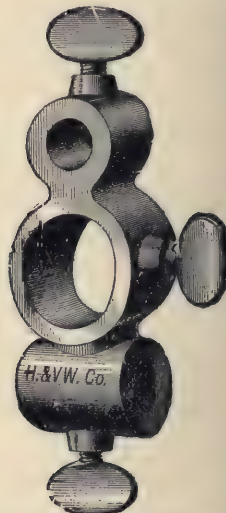
Rod Connections.—On all tanks there are only two terminals as lead connections,—one as positive, the other negative. All connections between anode and cathode rods must be arranged so that the current passes from the anodes through the solution to cathode.

Arrangement.—The most approved method of connecting tank rods is to have all of the connections made at the end of the tank nearest to the main line. See page 16.

Fitting.—All connections must perfectly fit the tank rods and branch wires.



No. 1 Rod Connection.



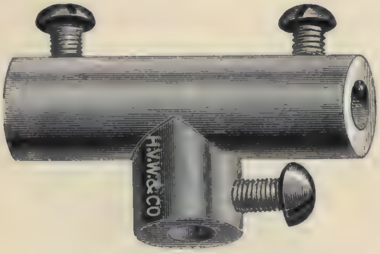
No. 2 Rod Connection.

A 2-rod tank requires	2 No. 1 connections.
A 3-rod tank requires	2 No. 1 connections. 1 No. 2 connection.
A 4-rod tank requires	2 No. 1 connections. 2 No. 2 connections.
A 5-rod tank requires	3 No. 1 connections. 2 No. 2 connections.

See page 16.

Branch Wires to Tanks.—These must be of pure copper and of a size suitable to carry the entire ampere capacity of the tank.

These wires should be connected to the main line by No. 3 connections,—one from the main line positive to the positive tank rod connection, the other from the main line negative to the negative tank rod connection. See diagram, page 16.



No. 3 Connection.

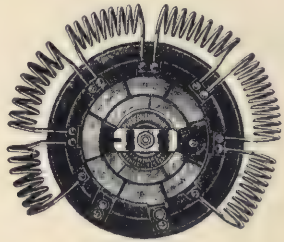
Bus Bar Connections.—For some purposes flat copper bars are used at either side on the upper edge of the tank, these extending for the full length of the tank, one bar as positive, the other as negative, connection through the solution being made by numerous cross rods of brass or copper; the anode rods are made flat on one end and come in contact with the positive bar, the opposite end being insulated by a piece of rubber tube.

The cathode rods are made flat at one end and come in contact with the negative bar, the opposite end being insulated by a piece of rubber tube.

TANK RHEOSTATS

The Use of Rheostats.—Rheostats are of the first importance in the plating room. Without them the varying degrees of current necessary for handling different solutions, or for manipulating baths of various sizes, cannot be obtained.

A rheostat is necessary in the field of the dynamo, where it will control the voltage along the entire line



Tank Rheostat.

of connection, enabling an initial current strength to be maintained while the tank rheostats further reduce this current to the proportions required.

The rheostat in field, while it affects the voltage by setting a fixed resistance in the field of dynamo, does not affect the ampere capacity except in a minor degree. On the other hand the rheostat placed between main line and tank affects both voltage and amperes, reducing the latter in the same proportion as the former is cut down. *It is necessary, then, that the rheostat selected for the tank be of ampere carrying capacity sufficient to handle the current used in the tank.* If the rheostat has not sufficient capacity to handle the ampere current a resistance is formed preventing the proper amount of current from flowing into the tank. The action of a current of electricity can be likened to the passage of water through a pipe, the force with which the water flows from the aperture representing the voltage, while the quantity discharged may represent the ampere current. If a valve or stop-cock is placed on this pipe the action would be similar to that of the tank rheostat in an electric circuit.

In arranging tanks it is necessary that conductors be of sufficient size to carry the greatest number of amperes the tank will handle. Different solutions require different amperes per square foot of work surface (all surface exposed to the action of the current). See page 50: Table of amperes required for different solutions, as well as a table of carrying capacity of copper wire in amperes.

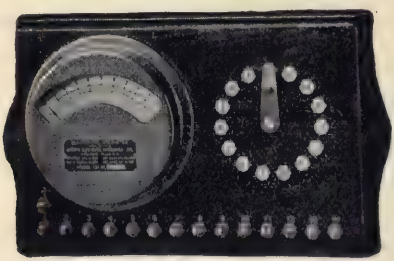
Connecting Tank Rheostats.—Connect a tank rheostat by cutting in on the negative branch wire between the tank and main line. The terminals of the rheostat should exactly fit this wire.

VOLTMETERS

Voltmeters bear the same relation to electrical generators that steam gauges do to boilers, by indicating the pressure of the electrical current.

Multiple Voltmeter, 14 Negative Points.—For direct current circuits only, 0-10 volts.

The most popular voltmeter is one made with binding posts for connecting to 14 tanks (1 positive and 14 negative posts), thus enabling the operator to use



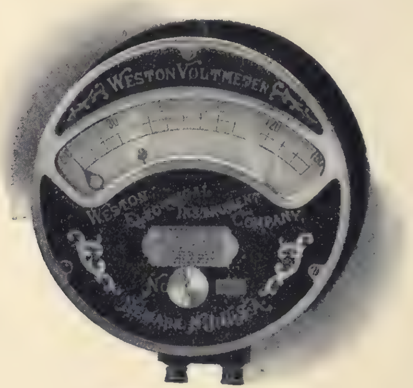
Multiple Voltmeter.

only one instrument in obtaining the reading of any number of tanks up to 14, by simply moving the switch lever to the tank numbers indicated on the switch of the instrument; and when used in connection with suitable patent tank rheostats it will enable the operator to reproduce at all times the same electrical conditions which, by observation and experience, he has found necessary in order to obtain a satisfactory deposit of uniform thickness and color in the shortest possible time.

Location of Voltmeter.—Attach the voltmeter to a suitable wooden frame or to the side wall, conveniently

near the dynamo and where the operator can easily reach it in order to shift the lever when taking the readings of the different tanks.

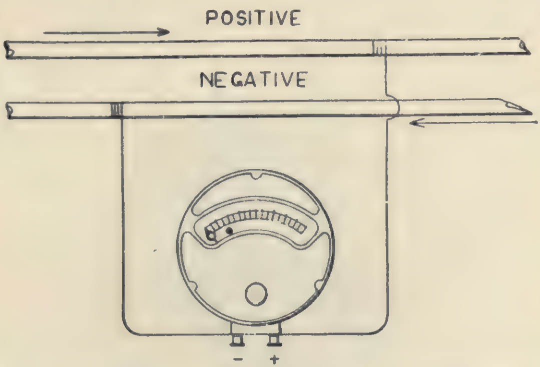
Connecting Voltmeter.—Connect voltmeter on the main line between the dynamo and branch lines of the first tank,—binding posts marked + to positive main line, and No. 1 negative post to negative main line. Ordinary No. 18 office wire may be used for this purpose; wind tightly around main line, giving several turns, taking care to make good contact. Fasten wire in place with a few drops of solder. Then when the switch is set at No. 1 post the reading of the main line may be obtained. The negative binding posts marked with successive numbers should be connected in their order to the various plating tanks on the negative or work line branch wires between the tank rheostats and tanks; then when the switch is placed at any one of these numbers, the reading of that particular tank may be taken. See diagram, page 16.



Voltmeter, Single Reading.

Voltmeters, Single Reading for Main Line.—Connect single reading voltmeters for main line circuits on the main line between the dynamo and branch lines of the first tank. Use No. 18 office wire; connect binding post marked + to positive line, and binding post marked — to negative line.

Voltmeters, Single Reading for Tanks.—Connect single reading voltmeters for individual tanks, by



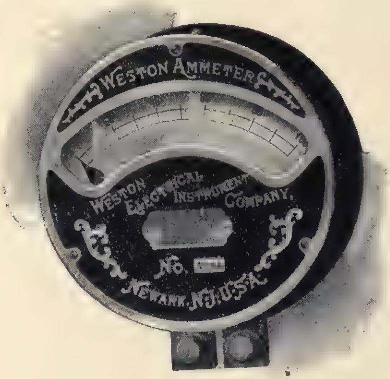
Voltmeter, Single Reading. *Method of Connecting on Main Line.*

using No. 18 office wire. Connect binding post marked + to positive main line between the dynamo and branch lines of the first tank, and binding post marked — to negative branch line between the tank and tank rheostat.

AMMETERS

Uses of Ammeters.—An ammeter connected in the main line circuit will register the volume or quantity of current generated by the dynamo.

An ammeter connected in a tank branch line will register only the quantity of current going into the tank.



Ammeter.

Ammeters are not always considered necessary, but they are an excellent guide for the operator. It is a fundamental law of electrolysis that a certain number of amperes passing through a plating solution will cause a definite weight of metal to be deposited. So, for instance, one ampere will deposit in one hour 17.06 grains of nickel, or 64.03 grains of silver. It is evident therefore that by means of an accurate ammeter the amount of metal actually deposited can be determined.

Kinds of Ammeters.—Standard ammeters reading up to about 200 amperes are generally self-contained; those reading higher are furnished with an external shunt.

Location of Ammeters.—Attach an ammeter to a suitable wooden frame or to the side wall. Place a main line ammeter near the dynamo and an individual tank ammeter near the tank.

Connecting Ammeters.—Main line ammeters should be connected in the negative main line between the dynamo and first tank branch line.

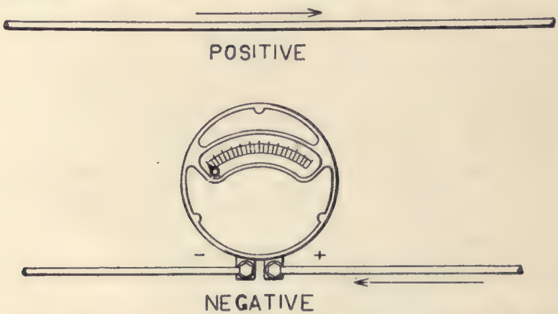
Individual tank ammeters should be connected in the negative branch line between the tank and tank rheostat. Both self-contained ammeters and those hav'ng external shunts should be fitted in place by cutting the negative main line at the point required.

Ammeters, Self-contained.—Each end of the line, where cut, should exactly fit the ammeter terminals.

Low reading ammeters often have suitable holes in the binding posts to receive the wire.

The higher reading ammeters have terminals made with a bolt over which the wire must fit; it is then held in place by a nut. The ends of the line may then be flattened and drilled to fit the terminals, or suitable ammeter connections may be obtained.

Connect a main line ammeter in the negative main line between the first tank branch line and dynamo. Connect binding post marked + to the end of wire leading from the tank. Connect binding post marked — to the end of wire returning to the dynamo.

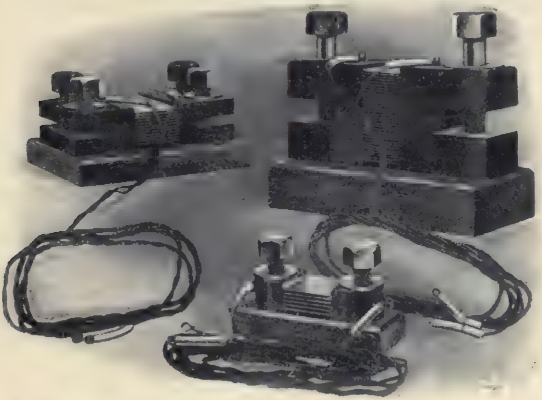


Ammeter, Self-Contained. Method of Connecting in Main Line or in Tank Branch Line.

Connect an individual tank ammeter in the negative tank branch line between the tank and tank rheostat. Connect binding post marked + to end of wire leading from tank. Connect binding post marked — to the end of wire returning to the main line.

Ammeters, Shunt Type.—Standard ammeters with external shunts are furnished with shunts made to connect with flat bars; therefore, if the line to be connected in is made of round wire or bars, it is necessary to have two shunt connections which exactly fit the round line wire at one end and a flat extension at the other end properly drilled to fit the ammeter shunt.

Shunt Connections.—These must be made of metal of high conductivity, and should be furnished by a

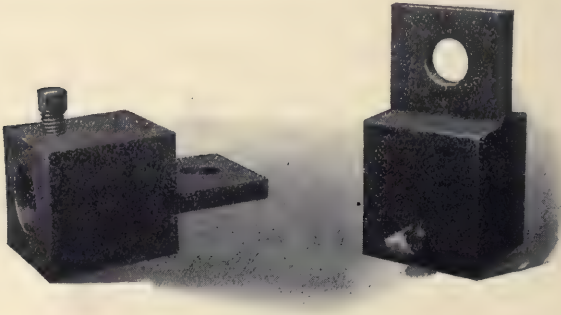


Ammeter Shunts. A Few Ammeter Shunts of Different Style Construction.

manufacturer, as it will be found difficult to have them properly made in the plating shop.

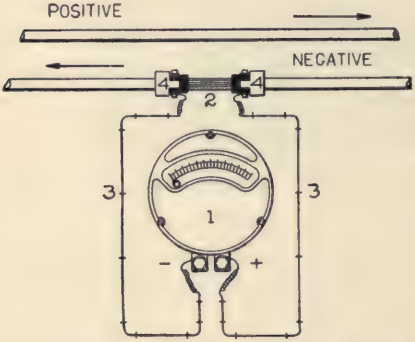
Connect the shunt of a main line ammeter in the negative line between the dynamo and branch line of the first tank.

Connect the shunt of a tank ammeter in the negative branch line between the tank and tank rheostat.



A Pair of Ammeter Shunt Connections.

It must be remembered that shunt ammeters are so constructed that they are not intended to receive



1 Ammeter.
2 Shunt.
3 Shunt cords.
4 Shunt connections.

Ammeter with External Shunt. Method of Connecting in Main Line, or in Tank Branch Line.

the entire quantity of current passing through the line, but only a very small percentage of it.

They are accurately arranged, and calibrated accordingly.

A shunt is a part of the instrument; thus it is absolutely necessary to use only the shunt that is made for a particular instrument and no other; also the flexible wire furnished with the shunt must in no way be altered.

If the ammeter fails to register, reverse the ends of the shunt wires at the binding posts of meter or at the shunt.

Points to Remember.—An area equal to one square inch is required to carry 1,000 amperes. A copper rod 1 inch × 1 inch, or a strip of copper 4 inches × ¼ inch or 2 inches × ½ inch, will fill this requirement. If round wire is used an area equal to 1 square inch must be employed, or a conductor about 1⅛ inch diameter.

The above specifications apply only to installations where the distance from the dynamo to tank—measuring along the entire length of the conducting wire—is not more than 40 feet. For distances greater than 40 feet the size of the conductor should be increased as distance is increased. Double the size conductor is needed for a line of connection of 80 feet, while 50 per cent. increase in size of wire is required if the distance is increased 50 per cent. over 40 feet.

In arranging branch wires from main line to tank it is necessary that the wires be large enough to carry, without heating, enough amperes to plate the full load of the tank. The capacity of the tank in square feet of work surface can be readily determined, then with a knowledge of the amperes required to plate a square foot of surface of the various metals, the total amount of amperes needed for a full tank and the size of wire best adapted to carry the current can be determined.

The following table gives the number of amperes required to deposit a square foot of surface of each of the various metals, and the carrying capacity of the different sizes of copper wire.

Amperes Required to Plate One Square Foot.		**Carrying Capacity of Copper Wire.**	
Solution and Metal.	Average Amperes.	Size.	Amperes.
Nickel	4	1/16 inch – .0625	3
Brass	6 to 8	1/8 " – .125	12
Bronze	6 to 8	3/16 " – .1875	27
Copper	6 to 8	1/4 " – .250	49
Acid Copper	10 to 12	5/16 " – .3125	76
Silver	2	3/8 " – .375	110
Gold	1½	1/2 " – .500	196
Zinc	10	5/8 " – .625	306
		3/4 " – .750	441
		7/8 " – .875	601
		1 " –1.000	785
		1 1/8 " –1.125	994

6 gallons of solution to 1 square foot of work surface are average figures for calculation.

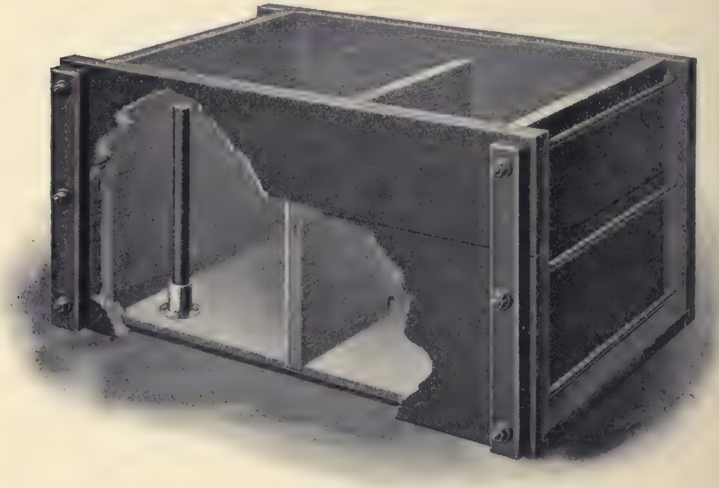
A gallon contains 232 cubic inches.

PART III.—SCOURING AND CLEANING EQUIPMENT

Scrubbing, Dipping, and Cleaning.—A plentiful supply of running water and steam heat is necessary in a properly equipped plant. See page 15.

Scrubbing Tanks.—These are wooden tanks not lined. They are generally made with a partition across the center and furnished with an overflow and outlet standpipe, the partition being a trifle higher than the overflow. A water faucet should be arranged directly over the compartment not containing the outlet. It is a good plan to attach to the faucet a rubber hose reaching to the bottom of this compartment so that the fresh water will flow in at the bottom. When this side of the tank becomes full the water flows over the partition into the side containing the pipe. When this is filled the excess water is taken care of by the overflow. The outlet pipe should extend below the bottom of the tank for the purpose of making a waste water connection.

A slanting board may be arranged along the side of the tank for scrubbing purposes; the side containing the outlet should be used for scrubbing and first rinsing purposes, the opposite side for clean or final rinsing.



Scrubbing Tank.

Wood Tanks for Acid Dips and Pickles.—Lead-lined wood tanks make the best possible containers for acid dips and pickles. It is a good plan to have them fitted with false wooden bottoms in order to prevent the lead from becoming punctured by any articles that may drop to the bottom.

Tanks of this kind are not always necessary.

A good stout tank or tub, lined both inside and outside with prepared tank lining, without being sanded, will answer the purpose for cold solutions.

Iron Tank for Potash, Lye, etc.

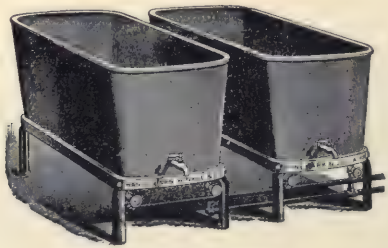
Iron Tanks for Potash, Lye, etc.—Plain square iron tanks, steel riveted tanks, and steam jacketed boiling kettles are used for potash, lye, etc.

The iron or steel tank should be fitted with an iron steam coil in the bottom. This will furnish the necessary heat for the solution. For convenience place a water faucet directly over the tank.

Tanks for Hot Water.—Iron or wood tanks may be used; wood tanks not lined are considered the best for this purpose. They are fitted with an overflow and outlet pipe arranged for connection to a waste water pipe.

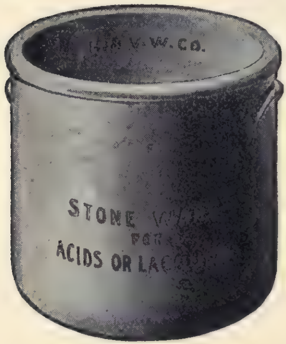
These should contain a lead steam coil placed on the bottom to give the necessary heat.

Place a water faucet directly over the tank.



Steam Jacketed Boiling Kettles.

Jars for Acid Dips.—Special chemically glazed stoneware acid jars only should be used for this purpose. Do not use common, cheap jars; they are porous and spongy and nearly always prove a source of annoyance.



Jar for Acid Dips.

The best method of arranging the jars is to place them in a large, wooden tank containing running water; the tank to be fitted with an overflow and outlet pipe. If the jars are of various sizes, they can be brought to a uniform level by being placed on common bricks.

Jars for Cyanide Dip.—Use chemical stoneware jars same as for acid dips.

Steam Sawdust Box.—Steam-heated sawdust boxes will be found very useful in the shop, but they are not always necessary.

Steam Sawdust Box.

They are particularly useful when it is necessary to dry large quantities of small work in a short time. The articles can be quickly separated from the sawdust by the use of a riddle.

PART IV.—SOLUTIONS, ANODES, CLEANING METHODS, AND GENERAL INFORMATION

Plating Solutions and Chemicals.—There is nothing more important in electro-plating operations than the use of absolutely pure chemicals. These should always be purchased from responsible manufacturers or dealers.

Some buyers believe they are saving money when buying chemicals from irresponsible dealers for a few cents per pound less than the regular market price. This is a mistaken idea. Cheap chemicals are to be avoided, as they generally prove to be very costly in the end. In nearly all cases when used they cause serious difficulty and often great expense, before the trouble due to their use can be remedied.

When a plater desires to use the ordinary plating solutions, such as nickel, copper, brass, and those made from specially prepared salts, he will find it better and cheaper to buy the chemicals and make the solution himself, thus saving considerable in express or freight charges on a large bulk of solution of which the greater portion is water, excepting, of course, special solutions that are made and sold ready for use.

Silver and gold solutions can be purchased in a concentrated liquid form, to which the plater has only to add the necessary amount of water to make the full quantity of solution required.

For instructions for making and maintaining various plating solutions, see Section 5.

Anodes.—Anodes are the source of metallic supply in electro-plating operations. They are made in all of the standard commercial metals. The anodes should be long enough to reach to or below the lowest point of the largest work. The tank should be deep enough to allow at least six inches between the lowest point of the anodes and the bottom of the tank.

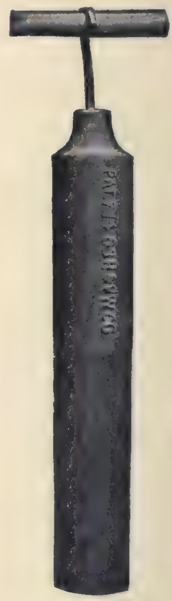
Suspend all anodes from the positive rods.

Flat Anodes.—Flat anodes have been in use for many years and are frequently used at the present day, but are rapidly being discarded owing to the many advantages gained by the use of the elliptic anodes.

Flat anodes can be obtained in any size or shape required. They may be placed in the tank from 2 to 4 inches apart; a space of about 2 inches should be left between them in order to allow a free circulation of the solution.

Elliptic Anodes.—The elliptic anodes are rapidly superseding all other shapes. They are superior to the flat anodes in that they present a larger active working

Flat Anode.



Curved Elliptic Anode. *Elliptic Anode.*

surface to the cathode and cause a better circulation of solution, consequently give a more uniform and smooth deposit in a shorter space of time.

These are cast in all metals; they are 2½ inches wide by 1½ inches thick, and made in any ordinary length with square copper wire hooks attached.

Elliptic anodes should be placed in the tank about two or three to each foot (not less then two).

Curved Elliptic Anodes.—The curved elliptic anodes are cast in all metals and are particularly adapted for use with revolving plating barrel solutions. The anode is curved to fit the periphery of the revolving barrel, and when an anode is hung at each side of the tank, the barrel holding the work is equidistant at all times from the anode, hence a regular and even deposit is obtained.

Curved elliptic anodes should be placed in the tank not less than three to each foot.

