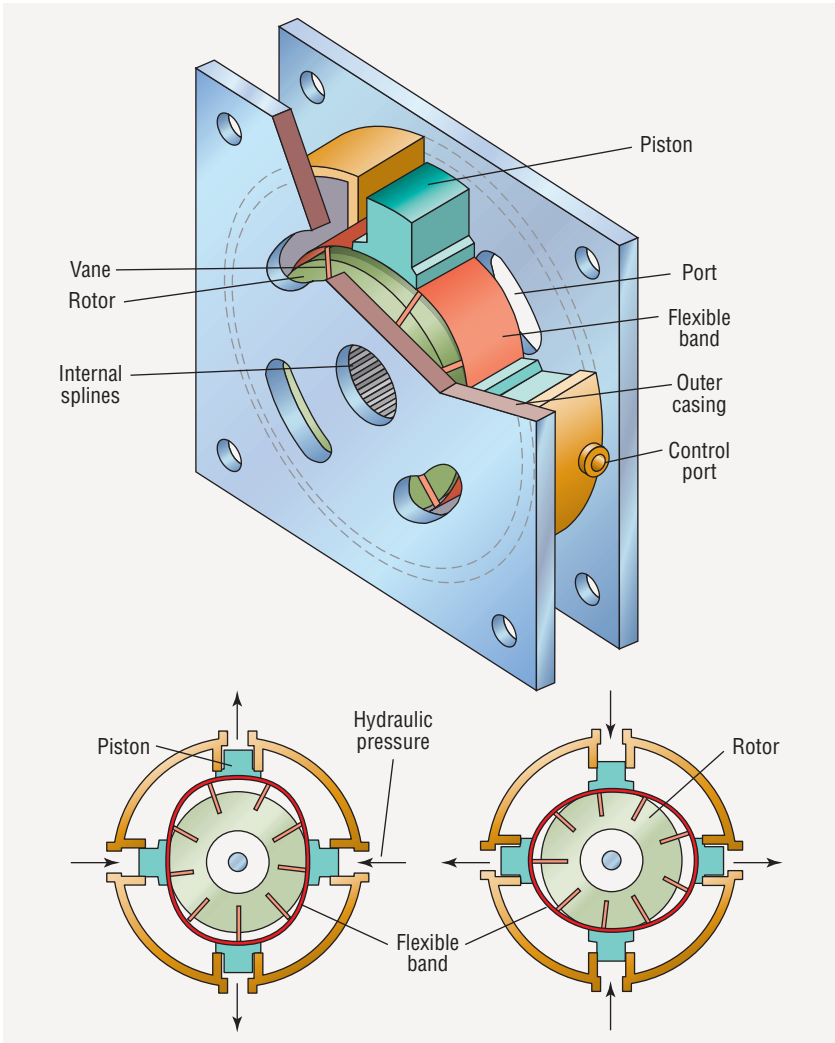
Edited by **Alan Hitchcox**

Variable-volume pump-motor departs from convention

One of the most significant breakthroughs in hydraulics technology came with the advent of the pressure-balanced vane pump, developed by Harry Vickers in 1925. A few years later came the variable-displacement vane pump. Since these developments, vane pumps and motors have gone through evolutionary refinements that have yielded moderate improvements in performance and efficiency.

Recently, however, a new design of vane pump-motor has entered the scene that offers a dramatic departure from convention — the *Hydristor*. Its inventor, Tom Kasmer, came up with the name as a combination of hydraulic and transistor. According to Kasmer, the Hydristor holds potential to revolutionize hydraulics technology, thereby opening opportunities for using hydraulics in applications that have not existed or have been replaced by competing technologies.

The Hydristor's greatest potential, says Kasmer, lies in its high efficiency. He says a prototype already has achieved combined mechanical and volumetric efficiency of 94.7%. Kasmer estimates that refined defined designs for production should approach efficiency of 97%. This compares, explains Kasmer, to no more than 80% overall efficiency for a fixed-displacement vane pump and lower efficiency for a variable-displacement model.



