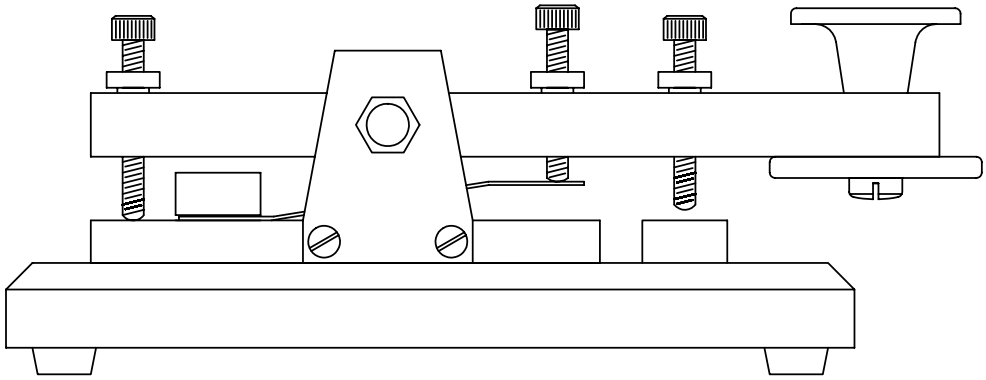
A Simple Straight Key Project

by

Richard Meiss, WB9LPU



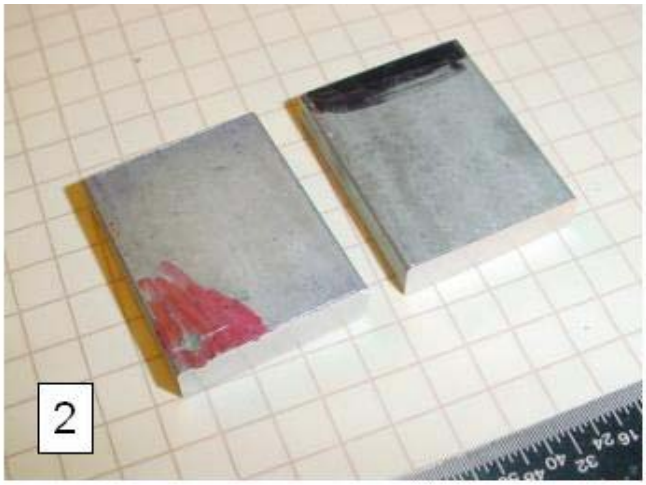
This project was designed to illustrate the kind of results that you can obtain by combining careful work with simple tools. While most home hobbyists (of the ham radio variety) do not have a milling machine or lathe, many typical home workshops contain all of the tools necessary to produce very good work. The key described here was made using a drill press, a belt sander (optional), and various common hand tools.

There were several design goals. One was simplicity of construction with a minimum of specialized tools. Another was a pleasing, even elegant, appearance. The final goal was to produce an instrument that worked as well and felt as good as an expensive commercial key.

The step-by-step instructions given will be a little more detailed than necessary so that the reasons for some of the operations can be discussed. This will give the builder the information necessary to make modifications to suit individual tastes and availability of parts. The design is such that the actual length of the various parts is not critical, so inaccurate cutting will not cause any problems with fit or appearance. Dimensioned drawings, a list of materials, and some useful shortcuts, will be given in the Notes section that follows these instructions. These directions will usually specify drill sizes in “number sizes”; the Notes section will give the fractional equivalents if number sizes are not available.

Getting Started

First cut the aluminum pieces to length. The base is made of ¼ inch flat bar stock, 1 inch wide. Measure off a 3 inch length and mark it to be cut with the combination square. It helps to coat the place where you will make the mark with red or blue magic marker; this will make your scribed mark much more visible and easy to follow. Cut the piece, using a



hacksaw, to a length of slightly more than 3 inches to allow for squaring and finishing of the ends. Cut the two supports for the pivot bearing (the “trunnion”) from more ¼ inch flat stock, also 1 inch wide. They will be 1-1/4 inches long; again, leave sufficient length to allow for finishing the ends. Cut the lever from a piece of 3/8 inch square bar stock for a finished length of 5 inches. The spring clamp and contact pad are cut from ¼ by ½ aluminum stock to a finished length of 15/16 inches (slightly less than 1 inch). See Fig. 1.

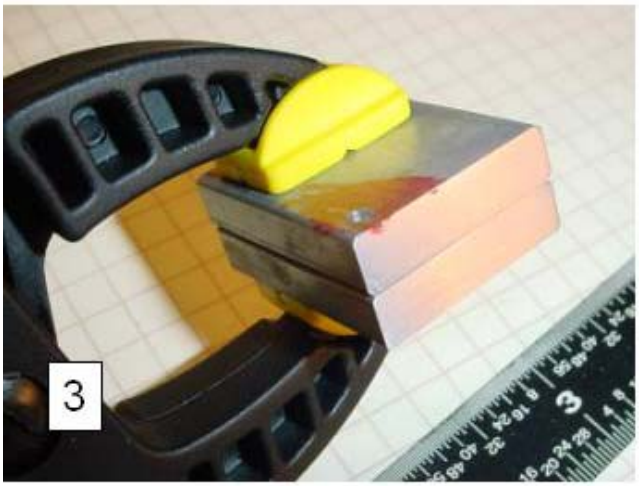
Finish and square the ends of all of these pieces with a belt sander, working slowly and keeping the work cool by dipping it into water when it gets too hot to hold. Use a sheet of sandpaper (220 grit) on a flat surface to remove the marks from the sanding belt. Get the final finish with 320 or 400 grit sandpaper. Keep checking the ends for squareness as you remove metal. Remember that with this design the actual length of the pieces does not matter, since it does not have to fit between any fixed points.

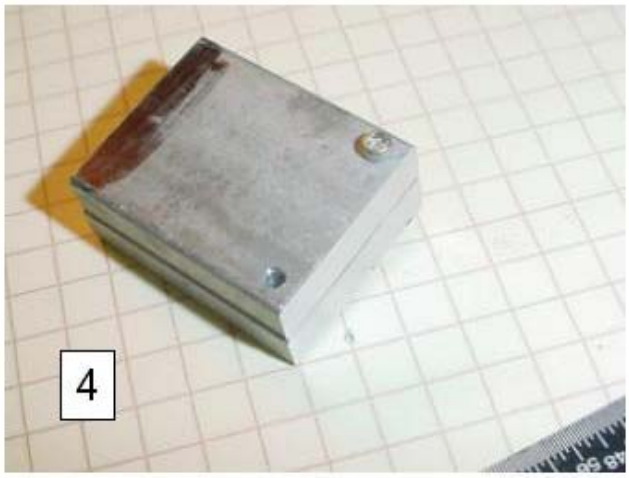
Drilling the base and trunnion supports

The first hole is the most critical, since it will serve as a guide for the rest of the holes to be drilled. See Fig. 2. Coat the side of one trunnion support with magic marker and, with your combination square set to 1/8 inch, mark a hole in the corner 1/8 inch in from the bottom and

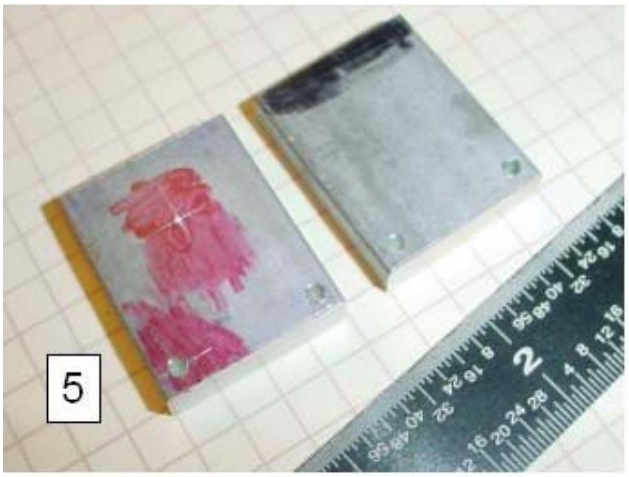
the side. Make a centerpunch mark where the lines cross. Drill a #44 hole through the mark, making sure that the piece is perfectly flat to the table of the drill press so that the hole will go straight through the workpiece. Backing the piece with a flat piece of hardwood or scrap metal will protect the drill press table and will reduce the tendency for the drill to grab as it breaks through.