Silver Anodes.—Always use pure silver anodes (999 fine) or good results cannot be obtained. These are generally furnished in thin rolled sheet form about 1-32 inch thick.

Suspend the anodes in the solution with small sized iron wire.

One square inch 1-32 inch thick weighs about .182 ounce.

Gold Anodes, 24 Karat.—These are for use with 24 karat gold solution, and should be suspended in the solution with small sized copper wire.

They are usually made in thin rolled sheet form about .015 inch thick. One square inch weighs about .154 ounce.

Gold Anodes, 14 *Karat.*—For use with 14 karat gold solution. It is important that these be made of a special alloy well adapted for the purpose. They should be suspended in the solution with small sized copper wire.

These are generally furnished in thin rolled sheet form about .020 inch thick. One square inch weighs about .143 ounce.

Anode Hooks.—These are generally made for flat anodes in the form of an "s" hook of nickel or copper wire, copper being the most used. The upper loop of the hook should be flattened in order to make a good contact on the anode rod; the lower loop should snugly fit the holes at the top of the anodes.

Elliptic anodes have square copper hooks attached.

Baume Hydrometers.—These are necessary articles in all plating shops. Without them the operator is

Baume Hydrometer.

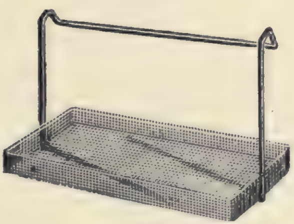
compelled to make and maintain the plating solutions and dips entirely by guess.

Baume hydrometers 0-20 are used for testing the specific gravity or density of the plating solutions.

Baume hydrometers 0-70 are used for testing the specific gravity or density of acids and acid dips.

Slinging Wire.—Copper wire of small size is used for this purpose, sizes varying from about No. 26 and larger according to the class of work to be plated.

This wire is used in short lengths, one end being looped around the article to be plated, the other over the negative or work tank rod. When the articles are suspended in the solution care should be taken to see that they do not touch the anodes.



Plating Basket.

Plating Baskets.—Shallow wire baskets are often used in place of the slinging wire when it is desired to plate a quantity of small articles, such as screws, tacks, rings, etc., the articles being freely distributed over the bottom of the basket. It is necessary, however, to frequently shake the baskets in order to change the position of the articles so that an even deposit may be obtained.

Plating Trees or Racks.—For some classes of work plating trees or racks may be used in place of the slinging wire. These may be made by the plater to suit the work to be handled. They are generally made with one or more perpendicular stems of narrow sheet metal, or stiff wire, curved at the upper end to fit the work rod. To these stems are fastened horizontal cross strips or wires having small hooks attached on which to hang or place the work. The racks may be improved by a covering of insulating material, excepting at the places of contact. This will prevent them from receiving the metallic deposit.

A large number of articles, such as buckles, rings, ferrules, rods, etc., may be quickly handled in this manner, thus avoiding the necessity of wiring them.

Kostico (Trade Mark), for Cleaning Work in All Plating Operations.—Kostico is used as a dip to replace potash or caustic sodas in cleaning nickel, copper, brass, gold, silver, etc. It removes grease and dirt without tarnishing the brightest surface, preparing the work for instant immersion in the plating solution, and retains its strength in the dip for a long time.

Kostico has a great advantage over other cleaners in that a uniform quantity will give a uniform strength of solution, removing grease and oil of all kinds without oxidizing or discoloring the polish of highly finished work.

Kostico.

It is quick to operate and being a dry, granular salt is easily handled without loss.

Kostico makes a clean solution; there is no surface scum to cling to the work. It is one of the best cleaners known, and has the property of cutting the mineral oil which is so generally used in covering bolts, nuts, screws, etc.

Formula:

Water..	1 gallon.
Kostico..	½ pound.

Must be used at boiling point.

Articles of brass or copper, when taken from the

Kostico dip, should first be rinsed in cold water, then

given a cyanide dip, after which rinse again in cold water and pass to the plating solution.

Articles of iron or steel, when taken from the Kostico dip, should first be rinsed in cold water, then given a muriatic acid dip, again rinsed in cold water and passed to the plating solution.

New England Cleaning Compound, for removing Polishing Compounds and Oil from Work.—New England Cleaning Compound combines the requisite qualities of potash, sal soda, soap, ammonia, and naphtha and is a substitute for these. It quickly and thoroughly removes all traces of oil, polishing compositions, or other foreign matter from highly finished metals without tarnishing or oxidizing them. It will also give a high color to brass work preparatory to lacquering.

In many classes of work it is very difficult to remove the remains of the polishing material without much labor.

This compound is easy to use, is quick to work, and avoids the danger in using naphtha, wood alcohol, etc.

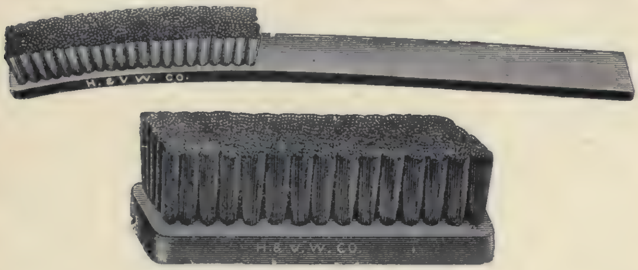
Formula:

Water	1 gallon.
New England Cleaning Compound	6 ounces.

Use boiling hot.

Allow the work to remain in the solution for a reasonable length of time. On some classes of work it is necessary at times to use the solution by scrubbing with a brush. When the work is taken from the solution, rinse first in cold and then in clean boiling water, after which dry in hot boxwood sawdust.

Scouring Brushes.—For use with powdered pumice stone and water, preparatory to plating, to remove any



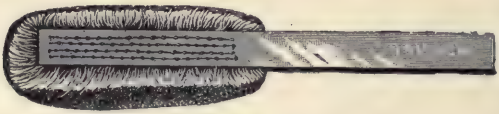
Scouring Brushes.

foreign matter which may adhere to the work and for preparing a suitable surface on the metal so that the metallic deposit will more readily take hold.

These are made of bristle or tampico of various sizes and shapes. The cuts show two of the most popular styles.

Potash Brushes.—These are made of cotton wick and are used for scrubbing or mopping the work with the potash or lye solutions, in order to thoroughly saturate the work and hasten the action of the solutions. Tampico brushes are also often used for this purpose.

Never use bristle brushes in lye or potash solutions.



Potash Brush.

Cyanide of Potassium (Poison).—Cyanide of potassium is a very poisonous chemical, consequently great care should be exercised when using it.

Cyanide of Potassium.

It is used in making many of the plating solutions; also, when dissolved in water as a dip, for removing stains or discoloration from brass, bronze, copper, and silver.

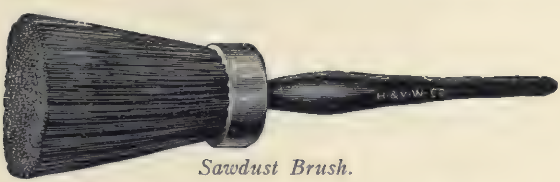
Pumice, Powdered.—This is used with a hand brush and water for scouring the work preparatory to plating. It is also used on bristle or tampico wheel brushes to produce finishes of different effects.

Litmus Paper.—This is used to test all kinds of plating solutions; it is generally furnished in small padded strips called "books."

Blue litmus turns red if a solution contains free acid. Red litmus will turn blue if free alkali is present.

Keep in a well-covered package when not in use.

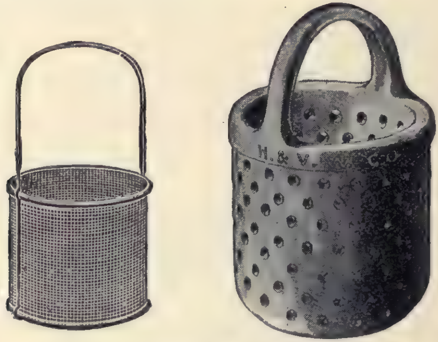
Boxwood Sawdust.—Boxwood sawdust is used in a regular steam-heated sawdust box, or a suitably heated pan or tank, for the purpose of quickly drying the work when taken from the plating tank or dips, after rinsing.



Sawdust Brush.

Sawdust Brushes.—These are used for brushing off any fine particles of sawdust that may adhere to the work, and are particularly useful in removing sawdust from articles having crevices or hollow places.

Dipping Baskets.—These are made of stoneware or wire and are used for dipping small articles in the lye, acid, potash, or cleaning compounds.



Dipping Baskets.

Aluminum baskets will be found very convenient for the purpose, owing to their light weight, and they are not so easily broken as the stoneware.

They are practically acid proof, but *must not be used in potash, muriatic or hydrofluoric acids.*

When selecting stoneware dipping baskets, always get them with holes as large as possible without allowing the work to slip through, so that the acid will flow out quickly.

SECTION II

POLISHING PLANT, MACHINERY, WHEELS, AND COMPOSITIONS

The Polishing Room.—The polishing room should be entirely separate from the plating room and so arranged that it will receive plenty of light.

If a separate room is not available, a section of the shop can easily be partitioned off with boards.

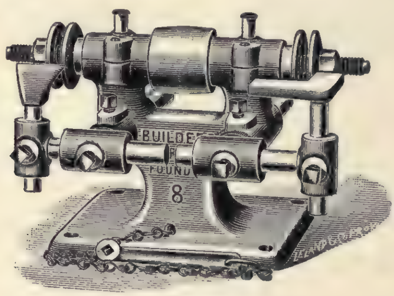
This is necessary, and of more importance than it may seem, in order to keep the plating room clean and free from particles of dust, lint, and polishing compositions, that always arise during polishing and buffing operations, and to keep them from settling on the plating solutions, work, and dynamo. If this is not done, trouble may be expected, as with a dirty or dust covered solution the plater cannot obtain good results.

Coloring or finishing should be done in a separate compartment of the polishing room, so that the grit from the emery wheels and cutting down compositions cannot in any manner come in contact with the fine finishing wheels.

Ventilation.—It is important that the polishing room be well ventilated so that the operator will not be compelled to inhale constantly the fine particles of dust and dirt.

For small shops, an exhaust fan driven by a small, round belt, and placed at the entrance of a chimney flue, or in a window sash, near the lathe, will be of great assistance in carrying off the dust.

In large shops it is advisable to have a sheet metal hood arranged over each polishing wheel, the hoods to connect, by sheet metal pipes of suitable size, to an exhaust blower. In this manner the room can be kept entirely free from dust and dirt, and at the same time receive perfect ventilation.



Grinder.

POLISHING PLANT

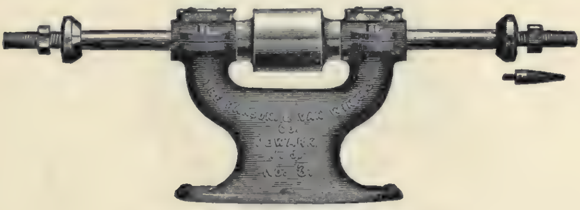
Grinders.—These are for use with emery or corundum wheels to cut off burrs or any uneven, rough, or lumpy places on the work in order to prepare it quickly for the finer finishes.

The speed at which a grinder should be run depends on the size of machine, size of wheel, and class of work.

See speed chart, page 230.

Lathes.—Lathes for polishing and buffing are made in many styles and sizes and should be carefully selected according to requirements.

Always buy a good quality lathe; it will run smoother and last longer than a cheap one.



Polishing and Buffing Lathe.

Polishing and Buffing Lathes.—These are made with single pulleys to be driven from a countershaft, also with tight and loose pulleys to be driven from a main line shaft pulley.

This style lathe may be fastened to a stiff bench or stout wooden frame; it is also furnished with iron stands or columns.

Double Column Lathes.—This style lathe is low, heavy, and rigid and particularly useful for large wheels and heavy work.

Speeds for polishing about 1,600 to 1,800 r. p. m.

Speeds for buffing about 2,400 to 3,000 r. p. m.

Double Column Lathe.

Independent Spindle Polishing Lathe.—The independent or twin spindle polishing lathe has only recently been placed on the market. It contains entirely new features which cover a long felt want, especially in the large polishing shops where many hands are employed.

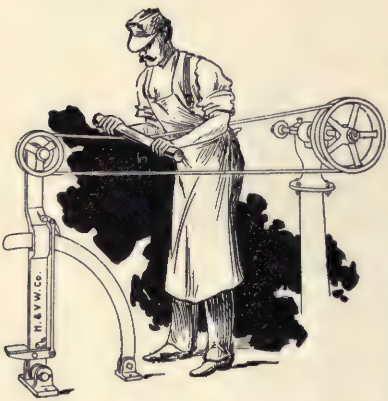
The machine is practically two lathes combined in one. It is constructed so that either end of the spindle may be started or stopped independently of the opposite end.

Throwing off a clutch brings a brake into action, which stops the spindle instantly; while the reverse motion releases the brake, which causes the spindle to start instantly.

Independent Spindle Polishing Lathe.

If a polisher at one end of the lathe stops to change wheels the one at the other end may continue with his work without interference. In many shops this means a saving of many hours in a month.

No countershaft is required with this lathe for the reason that, when both clutches are thrown off, the pulley of the lathe serves the same purpose as the loose pulley on a countershaft.



Belt Strapping Attachment.—This is used with endless polishing belts set up with glue and emery for roughing out and polishing.

It is particularly adapted for use on all sorts and conditions of metal surfaces that are inaccessible with the regular polishing wheels, such as plumbers' supplies, bicycle parts, gas fixtures, cutlery, etc.

The attachment is operated by a 12-inch flanged pulley attached to a polishing lathe; this drives the polishing belt, the other end of which is supported by a 6-inch flanged idler pulley attached to the strapping machine. The 12-inch pulley should run at a speed of about 1,600 r. p. m.

Endless Canvas Polishing Belts.—These are for use with the belt strapping attachment, and should be set up with glue and emery in a similar manner to the polishing wheels.

Directions for use, see page 96.

Scratch Brush Lathe.

Scratch Brush Lathes.—These are made with single pulleys, also with fast and loose pulleys. It is im-

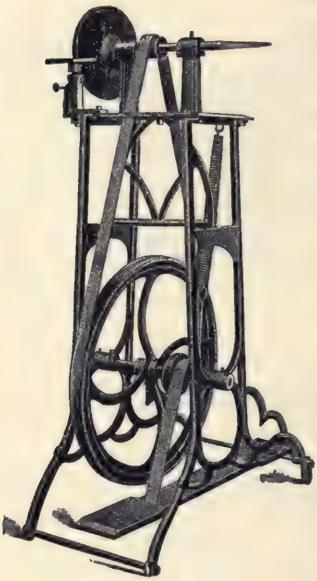
Electric Motor Polishing Lathe.

possible to recommend any stated speeds at which they should be run to obtain proper results.

The speeds depend entirely upon the class and shape of work to be finished, the diameter of the scratch brush, and the size and kind of wire of which it is made.

The speeds vary anywhere from 500 to 2,000 r. p. m.

Electric Motor Polishing Lathes.—Electric motor polishing lathes may be obtained in various sizes, with the motor wound to operate on any regular direct current circuit. They may be located at any convenient place without regard to line shaft or belting, and are so easily controlled that they are particularly useful to small manufacturers, jewelers, and dentists, also hotels, restaurants, etc.



Foot Power Lathe.

Foot Power Polishing and Grinding Lathe.—This style lathe will be found very useful for small manufacturers, electro-platers, jewelers, repair shops, etc., where no other power is available.

Steam Glue Heaters.—A first-class glue pot in a polishing room is of more importance than is generally supposed. No polishing room is complete without one.

The steam glue heater illustrated here is one of the best styles made; it is perfectly automatic in its water supply and needs no attention whatever after regulating the steam pressure. When two or more pots are connected, as shown in the cut, the water or condensed steam will remain at a uniform level up to the height of the overflow or outlet.

Steam Glue Heater.

The steam feed pipe runs through the larger connecting pipes and has numerous small perforations allowing the live steam to escape directly into the water chambers, thus insuring an even heat in all chambers, and the condensation will keep the water constantly at a uniform level.

The stand is fitted with upright arms to support the wheels while "setting up" with glue. This allows the surplus glue to drop back into the pot instead of on the floor.

Glue heaters of this design are made in several sizes, holding from one to six pots, the size being designated by the number of pots.

Polishing.—"Polishing" is the trade term given to the operation of grinding and smoothing metals by the use of wheels set up with glue and emery, in order to bring them up to the proper state for plating or other purposes.

The operation on rough metal is begun with a wheel set up with coarse emery. This is called "roughing out." The metal is then gone over with wheels set up with emery of varying finer sizes, until a smooth finish is obtained. If a very fine finish is wanted, the metal is again gone over with a grease wheel and finished on a dry fine wheel. See Section 3.

There is no set rule as to what kind of wheels or grades of emery to use to obtain certain results. Many experienced polishers differ widely on this subject, while the finished work of each may be all that could be desired. The quality of work turned out of course depends upon the kind of wheels and grades of emery used, but probably more depends upon the skill of the operator.

For speeds of polishing wheels, see chart, page 230.

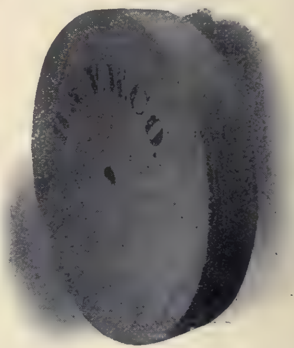
Polishing Wheels.—Polishing wheels set up with glue and emery are also used for a great variety of purposes not mentioned in the following general description.

Leather-covered Wood Wheel.

Leather-covered Wood Wheels.—These are standard wheels and are used chiefly for flat work, flat relief patterns, sharp corners, angles, etc. They are used for roughing out, also with the finer grades of emery, and make a splendid grease wheel.

Union Canvas Wheels.—These are made of layers of heavy canvas held together by cement. They are of a flexible nature, are good all-around wheels, and

Union Canvas Wheel.



Bull-neck Wheel.

are particularly adapted for roughing out stove work, drop forgings, plumbers' brass goods, etc.

Bull-neck Wheels.—These are made of layers of heavy bull-neck leather and are used for almost all purposes, from roughing out to finishing.

Walrus Wheels.—Walrus wheels are made from walrus, or sea-horse leather. The hide varies in thickness from ½ to 1¼ inches. It has a peculiarly tough grain and is used in finishing silverware, brass goods, stoves, cutlery, and agricultural implements that require a fine polish.

These wheels are used with crocus, emery, rouge, or rotten stone, and give a smooth, fine finish to the work.

Walrine Wheel.

Walrine Wheels.—These are made of layers of split leather cemented together, and while flexible still retain a hard, smooth face. The face may be shaped by turning, to fit almost any class of work. They are an excellent wheel for all purposes from roughing out to finishing, and make a fine grease wheel.

Felt Wheels.—These are used with emery and glue and also with the various polishing compositions according to the finish required. They make an excellent finishing wheel for flat relief parts similar to ornamental stove castings.

They may be used with all grades of emery from No. 100 and finer, and make an unusually fine grease wheel. They are also largely used with the finer polishing compounds for high coloring after plating.

They should be thoroughly balanced before using, and care must be taken that they do not become too hot from friction, as this will cause the face to burn in holes or pockets under the surface. When a felt wheel has been burned, it must be turned off down to the good felt.

Sheepskin Wheel.

Sheepskin Wheels.—These are furnished quilted, loose, or cemented. They are very soft and flexible and may be used with all grades of emery. They are particularly adapted for work having rounded edges and irregular curves, such as plumbers' supplies, gas fixtures, cutlery, etc., where it is impossible to reach with a hard, flat wheel.

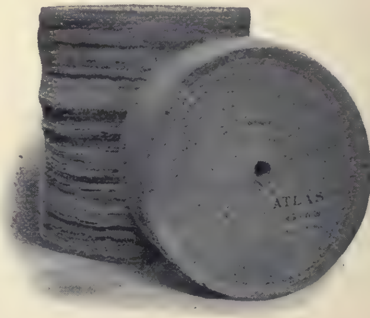
Emery Wheels.—Emery or corundum wheels are used for cutting off burrs or any rough or lumpy places on the castings to prepare them for the finer finishes to be made by the polishing wheels set up with glue and emery.

Muslin Buff.

Muslin Buffs.—These are made of either hard or soft muslin of various grades, either loose or stitched, and are used for cutting down and finishing the metal by being charged while in motion with the necessary cutting down or polishing composition.

They are used with tripoli composition for cutting down brass and copper before plating, and with lime composition for cutting and coloring nickel, brass, and copper after plating, also with the finer coloring compositions or rouges.

Canton Flannel Buff.



Atlas Buffs

Canton Flannel Buffs.—These are very soft and fine and are chiefly used in finishing solid or plated silver, gold, or on metals where a very high finish is desired. They are charged while in motion with gold or silver rouge or the fine white polishing compounds.

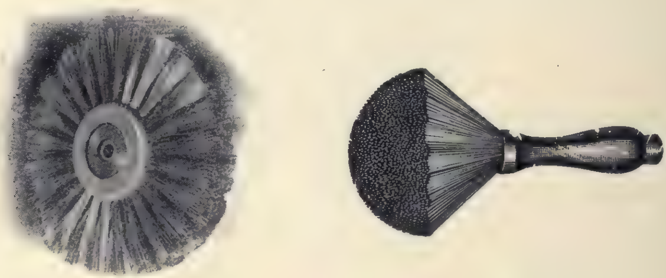
Brown Atlas Buffs.—These buffs are made from pieces of unbleached muslin cloth, sewed in sections about ¼ inch thick. They are a general utility buff, having considerable latitude. They are rigid enough for cutting down spun and sheet brass work, being used by lamp and chandelier makers; yet they are flexible enough to conform to the compound curves encountered in this class of work. They are also suitable for making up into polishing wheels by cementing together several sections and setting up with glue and emery. They can then be used for roughing out stove work and other iron castings.

Bristle Wheel, also Tampico Wheel.

Bleached Atlas Buffs.—These buffs are made from pieces of bleached muslin cloth, sewed in sections about ¼ inch thick. They are very superior buffs in general use for almost all metal lines, being especially adapted for cutting down on all kinds of brass work, such as brass beds, brass cuttings, etc., which have previously had one polishing operation. They are also largely used for cutting down spun copper and heavily nickel-plated parts, such as stove work, telephone parts, builders' hardware, etc.

Bristle and Tampico Wheels.—These are often used for cleaning the work after polishing by keeping them wet with water while in operation.

The larger sizes are used with water and pumice stone or special compositions for producing different old brass or similar effects, and with emery compositions for polishing iron and steel.



Scratch Brushes.

Scratch Brushes.—Brass and steel scratch brushes are used for cleaning castings and for producing satin finish or matte effects.

They are also used for beating down or burnishing the metal at times when the deposit does not properly adhere.

Scratch brushes should be used with a small stream of soap bark solution (1 ounce of soap bark to 1 gallon of water) or stale beer flowing on them. This can be arranged by suspending above the lathe a can with a faucet to which has been attached a small rubber tube.

Speed of Scratch Brushes.—No exact speed can be stated at which scratch brushes should be run. This depends entirely upon the class of work to be finished, on the diameter of the brush, and the size and kind of wire of which it is made.

In nearly all cases where complaints have been made of the wire breaking, it has been found that the speed has been entirely too fast, or the brushes have not been properly used. The coarser the wire the slower the speed should be.

Speed anywhere from 500 to 2,000 r. p.m., depending on circumstances.

Emery.—This is used in many different grades in setting up the polishing wheels for various operations, and should be contained in a long narrow box or trough in which the wheels may be rolled while the glue is hot.

See directions for use, page 94.

