A Simple Clutch-Connector for the Mini-Mill Power Table Feed

BY JOHN KRUEGER

The power feed option for my Asian mini-mill provides a uniform surface cut that is superior to that achieved by cranking the table by hand, and it certainly reduces a lot of effort in other tasks. But, I hadn't anticipated the annoying degree of extra drag due to the load imposed by the power feed's stepper motor when I'm manually displacing the table, which, of course, is just as often as not.

So the power feed sat disconnected, awaiting a clutch mechanism suitable for limited machining skills. I have seen a description on the Internet of a lever-engaged gear mechanism to connect a scratch-built power feed. That approach can add a mechanical advantage, but it requires scrounging, purchasing, or cutting gears. Having more parts, it seemed like more work. I also wanted a mechanism that fit within the unit as purchased, and that occupied no more space that could encroach upon the table's allowable excursion.

The solution was a simple clutch-connect that replaces the original coupling between the motor shaft and the slot in the end of the X-axis feed screw. It is easy to build and, being small, it occupies the same amount of space as the original coupling, which it simply replaces. As a simple compressible clutch, it also adds a versatile feature that could be exploited for uncoupling the power feed at a pre-selected position, which I describe in the discussion.

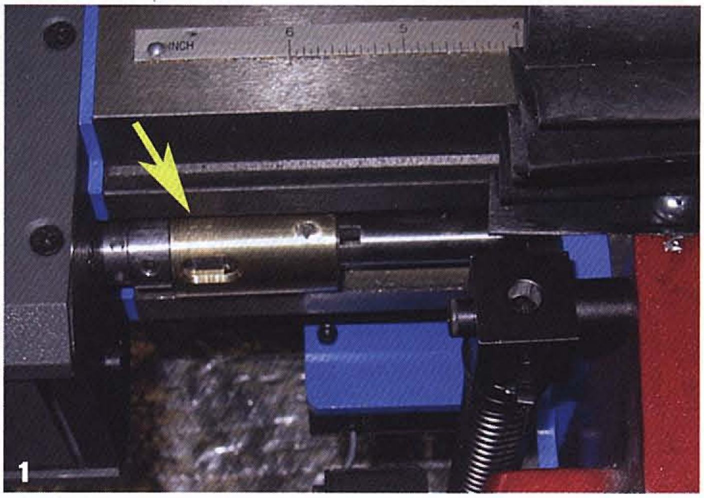
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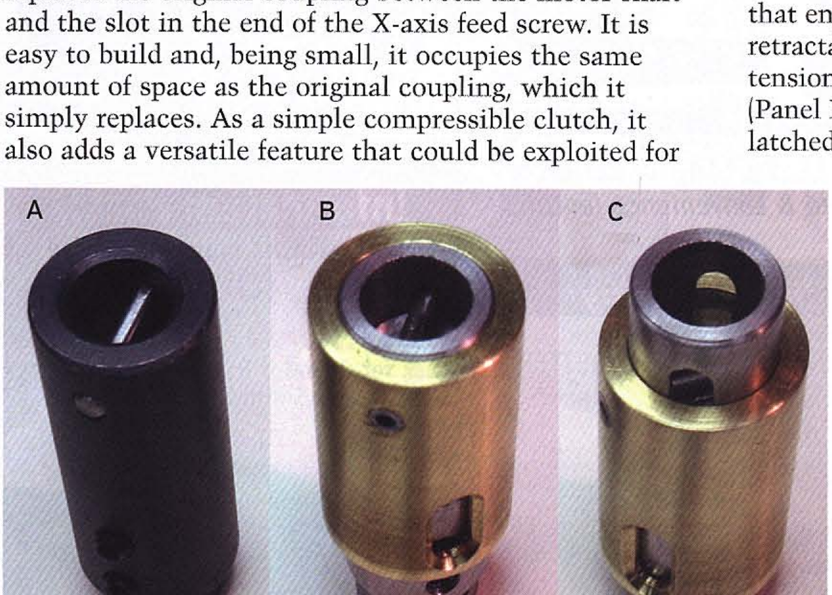
Photo 2 compares the original connector that was supplied with the power feed (Panel A) and my connector in its two positions (Panels B and C). The tension pin that engages the slot in the feed screw is attached to a retractable brass sleeve. In the "extended" position, the tension pin engages the slot in the mill's drive screw (Panel B), as did the original coupler. In the retracted, or latched, position, the tension pin is withdrawn from the drive screw and locked in a latchment consisting of a pair of opposed J-slots in the steel core (Panel C). For reference scale, the tips of a caliper are shown at the bottom of Photo 2, separated at 1".