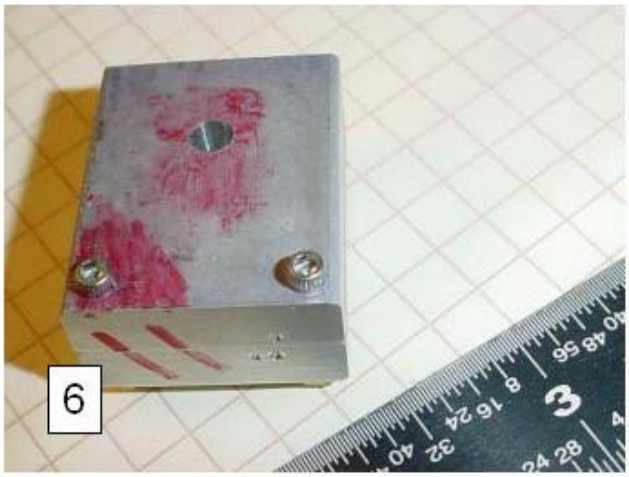
Now take the other trunnion piece and carefully align it with the drilled piece. Clamp the two pieces together (use a C-clamp or ratchet clamp – See Fig. 3). Place the drill bit through the drilled piece and continue drilling into the second piece, supporting the assembly from below with a block of wood or metal. Now each support piece has one hole in its corner. As you did above, use the drilled holes as guides to drill the other piece, aligning and clamping them as necessary – you now can bolt them together, if you'd like (Fig. 4). When you are done, you will have two pieces, each with a hole through both bottom corners. (Fig. 5)





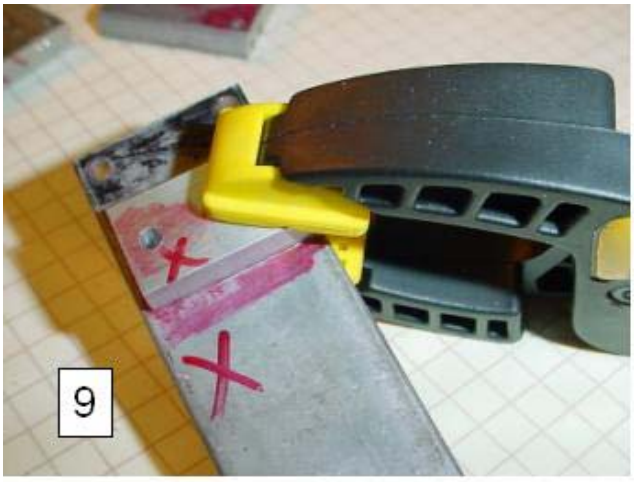
Drilling the holes for the trunnion is next. Choose one of the trunnion support pieces, and mark the position of the hole for the trunnion. (Figs. 5) Drill a #19 hole (to clear an 8-32 thread) through this piece. Using the corner holes you have drilled, bolt the two pieces together with 2-56 hardware (or clamp them as you did before). Using the drilled piece as a guide, drill the #19 hole through the other piece. Before you separate the two pieces, draw some diagonal lines across the edges of both pieces to identify their relative orientation, or otherwise mark them so that you can be sure that the holes will line up later on. (Fig. 6)

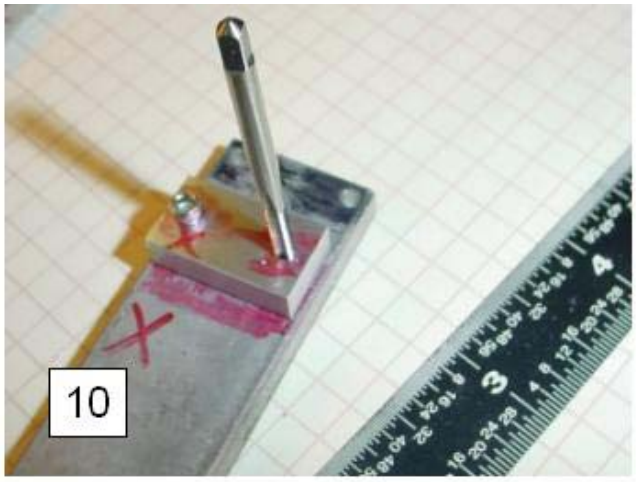




Now drill the holes in the corners of the base, using the holes in the trunnion supports as a guide. Clamp and support the pieces as you did before. Later on, you can enlarge the #43 holes in the base to clear a 4-40 screw (drill #33). See Figs. 7 & 8. Do not enlarge the holes in the trunnion supports yet.

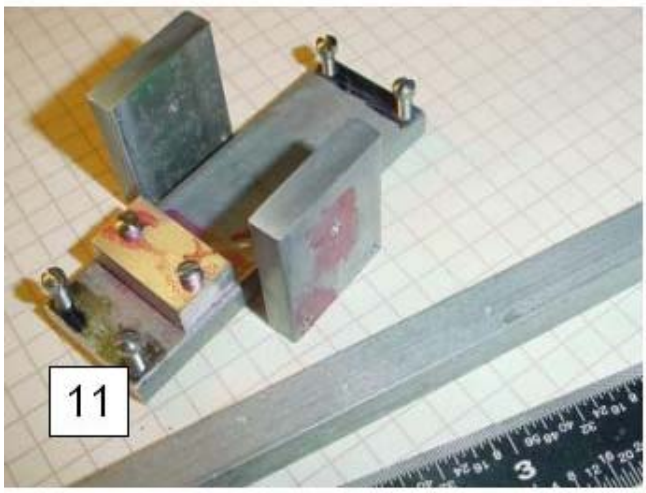
Drill the holes in the spring clamp piece and clamp it into place (Fig. 9). Then, using it as a template, drill and tap its mounting holes. Do this one hole at a time, using the first hole for a 4-40 screw to hold the piece firmly in place for drilling and tapping the other (Fig. 10). Figure 11 shows the parts in their relationship to each other.

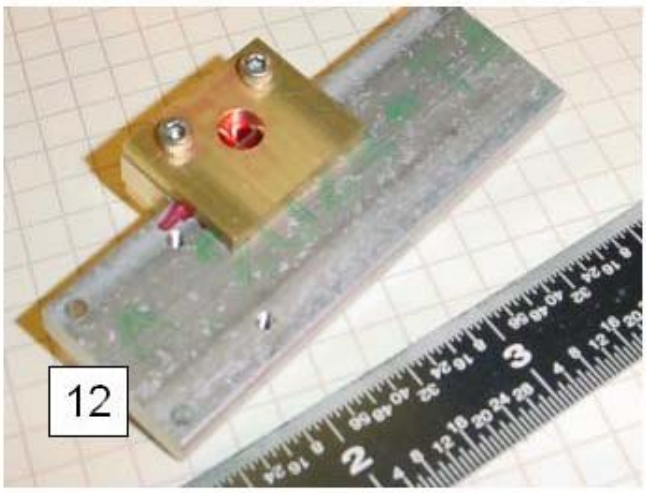




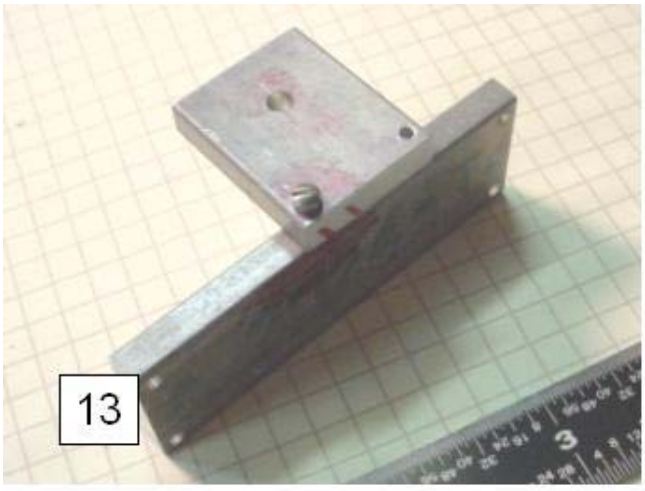
Drilling holes for mounting the trunnion supports

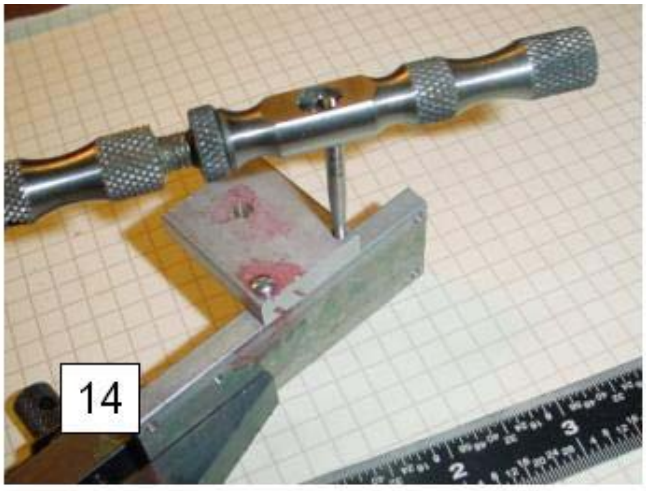
This operation will involve drilling accurately into the side of the base. Use a centering jig (described in the Notes – and see Fig. 12 below), or locate the hole carefully with your combination square set to 1/8 inches to just reach the center of the edge. Mark a location 1 3/8 inches from the far end of the base (see the dimensioned drawings). Mount the work in the vise (be sure it is squarely aligned) and drill through the jig with a #44 drill to a depth of about 5/8 inch. Now remove the drill bit from the drill press and place the 4-40 tap in the chuck.