Glue.—This is furnished either in flake or ground form, and is used while hot for facing the various polishing wheels before rolling them in the emery.

See directions for use, page 99.

Glue Brushes, Rubberset.—These are used to apply the glue to the various polishing wheels.

Always use the best glue brush obtainable; it is poor economy to try to save a few cents on this article.

Rubberset Glue Brush.

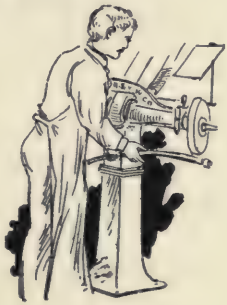
The rubberset glue brush is by far the best; the bristles are imbedded in solid rubber on which the required heat has no effect and the bristles cannot come out.

A low priced brush generally proves to be very expensive in the end; the bristles will come out, stick to the glue and emery, and spoil what otherwise would be a first-class wheel, making it necessary to clean the wheel and do the job again, thus losing much time and patience.

Do not leave the brush in the glue; keep it in clean water when not in use.

New brushes should be worked out a little on a rough board in order to release any short, loose bristles that may not have been imbedded in the rubber.

Buffing.—"Buffing" is the trade term given to the operation of cutting down the metal by the use of muslin or similar wheels charged with the various compositions, in order to bring the metal to the proper state for plating or other purposes.



Polishing Compositions.—The following descriptions are intended to give only a general idea of several grades of compositions and their uses. They are also used for many other polishing purposes.

Emery Paste.—This is a composition containing emery. It is made in several grades according to the grade of emery used. It is used with muslin buffs on brass and copper for quick cutting, and the finer grades are often used on grease wheels. See page 95.

It is also used with bristle or tampico wheels for cutting down and polishing iron and steel.

F. F. Composition.—This is a composition containing crocus and fine emery. It is used on muslin buff wheels and bristle or tampico wheels for cutting down iron and steel. It is very sharp and quick cutting.

Crocus Composition.—This is made in several grades and is used on muslin buff wheels to produce a smooth finished surface on brass or copper.

It is also used with oil or grease on bristle or tampico wheels for iron or steel.

Crocus composition has the property of both cutting and polishing.

Tripoli Composition.—This is made in various grades and is used on muslin buff wheels for cutting down and polishing brass, bronze, britannia, and other metals preparatory to plating.

Coloring.—"Coloring" is the trade term given to the operation of finishing or producing the final high polish on metals, by the use of soft muslin, canton flannel, felt or other wheels charged with the finer compositions or rouges.

XXX Buffing Composition.—For use on muslin, canton flannel buffs, or felt wheels to finish all metals where a high color is required, and especially for work that is engraved or ornamented, where the red rouge is objectionable.

Essex Lime Composition.—For use on muslin, canton flannel buffs, or felt wheels, to produce a high color on nickel. It also gives excellent results when used on brass or copper.

Rouge.—Hard rouge is made in several grades, as follows: nickel, brass, silver, and gold.

These are used on muslin, canton flannel buffs, or felt wheels, to obtain a high color on the various metals, as their names imply.

XXXX Polishing Compound.—This is an extra fine polishing material, used for silver and silver plated ware. It is made from pure white stock, leaving the work practically clean, and doing away with the necessity of further washing.

Electric Steel Finish, in Cartons.—Quick cutting, for high finish on steel.

This should be used on leather wheels, or leather-covered wood wheels, when finishing smooth work, or on bristle or tampico wheels for rough brass or steel.

Old Brass Finish Composition, in Cake Form.—This will produce the genuine old-brass finish effect. It should be used on bristle or tampico wheels running at about 1,800 to 2,000 revolutions per minute.

Good results may also be obtained when used on a soft buff about 9 inches diameter, at a speed of about 2,000 revolutions per minute.

Black Rouge, Hard, in Cakes.—This is an excellent polishing material for use on hard rubber, horn, celluloid, and other materials where the regular red rouge or lighter color compositions are objectionable.

SECTION III

POLISHING DIRECTIONS

The only rule to follow in polishing metals is to finish the work so that it is perfectly smooth and entirely free from scratches or any other imperfections, as these will show very plainly after plating. Consequently great care must be taken in this branch of the work.

If the work is unusually rough, a coarse grade of emery should be used for the first or roughing-out process. Articles having a fairly smooth surface may be roughed out with emery of a much finer grade.

It is advisable to first do all the roughing out on a job before doing any work on the finer grade wheels, and continue in this manner with each successive finer grade wheel until the entire job has been properly polished. The work can be done much quicker in this manner and without the necessity of frequently changing the wheels.

Polishing Various Metals.—The finest work is done by a four-wheel operation; good work can often be done with three wheels, while some classes require only two.

The following table will give a general idea of the various grades of emery to use on polishing wheels, in their respective order, to obtain a fine finish on different metals. It must, however, be understood that the grades given are approximate only, as all depends on the original conditions of the metals and the quality of the finish desired.

Metals.	Approximate Grades of Emery.
Cast iron (soft). Malleable iron.	Nos. 90, 120, 150 (180 grease).
Cast iron (hard).	Nos. 70, 90, 120 (180 grease).
Rough steel. Drop forgings.	Nos. 60, 90, 120 (180 grease).
Smooth steel.	Nos. 120, 180 (180 grease).
Cast brass. Cast copper.	Nos. 90, 120.
Cutlery.	Nos. 90, 120, 180 (flour grease).

Setting up Polishing Wheels with Emery.—Give the face of the wheel a good, even coating of hot glue with a glue brush.

Put the emery in a narrow, low box or trough.

Place a short, round stick through the arbor hole of the wheel, roll the wheel in the emery, giving considerable pressure, until the glue has taken up all the emery it will hold; scrape off the glue and emery from the edges of the wheel. Then hang the wheel up to dry.

Extra heavy coatings can be obtained by repeating the above operations. The wheels must be perfectly clean and free from grease before applying the glue, or it will not hold.

Emery Trough. Made of Cast Iron in One Piece.

Too much care cannot be given in keeping the several grades of emery entirely separate, as the slightest mixture will cause considerable trouble and expense in loss of time in resetting the wheels.

Grease Wheels for Extra Fine Finish.—Grease wheels of all kinds are prepared as above, using only No. 120 emery or finer grades.

The wheels should then be used just enough to remove the sharpness.

An old, fine grade wheel with a perfectly smooth face may also be used for this purpose.

While the wheel is in motion apply, with a rag, some tallow or tripoli composition; oil is sometimes used and very often a fine grade emery paste.

Dry Fining.—Work requiring a finer finish than that given by the grease wheel may be gone over again by the same wheel without using the grease.

A piece of charcoal, properly applied to the wheel while in motion, is the best way to remove the grease previous to dry fining. The face of the wheel should then be cleaned off with a cloth. A piece of lump pumice stone will sharpen all emery wheels of No. 100 grade or finer, that have become glazed.

To sharpen wheels of coarser grades than No. 100, use a coarse carborundum stone, or a coarse emery buff stick.

Many kinds of wheels, such as canvas, bull-neck, walrine, and felt, may have the face shaped by rounding or grooving to fit the work. When grinding a large quantity of odd-shaped work of a like kind, this method will be found useful in saving time as well as in having the work more uniform when finished.

Setting up Endless Emery Belts.—Place the belt over the end of a bench (this allows the slack to remain out of the way) and apply the glue with a glue brush, working it in well while hot. Cover the belt with emery and roll it into the glue by using a wooden or iron roller.

The above should be done in short sections, continuing until the belt is completed.

Then hang the belt up to dry.

When the belt has become worn it can be sharpened while running by using lump pumice stone.

To clean off the old glue and emery, use a carborundum stone or buff stick.

Cross Cutting.—When finishing work on emery wheels each successive operation, when possible, should be done so that the wheels cut the marks left on the work crosswise until all marks left by the previous wheel have been removed.

This is necessary in order to produce first-class work.

Balancing Wheels.—It is very important that all polishing wheels be carefully balanced, otherwise it is almost impossible to obtain good results. An unbalanced wheel will pound and clatter, causing the face of the wheel to run very unevenly, and, when the work comes in contact with the wheel, it will cause the emery to wear off quickly in spots.

The wheels may be tested for balancing by using two parallel, sharp, straight edges. These must set perfectly level and should be placed on a rigid bench. Cut a slot in the bench between them to receive the wheel; use a short mandrel that just fits the hole in the wheel, then, when placed on the straight edges, the heavy side of the wheel will roll to the lowest point. Mark the wheel at the highest point, and screw on the side of same a small piece of sheet lead. Test the wheel again. If too much lead has been put on, it can easily be cut off. Do not hurry. Have patience and do the work well.

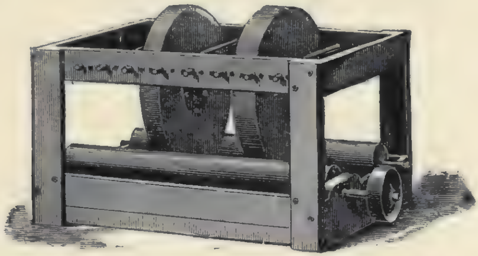
Emery Buff Sticks.—Emery buff sticks are used to remove old emery and glue from all polishing wheels, excepting leather-covered wood wheels; to clean these wheels properly in this manner requires considerable experience and skill, otherwise the leather covering will be quickly ruined. These should be cleaned in a regular polishing wheel cleaner.

The emery buff sticks can be made by using a stout stick set up with several coatings of glue and emery, from about No. 12 to No. 24. These, when held against the face of the wheel while in motion, will soon cut off all of the old material. Care must be taken not to give too much pressure or the friction will cause the face of the wheel to burn.

Emery sticks may also be used in cleaning off buff wheels and endless emery polishing belts.

Polishing Wheel Cleaner.—These machines are particularly useful for removing old emery and glue from leather-covered wood polishing wheels.

They are constructed with a zinc-lined water compartment. Fill the compartment with water until it just touches the wooden rollers. Then, by placing a worn wheel on the rollers and allowing the machine to run for a short time, all of the glue and emery will be removed without damaging or loosening the leather covering.



Polishing Wheel Cleaner.

The rollers carry just enough water to properly feed the face of the wheel, and the friction caused by the weight of the wheel revolving on the rollers quickly forces off the emery and glue.

Glue.—*Directions for Using:* Always use the best glue obtainable. It is false economy to use a cheap article, as this often means a considerable loss of time in setting up the wheels, and in glue and emery wasted.

Always soak flat glue in cold water over night, or for several hours.

The proper length of time depends on the size and thickness of the glue.

Ground glue should soak from 15 to 20 minutes.

Applying hot water to dry glue scalds it and prevents its adhesiveness.

After the glue has been properly soaked it may be cooked in the steam heater or pot until it becomes a smooth flowing liquid.

Do not cook it longer than absolutely necessary, as prolonged cooking injures its strength.

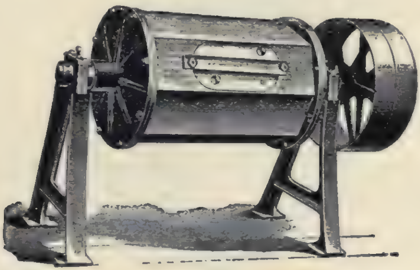
It is a good plan to prepare only a sufficient quantity for immediate use.

Always keep the pot and brush clean. Do not leave the brush in the glue, but keep it in clean water.

Tumbling Barrels.—A good tumbling barrel is of great advantage in metal finishing operations, both before and after plating, when it is necessary to smooth or polish large quantities of small work, such as rings, buckles, buttons, and articles of a similar character, not having square corners or edges which must be preserved.

Articles that are required to be finished with sharp corners cannot be treated in this manner.

By the use of a tumbling barrel much time and labor can be saved. When the work is placed in the barrel, and it is set in motion, no further attention is needed until the work is ready to be removed, except at times it is necessary to examine the work to see how it is progressing. Thus the workman may attend to other matters about the shop, while the polishing continues.



Horizontal Tumbling Barrel.

The barrels are built in several shapes and sizes, for both dry or wet tumbling.

For dry tumbling a great variety of material is used, leather meal, cut leather, sawdust, flint, etc. The proper article to use depends entirely on the class of work and the finish required.

For wet tumbling, solutions of cleaning compounds, borax soap, etc., are used, and often in connection with polished steel balls. The very best results can be obtained in the latter manner by using a barrel lined with sheet brass.

Experience will demonstrate the quantity of cutting or polishing material to use, as well as the quantity of work to put in each batch. The speed must be slow so that the work will tumble freely, 45 to 60 r. p. m.

Tilting Oblique Tumbling Barrel.

being the speeds generally used. A high speed cannot be used, as the work will cling to the side of the barrel and revolve with it without effect.

The horizontal barrel is well adapted for heavy or very bulky work.

The tilting oblique barrel is a style largely used for both dry or wet tumbling. The barrel is open at the top, and is so constructed that it may be easily tilted to quickly empty the contents into a bucket or box. The work can also be examined at any time during the operation without stopping the machine.

Leather Meal, Used for Dry Tumbling Barrel Polishing.—This is made from selected leather, ground into a perfectly smooth and fluffy meal, which, when used for polishing in a dry tumbling barrel, will accomplish more work and produce better results than any other material used for this purpose. It is equally efficient on light or heavy work and does not roll or mat into balls or cakes. It is cool, clean, and very durable.

The meal may be used in the same manner as any other material, although it is so very light it will not make the same weight for its bulk as scrap leather, sawdust, etc.

Experience will demonstrate the best quantity to use, too much of it being a hindrance instead of a help. It may be used over and over again, and if kept in a dry condition it does not lose its good qualities. Keep the barrel filled with a uniform quantity, replenishing what may be lost when opening the barrel and changing the work.

The meal gives excellent results in all cases, with one exception, and that is when the work is open, or of tubular formation, allowing the meal to pack and fill up the spaces. For work of this character it is advisable to use cut leather.

Cut Leather.—This is made from a very fine quality leather cut into pieces about one inch square, and is used for tumbling barrel polishing in the same manner as the leather meal.

Floated Silica.—This is one of the finest polishing powders known and can be used to great advantage in many ways in the polishing shop. It is a very light-weight material, white in color, perfectly clean, and will not stain or smut the work. It will be found excellent for dry tumbling barrel polishing, when a small quantity is added to the leather meal or cut leather.

Steel Balls, Used for Tumbling Barrel Polishing.—Many large manufacturing companies are now successfully polishing small metal articles such as buckles, buttons, rings, etc., by the use of steel balls in horizontal tumbling barrels. It is claimed by this method that they save time, labor, and expense.

Tumbling barrels, when used for this purpose, must be perfectly smooth inside, or they may be lined with sheet brass, which is much better. The metal pieces are tumbled preparatory to plating, and after they have received the metallic deposit they are again put through the operation, with the result that they come from the barrel in a highly burnished and polished condition, nearly equal to that of buffing. The proper quantity of balls to use for best results should be about double the quantity of work. The smallest sized balls are used for the purpose of reaching the crevices and hollow places where the larger sizes cannot enter. The proper size of balls to use depends upon the class of work to be polished. Mixed sizes may often be used, however, to good advantage.

The articles should be tumbled before and after plating in a solution of borax soap, as this has no ill effect on the work or balls. Ordinary soap should not be used, as it injures both the work and steel balls.

After the articles have received the desired polish they may be separated from the balls by being dumped into a riddle having a mesh coarse enough to allow the balls to pass through, but not the articles. The articles may then be placed in wire or stoneware dipping baskets and cleaned in the usual manner.

SECTION IV

PREPARATION OF WORK BEFORE PLATING

In all electro-plating operations the articles to be plated must be perfectly smooth and free from even the slightest scratches or imperfections, as these will show very plainly after plating. They must then always be dipped and rinsed until all traces of grease or foreign matter are removed, before being placed in the plating solution.

The higher the polish of the article the finer the finish will be after plating.

To accomplish this result, the articles must, with few exceptions, be put through a series of operations in the following described order:—

Order of Operations in Handling the Work.

1. Pickle to remove scale, sand, or rust.
2. Emery wheel to remove burrs or imperfections.
3. Polishing wheels set up with glue and emery (various grades).
4. Buff wheel to remove scratches left by polishing wheels.
5. Coloring wheel to produce fine finish.
6. Kostico or lye dip to remove grease.

7. Rinse in cold water to remove Kostico.
8. Scour with brush and fine pumice.
9. Rinse in cold water to remove pumice.
10. Acid dip to remove oxide (for iron and steel).
11. Cyanide dip to remove oxide (for brass, copper, silver, and gold).
12. Rinse in cold water to remove acid or cyanide, then pass to the plating solution.

The exact kind, number, and routine of operations necessary of course depend on the condition of the article when received in the shop, and the finish required. This to a certain extent must be determined by the judgment of the operator.

When handling articles of iron or steel omit operation No. 11.

When handling articles of brass or copper omit operation No. 10.

When articles of brass or copper are highly polished omit operation No. 8.

When replating old work it is necessary to remove all of the old plate until the base metal is in the same condition as it originally was before having been plated.

Scouring and Cleaning.—Articles of iron or steel, after having received a fine finish in the polishing room, must be given a thorough scouring and cleaning before they are ready to be plated. It is absolutely necessary that this be done with great care. They should be wired or put in earthenware or wire dipping baskets, then suspended in a hot Kostico or XXX lye dip, and allowed to remain for about 10 to 15 minutes. This is for the purpose of removing any oil or grease that is sure to adhere to them. Then rinse thoroughly in cold water and scour with fine powdered pumice and water, using a plater's scouring brush; rinse again in cold water, then dip in a muriatic acid dip. This is for the purpose of removing any oxide that may have formed. Rinse again in cold water and pass the articles to the plating solution while wet, before they have a chance to dry in the air, or oxidization will quickly take place.

Articles of brass or copper that have been highly buffed should be dipped in the Kostico or XXX lye dip, or they may be scrubbed with these solutions using a Tampico scrub brush. This is for the purpose of removing oil or grease. Then rinse in cold water, after which they should be dipped in a cyanide of potash dip to remove oxide, again rinsed in cold water, then placed in the plating tank.

When the articles are properly cleaned water will adhere to them evenly all over; if the water adheres only in spots they are not perfectly clean and must be treated again.

Preparing Non-metallic Surfaces to Receive a Metallic Deposit.—Non-metallic surfaces may be treated in the following manner to prepare them to readily receive a metallic deposit.

This applies to articles of glass, porcelain, wood and plaster, insects, leaves, flowers, etc.

Materials Required.—Lacquer or shellac varnish, electrotypers' varnish, electrotypers plumbago, camel's-hair lacquer brush.

The work should first be given a coating of lacquer or shellac varnish, then allowed to dry. (If it is of wood, care should be taken that the grain be first well filled.)

It should then be given an even coating of electrotypers' varnish; this will dry in a few minutes, after which apply the electrotypers' plumbago, using a dry camel's-hair brush. Give a careful and even coating and be sure that every part of the surface is well covered.

The work may then be wired in the usual manner and placed in the plating solution.

The action of the deposit may be hastened by metallizing the surface over the plumbago. This is done by sprinkling it freely with very fine iron filings, on which should be poured a solution of blue vitriol and water. Brush this gently over the work using a soft lacquer brush.

The action of the blue vitriol on the iron will cause a copper precipitate or film on the surface, to which the electro-deposit will take more readily than when deposited direct on the plumbago.

The article should be rinsed in clean cold water and placed in the plating solution.

An acid copper solution should be used for this purpose as it will deposit more rapidly than any other.

In a short time the article will take on a slight copper deposit in places. This will gradually creep until the entire surface is covered. This deposit may be made any thickness desired, depending upon the time it is allowed to remain in the solution.

When the article has received a fair deposit it may be buffed and cleaned, after which it may be treated by any of the usual methods.

Electrotypers' varnish is superior to other compounds used for this purpose, for the reason that, after it has been applied to the work, the surface will always remain in a suitable condition to readily take and hold the plumbago.

SECTION V

PLATING SOLUTIONS AND VARIOUS FINISHES

When making and operating plating solutions the following important points should be considered:—

1st, formula.

2d, the use of pure chemicals.

3d, the use of pure water.

4th, order of mixing.

5th, temperature.

6th, specific gravity, Baume scale.

7th, anode surface.

8th, current pressure or voltage.

9th, quantity of current or amperes.

10th, renewing.

In nearly all cases where the operator experiences trouble and fails to obtain proper results when pure chemicals are used, the causes may be traced to the improper cleaning of the work before plating, carelessness in handling the work or in making the solutions.

In all solutions used during cold weather trouble is experienced in the crystallization of the salts. All cold solutions should be maintained at a temperature of 70° to 80° Fahrenheit; at this temperature denser and more highly conductive solutions may be used, thus shortening the time of deposit and giving better results. A loop of lead steam pipe in the solution will be sufficient to supply the necessary heat.

The pipe entering and returning from the tank should be insulated from the heating system with insulating joints.

The anodes must be kept clean.

Care must be taken to see that all points of contact are kept clean and bright; the anode and work rods, as well as the loop of the anode hook, should be rubbed at intervals with emery cloth to remove any corrosion that may have formed.

A strip of thin sheet lead may be bent in U-shape and placed over the entire length of the anode rods, or a split rubber hose may be used; this will keep the drippings from the solution from interfering with the contact of the anode hooks on the positive rods.

When nickel-plating articles of iron or steel, although not always necessary, the very best finish may be obtained by first giving them a slight deposit of copper. The articles should then be buffed with a soft buff and fine coloring composition, after which they are dipped in the Kostico or lye, rinsed in cold water, then given a cyanide dip, again rinsed in cold water and placed in the nickel tank. After they receive the proper deposit they are ready for the final coloring or finishing.

Articles of a hollow formation, or those containing grooves or recesses, while being placed in the solution should be given a slight swinging or twisting motion, in order to release any air bubbles that may adhere to them. If air bubbles are not allowed to escape they will seriously interfere with the deposit.

Articles having a deep, hollow, cup-like formation cannot well be plated on the inside in the regular manner, for the reason that the deposit will not penetrate or "throw" to the required distance, this being prevented by the surface nearest the anodes, which more readily attracts the deposit. These places may be plated by arranging a small anode inside the hollow space.

The inside of bowls, pitchers, pots, etc., that cannot be plated in the regular solution tank, may be plated by using the vessel itself as a solution container.

The vessel should be placed on a non-conducting surface and filled with solution. The anode should then be suspended from the positive wire in the solution and the negative wire connected to the outside of the vessel.

The length of time that the articles should remain in the various plating solutions depends on general conditions and the thickness of the deposit required. All conditions being proper, a good deposit of metal in the various still-plating solutions should be obtained as follows:—

SOLUTION.	TIME OF DEPOSIT.
Nickel,	about 30 to 45 minutes.
Cyanide copper,	about 20 to 30 minutes.
Acid copper,	about 15 to 20 minutes.
Brass,	about 20 to 30 minutes.
Zinc,	about 20 to 30 minutes.
Silver,	about 30 to 45 minutes.
Gold,	about 10 to 15 minutes.

Time Dial.—To denote the time of removing work from the plating tanks.

These will be found of great assistance to the busy operator. They should be placed near the tank, and, when the work is put in the solution, the hands should be set at the time when it is to be removed.

Nickel Solution.

Formula:

Water..	1 gallon.
Nickel salts..................................	¾ pound.

Solution should stand at 6½ to 7° Baume.

Use a current pressure of about 2 volts.

Fill the tank with the quantity of water required, suspend the nickel salts in coarse muslin or burlap bags just below the surface; if the solution to be made is a large one, use several bags. A large quantity of salts will dissolve in this manner in a comparatively short time and without any attention. This will be found much more convenient than the old method of using live steam.

Time Dial.

