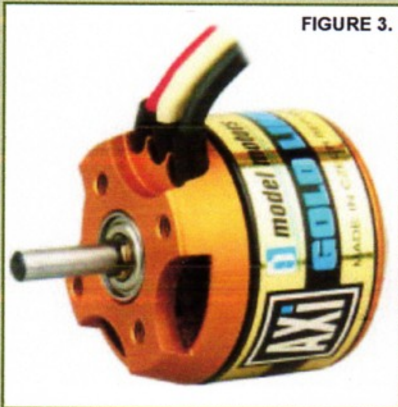

FIGURE 3.

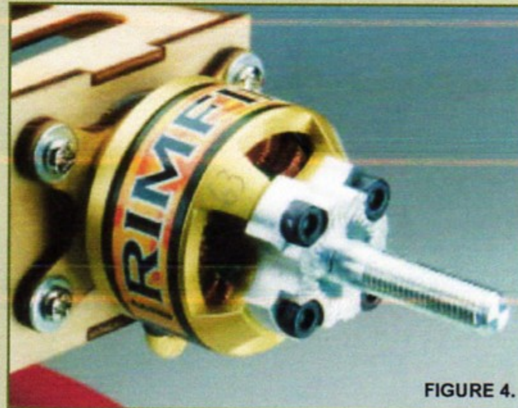

FIGURE 4.

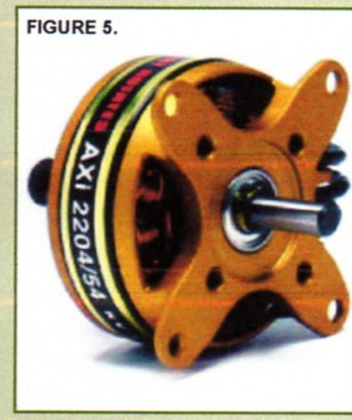

FIGURE 5.

clearance all around an outrunner, to prevent its outer spinning can from touching any structural part of the robot that could be bent during combat.

Popular brushless outrunners are the ones from Turnigy and the more expensive ones from the famous Czech Republic company AXi, pictured in **Figure 3**. We've also tested very good outrunners from E-Flite (such as E-Flite's Park 250) and Little Screamers (such as the "De Novo" model).

One important thing about outrunners is that they should be mounted "behind the firewall" for combat applications. Firewall is the flat panel, cross-shaped mount, or standoff at the front of a model airplane where the motor is attached to. Supporting the motor in front of the firewall (as shown in **Figure 4**) is a good idea in model airplanes to help the motor cool down with the aid of the propeller air flow. The motor shaft mostly sees axial loads in this case.

Pulleys used to power robot weapons put large bending forces on the motor shaft. So, for combat applications it is important to support the motor by mounting it as close to the output shaft as possible, behind the firewall, as shown in **Figure 5**.

To mount outrunner motors behind the firewall, you might need to reverse the position of the output shaft for it to stick out from the face where the firewall is attached to. This can be done through the repositioning of the shaft retaining clips or screws.

Since most brushless speed controllers do not allow the motor to reverse its spin direction during combat, the use of brushless motors in combots is usually restricted to weapons that only spin in one direction. Reversible brushless speed controllers will soon become cheap and small enough to allow their widespread use in the robot drive system, as well.

More information on brushless motors can be found in the wikipedia link at **http://en.wikipedia.org/wiki/Brushless_DC_motor**. SV

MANUFACTURING: Hobbyweight Weapon Blade and Hub

● by Pete Smith

I needed a new blade for my 12 lb Hobbyweight combat robot Surgical Strike — an existing titanium blade with steel teeth was becoming increasing bent and if it lost a tooth in a fight, then it became so unbalanced as to be useless. I had the idea of combining an easy to manufacture 7075 aluminum hub with a watercut steel blade (**Figure 1**).

The hub has an accurately bored center that allows the use of a heavy duty keyless bushing (McMaster part 1058K13) and a 5/8" case hardened steel shaft (McMaster part 6061K111). A center boss locates the blade and takes much of the stress of any hits, and six 1/4-20 hex head screws attach the two parts together.

The blade is 14" long, 1.5" wide, and 1/4" thick. I had it cut from 4140 ChromeMoly steel and hardened to RC45 by Team Whyachi (**www.teamwhyachi.com**).

