6 Transistor Super Regen Receiver

The following is a design for a separately quench super regen receiver I first tried in early 1992. It worked far better than any other solid state design, so I built a portable version for use during my commuting from the Blue Mountains to Sydney on the train. Running off 10x AA nicads, this gave me a weeks listening before recharging. Only recently, I submitted the basic circuit to Silicon Chip, whereupon it was published in the April 2003 issue (and I won a nice true RMS meter as a result). My portable version differs in that I use varicap tuning, the output transformer has a 1K primary, and the output transistor is a BC108, with bias components to suit. It also uses the headphone lead for the aerial.

Super-regenerative receiver for AM & FM

This little super-regenerative receiver is essentially an AM receiver, with "slope detection" used for FM. By tuning to one side of the carrier, the receiver's tuned circuit converts FM to AM. The bandwidth is about 200kHz so wideband FM stations can be demodulated by tuning the receiver to the most linear point of the response curve, rather than the top of the curve as one would for AM. In practice, this simply means tuning for clearest sound.

The heart of the receiver is Q2 which is a Hartley oscillator, with its tuned circuit in the base circuit. It determines the frequency of oscillation and hence the receiving frequency.

RF amplifier Q1 is a self-biased untuned common emitter amplifier stage, included to prevent aerial loading from affecting the detector's oscillation frequency and amplitude. It also reduces any RF radiated from the aerial. RF is coupled into the oscillator coil by C2. The aerial can be a piece of wire cut to 75cm. A 75cm telescopic rod aerial is better but a proper outdoor FM aerial is preferred for non-portable use.

Most simple super-regenerative detectors are self-quenched, however this makes it difficult to obtain the optimum quench waveform. Particularly for wideband FM, the quench waveform has a considerable effect on sound quality.

In this receiver, the quenching of the detector is achieved by Q6, a unijunction transistor (UJT) relaxation oscillator. The base of the UJT provides an approximate sawtooth waveform, which as it also provides the bias supply for Q2, takes the detector in and out of oscillation at about 50kHz.

It is necessary to be able to set the optimum quenching voltage and this is done by adjusting Q6's supply by trimpot VR2. This effectively functions as the regeneration control.

Present at the collector of Q2 is the demodulated AM or FM signal as well the supersonic quench. This is of sufficient amplitude to overload the following audio stages, so C6, R7, C7 and C9 provide simple low-pass filtering.

Transistors Q4 and Q5 form a class-A amplifier which can provide about 80mW output. Bias stabilisation is automatic using current feedback. If the current rises in Q5 then Q4 turns on harder, reducing the bias for Q5. Negative feedback is obtained from the secondary of the speaker transformer and fed into Q4 via R18. The windings of the transformer must be phased correctly, otherwise the amplifier will oscillate. The transformer is a standard DSE/Jaycar 500Ω to 8Ω output type.

The prototype receiver uses the local oscillator section of a plastic AM radio tuning capacitor, in the same way as SILICON CHIP did with the TDA7000 FM receiver (November 1992 issue). (The aerial section tunes a ZN414 AM receiver in the same enclosure, sharing the same audio amp).

The air-cored coil (L1) consists of four turns of 18-gauge B&S tinned copper wire on a former with a 3/8-inch ID and tapped at one turn. With this coil, frequency coverage is about 60-150MHz depending on tuning capacitance.

As with all VHF circuitry, some care needs to be taken with construction. My portable version was built on a small piece of Veroboard. When using this, or any other super-regenerative receiver, it may often be found that an audible tone is heard in the background when listening to a station transmitting stereo or SCA programs. This is a result of subcarriers beating with the quench frequency. Adjustment of the quench frequency will usually minimise the problem.

In this receiver, if adjusting VR2 doesn't get rid of it, then it's worth experimenting with C11. It's important to note that raising the quench frequency too high will reduce receiver sensitivity. Decreasing the quench frequency will improve sensitivity but the subcarrier beat will be more evident.