Pure cast nickel anodes should be used. The elliptic shape is the best; flat anodes, however, are often used and answer the purpose very well. As the solution does not act upon the anodes without the use of an electrical current, they may be allowed to remain in the solution when not in use.

Nickel salts are a combination of sulphate of nickel and ammonia. Nickel sulphate is not a good conductor, but furnishes the metallic properties of the solution, while the sulphate of ammonia is a good conductor and aids in this respect, consequently the combination of the two qualities produces the desired result.

A nickel solution will deposit freely from the solution itself; this makes it necessary to use a large anode surface in order that the solution may be fed from the anodes to replace that which has been taken up by the cathodes, or the solution will be constantly in an impoverished condition, making it necessary to frequently add more nickel salts.

The anodes should be long enough to reach to or below the lowest point of the largest work. The tank should be deep enough to allow at least 6 inches between the lowest point of the anodes and the bottom of the tank.

Elliptic anodes should be placed in the tank about 2 or 3 to each foot (no less than 2).

Flat anodes may be placed from 2 to 4 inches apart; this is optional, provided there is enough space left between them to allow for a free circulation of the solution.

The distance between the anodes and cathode, or work to be plated, should not be less than about 3½ inches and not more than about 6 inches.

Too large an anode surface, when used with a strong current, will often cause the solution to become alkaline.

In all plating operations a weak current will produce a fine, close, and homogeneous deposit, while a strong current produces a more open, porous, or spongy deposit. The most suitable current pressure for nickel plating is about 2 volts in the tank.

The quantity of current required for nickel plating is about 4 amperes per square foot of work surface (the term "work surface" meaning all surface exposed to the action of the current).

Nickel solutions should be slightly acid, but too much acid will cause the deposit to peel. Too much alkali will cause a dark deposit. These conditions may be easily determined by the use of litmus paper. Blue litmus paper turns red if a solution contains free acid, while red litmus paper turns blue if free alkali is present.

If the solution is acid and stands below 6½° Baume it has been stripped of metal; it may then be brought to its proper condition by adding single sulphate of nickel. This should be dissolved in water, then stirred into the solution until the proper amount of metal has been put in, as can be determined by the hydrometer.

If the solution is rich in metal and registers 6½°

Baume and is too acid, it may be remedied by adding carbonate of ammonia first dissolved in water.

If the solution is alkaline and will not take up more nickel salts, it may be made slightly acid by adding boracic acid dissolved in hot water.

The articles should receive a thin deposit in 2 or 3 minutes without generating much gas; this can be detected by small bubbles coming slowly and regularly from the surface of the articles. If the articles throw off a great number of bubbles and are immediately covered with a thick white deposit, which soon changes to a dull gray, particularly noticeable at the edges and corners, the current pressure is too strong and should be reduced with the tank rheostat.

"Burning the work" is the term applied when the deposit begins white and gradually turns through a gray to black; this indicates too strong a current pressure.

If too strong a current is used, though not strong enough to burn the work, the deposit will peel or blister, and will not stand the necessary buffing.

If, after the articles have been in the solution for a few minutes, they gradually turn dark without receiving any deposit, the current is too weak. This may be remedied by the tank rheostat allowing a stronger current to flow into the tank, or by reducing the amount of work in the tank.

If the voltmeter indicates that a suitable current is flowing into the tank and the deposit is spotted, off color, or streaked, the solution is alkaline, contains too much or not enough metal. It should then be tested with a hydrometer and litmus paper.

If both the current and the solution prove by test to be right and the deposit does not proceed properly, the work has not been properly cleaned, has been slighted in some manner, or has been handled or allowed to dry after cleaning.

If the deposit is good in quality but shows small holes or pits, it is an indication that a coating of dust was on the surface of the solution, some of which adhered to the article when it was placed in the tank.

The articles should be placed in the solution tank in such a manner that they will receive a direct and free circulation of current from the anodes. They must not be allowed to touch each other or the work will come out showing uncoated streaks or spots.

The articles will only take on a deposit on the side directly facing the anodes, consequently flat articles that are to be plated on both sides should be suspended between two rows of anodes, otherwise it will be necessary to reverse the article after a deposit has been obtained on one side. Large, round, or odd-shaped articles should have the anodes arranged around them as nearly equidistant as possible.

Long articles should be suspended in the solution in a horizontal position.

If it is necessary to suspend the articles vertically, they should be reversed after having received half of the required deposit. The reason for this is that the deposit is taken more freely from the lower portion of the anodes.

If the solution becomes chilled and salt crystals form on the anodes and on the bottom and sides of the tank, they should be scraped off, dissolved in hot water, and returned to the solution. Give the anodes a bath in hot water; this will remove all crystallization that adheres to them and will cause them to deposit freely.

Absolute cleanliness is a necessity.

Keep the surface of the solution well skimmed.

When nickel solution becomes alkaline, thick, and muddy, 2 ounces of boracic acid added to each gallon will often remedy the trouble. The boracic acid should first be dissolved in hot water.

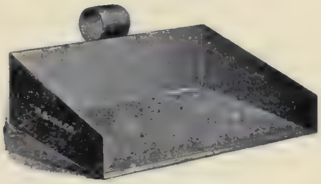
A nickel deposit of almost any thickness required, may be obtained when everything is in perfect order.

Articles requiring a dead white finish should be thoroughly rinsed in hot water, then swished in the air to throw off any moisture that may remain on them.

Solution Skimmers.—These will be found useful in removing the light floating matter that accumulates so rapidly on the surface of the plating solutions.

It is important that the surface of the solutions be kept clean as a dirty solution is often the cause of poor work.

After using the skimmer dip in hot water and hang it up to dry.



Solution Skimmer.

Single Sulphate of Nickel.—When an old nickel solution becomes sluggish and alkaline, and the deposit takes on a leaden color, a simple remedy is to add, after stirring, 2 ounces of single sulphate of nickel to each gallon; this will clear the solution and whiten the deposit.

Boracic Acid.—Boracic acid is often used to remedy nickel solutions that have become sluggish, muddy, and alkaline and produce a lead color deposit. Use 2 ounces of boracic acid, dissolved in hot water, to each gallon of solution. This will have the effect of clearing the solution and whitening the deposit.

Capstone Nickel Solution, for Use with Mechanical Plating Barrels.

Formula:

Water	1 gallon.
Capstone nickel salts	1 pound.

Solution should stand at 10° Baume.

Use a current pressure of 4 to 5 volts, when used as a mechanical plating-barrel solution, and 1½ to 2 volts, when used as a still solution.

Capstone nickel salts is a special salt for making nickel solution of high conductivity, and is particularly adapted for use with mechanical plating barrels, and for all operations where a quick bright deposit is required.

This salt is less liable to crystallize in cold weather than the regular double nickel salts. It is made in pulverized form, put up in muslin bags, and will readily dissolve when suspended in the water or solution.

If the solution at any time does not produce as white a deposit as it should, it may be improved by adding 2 ounces of boracic acid to each gallon. The boracic acid should first be dissolved in hot water.

Black Nickel Solution, No. 1, Producing a Gun Metal Finish.

Formula:

Water	1 gallon.
Black nickel salts No. 1	¾ pound.

Solution should stand at about 5° Baume.

Use at about 80° Fahr.

Use a current pressure of from 1 to 1½ volts.

Use regular white nickel anodes.

The anode surface should not be more than one half that of the cathode or work surface.

The anodes should occasionally be bright dipped.

The article to be plated should remain in the solution for about 3 to 5 minutes, and as soon as the proper shade is obtained it should be taken from the bath, dried, and lacquered.

No. 1 brush lacquer is the best for this purpose as it will not show iridescent colors.

Cast iron objects should first be brass, copper, or preferably nickel plated before being placed in the bath.

The more highly polished the work the better the results.

When the solution becomes impoverished it can be revived by adding black nickel salts No. 1 until it stands at 5° Baume.

Black Nickel Solution No. 2, Producing a Rich, Deep Black Finish.

Formula:

Soft water..1 gallon.
Black nickel salts No. 2..........................1 pound.

Stir occasionally before using.

Solution should stand at about 10° Baume.

Use solution at 80° Fahr.

Current pressure should not be more than 1 volt.

Use regular white nickel anodes.

The anode surface should not be more than one half that of the cathode or work surface.

The anodes should occasionally be bright dipped.

While the work is being plated it will assume various colors, changing from a straw color, through a blue to black.

If work shows white streaks the current is too strong, or the anode surface is too large, or both.

As soon as the proper shade is obtained the work should be taken from the bath, dried, and lacquered.

No. 1 brush lacquer is the best for this purpose as it will not show iridescent colors.

Cast iron objects should first be brass, copper, or preferably nickel plated before being placed in the bath.

Flexible articles, springs, safety pins, etc., should first be slightly struck in white nickel.

The more highly polished the work the better the results.

When the solution becomes impoverished it can be revived by adding black nickel salts No. 2 until it stands at 10° Baume.

Cyanide Copper Solution.

Formula:

Water	1 gallon.
Carbonate copper, dry	¼ pound.
Carbonate soda	¼ pound.
C. P. cyanide potash	½ pound.

Add ¼ ounce hyposulphite soda to each gallon of solution for clarifying purposes.

Solution should stand at 12° Baume.

Use a current pressure of about 3½ to 4 volts.

Solution may be used cold or hot.

First dissolve all of the cyanide in nearly the full quantity of water required, then dissolve the carbonate of soda in this.

Mix the carbonate of copper in the water held in reserve, until it forms a thin paste, then stir this paste in the bulk of the solution, after which add the hyposulphite of soda as a clarifier.

Cyanide copper solution when used with pure copper anodes will cause a fine, smooth, and close-grained deposit.

Cast or rolled copper anodes will give good results but the best possible work can be obtained by using the pure electrolytic copper. This solution is generally used cold; if used hot the action will be somewhat hastened.

The solution is easy to operate and maintain. A slight coating of copper given as a base to articles of iron or steel that are to be silver or gold plated, will be of great benefit, as these metals will deposit readily, adhere closer, look better, and wear longer over the copper than if deposited directly on the iron or steel.

The anodes in a copper solution usually bear a slight green coating. This is copper cyanide and is soluble in the free cyanide that the solution should contain. If this coating becomes thick and the solution soon refuses to deposit, it is an indication that the cyanide has been exhausted. It is then necessary to add cyanide previously dissolved in water, in small quantities, until the proper amount has been put in.

If the articles throw off gas bubbles freely without taking a deposit, the solution has been stripped of metal. Carbonate of copper, previously mixed to a paste in water, should then be stirred in.

Copper solution should be operated under a low current pressure. If too strong a current is used the work will blister. This can be regulated by the tank rheostat. If, after reducing the current, the trouble still appears, add more carbonate of copper.

All conditions being correct, articles left in a copper solution will take on a smooth, fine, thick deposit for an indefinite period, without showing any signs of blistering.

Ruby Copper Solution, Producing a Rich, Ruby Red Deposit on all Metals.

Formula:

Water	1 gallon.
Ruby oxide	2 ounces.
Bisulphite soda	2 ounces.
C. P. cyanide potash	6 ounces.

Solution should stand at 6° Baume.

Use a current pressure of about 3½ to 4 volts.

Solution may be used hot or cold.

Use pure electrolytic copper anodes.

First dissolve all of the cyanide in nearly the full quantity of water required. Mix the ruby oxide in the water held in reserve until it forms a thin paste, then stir this paste in the bulk of the solution. Dissolve the bisulphite of soda in a small quantity of water and add this to the solution.

The advantage in using ruby copper solution is that it will give a much deeper red deposit than it is possible to obtain with carbonate solutions. It does not require as large a quantity of material per gallon, and will produce a fine, smooth deposit without blistering.

When the solution becomes impoverished, it can be renewed by adding the chemicals originally used in their proper proportion as required.

Ruby oxide may also be used to good advantage in brass or bronze solutions, in place of carbonate of copper, and with carbonate of zinc. The solutions will then produce much smoother and better shades of deposit than the all-carbonate solutions, without danger of blistering.

Acid Copper Solution, also termed Duplex or Electrotyping Solution.

Formula:

Water	1	gallon.
Sulphate copper	26	ounces.
Sulphuric acid, by measure	3¼	ounces.

Solution should stand at 18° Baume.

Use a current pressure of about 1 volt.

First dissolve the sulphate of copper in the water, then add the sulphuric acid, stirring it in slowly.

Use only pure electrolytic copper anodes.

When the solution after use becomes impoverished, and does not work properly, it can be renewed by adding the original chemicals in their proper proportion as required.

For many classes of work an acid copper solution is the only one that will give the desired results. While the solution is apparently simple to use, it requires considerable care in looking after many little details.

Acid copper solution cannot be used to plate directly on iron, steel, or zinc, as these metals are electrically opposed to copper, in the presence of sulphuric acid, which at once starts a local action that throws off the deposit as rapidly as it is formed.

When plating on iron, steel, or zinc, the articles should first be given a slight coating of copper in a regular cyanide copper solution, after which they will readily take the acid copper deposit.

It is not always considered necessary when plating articles of brass, bronze, or soft metals, to first give them a coating in a cyanide copper solution, but it is safer and better to do so, as the results will warrant the little extra labor.

Cyanide copper solution is to a considerable extent self-cleaning, due to the action of the cyanide on the metal, while an acid copper solution is not at all self-cleaning and any stains or finger marks left on the article, when placed in the solution, will show very plainly after receiving the deposit, as the copper will not adhere to or cover the spots, consequently the articles must be cleaned with the greatest care.

Acid copper solution will not "throw" or cause the deposit to reach and cover deep recesses or hollow places in the article, as freely as a cyanide copper solution. To overcome this difficulty it is advisable to suspend a very small anode quite close to the recess, or a piece of pure copper wire can be used as an anode, this to be arranged to project into the recess. In this manner the deposit can be placed where needed.

An acid copper solution will cause a much quicker deposit than a cyanide solution, and for this reason it is used in electrotyping where it is necessary to obtain a very heavy deposit in a short space of time.

Brass Solution.

Formula:

Water	1 gallon.
Carbonate copper, dry	2 ounces.
Carbonate zinc, dry	2 ounces.
Carbonate soda	4 ounces.
Bisulphite soda	4 ounces.
C. P. cyanide potash	8 ounces.

Aqua ammonia, ¼ gallon to 50 gallons of solution.

Solution should stand at 12° Baume.

Use a current pressure of about 2½ to 3½ volts.

Solution may be used cold or hot.

First dissolve all of the cyanide in nearly the full quantity of water required, then dissolve the carbonate of soda in this. Mix the carbonate of copper and zinc in the water held in reserve until they form a thin paste, then stir this paste in the bulk of the solution, dissolve the bisulphite of soda in a small quantity of water and add this to the solution, after which add ¼ of a gallon of aqua ammonia to each 50 gallons of solution.

Brass solution is one of the most difficult to operate and maintain, owing to the combination of the two metals in the forms of carbonate of copper and carbonate of zinc.

Brass solutions for producing various shades may be made by varying the amount of the carbonates of the metals that are used.

Use only cast brass anodes, as the rolled brass is harder and does not deposit so freely.

A strong current pressure will cause a light color deposit, as it attacks the zinc more readily than the copper, while a weak current will cause a red deposit for the opposite reason, therefore a brass solution needs constant attention and care or it will soon be stripped of one or the other metals.

Brass solution, excepting the color of the deposit, is similar to copper to operate and maintain, but considerable judgment must be used when renewing, in order that the carbonates of the metals may be replaced in the same proportion to that in which they have been removed.

Bronze Solution.

Formula:

Soft water	1 gallon.
Carbonate copper, dry	3½ ounces.
Carbonate zinc, dry	½ ounce.
Carbonate soda	4 ounces.
Bisulphite soda	4 ounces.
C. P. cyanide potash	8 ounces.

Aqua ammonia, ¼ gallon to 50 gallons of solution.

Solution should stand at 12° Baume.

Use a current pressure of about 2½ to 3½ volts.

Solution may be used cold or hot.

First dissolve all of the cyanide in nearly the full quantity of water required, then dissolve the carbonate of soda in this. Mix the carbonate of copper and zinc in the water held in reserve until they form a thin paste, then stir this paste in the bulk of the solution, dissolve the bisulphite of soda in a small quantity of water and add this to the solution, after which add ¼ of a gallon of aqua ammonia to each 50 gallons of solution.

Use cast bronze anodes.

Bronze solution should be operated and maintained in about the same manner as brass solution. They are similar in all respects excepting color.

Silver Solution.—Silver solution is usually sent in a concentrated form. To the contents of the jug or jugs sent, as the case may be, add enough rain or distilled water, if procurable, if not, water that has been boiled and allowed to settle, to make the quantity ordered. A little of the water can be used to rinse out the jug and remove all of the concentrated solution. It is then ready for use.

Use at a temperature of 65 to 70° Fahr.

Current pressure should be about ½ to 1 volt, according to amount of work in the solution.

Anodes.—Connect the anode with an iron wire to the positive pole or carbon of the battery, or positive pole of the dynamo.

Work.—Connect the work to be plated to the negative pole or zinc of the battery, or negative pole of dynamo. The surface of anode is regulated to the amount of work being plated, being about the same, whereas in nickel plating the anode surface may sometimes be somewhat in excess. After getting a slight coat of silver on the article, it may be removed from the solution and scratch-brushed with the revolving scratch brush, on which should be allowed to drip a little soap bark solution (use 1 ounce of soap bark to 1 gallon of water); this lays down the grain of the silver, after which wash in clean cold water and plate again. When sufficiently plated, it can be scratch-brushed and buffed with a cotton flannel wheel, to which is applied a little of the soft gold rouge mixed with alcohol into a paste; this gives the high color which takes the place of the more expensive hand burnishing.

For plating silver on articles of iron or steel, it is well to give the articles a slight coat of copper from a cyanide of copper solution, which is very inexpensive. Another plan is to take away, say, one quart of silver solution when ready for use, and add 3 quarts of water and 6 ounces of C. P. cyanide of potash. Put in a large surface of silver and only a small surface of work at a time. The article will give off gas freely from this solution, before which it should be thoroughly cleaned and pumiced, and then will be obtained a yellowish coat of silver, which is very adhesive. From this the work can be placed in the regular silver solution to plate slowly until a sufficient deposit is procured. This can be regulated by the amount of anode immersed, distance between anode and work being plated, and the size of wire, which can be reduced until a sufficient resistance is obtained to prevent escape of gas.

Work must be chemically clean and well scoured. Grease can be removed by immersion in lye; use 3 ounces to a gallon of water.

When the solution becomes impoverished it can be renewed by adding 6 ounces C. P. cyanide of potash and 1 ounce of chloride of silver to each gallon of solution.

Finishing.—Finishing may be done with steel and agate burnishers, or scratch-brushed if the work is to be satin finished.

Silver Solution.—A good silver solution may be made as follows:—

Formula:

Water	1 gallon.
C. P. cyanide of potash	1 pound.
Chloride of silver	3 ounces.

Temperature should be about 70° Fahr.

Use a current pressure of about ½ to 1 volt, according to the amount of work in the tank.

First dissolve all of the cyanide in the full quantity of water. A small portion of this solution should then be put in a glass jar or earthenware pot. Add the chloride of silver to this, stirring thoroughly until it forms a thin paste. Then gradually, while stirring, pour this paste into the bulk of the solution.

24 Karat Gold Solution.—Gold solution is usually sent in a concentrated form. To the contents of the jug or jugs sent, as the case may be, add enough rain or distilled water if procurable, if not, water that has been boiled and allowed to settle, to make the quantity ordered. A little of the water can be used to rinse out the jug and remove all of the concentrated solution. It is then ready for use.

Solution.—Heat the solution to 140° Fahr. over a sand or hot water bath. Heat hastens the chemical reactions in the bath and the gold deposits much more rapidly.

Anodes.—Connect the anodes with a copper wire to the positive pole or carbon of the battery, or positive pole of the dynamo.

Work.—Connect the work to be plated to the negative pole or zinc of the battery, or negative pole of dynamo.

Strength of Current.—In gold plating as in other plating, the operator must always remember that a weak current of suitable quantity to deposit uniformly will give a close-grained, hard deposit, while a current that is too strong will give a coarse-grained deposit or a dark powder which refuses to adhere. The proper current should be 3 to 4 volts.

Cleaning Work.—A chemically clean surface is absolutely necessary to insure good results in plating.

Articles of iron or steel should first be copper plated.

Deposit.—After getting the first slight coat of gold, the work should be scratch-brushed with a fine brass scratch brush, allowing a little soap bark solution to drip on the brush. (This solution is made with 1 ounce of soap bark to 1 gallon of water.) This lays down the first coat of gold, which should be sufficient to cover the articles entirely. The scratch brush acts as a burnisher. After this the work is thoroughly rinsed in cold water and again placed in the solution. The time it remains will be governed by experience, but generally five minutes will give a sufficient coat to stand burnishing.

When the solution becomes impoverished it can be renewed by adding 2 ounces of C. P. cyanide of potash and 60 grains of chloride of gold to each gallon of solution.

Finishing.—Finishing may be done with steel and agate burnishers, or the work scratch-brushed if it is to be satin finished, or it may be colored with a soft canton flannel buff and rouge.

24 Karat Gold Solution may be made as follows:—

Formula:

Distilled water	1 gallon.
Phosphate soda crystals	9½ ounces.
Bisulphite soda	1½ ounces.
Cyanide Potash, C. P.	½ ounce.
Chloride gold	120 grains.

Use a current pressure of 3 to 4 volts.

Use at a temperature of about 160° Fahr.

Use 24 karat gold anodes.

Heat a portion of the water and dissolve the phosphate of soda in this. Then allow it to cool.

In another portion of the water dissolve the bisulphite of soda and cyanide of potash.

Dissolve the chloride of gold in the remaining water. Stir this solution slowly into the phosphate of soda solution, after which add the solution of cyanide of potash and bisulphite of soda.

The plating solution is now ready for use.

Rose Gold.—Rose gold color may be produced in the following manner:—

Use 24 karat gold solution.

Use 24 karat gold anode.

Use solution cold.

Use a current pressure of about 6 volts.

When the deposit has assumed a dark, loamy appearance the work should be removed from the solution. The relief parts should then be brightened by rubbing them with moistened bicarbonate of soda. This may be applied by the ball of the finger, or by a piece of soft muslin, thus leaving the background or recessed parts in the loamy condition, showing marked contrast between these and the parts in relief.

If the solution is rich in gold, a copper anode may be used to produce the desired result.

A rose gold solution may also be made by adding a very small quantity of carbonate of copper or cyanide of copper solution to the gold solution.

Many shades of rose gold may be produced from the same solution by varying both temperature and voltage. No set rule can be given for this, the conditions under which the various shades are produced being due to the manipulations of the operator.

Articles, excepting those of solid gold, should be given a coating of good quality lacquer.

14 Karat Gold Solution.—The 14 karat gold solution should be used with a fair 14 karat gold anode surface, using 2 anodes 2 or 3 square inches each, one on each side of the work.

Use at a temperature of not less than 180° Fahr.

Use a current pressure of about 5 to 6 volts.

Plate only a few pieces at a time.

The work, after being polished and cleaned, should be rinsed in cold water before being placed in the solution.

Keep the vessel covered while heating and getting the work ready for use.

Articles of iron or steel should first be copper plated.

Have the work highly finished before plating. If the deposit turns yellow the anode is too small, temperature too low, or current too weak. By moving the work up and down a few times in the solution it can be given any color desired, even to that of fine gold. Test a small quantity of the solution first to see that the conditions are correct.

When using batteries, four small Bunsen cells, coupled for intensity, zinc to carbon, are necessary.