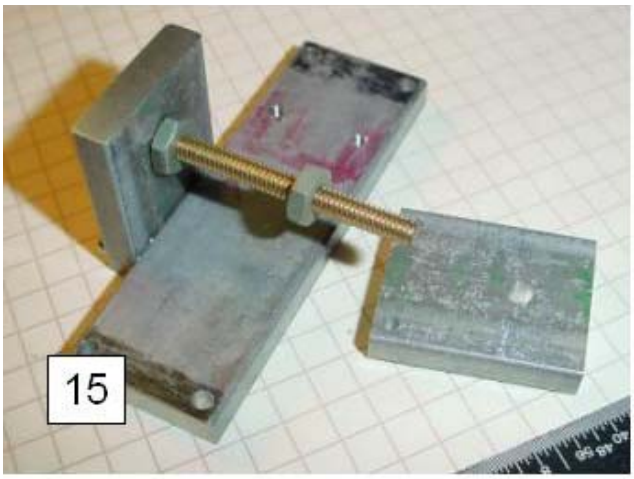
Turning the chuck by hand and using plenty of lubricant, carefully tap the hole as far as the tap will go without resistance.

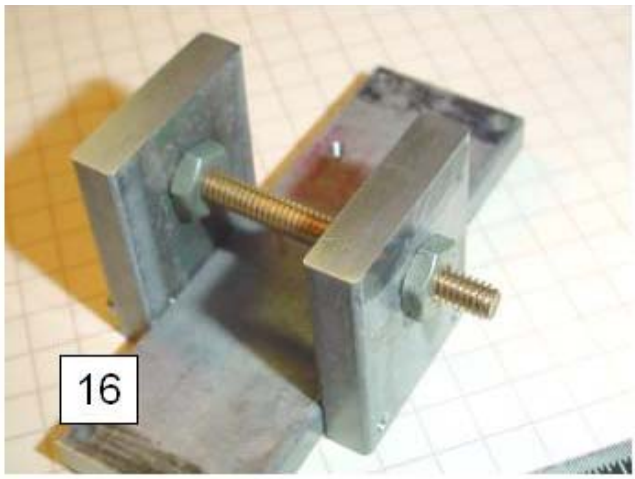




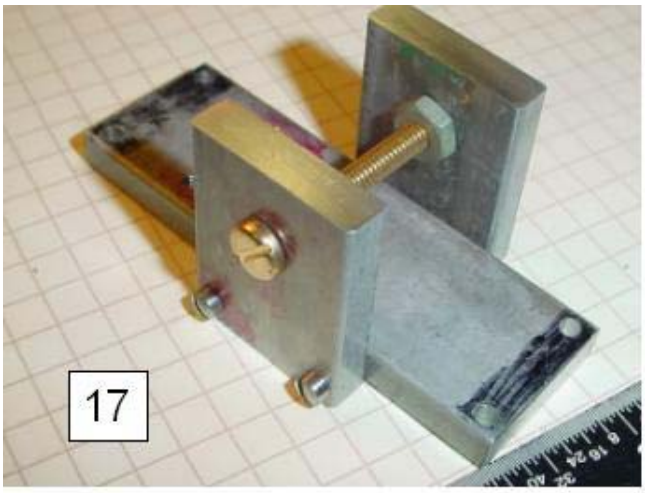
Carefully back it out and knock out the chips. Now take the appropriate trunnion support piece, and enlarge the hole that corresponds to the base-hole you just drilled. Use a #33 drill as before. With a 4-40 screw, mount the trunnion support to the base, using the hole you just threaded. Making sure that the support is properly aligned, use its other mounting hole as a guide for drilling the next hole into the base. Enlarge the hole in the trunnion support to #33 and re-align it with the hole in the base, and use it as a guide to tap the hole in the base. You can use a handheld tap wrench for this operation, or use the drill press as before. Knock the chips out of the hole, and fasten the trunnion support with both screws.

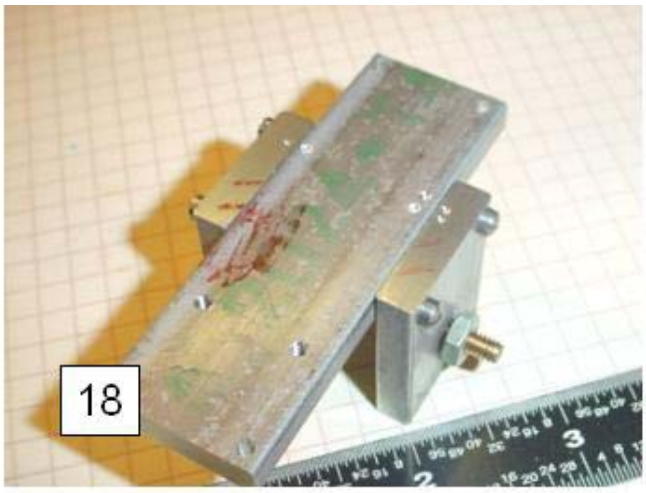
The other trunnion support must be carefully located so that the shaft will be properly aligned. Here's how to do that. Take a 2 inch length of 8-32 threaded rod, or a long 8-32 bolt. With a nut on either side of the mounted trunnion support, bolt the rod in place so that it extends across the base (as it will when the key is done). See Fig. 15. Now take the other trunnion support and mount it to the long bolt with two nuts, adjusting the spacing so that it is exactly one inch. This will put the free trunnion support in its proper position with respect to the base (Fig. 16). Use it to guide the drilling of the holes on that side of the base. Drill the first hole and thread it as before. Enlarge the trunnion support hole and fasten it with a 4-40 screw. Now drill the other hole and thread it. Finish by enlarging the trunnion support hole, and fasten it to the base with a 4-40 screw (Fig. 17).





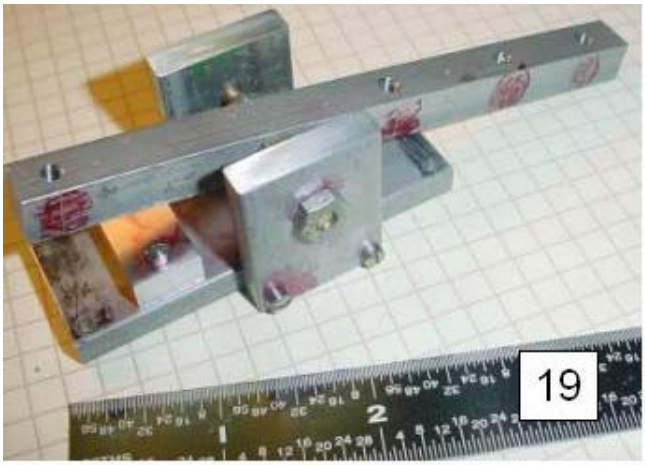
At this point, you should have both trunnion supports mounted in perfect relation to one another so that the shaft will not bind and the key lever will be properly aligned during final assembly. Mark both trunnion supports by making shallow drill marks (Fig. 18) so that you can mount them in exactly the same way later on. You can also breath a bit easier now – the hardest parts are done.

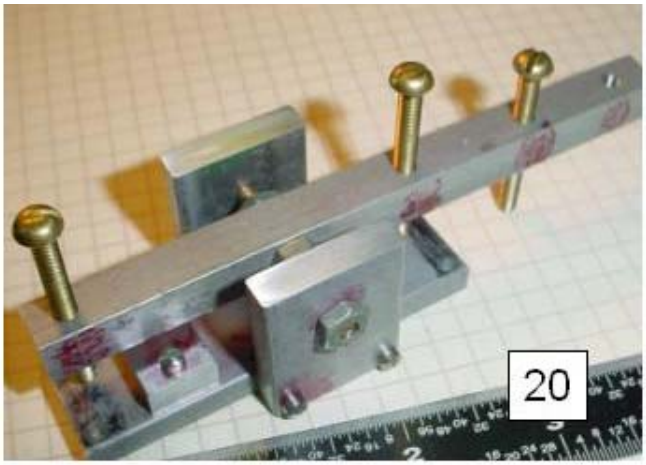




Drilling the key lever

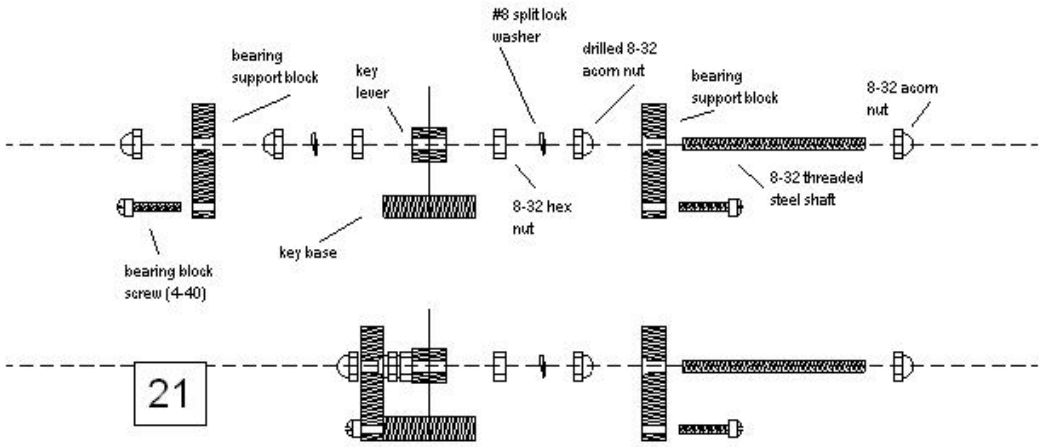
Mark the location of the four vertical holes in the 3/8” x 3/8” bar stock according to the diagram. Make sure that these holes are accurately centered in the bar. [Use of the jig described in the notes at the end of these instructions will make that an easy task.] Drill these holes for 8-32 thread. Now turn the lever on its side, and locate, mark, and drill the hole for the trunnion axle. With the workpiece secured in your vise, use the drill press to hold an 8-32 tap, making sure that you have an exact right angle. Carefully tap the holes, turning the drill press chuck by hand (no power!). Figures 19 and 20 show the drilled lever in a trial fit.



