Modifying Q80 Clock Movements

for the

FCC4 Fast Clock Controller

(Excerpted from the FCC4 User Manual)

by

Mike Dodd

mike@mdodd.com

February 4, 2018

What you'll need

you will need these basic electronics tools to modify Q80 clock movements (and to build the FCC4 kit, if you ordered that.

- Needle nose pliers. (All Electronics #PLR-55 http://www.allelectronics.com/make-a-store/item/plr-55/5-mini-long-nose-pliers/1.html).
- Wire cutters, (All Electronics #FC-14 http://www.allelectronics.com/make-a-store/item/fc-14/5-flush-cutter/1.html).
- Soldering iron, 30-45 watts, tip temperature of 700° to 800°. ***I strongly recommend a temperature-controlled soldering station,*** such as one of these. You can adjust the tip temperature, and the tip is isolated from the power plug to prevent household voltage from destroying sensitive electronics components as you solder them to the PCB.
  - Weller WTCPT (HMC Electronics: http://www.hmcelectronics.com/cgi-bin/scripts/product/1980-0217/?gclid=CPaA2vaMuZ4CFchn5QodJ2l0pg).
  - All Electronics IR-361 (http://www.allelectronics.com/make-a-store/item/ir-361/60w-temperature-controlled-solder-station/1.html).
  - All Electronics IR-50 (http://www.allelectronics.com/make-a-store/item/ir-50/temperature-controlled-solder-station-50w/1.html).
- 60/40 rosin-core solder (All Electronics #TS-110 (7' in dispenser) http://www.allelectronics.com/make-a-store/item/ts-110/60/40-solder/1.html or #SOL-564 (½-pound spool http://www.allelectronics.com/make-a-store/item/sol-564/60/40-solder-1mm-1/2-lb-roll/1.html).

In addition, you will need the these tools and parts specific to the movement modification:

- #1 (or equivalent) Phillips screwdriver (included in All Electronics #PSS-63 http://www.allelectronics.com/make-a-store/item/pss-63/6-piece-mini-phillips-screwdriver-set/1.html). Note: #1 Phillips screwdrivers are readily available at home improvement stores.
- Desoldering braid (also called "wick") (All Electronics #SWK http://www.allelectronics.com/make-a-store/item/swk/de-soldering-wick/1.html) or Radio Shack #64-2090 http://www.radioshack.com/product/index.jsp?productId=2062744).
- Solder sucker (All Electronics #50B-410 http://www.allelectronics.com/make-a-store/item/50b-410/solder-sucker/1.html). This is optional; desoldering braid often is sufficient by itself.
- 3/16" flat file. (included in All Electronics #FSET-2 http://www.allelectronics.com/make-a-store/item/fset-2/10-piece-needle-file-set/1.html) or a hobby knife with a harp blade..
- Approximately 6"-10" of insulated #24 or #26 solid (preferred) or stranded wire One twisted pair from a Cat 5 Ethernet cable is ideal. ***This wire is included in each MOV-KIT movement kit purchased from me.***
- One 22-ohm ¼-watt resistor (Digi-Key #22QBK-ND (http://www.digikey.com/product-search/en?pv7=3&k=22QBK-ND&mnonly=0&newproducts=0&ColumnSort=0&page=1&quantity=0&ptm=0&fid=0&pageSize=250). ***This resistor is included in each MOV-KIT movement kit purchased from me.***
- **Use only rosin-core solder.** If you insist on using liquid or paste flux, check and double-check that it is ***rosin*** flux, not ***acid*** flux. ***Never*** use acid flux to solder electronics.

About soldering

You need to know how to solder electronic circuits to modify Q80 movements. If you are unfamiliar with soldering techniques, you can find a good tutorial on the Web, such as this one at http://www.aaroncake.net/electronics/solder.htm

You can purchase a solder practice kit, such as this one: http://www.makershed.com/ProductDetails.asp?ProductCode=MKEL2 It definitely is a good idea to hone your skills before assembling the FCC4.

Soldering electronic components requires the use of a low-wattage soldering iron, about 35 to 45 watts. Ideally, use a temperature-controlled soldering station, as listed above.