If by mistake the solution is allowed to become exhausted of gold from too small an anode surface, or too large a surface of work, run in more gold from the anode by hanging a loop of iron wire in a small porous cup in place of the work. When first used, this solution may give a fine gold color, owing to excess of gold, but it will soon give the 14 karat color. If the anodes become dull, add a small quantity of C. P. cyanide of potash, but always try experiments with a small quantity of solution, remembering the proportions used.

If work is first highly polished no buffing is required after plating, this being a great advantage in the use of this solution.

Green Gold Solution.

Formula:

Water	4	gallons.
Cyanide Potash, C. P.	6	ounces.
Chloride gold	½	ounce.
Chloride silver	2	pennyweights.
Phosphate soda	1½	ounces.
Caustic potash (sticks)	¾	ounce.

Use cold with a 24 karat gold anode.

Use a current pressure of from 2 to 4 volts, according to the size of work and anode.

Dissolve all of the cyanide of potash in the full quantity of water; then add the chloride of gold, dip out a very small quantity of this solution and stir the chloride of silver in it, then stir this in the bulk of the solution, after which add the phosphate of soda, then the caustic potash.

See that each article is dissolved before adding the next. After the article has received the proper deposit the relief parts should be slightly rubbed with bicarbonate of soda. This will brighten them and leave the recessed parts a greenish tint, thus producing a very pretty and effective contrast.

Green from Gold Solution, for removing Green Oxide from Gold.—This solution is usually furnished ready for use.

Use solution cold.

Use the work as an anode.

Use a sheet lead cathode.

Use a current pressure of 5 to 6 volts.

During the process of manufacture of gold articles, the heat combined with the compounds of the flux used, during hard soldering, causes a film of green oxide to form on the surface. This coating is difficult to remove, and is often imperfectly done by pickling and polishing.

When the oxide is removed in this solution, the article will come out bright and smooth, thus saving time, expense, and gold in the final polishing and finishing. Any gold removed in this manner is taken up in the solution and can be regained by the usual method.

Tin Solution.

Formula:

Water	1 gallon.
Caustic soda, gran	8 ounces.
Fused proto-chloride of tin	3 ounces.

Solution should stand at about 11° Baume.

Use solution cold.

Use a current pressure of about 1 to 1½ volts.

Use only pure tin anodes.

First dissolve the caustic soda in nearly the full quantity of water required.

Then dissolve the fused proto-chloride of tin in the water held in reserve, after which slowly pour this in the bulk of the solution, and at the same time keep stirring the mixture. The solution is now ready for use.

If the solution becomes impoverished and deposits too slowly it is an indication that it has been stripped of metal. It should then be revived by adding fused proto-chloride of tin in very small quantities until the difficulty is remedied.

If the solution should have a milky appearance add caustic soda in very small quantities until it becomes clear.

Articles of iron or steel should first be given a slight copper deposit in a cyanide copper solution, preferably hot.

While the work is being plated it will take on a frosty appearing deposit which is porous and spongy. The work should then be removed and scratch-brushed. This must be repeated several times during the plating operation, depending on the thickness of the deposit required.

When this solution is used with mechanical plating barrels a current pressure of about 1½ volts is required. Under these conditions the scratch-brushing is not necessary for the reason that the rolling, tumbling motion imparted to the articles causes them to constantly rub together and burnish themselves.

COLD GALVANIZING (ELECTRO-GALVANIZING)

Cold galvanizing is now being successfully done in a commercial way by many large manufacturing concerns. Articles of steel, gray, and malleable iron, ranging from screws and bolts to wire cloth and architectural iron, are finished in this manner. The electro-deposition of zinc has been attempted for many years, but only within a short period have practical commercial results been obtained.

With the advantages secured by the use of modern compound-wound dynamos as a source of current, it is now possible to install complete plants for galvanizing all iron or steel articles, from small pieces to a ship's anchor and chain.

It has been demonstrated that, in the application of zinc by the Electrolytic Cold Process, a much smaller amount of protecting metal to the square foot is required than is necessary in hot galvanizing. At the same time the protective quality of the electrically deposited zinc is greater, and the deposit more uniform, than can be obtained where hot metal is used.

Tempered articles, coil springs, automobile and bicycle hardware, and like goods of comparatively small cross section or high temper, sometimes lose a part of their tensile strength or temper when subjected to the heat of the molten bath (774° Fahr.). This is a disadvantage not present in the cold process.

Cold galvanizing is successfully done in still-solution plating tanks, and also in the Mechanical Electroplating Apparatus.

Galvanizing Solution.

Formula:

Water	1 gallon.
Galvanizing salts	2 pounds.
Toning salts	1 ounce.

Solution should stand at about 18° Baume.

When used as a still solution the current pressure should be about 2½ to 3 volts.

When used as a plating-barrel solution the current pressure should be from 6 to 10 volts.

Use only pure zinc anodes.

Dissolve all of the galvanizing salts in the full quantity of water required.

Dissolve the toning salts in a portion of this solution, then stir it in the bulk of the solution.

Pure zinc anodes should be suspended in the solution and allowed to remain over night. Then skim and the solution will be ready for use. The solution should now stand at about 18° Baume.

If the solution after some use plates slowly and shows too blue a color on the work, add ½ to ¾ ounce of toning salts to each gallon. The toning salts should first be dissolved in a portion of the solution.

If, after considerable use, the solution stands below 18° Baume, add galvanizing salts to bring it up to the proper point.

It is of first importance that the work should have a clean, metallic surface free from grease, rust, and scale, otherwise good results cannot be obtained.

Grease and dirt can be removed by immersing the work in a Kostico dip: 1 gallon of water, 8 ounces Kostico.

This must be used at boiling point.

Hard scale, sand, and rust can be removed in a solution of H. F. acid or by sand blast: 15 parts of water, 1 part H. F. acid. Use cold.

For ordinary work a solution of muriatic acid can be used: 15 parts of water, 1 part muriatic acid.

Use hot at 115 to 120° Fahr.

This dip will remove light scale and rust. If the articles are not then sufficiently clean, scrub with flour pumice and water.

Work should invariably go through the Kostico before being placed in the pickle tank. After each cleansing operation the article must be rinsed in clean, cold water.

Work that is plated in a still solution will have a very white and frosty appearance. It can be easily brightened by giving it a slight scratch-brushing.

Work that is plated in a mechanical plating barrel will not have the frosty appearance, as the rolling motion imparted to it causes a burnishing effect while the deposit is going on, which will frequently cause it to come from the barrel in a fairly bright condition, depending on the class and shape of the work.

A good deposit should be obtained in a still solution in about ½ hour and a very heavy deposit in about 1 hour.

A good deposit in a mechanical plating-barrel solution requires from 1½ to 2 hours. These figures are approximate only and for ordinary cases under proper conditions. The actual length of time of deposit depends on the class of work and the thickness of deposit required.

Oxidizing Solution, for Copper, Bronze, and Silver.

Formula:

Water	1 gallon.
Sulphuret potash	½ ounce.

Use as a dip at about 130° Fahr.

After the article has been oxidized the high light is brought out by slightly touching the work to a felt wheel charged with rouge.

Sewed buffs are often used to good advantage and, for certain finishes, either steel or brass wire scratch brushes are used.

Articles of brass, iron, or steel must first be copper-plated.

The work should finally be given a good coating of lacquer.

Statuary Bronze.—First copperplate the article. Then oxidize it in a sulphuret of potash solution. The oxidization should then be nearly all scoured off by using a tampico hand or wheel brush charged with fine powdered pumice and water, after which the article should be lacquered.

Royal Blue Solution, producing a Blued Steel Finish on Steel, Iron, Brass, or Copper.

Formula:

Water	1 gallon.
Royal blue salts	9 ounces.

Use as a dip at about 180° to 190° Fahr.

Use an earthenware pot.

Heat the water to about 190° Fahr., then put in the royal blue salts and stir thoroughly until it is dissolved, excepting a small quantity of sediment, which will always remain in the bottom of the vessel.

The articles must be perfectly cleaned in the same manner as before plating.

Dip the articles in the solution and keep agitating them. The articles will then take on first a golden tint, then pink, etc. When the blue color appears the articles must at once be removed and dipped in clean, cold water, then in hot water, otherwise the color will change to a light, steel shade.

The articles should be given a coating of lacquer in order to retain the color.

It is better to experiment with one or two pieces of work in order to become familiar with the action of the solution, as the success in operating this is chiefly in knowing at what time the articles should be removed.

The solution should be used until exhausted, then make an entirely new one.

Copper or brass articles will take on a deeper blue than iron or steel.

If iron or steel articles are given a slight copper deposit the color will then be as deep as that given to copper or brass.

Verd-Antique Chemical Solution, for Antique Green Finish on Brass, Copper, or Bronze.—This will produce the genuine finish, as the chemical action of the solution on the metal causes a verdigris covered surface.

Brush the article with the solution and allow it to dry very slowly in a damp heated atmosphere for 24 hours or more, for the reason that as soon as the solution becomes thoroughly dry its corrosive action ceases. Proper results cannot be obtained if the articles are allowed to dry quickly.

Articles of iron or steel should be given a fairly heavy copper deposit.

If the article has been properly treated it will be entirely covered with verdigris, which presents various tints.

It should then be brushed with a flat bristle or tampico brush on which some beeswax has been rubbed.

The relief parts may then be set off with hematite, chrome yellow, or other suitable colors. Light touches with ammonia give a blue shade and carbonate of ammonia will deepen the color.

By applying verd-antique lacquer with a stipple brush on this finish various mottled effects can be obtained.

Verd-Antique Lacquer, for Antique Green Finish on Brass, Copper, or Bronze.—Verd-antique lacquer should be applied with a brush in the same manner as ordinary lacquer, but it is not suitable to use on highly polished surfaces; such surfaces should first be dulled by dipping in acid.

When this lacquer is applied over a verd-antique chemical solution finish, some very pretty effects can be produced.

Stop-off Varnish.—This varnish is used when it is necessary to deposit two or more metals on one article. It thoroughly insulates the parts covered, so they will not take on a deposit.

It should be applied with a brush in the same manner as lacquer, and allowed to dry before being placed in the plating solution. It can be easily removed with benzine.

SECTION VI

DIPS AND CLEANERS, PICKLES, STRIPPING SOLUTIONS

DIPS

Dips are used for the purpose of removing stains or discoloration, and to produce a uniform color on the metals.

After dipping the articles rinse first in cold and then in hot water. Small articles in bulk will retain considerable moisture and should be dried in hot sawdust, while large articles will retain little moisture but sufficient heat to cause them to dry quickly in the air.

When mixing water and acids of various kinds, the lightest weight liquid should be put in the container first, following with the next heavier in turn until the mixture is completed.

Always pour the acids in slowly and at the same time keep stirring the mixture.

Approximate weights per gallon.

Water, 8 pounds.
Muriatic acid, 18°, 10 pounds.
Nitric acid, 38°, 11½ pounds.
Aqua fortis, 36°, 11½ pounds.
Oil of vitriol, 66°, 15½ pounds.

Cyanide Dip (**Poison**) for Brass, Bronze, Copper, and Silver.—This will not affect the polished surface of the metals and may be used on articles that would have the surface injured by the use of acid dips.

Formula:

Water	1 gallon.
C. P. cyanide potash	½ pound.

Bright Dip for Solid Metals, Brass, Bronze, and Copper.

Formula:

Nitric acid	1 part.
Oil of vitriol	2 parts.
Salt to each gallon	1 tablespoonful.

Mix in order named.

Bright Dip for Plated Articles, Brass, Bronze, and Copper.—To give the metals a high-finished color, when it is not desired to have them buffed.

Formula:

Water	1 part.
Nitric acid	1 part.
Oil of vitriol	2 parts.
Salt to each gallon	1 tablespoonful.

Mix in order named.

Burning Acid Dip for Brass, Bronze, or Copper.—To remove oxidation formed by the process of hard soldering or annealing in order to prepare a better surface on the metal previous to the regular bright dipping.

Formula:

Water	1 part.
Nitric acid	1 part.

Mix in order named.

Ormolu Dip.—This is used to produce frosted or satin finish effects on brass, similar to those made by a sand blast or scratch brushes.

Formula:

Nitric acid	1 gallon.
Sulphuric acid	1 gallon.
Metallic zinc	½ pound.

Use in a chemical stoneware jar placed in a hot water bath.

First dissolve the zinc in the nitric acid, then, while stirring, add the sulphuric acid.

The work must be absolutely clean, the same as for plating.

Stir the dip each time before using.

Immerse the articles for a few seconds, then rinse in cold water, after which dip in a bright acid dip; then rinse in hot water.

If the finish should be too bright or have too fine a frosted appearance add more zinc previously dissolved in nitric acid.

If the finish should be too dull or have too coarse a frosted appearance add nitric acid only.

It requires some little experience and care to do this work well, but, after the operator has become accustomed to handling it, some beautiful effects can be produced.

Acid Dip for Iron and Steel.—To remove oxide or rust.

Formula:

Water	1 part.
Muriatic acid	1 part.

Mix in order named.

Kostico Dip for all Metals.—To remove grease before plating.

Formula:

Water	1 gallon.
Kostico	½ pound.

This must be used at the boiling point.

XXX Lye Dip for All Metals.—To remove grease before plating.

Formula:

Water	1 gallon.
XXX lye	3 ounces.

Use hot.

Potash Dip for All Metals.—To remove grease before plating.

Formula:

Water	1 gallon.
Common potash	½ pound.

Use hot.

Soda Dip for Iron and Steel.—To neutralize work that has been over-pickled in acid.

Formula:

Water	1 gallon.
Sal soda	½ pound.

Use hot or cold.

The work should be allowed to remain in the dip for 15 to 30 minutes, according to the condition of the metal.

CLEANERS

Chemical Cleaning Compound (C. C. C.).—A substitute for potash and caustic for cleaning work preparatory to plating. This compound is particularly useful where a hot potash solution cannot be used, and on very large surfaces such as sheet metal, urns, grate fronts, etc. It is also very useful for cleaning zinc work before plating.

Directions.—Mix the compound with cold water until it has the consistency of a soft paste; apply this paste to the work with a cotton potash brush, after which thoroughly rinse with cold water; then wash off with a clean cotton potash brush and clean water. The work is then ready for the plating solution.

Royal Cleaning Compound for removing Polishing Compositions from Work.

Formula:

Water	1 gallon.
Royal Cleaning Compound	6 ounces.

Use hot.

This is very useful for removing traces of crocus, tripoli, rouge, or lime compositions from all classes of work that have been polished or buffed, and especially those having recessed or hollow places in which the polishing compositions so readily adhere.

This particular compound will not tarnish or oxidize the work to the same extent as do many other kinds used for the same purpose.

After the work has been removed from the cleaning compound rinse thoroughly first in cold, then in hot water.

Royal Cleaning Compound will also be found very useful when used in a tumbling barrel solution with steel balls, for polishing small articles such as rings, ferrules, buckles, etc., both before and after plating.

Formula:

Water	1 gallon.
Royal Cleaning Compound	¼ pound.

When the work is taken from the barrel, use a dipping basket, and rinse thoroughly first in cold and then in hot water.

Electro-Chemical Cleaner.—Used for cleaning, by electrical action, all kinds of metal work, both before and after plating, polishing, or buffing. It will quickly remove all traces of grease or smut, leaving the work perfectly clean.

Formula:

Water	1 gallon.
Electro-chemical cleaning salts	1 pound.

Solution should stand at about 11° Baume when cold.

Use a current pressure of about 5 volts.

Solution must be used at boiling point.

Use a plain iron tank fitted with a steam coil, or a steam-jacketed boiling kettle. Heat the water to boiling point, then add the electro-chemical cleaning salts in small quantities, stirring it in thoroughly.

Connect the side or flange of the tank direct to the positive branch line. Place across the tank a brass rod on which to suspend the work. The rod must be insulated from the tank; this may be done by using short pieces of rubber hose slipped over the rod. Connect the rod with a rod connection to the negative branch line.

When the work is suspended in the solution by a copper wire attached to the rod, a strong electro-chemical action at once takes place, which will quickly force off all impurities from the surface of the metal.

Renewing.—In order to keep the solution at the proper density it is necessary to add from time to time small quantities of the cleaning salts; the quantity necessary to use can be determined by the action of the solution.

Time of Operation.—The average work can be properly cleaned in from 1 to 2 minutes; the actual length of time required of course depends upon the condition of the work when placed in the bath. After cleaning articles of brass, copper, zinc, or tin, they should first be rinsed in cold water, then dipped in a cyanide dip made as follows: 1 gallon of water, ½ pound C. P. cyanide potash; after which rinse in cold water and pass to the plating solution.

Articles of iron or steel after coming from the cleaner should be rinsed in cold water, then dipped in a muriatic acid dip, mixed in the order named: 15 parts of water, 1 part muriatic acid, 22°, after which rinse in cold water; they are then ready for the plating solution.

PICKLES

Pickles are used for the purpose of cleaning the metals by removing scale, rust, sand, etc., and not to brighten them.

After removing the articles from the pickle rinse first in cold and then in hot water. Small articles in bulk will retain considerable moisture and should be dried in hot sawdust, while large articles will retain little moisture but sufficient heat to cause them to dry quickly in the air.

Hydrofluoric Acid Pickle for Iron and Steel.—To remove scale, rust, and sand.

Formula:

Water....................................15 parts.
Hydrofluoric acid..............................1 part.

Mix in order named. Use cold.

This pickle should be used in a lead lined tank, or a wood tank or tub lined both inside and outside with prepared tank lining but not sanded.

The articles should be suspended in the pickle by wires or baskets and allowed to remain until the objectionable features have been removed.

The pickle can be used repeatedly, by adding about one third the original quantity of acid before charging again with iron.

When it is desired to keep the iron bright, it should be rinsed with water about 200° Fahr., immediately after coming from the acid, in order to dry it quickly. By this means all trace of the acid is removed, and the chance of corrosion or tarnish resulting, obviated. If washed with cold water, it will remain wet for some time and rust.

It is advisable to add a small quantity of lime to the wash water.

Wooden boxes with holes in the sides may be used to good advantage for immersing and removing the castings from the pickle. By this means the sand is retained in the bottom of the boxes and is removed with the casting, thus saving the acid's strength from acting on the sand when not in use.

Spent, weak acid should be discarded, and the tank should be cleaned every month.

As the strong acid will cause inflammation wherever it comes in contact with the skin, it should be handled even more carefully than other acids. Rubber gloves are the best protection, but if the acid has splashed on the skin it should be washed off immediately with water and diluted borax or sal soda solution, or with aqua ammonia, which will prevent injury.

Acid Pickle for Brass and Copper.—To remove scale.

Formula:

Water	20 parts.
Oil of vitriol	1 part.

Mix in order named.

Pickelene for Iron and Steel.—To remove scale, rust, and sand. Pickelene is far superior to acid pickles for iron and steel.

Advantages.—Pickelene is a dry salt, easier and cleaner to use, safer to handle and quicker to act than acid.

It has no disagreeable or injurious fumes such as are encountered when using acid pickles.

It will not deteriorate with age or when exposed to the air.

It can be shipped without danger of breakage, and, unlike acid, may be sent by express as well as by freight.

Express companies will not receive or forward acid shipments, consequently it is necessary to ship by freight, often causing delay when badly needed. Acid is always shipped at buyers' risk of breakage in transit. The carboys must be handled with the greatest care, and even then are often broken, losing their entire contents.

Formula:

Water	1 gallon.
Pickelene salts	1 pound.

Use hot; the hotter the better.

Solution should stand at about 11° Baume when cold.

Pickelene may be used in either a lead lined or unlined wood tank, fitted with a heavy lead steam coil. Do not use iron tanks.

When the articles are suspended in this solution a very powerful chemical action takes place, about 10 to 15 minutes only being required to remove scale or rust from ordinary work, and the same length of time to loosen sand.

After removing the work from the pickle, rinse first in cold and then in hot water. Sanded articles should be scrubbed in cold water, then rinsed in hot water.

Renewing.—When the solution after use becomes depleted of active element, it is an indication that more pickelene salts should be added.

STRIPPING SOLUTIONS

Nickel Stripping Solution.—Used as a dip for removing nickel from work.

Formula:

Water	½ gallon.
Oil of vitriol	½ gallon.
Saltpeter	½ pound.

Mix in order named.

Immerse the article in the solution; keep constantly shaking and changing its position until the nickel has been removed, then rinse, first in cold and after in hot water.

Silver Stripping Solution.—Used as a dip to remove silver from brass, or German silver before replating.

Formula:

Oil of vitriol	1 gallon.
Saltpeter	½ pound.

Use at a temperature of 120° to 130° Fahr. with the vessel placed in a sand or water bath.

Silver Stripping Solution for Steel.—To remove silver from steel before replating.

Formula:

Water	1 gallon.
C. P. cyanide potash	½ pound.
Chloride silver	½ ounce.

Mix in order named.

Mix the chloride of silver in a small portion of the cyanide and water solution until it forms a thin paste, then stir it in the bulk of the solution.

Use a current pressure of 1½ to 2 volts.

Use the article as an anode and the silver anode as a cathode.

Essex Stripping Salts for Silver and for deplating Spelter.—Many operators, especially those doing silver plating, will find that by using iron racks or trees they can use an Essex stripping solution with a reverse current and thus strip all their racks of deposited metal, leaving them perfectly clean and the same as new, and at a great saving in cost.

It is especially advantageous for silver, as by this method the silver is precipitated to the bottom of the tank. To recover the settlings the solution should be siphoned off; the silver can then be handled at a less cost than when taken up in the solution, as is the case with cyanide.

Formula:

Essex stripping salts...........................	¾ pound.
Water..	1 gallon.

Solution should stand at 7° Baume.

Use a current pressure of 4 to 5 volts.

Arrange the tank the same as for plating except with a reverse current, and use thin steel cathodes.

Silver Quickening Solution.—Used as a dip. For use on brass and German silver before silver plating, to hasten the action of the silver deposit, by giving the surface of the metals a slight coating on which the deposit will readily take.

Formula:

Water	5 gallons.
Corrosive sublimate	1 pound.
Muriatic acid	1 pint.

Mix in order named.

Dissolve the corrosive sublimate in hot water.

"H. & V. W." Acid Pump.—This can well be called an article of great value for the plating room as it reduces to a minimum the well-known danger of handling acids in carboys.

"H. & V. W." Acid Pump.

The pump can be operated by a boy. The pitcher or receptacle is placed near the carboy. One end of the rubber tube is placed in the acid, the rubber cork making an air-tight joint in the neck of the carboy;

the other end of the tube is placed in the pitcher. When the pump is operated a steady flow of acid is obtained. The pump can also be used as a siphon for small quantities after the flow is started.

Automatic Rubber Respirator.

Automatic Rubber Respirators.—For use when working in fumes, vapors, smoke, and all kinds of dust. They will be found a great relief in all dipping operations where the obnoxious acid fumes arise from the dips, also in all dusty, grinding, and polishing operations.

They are provided with a closed and protected automatic ventilating valve, which operates under all conditions, thus securing perfect ventilation. A fine, damp sponge or a wet, silk cloth is the best filtering material for separating impurities from the air, and, when these two valuable filtering materials are combined in their action, the protection is practically complete, and it is a very difficult matter for fumes or gases to pass through the respirator.