Further decreasing it will make the quench audible at all times. For non-FM stereo/SCA applications, C11 can be increased until just before the quench becomes audible.

Optimum sensitivity occurs with VR2 adjusted to the point where the receiver has just gone into oscillation. At this point, a "rushing" noise becomes evident and stations can be tuned in. With very weak signals, it will become obvious that the settings of VR2 and C4 interact slightly. I tested this receiver with an HP 8654 signal generator and could receive a 3μV signal, albeit with some noise.

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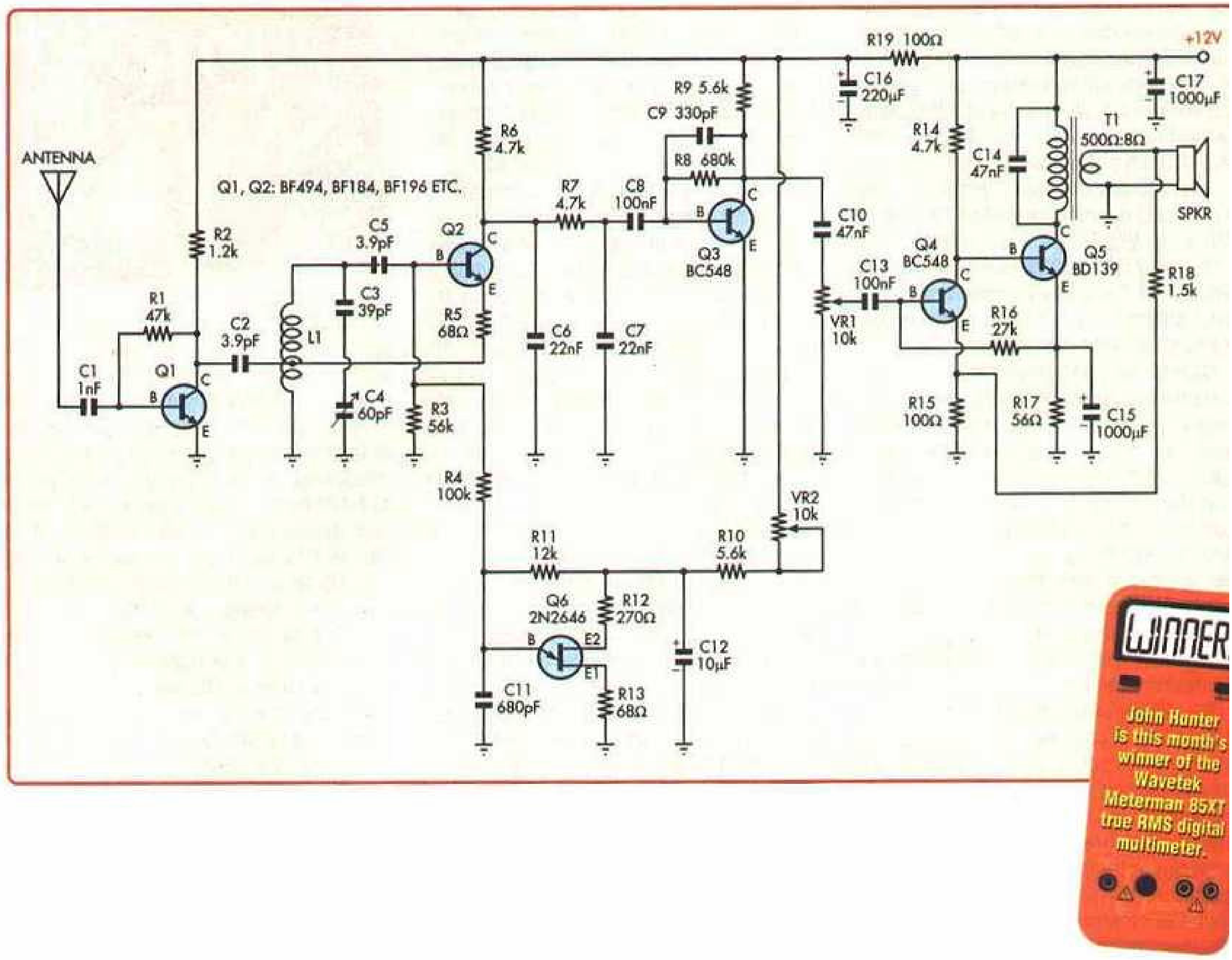
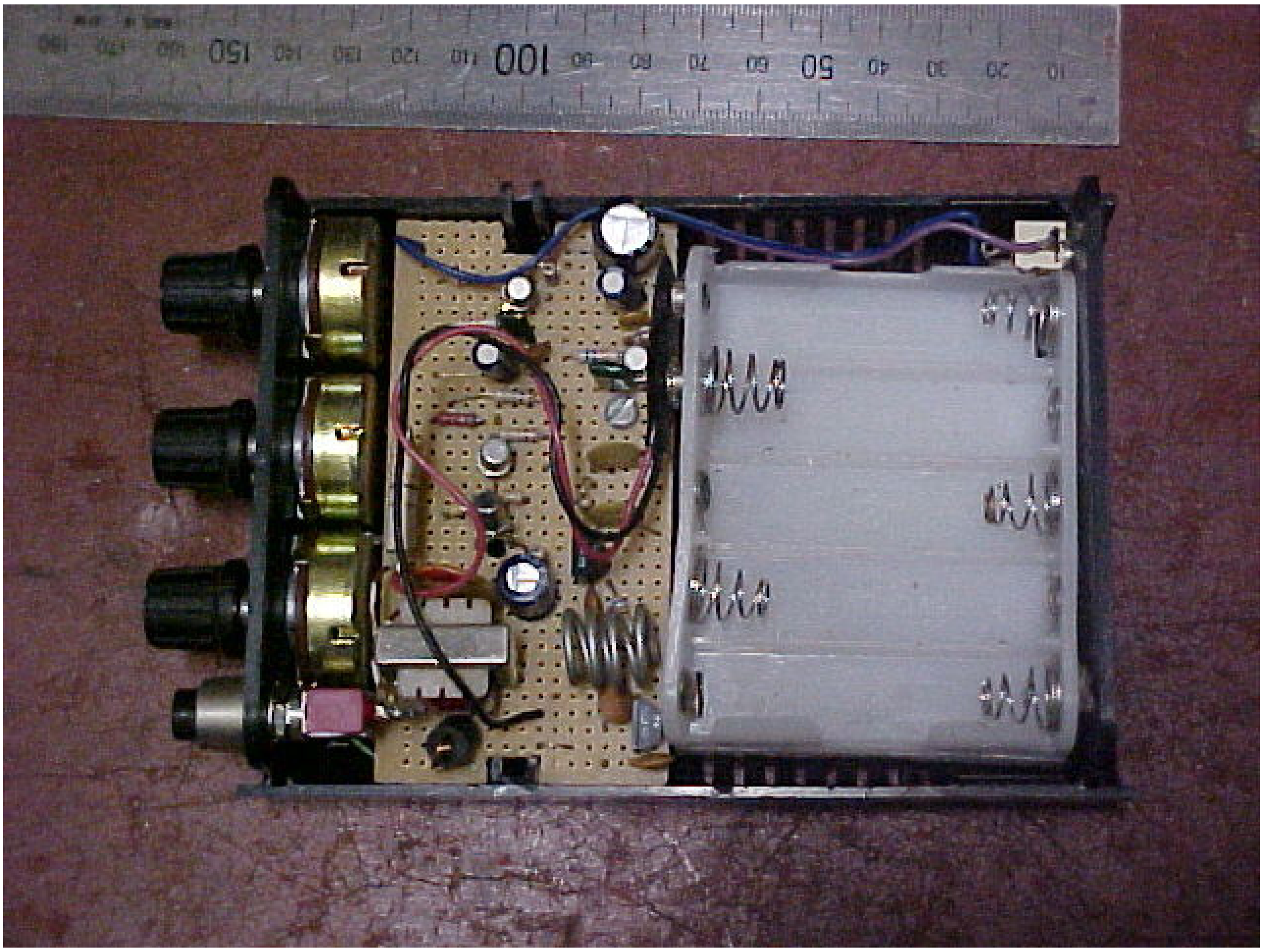
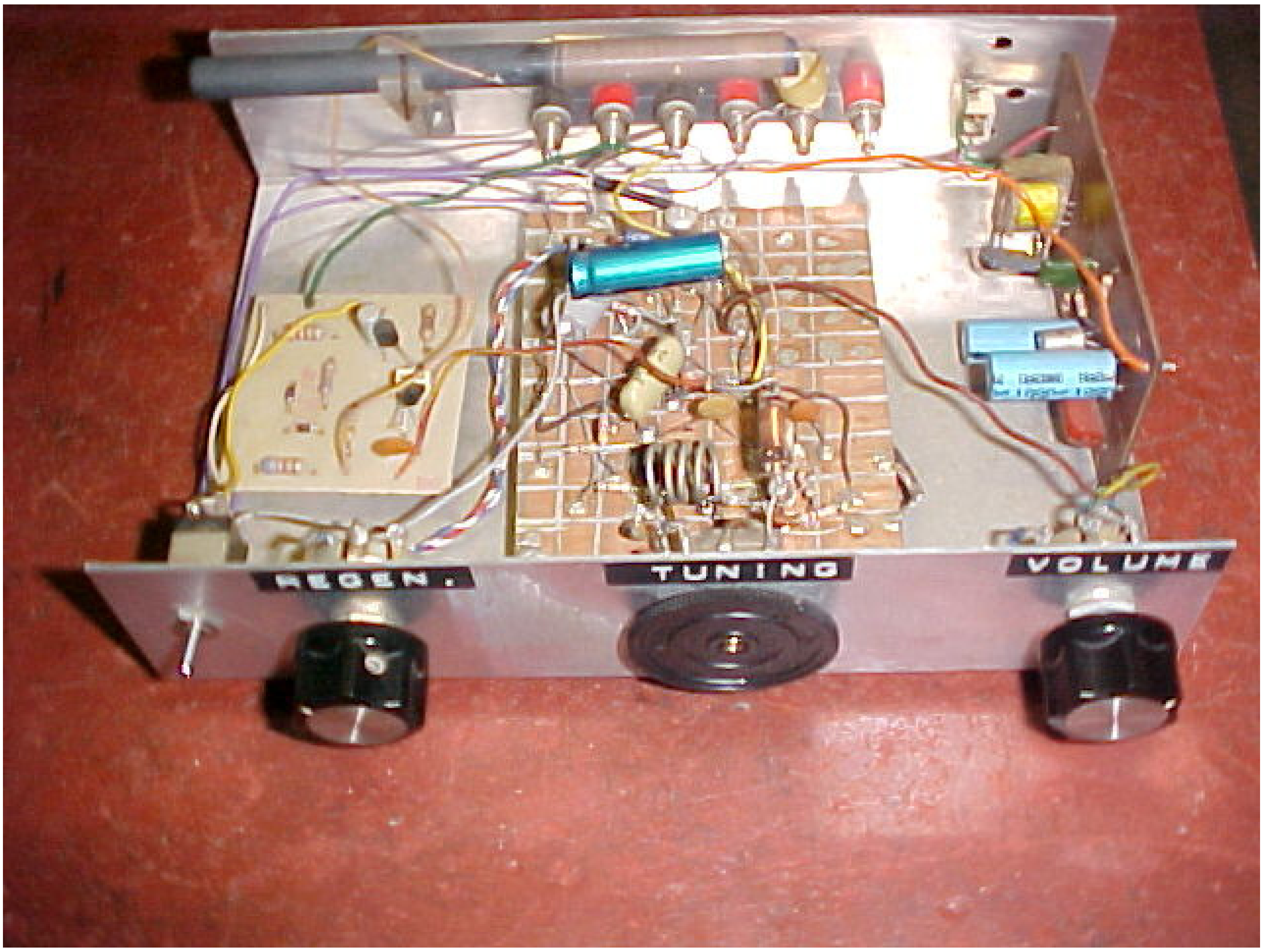


