



SIERRA ALLOYS
TSI TITANIUM
SIERRA SHEET & PLATE

STS Metals Companies

Company History



- ▶ TSI Titanium was founded by Edward F. Sobota in the mid-1970's.
- ▶ Mr. Sobota worked as a metallurgist for the former Teledyne VASCO. His responsibilities included monitoring the conversion of titanium bar product.
- ▶ In the early 1970s, Mr. Sobota left Teledyne and began consulting for titanium companies
- ▶ In 1975 his business expanded to perform actual value-added processes in Latrobe, PA
- ▶ 1976, the fledgling company expanded to TSI's current location in Derry, PA
- ▶ TSI is now owned by Tinicum and is part of STS Metals

Southwestern Pennsylvania History With Regard To Titanium

- ▶ Largest center for production of specialty and tool steel in nation
- ▶ Specialty steel production requires extra care and attention to detail compared to basic steel
- ▶ Titanium requires much of the same attention to detail
- ▶ The roots of titanium production in SW PA led to proliferation of titanium-specific companies in region



General Company Overview

- ▶ Producer of titanium and titanium alloy bar product
- ▶ Direct sale and conversion
- ▶ 130,000 sq. ft. manufacturing facility
- ▶ Located in Derry, Pennsylvania
- ▶ <https://youtu.be/FJEMCr136o0>

