Direct Conversion Lives!

—excitingly simple receiver project

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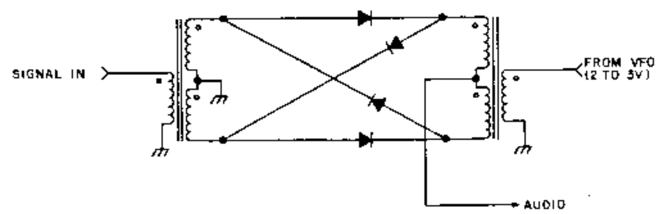

Fig. 1. Passive double-balanced mixer. Transformers are trifilar wound on toroids. Diodes are 1N914, 1N4148, etc.

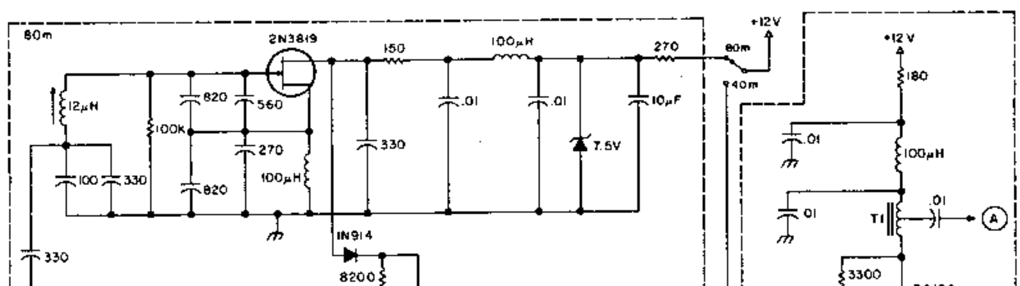

Fig. 2. 80m and 40m oscillators and buffer. The output parts of the oscillators and the buffer are the same as that of Rollema.[3] *For T1, see text.*

Ever since the Japanese started building receivers and transmitters for us, we hams who like to do something with our hands in the evenings were left with building accessories for the shack, QRP transmitters for CW, simple receivers, power supplies, etc. Even power supplies in the high-current range are nowadays probably cheaper to buy than to build.

One of the most interesting of the simple receivers is the D-C (Direct-Conversion) receiver in which the rf signal is converted directly to audio without any intermediate-frequency (i-f) amplification. Through the years, I have built quite a number of versions of the

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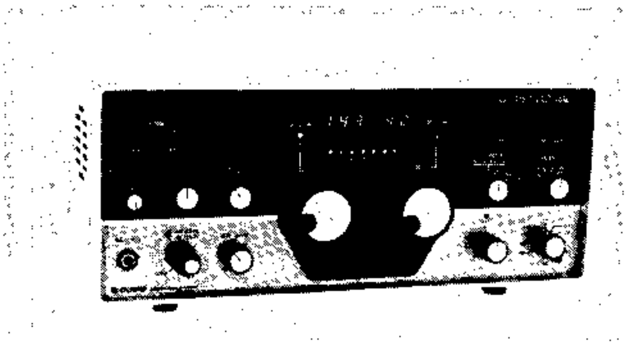	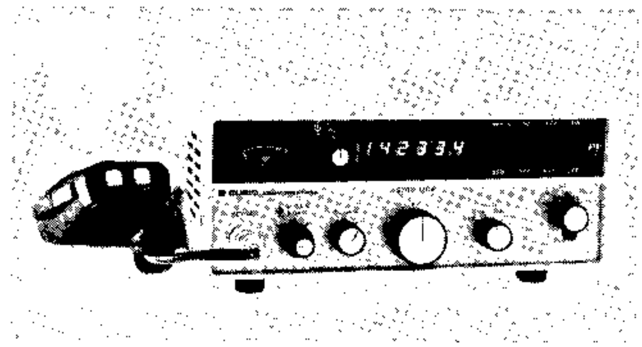
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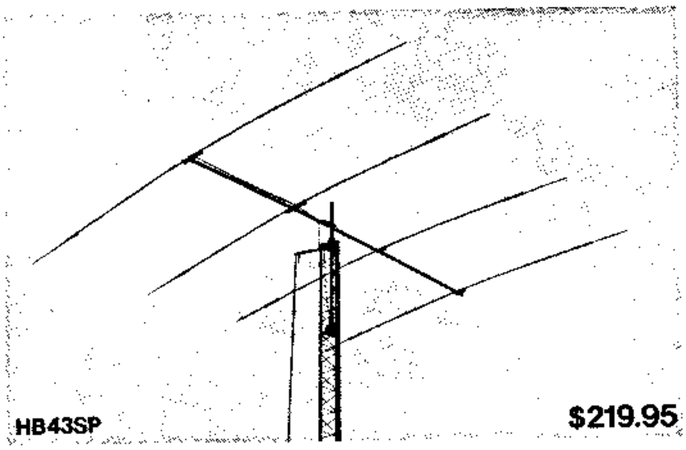