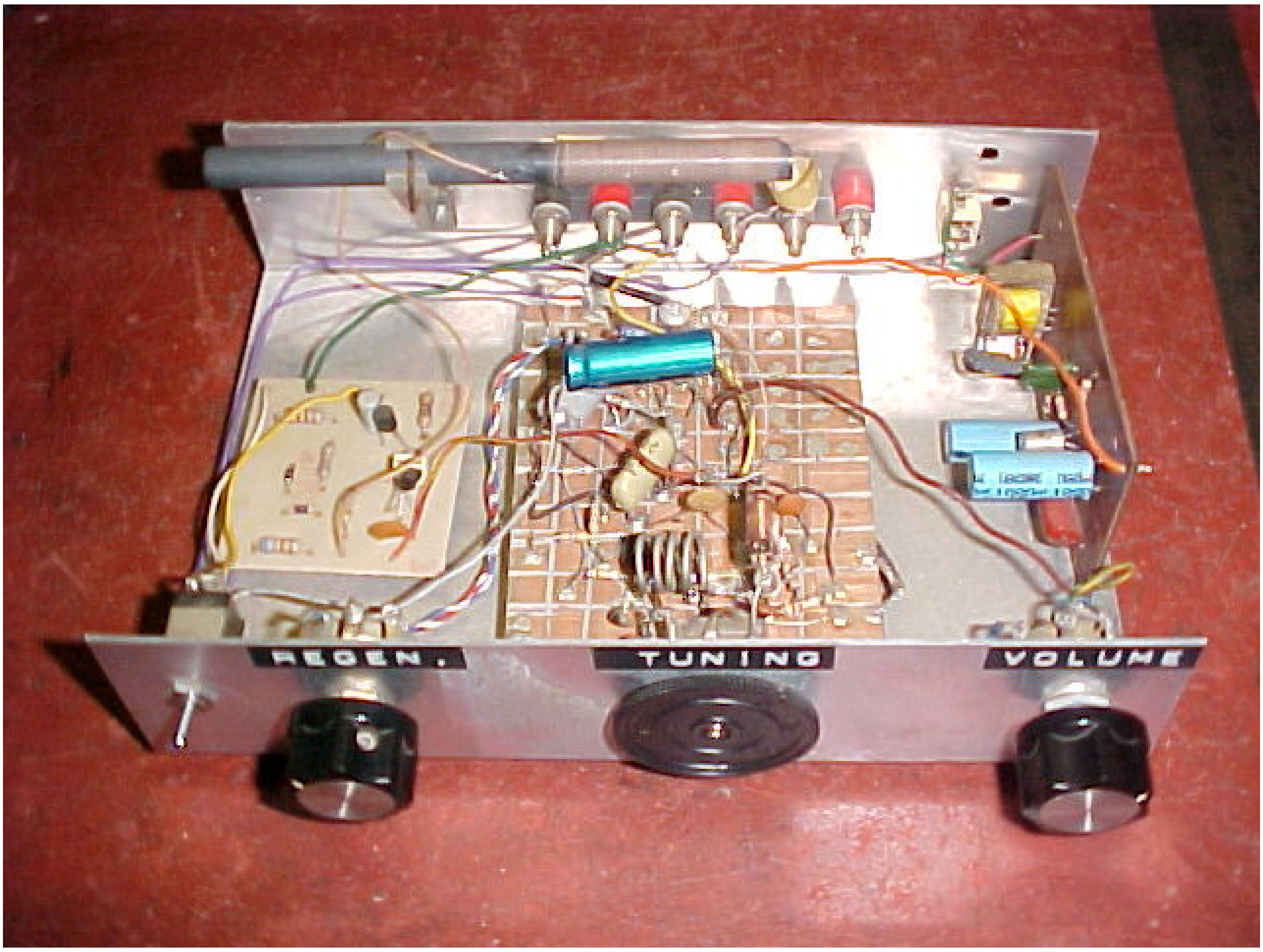
ANTENNA
Q1, Q2: BF494, BF184, BF196 ETC.
C1 1nF
Q1
R1 47k
R2 1.2k
C2 3.9pF
L1
C3 39pF
C4 60pF
C5 3.9pF
Q2
R3 56k
R4 100k
R5 68Ω
R6 4.7k
R7 4.7k
C6 22nF
C7 22nF
C8 100nF
C9 330pF
R8 680k
R9 5.6k
Q3 BC548
C10 47nF
VR1 10k
VR2 10k
R10 5.6k
R11 12k
R12 270Ω
R13 68Ω
Q6 2N2646
C11 680pF
C12 10µF
R19 100Ω
+12V
C16 220µF
C17 1000µF
R14 4.7k
C14 47nF
T1 500Ω:8Ω
SPKR
C13 100nF
Q4 BC548
Q5 BD139
R18 1.5k
R16 27k
R15 100Ω
R17 56Ω
C15 1000µF
WINNER!
John Hunter is this month's winner of the Wavetek Meterman 85XT true RMS digital multimeter.