Use only rosin-core solder to modify Q80 movements. If, despite this warning, i you nsist on using liquid or paste flux, check and double-check that it is ***rosin*** flux, not ***acid*** flux. ***Never*** use acid flux to solder electronics.

Modifying clock movements

Modifying your clock movements is simple (10-15 minutes apiece), but requires care and attention.

Fig. 1 shows a modified Quartex Q80 movement. The only evidence of the modification is the two wires coming through a slot on top. The threaded bushing is available in various lengths, so be sure to order a movement with a bushing long enough to reach through your your clock dial. This movement has a bushing for a 1/8" dial. It's long enough to extend through the dial, and still have exposed threads for a mounting nut.

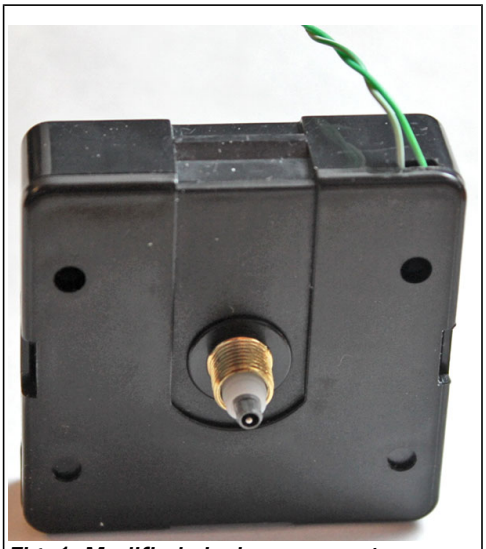

Fig. 1: Modified clock movement.

What you'll need

You will need the basic electronics tools and soldering iron listed in **What you'll need** on page **1**, plus these additional items:

- #1 (or equivalent) Phillips screwdriver (included in All Electronics #PSS-63 http://www.allelectronics.com/make-a-store/item/pss-63/6-piece-mini-phillips-screwdriver-set/1.html). Note: #1 Phillips screwdrivers are readily available at home improvement stores.
- Desoldering braid (also called "wick") (All Electronics #SWK http://www.allelectronics.com/make-a-store/item/swk/de-soldering-wick/1.html) or Radio Shack #64-2090 http://www.radioshack.com/product/index.jsp?productId=2062744).
- Solder sucker (All Electronics #50B-410 http://www.allelectronics.com/make-a-store/item/50b-410/solder-sucker/1.html). This is optional; desoldering braid often is sufficient by itself.
- 3/16" flat file. (included in All Electronics #FSET-2 http://www.allelectronics.com/make-a-store/item/fset-2/10-piece-needle-file-set/1.html).
- Approximately 6"-10" of insulated #24 or #26 solid (preferred) or stranded wire One twisted pair from a Cat 5 Ethernet cable is ideal. ***This wire is included in each MOV-KIT movement kit purchased from me.***
- One 22-ohm ¼-watt resistor (Digi-Key #22QBK-ND (http://www.digikey.com/product-search/en?pv7=3&k=22QBK-ND&mnonly=0&newproducts=0&ColumnSort=0&page=1&quantity=0&ptm=0&fid=0&pageSize=250). ***This resistor s included in each MOV-KIT movement kit purchased from me.***
- ***Use only rosin-core solder. If you insist on using liquid or paste flux, check and double-check that it is rosin flux, not acid flux. Never use acid flux to solder electronics.***

Remove the cover from the case by releasing the two locking clips, one on each side.

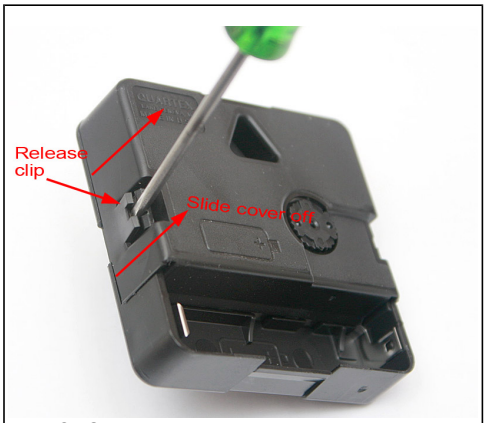

Fig. 2: Opening a movement.

