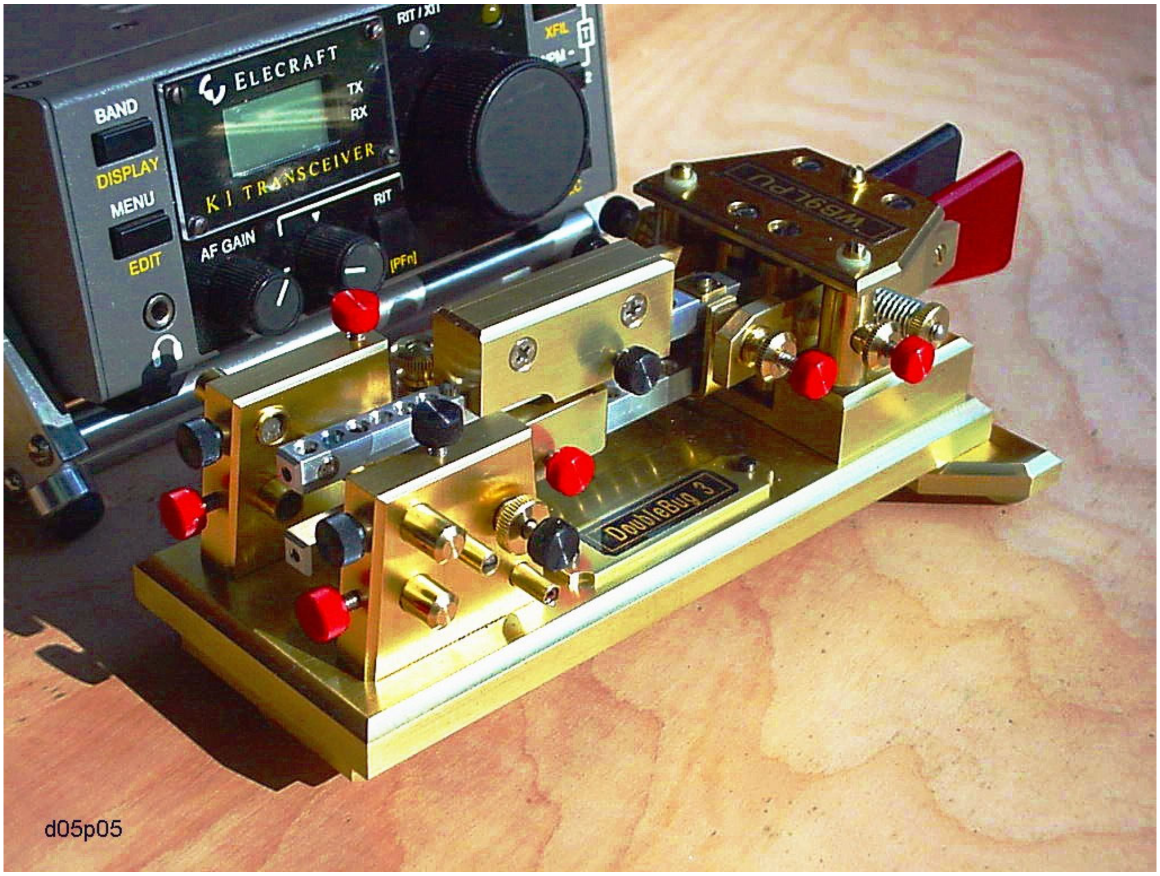
The Millenium Bug Project – *Continued*



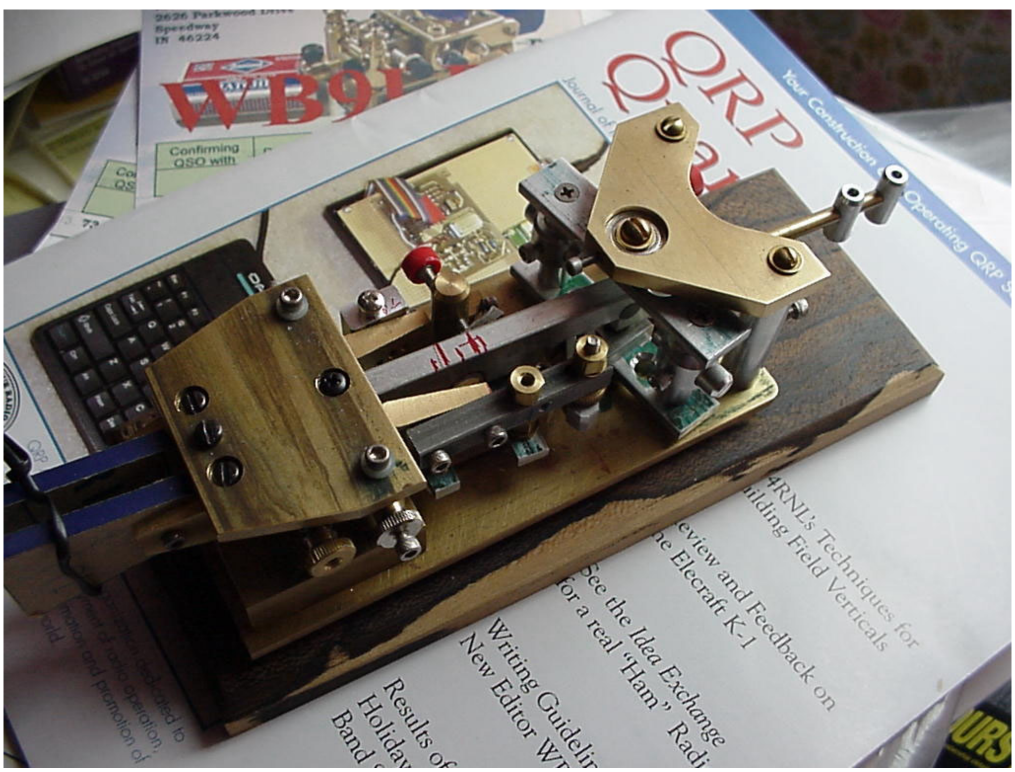
The Parkwood DoubleBug

The first attempts at bug-building in this project produced some designs (including two right-angle models) that worked well but had lots of room for improvement. The next second phase consisted of more conventional-looking units that used the "release of energy" principle to start the oscillation. These worked quite well, and a number of them have been built. All of the bugs up to this point were semi-automatic, like conventional bugs; that is, they made only dots automatically, and dashes were made manually. The challenge of making a fully automatic bug was too much to resist, so about a year ago, I began to work on such a design. What has come out of this is the DoubleBug.

A Bit of Design History

Previous designs had proved the utility of the basic magnetic pendulum / reed switch principle, which allowed for good control of speed and weight, so I decided to use this in the new design. The first attempt was a device with a single pendulum. The advantages of this were that a single adjustment would control both dots and dashes. In this design, the pendulum would swing to one side of center to make dots, and the magnetic field would be strong to produce a fast rate of oscillation. Dashes would be made by allowing the pendulum to swing to the other side in a magnetic field that was weakened by moving one magnet further away at the same time as the pendulum was released. It worked well for letters with only dots or dashes, but in transitions from dots to dashes, the momentum of the pendulum was hard to control, and only slow speeds (very slow) were possible. The use of eddy-current magnetic damping was explored, but it did not lead to a workable solution.

The next two designs had the pendulum swinging to the same side for both dots and dashes, with the magnetic field being changed by moving the dash magnet further away. It worked on paper, but from a practical standpoint, the amount of force required to operate the mechanism, and the same old momentum problems, produced an instrument that would be slow and tiring to use.