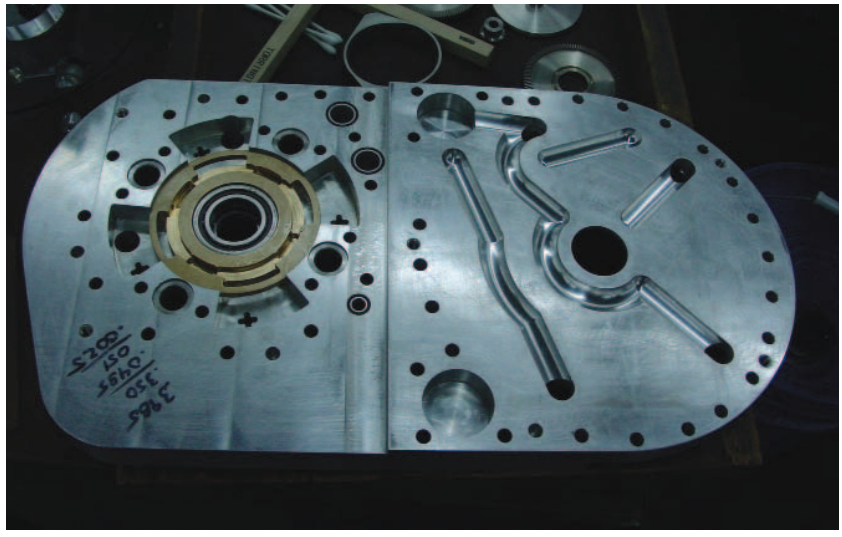
Cutaway view of the Hydristor shows internal components. Lower drawing shows how selective pressurization and relaxation of control pistons changes the shape of the flexible band, thereby changing pump or motor displacement or allowing a pump to act as a motor or vice versa.

How it works

Referring to the illustration, the Hydristor pump consists of a slotted rotor that typically is driven by a gas or diesel engine. As with a conventional vane pump, a vane in each slot slides radially inward and outward as the rotor spins. The Hydristor also shares the kidney-shaped ports the route fluid axially into and out of the pumping chambers bounded by the vanes. But unlike a conventional vane pump — where the outer edge of each vane slides around the inner circumference of a housing — vanes in the Hydristor do not slide around a mating inner surface with each revolution of the rotor. Instead, the outer edge of each vane contacts the inner circumference of a set of flexible metal bands, which is free to rotate with the vane and rotor assembly. The outer circumference of the flexible bands, in turn, slides against the contoured bottoms of four pistons.

Pressure applied to the tops of these pistons applies opposing forces to the flexible bands. The resultant shape of the bands determines pump displacement. For

example, referring to the lower left-hand drawing, with the rotor spinning clockwise, fluid entering ports located at the 10:00 and 4:00 positions would be forced out of the pump at the 2:00 and 8:00 ports. In the lower-right drawing, pressure in the pistons positioned at 3:00 and 9:00 has been relaxed, and pressure has been applied to pistons at the 12:00 and 6:00 positions. This changes the shape of the pumping chamber to reverse the direction of fluid flow.



With one end cover removed, internal componentry of Hydristor becomes visible. At left are the four pistons that encircle the flexible bands, and the rotor-vane assembly inside.

Results of the design

Kasmer says that essentially eliminating the sliding contact between the vane's outer edge and the inner circumference of the housing removes a major source of friction. Furthermore, he explains that hydrodynamic lubrication established in the sliding contact between the outer surface of the flexible band and the contoured bottom surface of the pistons offers far less drag than that created by the vane edges and the inner surface of the housing in a conventional vane pump.

Hydrodynamic lubrication occurs when fluid is drawn into contact area of elements in relative motion. The hydrodynamic pressure that results keeps the elements from actually contacting each other. A common example can occur with a car driving on a rainy day. The tires of a slow moving car maintain contact with the road surface. But if the car travels fast enough and encounters a puddle, hydrostatic pressure from the fast-moving tire and stationary ground can lift the tire off the ground.

Another source of inefficiency in vane pumps and motors is friction and leakage that occurs between the edges of the vanes and side plates of the pump. Even when contact pressure between the vanes and side plates is optimum, drag from the contact friction generates torque that resists rotation. As the vanes or side plates wear, contact pressure decreases, which decreases volumetric efficiency by allowing high-pressure fluid to leak past vanes into low-pressure chambers. If adjustments are made to increase contact pressure, too high a contact pressure will increase drag, thereby decreasing mechanical efficiency.

The Hydristor avoids this problem by allowing side plates to rotate with the rotor. Therefore, the vanes simply slide axially within slots in the side plates rather than making a circular path around the side plates. The outer surface of the side plates rotate against mating surfaces and, again, exhibit low friction through hydrodynamic lubrication.

What's in store

Kasmer has identified several industries that can benefit from incorporating the Hydristor. One of these is mobile equipment, where Hydristors can be used as a hydrostatic transmission with auxiliary outputs to operate implements, such as lifting forks or a loader bucket. Combining two Hydristors back-to-back forms a closed-circuit hydrostatic transmission. In such a setup, an engine would drive one Hydristor as a variable-displacement pump. Flow from this pump would be piped directly to the inlet port of the second Hydristor, which would act as a variable-displacement motor. Because displacement of both the pump and motor can be varied independently, this setup would create a continuously variable transmission (CVT).

Kasmer says he has already retrofitted a John Deere tractor with a Hydristor CVT and conducted test that bear out his calculations. He explained that a key to dramatically improving fuel economy of vehicles lies not only with a CVT, but with modifying engine operation to fully utilize the capabilities of a CVT. For example, Kasmer offers that a car may cruise at highway speed with the engine running at around 3,000 rpm. But he says engines generate enough torque to cruise at 600 rpm if a CVT is applied. Some of his other studies have delved into acceleration and traction control.