- ☐ Insert a small screwdriver and gently pry a clip outward. When it opens, slide the cover away slightly, then release the other clip. The plastic case is slippery, so the screwdriver might slip out before the latch releases. Keep trying.
- ☐ With both clips released, pull the cover off.

Fig. 3 shows what you'll see with the cover removed. The mechanism is completely enclosed and contains the stepper motor (copper wire coil) and the gears. It rests freely inside the case; there are no screws to remove or wires to disconnect. Notice the metal clips in the battery compartment.

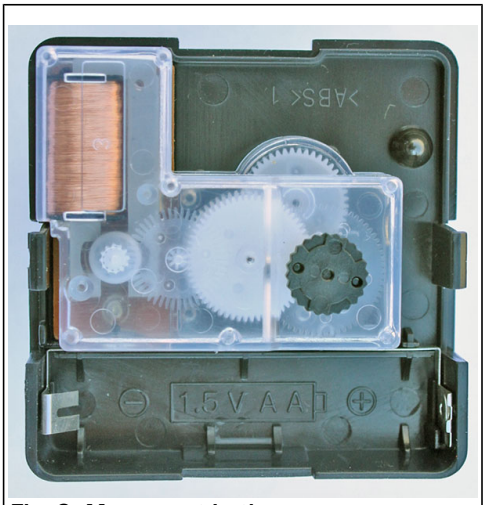
Fig. 3: Movement in the case.

Opening the case

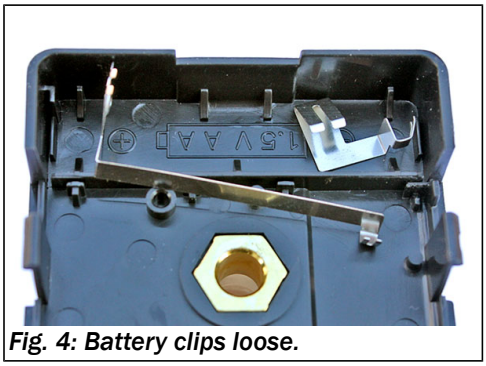
Fig. 4: Battery clips loose.

- ☐ Lift the movement out of the case and set it aside. Tap the case against a table to loosen both battery clips, or pull them loose with your fingers or pliers (Fig. 4). Discard the battery clips – they are not used in fast-time movements.

Terminology

The clock movement consists of an outer black "case" with a threaded brass bushing on the front, and a removable cover on the back. The movement's motor and gears are contained in a clear plastic "housing," with a circuit board (PCB) on top, that rests inside the case when the movement is assembled. These terms are used in the following instructions to avoid confusion.

Two methods to modify a movement

There are two ways to modify a Q80 movement. Both methods involve soldering a resistor and two wires to the motor, but differ in how these components connect to the motor terminals.

- ***Method 1 is preferred*** because it reduces the chance of breaking the fine motor wires. You use a hobby saw to cut the PCB and remove most of it, leaving only a narrow sliver still attached to the motor terminals. Then you solder the resistor and wire to the terminals on the remaining sliver. Thanks to Julian Garner for this idea.
- With Method 2, you unsolder and remove the entire PCB, then solder the resistor and wire to the bare motor terminals.

Modifying the movement – Method 1 (preferred)

- ☐ Cut two lengths of insulated #26 or #28 wire 6" - 10" long. Solid wire is better than stranded for this application, but stranded will work. This "pigtail" ultimately will connect your clock to a

"bus" cable that you will run around your layout, so you might want to make it long enough to reach the bus cable location – several feet, if necessary. Wire color is not important. Cat 5 Ethernet cable with solid wires is ideal, and one length of cable yields pigtails for four clocks.

- ☐ Cut one wire about ½" shorter than the other. Strip 1/8" of insulation from one end of each wire (Fig. 5). Tin the bare wires with solder. "Tinning" means to coat the copper wire with a thin layer of molten solder. This is especially important with stranded wire, as it bonds the strands together.

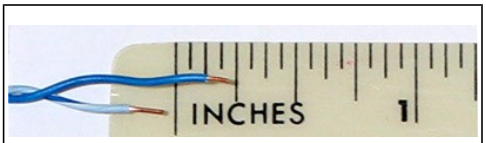

Fig. 5: Wires ready to tin.