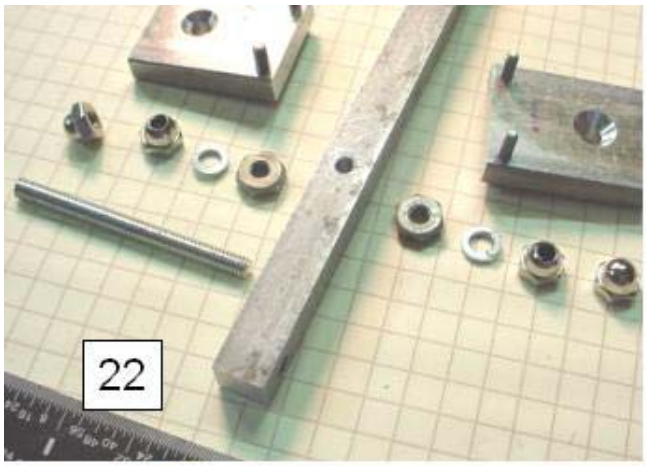


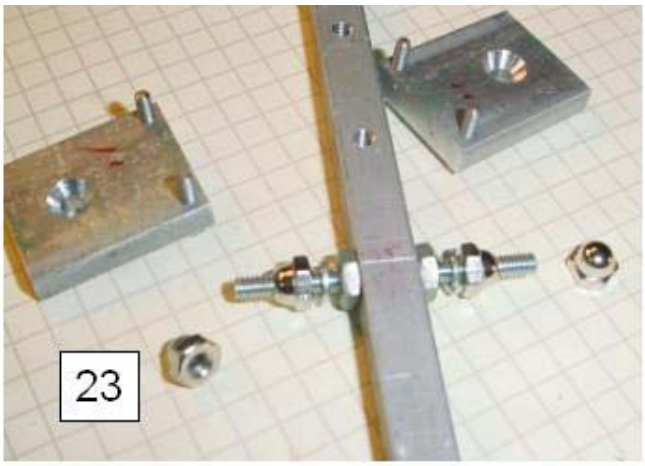
Making the trunnion

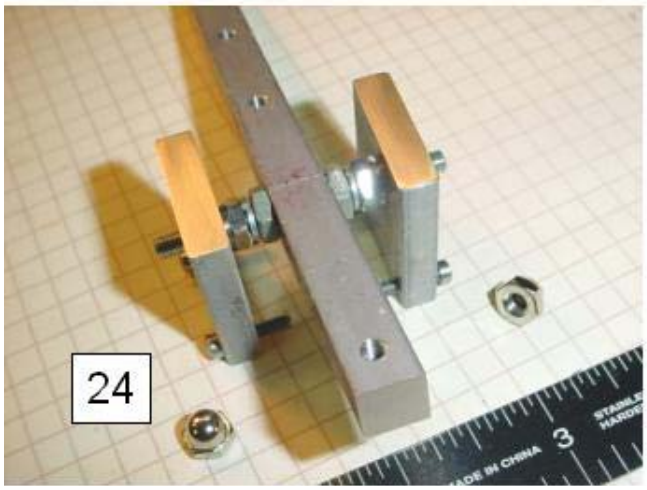
Thread the 8-32 rod halfway through the key lever, and thread an 8-32 nut in from either end, tightening them finger tight. Make sure the 8-32 rod is accurately centered. Now take an 8-32 acorn nut and mount it in the vise so that you can drill the hole the rest of the way through its top (use a #29 drill or equivalent – see Notes). Use an 8-32 tap to thread the hole all the way through the nut so that it can be threaded onto the trunnion axle. The drawing below (Fig. 21) gives the order in which the various nuts and washers are mounted to the trunnion shaft.

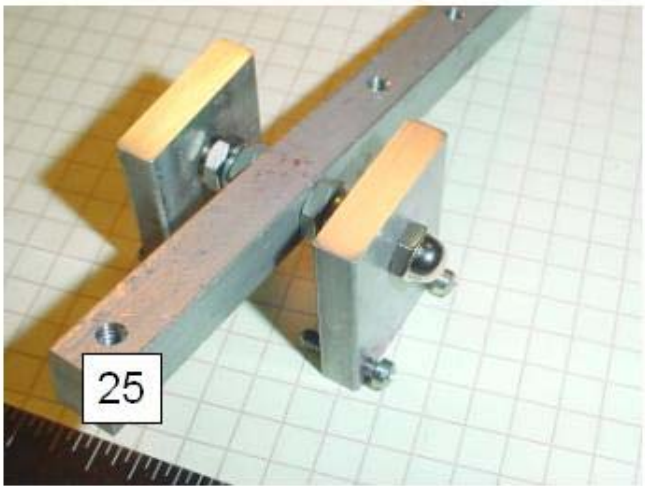


These parts are shown in Figures 22 and 23 on the next page. Note also that the inner faces of the two trunnion supports have been smoothly countersunk to a depth of about 1/16" – this can be touched up later if the adjustment provided by the shaft nuts is insufficient. A trial assembly of the trunnion and its supports is shown in Figures 24 and 25. At this point you can shape the trunnion supports into the trapezoid shapes shown in the drawings and later photos. Use the belt sander for this (keep the work cool by dipping it into water as you sand it to shape), or use a coarse file, followed by a finer one.



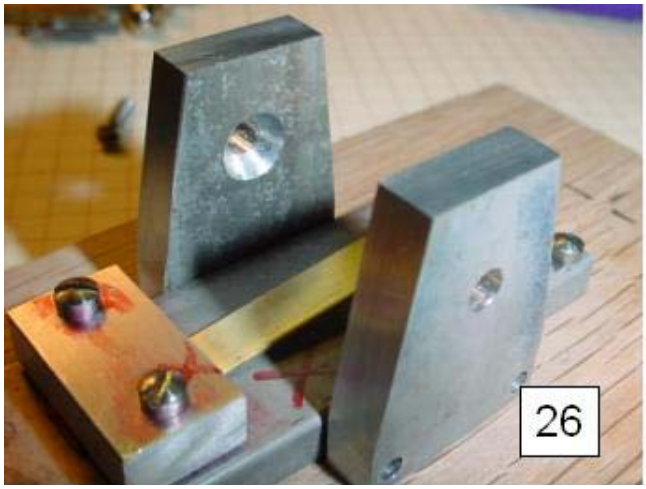


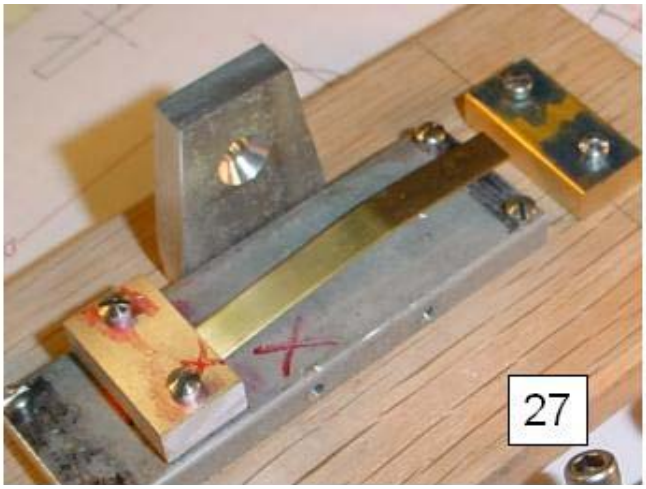




Making the tension spring

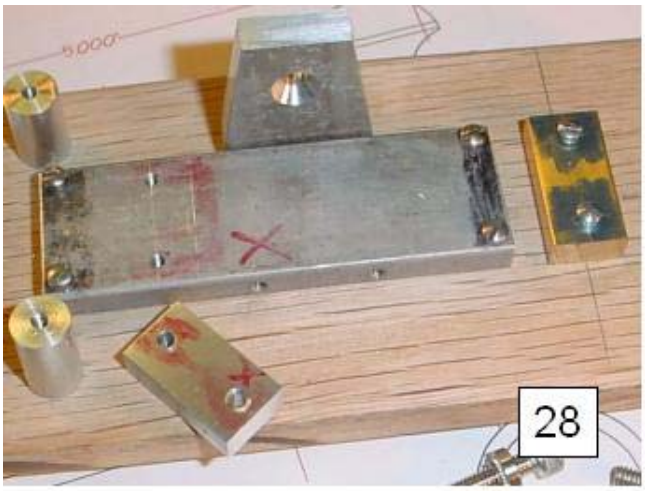
Bend the 3 inch brass strip approximately as shown in the diagrams. Slip it under the spring holder and carefully center it, then tighten the 4-40 screws that fasten the holder.

