ZINC

The Science and Technology of the Metal, Its Alloys and Compounds

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Rolled Zinc for Photoengraving*

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The manufacture of photoengraving zinc begins with the spelter (virgin zinc) purchased from the refiner. The grades are especially picked for their low impurities. This material must be free from copper, tin, indium and aluminum. Some of these are present in most zinc ores, and careful control of the spelter, with respect to its character and origin, must be exercised. For two of the alloys manufactured the spelter must contain very small controlled amounts of iron to regulate the grain structure under elevated-temperature conditions in the final manufactured product. Each shipment of the spelter, once a supplier is established, is then very carefully analyzed before it goes into production.

* This section, through p. 528, by Mr. Somers.

The first operation in the manufacture of photoengraving zinc is the remelting of the spelter in electric induction furnaces. In these furnaces very accurate control of temperature and alloy is maintained. Here, the metal is alloyed with additions of cadmium, magnesium and manganese. These alloying elements are used in very minute quantities depending on the alloy and do not in general exceed two-tenths of one per cent in any case.

Once the metal is poured from these furnaces, the alloy, the width and the engraving surface are established. The molds are specially equipped to permit controlled cooling to give as perfect a slab, or bar of metal, as possible. These slabs are then inspected for defects. If passable, they are placed in an oven and held at a controlled temperature, depending on size and alloy, for rough rolling.

The slabs are progressively reduced from 2 inches to a thickness depending on the final gage which the finished product is to take. The edges of the resulting sheets are trimmed and the sheets cut into smaller sizes. Gage and quality are checked. After cooling to room temperature the material is cold-rolled on another mill. The rolls on this mill are of a high finish and the mill is built for very precise work. Sheets are accurately gaged as they leave this mill and are trimmed to their final width.

This material is then degreased and prepared for painting. The backs are painted with a special acid-, alkali-resistant material and then the sheets are baked and annealed at a temperature commensurate with the requirement for the particular alloy. After cooling, the sheets are ground in pairs on a wide-belt grinding machine.

These grinders use coated abrasive belts up to 50 inches in width. The face of the sheet is ground, washed, gauged and inspected. Defects found at this point can sometimes be corrected. If so, the material is corrected and reground; if not, the material is scrapped.

The next operation, polishing, is done on a similar machine. The coated abrasive belts used here are manufactured specifically for the producer of photoengraving zinc. The sheets are again cleaned and treated with a preservative to protect the finish from corrosion. They are then gaged and inspected. Sheets with defects at this point must be scrapped. The sheets are then sheared to smaller lengths, depending on customer requirements, inspected again, individually wrapped in tissue and kraft paper and placed in wooden shipping containers.

Because of the gage requirements and the perfection of surface finish necessary to the photoengraving industry, there is a large percentage of reject material throughout the operations. A quality-control laboratory is maintained to continually check all phases of the operation. Physical and chemical checks are taken at all points in the production cycle.

Rolled Zinc in Lithography. The modern commercial lithographic process is almost always referred to as "offset lithography." It is based on the principle that grease and water do not mix. This was the principle used by Alois Senefelder in Bavaria when he invented, in 1798, his third method of stone printing which he called "chemical printing." In this process, only the image to be printed takes the ink, with the non-image areas being protected by water. Prior to 1889, all lithography had been produced using flat press plates of stone, tile or copper.

In 1889, the rotary principle was applied to the lithographic press. The image was produced on a thin zinc sheet which was mounted on a cylinder. This direct-rotary press had its limitations in transferring true reproductions and, in 1904, the offset press was developed.

A third cylinder was incorporated into the rotary press, between the plate and impression cylinders. This cylinder was covered with a rubber-coated fabric blanket. The plate transferred its ink to the blanket which in turn transferred the image to the paper. This allowed the necessary fidelity in transfer of fine tones and color, and it was now possible to produce full-color copy in four colors. From this press has been developed today's modern offset presses for lithographing papers, metals, plastics, etc.

Rolled zinc sheets as offset press plates have played the major part in the development of the present high standard of offset lithography. Zinc lithograph plates are for the most part pack-rolled sheets. These sheets are designed by chemical composition and rolling technique to provide a press plate capable of meeting the precise demands of the modern offset press. The plate must have sufficient tensile strength to allow proper clamping without distortion of the plate cylinder. It must also have toughness to resist fatigue and clamp bend breakage.

Particular care must be taken to assure flatness and surface perfection. In recent years, a large percentage of zinc lithograph plates are being produced with a ground printing surface to assure better surface quality in subsequent processing.

Zinc offset press plates may have either a plain or grained surface. Considerable research has been carried out in recent years on the plain-surface zinc plate, but the grained-surface zinc plate must be considered standard for the industry.

