Redesigned mower brake STOPS *on a* DIME

Engineers meet stop-time requirements by tripling the braking torque with a unique design

Karen Auguston Field, Executive Editor, *Design News*

One summer day when I was about 7 years old, I lost control of a manual push-mower on a downhill stretch of our lawn, running directly over a sandal I'd kicked off in the grass earlier. I remember my mother nearly fainting at the sight of the tattered ribbons of rubber, automatically glancing down to make sure that I still had five toes remaining on each foot.

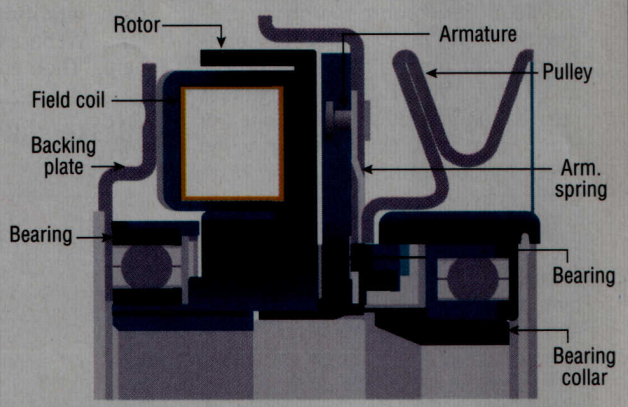
Controlling the whirling blades of lawn tractors and mowers is always a major concern for engineers who design this type of equipment. But figuring out how to achieve a quick braking time for a new line of lawn tractors was a particular challenge recently for Simplicity Manufacturing. The Port Washington, WI-based company was developing its first "center-discharge" tractor for both the European and U.S. markets.

Unlike the popular side-discharge style of tractor, which simply shoots the grass clippings out the side of the mowing deck onto the lawn, a center-discharge unit directs them into a rear collection bin. But in order to move the clippings from point A to a new point B efficiently, engineers had to modify the design of the power transmission system and increase the mass of the blades.

"In our traditional mower deck, the blades are connected by a V-belt, so that the belt actually tends to slip when you apply the brake–that's an advantage," says Steve Weber, a senior project engineer who has been designing lawn equipment for 14 years. "Compounding the problem, the two blades in our new design are held together with a timing belt, so that the inertia of both blades is directly connected to the clutch. Add in the fact that the blades on this style mower are considerably larger, with more mass concentrated at their ends, and we have quite a bit more inertia in this design."

Overcoming inertia. Unfortunately, the increased inertia prevented engineers from meeting stop time and durability requirements set by the Outdoor Power Equipment Industry (OPEI). These requirements specify that the blades must come to a complete stop five seconds from when the brakes are first applied, and that the braking system must continue to perform at this level after 5,000 on/off cycles.

Simplicity's clutch/brake assembly



When the clutch is engaged on this electromechanical brake/clutch system from Ogura, power is supplied directly to the blades on Simplicity's new center-discharge tractor mower. When the coil voltage is released, a mechanical brake engages and slows the blades. Increasing the thickness of the leaf springs that pull the armature against the brake increases the torque, reducing the braking time.

■ VENDOR-SUPPLIED COMPANY PROFILE

Boards put computer power to work

National Instruments emerged from the garage of its co-founder and CEO, Dr. James Truchard, to become an industry leader in computer-based measurement and automation. Truchard, Jeff Kodosky, and Bill Nowlin founded the company in Austin, Texas in 1976, and National Instruments introduced its first product in 1977. It was a computer board that allowed engineers and scientists to use a computer to control scientific instruments that measure physical phenomena, such as temperature, pressure, and voltage.

Rapid growth began in 1983 when the company introduced a mainstream computer board for IBM personal computers that let users control instruments. Three years later the company introduced LabVIEW™, a graphical programming language that has become a leading software environment for programming instruments in all major computer platforms, including Windows, Macintosh, and Linux. With LabVIEW, engineers create programs by stringing together icons into flow charts—there is no need for programming with text-based code.

Today, National Instruments offers product lines to a wide variety of engineers and scientists. The company manufactures hundreds of software and hardware products, which, when combined with industry-standard computers, can not only control traditional scientific instruments but in many cases can replace these instruments with powerful boards that fit inside computers. These boards use the increasing power of desktop and portable computers to acquire, analyze, and display data.

Engineers also use National Instruments software and measurement products to acquire data for automating processes—from controlling machines and opening valves to filling and monitoring storage tanks. For example, the Spoetzl Brewery in Shiner, TX, uses National Instruments products to increase productivity while maintaining a quality blend of ingredients in its beer. Circle 830

Simplicity's new center-discharge motor meets the outdoor equipment industry's requirements for stop time and durability.

Simplicity engineers planned to use an electromechanical clutch/brake system from Ogura Industrial (Somerset, NJ). In this type of design (see diagram), a voltage is applied to a coil, which produces a magnetic flux. This flux causes the rotor, which is mounted on the input shaft and provides the input rotation, to pull in. The magnetic flux is then transferred to the armature, which is the output of the clutch. When the voltage to the coil is cut off, the armature is released and pulled back via leaf springs against the brake shroud, which helps to slow the blades.

However, the 2.2 ft-lbs of torque provided by Ogura's standard PTO clutch/brake assembly was not sufficient to meet Simplicity's stop-time requirements. "Although the clutch initially met the stop-time requirements, it failed after just a few hundred cycles," says Weber. "We suspected it was because of all of the inertia, which was wearing out the brake that much quicker."

Without any real alternatives other than modifying the clutch/brake system, Weber went back to Ogura for help. "Their engineers have had so much experience in applying the technology to similar outdoor power equipment that we felt confident they could find a way to increase the brake torque in the assembly," says Weber.

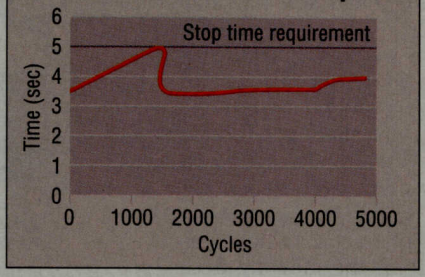
One major constraint was that the physical dimensions of the clutch/brake system could not be changed. But after some experimenting, Ogura engineers discovered that they could triple the brake force (from 2.2 to 6.6 ft-lbs) simply by changing the thickness of the leaf springs in the armature assembly. The greater frictional force against the internal brake shroud increases the torque, thereby reducing the amount of time required for the blades to come to a complete stop.

Depending on the specific inertia of the system, the leaf springs can be adjusted in thickness to produce less or more torque. In addition, the springs can be adjusted as the friction surface wears, providing constant torque even after thousands of cycles.

Simplicity engineers found that the clutch had an initial wear-in period of 1,500 cycles, after which it was necessary to readjust the clutch. After this adjustment, the blade stop time remained below the five second threshold.

By all accounts, Simplicity's new mower line has been a success. The product has taken the European market by storm, and will soon be introduced here in the U.S.

Brake/clutch meets the specs



Simplicity engineers found that the clutch had an initial wear-in period of 1,500 cycles, after which readjustment was necessary. Afterward, the blade stop time remained below the five-second threshold set in the specs. There are two reasons why the stopping time increases at the outset, before leveling off. First, both the clutch and the brake burnish in. However, the brake does not see as much force as the clutch so it takes considerably longer for steel points to wear down. Second, when the stop time increases and the clutch is readjusted (air gap reduced), part of the clutch face is worn away. The result is that the readjusted clutch has brake springs that are stressed further than they were initially.

For more information

Clutch/brake system from Ogura Industrial Circle 772