SECTION VII

MECHANICAL ELECTRO-PLATING

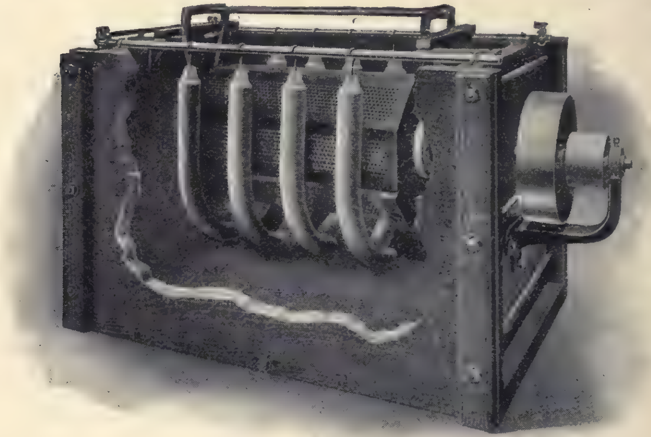
No branch of the electro-plating industry has in the last few years received the careful attention and made such rapid progress as the plating of small articles in bulk, by mechanical operations.

Manufacturers of this class of goods were quick to perceive the advantages gained by the use of such machines, owing to the large quantities of material that can be so quickly handled, the great saving in time and labor and the consequent reduction in the cost of the finished articles. The result has been that, at the present time, several hundred perfected machines are in daily use, operating with the various plating solutions.

A mechanical plating apparatus consists of an outer tank for containing the solution and a revolving plating barrel made of perforated wood or celluloid in which to hold and tumble the work while deposition is going on. The barrels are belt driven from a countershaft.

The revolving tumbling motion imparted to the work creates a constant burnishing action, as the articles receive the deposit, consequently many classes of work come from the barrel in a highly polished and burnished condition.

With these machines from 40 to 80 pounds of small work, according to the character of same, can be



The "H. & V. W." Mechanical Electro-Plating Apparatus, Patented.

plated in one operation. This avoids the necessity of plating small articles in the old style depositing baskets, which is a slow and tedious method requiring the constant attention of the operator, and is very unsatisfactory at best; while the saving in nickel, that under the old methods was deposited on the baskets, is very considerable, the chief factors which recommend the mechanical apparatus to the user are time, evenness of finish, economy of nickel and slinging wire, and the ability of the operator to handle large amounts of work daily.

These machines are now largely used in plating shops where it is necessary to turn out quantities of small work in a short space of time. They are successfully operated with all of the regular plating solutions.

THE "H. & V. W." MECHANICAL ELECTRO-PLATING APPARATUS, PATENTED

The apparatus herein described has been much simplified. The barrel is entirely submerged. The drive is from the outside, thus avoiding the use of belts running in the solution. Two speeds are provided for. The barrel is removable at any time without throwing off the belt, or interfering with the drive.

The machines are made in several sizes with revolving barrels of wood or celluloid containing perforations of various sizes, depending on the shape and class of work to be plated.

A patent mechanical plating apparatus, complete, consists of a wood tank, revolving plating barrel, necessary rods and connections, and a special patent countershaft. The solution, anodes, and tank rheostat are extra.

Directions for Setting Up and Operating the "H. & V. W." Patent Electrolytic Plating Apparatus.

Belting.—If possible place the apparatus in such a position that a slanting belt can be used, and so that the underside of the belt does the pulling. The length of belt to use for best results is one that will allow for about from 10 to 15 feet between the centers of the pulleys.

Apparatus.—These are fitted with suitable terminal connections and are to be connected to the main line in the same manner as an ordinary plating tank, with suitable size of wire, as shown by the branch holes in the connections.

Anode rods +, revolving plating barrel to contain the work —. A rheostat should be cut in on the negative line between the tank and the main line. When the barrel is being filled or emptied the lever of the rheostat should be thrown on the "off" point. This is in order that, if a current of high tension is used, the work may not be burned while removing it from the tank.

Care should be taken to see that all points of contact are kept clean. A strip of thin sheet lead should be bent into U-shape and placed over the entire length of the anode rod, or a split length of rubber hose can be used. This will keep the drippings and dirt from the solution from interfering with the contact between the anode hooks and rods.

Two speeds of the revolving barrel are provided for. To obtain correct speeds the countershaft should run at 10 r. p. m.

Voltage to be used with various solutions:—

Acid copper solution, 18° Baume, 2½ to 5 volts.

Cyanide copper and brass solution, 12 to 15° Baume, 4 to 5 volts.

Nickel solution, 10° Baume, 4 to 5 volts.

Zinc solution, 20° Baume, 6 to 10 volts.

When plating round articles or those having no sharp edges or corners, a higher speed may be used, and, consequently, a higher voltage may be maintained and time of deposit shortened. The higher speed has a tendency to give a preliminary polish to the articles in the barrel. In the lower speeds almost any work which will not hang to the periphery of the barrel may be handled, and it is advisable that with the slow speed a lower current pressure be used.

Curved elliptic anodes are recommended for use with this outfit for the reason that there is a better circulation of the solution and more even disintegration in an anode of this shape, and the curved form entirely surrounds the work being plated in the barrel. It has also been demonstrated that the current works more freely from the edges of the anodes, so, if a wide plate be used, the work directly opposite the edges will be likely to receive a heavier coating than that part opposite the center of the large plate.

Best results can be obtained when the barrel is about half full, or even to the shaft, with work.

Average length of time required to get a good deposit, of different metals in ordinary cases, under proper conditions:—

Acid copper solution, 20 to 40 minutes.

Cyanide copper and brass solution, 30 to 45 minutes.

Nickel solution on brass, 15 to 30 minutes.

Nickel solution on steel, 45 to 60 minutes.

Zinc solution, 1½ to 2 hours.

These figures are approximate only and will not apply to all cases.

Oblique Plating Barrel Apparatus.—The oblique plating barrel apparatus can be used to advantage in shops where not enough of the small work is regularly handled to warrant the expense of installing the larger horizontal barrel type.

These apparatus are furnished complete with or without tank; it is not necessary to use any particular tank, for the reason that a barrel only, complete with shafts, hanger gear, and pulley, can be attached to any regular still-plating tank without trouble. Suitable anodes, rods, and connections can easily be arranged by the operator. For best results curved elliptic anodes should be used, these to be placed about 1½ to 2 inches from the barrel. Ordinary flat anodes may be used, but in this case a much higher voltage is necessary.

When a barrel is rigged in this manner it can at once be removed, and the space it occupied in the tank can

Oblique Plating Barrel Apparatus

be used for still plating. When desired, several of these barrels of the same or varying sizes can be operated in one solution tank, each plating work of different size or character, that may be kept in separate lots when necessary.

The barrel is made in cylinder form, of material which resists the action of the solutions, and is so constructed that no part of the apparatus itself will receive the metallic deposit from the anodes. The barrel is suspended in the solution at an oblique angle, by a mechanical arrangement at the top of a tank, either at the end or on the side.

These apparatus are made in four regular sizes, having capacities ranging from 10 to 40 pounds of screws, nails, or similar articles.

The drive is from the outside, avoiding the necessity of having a belt or chain running in the solution. The barrel may be driven either from a countershaft or direct from a small electric motor.

A rigid swinging hanger allows the barrel to be raised or lowered with ease and without interfering with the drive. These movements are controlled by the projecting shaft, on the end of which is a swivel handle. In this manner the work can be examined at any time without stopping the machine.

The barrel can be tilted to an angle sufficiently high to empty the contents into a basket or container that may be placed under it, or by loosening a wing screw nut the entire barrel may be removed with the work in it and used as a dipping basket for rinsing purposes.

The density of the solutions, current pressure, and time of deposit, when using curved elliptic anodes, are practically the same as those given for the horizontal type on pages 177 and 178.

Centrifugal Dryer for Small Work.—This machine is now being used extensively in plating shops for drying quickly large quantities of small work, buckles, buttons, bolts, nuts, ferrules, and similar articles, excepting those having recessed or pocket-like formations, without an outlet from which the moisture can

Centrifugal Dryer, for small work.

escape. These cannot be successfully dried in this manner, as the motion imparted by the machine will cause the moisture to remain in the hollow places instead of throwing it off.

It is claimed that by the use of this machine, time, heat, and sawdust are saved; a greater bulk of work handled in a day, and the staining of nickel-plated work greatly reduced.

One to three minutes only are necessary for the operation.

The work is placed in a removable tapering pan which fits over a vertical shaft. A cover for the pan is screwed on the top of the shaft; this prevents the work from being thrown out. The rapid centrifugal motion causes all moisture to be forced up and over the side of the pan. It is then caught by an inward curved flange of the outer shell and runs off to a pail placed under an outlet pipe.

SECTION VIII

BURNISHING

Steel Burnishers.—Burnishing is a branch of the electro-plating industry in a class by itself and the beginner must not expect to obtain very good results, as to do this requires long and careful practice.

Burnishing is done to lay down the frosty or porous deposits of silver or gold, while at the same time it improves the finish and makes a harder and tougher surface.

Burnishing is often done on articles having fancy relief patterns or raised borders in order to show a marked contrast to the body of the work.

To do this work properly the article must be held so that it will at all times be under the control of the operator without any unnecessary exertion. Attach to the workbench a small projecting shelf about 6 inches long by 6 inches wide and about the height of a low desk. The shelf should be covered with a cushion of canton flannel or other soft material tacked on the underside. This will keep the work from scratching. This shelf is called the peg. The operator can then work while sitting.

It is necessary to use some pressure. Hold the tool firm with the right hand close to the blade, the end of the handle resting on the operator's left breast. The rounded edges of the tool are the parts to use. Use the narrow edge for first cutting or laying down the metal and the thicker edge for the final polishing.

Steel Burnishers.

Slide the tool back and forth over the work with a swift wrist motion, keeping the tool on the work. Care must be taken that the tool does not cut or scrape the work.

The tool should be frequently dipped in a jar of soap water. Tack a piece of walrus or heavy leather on the bench near the operator for the purpose of keeping the tool highly polished. Cut two small grooves in the leather; in one sprinkle some fine flour emery, in the other sprinkle some fine quality powdered crocus. Rub the edges of the tool frequently first in the emery and then in the crocus. The tool will soon form deep grooves for itself which will aid in the polishing. Burnishers are made in many different shapes to suit the various styles of work.

SECTION IX

LACQUERS

Lacquers are used for coating finished metal articles to keep them from tarnishing, while at the same time they improve the luster.

Articles coated with good quality lacquer may readily be cleansed by wiping with a damp cloth; thus fly specks, accumulations of dust, etc., can be removed from fine articles without the necessity of refinishing.

There are two ways in which to use lacquers, and they are made accordingly; one to be used as a dip, called dip lacquer; the other to be applied by a brush, called brush lacquer.

They are made in many grades of the following kinds: transparent dip, transparent brush, black dip, black brush, colored brush (all colors), red gold brush, yellow gold brush.

Dip Lacquers.—Use a tin-lined wooden tank, enameled iron tank, glass jar, or earthenware pot. Do not use zinc or galvanized iron tanks, as they will often discolor and spoil the lacquer. When not in use keep tightly covered to prevent evaporation and to keep out dust.

The work must be absolutely clean, the same as for plating.

Arrange the goods so the lacquer will run off properly.

Allow them to drip over the tank until the lacquer stops flowing.

Dry in a temperature of 100° Fahr., if possible, using a thermometer. Dip lacquers will dry in the air, but baking improves the finish.

Use the lacquer as shipped until it shows a drip or nipple in drying. When the body becomes too heavy, it needs "thinner." Be sure to use only a thinner of the same grade as the lacquer.

If the work shows rainbow colors, give it a second dip after the first coat has dried. This will often remedy the trouble.

Brush Lacquer.

Brush Lacquers.—Brush lacquers cannot be used as thin as dip lacquers.

Use as thin as possible without showing rainbow colors.

Give a flowing coat with a soft lacquer brush. A stiff brush will require a thicker lacquer and will cause foaming or small air bubbles. When the body becomes too heavy it needs "thinner." Be sure to use only a thinner of the same grade as the lacquer.

Dry in a temperature of 100° Fahr. if possible, using a thermometer. Brush lacquers will dry in the air, but baking improves the finish.

Rainbow colors are, in most cases, caused by the lacquer being too thin or by carelessness in removing the polishing composition or rouge from the work.

Grease is very injurious to lacquer.

Rainbow colors will often disappear when the article is given a second coating of lacquer after the first has dried.

Gold Lacquers.—In nearly all instances gold lacquer is made for brush use only and cannot be used to advantage by dipping.

Gold lacquer is seldom shipped ready for use. It is sent out in transparent form with a suitable quantity of red or yellow gold color dye.

It is mixed by adding the gold dye in very small quantities to the transparent lacquer until the desired shade is obtained. If possible it should stand about 24 hours before being used, and can then be applied in the same manner as ordinary brush lacquers.

Special Directions to Lacquerers.—Special care must be taken in preparing the articles for lacquering, as this will add greatly to the finished product. In nearly all instances when complaints have been made the cause was proved to be due to inexperience, improper cleaning, or carelessness in application.

If lacquer is too thin, it will show iridescent colors.

If lacquer is too heavy, it will show a drip when used for dipping; it then needs a thinner.

If lacquered articles show a white, milky cloud, it is always due to moisture or grease. It requires only the smallest amount of moisture to ruin the work.

Be careful of escaping steam from the radiator or pipes, or damp air from an open window.

Removing Lacquer from Work.—Lacquer may be removed from work by immersion in a hot Kostico, potash, or lye solution. The work should then be cleaned in the same manner as when preparing it for plating.

When it is necessary to remove lacquer from work which for any reason cannot be dipped in Kostico or potash solutions, it may be removed by immersing it in lacquer thinner, or by liberal applications of the same.

Care should be taken to use only a thinner of the same grade as the lacquer.

The Lacquer Room.—When possible a separate room should be used for lacquering, or a portion of the shop may be partitioned off for this purpose, in order to avoid all dust or moisture.

The lacquer room should be light, dry, and well ventilated. When it is necessary to use artificial light, it is safer and better to use incandescent lamps.

Do not have a stove or gaslight near the lacquer room, as both the lacquer and thinner, as well as the gases which arise from them, are very inflammable.

Lacquer Dryers or Ovens.—The most suitable dryers for this purpose are sheet metal ovens, zinc-lined wooden ovens, or wooden closets with dust-proof doors; these to contain a steam radiator with regulating valves on the outside.

Rods or hooks can be placed at a convenient height on which to suspend the work with wires; shelves or racks of wire netting will also be found very convenient.

Hang a thermometer in the dryer.

Keep temperature at about 100° Fahr.

Lacquer Spraying.—Manufacturers of metal goods are now successfully applying lacquers to their product by the use of sprayers operated by air pressure supplied by power.

Chandeliers, hardware, buckles, buttons, etc., also the finest finishes in gold and silver, are being lacquered in this manner.

The claim is made that by the use of this method both time and labor are saved and that the finish obtained is superior to brush lacquered work, especially so when applying colors or the various shades of gold lacquer.

Large quantities of work can be finished in a short time and the percentage of loss in material, which at first thought would appear to be great, is comparatively small.

The most satisfactory sprayers are small and light in weight. They may be fitted to a bottle or similar container in which to hold the supply of lacquer.

The air pressure supply is delivered through a flexible rubber tube, thus allowing the operator to hold the sprayer in any desired position.

The sprayers contain a spray regulator, which provides for an instant increase or diminish of flow as the operator may desire. The lacquer can be placed on the work exactly where required and distributed very evenly.

The sprayers are not very expensive; the greatest expense is to install the necessary air pressure plant.

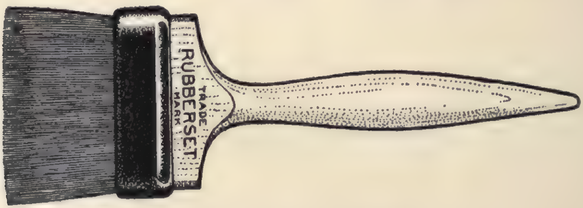
Many of the present day shops are already equipped with air pressure plants for soldering or sand blasting purposes. In these shops a sprayer outfit could be installed at slight expense.

Dip lacquers are generally used for spraying purposes. These should have a much thinner body than when used as a regular dip.

Lacquer Brushes, Rubberset.—When applying lacquers always use the best brush obtainable.

The rubberset brush can safely be recommended as the best for this purpose. The bristles are set in solid rubber and cannot come out.

Cheap brushes are poorly made; they will shed the bristles in the lacquer and on the work, often making it necessary to finish the work the second time.



Rubberset Lacquer Brush.

The best results can be obtained by using a flat rubberset camel's-hair brush, but for many classes of work a flat rubberset fitch-hair brush will answer.

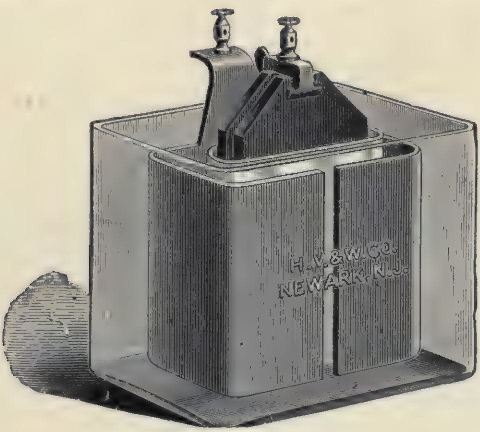
It is very important that lacquer brushes be kept clean, soft, and free from moisture. After using keep the brushes suspended in a wide-mouthed bottle or covered tin, containing thinner of a suitable grade. Do not allow the bristles to rest on the bottom.

New brushes should be worked out a little on a rough board in order to release any short, loose bristles that may not have been imbedded in the rubber.

SECTION X

BATTERIES

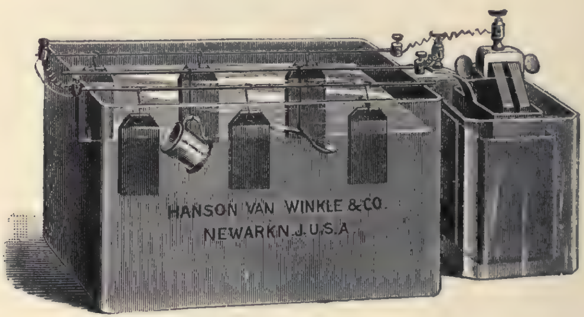
Batteries are often used in place of dynamos for experimental purposes, also for regular electro-plating in a small way.



"H. & V. W." Battery No. 1.

"H. & V. W." Battery No. 1, 1.9 Volts, 15 Ampere Hours, Positive (Carbon), Negative (Zinc).—This is a Bunsen cell of great power and is particularly adapted for use with nickel, copper, brass, or bronze solutions.

Directions.—Amalgamate the zinc inside and outside. Place this in the glass jar. Inside the zinc place the porous cup, and within the porous cup the carbon plates. Fill porous cup nearly full with nitric acid. Fill the outer jar with a mixture of 1 part oil of vitriol to 12 parts of water (previously mixed and allowed to cool) to a height equal to the liquid in the porous cup. When the outer liquid becomes milky, withdraw it with a syringe or siphon and refill, adding occasionally small quantities of nitric acid to the porous cup. Keep the zinc thoroughly amalgamated. The best results may be obtained when used in this manner.

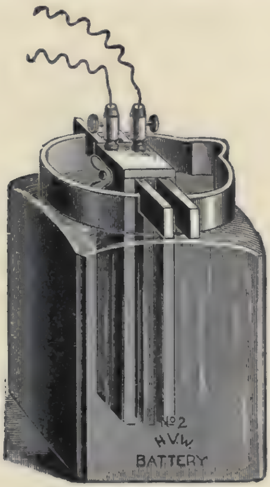


No. 1 Battery Connected to Plating Tank.

Battery Salts.—Battery salts may be used in place of the diluted oil of vitriol avoiding the necessity of amalgamating the zinc, using about 2 pounds, leaving some undissolved. This avoids the danger of having mercury around gold work. Glass strips may be placed between the porous cup and zinc to prevent contact.

Electropoion solution may be substituted for the nitric acid in either case.

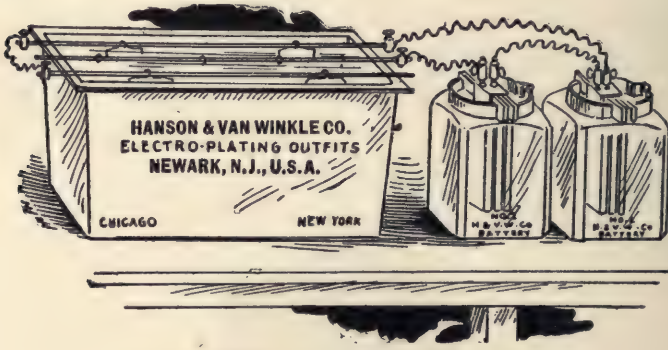
Before amalgamating the zinc, dip it in lye or potash solution to remove grease. Rinse in cold water, then



"H. & V. W." Battery No. 2.

place it in the amalgamating solution. The mercury will readily adhere to the zinc. After using the battery remove porous cup, carbons, and zinc, pour the contents of the porous cup in a glass jar, wash all three in clean water and put away for further use.

"H. & V. W." Battery No. 2, Positive (Carbon), Negative (Zinc).—This is a small sized Smee battery and is suitable for small silver and gold plating solutions.



No. 2 Batteries Connected to Plating Tank.

Directions.—Amalgamate the zincs. Fill the jar to within about one inch of the wooden support with a mixture 1 part oil of vitriol to 10 parts of water. When plating very small surfaces a small quantity of the dilute acid may be used. For silver, 1 cell will give a very fine deposit, but when used with a striking solution 2 cells should be used, connected zinc to carbon.

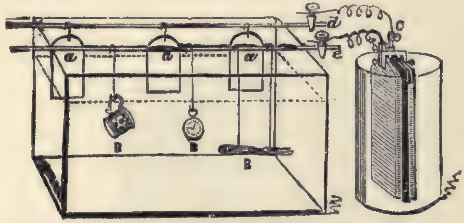
When exhausted, renew the solution. Two ounces of chromic acid or bichromate of potash may be added to each cell to increase power for nickel plating. After using remove the zincs and carbon and wash them in clean water.

Smee Battery, E. M. F., .5 Volt, Positive (Carbon), Negative (Zinc).—For use with silver and gold solutions. This is a well-known battery and needs little explanation. They are regularly furnished in 4 sizes.

Directions.—Amalgamate the zincs and fill jar to within about one inch of the wooden support with a mixture of 1 part oil of vitriol to 10 parts of water. After using remove zincs and carbons, and wash them in clean water.

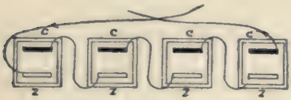
Smee Battery.

Primary Batteries. "*Modes of Arranging Cells.*—If two similar cells be joined, carbon to carbon and zinc to zinc, the electro-motive force is no more altered than would be the total fluid pressure produced by placing two pails of water side by side upon a level floor, in place of one; for both the cells are yielding the same pressure of electricity, and the mere coupling them in parallel arc, as it is termed, is only equal in effect to increasing the size of a single cell, which is without influence on the E. M. F. But if the cells be disposed with the carbon of one joined to the zinc of the next, and the free elements connected to the main circuit, the current generated in the first cell has

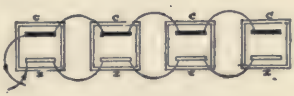


Smee Battery Connected to Plating Tank.

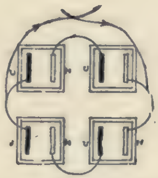
to flow through the second, and that of the second through the first, in order to complete the whole circuit, with the result that the electro-motive force is doubled. This arrangement, which is termed coupling in series, is exactly analogous to lifting the one pail of water above referred to and placing it upon the other, when the pressure is, of course, doubled. In setting up any number of cells, if placed all parallel, the E. M. F. is only that of one cell, but the internal resistance is reduced, as it would be in one large cell of the same type; while, if all are arranged in series, the E. M. F. will be raised in direct proportion to the number of cells in use."



Cells in Series.



Cells in Multiple.



Cells in Multiple-Series.

