Floating armature speeds response

Zero-gap clutch/brake is one of the design secrets behind Pitney Bowes' newest mailing machine

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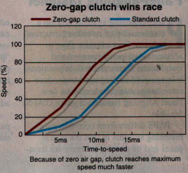
T*okyo, Japan*—Early in the design of Pitney Bowes' 14 Series high-speed insertion machine, engineers realized they would need a clutch/brake solution that could perform significantly better than conventional electromagnetic technology. A zero-gap clutch/brake design proved the answer. Developed by Ogura Industrial Corp., the system features an armature that floats on a splined hub allowing it to move axially for featherlight contact with the rotor.

Problem. Designed to fold, insert, and apply postage to customer statements, the new Pitney Bowes machine had a process goal of nearly four sheets per second. When the time for a sheet of paper to physically move between three buffer stations within the machine is factored in, the clutch has a mere 25 msec to respond.

A conventional electromechanical clutch takes about 35 msec to reach full speed from the time voltage is applied to the coil—too slow. Also, the faster cycle time required by the new machine meant components would wear out quicker. Engineers estimated they would have to improve life expectancy of the clutch/brake system by an order of magnitude.

While servo technology initially appeared to be an option, Pitney Bowes Technical Advisor John Sussmeier explains that engineers could not justify cost. "With servo, we would have needed a separate controller for each of the three motors in our machine." Increasing voltage was another alternative, but Sussmeier says this approach led to concerns about thermal management. "When you double the voltage, you quadruple the power, and then you have a heat problem."

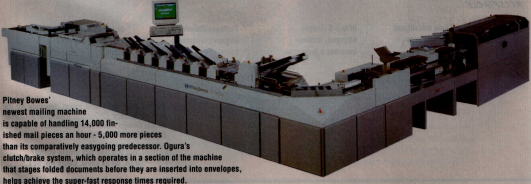
Solutions. The Ogura clutch/brake overcomes the time-to-speed issue in two ways. First, in order to increase torque, it uses a low-inductance/high-efficiency coil to generate a magnetic field more quickly than standard coils. Second, it eliminates the air gap completely.



In head-to-head testing, Ogura's zero-gap clutch/brake design outperformed the competition by reaching maximum speed faster.

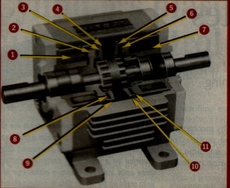
Conventional electromechanical designs have a space of about 0.25 mm between armature and rotor. Since magnetic field strength is a function of the inverse square of the distance, this gap has an adverse impact on cycle time: The larger the gap, the longer it takes for the coil to build up sufficient voltage to pull in the armature.

Ogura's zero-gap clutch features a "floating" armature mounted on a splined hub. Instead of requiring a leaf spring for rotor disengagement, the armature "floats" axially in response to the rotor's magnetic field. Fast cycle times, therefore, mean the armature has little time to move away from the rotor. Result: the rotor's residual magnetic field is strong enough to maintain light contact with the armature between cycles.



Pitney Bowes' newest mailing machine is capable of handling 14,000 finished mail pieces an hour - 5,000 more pieces than its comparatively easygoing predecessor. Ogura's clutch/brake system, which operates in a section of the machine that stages folded documents before they are inserted into envelopes, helps achieve the super-fast response times required.

Anatomy of a zero-gap clutch/brake



1. clutch coil
2. clutch rotor
3. zero air gap
4. ceramic friction material
5. zero air gap
6. ceramic friction material
7. brake coil in coil shell
8. ceramic friction material
9. zero gap
10. brake armature
11. ceramic friction material

With the armature and rotor in constant contact, engineers needed a friction material that was hard enough to resist wear and meet the daunting life cycle requirements, yet hold some residual magnetism.

A ceramic composite material made exclusively for Ogura for use in clutch/brake applications satisfied the need. Although engineers would not divulge the exact composition of the material, they claim that its hardness is 2.5 to 3 times better than bearing or hardened steel. To minimize wear of the armature, they also used a nitrided chemical surface hardening treatment.

Performance. So good were these design changes, that after conducting a head-to-head comparison of several brake designs, Pitney Bowes' Sussmeier was surprised with the test results. "We thought wear on the friction surfaces would be a problem, but after 7 million cycles, they showed only about 0.10 mm of wear. With those kind of numbers, we estimate that the clutch/brake will last at least 25 million cycles—well within our requirements." **gdn**

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