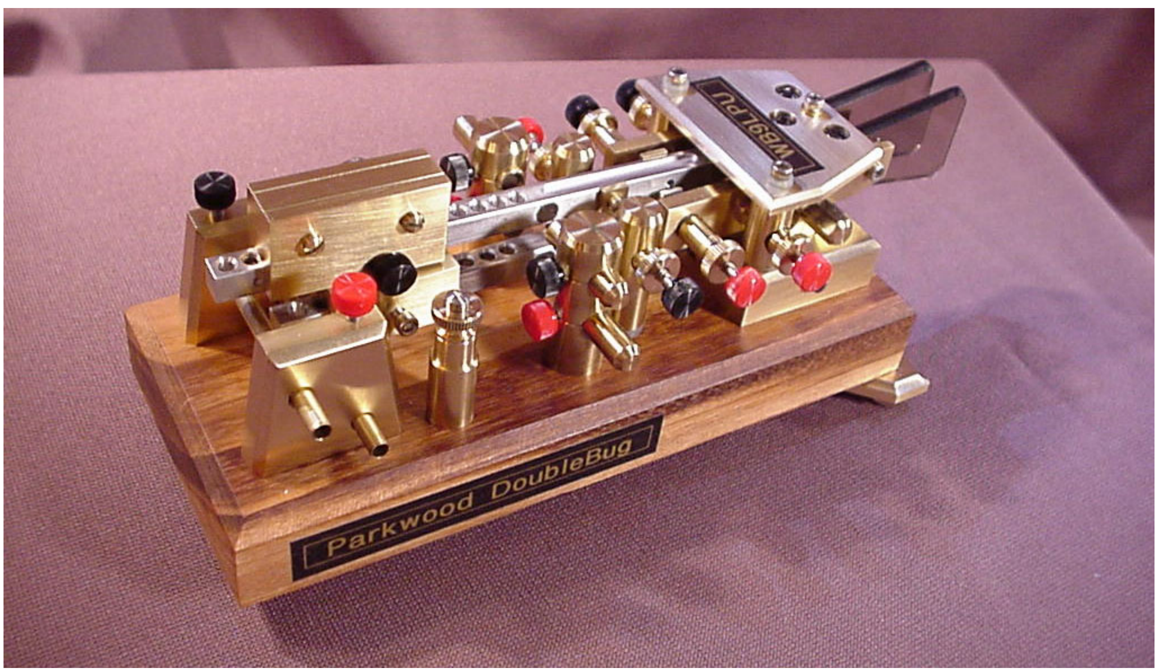


So the next design retained the one-side single- pendulum idea, but rotated the magnetic field to weaken it and produce dashes. This solved the paddle-force problem, but not the momentum problem. It also used a very complex set of linkages that was tricky to adjust and noisy in operation. This design could probably be refined into a working instrument, but it was time to apply the K.I.S.S. principal and abandon the single-pendulum design altogether.

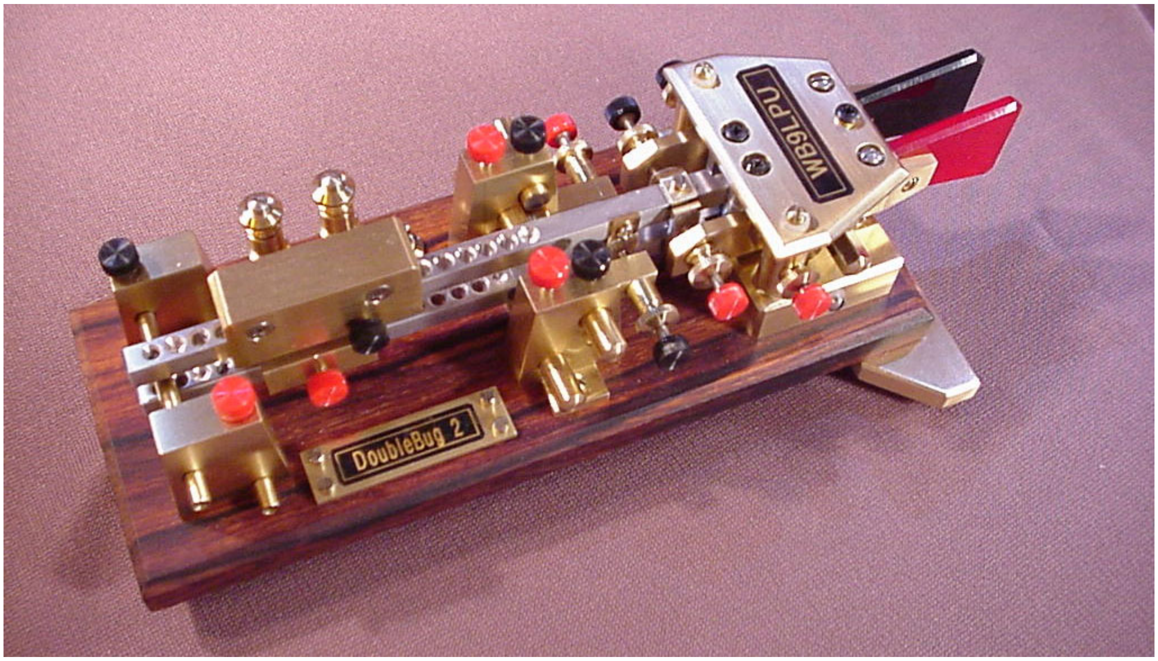
The design that finally worked used a dual-pendulum approach. The two pendulums were arranged in an over-and-under configuration to reduce the width of the unit. The pendulums operate independently, so the dot- and dash-rate and duty cycle are independently adjustable. This is important, because for dots a 1:1 element-to-space ratio is desired, while for dashes the ideal ratio is 3:1. To eliminate the need for mechanical dampers for the pendulums, each magnetic reed switch pickup is wired in series with the paddle contact. This arrangement swallows up any "after-bounce," but it makes the duration of the last dash in a stream more sensitive to the timing of the user.