I had them make a pair; the cost was less than $150 each. If you wish

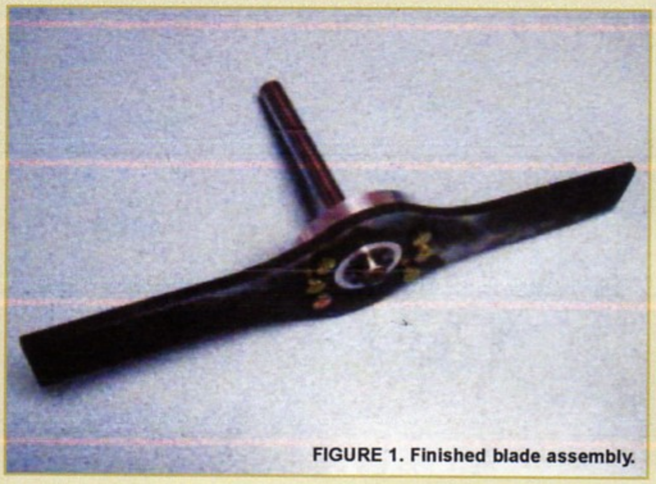
FIGURE 1. Finished blade assembly.


FIGURE 2. Face and turn to major diameter.

to make the blade yourself or have one made for you, then PDF, IGS, and DXF files are available in the article download on the *SERVO Magazine* website or through the Kitbots' website (**www.kitbots.com**).

The hub is fairly easy to make on any lathe capable of taking a 3.5" diameter workpiece.

Drawings and an IGS file for the hub are also available in the downloads.

Safety Warning: Lathes are not toys and can easily injure or kill if used incorrectly. Read and follow all the manufacturer's safety notes. Do not wear loose clothing or jewelry, and always wear safety glasses.

I secured the 3.5" diameter bar in the three jaw chuck, faced off the end, and turned the exterior down to the required 3.25" (**Figure 2**). I was making two hubs, so I turned down a long enough section to allow for the two hubs plus the two cutoffs required to separate the parts from the original bar. I used 7075 aluminum as it is one of the toughest grades available, yet still machines easily.

The boss for the blade was turned down to the correct diameter (**Figure 3**) and I test-fitted the blade to the hub to check that it was a precision fit (**Figure 4**). If the fit is too loose, it will allow the blade to become unbalanced and also adds a lot more strain on the securing screws.

The next operation required the most accuracy. The bore for the keyless bushing has the tightest tolerance; this is required to ensure that the bushing grips the hub correctly. I first center-drilled (**Figure 5**), then drilled the part (**Figure 6**) with the biggest drill bit I had. I then used a boring bit (**Figure 7**) to increase the diameter to the required dimension. This requires patience (not really my forte) and frequent measuring. I bored the hole deep enough to allow for two hubs and the required cutoffs.

I then cut off the first hub and repeated the boss machining operation to make a second hub and cut that off, as well.

I used the blade as a pattern for positioning the mounting holes in the hub. I positioned the blade on the hub and used an appropriately sized transfer punch to locate one of the holes. I then drilled and tapped that hole and then repeated the operation for the remaining holes, adding each mounting screw in turn

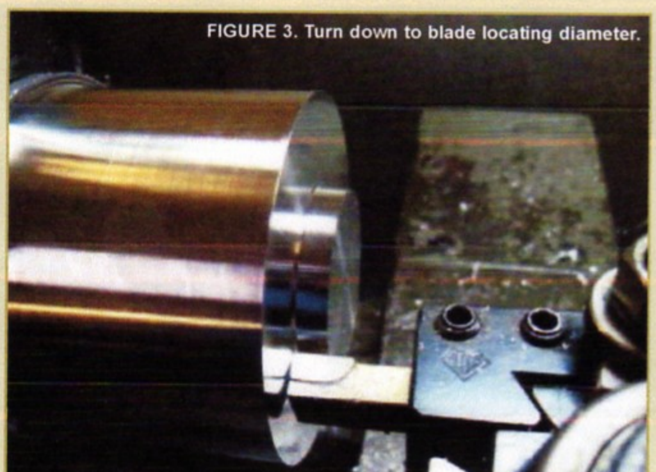
FIGURE 3. Turn down to blade locating diameter.

