Phoenix incorporated

Vertical Turning/Milling Centers

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Phoenix Vertical Turning Centers (VTC), Vertical Milling Centers (VMC) and Vertical Turning and Milling Centers (VTMC) are designed with common structural components. All are designed to provide high machine stiffness and high precision positioning and repeatability. Constructed with all cast iron structural components and steel ram forgings and the best bearing support systems in the industry, an exact repeatable cut is always guaranteed. Custom made to your part height and part swing requirements, the Phoenix vertical family provides both flexibility and value. Depending on your application a second head can be added for milling, drilling, turning or a combination of all three. In addition, a custom pallet or gantry loading system is available to automate loading and reduce setup time. Power chucks are also available in various configurations.

Over the past 15 years Phoenix has manufactured and installed more than 60 machines of this design and more than 50 of these machines have had swings of 12 foot and larger. The various models that comprise our vertical family are used by our customers to make aircraft engine parts, large bearings, heavy cast iron pump housings and impellers, nuclear pressure vessels and steam/gas turbine parts to name just a few. Phoenix machines are even used to manufacture new Phoenix machines as two of our customers use our machines to make bases and tables for new Phoenix machines!

General Design Principles

Flexible Design

- Part Height – from 72" to over 192" (48" fixed rail)
- Part Swing – from 50" to over 280"
- Cutting Tool ram – 1 or 2, either turning, milling or both
- Table Transmission – Heavy duty (100 KW) or low profile (60 KW)
- Table Style – Plain faceplate style or power chuck
- Table Support – Cross roller or hydrostatic bearing depending on application
- Tool Changer Magazine – from 12 to 36 tools
- Pallet System or Gantry Load System
- High Pressure Coolant System
- Part and Tool Probing

Quality Design

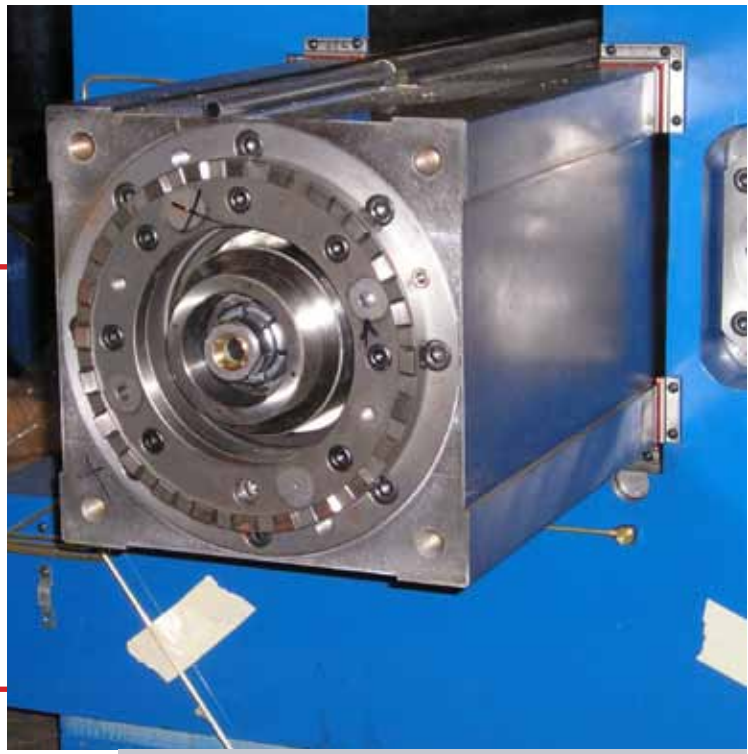
- Rail Leveling System – Servo controlled with hardened shelves and way support on both sides
- Table Transmission – Hardened gear driven without belts, temperature controlled forced lubrication
- Ways – Hardened and ground box ways with anti friction material on mating surfaces
- Ram – 12" square for reduced deflection and increased reliability. 10" square and 16" square rams also available
- Base and Rail – Class 35-40 cast iron for stability and vibration reduction
- Ball Screw – 3" diameter with 8 support bearings for large load capacity
- Tool Clamping – Strongest and most reliable in the industry

Optimized Design

- Table Transmission – optimized for maximum torque and power at usable RPM
- Rail – Fixed or adjustable
- Finite Element Analysis – To optimize strength and stiffness while minimizing weight
- Large mounting holes – Easily adapts to power chucks
- Tool Changer Style – Carrousel or Stacked for reduced footprint

Ram Assembly

The 12" square ram is made from a forging and is hardened and ground. It is supported on the four corners and all mating surfaces are lined with anti friction material. The vertical ball screw is 3" in diameter and is support by a quad set of ball screw support bearings on each end. Integrated into the ram is an absolute scale for position feedback.

