SCRAM

According to its inventor, John Hammerbeck, the revolutionary thing about his Simple Continuous Ratio Adjusting Machine, or SCRAM, a new design in infinitely variable transmissions, is its belt. "Previous systems all use the interaction of differing diameters of wheels and/or belts to change speed," says Hammerbeck. "SCRAM uses the entirely new principle of an extendible belt constructed so that for a given input at the drive point, the belt will loop past the drive point in a fixed time however much the belt is extended. When the belt is extended, a greater length runs over an output wheel, making the output faster." One version of this system uses a tension coil spring as the belt, which is driven by lugs mounted within a hollow drive shaft and interacting between the windings of the coil. "Turning the shaft causes the lugs to propel the coil forward," says Hammerbeck. "It will be apparent, as the number of windings of the coil does not change, that for a given input RPM, the belt will pass the drive point in a fixed time."

According to Hammerbeck, this system has a number of distinct advantages over traditional gear drives and other "infinitely variable" systems as both a reduction mechanism and a speed control mechanism for both commercial and industrial applications. One of these advantages is that the technology depends on well-understood parts and processes. To the question of metal fatigue affecting the spring belt, Hammerbeck acknowledges the problem but answers, "Yes, but springs are studied and understood. The valve springs in your car do 500 million cycles while you drive 100,000 miles. Have you ever had a valve spring failure? The fatigue characteristics of compression springs are the same as extension springs." Other advantages include smooth, continuous ratio change while under power, a wide range of ratios, precise speed control, no backlash, little vibration, good heat dissipation, minimal lubrication and others. It is also easy to control, since there are no complex gear changing linkages, and easy to work on since there is no casing and no oil bath. The unit has a standard reduction of 25 to 1, which makes it suitable for high RPM input, but this can be modified to suit the application by specifying different springs or placing units in series. It can also buffer input energy, automatically storing it when output meets resistance instead of slowing the propulsion unit.

"SCRAM is an extremely cheap, light and effective ratio altering machine," says Hammerbeck, who came up with the initial idea while working to develop an accelerating moving sidewalk. "Its ability to take the most efficient, steady RPM from the power source and accelerate the system to high RPM without disengaging power gives it considerable advantages over previous systems, and its low cost will spawn new applications." Consumer applications for this technology include systems in both conventional and electric vehicles, household appliances, videotape machines, garden machinery, electric motors, bicycles and climate control. Industrial uses would include compressors and hydraulics, textile machines, machine tools, centrifuges, oil drills, lifts and conveyors, marine propulsion, wind generators and special vehicles. These last could include solar powered vehicles, lunar and amphibious vehicles, and human-powered flight. "Buffering of power could enable rowing action and, therefore, fuller utilization of body strength than cycling action," says Hammerbeck.

On the 28th of June, 2000, the Simple Continuous Ratio Adjusting Machine made its debut at the BBC Tomorrow's World Invention Fair in London, England. The two working proof-of-concept machines received what Hammerbeck calls a "tremendous response" from engineers in a variety of fields. Hammerbeck believes the range of applications for his invention is very wide because it makes continuous and automatic speed control very cheap. The unit itself has no casing and no gears to cut—just wire, plastic and fastenings. "I imagine that it might be used first in fun applications like Robot Wars," says Hammerbeck. "These devices are very easy to make, so I hope many amateurs will experiment with them."

Circle 301

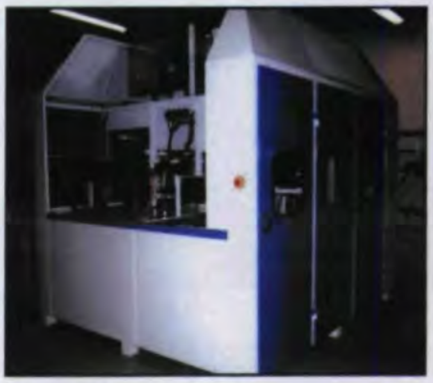
Welcome to **Revolutions**, *the column that brings you the latest, most up-to-date and easy-to-read information about the people and technology of the gear industry.* **Revolutions** *welcomes your submissions. Please send them to* **Gear Technology**, *P.O. Box 1426, Elk Grove Village, IL 60009, fax (847) 437-6618 or e-mail* **people@geartechnology.com.** *If you'd like more information about any of the articles that appear, please circle the appropriate number on the Reader Service Card.*

New Currents in Deburring

Most metalworking processes leave burrs and other attached material residues that need to be removed before a part can be put into service. The more complex the part, the more difficult the task of finishing it. Now, from 3CD Gradningsteknologi AB, we have a deburring and polishing process that works with even the most complex and difficult to machine parts. Called the 3CD Process, this electrolytic polishing and deburring method promises to leave parts burr-free, with smooth edges and corners and a soft, clean surface with a lower Ra-value.

The Process. For simple workpieces, the part to be processed is connected to the machine as an anode (positive pole) in a direct current voltage circuit with a cathode (negative pole). An electrolyte solution (electrically conductive fluid) consisting of glycol and three different ammonium salts completes the circuit. This solution maintains a pH level of 6–7 and has a working temperature of 15–20° C.

According to Bo Magnusson, marketing manager for 3CD Gradningsteknologi AB, "In the electrolyte, there are free negatively charged chlorine and positively charged ammonia ions. When the current circuit is established, the chlorine ions move towards the anode and at the surface join the positvely charged iron ions, removing them from the work piece/ anode. In the electrolyte, the molecule splits and the iron ions join free OH-ions



The 3CD deburring process.

and fall to the bottom as $Fe(OH)_2$. The OH-ions form as a result of the electron movement in the current circuit. At the cathode, water molecules are split into an H_2 gas and OH-ions. When the current circuit is established, the ions and the electrons move along current lines. These are most frequently located on the corners and edges of the workpiece, where you find more deburring activity."

