ELECTROPLATING SOLUTIONS

BARREL PLATING

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DEFINITION

In barrel plating a bulk work load is tumbled in a rotating vessel incorporating electrical contacts to attract metals out of solution onto the work. This is the most effective method for treating bulk parts and any pieces which do not require individual handling. The work-pieces, in effect, are part of the plating equipment because they become bipolar electrical contacts to the other pieces in any work load. This inherent feature greatly contributes to the higher efficiencies experienced in barrel plating since the entire surface of the work load, in the current path at any time, is in cathode contact.

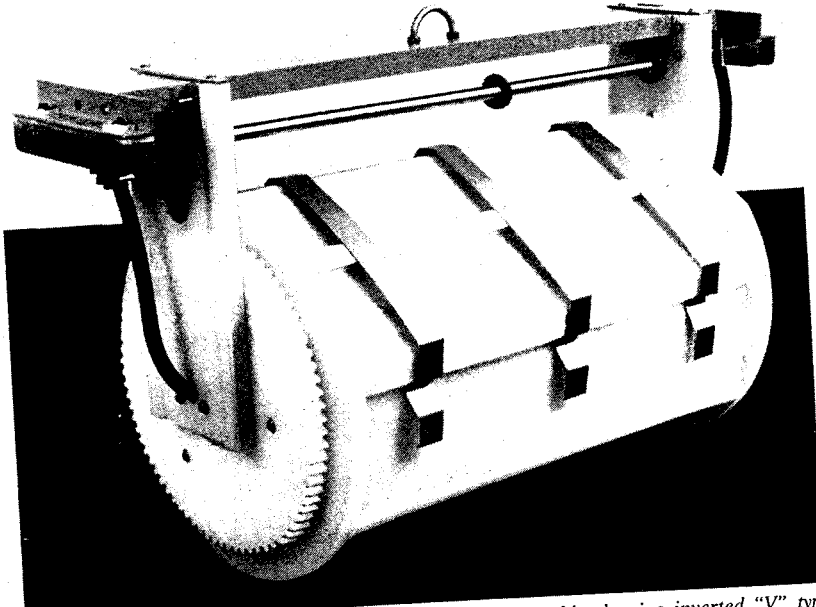

Fig. 1. Typical horizontal barrel and superstructure assembly showing inverted "V" typ contacts.

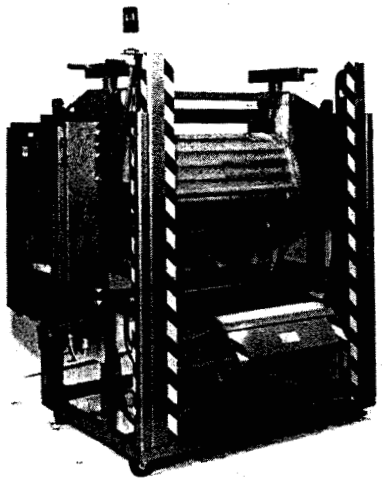

Fig. 2. Fully automatic load/unload system with integral door barrel assembly for "hands off" operation.

ADVANTAGES

The major advantage of barrel plating is higher efficiency. Other advantages are many and interrelated. The relatively large cathode contact area allows faster, large volume production when ample current is provided. The space required and equipment dollars invested for a barrel plating line are both less than that required for a rack or other type plating line of similar capacity.

A most significant "on going" advantage of barrel plating is the elimination of expensive labor costs necessary in racking, handling and transferring of each workpiece or part from one operation to another individually. In barrel plating, the work remains in the same vessel for other operations including: cleaning, electrocleaning, rinsing, pickling, chromating, or sealing. This is possible because the barrel equipment is of mostly chemically inert construction, able to be used in various acid and alkaline solutions.

Barrel plating has the greatest versatility in the variety, type, and size of parts which can be processed in the same equipment. Special "formed" anodes based on the individual part type or shape and other "purpose-built" equipment is generally not required, as in rack plating and other type operations.

The tumbling and cascading of the work load, due to barrel rotation and the constant bipolar electrical action through part contact, generally results in a more uniform plate than is possible in rack plating. Agitation of the tank solutions is inherently caused by the barrel motion yielding a more homogeneous bath and minimizing any potential stratification. Additional agitation equipment is not required.

ORIGINS AND EQUIPMENT

Barrel plating methods originated in the post Civil War era with equipment adapted from readily available wooden barrels or kegs. The initial evolution lasted into the first three decades of this century culminating with now familiar basic designs.

