cost in the finishing of this barrel to its final shape, both on the outside and the inside. The economic stake in the elimination of the current blank preparation, drilling the hole, turning the outside diameter, the reaming, chambering, and choking of the bore, amounts to between $350,000 and $400,000 annually in operating costs. We have been addressing ourselves to this savings plus a lower Capital investment process for the past few years.

A chronological history of our efforts, accomplishments, and present status is as follows:

Cold forging of a no-turn, no-ream barrel on the GFM machines. Cold forging requires a longer blank than hot forging, roughly 22" versus 14". This is because you cannot cold work steel as severely as hot, for cold working approximately 35% cross-sectional area reduction is the limit whereas for hot working, a 70% cross-sectional area reduction is easy. Cost of material and drilling bar stock this longer length is prohibitive. This is why we started to investigate high frequency (375/400 kilohertz) welded tubing as a material for shotgun barrel manufacture. Its cost is somewhat greater than bar stock but since the hole is already in the material, the net result is essentially a standoff in the cost of a blank ready for the GFM machines. However, the wall thickness of the tubing available at that time was not sufficient to make the chamber section of the barrel. To overcome this deficiency, we developed a process for a closed die, electric resistant upsetting of the end of this tubing so that it would satisfy the needs for the breech end of shotgun barrels. With this development, tubing blanks were made ready for a GFM no-turn, no-ream process. New short mandrels with chambers included were fabricated and the GFM machine was modified for these trials. A substantial quantity of barrels were