MASTER

METAL WORKING AND METAL FORMING TECHNOLOGY (a)

O. J. Wick (b)

Battelle Memorial Institute
Pacific Northwest Laboratory
Richland, Washington

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- (b) Deputy Manager, Metallurgy Department, Pacific Northwest Laboratory, operated by Battelle Memorial Institute for the United States Atomic Energy Commission, Richland, Washington.

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METAL WORKING AND METAL FORMING TECHNOLOGY

It is a privilege to talk shop with those of you in the metal working industry and the rest of you in the metal using industry. We in nuclear research and development depend on and have often turned to small business companies for our special requirements. In return we hope that some of the new technology developed can be applied to the problems of industry in general.

The atomic energy program created a host of problems in working reactive, toxic, radioactive, corrosion resistant, high purity metals and metals with special properties. These problems were solved by borrowing methods and materials used in biology and medicine, deep sea diving, the child's toy industry, forestry, the physics laboratory, the plastics industry, and using them to adapt conventional metal working methods to the problem.

For example, in order to safely handle toxic and some radioactive metals the glove box was borrowed from the bacteriologists who had developed them in order to handle dangerous bacteria. When working in glove boxes one draws surgeon's rubber gloves over mortician's cotton gloves and results are literally brought forth through obstetrician's gloves penetrating the glove box. Glove boxes are ventilated through absolute filters originally developed by the Chemical Warfare Service and known as CWS filters. Since they were originally used in metal working, glove boxes have been modified and adapted to a wide variety of tasks. We now have static and dynamic atmosphere boxes, inert atmosphere boxes, vacuum boxes, negative and positive pressure boxes. Machine tools, casting furnaces, rolling mills, welding processes, and all types of equipment have been housed in glove boxes. Industry is using them in increasing numbers. Their use is indicated whenever the operator must be protected from the product because of toxicity or when the product must be protected from contamination by air, dust, or whatever, or when a special atmosphere is required. Glove box techniques should have application not only in the metal industry but in the chemical industry and the food products industry as well.

The frogman suit was borrowed from divers and used to protect men entering another hostile environment - atmospheres contaminated with toxic dusts. Model railroad locomotives have been pressed into service to haul materials from one work station to the next in lines of process glove boxes. The air operated tugger hoist familiar in mining and lumbering is a useful power source in tube drawing. The vacuum bell jar from the physics laboratory becomes a component in an electron beam welder, and plastic bags are as useful in packaging metals as in packaging foods. While we have shamelessly borrowed technology wherever we could find it, we have adapted it to new uses and added contributions of our own.

Most AEC-metal fabrication development has been devoted to nuclear fuel elements. Because this is a highly specialized industry I will not discuss fuel fabrication as such but rather those associated developments of broad application.

Perhaps the most significant development in the area of Metal Working to date has been the development of electron beam welding. The need grew out of the requirement to can nuclear fuel in a high vacuum. Ordinary welding techniques are unworkable in a high vacuum so an alternate method was sought. Many years earlier French investigators had noted that the targets of x-ray tubes were often melted by the impinging beam of electrons used to excite emission and had speculated on the possibility of using an electron beam for welding. No application of the idea had been made however. By assembling a vacuum pump, power supply, an electron gun in a bell jar large enough to serve as a work chamber and making the fuel element the target, it proved possible to weld closures on fuel elements under high vacuum. (Slide 1). Because an electron beam can be focused to a very small spot, weld joints are very close fitting and no filler metal is used. Within six months of publication of this development, commercial EB welders were on the market and now very large and powerful machines are marketed. However the original machine assembled from relatively inexpensive components is still functioning as designed and in regular use in the laboratory.

A metal fabrication technique of great promise, and with potential application to some nonmetals as well, for the fabrication of complex shapes, cellular or honeycomb structures, creating large surface areas, and producing bonded composite structures is by coextrusion with sacrificial materials making up a filled billet. The billet is made up with a cross section of the desired geometry and the vacant areas filled with sacrificial material. When extruded to the size required the cross sectional geometry remains very nearly identical with that of the billet except that the area has been reduced in proportion with the extrusion ratio and the linear dimensions reduced in proportion to the square root of the extrusion ratio. During the hot extrusion process all elements of the billet are pressure diffusion bonded to result in a completely bonded structure. After extrusion, the sacrificial material can be removed chemically or thermally to result in the desired product. (Slides 2 through 10).