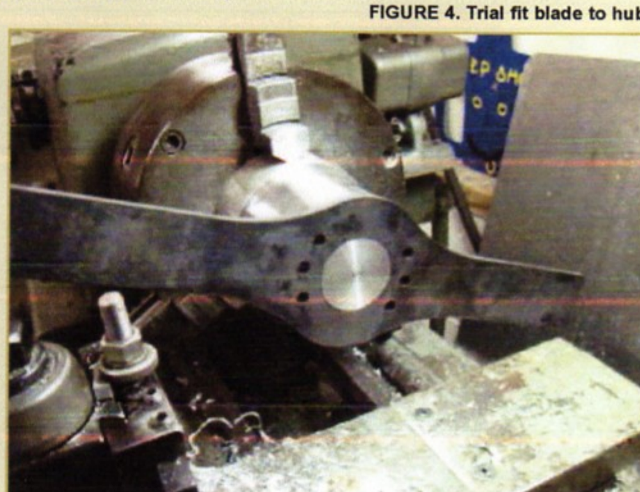
FIGURE 4. Trial fit blade to hub.

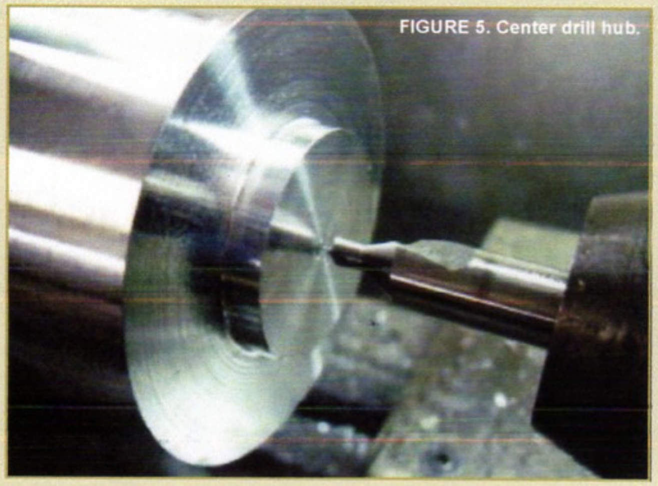
FIGURE 5. Center drill hub.

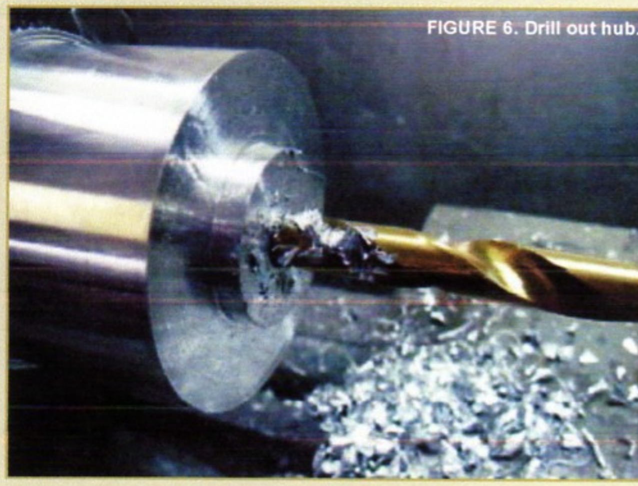
FIGURE 6. Drill out hub.

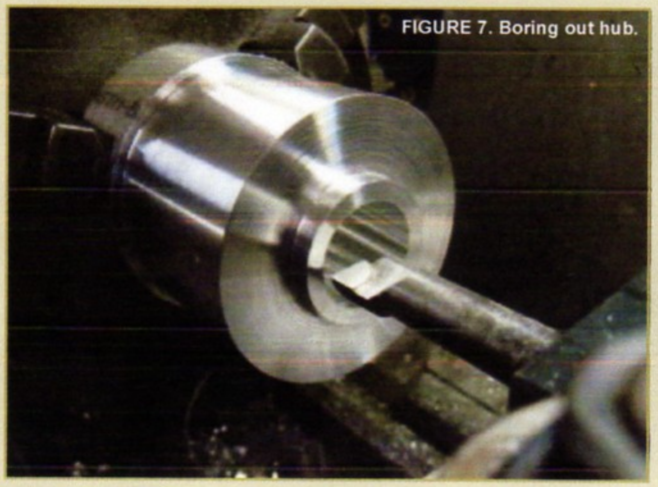
FIGURE 7. Boring out hub.