The grained printing surface of a zinc plate is produced in a graining machine in which zinc plates are placed in such a manner as to cover the bottom of the machine, and are securely clamped with the printing face up. The plates are covered with steel balls, water and an abrasive. The graining tub is then oscillated in a horizontal plane to produce a scouring action on the printing surface of the plate, called "graining." The fineness, depth and sharpness of the grained surface is controlled by the size of ball, type and coarseness of abrasive, amount of water and speed of oscillation of the graining tub. After graining, the plates are removed from the graining machine and are thoroughly washed to remove all abrasive from the grained surface. They are then dried, using a minimum of heat in order to prevent recrystallization of the zinc plate. The finished, grained plate must be clean, uniform in grain depth and size, and free from scratches, in order to provide a satisfactory printing surface.

The grained surface of the plate provides a tooth for the printing image and ink, and enables the plate to carry the proper amount of water in the nonprinting areas. A wide range of grain characteristics can be produced on a zinc plate to fit specific requirements in offset lithography.

There are two basic types of zinc offset plates: namely, Surface Plates, and Deep Etch Plates. Copy to be lithographed by either type plate is photomechanically reproduced on film. This copy is divided into two categories: (1) line copy, which includes type proofs, pen and ink drawings or lettering and solid reverses, etc.; and (2) tone copy, which is photographed through the halftone screen to get the halftone dots of varying size to show tones of shading; this includes photos, wash drawings, paintings, etc. The film copy in either type is the exact size defining the image to be lithographed.

Films are positioned on a flat in such a manner as to fit the size of press plate required. This flat is placed in contact with a sensitized press plate in a vacuum frame and burned in with a carbon-arc lamp. The same procedure can be carried out in a step-and-repeat machine where one or several films can be positioned, burned in, then accurately repositioned and burned in for a number of cycles until the plate area is covered.

In making a Surface Plate the film is a "negative" and the exposed portion of the coating becomes the base for the ink-receptive image. The unexposed coating is removed during development and becomes the water-carrying area.

Deep Etch Plates are made from "positive" film where the exposed coating acts as a stencil for the image area. The coating on the image area is removed and this area is etched to a depth of 0.002 to 0.003 inch. Lacquer and ink are applied to the image areas to provide the ink-receptive surface and the non-image areas are cleaned of coatings to provide the water-carrying surface. The Deep Etch Plate will produce more impressions per plate than can be obtained from a Surface Plate.

If the image to be printed is in more than one color, color separations are made in the preparation of the positive or negative films, and plates are made for each color.

Offset presses are made for either single or multicolor. If color work is to be produced on a single-color press, the material being lithographed must be rerun through the press for each of the colors required. The same is true for the multicolor press if the number of colors required exceeds the color capacity of the press.

The completed press plate is carefully positioned on the plate cylinder of the press. This is especially important in color work, where register is most necessary. Adjustments are made to assure proper ink and water pickup as well as the "squeeze" contact with the rubber blanket on the transfer roll. This contact is two to four thousandths of an inch depending upon the type of press plate, blanket and material being lithographed. The image is transferred from the press plate to the rubber blanket and then, in turn, to the material on the impression cylinder using the same amount of "squeeze" as between the blanket and the press plate.

Zinc press plates fit snugly to the plate cylinder and in color lithography have sufficient "give" to assure perfect register. Finished lithographed material is then cut, folded, stamped, etc., depending on the type of finished product.

In many cases, after the completion of the press run, the zinc press plates are removed, cleaned, flattened and regrained. This makes the plate available for further press runs. It is not uncommon for zinc plates to be regrained from five to ten times. It is also common practice to store press plates at the completion of a run where a rerun is anticipated. The plate is cleaned, coated with asphaltum and stored for future use.

Rolled Zinc in Dry Batteries. The first practical dry cell was produced by Gassner in 1888. The term "dry cell" is only relative, as the contents of the cell are in pasty form compared to liquid in other type batteries. The first standard dry cells measured $2\frac{1}{4}$ by 6 inches. Early uses of this cell were in the telephone and auto-ignition field. Later developments produced the "A" and "B" batteries used in radio receiving sets.

These cells used a cylindrical shell of zinc. The inside surface of the zinc shell is covered with paper board. A carbon rod is placed in the center of the cell and the space between carbon and zinc shell is packed with a depolarizing paste that varies with the ultimate requirements of the finished battery. The specific compositions of this paste are withheld by the various battery manufacturers, but the composition is approximately ten parts each of manganese peroxide and carbon, or graphite, two of salammoniac and one of zinc chloride. The zinc chloride is a wetting agent to prevent loss of moisture in the water paste.

These shell-type batteries are now produced in sizes from the small penlite photo flash and flashlight sizes, to the standard dry cell. The smaller-type shells are in some instances combined in various-sized units and connected in series to produce 50 volts or more.

The other primary dry battery is known as the flat-cell type. This consists of flat zinc of the proper size, gage, surface finish and shape as the electrode. The zinc is coated on one side with pasted pulp-board and on the other side with waterproof, conducting plastic, the latter serving as the cathode terminal. The plastic-coated side is covered with a mix cake consisting of a suitable mixture of manganese dioxide, carbon and electrolyte. These units are stacked one on another until a sufficient number of cells are combined in a block to produce the desired battery characteristics. Electrical contact between cells is obtained through the coated zinc. No separate connections are required. These units are then encased and sealed as individual units, or combined in multiple units, depending upon the type of finished battery.