For more information on the Hydristor, visit www.hydristor.com or e-mail tkasmer@yahoo.com

Pressure drop may affect Hydraulic system efficiency

As a general rule, when choosing hydraulic hose to transmit fluid under pressure, it's best to allow a generous margin of safety.

Typically for dynamic hydraulic applications, the minimum burst pressure rating is four times that of the maximum working pressure rating.

It also is important to allow for pressure drop that occurs between the pressure of a fluid as it enters one end of a hydraulic hose assembly and the pressure of that fluid as it leaves the other end.

According to Gates engineers, the following factors can affect the amount of pressure drop and the efficiency of the hydraulic system:

- Friction – This is the rubbing of fluid against the inside walls of the hose assembly.
- Viscosity – The lower the viscosity of a fluid, the more difficult it is to convey a fluid.
- Fluid temperature – Elevated temperature thins fluids so they are moved more easily.
- Hose I.D. – This affects the fluid velocity for the given flow rate. Higher velocities result in greater pressure drop. Therefore, a larger I.D. hose will produce less pressure drop.
- Couplings and adapters – Any change in bore or change in direction (such as with 45° or 90° elbows) can increase the amount of pressure drop. Turbulent flow can also increase if there is a change in direction. This is usually more severe when the change in direction in made in the adapter.
- Flow rate – Pressure drop increases with flow rate for the same size hose.

To learn more about hydraulic hose maintenance, including Gates free Safe Hydraulics program, go to www.gates.com/safehydraulics or call 800-777-6363.

Gates Corporation
Denver, Colorado

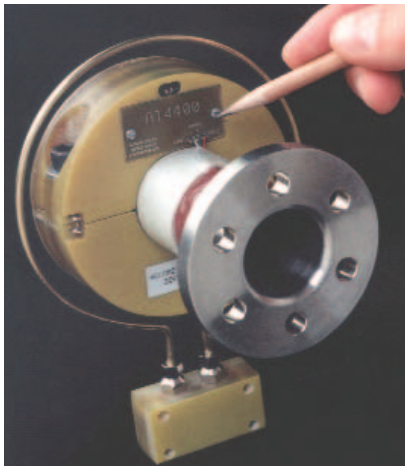
Circle **23**

System makes it easy to measure torque

Any time sensors are placed on rotating machinery, there's a problem: How do you get signals off the rotors in a reliable and accurate way that doesn't interfere with machine operation?

Rotor telemetry solves the problem by mounting miniature, rugged transmitter modules on rotors and using wireless techniques to transmit data to nearby receivers. New in this field is the 16-bit AT-4400, specifically designed to measure torque on existing shafts without machine modification or precision alignment.

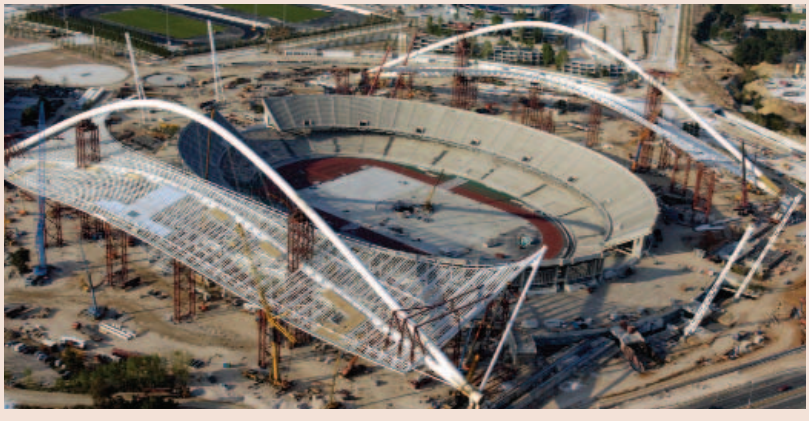
The system, from Accumetrics Associates Inc., Schenectady, N.Y., requires no calibration, and inductive power eliminates battery changes during long-term monitoring. By mounting strain gages directly on the shaft and clamping the AT-4400 split collar around it, users can obtain torque measurements without breaking existing shaft systems to install in-line transducers.



Unlike older analog FM telemetry systems, which are limited in accuracy and subject to noise and dropouts, the AT-4400 conditions and digitizes strain-gage signals within a miniature transmitter module mounted on the rotor. The device is suitable for on-vehicle testing and industrial drives.

For more information on the AT-4400, go to www.accumetrix.com.

Coming in August: Hydraulics wins over Olympics organizers



Next month, *H&P* will provide details on the role of hydraulics in creating the centerpiece of the upcoming Summer Games, the Athens Olympic Stadium. Two 940-ft arches needed to be moved into place over the reconstructed stadium — and only hydraulics could provide that kind of power.