- ☐ Clamp the movement in a vise, or otherwise secure it (you can tape it to your table).
- ☐ Use a small (#0 or #1) Phillips screwdriver to remove the screw holding the PCB to the housing. Discard the screw.

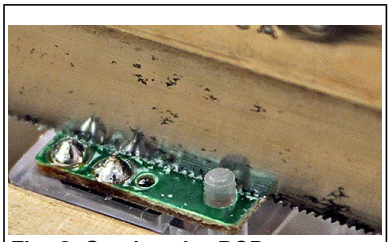
Fig. 6: Sawing the PCB.

- ☐ Use a hobby saw such as the X-Acto #34 blade (http://www.amazon.com/Xacto-X75300-Precision-Razor-Saw/dp/B00004Z2U4) to carefully cut through the PCB adjacent to the two motor terminals. See Fig. 6. Work slowly and carefully. Occasionally pause and lift the far end of the PCB to check if the saw has cut completely through. Fig. 7 shows the remaining PCB soldered to the motor terminals.

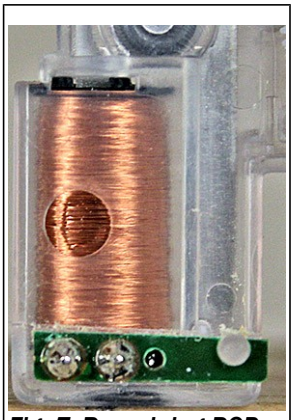
Fig. 7: Remaining PCB .

- ☐ Cut both leads of the 22-ohm resistor to ¼". Bend one lead of at a 90° angle close to the body. Leave the other lead straight. Tin both leads to ensure solder flows smoothly when soldering to the resistor leads.
- ☐ Orient the movement as shown in with the motor terminals closest to you. Lay the resistor on the clear housing so the bent lead is near the hole on the housing, and bends toward the left. See Fig. 8.
- ☐ Use needle nose pliers to hold the resistor by the bent lead. Position the straight lead against the solder on the right side of the right-hand motor terminal. Touch a soldering iron to the terminal to melt the solder and allow the resistor lead to drop into it. The solder should flow onto the resistor lead. Allow the solder to cool. The resistor is now soldered in place.
- ☐ Similarly, lay the tinned end of the short pigtail wire you prepared earlier against the solder on the right side of the left-hand motor terminal. Touch a soldering iron to the terminal to melt the solder and allow the wire to drop into it. The solder should flow onto the wire. Allow the solder to cool.

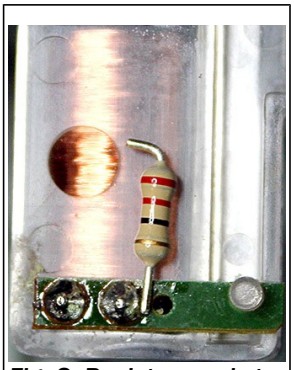
Fig. 8: Resistor ready to solder.

- ☐ Position the tinned end of the long pigtail wire against the bent resistor lead, and solder. It is not necessary to bend the wire around the resistor lead. The solder will hold it securely.
- ☐ Press a finger or thumb over the motor terminals, resistor, and the two wires. Carefully bend the wires downward 90° where they cross the edge of the housing, as in Fig. 16. This bend allows the movement to sit flat in the case, and the wires to pass through a slot you will cut in the case (next, below).

Fig. 9 shows the finished modification before bending the wires. Notice how the wire and resistor lead are soldered on the *right* side of the motor terminals (red arrows), and the long wire runs *between* the terminals. This positions the wires correctly to exit the movement case through a slot you will cut next. **Important!** Be sure the resistor lies flat against the housing, and it and the long wire are clear of the large hole in the housing.

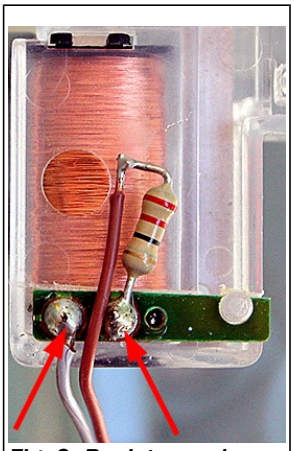

Fig. 9: Resistor and wires.