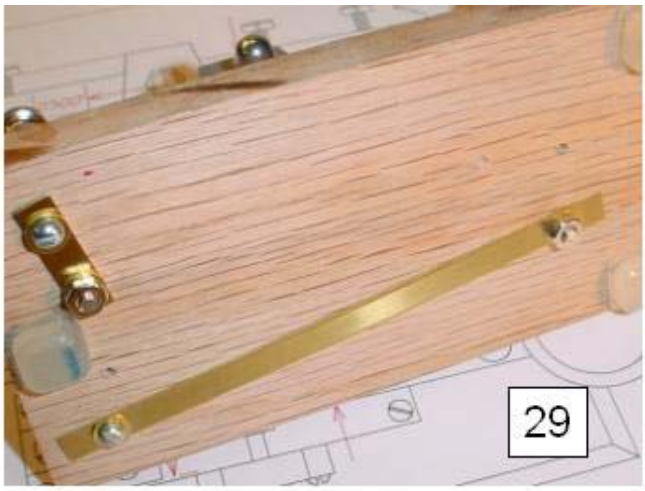




Mounting the parts on the wooden base

Carefully place the key baseplate on the wooden base, making sure it is centered accurately. Secure it with a clamp. Drill through one corner hole with a #43 drill or equivalent, going as deeply as necessary into the base to hold a 4-40 screw. Enlarge the corner hole in the baseplate to size #33 or equivalent and use it to guide your 4-40 tap as you thread into the wooden base. Fasten the baseplate down with a 4-40 screw and drill the other three holes in the wooden base. Enlarge the three baseplate holes and thread the holes in the wooden base. The front right screw should be long enough to pass through the wooden base to make the electrical connection. See Fig. 28. Temporarily set the lever in place and use the contact





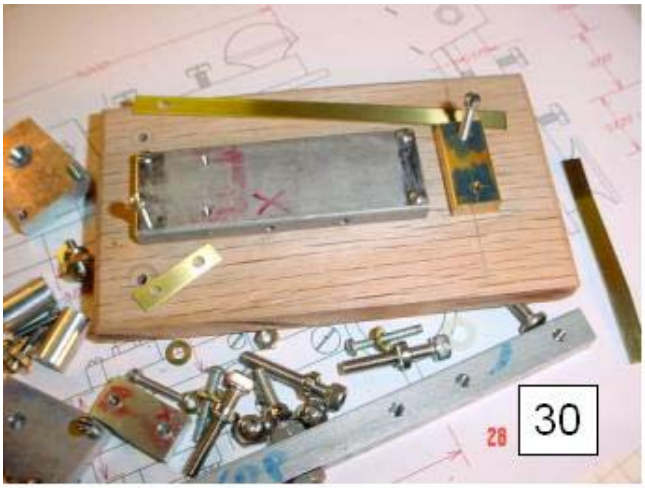
screw hole to locate the lower contact pad shown just to the rear of the main baseplate. Drill the holes as before; one mounting screw must be long enough to pass through the wooden base to make the electrical connection.

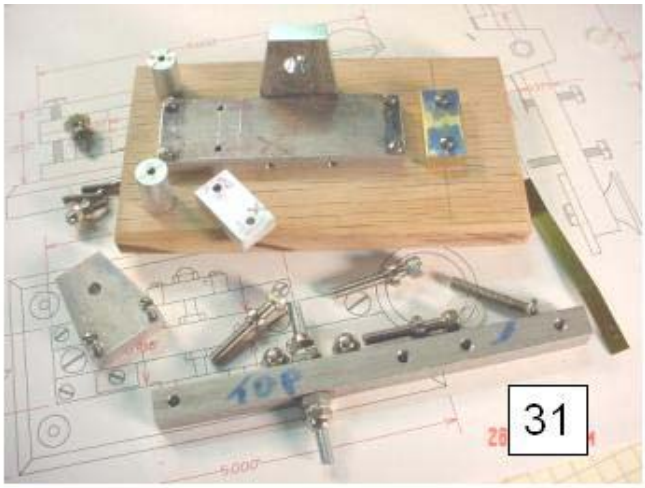
Electrical connections

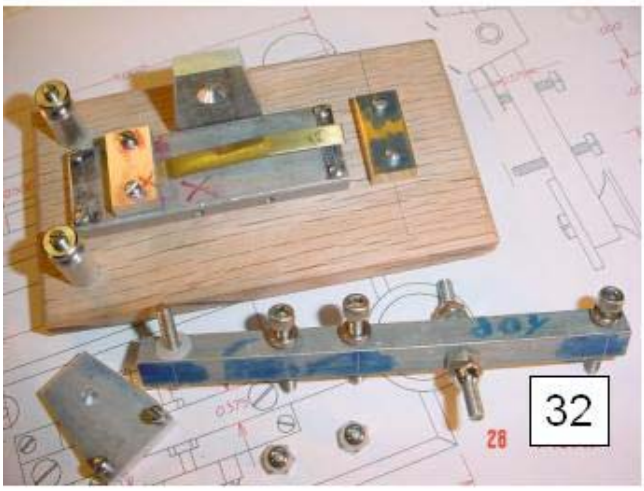
Lay the longer brass strip on the bottom of the base to determine its proper length. Allow about ¼" extra on each end. Drill a #33 hole ¼" from one end of the strip, and place it over the projecting screw that comes from the top of the key (or the binding post – either end is OK). Now mark the location for the other hole and drill it #33. The strip should fit over both screws without bowing upward. You may have to enlarge the holes with a bigger drill or fine file if they are slightly off. Now repeat this for the shorter strip (Fig. 29). Note that the version of the key shown here uses machined aluminum binding posts. Later photos will show a version using commercially-available banana jacks as binding posts.

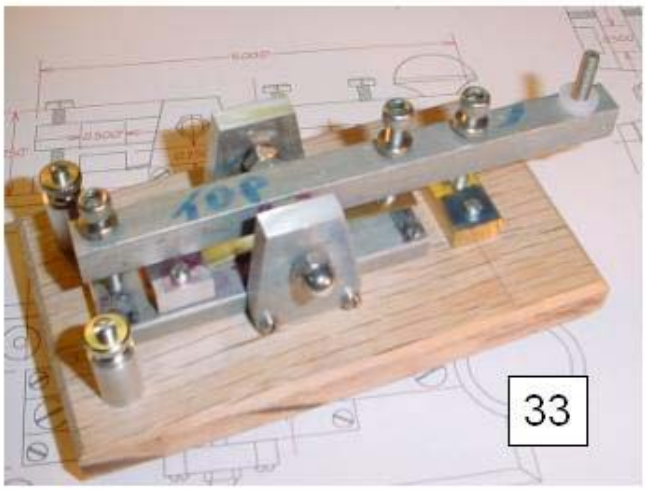
Trial Assembly

At this point the machine work has been done. Before the final finishing and polishing, it is a good idea to put the key together and make sure everything fits. Better to scratch a part now before it is polished. In the frames below, the key goes from a collection of parts to what almost looks like a functional key. The knob will be added later.





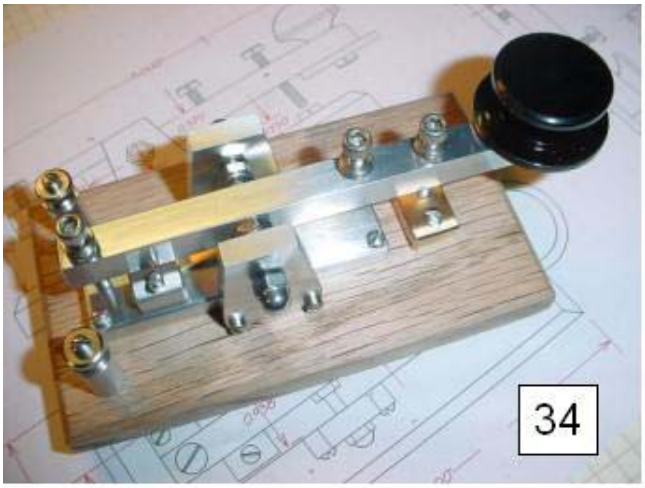


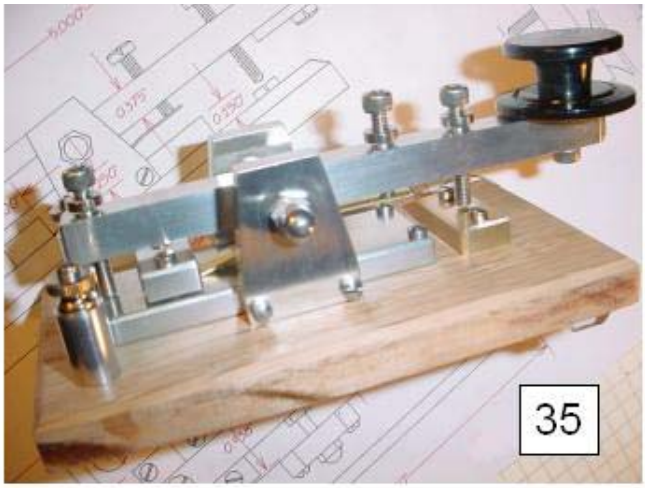


Finishing the metal parts

Now the cosmetic work begins. Here is where you can go a long way towards making this look like the product of an experienced craftsman. To obtain a smooth finish on the aluminum parts, several steps are necessary. For the initial removal of tool and sawing marks, place a sheet of 220 grit wet-or-dry emery paper upside down on a smooth surface, and draw the edge of the work piece smoothly across the paper, taking care to keep it perpendicular to the work surface and to move in a straight line in the long axis of the part. You can also substitute a fine flat mill file for the sandpaper. Be sure to remove any metal chips from the file