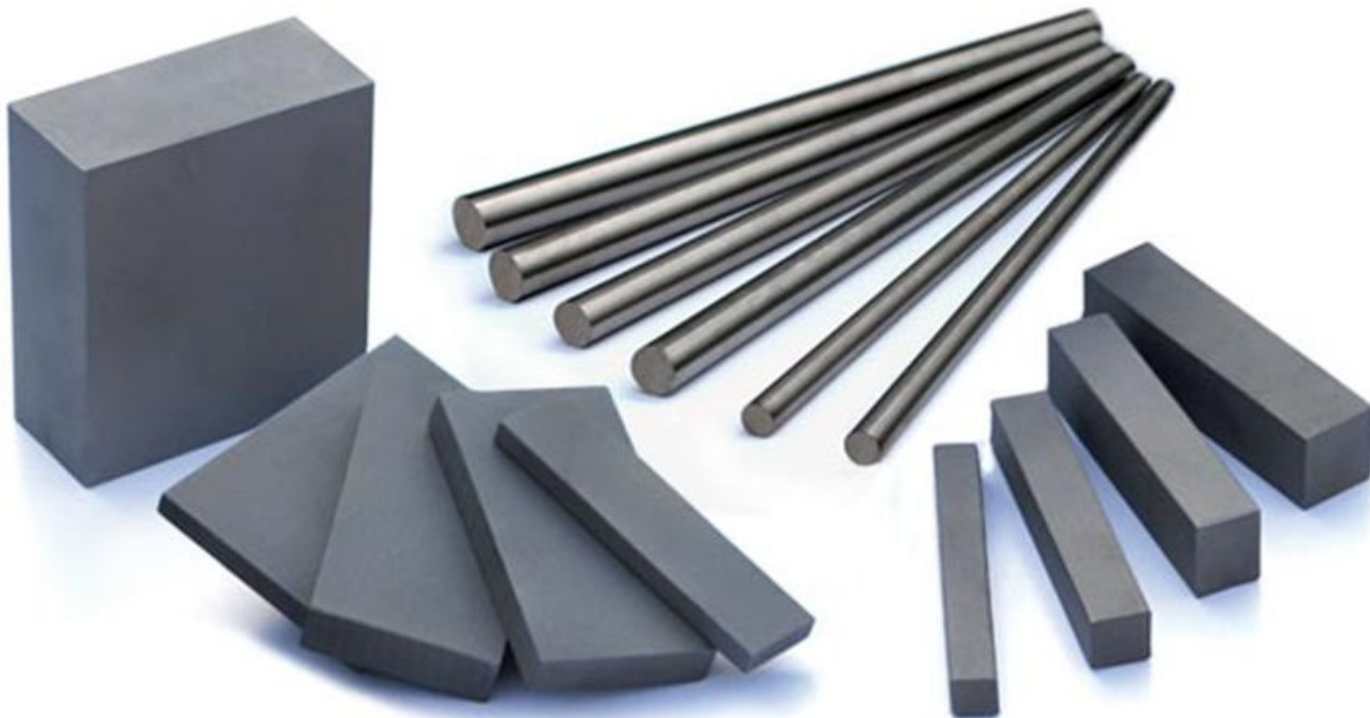


Titanium Grades Produced or Processed at TSI Titanium

- Ti 6Al-4V
 - Ti 6Al-4V ELI
 - Commercially Pure Grade 2
 - Commercially Pure Grade 4
-
- | | |
|------------|-----------|
| ■ Grade 7 | ■ 6-2-4-6 |
| ■ 6-2-4-2 | ■ 6-6-2 |
| ■ 10-2-3 | ■ 7-4 |
| ■ 3-2.5 | ■ Beta C |
| ■ Grade 12 | ■ 5-1-1-1 |

Shapes/Sizes & Capabilities

- Rolled round bar: 0.375" Ø to 3.500" Ø
- Forged round bar: 3.500" Ø to 20.000" Ø
- Rolled rectangular bar: 0.250" thick and greater, 0.750" wide to 4.000" wide
- Forged rectangular bar: 3.000" thick and greater, 4.000" wide and greater



Ingot Breakdown



Titanium is purchased in ingot form, generally 34" diameter by 14,000 to 16,000 pounds.

Ingots are forged at subcontracted forging companies.

- ▶ Forged to 9-11" blooms
- ▶ Conditioned to remove gross surface defects
- ▶ Subsequently rolled or forged to input billet or to a final product oversize.

Billet preparation

Billet (product at an intermediate stage) is fully conditioned and cut before it is rolled or forged.

- ▶ Square or rectangular billet is abrasively ground
- ▶ Round billet undergoes a light bar peel pass
- ▶ Belt polish
- ▶ Spot conditioned
- ▶ Billets are cut to appropriate weights to be rolled or forged

Billet Grinding

- ▶ The dry grinding of titanium billet produces a nuisance dust that must be captured.
- ▶ Product must be defect free at this stage to ensure a defect free rolled product.



Rolling Procedures

Based on final bar size, billet is either:

1. Rolled directly from input size to hot-rolled size for finished sizes 1.500" dia. to 4.000" dia.
2. Reduced to another intermediate size for finished sizes smaller than 1.437" dia.

Bar Mill

Combination 10" and 12" rolling mill

- ▶ Hand mill with three 12" mill stands and five 10" mill stands
- ▶ Multiple natural gas fired batch furnaces that are equipped with modern electronic controls and surveyed to AMS H 81200 requirements
- ▶ Rolled lengths up to 65 feet with inline abrasive cutting to finished bar lengths
- ▶ Large inventory of rolls for various rolled sizes and shapes
- ▶ In-house roll turning and machine shop, including CAD and CNC capabilities