After completing the deburring and polishing process, the part is then washed and rinsed. For more complex pieces, locally positioned auxiliary electrodes are used to direct the current. When deburring or polishing interior spaces on a part, such as intersecting holes, the process can be performed on a specially designed rig with auxiliary cathodes applied to the areas where deburring is to be carried out. In these cases, the electrolyte is routed to the area to be machined by means of a hose and drained via a collection pan into a pump-fitted system tank.

Material removal is directly proportional to the current strength and time. However, the material removal rate is also influenced by such parameters as the composition concentration, flow, temperature, electrolyte conductivity, the tendency of the metal to become passive, and the alignment and pulsation of the current. Still, the process is entirely safe for the workpiece, says Magnusson. "The electricity does not affect the work piece at all," he explains. "The deburring process can also offer the positive effect of removing cracks from the surface." The process is designed to handle burrs that are less than 2 mm in size and is capable of processing a part in 2–4 minutes when the burrs are about 1 mm in size.

Parts and Tooling. All parts can be treated. However the method is most profitable for parts with a certain value and with a high demand for burr-free surfaces. The size of the parts that may be treated depends on whether they must be placed in the electrolyte or not. Large surfaces demand more voltage, and the burrs on them tend to be less concentrated. Whether a hole can be treated depends on its depth, placement and diameter. Normally, holes with diameters of 2 mm or more can be treated. Threads on a part tend not to be a problem.

Different parts on a gear are usually deburred separately, although gear rings can be deburred all at once. "Any gear part can be deburred, but you have to use special cathodes/tools for different parts," says Magnusson. "Depending on the production method, you can transport the parts on a belt conveyor or pick-and-place robot into the deburring area, automatically apply the tools to the parts, deburr, remove the tools and then restart the conveyor or robot for the next part."

Materials and Tolerances. Any electrically conductive material, with the exceptions of titanium and zinc alloys, can be treated. Alloys with silicon and carbon can be processed; however each poses its own unique problems. The surface of alloys with silicon end the process covered with silicon oxide. Carbon content decreases the effectiveness of the process in proportion to its amount. In other words, the more carbon, the less effective is the process. Under normal circumstances, the metal removal rate for the process is 0.005 mm/min, a rate Magnusson says designers can count on when working out part tolerances.

The metal that is removed is discharged as hydroxide sludge. This could be environmentally hazardous if the machined components contain heavy or toxic metals. For this reason, sludge from the electrolyte bath and rinsing water must be separated before being discharged. 3CD Gradningsteknologi AB offers its customers solutions and equipment for this type of materials handling.

According to 3CD Gradningsteknologi AB, the flexibility of the 3CD process and its versatile range of use offer a high level of utilization, creating economic benefits for the user. This is regardless of whether the process is being used in a short-run job shop or on an automated production line. Other benefits stem from the energy-efficiency of the process and the long service life of the electrolyte solution.

Circle 302

Improved Diamond Dresser

Continuous gear grinding is one of the most important grinding processes for the manufacture of high precision gears. The grinding wheel, formed with a rack and tooth profile, is used as a cylindrical grinding worm. The involute profile of the grinding worm is formed and maintained by the profile of a diamond dresser disk.

The quality of the gear tooth flank depends on the accuracy of the involute form of the grinding wheel. Advanced design gearboxes utilize special gear tooth forms to improve noise and operating qualities. Gear tooth modifications, such as tip and root relief created by a combination of two radii or a radius and straight line in addition to simple crowning, are formed in the grinding wheel by use of a profile form diamond dresser disk.

The lifetime of the diamond dresser disk is an important consideration in continuous gear grinding. Diamond dresser disks are available with a direct- or reverse-plated single diamond layer, or with a sintered single or multiple diamond layer. Sintered dresser disks offer a long life and have excellent corner wear characteristics. Sintered tools also utilize high dressing pressures and cannot produce as sharp a grinding wheel as can a direct plated diamond dresser disk. As a result of the excellent T.I.R and more aggressive diamond layer of the direct plated diamond dressers, the grinding wheel is more aggressive and free cutting. Direct-plated diamond dressers can be refurbished or modified by stripping and re-coating the diamond layer and/or regrinding the profile for a different tooth profile.

Sintered and direct plated diamond dresser disks can be re-lapped to restore the original involute profile; however sintered dressers cannot be re-plated.

A new generation of polycrystalline diamond (PCD) corner-reinforced, direct plated diamond dresser disks, designed and produced by Dr. Kaiser Diamond Tools, offers the advantages of both sintered and direct-plated dresser disks—high corner wear resistance and a free cutting grinding wheel. The combination of reinforcing PCD to counteract excessive edge wear on the outside diameter of the dresser disk, and direct-plated diamonds, improves gear grinding and dresser disk life equally. The direct-plated, PCD reinforced dresser disk can be stripped and recoated several times. Tooth form modifications such as tip relief or crowning, for example, can be built into the dresser disks.

The new generation PCD reinforced dresser can be utilized on all common dressing units. Small module applications offer a distinct opportunity for process improvement since the small width of the dresser disk can wear quickly. The PCD reinforcement leads to exceedingly long diamond dresser life, particularly if a separate root reliever cannot be utilized.

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