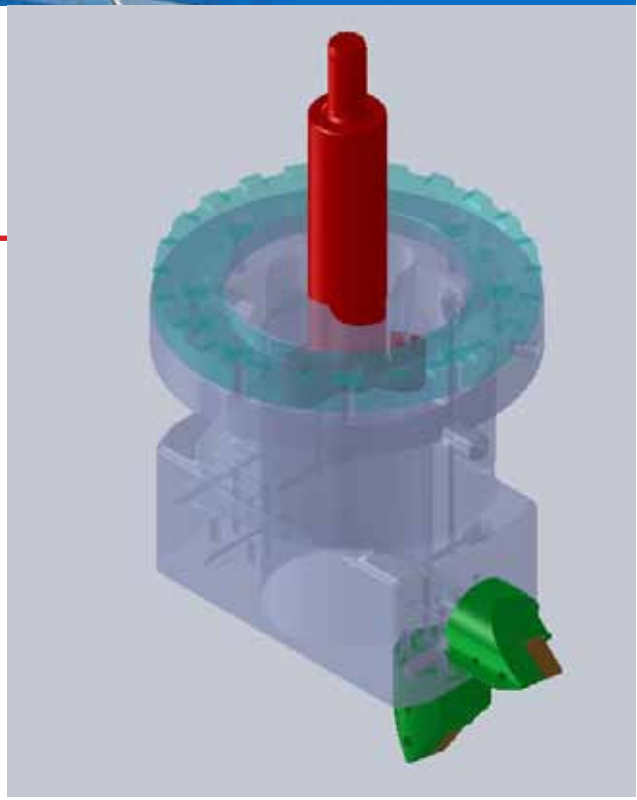


Turning Ram

- Fail safe using large Bellville washers to clamp the tool block
- Positive using (3) lobed male clamp stud which is inserted into the female opening of the tool block
- Up to 26,000 Lbs. of clamping force
- Coolant ported through the draw bar and into the turning tool block allows each block to be customized for ideal coolant direction
- The end of the ram uses a large diameter Curvic coupling to lock the turning tool blocks against rotation

Milling Ram

- Many tapers available, CAT 50, HSK100, KM80
- 2 Speed gearbox provides 1:1 and 4:1 speed ranges
- Up to 40KW power available
- Spindle is supported by (5) large angular contact bearings
- Spindle Cartridge is removable from the bottom for service and repair – ram does not have to be removed from the machine

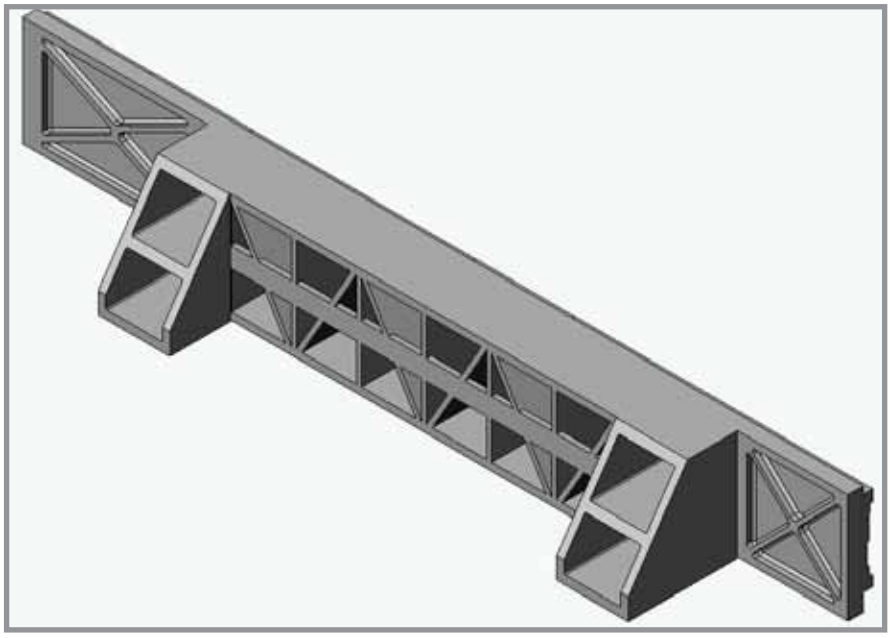


Combination Ram

- Same spindle design as the Milling Ram and same tapers available
- Live spindle is built in to the ram, not a separate head to be picked up
- Turning blocks use the same large Curvic coupling to lock and prevent rotation
- Allows a single ram to be used for both turning and live spindle applications

Cross Rail Assembly

The cross rail has been designed using Solidworks and COSMOSworks FEA software to provide the stiffest and yet the lightest cross rail possible. The rail sag is predicted using this software and the way seats are machined to reverse this sag. The rail is massive, weighing about 45,000 Lbs depending on the machine swing.