Available equipment varies widely, but generally conforms to two major configurations. These are horizontal barrels and oblique barrels. Horizontal units are the most common, being generally adaptable to a greater variety and capacity of work. While rotation about a horizontal axis is universally used, many construction, component and feature variations improve the use for a variety of plating applications. Features which allow platers greater productivity levels include: cylinders designed for maximum load volumes (See Fig. 1) without changing the size or capacities of related or interacting equipment; extra large (diameter

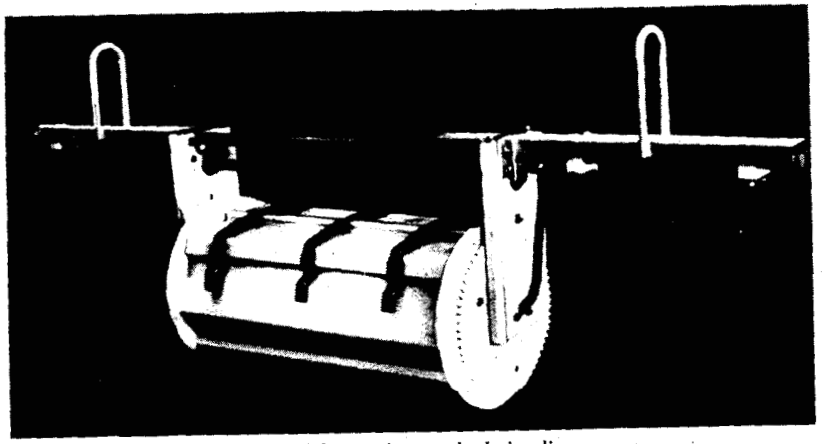

Fig. 3. Barrel assembly equipped for use in a rack plating line.

and/or length) horizontal type cylinders; high efficiency, positive, electrical contacts (allowing continuous operation of an individual unit at over 1400 A without overheating); and various automatic handling, load and unload features to further reduce labor requirements (See Fig. 2). Other cylinder and equipment system enhancements reduce cycle times, dragout and maintenance requirements. Optional equipment types are many, including horizontal barrel assemblies manufactured to operate in existing rack plating installations (See Fig. 3).

Another type unit is the horizontal "oscillating" barrel. Motion is limited to a 180°, back and forth rocking action, rather than 360° full rotation. These barrels are open on top, and have no doors or clamps. The motion is more gentle for very delicate parts; however, because agitation and tumbling of parts is not as vigorous as full rotation, care must be taken to avoid "nonuniform" plate results (especially of parts that tend to nest). To avoid spillage and loss, processing is limited to smaller loads, because of the always open top. The oscillating barrel is utilized much less today, largely because platers use slow rotational speeds on full rotation units to obtain the same benefits. Many older installations of this type have been converted to full rotation machines.

The second major barrel equipment style, the oblique barrel, incorporates a rotation mechanism which generates a tumbling action around an axis tilted from the vertical to a maximum 45° (beyond which angle capacity diminishes.) The feature of oblique barrels is the elimination of handling doors, or closure devices. The top being open, loading and unloading are accomplished by tilting the rotational axis to the necessary position. Unfortunately, as with 180° horizontal oscillating barrels, this compromise results in relatively small work loads and reduced tumbling action. Today platers can take advantage of fully automatic doors on full rotation horizontal barrels to accomplish the same requirements with greater ease and production.

FINISH TYPES

All common types of plating are known to be done in barrels. These include zinc, (alkaline and acid in various chemical systems), cadmium, tin, copper, precious metals, nickel (both electroless and standard), and even chrome (where ample current is available with continuous contact and when gentle part contact is not a problem). The capability of equipment to plate a particular finish and function in the required solutions and temperatures determine its usefulness. Adaptability to produce a variety of finishes is accomplished on some equipment, though most plating lines are dedicated to one finish type. Any single line producing more than one finish type must effectively control the effect of different plated metals in rinse, sealer, chromate and cleaner tanks.