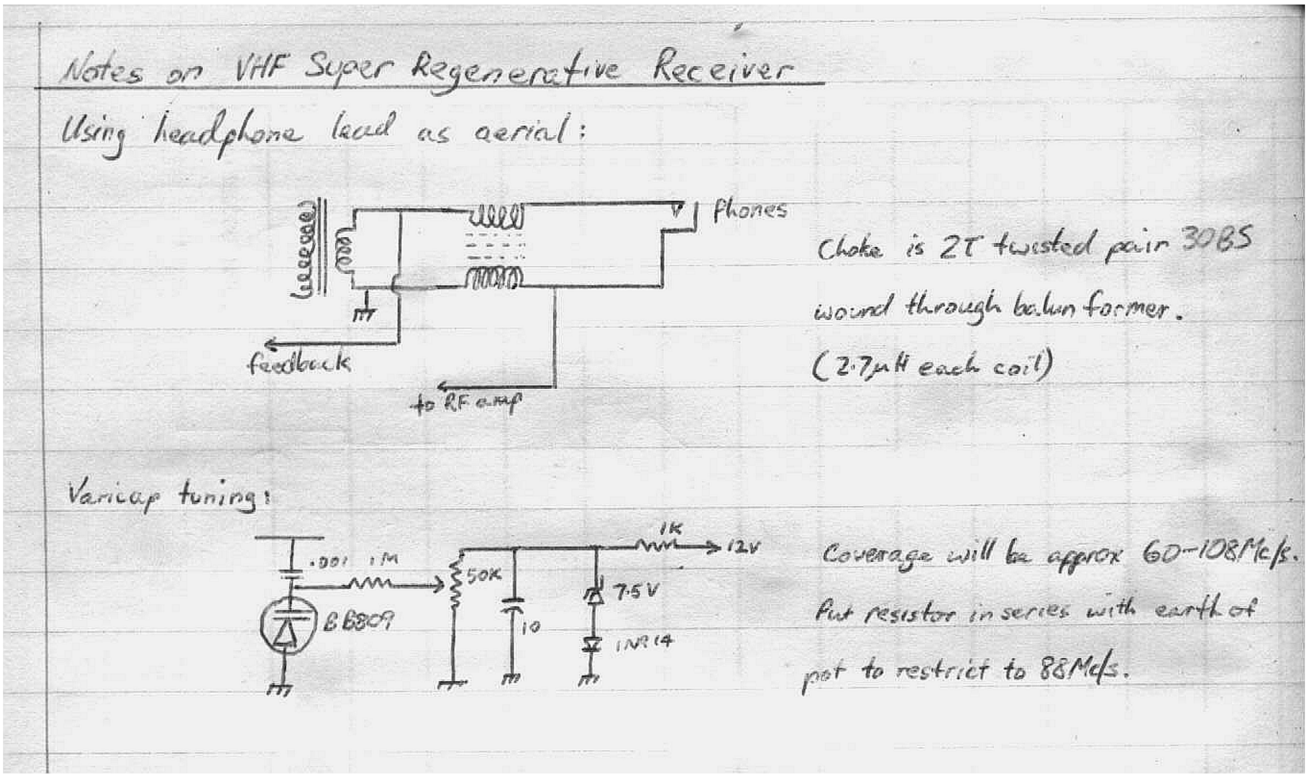


Note the three pots. This portable version uses varicap tuning.



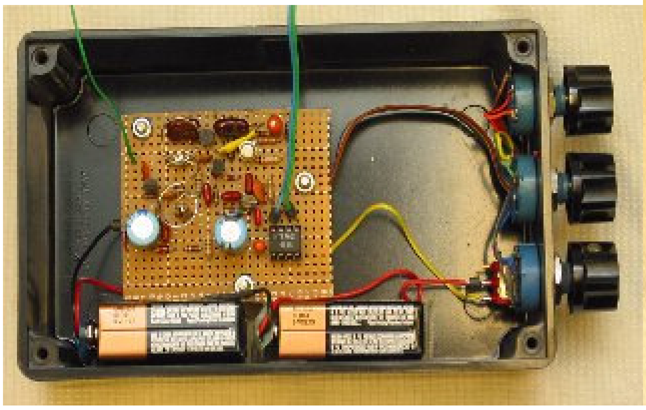
The prototype, February 1992. The small PCB on the left is an MK484 receiver for Medium Waves, while the PCB on the right is a two germanium transistor audio amp



