Drive & Control **profile**

Roll with the Changes:

Ingersoll Crankshaft Rolling Machine Uses Integrated Axis Control Valves and MTX Controller to Improve Precision, Reduce Machine Size

Using Rexroth IAC-R integrated axis controller proportional valves, Ingersoll CM Systems made its machine 25 percent more compact.

As diesel engines are increasingly required to have greater output at smaller sizes, engine parts manufacturers are seeking new ways to efficiently meet these criteria in their production environments. Crankshaft manufacturers, for example, are constantly driven to improve product strength, reliability, and quality. One way they achieve this is by applying external forces to the crankshaft's surface to reduce fatigue.

Ingersoll CM Systems, Inc. of Midland, MI (www.teamicms.com) is a leading developer of crankshaft manufacturing systems and machinery. The company produces special equipment used in automotive crankshaft manufacturing, including its

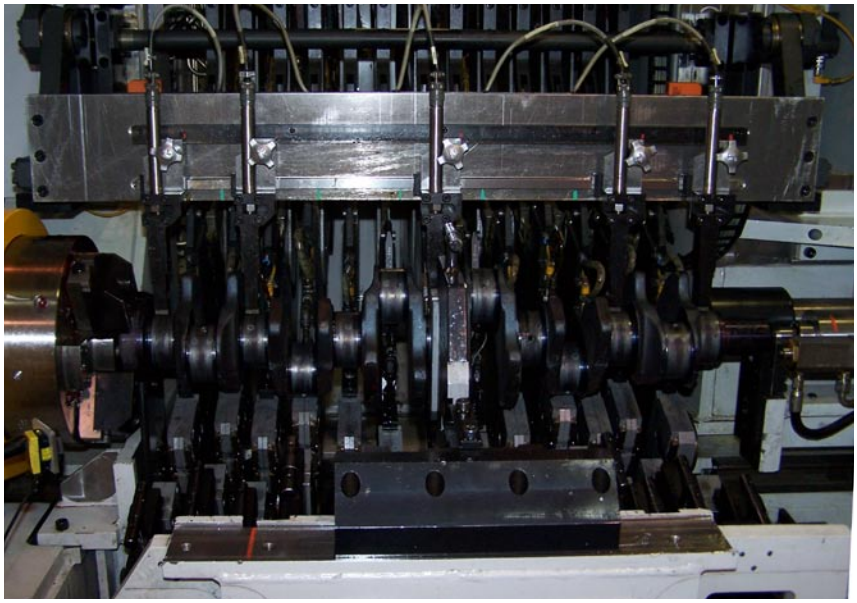
How Ingersoll CM Systems Saved Space, Improved Precision on Rolling Machine

Bosch Rexroth Solution

- IAC-R Integrated Axis Controller proportional valves
- IndraMotion MTX CNC with SERCOS and Profibus DP
- IndraDrive servo drives
- 15-inch HMI display panel
- IndraWorks software

Benefits

- Machine design is 25 percent more compact
- Integrated assembly for electro hydraulic motion control significantly shrinks panel space and wiring requirements
- Reduce field wiring by 25 percent
- 15 percent savings in machine control costs
- Precise closed loop force control up to 30 kN within a +/- one percent tolerance band
- Force changes achieved in 1/10 second for the hydraulic actuator
- PLC scan time is ten times faster



Depending on the crankshaft requirements, the rolling machine includes from nine to 13 arms of independent rolling axes.

crankshaft deep fillet rolling machines. The purpose of the crankshaft deep fillet rolling machine is to induce compressive residual stress at and below the surface of the crankshaft being rolled. The method has been used in the automotive, truck, and off-road industries for many years, and has proven to be a reliable and cost-effective method to improve the fatigue strength of crankshafts.

Previously, Ingersoll's rolling machines used separate control cards for each of the 13 axes of motion, which meant a larger processing area on the machine, expansive cabinet space for individual controllers, and excessive wiring for components and I/O. But as crankshafts have become more compact, Ingersoll wanted its next generation of crankshaft rolling machines to be more compact.

Ingersoll, which has a longstanding relationship with Bosch Rexroth Corporation (www.boschrexroth-us.com), called upon the company's Hydraulics and Electric Drives and Controls technology groups to provide an innovative control solution that would help them satisfy industry demands for greater crankshaft strength and precision as well as faster crankshaft production. Ingersoll used Rexroth's IAC-R Integrated Axis Controller proportional valves with integrated motion control on the hydraulic axes and combined them with a Rexroth IndraMotion MTX controller to achieve a design that's 25 percent more compact. The new design not only produces the crankshaft strength and precision Ingersoll's customers demand, but also saves space on the factory floor.

A Hot Idea for Cold Work

To understand the impact of integrated motion control used in Ingersoll's crankshaft deep fillet rolling machine, consider the function of the machine and how it operates.