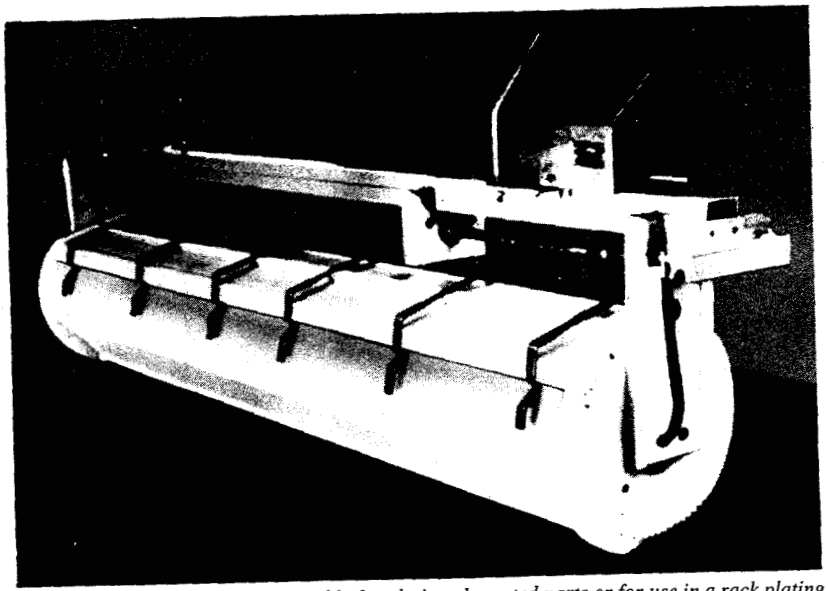

Fig. 4. Special length barrel assembly for plating elongated parts or for use in a rack plating line.

WORKLOAD

Considerations for applying given finishes on a particular part in barrels must be based on finish function (i.e. part and use), part configuration, size, weight, area, and barrel equipment and system features, and capabilities.

Plated finish functions are of three basic types:

1. Engineering applications for dimensional requirements and/or as a bearing surface.
2. Decorative plating for appearance to enhance the value of the base material.
3. Corrosion protection to increase or maximize the useful service life beyond performance of the unplated base material.

In large proportion, a combination of these three basic functions is required. Fewer engineering plating requirements are met with barrel plating, while decorative plated parts are successfully barrel plated when surface effects are controlled to an acceptable level. Barrel plating is most commonly used for finishing parts for corrosion protection.

Part configuration affects the ability of work to be successfully barrel plated. Generally, individual parts less than one pound in weight and less than 25 cubic inches in volume are barrel plated.

WORK LOAD CONSIDERATIONS

A simple shape is obviously easiest to barrel plate. Yet barrel plating is the only successful, cost effective way to uniformly plate threaded parts or fasteners. The making and breaking of electrical contact throughout the tumbling load on these type parts assures the most even coverage on the root, mean diameter, and crest of the individual threads.

Whether the work is bolts, nuts, stampings, forgings, or castings, check that the material is not adversely affected by any cleaners or baths required in the total plating cycle. In evaluating the barrel method of plating for any potential part, a trial load is a most useful decision making tool.

Entangling or long parts such as rods, bars, or tubes are successfully barrel plated (See Fig. 4). Methods used include long barrels; compartments; rocking motion; or special contacts.

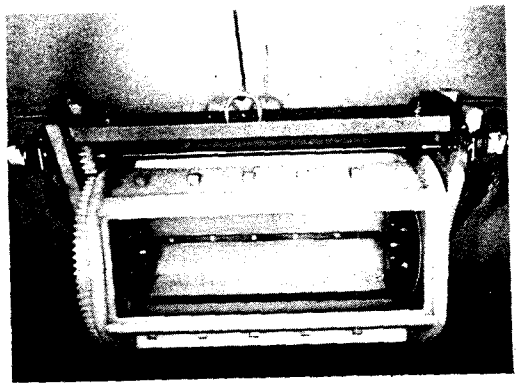

Fig. 5. Barrel interior showing disc and strip type contacts.

Disc and strip or other comparable stationary style cathode contacts can be used to plate small, delicate, or nesting parts (i.e. electronic components, etc.). These alternate type contacts prevent damage and assist in tumbling the load (See Fig. 5). Plating any of the above type parts can be more easily facilitated by including a reversing switch and adjustable control timer on the barrel drive to alternately rotate the cylinder in each direction one to three rotations.

Parts that may be both flat and lightweight should be plated in barrels with convoluted interior surfaces that are not continuously flat and smooth. An uneven barrel interior promotes tumbling and prevents sticking.

When finishing recessed and cupped parts, other smaller parts may be mixed in the same load to better provide contact into the recessed areas; however, post plating separation costs must not be prohibitive and the smaller parts used must either be acceptably plated or not adversely affected.

EQUIPMENT METHODS

The barrel equipment, whether horizontal, oblique, or other design, must contain features to maximize the productive capability of the method. Ease of maintenance and minimal labor requirements should always be design factors of well manufactured components and systems.

For the majority of plating, flat sided barrels are best, especially when the interior surface is configured to eliminate sticking and promote tumbling of the work. Round barrels don't produce "pumping action". It is a benefit of rotation of flat sided cylinders. Pumping action constantly replaces "metal depleted" solution inside the barrel with fresh solution from the rest of the tank. Round barrels do not tumble parts as effectively as flat sided barrels. The situation can be alleviated, somewhat, with tumbling ribs, cross bars, or load breakers of various types. Most oblique type barrels incorporate uneven or "stepped" bottoms to aid the tumbling of the work.