The Ones That Worked

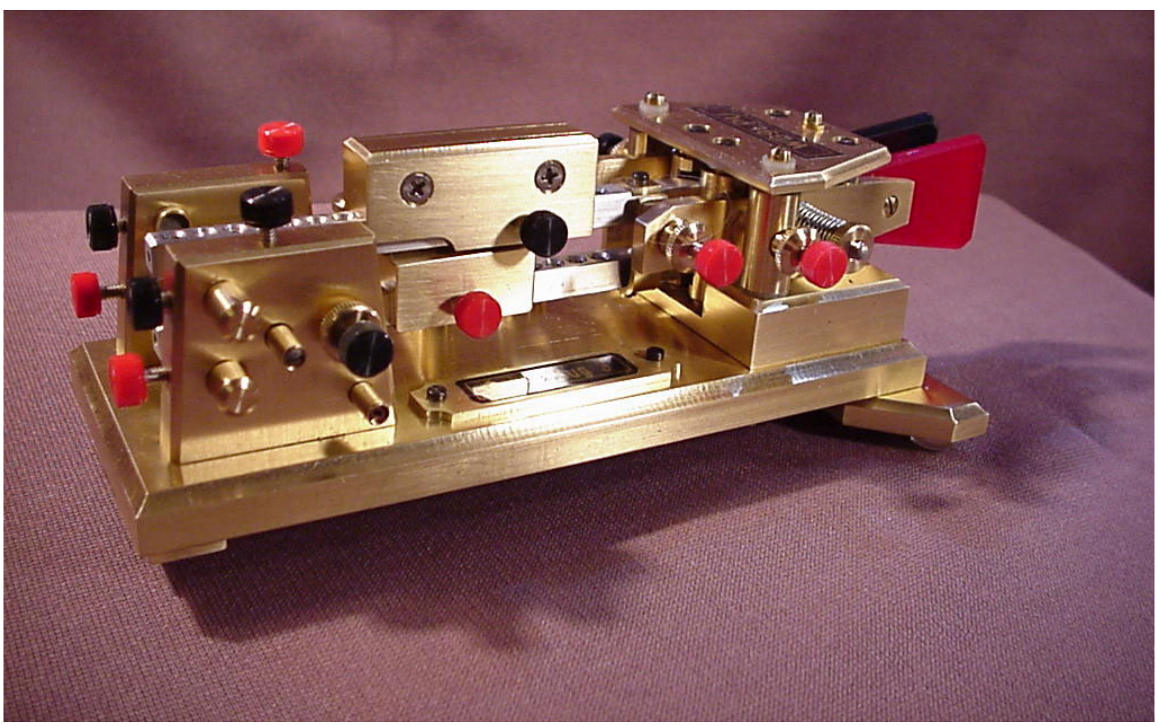
The first successful prototype had its pendulum pivots in line, and the various stops and magnets were laid out much like the previous semi-automatic designs. It worked well, but it was very hard to adjust because of the difficulty in reaching the controls. The bearing support mechanism for the lower (dot) pendulum was attached at only its lower end, so it wouldn't get in the way of the dash pendulum. This made it less robust than the upper (dash) pendulum, whose bearings were supported above and below.