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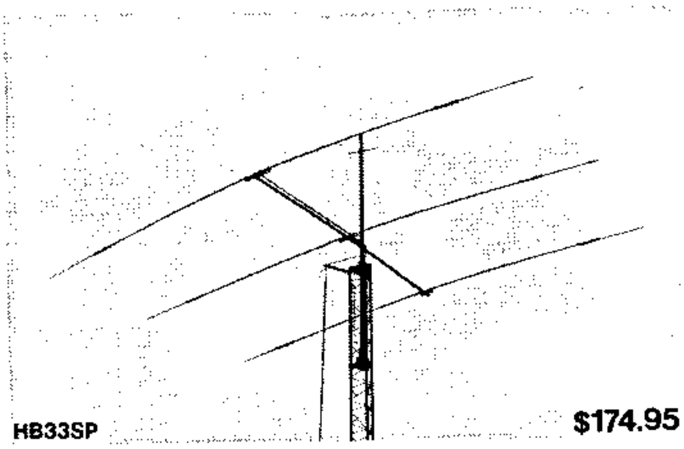

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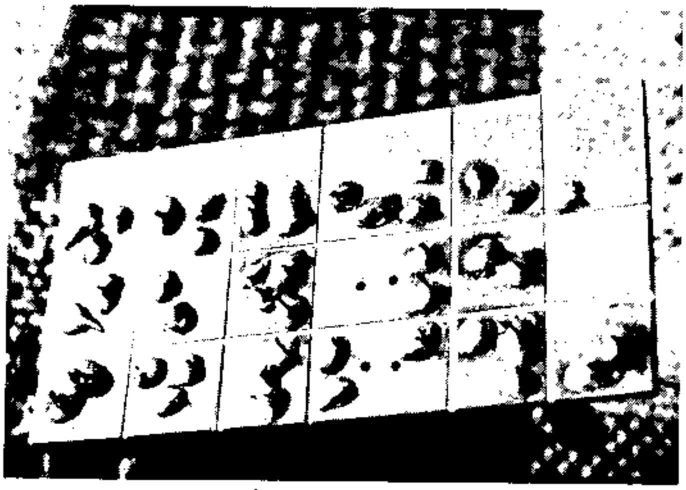

Photo A. *Copper side of PC board. The grooves cut in the copper foil are made by an ordinary hacksaw.*

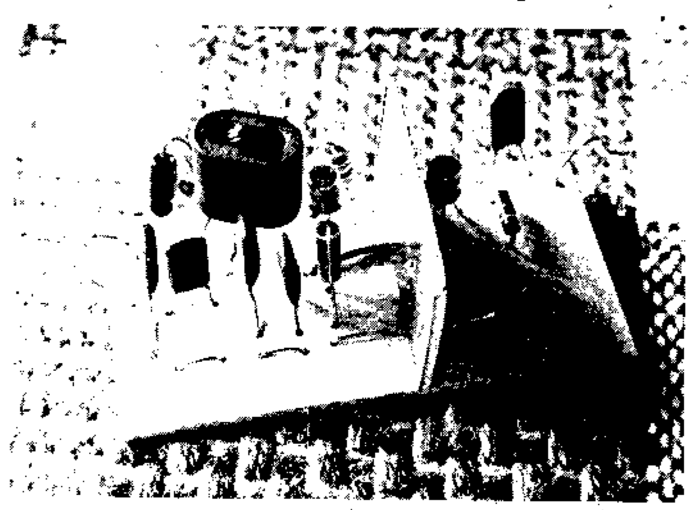

Photo B. *Component side of PC board. The buffer module is shown here.*

D-C receiver and in this article, I want to present my latest version, which I modestly think is not far from the ultimate, keeping in mind that simplicity is the key word. First, I shall give a few short notes about some parts of the D-C receiver and, thereafter, the complete circuit.

