To: H. E. McCoy

Subject: Fluting of Hastelloy N Tubing by Planetary Swaging

The planetary swagers located in the Materials Processing Laboratory are experimental devices used primarily to reduce the wall thickness of tubing by a mechanism similar to shear forming. Whereas a draw-bench can be used to produce tubing with an infinitely varying inside diameter, a planetary swager can be used to economically produce tubing with an infinitely varying outside diameter and a constant inside diameter. (See attached photo of planetary swaging head.)

By increasing the ratio of the drawing speed to the rotational speed, tubing having helical convolutions or flutes can be produced. (See attached photo of fluted tubing.) By replacing the balls with conical-shaped needles, a narrow-deep convolution can be formed. Effectively, this increases the surface area on the inside and outside diameters of the tubing as well as promoting turbulence on the inside and drop-wise condensation on the outside. This configuration may be utilized to improve heat-transfer coefficients in power plant steam generators and condensers and in reactor fuel elements. Therefore, with this single device either smooth-wall or fluted tubing can be produced.

To date, tubing of the following materials has been successfully fluted in the Materials Processing Laboratory: copper-nickel, nickel, and brass. The existing planetary swaging heads are capable of fluting 1/4-in.-OD through 3/4-in.-OD tubing. The brass and copper-nickel tubing has been used for development studies to improve the performance of large, multistage flash distillation, sea-water conversion plants. Such modification of a smooth tube resulted in doubling the overall heat-transfer coefficient for the same coolant flow rate, steam temperature, and other process boundary conditions. While the pressure-drop gradient also doubled, halving the tube length would leave the overall pressure drop unchanged.

Since copper-nickel, nickel, and brass tubing has been successfully fluted with sizes having wall thickness less than 0.040 in., we believe that Hastelloy N tubing can be fluted with no equipment modification, provided that the wall is not too thick (estimated to be less than 0.030 in.) Generally the cost of fluted tubes should be low, perhaps less than $0.05/ft.
In order to produce smooth-wall tubing of Hastelloy N by planetary swaging, certain equipment modifications would be required. The drive spindle speed of the motor would have to be increased to approximately 1000 rpm, and the swaging heads would have to be "beefed up." The estimated cost of this modification is approximately $3000.

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