BY DAVID R BRYCE • DATARAM CORP

It's an electromagnetic-mechanical world

In the late 1980s, I was working on a currency counter that included an option to detect counterfeit currency. The counter's mechanism consisted of shaft-mounted rollers that transported the bills, one by one, through the machine. A dc motor drove the system, which would guide the bills over a magnetic pickup head where the system would generate different signals depending upon the type of ink the printing process used. In this way, it could detect the ink used on counterfeit currency.

The system applied the weak signal from the magnetic pickup head to a high-gain instrumentation amplifier before some simple analog processing. On some machines, a troublesome noise spike appeared in the signal. We did not correlate the noise with the passage of the currency notes, but its repetition rate varied as we changed the motor speed. In addition, slowing the transport mechanism diminished the amplitude of the noise spike, although the spike never went away, even with the system operating at its lowest speed.

I was tempted to accuse the motor or its control circuitry of injecting the noise, but I had seen quite a bit of motor noise by this time in my career, and it just didn't look the same. In my experience, noise from dc motors tended to resemble broadband noise and was continuous; the noise I was seeing was as spiky as an electrocardiogram.

To rule out the motor, I killed the power supply to the motor-control circuitry. Then, I forced the transport mechanism to move by pulling on a drive belt as fast as I could. The result was significantly slower than the motor could have achieved but fast enough to show that the noise spike was still there. I had vindicated the motor.

By judiciously disconnecting belts and pulleys, I narrowed down the field of search to the rotation of a single shaft and its attached rollers. When I removed the rollers, the noise disappeared; when I replaced the same rollers on the shaft, the noise returned.

I examined the rollers—not much more than aluminum hubs covered with a rubbery surface, neither of which seemed likely to cause electrical noise. I pondered more, idly fingering the Allen wrench I used to loosen the set screws that held the rollers to their shaft. Aha! The set screws! The tiny *steel* set screws had somehow become little magnets, rotating with the shaft only a few inches away from a magnetic pickup head. I had a flashback to my childhood, when my father showed me how moving a magnet near a coil of wire would make an oscilloscope trace jump and wiggle. Same effect; different decade.

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I solved the noise-spike problem by changing the set screws to screws made of nonmagnetic stainless steel. Then I went home and called my dad. EDN

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