

# Servo press forming applications

## Part II: Drive systems

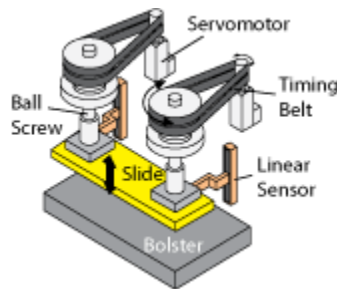
By Taylan Altan

April 10, 2007

Servo presses are classified into two main types based on their drive systems: direct drives with high-torque, low-speed servomotors, or low-torque, high-speed servomotors.

*Editor's Note: This is Part II of a three-part series on servo presses. Part I, which appeared in the March issue, discussed the benefits servo presses offer. Part III, appearing in May 2007, will cover current and future applications.*

This column was prepared by Ajay Yadav, staff member of the Center for Precision Forming (CPF, formerly ERC for Net Shape Manufacturing), The Ohio State University, Taylan Altan, professor and director.



**Figure 1**

In a screw-type servo press, motor rotation is converted to linear movement via the ball screw.<sup>1</sup> Press ram tilt is detected by linear sensors and corrected by adjusting the motion of each individual motor accordingly.

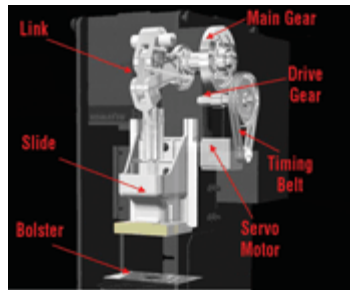
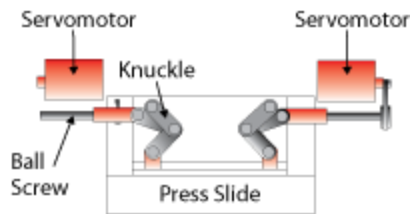
In servo-controlled presses, the flywheel and clutch assembly is replaced with a servomotor. The latest servo presses are equipped with rotary servomotors with torque capacities ranging from 100 newton-meters to 3,000 newton-meters. This technology allows press manufacturers to build servo presses with capacities up to 1,000 metric tons (10,000 kilonewtons). Besides rotary servomotors, direct linear servomotors also can be used to control slide motion.

### Servo-drive Systems

Servo presses are classified into two main types based on their drive systems: direct drives with high-torque, low-speed servomotors and low-torque, high-speed servomotors.

**Screw, or Ball Screw, Drive.** A screw-type press's operating principle is similar to that of a friction screw press (see **Figure 1**). The flywheel is replaced by a servomotor, and the servomotor rotation is transmitted to a ball screw mechanically or through a timing belt. The press slide is moved up and down by the ball screw's reciprocating motion. Maximum load is available throughout the press stroke, but press load capacity is limited by the ball screw's strength and the servomotor's capacity.<sup>1</sup>

**Screw-and-Link Drive.** **Figure 2a** shows a low-torque, high-speed screw-and-link press drive. In this servo press, the rotation of the motor is transmitted to a reciprocating ball screw by a timing belt. The knuckle-link mechanism is activated by the ball screw, which results in the press ram's linear motion.



(left) Figure 2a - (right) Figure 2b

(left) A screw-and-link drive can support large press loads.<sup>1</sup>, (right) Because of an eccentric main gear, continuous high speeds are achievable without the reversed motion of the servomotor.<sup>1</sup>

A screw-and-link press requires reversed servomotor operation for reciprocating press slide movement. Continuous, high-speed reciprocating can be achieved without the reversed motion of the servomotor by using a gear drive and a main gear eccentric shaft (see **Figure 2b**). Because a link mechanism is used, its characteristics are adopted; for example, the load generated will change with the press stroke.