Modifying the movement – Method 2

Important! **Method 1** is the preferred way to modify a movement because it reduces the chance of breaking the fragile motor wires inside the housing. Work carefully if you choose Method 2. You will unsolder and remove the circuit board (PCB), then solder a resistor and a wire to the exposed motor coil terminals.

Important!

In the following steps, you will be using a hot soldering iron to unsolder and remove a PCB from two motor terminals, and then to solder a resistor and wire on those same terminals. Extremely fine wires connect these terminals to the motor coil inside the clear plastic housing. The terminals are into holes in the plastic housing. Excessive heat can soften or melt the plastic, allowing the terminals to move, which can break the fine wires. It is impossible to repair a broken coil wire, so the movement is destroyed if one breaks. Work quickly and move the terminals as little as possible.

- ☐ Cut two lengths of insulated #26 or #28 wire 6" - 10" long. Solid wire is better than stranded for this application, but stranded will work. This "pigtail" ultimately will connect your clock to a "bus" cable that you will run around your layout, so you might want to make it long enough to reach the bus cable location – several feet, if necessary. Wire color is not important. Cat 5 Ethernet cable with solid wires is ideal, and one length of cable yields pigtails for four clocks.
- ☐ Cut one wire about ½" shorter than the other. Strip 1/8" of insulation from one end of each wire and form the ends into "J" hooks. Tin the bare wires with solder. "Tinning" means to coat the copper wire with a thin layer of molten solder. This is especially important with stranded wire, as it bonds the strands together.

Fig. 10: Wires ready to tin.

- ☐ Clamp the movement in a vise, or otherwise secure it (you can tape it to your table).
- ☐ If you're using a solder sucker, place it on one of the two terminals at the end of the PCB, and heat the solder around the terminal with your soldering iron until it melts. Press the button to suck up the molten solder. Work quickly to avoid melting the plastic that holds the terminals beneath the PCB.
- ☐ Use a small (#0 or #1) Phillips screwdriver to remove the screw holding the PCB to the housing. Discard the screw.
- ☐ If you're using desoldering braid, place it on the solder around one terminal, then heat the braid with your soldering iron. The hot braid will melt the solder and wick it away from the terminal; see **Fig. 12**. Work quickly to avoid melting the plastic that holds the terminals beneath the PCB.

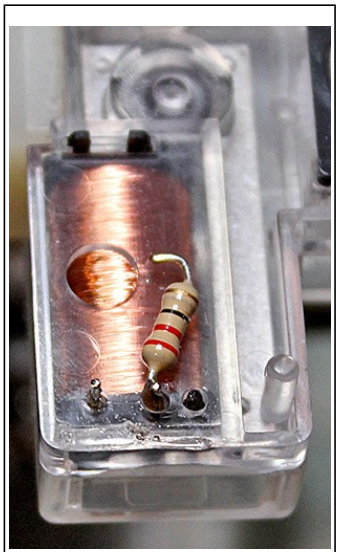

Fig. 11: Resistor soldered.

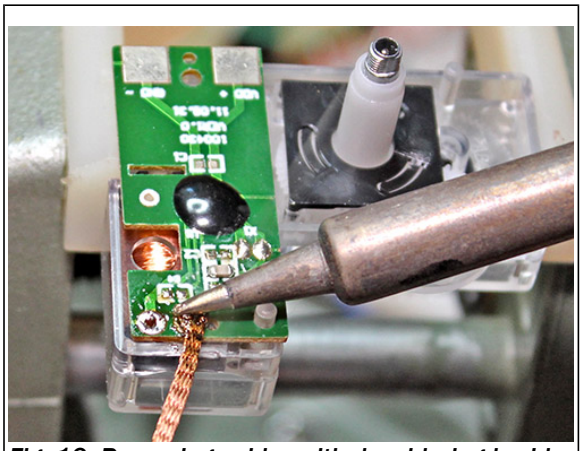

Fig. 12: Removing solder with desoldering braid.

