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WORLDWIDE ENGINEERS AND MANUFACTURERS

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TECHNOLOGY FOR TITANIUM COIL SHAVING-POLISHING, SMALL DIAMETER COIL TO BAR, AND BAR TO BAR PROCESSING

Hetran has supplied more coil to coil shaving and polishing lines and bar peeling and polishing machines to titanium producers than any other finishing machine manufacturer. Hetran has supplied these processing systems to North American titanium bar and coil processors for more than 40 years.

There are many titanium alloys. Ti 6-4 Titanium (Titanium with 6% Aluminum and 4% Vanadium added as alloying elements) and CP (Commercially Pure, i.e., low interstitial) are two of the most common. These are "grade 5" and "grade 2" alloys, respectively. Ti 6-4 is commonly used in aerospace and in many other applications including golf clubs, and specialty applications including face shields for hockey goalies and facemasks for American football players. CP is commonly used for medical implants.

Titanium has unique physical properties that must be considered when cold finishing the product. It has extraordinary corrosion resistance, high tensile and yield strength, yet elasticity and yield can significantly be improved for most titanium alloys by heating to relatively low temperatures (600-800 degrees Fahrenheit) to avoid inducing a structural transformation like that from a "full anneal".

Generally speaking, the processing speeds, including the peeling and grinding (polishing) surface speeds for machining must be slower than those used for processing other metals. Cold drawing of titanium is not possible with standard soap and grease lubricants.

Due to the unique properties of most titanium alloys, cold finish processing methods and equipment design features for straightening, peeling, polishing, grinding and drawing are different from those for stainless and super-alloys.

Hetran has supplied more bar and coil shaving machines to North American producers than all other machine builders combined. Brown Europe will recognize these producers and processors: Dynamet, Perryman, ATI, Oremet, RTI, TIMET, and Tech Spec.

Dynamet and Perryman, with production facilities in Pennsylvania and Florida, are very competent producers of precision shaved and polished coils, coil to bar products and larger bars to (125mm). Combined they have at least 14 Hetran coil to coil shaving polishing lines (none from other machine producers) and seven bar to bar processing lines (also 100% supply from Hetran). Dynamet and Perryman are leading suppliers of precision turned and polished coils and precision ground small diameter bar from coil for aerospace and medical implant applications, and forge bars.

Hetran is a major supplier of coil to coil, coil to bar and bar to bar peeling and polishing machines also to Russian and UK titanium processors.

Titanium processors know that processing methods to finish titanium coil and bar are not widely understood and generally they are extremely protective of this technology. Seldom will they allow visitors to see their finishing facilities and methods.

REGARDING COIL TO COIL PROCESSING

Currently, it is not possible to die shave most titanium alloys as the surface speeds required are much too high for titanium. The carbide shaving ('broaching") cutting tool will fail very quickly if titanium is processed. Only rotary style peeling is possible as the surface speeds can be varied. Coolant flow and presssure, cutting tool geometry, chip clearance, spindle speed and tool holder design in the spindle assembly are special. Hetran has been a leading supplier of these machines.

The coil to coil shaving (peeling) process typically requires abrasive polishing capability in-line between the peeling head and the take-up. Hetran planetary polishers are ideal for this application and are the standard for the titanium industry.

Casting the coil dead and simultaneously avoiding surface marking during take-up requires special take-up features due to the high strength of the titanium alloys. Coil to coil shaving is readily done in sizes up to 13 mm and can be done as small as 3.0 mm. Coil to coil shaving of diameters greater than 15 mm is difficult and instead bar to bar processing is typically preferred.

Line speed typically is dictated by the tolerance to be attained. It is possible to achieve ultra precision diameter tolerances on the Hetran coil to coil shavers and polishers as close as +/- 0.0076 mm and where the finish is mirror smooth and reflective but the line speed will be slow...as low as 2.0 m/minute, or even slower depending upon diameter. Laser gauging is a must when making ultra-precision tolerance diameters. A roughing pass may be needed before peeling the coil to finish.

Peeling titanium coils to +/- 0.07mm or more liberal tolerances is done at much higher line speeds. Coil to coil shaving and polishing of decent quality 10mm titanium rod (not excessively out of round) with 0.05 mm removal from the diameter can be done on grade 2 or 5 coils at line speeds as high as 6 meters/minute or more.