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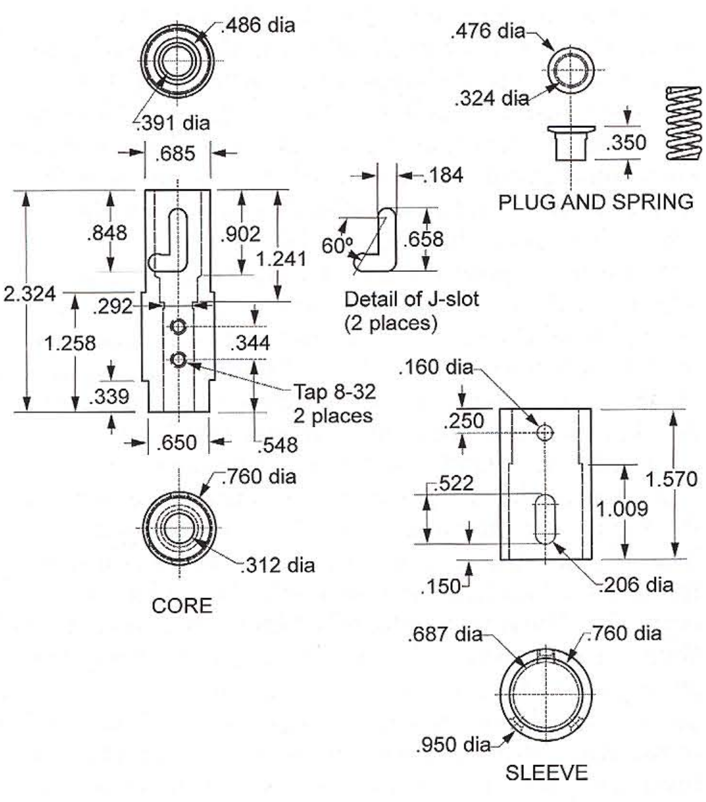
The clutch connector has only five components (excluding setscrews): 1) An external brass sleeve that has diametrically opposed holes for friction fit of 2) a tension pin that engages the slot at the end of the feed screw controlling the mill's X-axis excursion, and 3) an inner steel core with a latchment consisted of two opposed J-slots. The latchment permits the tension pin (and sleeve assembly) to extend to the top of the "J" to couple the power feed to the feed screw, or to hold the sleeve and tension pin in a retracted position at the bottom of the "J." Finally, 4) an aluminum plug that abuts against the tension pin is snug fit into 5) a coil spring (Photo 3). Importantly, only three of the five components need to be constructed. The connector is completed with two setscrews that secure the core to the shaft of the power feed's motor.