Mixer

The mixer is the most important part of the D-C receiver. My first experiments were all with single active mixers. The 6 dB of conversion gain was always very attractive to me, but with this kind of mixer, you nearly always get AM breakthrough from nearby commercial broadcast stations. This is particularly true of the 40m band, which in South Africa is from 7000 kHz to 7150 kHz; just above the latter figure, there are some strong AM stations.

I then moved to active balanced mixers, more or less like the one used by Rusgrove W1VD.[1] This cured most but not all of the AM breakthrough—you could still hear a little background music between the ham stations! My next move was to try double-balanced mixers using passive elements (4 diodes) approximately like the ones used by O'Grady WA5WWN[2] in a QRP transmitter (represented in Fig. 1).

In my experience, this mixer was the best of all that I tested, and no AM breakthrough was noticed. I was very pleased, when the article of Dick Rollema PAØSE[3] appeared, to see that he came to the same conclusion. PAØSE's article is an excellent one and must surely go down in history as a classic as far as D-C receivers are concerned. PAØSE went even one step further with the mixer and used a ready-made double-balanced mixer, the Anzac MD108. This mixer was unavailable in this country, so I immediately wrote to Anzac in the faraway USA; I was quite surprised when this friendly firm sent me one of their mixers. I tried it and the results were virtually the same as with the mixer in Fig. 1, but with one big advantage: The MD108 needs far less drive from the vfo—0.5 volts—not the 2 to 3 volts needed for the mixer in Fig. 1.

Front End

Builders of D-C receivers are always in doubt as to whether they must use some rf amplification before the mixer. With rf amplification, there is always the danger of worsening the selectivity and AM breakthrough. On the other hand, rf amplification really helps with weak stations in a quiet band. I put an rf amplifier in my receiver and took it out again several times. In the end, I reached a compromise: I put in a broadband rf ampli-

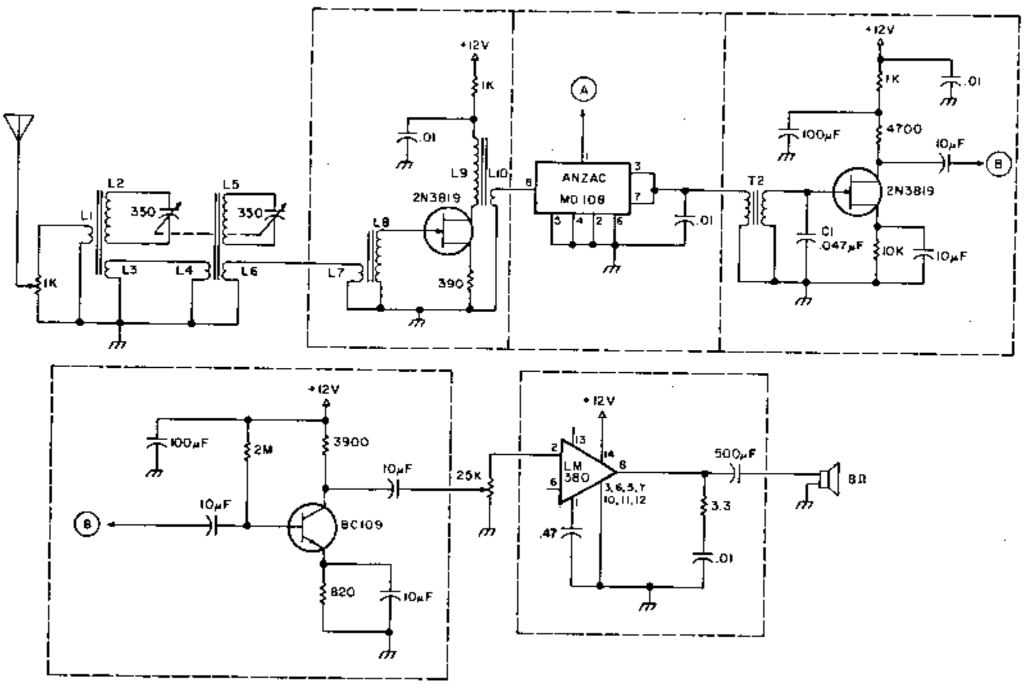

Fig. 3. Input, mixer, and audio parts of the D-C receiver. For L1 to L10 and T2, see text.