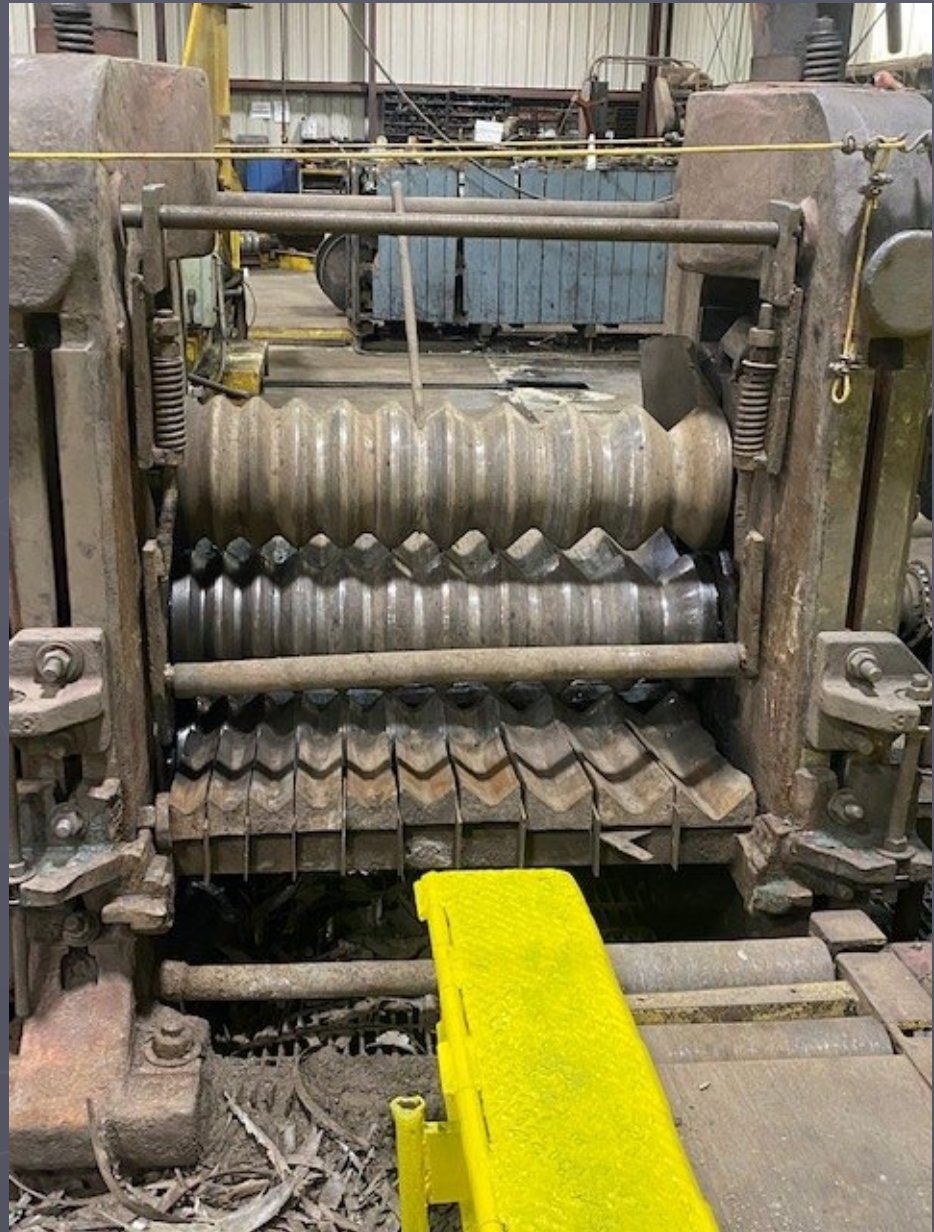
Hot Rolling of Bar

- ▶ Billet is charged in furnaces to grade-specific temperature
- ▶ Billets are individually pulled from furnace
- ▶ Billets enter mill and proceed through a series of calculated passes to reduce size and finish with desired shape



Rolling Mill Stand

- Three high mill stand allows input stock to be reduced in both directions.
- This is an input stock breakdown set of rolls.



Forged Bar

- ▶ 1500 ton forging press with synchronized manipulator.
- ▶ Computer controlled operating system.
- ▶ Forged sizes from 4.125" dia. to 13.00" dia.
- ▶ Rectangular sizes from 3.500" Thick to 12.00" Wide.

On the Die!

- ▶ Bar stock is held by a 5 ton manipulator.
- ▶ Press operator chooses computer program to be run.
- ▶ Press crew monitors the program and the product while on the die.