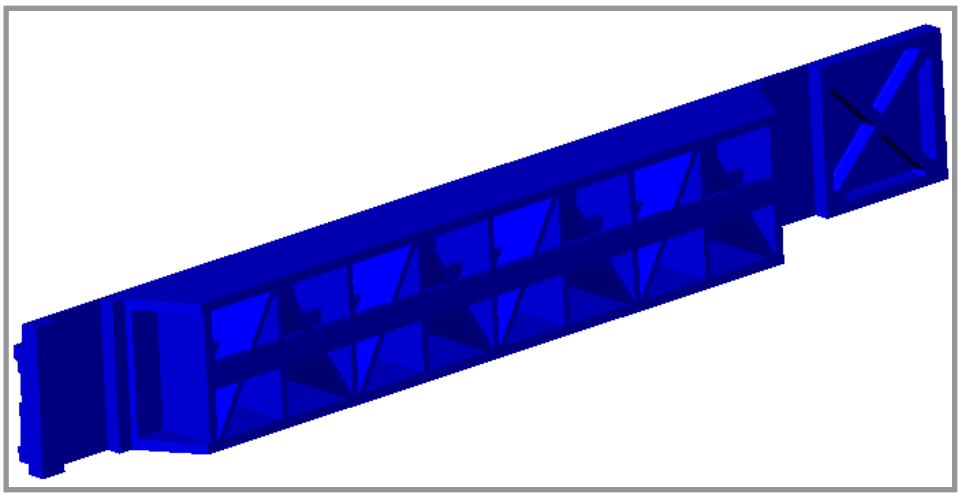


The cross rail horizontal ways that support and guide the X Axis saddle casting are hardened and ground box ways with a 3" x 7" cross section. The mating surfaces that slide on theses ways are lined with Turcite "B" on horizontal surfaces and Moglice FL Putty on vertical surfaces. All of the mating surfaces are designed to incorporate removable plates which allow a damaged surface to be restored without removing the saddle casting from the rail.

Absolute scales are integrated into the cross rail and are mounted on surfaces machined in the same setup as the way seats for optimum alignment. Neither the X or Z axes require homing operations, even on power up.

Way lubrication is determined based on either distance travelled (Siemens control) or time in motion (Fanuc control). Each axis is lubricated separately from the rest allowing lubrication to be delivered only when and where it is required. This eliminates over lubrication and also automatically adjusts as the machine cycles change.

On machines with adjustable cross rails, the rail is supported on both ends by 3" diameter ball screws. The ball screws are driven by a single servo motor which retains its position even with the power off. Movement of the cross rail is controlled by a macro program and requires only a single M code to move the rail. This can even be done within the part program. The rail always ends a move by placing the rail on precision ground support shelves at each side of the rail which assures that the rail location is known and that the rail is level. Failure to actually contact the shelves is detected by the machine and reported as an error message to the operator.



Machine Base Assembly

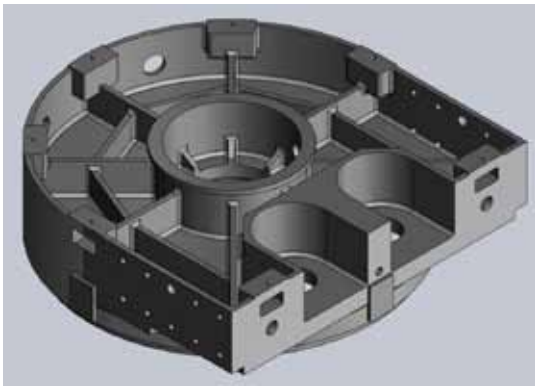
The machine base is manufactured from a casting for thermal stability and stiffness. Like the cross rail and columns, the base was designed using finite element analysis software to provide the required stiffness even under the heaviest part loads. Depending on the size of the machine, the base casting weighs between 15,000 and 50,000 Lbs. The table is driven through a 2 speed transmission providing 1:1 and 4:1 speed ranges. The final drive to the table is through a hardened and precision ground pinion and table ring gear.

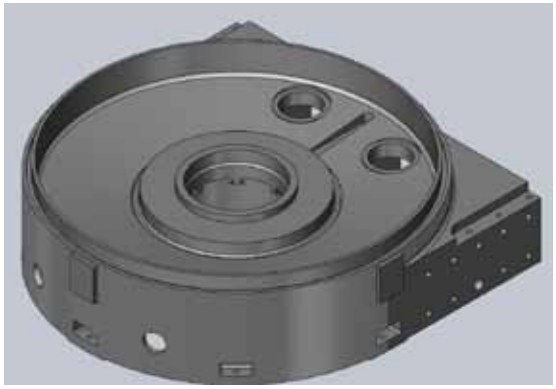
The table is supported by either a precision cross roller bearing or a combination radial roller bearing for radial support and hydrostatic bearing for axial support. The design used is based on the table load requirements of the customer. Phoenix can provide table loads of 1,000,000 Lbs. and even more if required. Depending on the machine size, the cross roller bearing diameter ranges from 20" to 72".