Proper design will reduce costs for replacement parts. Barrel equipment using integral wear parts (such as hanger (support) arms with trunion hubs molded as one piece, or integral cylinder gears molded into the barrel end) should be avoided. The replacement of any "combination" component due to wear or failure requires replacement of the entire unit. Capability to replace individual components or worn parts significantly reduces costs.

Barrels should be constructed of relatively chemically inert materials for the applicable process. They should also be capable of continuous operation in excess of the maximum system bath temperature. High temperature capability assures integrity of the barrel assembly and sometimes, as an added benefit, allows faster plating. A barrel unit may expand and contract up to ⅜" in overall length due to temperature changes of baths in a plating cycle. Construction materials with different coefficients of expansion in the same assembly should be avoided.

Perforation size on barrel equipment must be specified relative to its use. Job shops generally obtain units with smaller openings to accommodate the widest range of potential parts. Captive shops many times have the luxury of using barrels with larger holes because they can more easily predict their minimum part size. Because of liquid surface tension, larger perforations usually exhibit faster drainage; easier exchange of "metal depleted" solution from inside the cylinder (due to the pumping action) and less dragout (carry out) contamination of adjacent tank solutions. Many shops have extra barrel assemblies on hand of different perforation sizes. They can plate a broad range of part sizes using the large hole barrels as much as possible and the smaller hole barrels when necessary.

It is very important that all barrels used on any single production line have the same open area ratio. Barrels plate by percentage of open area. The open area ratio relates the size and number of perforations to the undrilled panel area on a percentage basis. Using this foresight, a barrel with equivalent open area ratio can be used in the plating line, regardless of hole size, without the necessity of re-adjusting rectifier or current settings.

There are other special, optional perforation configurations available to the plater. These include herringbone, screen inserts, and slots which can be utilized for barrel plating small, straight or round pieces, (i.e. nails, pins, etc.).

Component features can substantially affect equipment performance and serviceability. On horizontal barrel assemblies an idler gear will ensure fully submerged plating for maximum current access to the work. "Fully submerged" barrel plating also minimizes potential for trapped hydrogen explosions. Idler geared units also ensure that the center of gravity of the cascading work load is best positioned to maintain electrical contact between the barrel superstructure and tank electrical contacts. Plastic (nonconducting) hanger arms eliminate the possibility of current/efficiency loss and "treeing". Simplicity of design on all barrel equipment, especially on any portions operating below the solution line, is most desirable for ease of maintenance. Assembly fasteners should be high alloy or nonreactive to the chemical system in use.

Contributing to the variety of work which can be barrel plated are the several styles of interior electrical contacts available. The flexible dangler (cable type) contact is most utilized. Best results are produced when the danglers are properly submerged in the work load to eliminate potential arcing, sparking, or burning. For rods or other long parts, disc, strip, center bar, cone, or other "stationary" type contacts will usually do a good job. Button, chain, and star contacts are other available types. A plate style contact is largely utilized in oblique barrel equipment.

Equipment features of tanks and hoists can enhance barrel system capabilities. Most tanks and systems are designed to maintain the solution level approximately 5" from the top rim. Therefore, the barrel portion of any equipment should run fully submerged at that level. One benefit of keeping the tank level to the 5" dimension is to minimize the chance of excess hydrogen accumulation (for some plating types) in the unsubmerged portion of the barrel interior. Fully submerged operation eliminates accumulation and reduces the potential for explosion. A solution level higher than 5" allows solution to be splashed out and lost or wasted during barrel entry, exit, and normal rotation.

Solution loss and adjacent tank contamination can also be greatly reduced by equipping the hoist system with a means of "up barrel" rotation. The barrel tumbles the load in the overhead, above tank, position. Up barrel rotation, as it is termed, facilitates drainage, especially when finishing cupped or complex shaped parts.

Greatest current densities at the work load are ensured by plating the tank anodes (including anode baskets or holders) in the closest possible proximity to the barrel exteriors without allowing structural or mechanical interference. For horizontal barrels, anodes that are contour curved to just clear the rotational outside diameter, can result in 10 to 20% current density increase.

Tank drive units on horizontal barrel equipment should be adjusted vertically to maximize drive gear engagement. If adjusted too high, however, the drive will "carry" the barrel assembly weight and full electrical contact between the tank and barrel superstructure is not possible. In addition, the drive shaft and bearings can wear prematurely if the weight of the