Amalgamating Solution for Battery Zincs.

Formula:

Water	1 gallon.
Corrosive sublimate	1 pound.
Muriatic acid	1 pint.

Mix in order named.

Dissolve the corrosive sublimate in hot water.

The zinc must be thoroughly cleaned before it can be properly amalgamated. This should be done by immersing it in a solution of lye or potash, after which rinse in clean cold water. Then place the zinc in the amalgamating solution, and the mercury will readily adhere to it.

Another method of amalgamating zinc is to clean it by dipping in diluted sulphuric acid and rubbing on metallic mercury with a cloth or brush.

Electropoion Solution.

Formula:

Water	½ gallon.
Oil of vitriol	1 quart.
Bichromate soda, pulverized	1½ pounds.

Mix in order named.

Pour the oil of vitriol slowly in the water, and at the same time keep stirring the mixture, which will become hot.

While the mixture is still hot stir in the bichromate of soda.

When cold the solution is ready for use.

SECTION XI

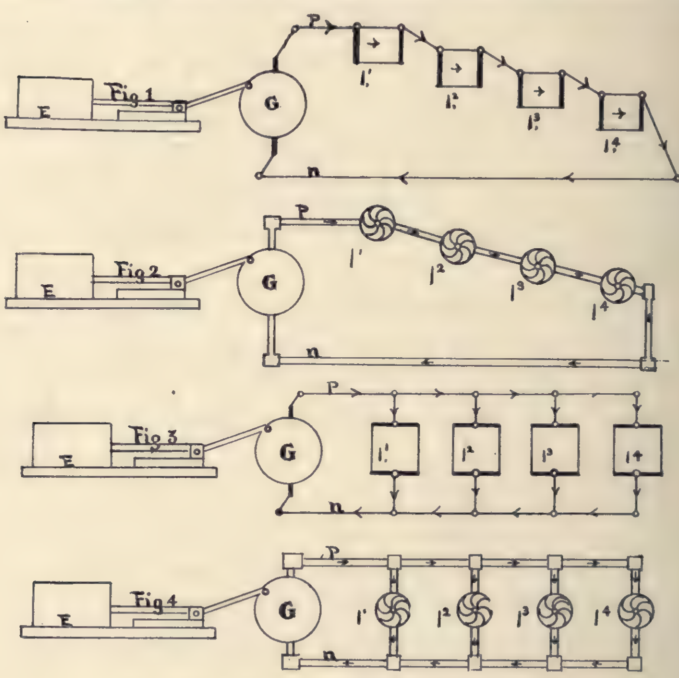
THREE SYSTEMS OF CURRENT DISTRIBUTION

It is of advantage to the operator of a plating dynamo to have clearly fixed in his mind the various methods of wiring, in order that he may distribute the current generated by the dynamo to the best possible advantage.

To illustrate three methods of current distribution the following clear electrical diagrams are given, with water analogues, for comparison, in each instance.

Fig. 1 illustrates the series system, usually employed in copper refining, or in the recovery of metal, *E* being the engine, *G* the dynamo or generator, *P* and *N* the positive and negative conductor, and 1^1, 1^2, 1^3, 1^4, the tanks. In this illustration, as will be noticed, the current passes from the dynamo through all the tanks in the series, each tank taking its proportion of the initial voltage, the total ampere capacity of the dynamo, if the work surface calls for this amount, being used in each tank, the initial voltage, however, being divided by the number of tanks in series, as stated above.

Fig. 2 illustrates the water analogue, in which E is the engine, G the rotary pump, and P and N the positive and negative pipes conveying the water; 1^1, 1^2, 1^3, and 1^4 are in this case water motors, arranged in series



and operated one after the other by the water passing from the first motor to the second motor, and so on through the series, each motor using its proportion of the energy.

In Fig. 3 is represented the usual multiple arc, or parallel arrangement of plating tanks, each tank taking the current from the positive conductor and delivering it with a certain fall of voltage to the negative conductor.

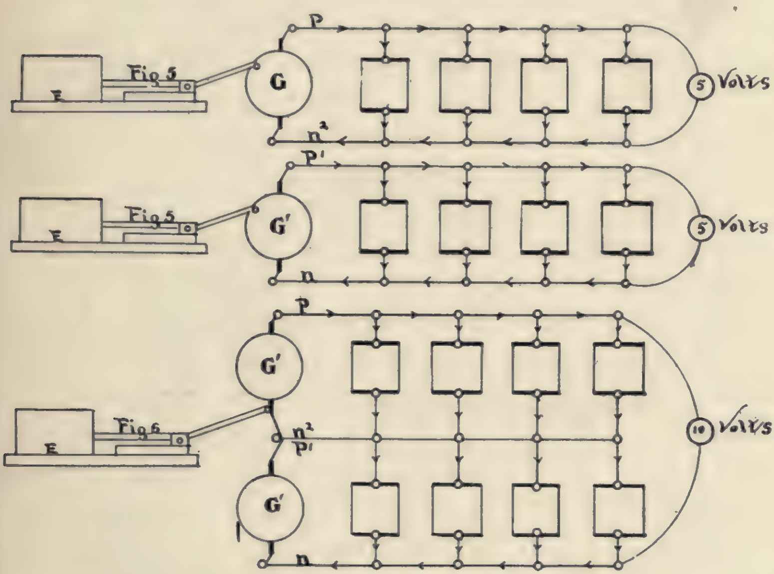


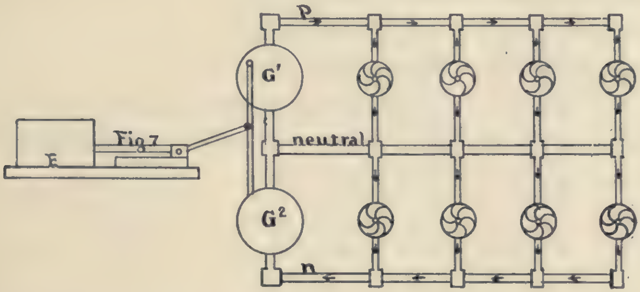
Fig. 4 illustrates the water analogue to the multiple arc system, each motor taking water from the positive pipe and delivering it to the negative pipe, with a fall of potential due to the amount of energy absorbed in the motors.

In Figs. 5 are shown two like multiple arc systems, placed parallel with each other, with the positive conductor of one system adjoining the negative conductor of the adjacent system, the arrows indicating the direction of the current in each system.

It will be seen that if the same amount of energy is absorbed in each of these two systems, the negative conductor *N* of the upper system must carry a negative current exactly equal to the positive current carried in the conductor *P* of the lower system, and the currents in these two conductors being equal and opposite would neutralize each other if carried on the same conductor, as is indicated in Fig. 6, in which the negative conductor *N* and positive conductor *P* are merged in one. In this case, with the generators *G* and *G* arranged in series, the electro-motive force being 10 volts (which is suited to two 5 volt tanks in mechanical series), so long as equal resistances are placed in the two parts of this circuit (called three-wire system), the central wire remains neutral, and no current passes in either direction; but as soon as this balance is disturbed by cutting out or adding one or more tanks, a current due to the difference in the resistance of the two branches passes over the neutral wire. This system is illustrated by the water analogue shown in Fig. 7.

Fig. 7. In this case two generators, or pumps, *G* and *G*, circulate the water through the system; the

upper outside pipe representing the positive conductor, the lower pipe representing the negative conductor, and the central pipe the neutral conductor. Upon each side of the neutral pipe and communicating with the outside pipes are motors corresponding to the tanks in the electric circuit. So long as the quantity of water consumed by the motors on both sides of the central pipe remains the same, the water is



circulated by passing forward through the upper pipe, through the motors, transversely through the neutral pipe, returning to dynamo by the lower pipe; but as soon as the equilibrium is disturbed by shutting off one or more of the motors on one side of the system, the water which would have been required to run that motor must return to the pumps through the neutral pipe, or be forced outward through the neutral pipe, according as the positive or negative current is shut off. This latter system of current distribution is highly advantageous for shops operating a number of solutions, requiring different voltages, for, with the three-wire dynamos which may now be obtained, it is possible to take from the machine two different voltages at the same time, one voltage being twice that of the other. Where plating barrels are operated or basket work is handled, requiring a high voltage, a current strength of 10 or 12 volts may be obtained by connecting the tank to the negative and positive main conductors. If at the same time it is necessary to operate tanks at the ordinary low voltage, this current may be taken from the dynamo by connecting the tanks to the neutral conductor and to either the positive or negative conductor.

THE THREE-WIRE SYSTEM OF CURRENT DISTRIBUTION

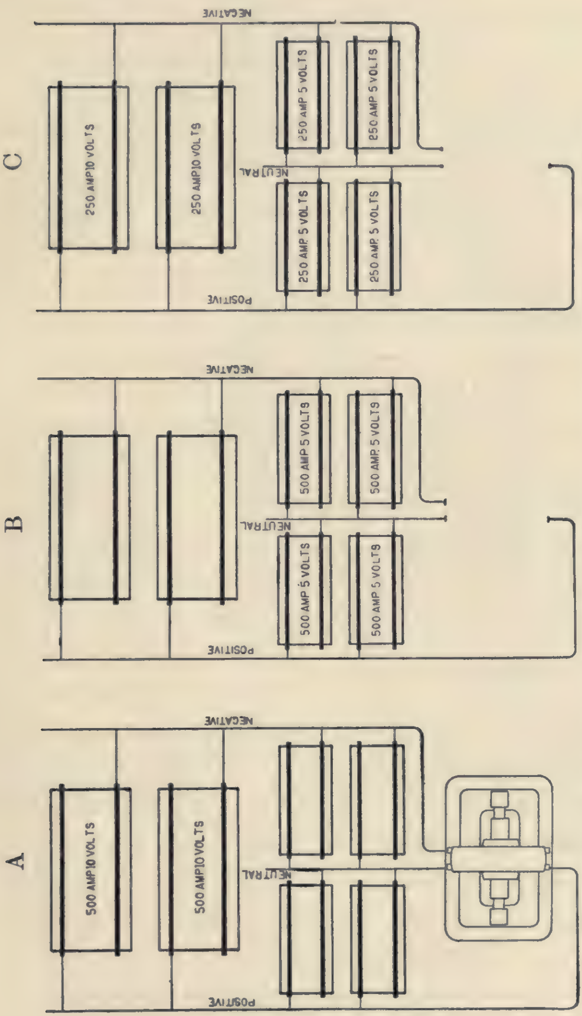
This method of current distribution has been generally adopted in the larger shops where a variety of solutions are in use. The operator familiar with electro-deposition understands the necessity of employing different voltage strengths in different solutions, and it has been generally recognized by experts that a stronger voltage and higher current density can be advantageously used in many solutions where it was formerly thought a low voltage only could be employed.

The necessity of shortening time of deposit without deterioration of the quality of work has been apparent; this condition is effected through the agitation of the solution, and the consequent employment of a higher voltage, with proportionate increase in the ampere current. The majority of plating dynamos in general use are capable of delivering 4 to 6 volts only, and their use precludes the adoption of the newer labor-saving method. To meet the demand for generators that will deliver a higher range of voltage, dynamos are now constructed to operate on the three-wire system, which will deliver a range of voltage up to 12 volts or higher if desired. These three-wire dynamos are constructed to deliver 4 and 8 volts, 5 and 10 volts, 6 and 12 volts, and 8 and 16 volts. By the use of these dynamos it is possible to take from the machine, voltages of two different strengths, at the same time, the higher voltage being double that of the lower, and thus provide a high pressure for mechanical plating apparatus, basket work, or agitated solutions, and at the same time operate solutions at a low voltage.

On page 211 a diagram is given indicating a few of the methods which may be used. For example, a dynamo is taken having a capacity of 2,000 amperes at 5 volts, and 1,000 amperes at 10 volts, connections being arranged for the three-wire system.

In wiring for this system, three main line conductors are used, the positive and negative, or outside lines, and the neutral or middle line. In this method of wiring there is a saving of over 37 per cent. effected in the cost of copper, as it is not necessary to use conductors of so large a cross-section as would be the case in the ordinary two-wire system.

By connecting tanks to the outside or positive and negative conductors, 10 volts are obtained in the tank. By connecting tanks to the positive and neutral conductors, or to the negative and neutral conductors, 5 volts are obtained.



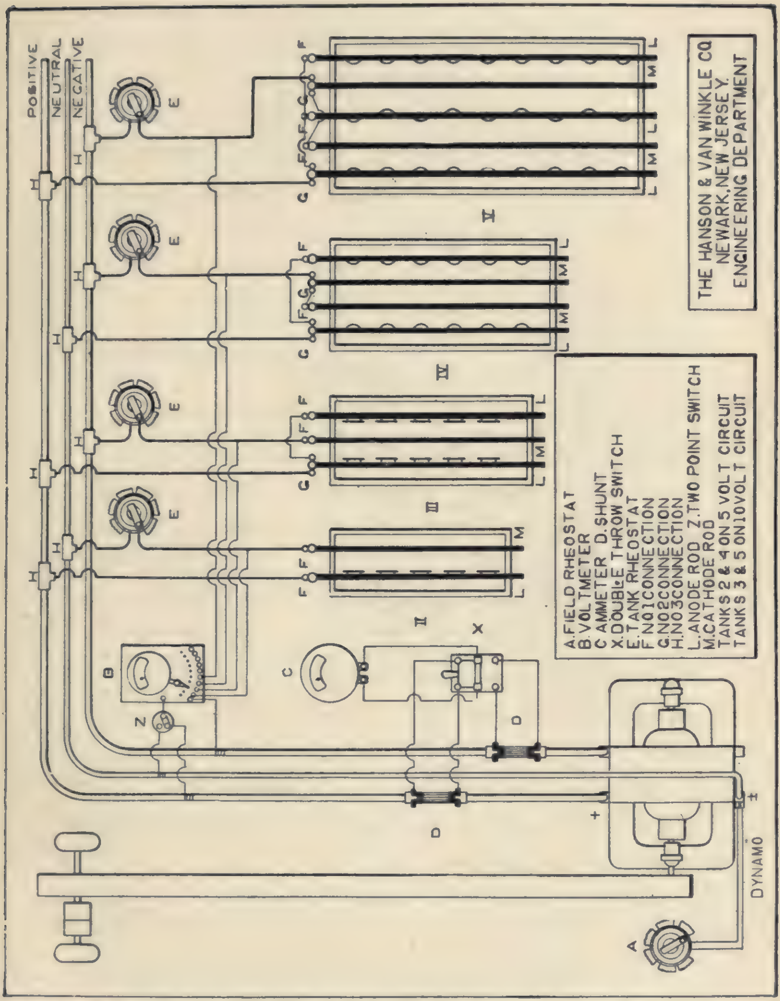
Distribution of Current—Three-Wire System. Example: 2000 Amperes, 5 Volts.

Where loads in the tank are equal, as shown in example *C*, the course of the current is from the generator along positive line, through the tank, transversely through the neutral conductor, through the next tank in series, to the negative conductor, thence returning to the dynamo. When loads are unequal, one tank being empty or having a smaller work surface than the other tanks, the two sides of the series are unbalanced, one side calling for more current than the other. This condition, however, is taken care of by the neutral wire, the surplus current flowing along the neutral wire to the dynamo, and the balance between the remaining tanks in the series is maintained.

Explanation of Diagram.—In example *A* are shown two tanks connected to outside conductors, taking collectively the full capacity of the dynamo at 10 volts.

In example *B* is shown a number of tanks connected in series, taking the full capacity of the dynamo at 5 volts.

In example *C* the dynamo is distributing its entire current to a number of tanks, part taking 5 volts, the balance taking 10.



Method of Connecting Dynamo, Tanks, and Instruments. Three-Wire System.

SECTION XII

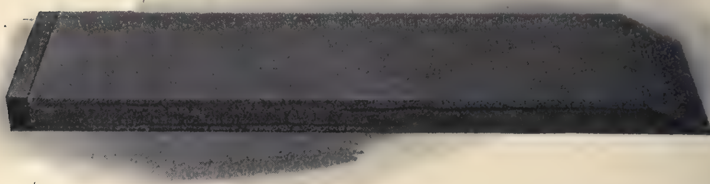
MANAGEMENT OF A MODERN PLATING DYNAMO

Location.—It is necessary, for successful operation, that the dynamo be located in a clean, dry place, preferably of low temperature, and that the foundation or pier upon which the machine rests, be substantially constructed of such material as will reduce the vibration to a minimum.

Field Rheostat.—A rheostat is necessary in the field of the dynamo, where it will control the voltage along the entire line of connection, enabling an initial current strength to be maintained, while the tank rheostats further reduce this current to the proportions required.

The field rheostat affects the voltage by setting a fixed resistance in the field of the dynamo, but does not affect the ampere capacity, except in a small degree. On the other hand, a rheostat placed between the main line and tank affects both voltage and amperes, reducing the latter in same proportion as the former is cut down.

Contacts, Cleanliness.—It is important that all contacts and connections of main lines, field coils, and rheostats be kept clean and bright in order to obtain the least resistance and best possible conductivity. Bolts and screws used for connecting should be examined frequently for perfect contact. Loose connections offer resistance, cause heating of the conduct-



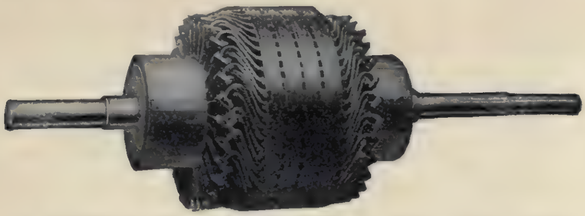
Woven-Wire Dynamo Brush.

These brushes, made of high conductivity gauze, are the best preventive of sparking or scoring the commutator.

ors, arcking, and, in some cases, the entire breaking of the circuit by being burned off, through not having sufficient cross-section of conductor at the weak point to carry the required amount of current. The heat of the arc being very intense, a small one, if allowed to continue for a short time, will melt a very large conductor. Copper conductors, if not of sufficient cross-section, heat readily. Wrenches, hammers, oil cans, etc., should not be left near the dynamo, as they often cause serious trouble, either from vibration or the force of magnetism.

Grinding of Brushes.—The brushes should not be permitted to bear so hard on the commutator that they grind, as this will cause a copper dust to accumulate on the commutator, causing much trouble, injuring the insulation of the commutator and field coils.

The brushes must be set with sufficient tension to take up the current from commutator, but under no circumstances should they bear so hard on commutators that they grind.



A Multipolar Type Armature having Two Commutators.

The Armature.—Too much care cannot be exercised in handling the armature, as from the manner of construction—the mounting of wires upon a shaft—they are susceptible to any blow or unusual strain, which might cause an abrasion of the wires or a shifting from their true position.

When handling the armature it is advisable to use only rope and wooden bars, the bars to be placed under the body. It should be handled by the shaft as much as possible, never by the commutator; nor should the weight of the armature, under any circumstances, rest upon the commutator.

Field Magnets.—If the field magnets, yoke, or pole-pieces have been removed, the joints should be thoroughly cleaned before replacing, then bolted together as tightly as possible. Imperfect joints, as well as dirt between iron in a magnetic circuit, cause resistance to the flow of magnetism, which resistance, if increased, diminishes the efficiency of the machine.

Bearings.—An unusual heating of the bearings is especially noticeable when the boxes, or sleeves, have been replaced after having been removed for an examination. It is almost impossible to replace the boxes in their exact previous position, and, like a new bearing, they should be carefully watched, the machine being allowed to run slowly for a short time until the bearings reach the proper temperature and the shaft runs evenly. New dynamos are very apt to heat abnormally for the first few days. They should be carefully watched and liberally supplied with oil during that time, after which they should run at normal temperature. After a dynamo has been running a short time under full load, its armature imparts a certain amount of heat to the bearings; a little more to the bearings on the commutator end of shaft; beyond this there is no excuse for excessive heating. The latter may result from a variety of causes, some of which are given in the following, with remedies for same:—

Cause.—Poor quality of oil, presence of dirt or gritty matter in the oil.

Remedy.—The speed at which a dynamo runs calls for the use of a perfect lubricant, and only those oils adapted to the requirements should be used. The special requirements of a good oil are: sufficient body to keep the surfaces between which it is interposed from coming into contact under the greatest pressure, and the greatest adhesion to metallic surfaces. Mineral oils are superior. The fluidity should be as great as is consistent with the above conditions.

Cause.—Journal boxes too tight.

Remedy.—Tight journal boxes produce excessive friction; the bolts should be removed, a small piece of cardboard of the proper size and thickness inserted, and the box again bolted down.

Cause.—Rough journals—badly scraped boxes.

Remedy.—Rough journals are generally caused by foreign substances carried in with the oil. When so injured, the boxes should be taken out and re-scraped; care must be exercised to scrape the complete exposed surface of the box.

Cause.—Belt too tight (a frequent cause of trouble).

Remedy.—The belt governs the speed of the dynamo, thus regulating the voltage, and for successful running it must fulfill several conditions. The best possible belt is an endless one, perfectly straight and of equal thickness. When lacing a belt the ends should be cut at right angles to the sides, and holes made oval in shape, lengthwise to the belt. The lacing should be started at the center and carried to each edge, to give uniform strength; never cross the lace on the inside of the belt. Long centers between the driving and driven pulleys are desirable, as the belt can run much slacker; 10 to 15 feet is a good average. The belt should be arranged to pull from the underside of the dynamo pulley, its weight with the large circumferential contact developing a greater transmitting power. Tight belts, as well as vertical belts, are very objectionable, the former producing a very unevenly distributed strain upon the bearings and greatly increasing the wear. A vibrating ammeter needle indicates that the belt is slipping and not carrying its proper load, and should be taken up; while a failure to maintain the standard voltage, with the proper resistance in the fields, indicates that the speed of the dynamo is not high enough, and that the belt should be tightened.

Cause.—Bearings out of line.

Remedy.—Bearings out of line will generally show by the belts running over the side of the pulley, or sometimes the belt will be thrown out of line by an uneven setting of the dynamo.

Cause.—Overload on dynamo.

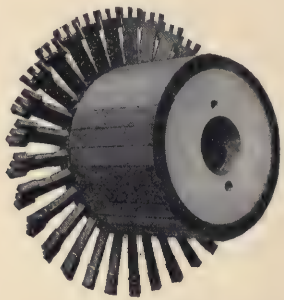
Remedy.—When a dynamo is overloaded it may readily be detected by the ammeter, which will register higher than the rated capacity of the machine. There is also an excessive heating of the bearings, armature, and field coils, as well as sparking at the commutator. The dynamo should be immediately relieved, for, beside the injury liable to the machine itself, the overload causes an extra strain upon the belt, which, of course, impairs it for the regular load.

Cause.—Bent armature shaft.

Remedy.—Bent armature shafts are of rather rare occurrence, but when one becomes bent it should be straightened by a skillful machinist. An armature running untrue is dangerous, as the mounted wires are liable to strike the pole-pieces and cause considerable damage.

The Commutator.—There is no portion of a dynamo which requires more care and attention than the commutator and brushes. Although it is a comparatively easy matter to keep these parts in proper working order, in many plating rooms the condition of the dynamo shows absolute negligence or ignorance on the part of the attendant in charge.

A commutator in good condition should present a smooth, glazed or polished, dark brown or chocolate-colored appearance, and have a true circumference. The latter can be readily tested by allowing the back



Commutator.

of the finger nail to rest upon it when in motion; the nail being very sensitive to any irregularity, the condition is at once indicated. Grooves and ridges cut in the commutator are caused by using brushes with hard burnt ends, which are not pliable, also by too great pressure of the brushes upon the commutator. Sparking at the brushes is expensive and detrimental, chiefly because it results in burning the brushes and commutator. Every spark consumes a particle of copper, torn from the commutator or brushes. The longer the sparking continues, the greater the evil becomes, and the remedy should be applied without delay.