If the machine is equipped with a live spindle (VMC or VTMC), the base will also house the separate C Axis servo motor. This motor and gearbox is automatically retracted from the table drive gear when the machine is in turning mode and re-engaged only for C Axis operation. The center of the base also includes a high resolution angle encoder to provide position feedback at the center of rotation. Accuracy of +/- 3 arc seconds can be expected on our C Axis and repeated checks of machines in the field for more than 10 years show that this accuracy is normally even better and does not degrade over time.

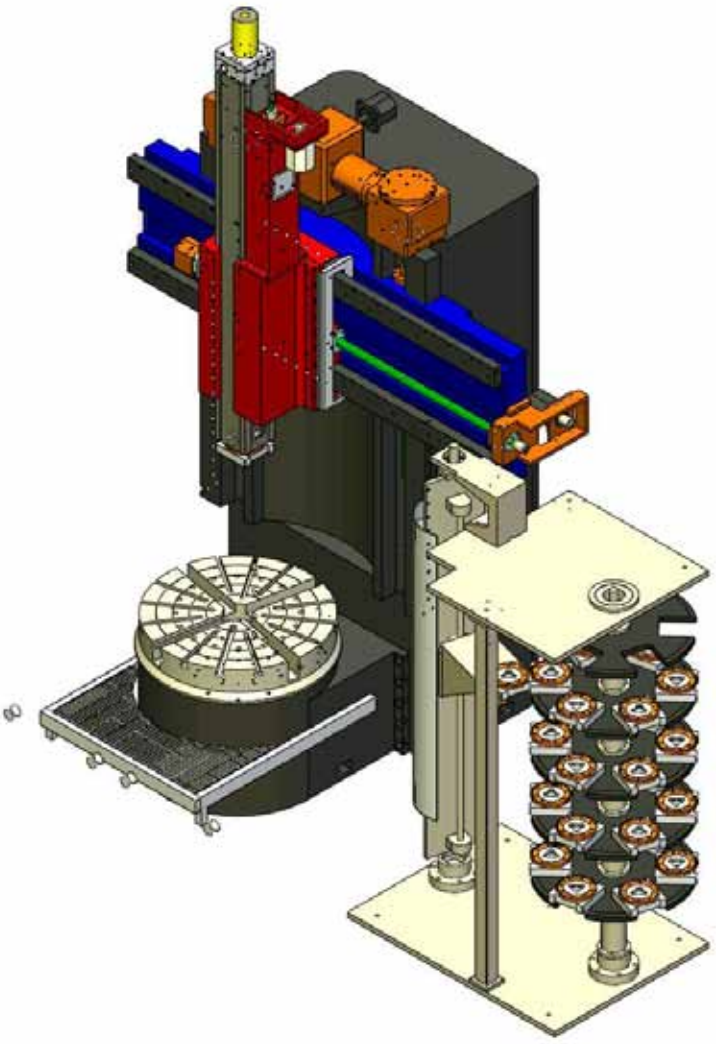
We offer two transmission styles. Both provide two speed ranges and the same gear ratios but one is designed to accept up to 100 KW of input power while the other is designed to fit our low profile base design and accepts up to 60 KW of input power. We will recommend which design best fits your requirements.

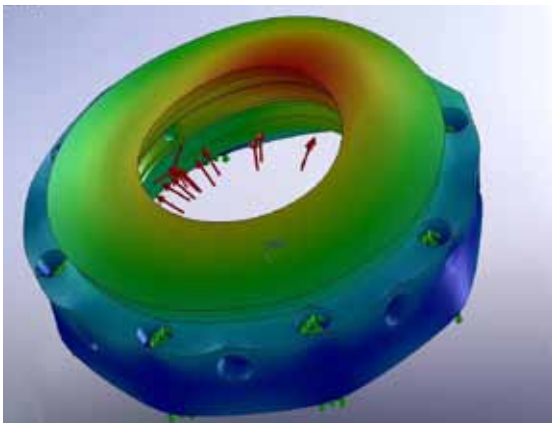
Both the cross roller bearing design and the hydrostatic bearing design feature a large center hole that allows power chucks to be applied where required.





Solid Modeling/FEA





Sales/Marketing Department:

Steven Fuller
steven.fuller@phoenix-inc.com

Headquarters:
257 Pine Street
Seekonk, MA 02771, U.S.A.

Phone: 508-399-7100
Fax: 508-761-6250
Web: http://www.phoenix-inc.com

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