In addition to the knuckle-joint drive, different link drives also are used with gears or pulleys to transmit the motor's rotary motion to achieve linear press slide motion.<sup>2</sup>

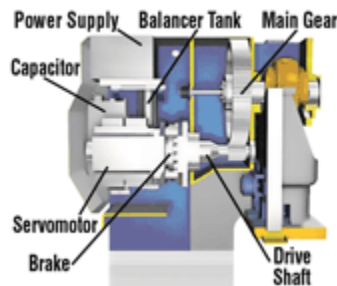


Figure 3

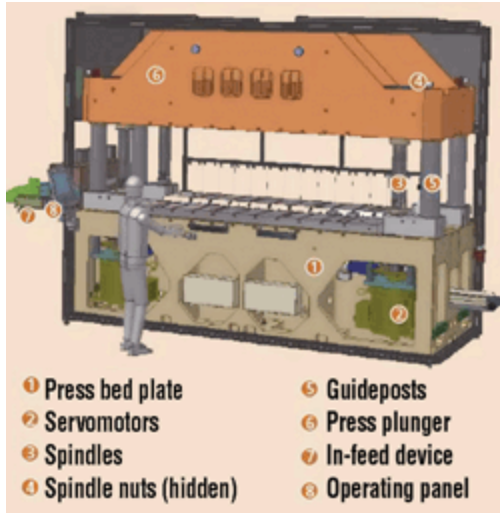
With high-torque, low-speed servomotors, direct-drive gear servo presses have the capacity to support up to 300 metric tons per drive motor.<sup>4</sup>

Because screw-and-link drives have limited torque and energy capabilities, forming applications are limited to embossing or blanking. For example, a single low-torque motor-driven servo press can provide up to just 40 metric tons.<sup>3</sup> To use these servomotors in high-tonnage presses, multiple motors are needed with expensive and complex drive systems.

**Direct-driven Gear Drive.** High-torque, low-speed servomotors have been developed with capacities up to 300 metric tons per drive motor. Last month's column discussed the operating principle and the construction of a direct-gear-driven servo press with high torque capacity (see **Figure 3**).<sup>4</sup>

**Direct-driven Spindle Drive.** A direct-driven spindle servo press consists of four threaded spindle drives located at the four corners near the press's guideposts (see **Figure 4**). Each spindle drive is driven by its own high-torque, low-speed motor. Because gears aren't used to couple the servomotor to the drive shaft, press height increases. Large servomotors are needed to obtain high torque.

The best possible parallelism between the press slide and bolster is achieved, even in off-center loading conditions, by using four threaded spindle shafts near the guideposts. Modern spindle-driven servo presses are equipped with sensors to electronically monitor and control rotational speed and forces in each spindle to check parallelism and safeguard against overloads.<sup>5</sup>



**Figure 4**

A spindle-driven press couples the servomotor directly to a threaded spindle shaft. Each of the four threaded spindle shafts located near the guideposts is coupled to a servomotor.<sup>5</sup>

**Linear Drive.** Traditionally, linear-drive servomotors are used in machine tools. Commercial servo presses with a linear motor are used for special applications in which the bottom dead center ram position needs to be controlled at micron accuracy, such as blanking foil sheets and punching fine holes.<sup>2,6</sup>

#### Notes:

1. K. Miyoshi, *Stamping Press KBU - Komatsu Industries Corporation*, "Current Trends in Free Motion Presses," in proceedings from the 3rd Japan Society for Technology of Plasticity (JSTP) International Seminar on Precision Forming, presentation slides, Japan, March 2004.
2. T. Nakagawa, "Servo Motor Driven Press and Market Trend in Japan," *Press Gijyutu*, Vol. 44, No. 9 (2006), pp. 18-29.
3. GE Fanuc, "Servo Motors and Amplifiers for Press Applications" presentation slides, November 2006.
4. D. Boerger, "Servo Driven Mechanical Presses," *AIDA-TECH*, AIDA-Dayton Technologies Corporation, Vol. 6 (2003).
5. *synchropress® technical brochure*, [www.synchropress.de](http://www.synchropress.de), 2006.
6. P. Groche, R. Schneider, and D. Schmoeckel, "Method for the Optimization of Forming Presses for the Manufacturing of Micro Parts," *CIRP Annals 2004, STC M*, Vol. 53, No. 1 (2004), pp. 281—284.

## Taylan Altan

Professor and Director,  
Center for Precision Forming

Taylan Altan is a professor and director of the Center for Precision Forming (formerly Engineering Research Center for Net Shape Manufacturing), 339 Baker Systems, 1971 Neil Ave., Columbus, OH 43210-1271, 614-292-9267, [www.cpfforming.org](http://www.cpfforming.org).

The CPF conducts research and development; educates students; and organizes workshops, tutorials, and conferences for the industry in stamping, tube hydroforming, forging, and machining.