The original $2^1{}_4$ by 6 inch dry-cell can was produced using sheet zinc for the battery side and bottom. In recent years most producers of this type battery have used strip zinc for the shell. The battery can of this size is formed and has soldered seams.

The standard flashlight battery was first produced with a soldered can using strip-rolled zinc for side and bottom. In recent years this type of battery and also the smaller types have used drawn zinc cans as the battery shell. The flat-cell type of battery uses strip-rolled zinc. Impact-extruded cans are also being used in and below the flashlight size.

The requirements for, and capacities of, dry cell batteries are ever-changing. Electronic developments constantly demand new types of, and better performance from, dry cell batteries.

Fabrication and Finishing of Zinc Articles

As noted previously, zinc strip of approximate High Grade purity and with low iron content is suitable for a wide range of drawing operations. A temperature somewhat above ordinary room temperature is desirable and lubrication with warm soapy water is generally satisfactory.[8, 10] Self-annealing between drawing operations permits successive operations and separate annealing must in general be avoided owing to the danger of coarse grain growth.

Thickness of the stock should be maintained and the reduction in diameter from blank to cup should be moderate (not more than 40 per cent[8]), with considerable decrease in this reduction during the successive drawing stages (not more than 20 per cent[8]). Sizable die clearances and generous fillets are required.

With zinc of lesser purity, or alloyed varieties, the forming characteristics must be especially evaluated in any desired operation. Some of the alloyed zincs strain-harden considerably and can be annealed between draws without excessive grain growth.

Bending is favored across the grain, i.e., around an axis normal to the strip length, and in all cases sharp bends must be avoided.

Rolled zinc is easily soldered with half-and-half solder and a cut muriatic acid flux. Overheating should be avoided by working rapidly with a moderately hot iron.

Rolled zinc may be buffed, painted, plated, lacquered, chemically colored and enameled to provide a large variety of finishes of diverse characteristics. The American Zinc Institute has a brochure on "Preparing and Painting Zinc Surfaces" and can supply information from many sources concerning current finishing techniques. Standard Specifications for an "Electrodeposited Coating of Nickel and Chromium on Zinc and Zinc-Base Alloys (B 142-58)" are issued by the American Society for Testing Materials. For comparison, the last part of the text on zinc-base die castings in a preceding section of this chapter, designated "Finishing of Zinc Die Castings" may be reviewed.

REFERENCES*

1. Anon., "Copper, Brass and Zinc Rolling," (Brinsdown Works of Enfield Rolling Mills, Ltd.), *Metal Ind.* (London), **84**, 421-2 (1954).
2. Anon., "Rolling of Zinc Strip," *ibid.*, **58**, 107-13 (1941).
3. Arend, A. G., "Characteristics of Zinc Plates for Lithographing," *Ind. Chemist*, **27**, 453-63 (1951).
4. Arend, A. G., "Preparation of Zinc Sheets for the Engraver," (Casting, rolling, grinding, polishing and inspection), *Process Engraver's Monthly*, **58**, 234 (1951).
5. Carlson, E. G., "Vapor Blasted Grain for Lithographic Plates," *National Lithographer*, **55**, 39, 106 (1948).
6. Editorial, "Wrought Zinc Alloys; Typical Properties," *Materials and Methods*, **32**, 91 (Oct., 1950).
7. England, F. E., "Grain of Lithographic Plates," *National Lithographer*, **58**, 28-9 (Dec., 1951).
8. Gent, E. V., "Spun and Drawn Zinc Parts Have Many Applications," *Materials and Methods*, **36**, 102-4 (Dec., 1952).
9. Hofmann, W., and Trautman, B., "Die Walztextur von Zink und ihr Einfluss auf die technologischen Eigenschaften, insbesondere die Tiefziehigkeit," *Z. Metallkunde*, **39**, 293-303 (1948).
10. Jevons, J. Dudley, "The Metallurgy of Deep Drawing and Pressing," pp. 285-90, New York, John Wiley and Sons, Inc., 1940.
11. Kelton, E. H., "Working of Zinc and Zinc Alloys," in "The Metals Handbook," pp. 1082-3, Cleveland, Ohio, American Society for Metals, 1948 edition.
12. Peirce, W. M., "The Rolling of Zinc," in "Nonferrous Rolling Practice," Institute of Metals Division, Symposium Series, No. 2, pp. 117-28, New York, Am. Inst. Mining Met. Engrs., 1948.
13. Roberts, C. W., and Walters, B., "The Rolling of Zinc and Zinc-rich Alloys," *J. Inst. Metals*, **76**, 557-80 (1949-50).
14. Sheridan, S. A., "Plate Metal and Grain Standardization," (Zinc and Aluminum), *Modern Lithography*, **14**, 30-5 (1946).

* There is no extensive bibliography on the rolling of zinc. These references will supply some material for collateral reading, including additional information on a few important applications. (Ed.)