Three general categories of materials have been produced by this process; structural shapes, nuclear fuel, and fibrous composites in which case no removal of sacrificial material is required.

Users and fabricators of metal wire whether it be for springs, Fourdrinier wire, welding electrodes or other purposes will be interested in a cold drawing lubricant developed in the Fabrication Development Laboratory at Hanford. Most drawing is performed using a chemical conversion coating on the material being worked. These coatings, which are oxides, phosphates, or other compounds, are very tenacious and must be vapor blasted or chemically etched to remove them. These treatments also affect the underlying metal and are particularly objectionable on thin material. One of our engineers in searching for an alternate drawing lubricant, and not having much success, in desperation tried using a stick of belt dressing. When this showed some promise there followed a lot of patient detective work to identify the active ingredient. From this information a special asphalt base lubricant was developed which can be easily applied by spray, brush, or wiping, is tough enough to withstand repeated draws, yet can be easily wiped off with kerosene. It is sometimes used with stearate powder which adheres well to the lubricant.

This lubricant cannot be used for hot work but is compatible with water which can be used to keep work cool under severe drawing conditions. This lubricant produces very high quality surfaces remarkably free from laps and seams. Its use has permitted cold drawing of difficult to work metals and alloys. It has been applied to V, U, Ta, Zr, Nb, Hf, Mo, W, Inconel, Hastelloy, Stainless steel, and other common metals. If you need cold drawn tubes or wire of materials not available in these forms, or if surface flaws give trouble by initiating fatigue failure as in springs, or weld flaws produced when welding wire contains trapped lubricants in laps or seams, then you should consider use of this lubricant.

Adapting conventional equipment to accomplish unconventional jobs is a common problem and I will cite a few examples which may be of interest. Swaging machines (Slide 11) are in common use and by changing dies a number of unconventional shapes can be generated. For example external ribs can be formed on tubes as shown in Slide 12. External gear configurations can be produced as shown in the next slide (Slide 13). Internal ribs can also be produced by swaging over a mandrel. Both internal and external ribs can be spiraled if desired. Pointing is another useful application as it can be done over wood for example (Slide 14). Tapering for transition from one size to another is shown in the slide (Slide 15). The ability to produce a variety of tube sizes from a single starting size by swaging over a mandrel is extremely useful. (Slide 16)

Tube drawing in lengths greater than the capacity of existing draw benches can be improvised by anchoring a die holder to the shop floor and at the required distance an air operated tugger hoist. A cable from the hoist to the grip seizing the work completes the facility. Tubes 40' long have been drawn with such a set up.

Annealing and heat treating long tubes or rods is a problem easily solved by attaching a welding machine to each end of a pipe long enough to contain the work, filling it with the atmosphere needed and passing current through the pipe to resistance heat it to the temperature required. The same arrangement can be used to straighten rods or tubes by suspending them vertically with a weight on the lower end. The temperature is raised until the work straightens and it is allowed to cool in place.

Bending tubing by filling it with sand creates a problem of removing the sand after bending. A simple alternate is to fill the tube with a mixture of bicarbonate of soda and citric acid in equal volume. After bending the work is simply immersed in water and the mixture comes boiling out leaving the tube clean. Of course the same thing can be done by filling the tube with water freezing it before bending and then simply melting out the water afterward.

In summary then considerable technology is available on:

1. The design, operation, and application of glove boxes for controlled atmosphere contamination free operations in metal working as well as other fields.

2. The development and application of electron beam welding.
3. Fabrication of complex shapes by the filled billet technique.
4. The development and use of a cold drawing lubricant.
5. The application of swaging machines to a variety of metal forming tasks.

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TUNGSTEN EXTRUSION

URANIUM AND ZIRCONIUM EXTRUSIONS

TUNGSTEN EXTRUSION