(with a piece of wood moved in the direction of the file grooves) or you may put deep scratches in your workpiece. When the cut edges show no more tool marks, you can go to finer emery paper (320 or 400 grit). With this finer paper, finish all of the surfaces in the same way as you did for the edges. You can get a slightly rounded effect by placing a layer of paper toweling under the sandpaper. Finally, use fine steel wool to give a satiny luster. Don't push too hard with the steel wool, or the surface of the aluminum will "gall" and have a dull finish. You can fix this by going back to the emery paper stage. When the steel wool work is done, you will have a final finish. You could enhance this further by using a Dremel tool with a cloth wheel and polishing compound, but this is not necessary. Compare the finish in Figures 34 and 35 with the prior figures. The oak base in these figures was sanded fine, beveled with a fine file and



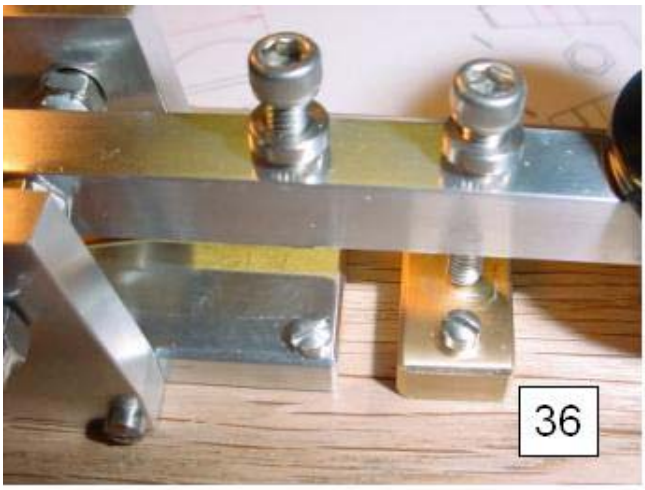


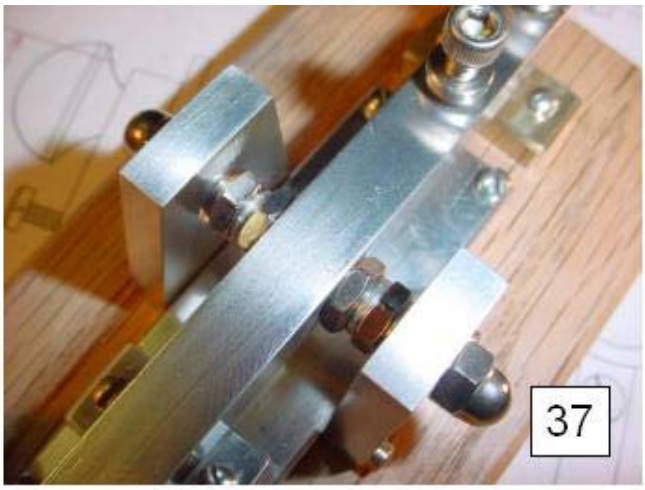
then finished with an application of paste wax, and polished with a soft cloth.

Final assembly

When you are satisfied with the polish of the metal parts, reassemble the key, making sure that the parts are properly oriented so that the holes all line up. Fasten the baseplate to the base with 4-40 screws into threaded holes in the oak – the wood is hard enough that good threads can be tapped into it. Connect the short brass buss-bar from the longest screw to the "GND" binding post, and connect the long bar from the contact plate to the "HOT" binding post. Before mounting the key lever, make sure that the drilled acorn nuts are tightened all the way, so as to produce maximum flattening of the lock washers. Attach one trunnion support to the base plate, place the threaded shaft through the hole, and attach the other trunnion support. At this point, the lever should move freely up and down, but there will be some looseness and "side play". Use a small wrench to back off (unscrew) the acorn nuts so that they move into

the countersunk recesses in the trunnion supports and tighten the assembly. Distribute the adjustment evenly between both sides. At some point the slack will be taken up and the movement of the lever will be very clean and precise. If the lever binds with the acorn nuts turned all the way in, make the countersunk recesses a little bit deeper. Thread an acorn nut over each end of the threaded shaft – if they go on too far and bind the lever, place a small object (end of a matchstick, etc.) in the nut to limit its depth. The lever adjustment screws in

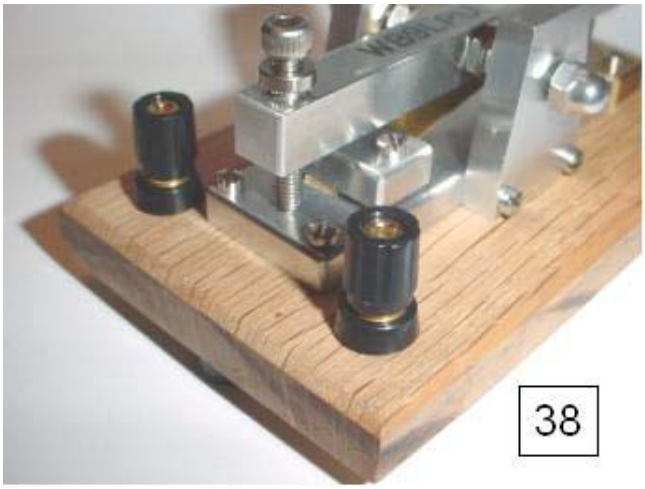




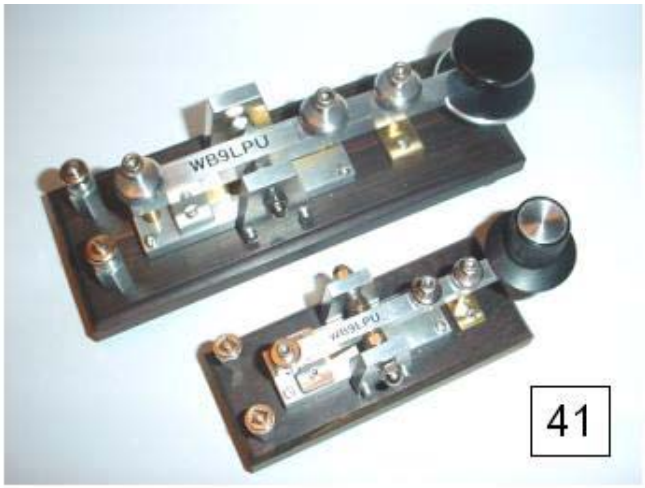
the figures above are stainless steel 8-32 allen head cap screws, and the locknuts are PEM nuts (as used to fasten sheet metal parts). The tension spring should just touch the bottom of the lever when it is horizontal. Carefully bend it up or down as necessary to obtain the proper tension, and thread its adjusting screw through the lever until it touches the spring. This key uses a salvaged knob from an old key, with a round button from a fabric store to serve as a knob skirt. Install the two other adjusting screws and set the key position and travel to your liking. Connect the key to your rig, and you are ready to go.

Some variations on the basic plan

To save time making aluminum binding posts (as shown in the previous illustrations), commercial posts can be used with no changes in the design. Figure 38 shows this modification. With a little extra work, a “step-down” can be added to the lever as shown in Figure 39. This modification (also possible without a milling machine) adds a nice touch to the lever. Making the aluminum binding posts and the step-down could be the subject of a future article. The knob skirt can be eliminated, and a more rounded knob can be used for a more “European” look.



Since the design is very flexible, you can experiment with different proportions and base designs. Figure 40 shows a somewhat fancier version of the key mounted on a base of ebony wood. The base is longer and narrower than the one described in the drawings here. The design can also be miniaturized, as shown in Figure 41. Here the dimensions are reduced to three-quarters of the standard size, leading to a key that is smaller but still fully functional.



So this is one way to make a custom key that you can be proud to show off. If there is any help or advice that I can give, I would be glad to help. Just drop me an email (or snail mail).