- ☐ Repeat the unsoldering operation on the second terminal. When done, the terminals should move freely inside the PCB holes.
- ☐ Allow the unsoldered terminals to cool. Gently wiggle or pry the PCB upward away from the clear plastic housing. If it doesn't lift easily, probably some solder remains on one or both terminals. Remove the last of it with desoldering braid. It helps to push the pin toward the center of the hole with the braid and soldering iron while the solder is molten.
- ☐ Remove the PCB from the movement and discard it.
- ☐ Bend the leads of the 22-ohm resistor at 90° angles close to the body, one toward the left, and the other toward the right (Fig. 13).

Fig. 13: Resistor leads bent 90°.

- ☐ Cut each lead ¼" beyond the bend. Orient the movement with the motor terminals closest to you, as shown in **Fig. 11**. Lay the resistor on the clear housing so the near lead bends toward the right. Use needle nose pliers to loop this lead around the right-hand motor terminal. Solder the resistor to the terminal. The other resistor lead should point toward the hole in the housing.
  - ◆ It is vital that the resistor lies flat against the housing before soldering. It must be below the top of the motor terminals.
- ☐ ***Important! Glue the resistor.*** Heating the motor terminals can loosen them in the plastic housing. The resistor acts like a lever to rotate the terminal. If the terminal rotates too far, the fine motor wire connected to it inside the housing will break, rendering the movement useless.

  Don't take chances! I strongly recommend securing the resistor to the housing before you perform the next step, using adhesive such as rubber cement, Goop (**Fig. 16**) http://eclecticproducts.com/ag_adhesives.htm, or cyanoacrylate ("super glue"), seen here in Fig. 14. Keep the adhesive off the resistor leads, or soldering will be impossible.

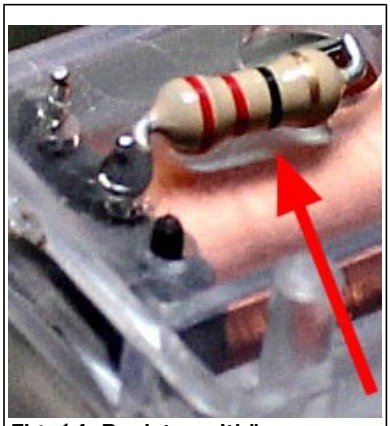

Fig. 14: Resistor with"super glue."

- ☐ Use needle nose pliers to wrap the hooked end of the longer "pigtail" wire you cut earlier around the remaining bent lead on the 22-ohm resistor. If you didn't glue the resistor as recommended above, be very careful not to rotate the resistor and the motor terminal more than a few degrees. The resistor acts as a "handle" that easily rotates the terminal. Run the wire between the two motor terminals at the edge of the movement housing to the resistor lead near the hole in the housing (blue wire, upper arrow in **Fig. 15**). Solder the wire to the resistor lead.
- ☐ Use needle nose pliers to wrap the hooked end of the shorter pigtail wire around the left-hand motor terminal (white/blue wire, lower arrow in Fig. 15), and solder it.

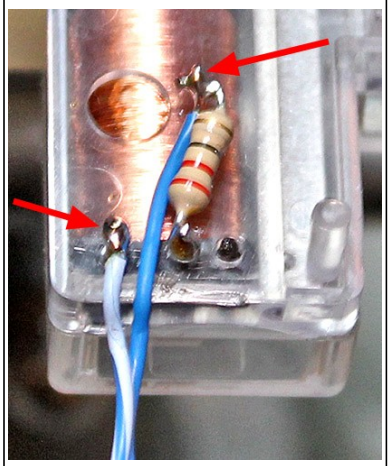

Fig. 15: Pigtail wires soldered.

☐ Press a finger or thumb over the motor terminals, resistor, and the two wires. Carefully bend the wires downward 90° where they cross the edge of the housing, as in Fig. 16. This bend allows the movement to sit flat in the case, and the wires to pass through a slot you will cut in the case (**below**).