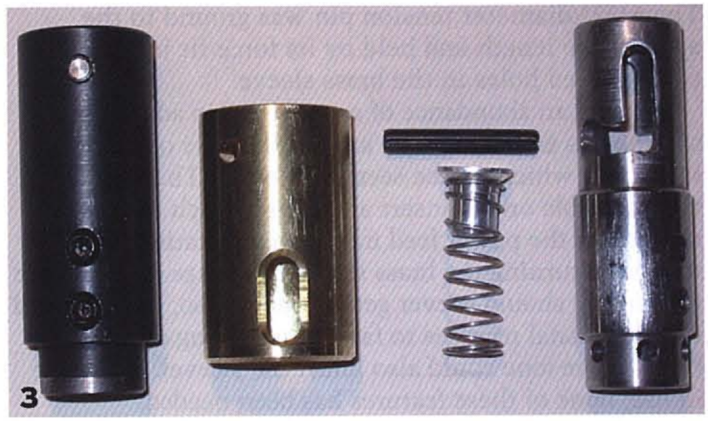
DIMENSIONS

Detail 1 illustrates the dimensions of the pieces of the clutch-connector. Note that the tapped holes and access ports are circumferentially displaced relative to the prototype to simplify drawing. All dimensions are given in inches, and tolerances are more generous than I've shown. These dimensions are based on my measurements of the power feed option from Micro-Mark (the stepper motor assembly that appears visually the same as that provided by *Littlemachineshop.com*), and the Micro-Mark (No. 82573) version of the Asian mini-mill. I understand the same factory (Sieg) also makes the mini-mills offered by Grizzly, Harbor Freight, Homier, and Cummins Industrial Tool, but with slight differences in dimensions. The key dimension to check would be the clearance of the worm drive and the separation between the bottom of the table and the mill's saddle (see later discussion). It would be surprising if those dimensions in the latter mills differed significantly.



MATERIALS

I used brass for the outer sleeve. The sleeve bears little mechanical stress since it only serves to move the tension pin to one of the two positions in the J-latch. Any force with power feed is transmitted directly between the tension pin and inner steel core, which holds the unit in the retracted, unloaded, latched, or the extended unlatched position to couple the drive feed. The 3/4" in diameter inner core was constructed of tool steel, simply because it was on hand. One could use the original connector as the material for the core (Photo 3). In this case, you might want to add a sleeve to get firmer seating for the coil spring. The end plug for the coil spring was made of aluminum. The coil spring (No. 148, 1-5/32" × 3/8" × .028"), the tension pin (5/32" × 1", ground to a length of .950"), and the setscrews (8-32 × 3/16") were purchased at the local hardware store.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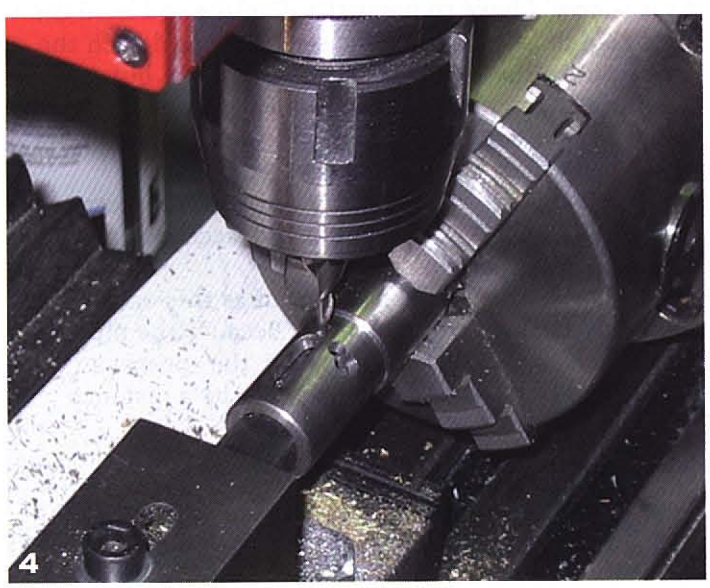
CONSTRUCTION

Construction is straightforward. The vertical part of the J-slot was milled out first with a 3/16" end mill. Next, the base of the J-slot was made by rotating the core 60° clockwise and milling out the far end of the base of the "J." The hole should be extended approximately .04" away from the base to create a secure seating to hold the connector in the retracted latched position. Using the small tip of a centering drill (Photo 5), as much of the slot for the J-hatch as possible was removed. The remaining base of the slot was milled with the 3/16" end mill by rotating the indexing table. All edges of the slot were smoothed.

The brass sleeve was bored to the dimensions shown, the access holes for the setscrews were milled out with a 3/16" end mill, and the beveled edge for each was then added with a 3/8" ball nose end mill.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The 5/32" diameter tension pin was ground to the appropriate length and held by its force-fit into the two opposed holes in the brass sleeve.

Out of an abundance of caution, I also added six small holes equally spaced around the base of the inner steel core, which can be seen in Photo 3. The idea was they'd enable one to insert an Allen wrench to lock the rotation of the power feed motor shaft rotation while manually turning the brass sleeve to engage or disengage the clutch, should it ever get jammed. Also, I have added two additional recesses to facilitate holding onto the brass sleeve (one could also knurl the sleeve). However, in use, none of these features has been needed.