73 de Rich, WB9LPU

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Notes, Hints and Kinks, and Other Information

Bill of Materials

Aluminum Stock (2024-T4 or 6061)

1 pc.	1/4" x 1" x 3"	Key base plate
2 pcs.	1/4" x 1" x 1-1/4"	Bearing blocks
1 pc.	1/4" x 1/2 " x 1" or 3/16" x 1/2" x 1"	Spring holder
1 pc.	1/4" x 1/2 " x 1"	Lower contact
1 pc.	3/8" x 3/8" x 5"	Key lever
2 pcs.	1/2" x 3/8" diameter rod stock	Binding posts

Brass Strips

1 pc.	1/32" x 1/4" x 3"	Tension spring
1 pc.	1/32" x 1/4" x 4"	"Hot" buss bar
1 pc.	1/32" x 1/4" x 1-1/2"	"Gnd" buss bar

Machine Screws

10 pcs.	4-40 x 1/2"	Round head machine screws (for mounting base plate, bearing blocks, and spring holder)
2 pcs.	4-40 x 7/8"	as above (for making contact through wooden base)
3 pcs.	8-32 x 1"	Allen head cap screws (for adjusting screws on lever)
1 pc.	8-32 x 3/4"	Round head machine screw (to attach knob)
2 pcs.	4-40 x 1-1/2"	Round head machine screws (for binding posts)
1 pc.	8-32 x 2"	Threaded rod (trunnion shaft)

Nuts

5 pcs.	8-32 hex nuts	(shaft nuts, lever adjustment lock nuts)
4 pcs.	8-32 acorn nuts	(trunnion bearings and end caps)
3 pcs.	8-32 PEM nuts	(alternative adjustment lock nuts)
4 pcs.	4-40 hex nuts	(for electrical connections to buss bars)
2 pcs	4-40 knurled nuts	(for optional binding posts)

Miscellaneous parts

1 pc.	1/2" x 3" x 5" wooden base (oak, walnut, maple, etc.)
2 pcs.	#8 split-ring lock washers (for trunnion bearing tension)
1 pc.	8-32 threaded cabinet knob cabinet knob (or telegraph key knob)
3 pcs.	#8 brass or nylon flat washers (use under adjusting lock nuts)
2 pcs.	4-40 thread binding posts (if you don't make them from aluminum)

Some Notes on Drills and Taps

Taps for cutting threads in screw holes require that the holes be of the proper diameter. Usually the screw sizes are specified as “number sizes” (the bigger the number, the smaller the drill). Number-sized drills may be hard to obtain, so the table below lists the fractional drills that are nearest in size – most are slightly large, but this will be no problem.

Thread sizes are specified by a number such as 4-40, 8-32, etc. The first number refers to the diameter (here the smaller the number, the smaller the diameter), and the second number refers to the number of threads per inch. “Tap Drill” refers to the diameter of the hole to be threaded, and “Body Drill” refers to the size of hole the screw will just pass through. For your reference, the table lists some sizes that are not used in this project.

Tap Size	**Tap Drill**		**Body Drill**	
(thread)	*# size*	*fract. equiv.*	*# size*	*fract. equiv.*
2-56	50 (0.070”)	1/16”	44 (0.086”)	3/32”
4-40	43 (0.089”)	3/32”	33 (0.113”)	1/8”
6-32	36 (0.106”)	7/64”	28 (0.140”)	9/64”
8-32	29 (0.136”)	9/64”	19 (0.166”)	11/64”
10-32	21 (0.159”)	5/32”	11 (0.191”)	13/64”

Sources of material

There are many sources of metal and other materials and parts that do business over the internet. A good source for materials (screws, nuts, and metal stock) is McMaster-Carr (www.mcmaster.com), which has an excellent interactive web site and offers very fast service, even with small quantities. Small Parts, Inc. (www.smallparts.com) also has an excellent stock of such materials, although they are a bit more expensive. For metals only, you can try OnLine Metals (www.onlinemetals.com). They are very accommodating and will cut metal to length for a small fee. These companies also have lots of written material describing the projects and what they are best suited for.

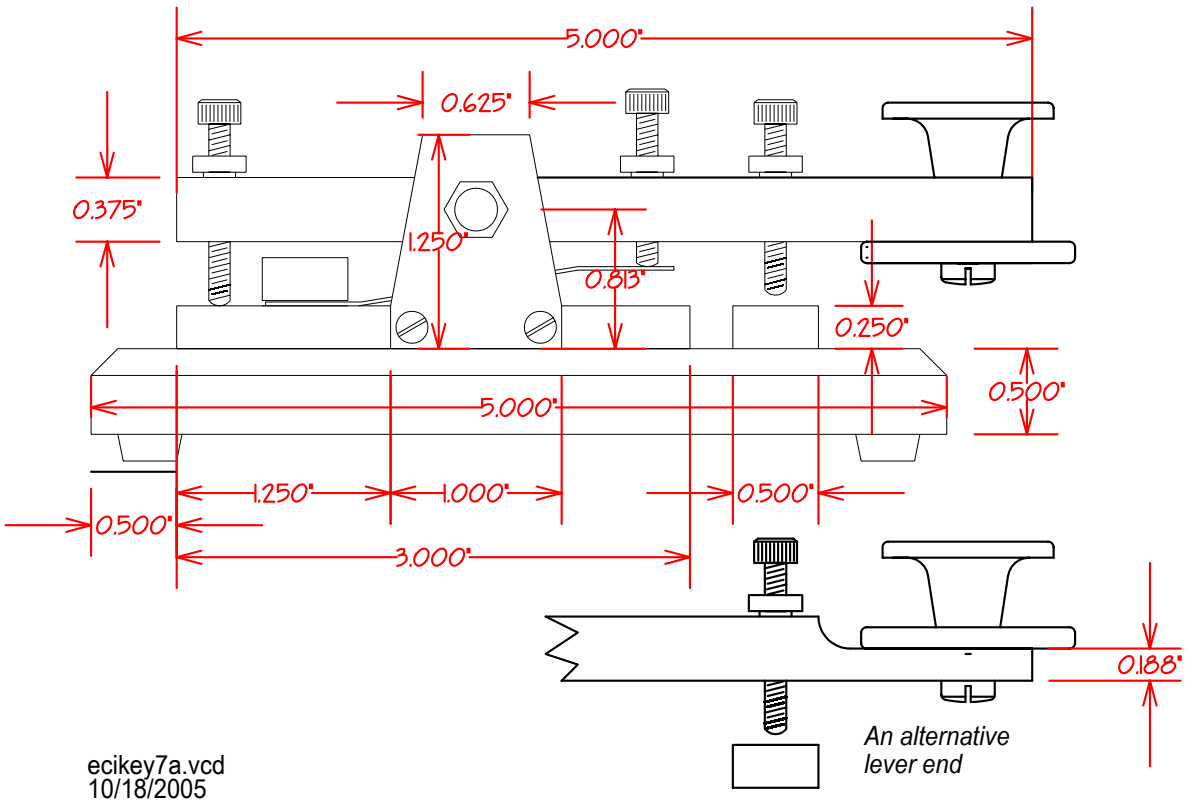
Hamfests and flea markets are often good sources of small parts and pieces of metal that can cost far less than standard commercial products. Often you can incorporate some interesting part into a project that will give it an elegant touch.

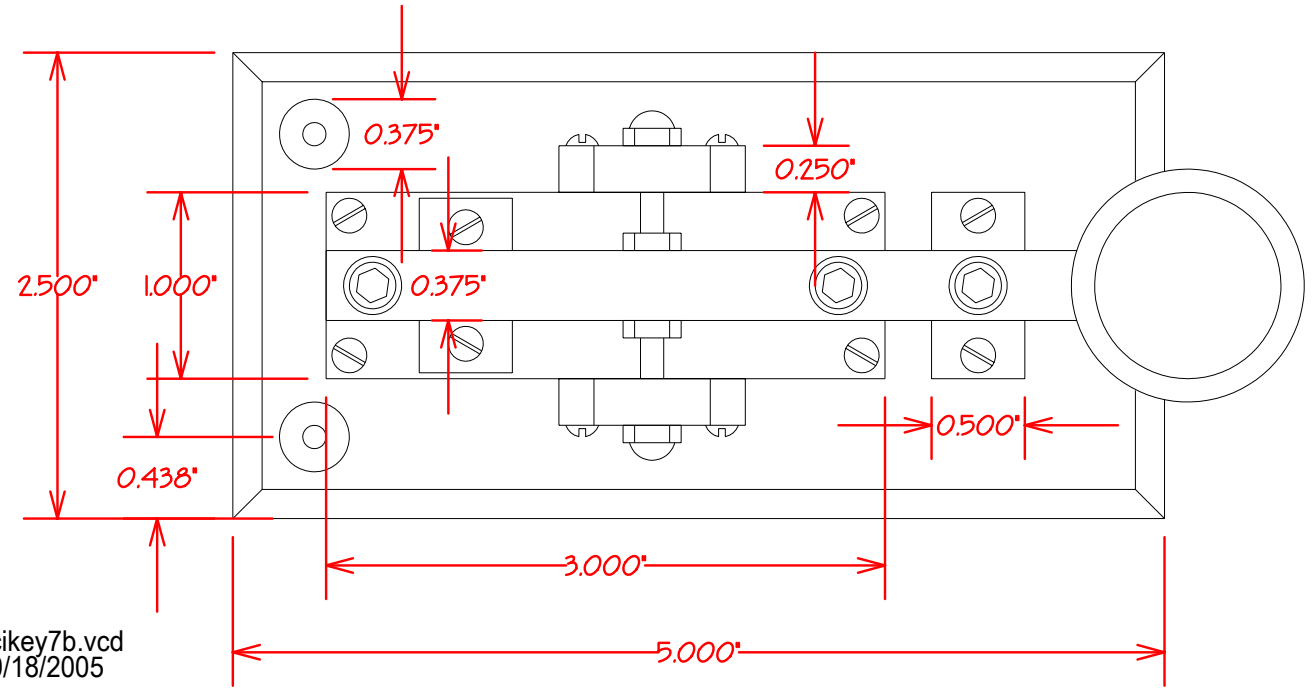
Some comments on metals

The metal alloys specified in the Bill of Materials are 2024-T4 (best) or 6061 (also OK). These are “aircraft” alloys and can be machined very precisely and cleanly. Softer alloys (hardware store “do-it-yourself” aluminum) machine poorly, do not take a high polish, and scratch easily. You will be unhappy if you use them – and the specified aluminum types will cost only a few dollars more.