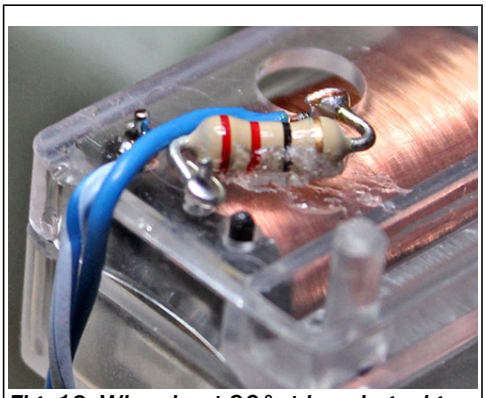

Fig. 16: Wires bent 90° at housing edge.

Cutting a slot in the case for the wires

The wires you added to the movement motor must must exit the black plastic case in the upper-left corner, as viewed from the rear (upper-right, as viewed from the front). As you can see in **Fig. 1**, there isn't much clearance between the movement and the case, so you must cut a slot in the both halves of the case for the wires to pass through.

The easiest and neatest way to do this is to use a narrow flat file, as shown in Fig. 17. Or you can use a sharp #11 blade in a hobby knife.

☐ Make the slot about 3/16" wide and about 1/16" deep. On the case front (Fig. 17), cut only the flange (ridge) that runs around the case. Stop cutting when you reach the case surface itself. One side of the slot should be adjacent to the corner curve in the flange; this is the correct location for the motor wires you installed above.

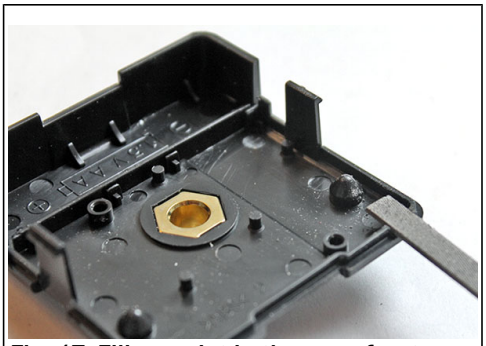

Fig. 17: Filing a slot in the case front .

☐ Cut a matching slot in the top side of the case cover (near the corner farthest from the large hole for the time-setting knob). Fig. 18 shows the notch in the case and the matching notch in the cover, which is flipped over to the right. Refer to **Fig. 1** for a front view of the movement with the wires exiting through the slot.

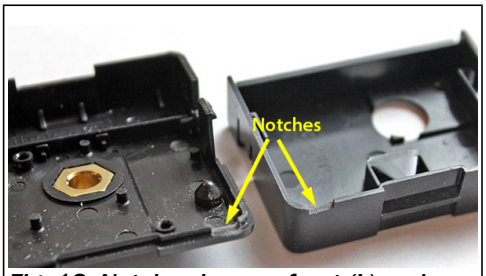

Fig. 18: Notches in case front (L) and cover (R).

☐

Reassembling the movement

☐ Place the modified movement into the case, with the shaft passing through the brass bushing. Ensure that the wires rest in the slot you cut into the case flange (Fig. 17). Also ensure that the wires don't hold the housing too high. There is a conical protrusion molded into the case (visible at the end of the file in Fig. 17). This protrusion should fit into the hole in the movement housing above the motor coil, seen in **Fig. 9**.

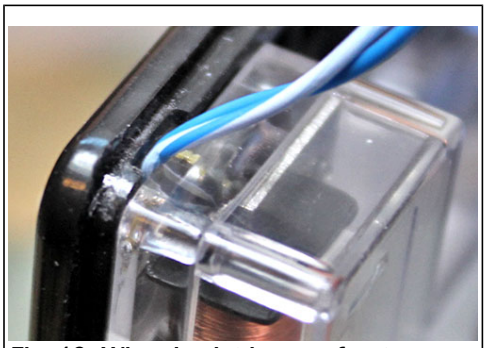

Fig. 19: Wires in slot in case front.

☐ If the movement is not seated flat in the case, and firmly onto the conical protrusion, remove it and bend the wires close against the end of the movement housing, as shown in **Fig. 16**. This should allow the movement to seat flat.

☐ Hold the movement against the case front, making sure the wires pass freely through the slot. Gently bend the

wires so they are parallel to the case front (e.g., bend them 45° toward the left in **Fig. 19**). Snap the case cover onto the case front. Be sure the slots in the case front and cover case align, and that the wires pass easily through the slot; see **Fig. 1**.