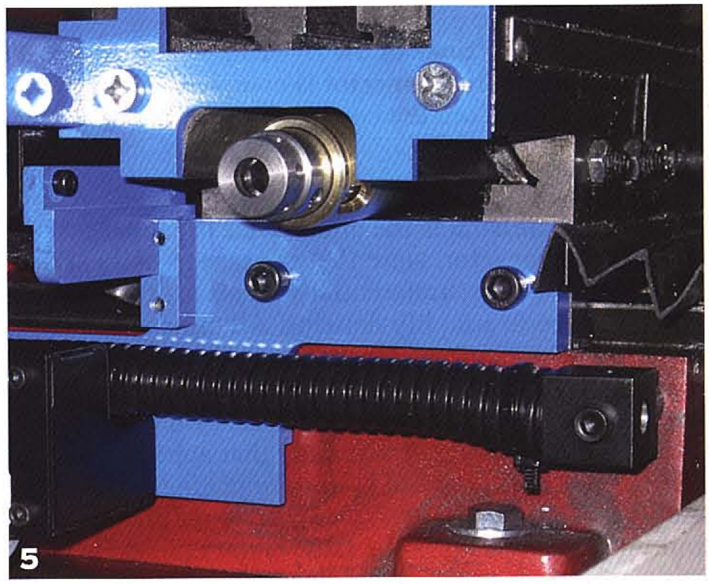
Relative to design, the only element that proved sticky was the plug capping end of the coil spring, since its sharp edge, at its widest diameter, occasionally grabbed the lower edge of the J-slot, thus causing the sleeve to stick in the retracted uncoupled position. Simply filing the inner edges of the J-latchment and adding a bevel to the top lip of the plug eliminated the problem. In retrospect, it would be better to make the plug slightly spherical at its widest diameter so there would be no edge to grab. Any adjustment of the height of the plug, however, will require lowering its seating in the core so that it does not impede the spring pin's access to the J-slot's latchment. The clearance between the top of the plug and the bottom of the J-latchment should be confirmed prior to final assembly.

DISCUSSION

The little clutch connector works great. The dimensions given should work for the mini-mill and motor described. They ought to be close to the other Asian mini-mills, but be sure to confirm the clearance between the saddle and the bottom of the table on your particular mini-mill (Photo 5). If you make the connector, think about the options for assembly and about the two slight changes in design.

First, a comment about assembly: I've shown three access ports in the sleeve, since they also serve as finger grips. With two access ports, there are two useful ways to assemble the sleeve with respect to the core. As it is now, I have to manually displace and hold the brass ring to get access to the setscrews to detach the coupler from the motor. That's no problem, but it is "klutzy." Reorienting the sleeve by about 180° (with respect to the core) would have allowed the setscrews to be accessed in the sleeve-retracted position. Alternatively, one could simply add another access port displaced 60° CCW. That would give access to the setscrews in either position.

Second, even as simple a project as this one generates ideas for improvement. Because the plug capping coil spring has a flat spring, the spring can technically only push the tension pin by a distance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equal to the latter's diameter into the slot of the feed drive. However, this pin does appear to extend itself further into the slot, probably by acceleration due to release of energy of the compressed spring, and it remains in that position. In principle, the tension pin might be forced to extend itself (by the twisting action of the motor) by simply widening the channel slightly at the apex of the J-slot. Also, the addition of a protrusion at the top of the plug could also be used to force the pin into the worm drive farther, but then other dimensions would have to be altered accordingly.

Third, the fact that this clutch connector uncouples with compression adds a versatile feature to the mill. One can add a mechanical stop that uncouples the power drive from the mill's feed drive at a predetermined position. This feature could be as an adjunct to the electrical safety stop to prevent damage at the end of the table's excursion, but could just was well be an adjustable stop to facilitate the cutting of channels. The connector always moves with the table. All that would be required is an adjustable stop attached to the saddle, one that abuts the end of the brass ring as the latter is drawn into the space between the saddle and the table (Photo 5). At the desired location, the stop would compress the connector into the retracted position and uncouple the feed drive. Once the clutch uncouples, the table's excursion stops. With the dimensions shown in the drawing, this occurs before the bottom of the "J" is reached, and so the connector will automatically re-couple the power feed to the worm drive when the power drive's direction is reversed or the table's excursion is reversed manually, i.e., hand-cranked, to displace the mill table to the left to decompress the connector.

Photos and drawings by Author