You could also use brass for the key. The best alloy of brass for this purpose is called C360. But a word of caution is in order. Brass tends to grab when used with ordinary drill bits, and this can injure you and the project. The so-called “Bullet Drills” are somewhat better, and best of all are the “slow spiral” bits available from specialty houses. Brass takes a high polish, but it will tarnish readily unless coated with a good grade of clear lacquer. McMaster-Carr carries an ideal lacquer on their web site.

Drawings





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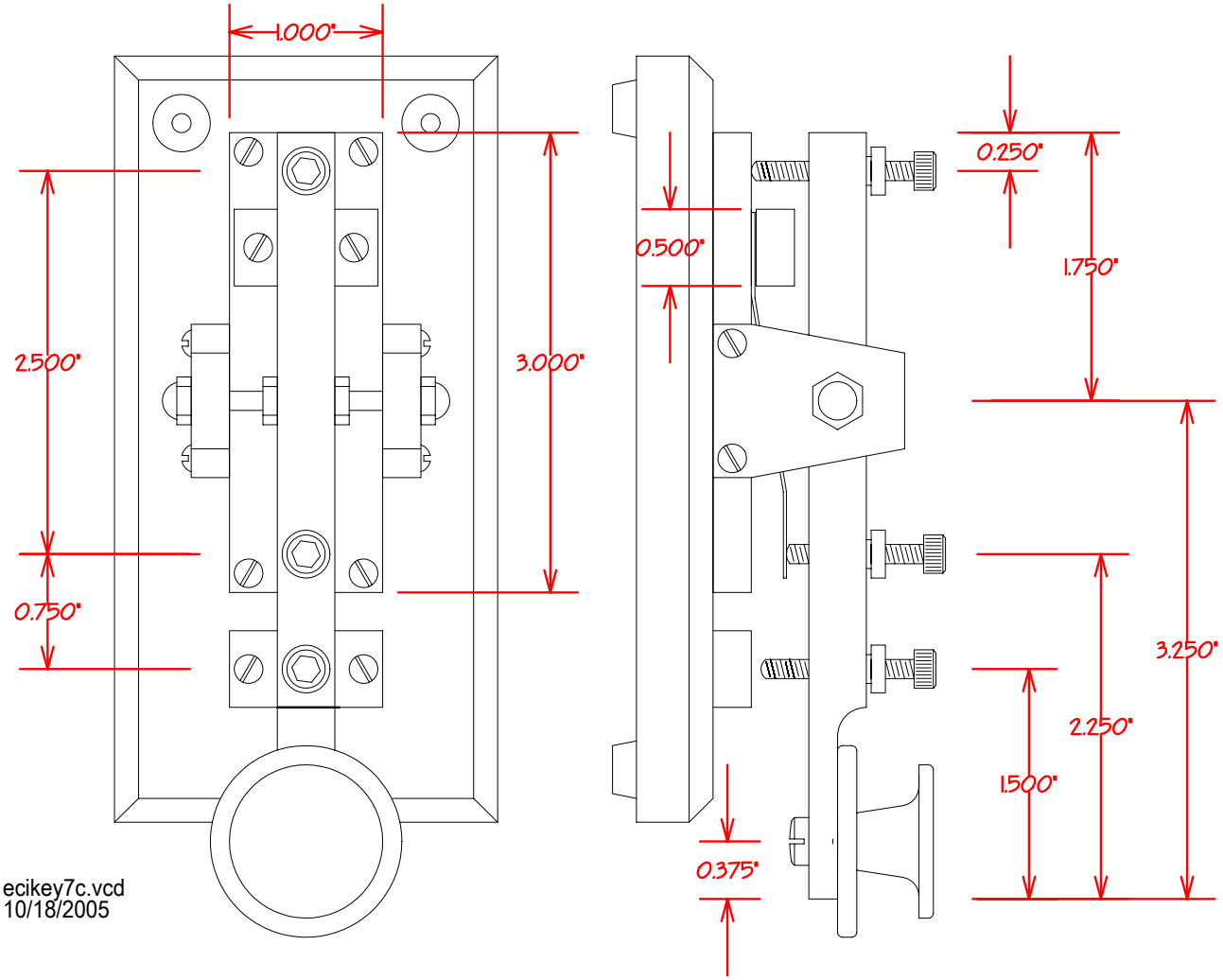

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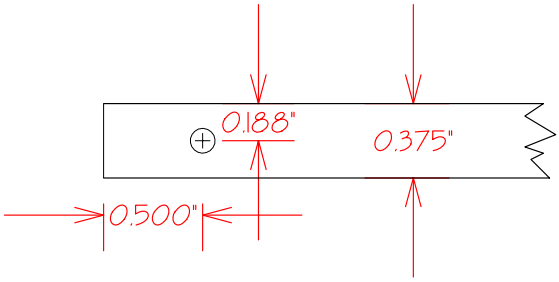
Note that due to variable scaling in the printer, etc., the drawings are not necessarily exactly life-size. Use the dimensions given on the drawings for accurate result.

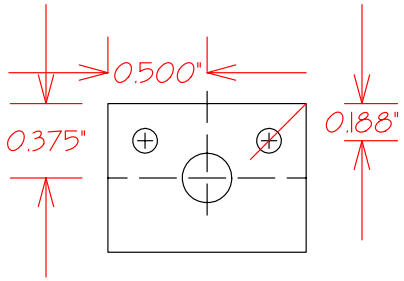
A Jig for Drilling Accurately-Centered Holes in Edges of Dimension Stock

Often there is a requirement for a hole to be drilled accurately centered in a relatively thin piece of metal. In the key project, this would include the sides of the base where the bearing supports attach, as well as for the adjusting screws in the lever of the key. Here is a little jig that will help greatly in this operation. The first version is for use with 3/8" stock (like the key lever).

You will need a length of 3/8" by 3/8" square stock about 3 inches long (to allow for some trial and error). Also required are two identical pieces 1/8" x 1" x 3/4". Following the diagram below, first drill a hole (with a small drill, such as a #50) one-half inch in from one end



1. Drill centered hole in 3/8" piece.



2. Make two side pieces.

3. Scribe a line on the SIDE of the bar stock.

4. Using a side piece as a template, drill two holes to clear 4-40 screws.

5. Fasten the two side pieces to the bar stock.

of the square stock and center it accurately (**Step 1**). You can find the center by setting your combination square to 3/16" and scribing a mark on the square stock from either side. If you were exact, there will be one line; if you were a little off, there will be two lines, and you will place your centerpunch exactly between them to mark the hole. If the hole comes out a little bit off-center, try again about ¾" further down the piece of bar stock. **Step 2** – Make the side pieces, with clearance holes for 4-40 screws located 3/16" in from the top and side edges. Drill a ¼" hole in the exact center of each piece. **Step 3** – Scribe a sharp line on the side of the bar stock to mark the exact location of the vertical hole. **Step 4** – Using a side piece as a template, mark one of the side holes in the bar stock and drill it to clear a 4-40 screw, making sure that the scribe mark is located exactly in the middle of the ¼" viewing hole. With a 4-40 screw and nut, bolt the side piece to the bar stock and use it as a template for the other side hole. Drill this hole, and then use another 4-40 screw and nut to finish holding the side piece in place.

To use the jig, mark the location of your desired hole on the workpiece (on its flat, not its edge). Loosen the screws of the jig and place it over the edge of the workpiece. Line up the scribed line on the jig with the line on the workpiece, and tighten the screws to hold the jig in place. Supporting the workpiece in your vise, drill through the vertical hole in the jig, going only a little way into the workpiece. Remove the jig, and you should find an accurately located hole in the edge of the workpiece. Finish drilling this hole to the desired size and depth for the tap you wish to use. The photos below should make this operation clear. To use this jig for ¼" stock, make a second center spacer as you did for the 3/8" version, only use ¼" stock. You can use the same side pieces. To save wear and tear on the jig, use it only to start the holes, and finish the holes without the jig (with the work clamped vertically in the drill press).