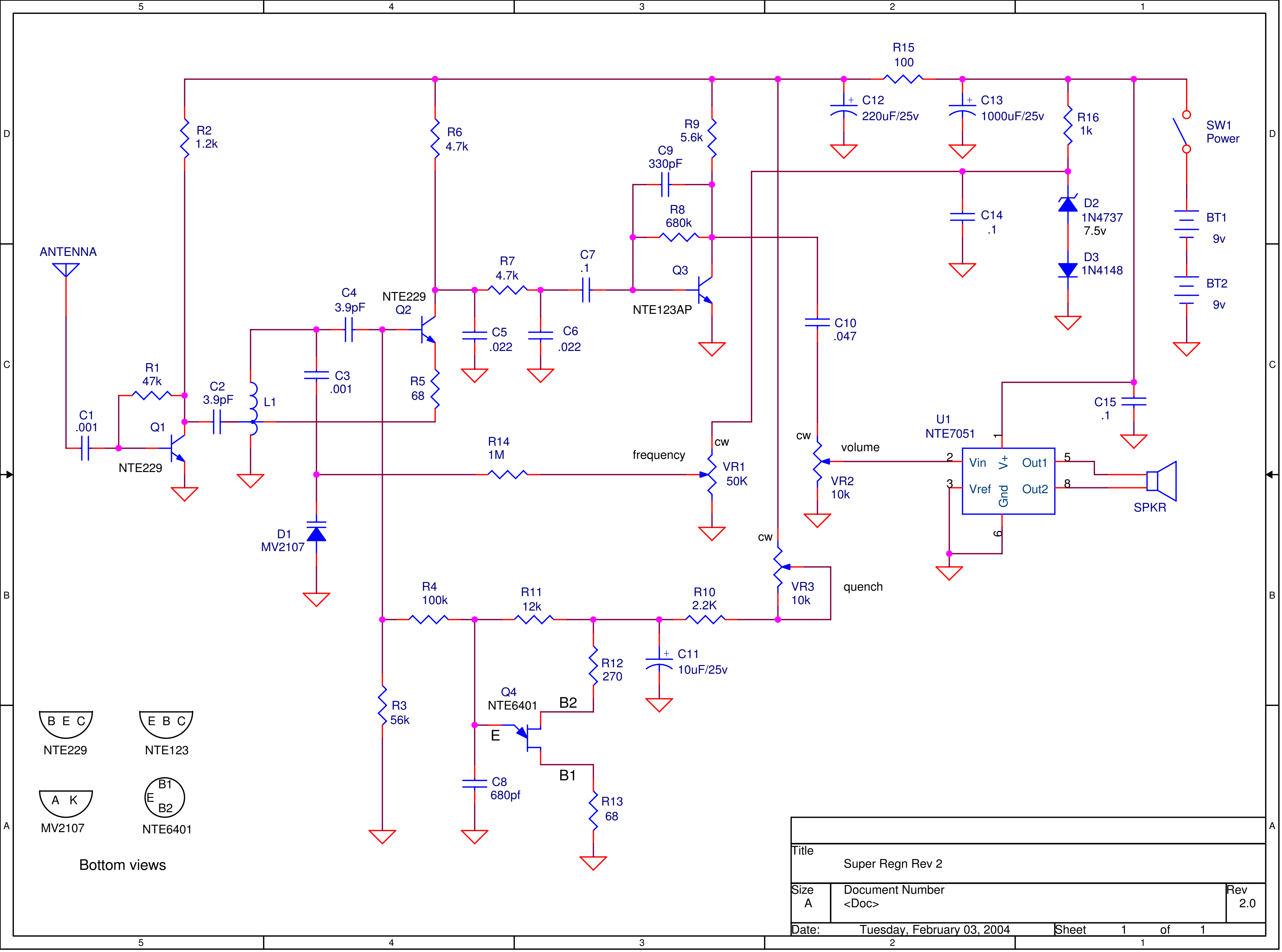


Taken from my original notes, this is how to use varicap tuning and the headphone lead as an aerial.

Fellow enthusiast, Andy Mitz, decided to have a go at building this receiver with a few minor changes.
The front end was kept as is, but an audio amp IC replaced my two transistor circuit, and an 18V supply was used.
This is what Andy had to say: *I have attached some photos of a regen build using much of your design. This version uses a Motorola varicap diode and a Philips audio amp chip. The unit is sensitive (does not need the whip antenna), selective, and has enough audio to overdrive the speaker.*




Inside and outside views of Andy's receiver. The 18V supply would provide better
stability for the varicap tuner's zener diode stabiliser as well as providing high audio output.



R15
100
C12
220uF/25v
C13
1000uF/25v
R16
1k
SW1
Power
R2
1.2k
R6
4.7k
R9
5.6k
C9
330pF
R8
680k
C14
.1
D2
1N4737
7.5v
D3
1N4148
BT1
9v
BT2
9v
ANTENNA
R7
4.7k
C7
.1
Q3
NTE123AP
C4
3.9pF
NTE229
Q2
C5
.022
C6
.022
C10
.047
R1
47k
C2
3.9pF
L1
C3
.001
R5
68
C1
.001
Q1
NTE229
C15
.1
U1
NTE7051
R14
1M
frequency
cw
VR1
50K
volume
VR2
10k
Vin
V+
Out1
Vref
Gnd
Out2
SPKR
D1
MV2107
VR3
10k
quench
R4
100k
R11
12k
R10
2.2K
R12
270
C11
10uF/25v
R3
56k
Q4
NTE6401
B2
E
B1
C8
680pf
R13
68
B E C
NTE229
E B C
NTE123
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Bottom views
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