As the name would imply, the crankshaft deep fillet rolling machine rolls or "cold works" the fillets or undercuts located at each end of a crankshaft's bearing surfaces. Deep fillet rolling is the name given to the process of rolling under high loads. The term is used because of the depth to which the material is strengthened—up to .125 inches. Rolling is one method of cold working in which a metal strip is passed through a narrow gap between two rolls to produce additional dislocations within the metal structure. A dislocation is a defect in the metal lattice where atoms in a layer of the metal are missing. When two or more dislocations meet, they hinder each other's movement, which increases the strength of

Ingersoll CM Systems developed a new generation of rolling machines to accommodate crankshafts that are more compact.

the metal and makes it stiffer, less malleable, and less ductile. In other words, it is more difficult to change its shape. To achieve this strength, the crankshaft is revolved a specific number of times within the deep fillet rolling machine at the required rolling force measured in Newtons.

Depending on the crankshaft requirements, specifically if the crankshaft is for a four- or six-cylinder engine, the rolling machine includes from nine to 13 arms of independent rolling axes per machine. Each arm applies a different force at a different point along the length of the crankshaft to condense and strengthen the crankshaft. In some cases the rolling machine is used to restore a crankshaft if it is found to have an unacceptable amount of distortion after rolling. In this case, a higher load force is selectively applied. One Rexroth IAC-R proportional hydraulic valve is assigned to each rolling axis of motion on the machine. The overall machine is controlled by a Rexroth MTX motion controller, which tightly integrates the multi-tasking PLC with the CNC and is capable of controlling up to 64 axes of motion.

Ingersoll's machine takes advantage of distributed digital intelligent devices such as the IAC-R hydraulic valves, Fieldbus I/O, and electrical drives from Rexroth to significantly shrink panel space and wiring requirements.

Proportional valves with electronics directly on the valve have been widely used for some time. However, the control of the hydraulic drive axis has normally required a separate axis motion controller. In contrast to traditional designs, the Rexroth IAC-R valve provides a programmable, fieldbus compatible, 32-bit digital motion controller for the hydraulic axis—all packaged on board a high performance servo solenoid valve. The axis feedback devices, including position, pressure, and force, plug directly into the valve's on board electronics. The result is a completely integrated assembly for electro hydraulic motion control that significantly cuts panel space and wiring requirements. These advantages become available with the use of distributed digital intelligent devices such as the IAC-R hydraulic valve, Fieldbus I/O, and electrical drives provided by Rexroth.

"The use of the IAC-R valve reduced field wiring by 25 percent and eliminated one of the four previously required electrical panels, saving us approximately 15 percent in machine control costs," described Gary Munger, Ingersoll controls engineering manager.

Further benefits of the control design include PLC communication with the motion axes over a Profibus network. This, coupled with distributed intelligence in the valves, removes limitations in control performance commonly associated with continuous closed-loop control concepts over a Fieldbus.

According to Munger, Ingersoll's control package requirements for the crankshaft deep fillet rolling machine were primarily that the system supply incremental, precise pressure variations for a resulting force up to 30 kN within a +/- one percent tolerance band. In addition, programmed force changes had to be achieved in one-tenth of a second for the hydraulic actuator.

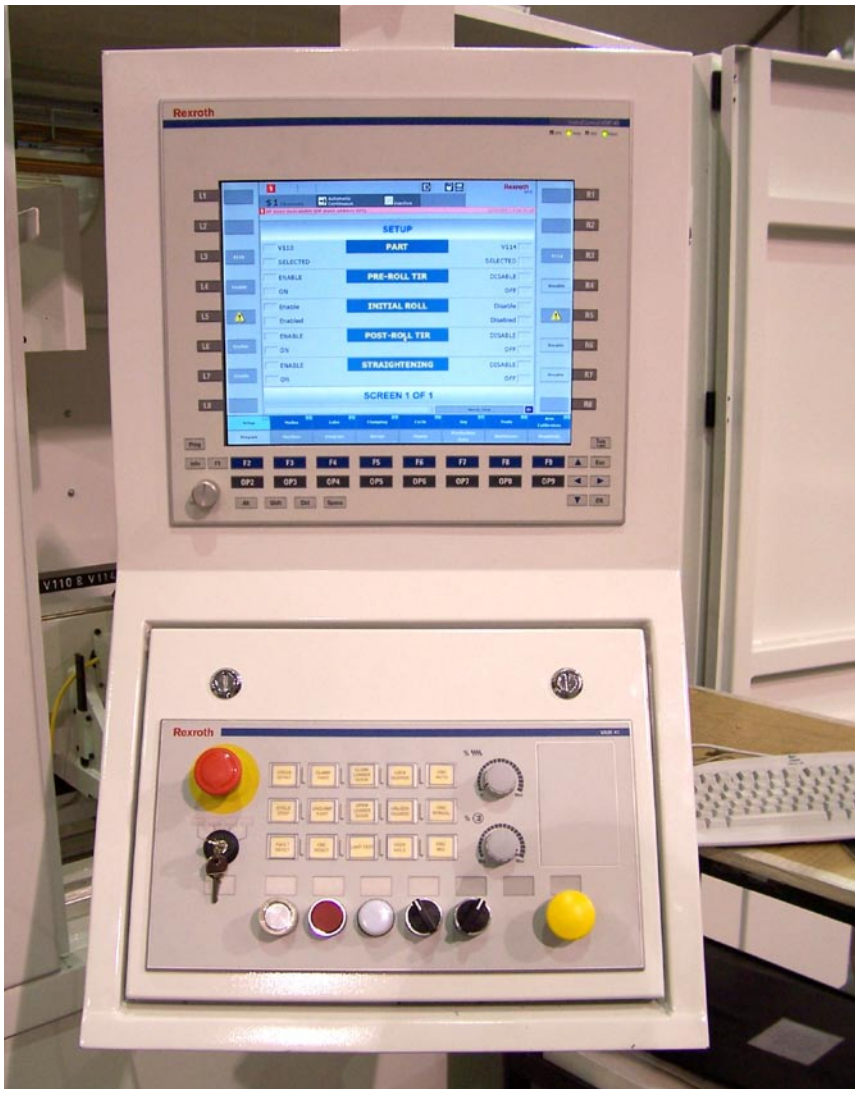
"Essentially, logic execution and synchronization are much faster. We're able to achieve a PLC scan time of less than two milliseconds, which is more than ten times faster than the other controls we have used recently. It all equals more uptime and greater precision, which is critical in this industry," said Munger.