The next attempt used over-and-under pendulums with side-by-side bearings. The magnet holders were redesigned to make adjustments more accessible, and more room was allowed for the sliding weights. This produced a key that was easy to adjust and use - it feels like a conventional paddle with a fairly large travel of the dot and dash levers. The elements (dots and dashes) are not self-completing, so a little care must be taken.

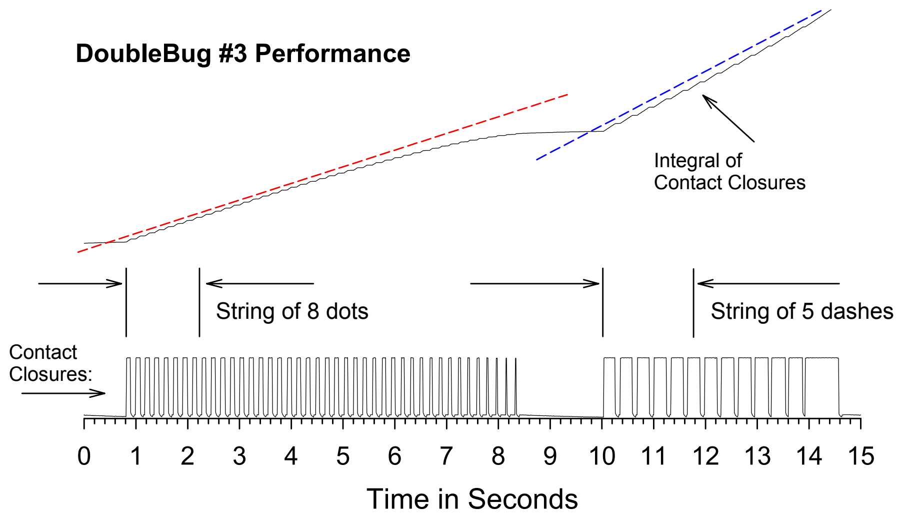


The last instrument in this series was an all-brass design in which tried to take into account all that I had learned in the previous attempts. The travel stops, pendulum magnets, and magnetic pickups were moved to the far end of the pendulum to open up a greater length for adjustment. A leveling screw was added to the base to compensate for the effects of position on the pendulum rates. Both this and the previous model use color-coded adjustment knobs in an attempt to reduce confusion in setting up the bug.

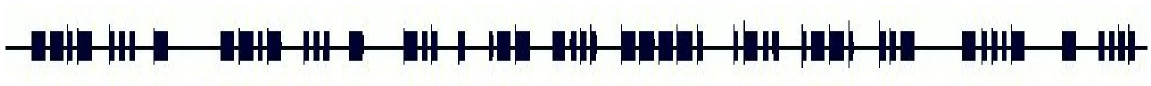


A Look at Performance

The graph below shows the dot and dash characteristics of the third DoubleBug. The slope of the integral curve is determined by the duty-cycle (the *weight*, in Morse code terms). It is quite constant for a significant time beyond the maximum needed string of dots and dashes



Shown below is an off-the-air recording of the waveform of a CW message. The errors in timing are primarily those of the operator, not the instrument.



What's Next?

Now that the basic design is established, it can be miniaturized. On the drawing board (and in my head) is a smaller version with a base that will measure 2" x 4". The single-pendulum design is not dead – but its use will require some devices (like a magnetic divide-by-two mechanism) that have not been perfected.

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