Heat Treating and Straightening

- ▶ TSI Titanium is Nadcap approved for the heat treatment of titanium alloys.
- ▶ Titanium bar is heat treated to applicable material specifications. Examples are annealing, solution treating and aging
- ▶ All furnaces are certified to AMS H 81200 and AMS-2750 requirements.
- ▶ Bars are straightened via rotary, multiple-plane straighteners or hydraulic ram machines.

Drop Bottom Heat Treat Furnace

- ▶ This furnace is used for water quenching at the end of a solution treatment cycle.
- ▶ The door facing you opens and the floor tilts about 60 degrees to quench the batch into the water below



Bar Straightening

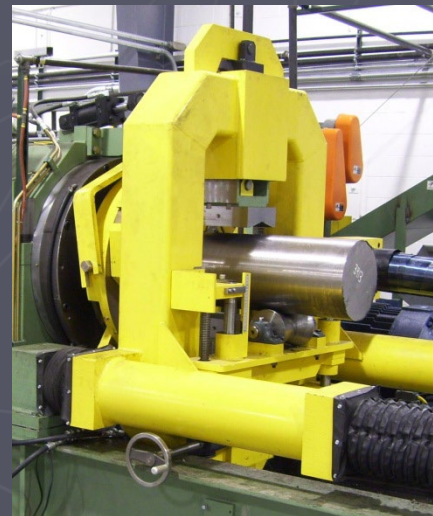
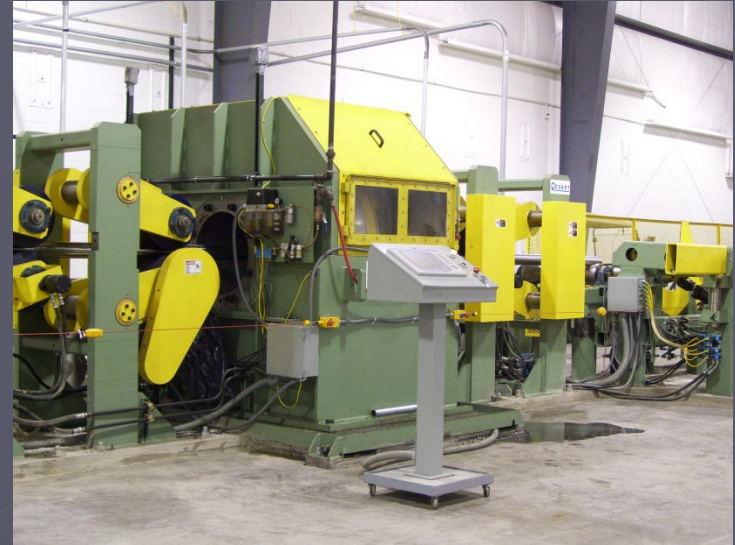
- ▶ Bar product enters machine via a guide and is “bent straight”.



Bar Finishing

- ▶ Sizes 1.000" dia. and greater
 - Peel to within 0.001" of final tolerance
 - Visually inspect bar ends to detect and remove defects and/or mill ends
 - Cut samples for metallographic and mechanical testing
 - Belt-polish to final size and surface condition
 - Line mark per customer PO / material specification requirements.
- ▶ Sizes under 1.000" dia.
 - Peel to an oversize to allow for re-straightening
 - Re-straighten bars as needed
 - Visually inspect bar ends to detect and remove defects and/or mill ends
 - Cut samples for metallographic and mechanical testing
 - Re-peel and belt-polish or centerless grind to final size and surface condition. Line mark as required.

Bar Finishing



Accreditations

- ▶ TSI Titanium is AS9100 /ISO 9001 accredited.

**ISO 9001:2015 • AS9100D
CERTIFIED COMPANY**



- ▶ TSI Titanium is Nadcap approved for the heat treatment of titanium alloys.



SUMMARY

- ▶ TSI Titanium is a highly respected manufacturer of titanium bar products.
- ▶ TSI has been serving the aerospace and medical markets for almost fifty years.
- ▶ TSI Titanium has the highest reputation for product quality, integrity and customer service.



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