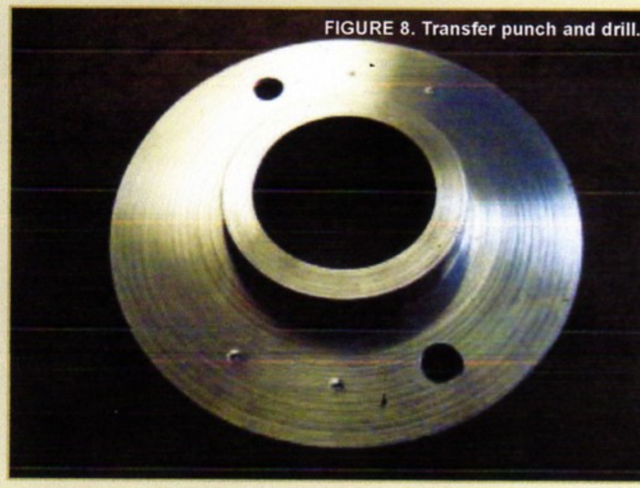
FIGURE 8. Transfer punch and drill.

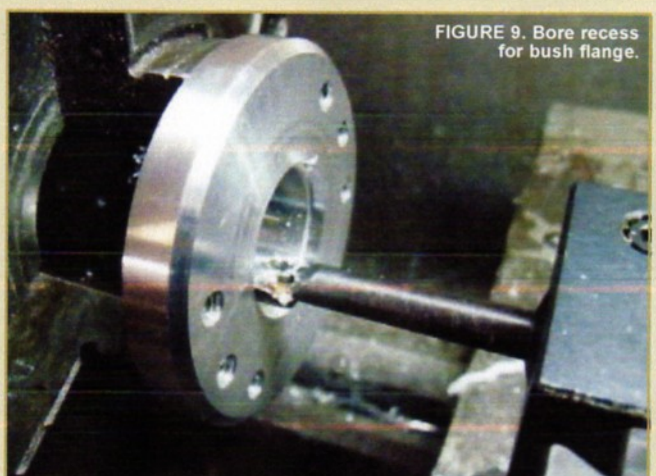
FIGURE 9. Bore recess for bush flange.

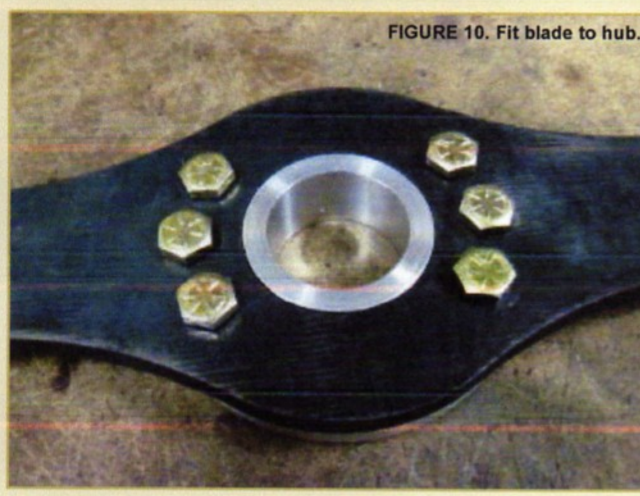
FIGURE 10. Fit blade to hub.

(**Figure 8**). This ensured that they all lined up correctly. One could use a rotary table or indexer to locate the holes, but the above method worked well enough for the small number of parts I was making.

The last machining operations were on the top side of the part. A recess was added to allow the flange of the bushing to sit flush with the top surface (this protects the expensive bushing and shortens the overall length of the assembly). This was done using the boring bar and is a simple clearance fit (**Figure 9**). I also added a small chamfer on the top outside edge to improve appearance and lose a little weight. It should be noted that neither of these operations required great accuracy or exact concentricity with the rest of the part. A three jaw chuck will produce very accurate work as long as the part is not taken