"We looked at other valves with pressure feedback and closed-loop control based on direct pressure, but the valves were deriving their measurements instead of actually measuring," explained Munger. "The IAC-R valve actually measures the force."

Munger also noted that all setup parameters for the Rexroth IAC-R digital controller are saved in Flash Memory on the valve and is stored at the machine-level control. This allows quick configuration of series machines and minimum downtime in the field in the event of machine replacement. All parameters can be saved and uploaded or downloaded as needed, whereas before this was a manual adjustment. As a result, field changes can easily be made from one machine to another, taking less than half the commissioning time required in previous designs.

The overall machine is controlled with the MTX CNC controller. The performance CNC card running the CNC motion and all machine logic is installed in a Bosch Rexroth IPC40 located in the main electrical enclosure. A single cable connects the 15-inch display panel in the operator console, providing keyboard, machine key, USB, and mouse functionality. This installation offers a lightweight, rugged and slim operator console. In addition, the Rexroth IndraWorks software package used with the MTX controller offers all the tools necessary to engineer, commission and operate the machine. The operator interface can easily adapt to fit the machine and operator needs using an integrated WinStudio custom screen editor.

Compared to other CNCs, the MTX controller provides fast PLC



The installation uses a slim yet rugged Rexroth operator console connected with a single cable to the main electrical enclosure.

program execution and expedient processing of NC-blocks and auxiliary functions for reduced controller-related time delays and improved machine productivity. The MTX uses SERCOS with fiber optic cable to control all servo and spindle motion, and Profibus DP to permit fast control of distributed I/O and hydraulic axis control via the IAC-R valve. The IAC-R valve has five modes of operation, open loop flow control, closed loop pressure or force control, position control, alternating control (closed loop position and pressure), and onboard NC functionality. Feedback devices can be either analog, SSI, EnDAT or one volt p-p sine wave. Each valve counts and stores the "powered on" time, operation time, and fault history as well as first, last, and next service dates for troubleshooting and preventative maintenance. A 64-character device description can also be assigned to each valve and, like all parameters, can be read by the PLC or other control system via fieldbus.

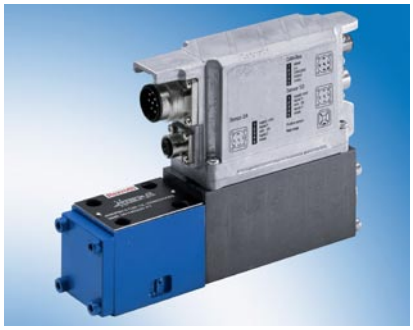
The cast aluminum housing containing the on-board valve electronics package is extremely robust, and allows the IAC-R to be rated for IP 65 sealing, EMC compatibility and sustained vibration of 25 Gs for 12 hours in all three dimensions.

Brian McMinn, a sales engineer for Morrell, Inc., the Rexroth distributor supplying Ingersoll, noted inter-machine communications between all control elements as a key benefit of moving to the IAC-R valve.

"Ingersoll moved from cumbersome analog communication to communication via Profibus, which minimizes the machine's wiring, eliminates noise, and gives Ingersoll a digital interface to the valve," said McMinn. He noted that Morrell and Rexroth have committed to stocking IAC-R valves for Ingersoll, as they typically build a rolling machine in less than 26 weeks, making delivery critical.

The move to IAC-R valves and the MTX controller has also provided an aesthetic improvement, according to Munger, as the operator interface pendant has a smaller, slimmer look.

"The benefits for our customers are that they can check processes frequently, check forces daily or weekly, adjust and calibrate as needed via the operator interface, and send information directly to the valve. Before, they would measure with a voltmeter and potentiometer, which would take twice as much time for calibration," explained Munger.



IAC-R Valve

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