Lubricating Commutator.—An excellent method of lubricating the commutator is by the use of a piece of soft felt, called a "felt oiler." This should be the full length of the commutator and shaped to fit snugly between the brush holder and commutator, as shown in the illustrations on pages 224 and 225. The felt should be kept moist (not saturated) with a good quality cylinder oil. In this manner the oiler will keep the commutator properly lubricated, while at the same time it will take up any particles of dust or grit that may get on it.

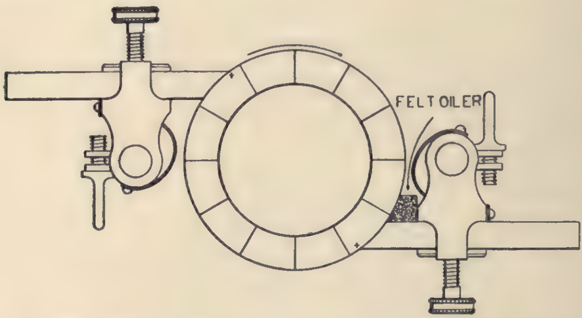
Causes of Sparking and Remedies.

Cause.—Brushes not set at the neutral point.

Remedy.—The brushes having been previously set diametrically opposite, they can be readily adjusted by moving the rocker arm backward or forward, until the non-sparking point is found.

Cause.—Brushes not set diametrically at opposite points.

Remedy.—Great care must be taken to have the brushes set diametrically opposite each other before starting, as their readjustment while running is troublesome. If any individual brush sparks while the other brushes are working perfectly, it is out of alignment. To adjust, shift brush in holder and ascertain non-sparking point by trial.



Correct Position of Brushes on Commutator of a Bipolar Dynamo, showing Felt Oiler in place.

Cause.—Brushes set so as not to get full bevel to the circumference of commutator.

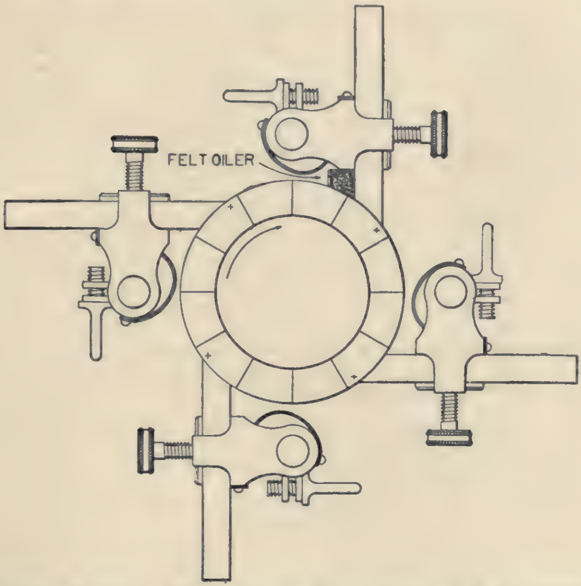
Remedy.—Readjustment must be made to secure full contact of the face of brush on commutator at proper bevel.

Cause.—Brushes set with insufficient pressure.

Remedy.—This fault can be remedied by increasing the tension on the spring of the brush holder.

Cause.—Face of brushes spread apart and filled with oil and dirt.

Remedy.—Oil, copper dust, and dirt will accumulate between the wires of the brushes and spread the ends apart. All this can be removed by thoroughly washing the brushes in benzine, or in a hot solution of sal soda or strong potash water.



Correct Position of Brushes on Commutator of a Multipolar Dynamo, showing Felt Oiler in place.

Brushes so badly burned that pliability is lost, should be thrown away; but if still pliable and of sufficient length, cut off the burnt portion and file to proper bevel.

Commutator Bar Loose, High, or Low.

Remedy.—A single high bar in the commutator will vibrate the brush, causing poor contact and consequent sparking. A heavier tension must be applied to the spring of the brush holder until the dynamo is stopped, when it can be repaired.

If commutator bars are loose, screw up the ring or nut at the end of the commutator.

If a bar is high, set it down in place with a wooden mallet, and screw up the end nut.

If a bar is low, screw the end nut firmly in place, and turn the commutator true in a lathe.

Cause.—Loose connection between armature coil and commutator bar.

Remedy.—A loose or broken connection between commutator and armature coil will cause a peculiar, blue snapping spark, just as the bar leading to it is passing under the brush. This will show itself on the particular bar having the loose connection. The dynamo should be stopped as soon as possible and the connections of armature examined, and any loose joints properly soldered.

Cause.—Section short-circuited either in the commutator or armature coils.

Remedy.—This requires a thorough examination of the insulation of the commutator and armature, and probably a rewinding of some of the coils.

Cause.—Armature damp, with consequent short-circuiting coils.

Remedy.—It can be generally dried out by placing it near a source of heat.

Cause.—Short or cross on the dynamo mains.

Remedy.—A cross will cause the brushes to spark and sputter severely. It may be either burned off or the main switch opened until the trouble is removed.

Cause.—Commutator dirty, oily, rough, worn in ridges, or out of true circumference.

Remedy.—Oil or dirt can be wiped off with a piece of canvas or waste; then polish commutator with fine sandpaper. If ridges are worn in the commutator, it must be turned down in a lathe. Never use emery cloth.

Cause.—Dynamo overloaded.

Remedy.—This cause of sparking is easily detected at the ammeter. A larger dynamo should be used.

Cause.—Armature coils or commutator sections short-circuited by accumulation of copper dust.

Remedy.—The accumulation of copper dust on a dynamo, and its gradual penetration into the coils of the armature and fields, is often the real cause of serious accident and expensive repairs. This is one of the principal features which denotes carelessness on the part of the operator.

The dynamo must be kept clean of copper dust and oil.

General Faults.

Burning Out of Armature Coils.—This may be occasioned by overloading the armature, causing the insulation of the coils to give way, and is indicated by the armature suddenly beginning to smoke. The armature is thus rendered useless, and should be returned to the maker for repairs.

Ring of Fire Around the Commutator.—This is caused by small particles of copper dust between the bars of the commutator making a local short-circuit from bar to bar across the mica insulation. To remedy it, clean the commutator carefully, and do not allow the brushes to cut and scratch it.

Reversal of Polarity of the Field Magnets.—This sometimes occurs, especially where several dynamos are located near each other, the strong field of a dynamo while running, reversing the weak polarity of a dynamo shut down; sometimes the return current from the tank will reverse the polarity of the fields. The polarity can be changed by sending the current from another dynamo or battery around the field coils in the proper direction, thus saving the trouble of changing the tank connections.

SECTION XIII

TABLES AND GENERAL INFORMATION

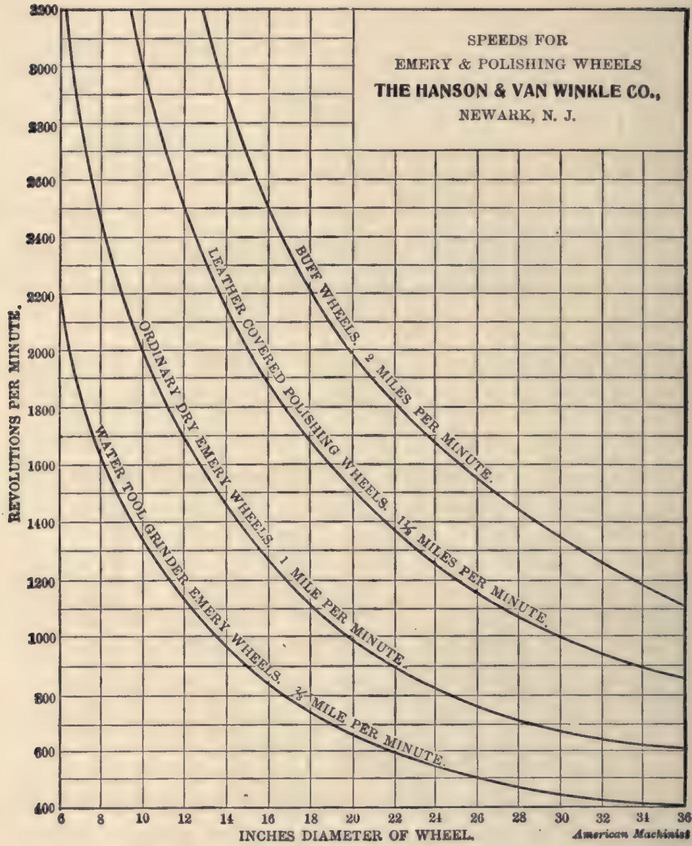
APPROXIMATE SPEEDS FOR EMERY AND POLISHING WHEELS

There can be no set rule for the speeds of emery and polishing wheels, owing to so great a variety of work to be done.

The speeds generally considered by experts to give best results can be determined by the chart, page 230. Trace a vertical line from the figure representing the diameter of the wheel to the curved line and from the intersection point, a horizontal line to the figure, which will give the r. p. m.

RULES FOR SPEED

To Find Speed of Countershaft in Accordance with Main Shaft and Machine.—Subtract the number of revolutions of the main shaft from the number of revolutions the machine should make; divide the remainder by two. The quotient will show the number of revolutions of the countershaft.



Example.—The main shaft runs 200 revolutions per minute, while the machine should run 1,000 revolutions per minute. Deduct 200 from 1,000, leaving

800, which divide by two; the quotient will then be 400, which is the number of revolutions the countershaft should make.

To Find Diameter of Pulley on the Main Shaft.—Multiply the diameter in inches of the receiving pulley of the countershaft by the number of revolutions the countershaft should make, and divide the product by the number of revolutions the main shaft makes.

Example.—The countershaft runs 400, the receiving pulley is 7½ inches in diameter, and the main shaft runs 200; 400 times 7½ equals 3,000, which, divided by 200, equals 15; this is the diameter of pulley on main shaft in inches.

To Find Diameter of Pulley on Countershaft Carrying Belt to Machine.—Multiply the number of revolutions the machine should make by the diameter of pulley of machine and divide by the number of revolutions the countershaft makes.

Example.—Say machine should make 1,000 revolutions, the diameter of pulley on machine being 6 inches, and the countershaft making 400 revolutions, then multiplying 1,000 by 6 equals 6,000; dividing this by 400 gives 15, which should be the diameter of pulley carrying belt from countershaft to machine.

To Find Speed of a Machine.—Multiply the number of revolutions of the main shaft by the diameter of pulley in inches, and divide by the diameter of receiving pulley of the countershaft. The result is speed of countershaft. Then multiply the number of revolutions of countershaft by diameter of transmitting pulley, and divide by diameter of pulley on machine. The result will be speed of machine. It should be well understood that no other pulleys but those in contact with one belt should be considered.

To Find the Horse Power a Belt will Safely Transmit.—Multiply diameter of pulley in inches by its revolutions per minute and the product by width of belt in inches. Divide this product by 3,300 for single belting or 2,100 for double belting, and the quotient will be the horse power that can be safely transmitted.

To Find the Length of the Belt.—Add the diameters of the two pulleys, divide by 2 and multiply by 3.1416. To this add twice the distance between centers of pulleys. This is practically correct where pulleys are not very different in size, and are to run with short belt.

A belt velocity of 2,600 per minute is said to give the best results.

All belts should run as nearly horizontal as possible.

ANTIDOTES FOR POISONS

Sulphuric, nitric, hydrochloric, or glacial acetic acids require magnesia, chalk, whiting, limewater, or carbonate of soda administered, stirred up with water.

Caustic alkalies require vinegar or the juice of an acid fruit or extremely dilute acetic, citric, or tartaric acids.

Arsenic,—Freshly made hydrated ferric oxide with magnesia.

Copper,—White of egg mixed with water and plenty of milk.

Cyanides,—Freshly precipitated peroxide of iron with potassium carbonate, coldest water poured over head and down spine.

Lead,—A very dilute solution of sulphuric acid.

Mercury,—White of egg mixed with milk, the white of one egg to each four grains of mercury chloride taken.

Oxalic acid and oxalates,—Limewater or chalk may be used, but alkaline carbonates must not be used.

Silver nitrate,—Common salt in solution.

Zinc salts,—Warm barley water may be taken.

In all above cases the application of special remedy must be preceded by the use of strong emetics, except in strong acids, when water should be taken to dilute acids before inducing the vomiting.

For burns and scalds, around the plating room and elsewhere, wet the part with cold water, and sprinkle with bicarbonate of soda (baking soda); the relief is instantaneous and permanent.

SOME OF THE CHEMICALS USED IN ELECTRO-PLATING, HAVING TWO OR MORE NAMES

Technical Name.	Common Name.
Acetate of copper	Distilled verdigris.
Acetate of lead	White sugar of lead.
Arsenous acid	White arsenic.
Bicarbonate of soda	Baking soda.
Bichloride of mercury	Corrosive sublimate.
Boric acid	Boracic acid.
Carbonate of lead	White lead.
Carbonate of potash	Salts tartar.
Carbonate of soda	Sal soda, soda crystals.
Chloride of ammonia	Sal ammoniac.
Chloride of antimony solution	Butter of antimony.
Ferric chloride	Chloride of iron.
Ferric oxide	Oxide of iron.
Ferro cyanide potash	Yellow prussiate potash.
Hydrochloric acid	Muriatic acid.
Hydrocyanic acid	Prussic acid.
Hydrofluoric acid	H. F. acid.

Technical Name.	Common Name.
Muriate of ammonia	Powdered sal ammoniac.
Muriate of soda	Common salt.
Nitrate of potash	Saltpeter.
Oxide of tin	Putty powder.
Single sulphate of nickel	Single nickel salts.
Sulphate of nickel and ammonia	Double nickel salts, nickel salts.
Spirits sal ammoniac	Muriatic acid.
Stannous chloride	Chloride of tin.
Sulphate of copper	Blue vitriol, blue stone.
Sulphate of iron	Copperas.
Sulphate of soda	Glauber's salt.
Sulphate of zinc	White vitriol.
Sulphuric acid	Oil of vitriol.
Sulphuret of potash	Liver of sulphur.

ROUND COPPER WIRE AND ROD

Approximate Weights per Lineal Foot

1/16 in. diam.	– .01155 lbs.	13/16 in. diam.	– 1.998 lbs.
1/8 " "	– .047 "	7/8 " "	– 2.318 "
3/16 " "	– .106 "	15/16 " "	– 2.660 "
1/4 " "	– .189 "	1 " "	– 3.03 "
5/16 " "	– .296 "	1 1/16 " "	– 3.42 "
3/8 " "	– .426 "	1 1/8 " "	– 3.831 "
7/16 " "	– .579 "	1 3/16 " "	– 4.269 "
1/2 " "	– .757 "	1 1/4 " "	– 4.723 "
9/16 " "	– .958 "	1 1/2 " "	– 6.811 "
5/8 " "	– 1.182 "	1 3/4 " "	– 9.27 "
11/16 " "	– 1.431 "	2 " "	– 12.108 "
3/4 " "	– 1.703 "		

ROUND BRASS TUBING USED FOR TANK RODS

Approximate Weights per Lineal Foot

1/2 inch O. D. Wall No. 12 B & S Gauge	– – – .39 lbs.
5/8 " " " " 10 " "	– – – .61 "
3/4 " " " " 10 " "	– – – .76 "
7/8 " " " " 10 " "	– – – .91 "
1 " " " " 10 " "	– – – 1.06 "
1 1/8 " " " " 10 " "	– – – 1.20 "
1 1/4 " " " " 10 " "	– – – 1.35 "

To ascertain the weights of copper tubing add 5% to the above.

Avoirdupois Weight

	=Ounces.	=Drachms.	=Grains.	=Grammes.
1 Pound........	16	256	7,000	453.25
1 Ounce........	1	16	437.5	28.33
1 Drachm,......	0.062	1	27.34	1.77

Troy Weight

	=Ounces.	=Penny-weight.	=Grains.	=Grammes.
1 Pound,........	12	240	5,760	372.96
1 Ounce,........	1	20	480	31.08
1 Pennyweight,..	0.05	1	24	1.55

Apothecaries' Weight

	=Ounces.	=Drachms	=Scruples.	=Grains.	=Grammes
1 Pound,..........	12	96	288	5,760	372.96
1 Ounce,..........	1	8	24	480	31.08
1 Drachm,........	0.125	1	3	60	3.88
1 Scruple,........	0.042	0.33	1	20	1.29

Imperial Fluid Measure

	=Quart.	=Pints.	=Fluid Ounces.	=Fluid Drachms.	=Minims.
1 Gallon,	4	8	160	1280	76,800
1 Quart,	1	2	40	320	19,000
1 Pint,	0.5	1	20	160	9,600
1 Fluid Oz.,	0.025	0.05	1	8	480
1 Fluid Drachm,	0.0031	0.0062	0.125	1	60
1 Minim,	0.00005	0.0001	0.0021	0.0167	1

Imperial Fluid Measure—Continued.

	=Weight in Grains.	=Cubic Inches.	=Liters.	=Cubic Centimeters.
1 Gallon,	70,000	277.276	4.541	4,541
1 Quart,	17,500	69.319	1.135	1,135.2
1 Pint,	8,750	34.659	0.567	576.6
1 Fluid Oz.,	437.5	1.733	0.0284	283.8
1 Fluid Drachm,	54.7	0.217	0.0035	35.5
1 Minim,	0.91	0.0036	0.00006	0.59

LIST OF VARIOUS ARTICLES SHOWING PRICES USUALLY CHARGED FOR ELECTRO-PLATING

Silver Plating Tableware

		Single.	Double.	Triple.
Tea Spoons....................	[six pieces]	$0.75	$1.00	$1.25
Dessert Spoons.................	"	1.25	1.50	2.00
Table Spoons..................	"	1.50	1.75	2.50
Table Forks...................	"	1.50	1.75	2.50
Dessert Forks.................	"	1.75	2.50	3.25
Knives, steel handles...........	"	1.50	2.25	3.00
Knives, ivory or rubber handles..	"	1.25	1.75	2.25
Butter Knives.................	[single piece]	.30	.40	.50
Sugar Shell....................	"	.30	.40	.50
Sugar Tongs...................	"	.35	.50	.70

Silver Plating Watch Case

Hunting Case.............................	each	$0.75 to	$2.00
Open Face................................	"	.50 to	1.00
Watch Charm..............................	"	.75 to	2.00

Carriage Trimmings—Silver Plating

Lamps............................	per pair,	$4.00 to	$12.00
Axle Nuts.........................	per set,	.50 to	3.00
Singletree Tips....................	each,	.50 to	.75
Sulky Rails........................	"	1.00 to	1.50
Crab Yoke.........................	"	1.50 to	2.50
Hearse Rails.......................	per foot,	.50 to	.75
Brackets..........................	each,	.50 to	.75
Door Handles......................	"	.65 to	1.50
Hub Bands.........................	"	1.00 to	2.00

Miscellaneous Silver Plating

Soda Fountains	each,	$3.00 to	$40.00
Communion Sets	"	12.00 to	15.00
Bell Pulls	"	.50 to	1.25
Door Knobs	per set,	1.00 to	2.00
Candle Stands	each,	1.50 to	3.00
Faucets	"	.50 to	1.50
Ticket Punches	"	.50 to	1.00
Dog Collars	"	2.00 to	4.00
Casters	"	2.00 to	4.00
Goblets	"	.70 to	1.50
Cups	"	.50 to	1.25
Cake Baskets	"	1.50 to	4.00
Card Receivers	"	1.20 to	4.00
Celery Stands	"	1.25 to	2.25
Fruit Stands	"	.25 to	4.00
Oyster or Soup Tureens	"	4.00 to	6.00
Pickle Stands, double	"	1.25 to	2.20
Butter Dishes	"	.50 to	2.25
Sugar Bowls	"	1.25 to	2.00
Coffee Pots	"	2.50 to	6.00
Tea Urns	"	2.00 to	3.50
Call or Tea Bells	"	.50 to	1.25
Door Plates	"	.75 to	2.00
Cream Pitchers	"	1.00 to	2.50
Spoon Holders	"	1.25 to	2.00
Napkin Rings	"	.30 to	.75
10 Inch Trays	"	1.00 to	2.00
12 " "	"	1.50 to	2.50
15 " "	"	2.00 to	3.00
18 " "	"	3.50 to	4.00
21 " "	"	3.00 to	4.00
24 " "	"	4.00 to	6.00
40 " "	"	6.00 to	10.00
45 " "	"	10.00 to	15.00
Common Goblets	"	1.00 to	2.00
Baptismal Bowls	"	2.50 to	5.00

Mouth Pieces, small	each,	$0.25 to	$0.50
" " large	"	.50 to	1.00
Gilding Cornet Bells	"	1.50 to	3.00
Sword Hilts, Scabbards and Belt Trimmings	"	1.25 to	3.00
Bracelets	per pair,	.50 to	1.00

Gold Plating Watch Cases

Hunting Cases	each,	$1.00 to	$5.00
Open Face Cases	"	.75 to	3.50
Watch Case Caps	"	.25 to	.50

Miscellaneous Gold Plating

Ear Rings	per pair,	$0.50 to	$1.00
Sleeve Buttons	"	.50 to	1.00
Bracelets	"	1.00 to	4.00
Slop Bowls, inside	each,		1.50
Cream Pitchers, "	"		1.00
Spoon Holders, "	"		1.00
Goblets, "	"	.50 to	.75
Cups, "	"	.25 to	.50
Baptismal Bowls, "	"		3.00
Salt Cellars, "	"	.25 to	.50
Tobacco Boxes, "	"	.35 to	.50
Pins	"	.50 to	1.00
Finger Rings	"	.50 to	1.50
Pistols	"	3.00 to	5.00
Opera Glasses	"	1.50 to	5.00
Combs	"	.50 to	2.00
Teaspoon Bowls	doz.,	2.00 to	2.50
Sugar Shells	each,	.25 to	1.50
Spectacles	per pair,	1.00 to	1.75
Cane Heads	each,	1.50 to	4.50
Crosses and Charms	"	.50 to	1.25
Military Buttons	"	.15 to	.50
Uniform Badges	"	.25 to	1.50
Sword Hilts	"	1.00 to	2.00

Swords, Hilts, and Blades	each	$2.00 to	$4.00
Saber Trimmings	"	.50 to	1.50
Harness Buckles	"	.25 to	.75
Bits	"	1.00 to	2.50

Nickel Plating

Knives	per set—six pieces,	$0.60 to	$1.50
Forks	" "	.60 to	1.50
Tea Spoons	" "	.50 to	1.60
Table Spoons	" "	.60 to	1.25
Carving Knives and Forks	per set,	1.25 to	3.50
Soup Ladles	each,	1.00 to	2.20
Nut Picks	"	.75 to	2.50
Napkin Rings	"	.25 to	1.00
Bell Pulls	"	.25 to	1.00
Door Knobs	per set,	.50 to	1.75
Faucets	each,	.25 to	1.00
Ticket Punches	"	.25 to	1.00
Dog Collars	"	.25 to	.75
Bracelets	per pair,	.25 to	.75
Pistols	each,	1.00 to	2.50
Soda Fountains	"	1.75 to	25.00
Candle Holders	"	1.75 to	2.50
Mouth Pieces, small	"	.50 to	.75
Casters	"	1.50 to	3.50
Coffee Pots	"	1.00 to	4.00
Tea Urns	"	1.00 to	3.00
Bits	"	.25 to	2.50
Smoothing Irons	"	.15 to	.50
Stove Lifters	"	.05 to	.35
Bicycle Handles	"	.50 to	1.25
All Parts of Bicycles	"	5.00 to	10.00
Coffee Heaters or Urns	per gallon,		1.00

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