Titanium has erratic "spreading" characteristics. During hot rolling the rod often times becomes significantly out-of-round. It is not uncommon to have hot rolled coils that are 0.5 to 0.8 mm out- of- round. In these cases, a peeling "roughing" pass to "round- up" the diameter of the coil can be beneficial before peeling to finish.

If drawing is to be done, the drawing lube must be totally dry. Typically the coil payoff is enclosed in a "furnace" where it is heated to assure the lube is totally dry. Lubricants including graphite and/or moly di-sulfide typically are required. Draw speeds are lower than for stainless alloys.

REGARDING COIL TO BAR & BAR TO BAR PROCESSING

Some coil to bar processors find it is necessary to heat titanium coils to enhance straightening. Generally, Hetran coil to bar machines are designed to eliminate this requirement. Our equipment design and our coil to bar processing know how enables Hetran machines to convert a hot rolled coil into a standard tolerance (H-10, H-11) bar by uncoiling, straightening, peeling, rough polishing, cutting to length, 2-roll burnishing, then finish polishing in one continuous coil to bar process. As a general rule, this process methodology is reliably performed on grade 2 and 5 titanium alloys in finish diameters between 7 and 13.0 mm. It produces a bar that is directly comparable to a standard quality centerless ground bar like is required for forge bar but with much higher processing efficiencies.

If precision ground bars (like +/- 0.0076mm) are required coil to bar in this size range, it is necessary to use a centerless grinder to finish the bars from the coil to bar machine. Typically one, and certainly no more than two, finish grinding passes are required to make the finish precision ground bar from the H-10 or H-11 bar from the coil to bar machine. It is highly recommended to have a small press straightener to "bump" straighten some of the bars made coil to bar that may have an slight out of straightness condition that could interfere with precision grinding. This optimizes the yield of precision ground small diameter bars that are processed coil to bar.

Hetran has working arrangements with a company that supplies fully remanufactured Cincinnati Twin Grip centerless grinders including automatic size compensation that are ideal for precision centerless grinding requirements and are more affordable in comparison to buying a new machine.

For bar diameters greater than 13mm, one should consider bar to bar processing.

Generally, Hetran processing lines for processing cold finish titanium bar to bar are sized 12 to 32mm, 20 to 50mm, 35 to 75mm, and include black bar straightening (bars must be heated for black bar straightening), peeling, 2-roll burnishing and, abrasive belt polishing. These processes produce centerless ground equivalent bars with higher efficiencies and yields than is possible via the standard turning, re-straightening and multiple centerless grinding pass finishing methodology.

Tolerances achieved in the Hetran bar processing cells are H-10, H-11. If very precision diameter tolerances are required such as +/- .007mm, centerless grinding bars from the bar-to-bar process from a very small oversize (no more than 0.127mm from the diameter) is recommended.

Hetran also builds turn and polish machines for peeling larger titanium bar up to 650 mm diameter. Hetran has extensive experience in processing large diameter bar for aerospace applications where the peeled and polished bar must have a very smooth and uniform bar surface for immersion UT evaluation.

Hetran routinely supplies all the processing machines for these large bar peeling and polishing lines including the handling equipment required for the ultrasonic testing machinery itself. The UT equipment per-se is supplied by Non-Destructive Evaluation (NDE) equipment vendors with whom we have extensive working arrangements. Typically Hetran integrates their NDE machines into the processing line.

REGARDING EC TESTING OF TITANIUM

Titanium is a very noisy metal. It is non-magnetic and has lower permeability and conductivity than does stainless. There is a larger "push-back" field for titanium versus stainless and super alloys.

The defect level to be detected needs to be considered. There is a big difference between looking for defects as small as .002" versus .020" defects. In any event, both rotating probe and encircling coil systems can be used but surface smoothness and freedom from vibration is essential.

EC testing of titanium wire requires very smooth and uniformly polished surfaces. EC testing of as-shaved wire is totally impractical because defect detection will be highly unreliable. For as-shaved wire, one would have to turn down the sensitivity to the level where even gross defects would likely be missed.

We know that some processors successfully EC test wire. They make sure the wire is super-smooth. If the wire is to be made into bar, it would be easier and more effective to **immersion sonic test** the bar, not EC test the wire.

We don't know anyone who has successfully immersion sonic tested titanium wire.

SUMMARY

Hetran has extensive experience and know how regarding titanium coil to coil, coil to bar and bar to bar finishing. Clearly we are well positioned and we are most interested in providing equipment to Brown Europe.

Please advise if there is further interest and when and how we can proceed.

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