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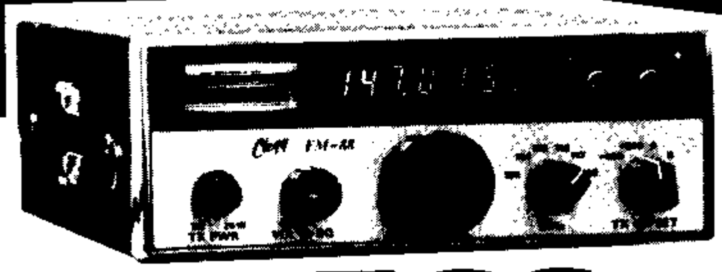

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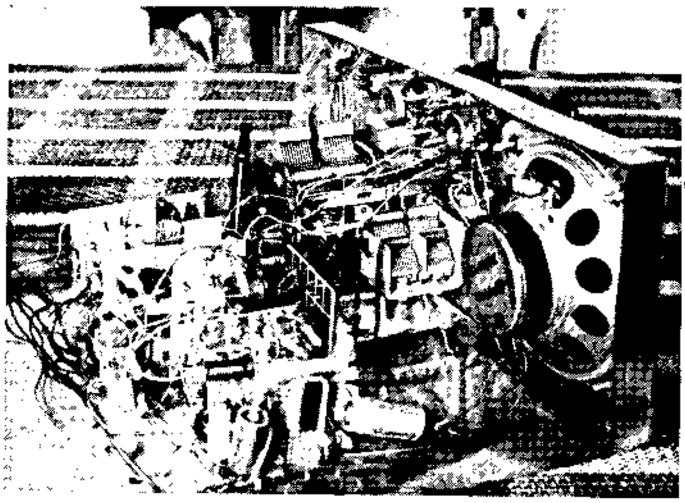

Photo C. Inside of the receiver. The modules are mounted vertically by means of Terry clamps.

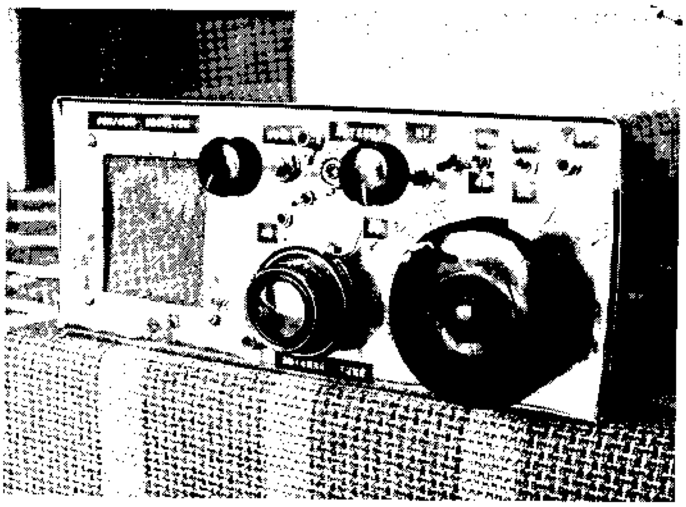

Photo D. Front part of the receiver. The extra switches and sockets are for interfacing with a 5-Watt DSB transmitter.

fier with low amplification, but with a DPDT switch to disable the amplifier if I so wished. To avoid confusion, this switch is not shown in the circuit diagrams.

The complete circuit diagram of my 80m/40m receiver is shown in Figs. 2 and 3. Here are some notes about the circuit.

Audio Filters?

Purists will immediately ask: Where is the audio filter? I tried several audio filters and found out one thing very quickly: The input impedance of the filter must exactly match the output impedance of the preceding stage; the same applies for the output of the filter and the input of the succeeding stage. The other problem was that no cheap 88-mH inductances are available in this country. The best filter that I used had more or less the same effect as capacitor C1 in Fig. 3. So I chucked out the filter and used only this capacitor. I use my receiver only for SSB—perhaps if you want to use it mainly for CW, a filter is necessary.

Construction

My experience is that no two hams use the same construction methods, so here are a few sentences on my own construction method—which is far from ideal. May I say, first, that I am no sucker for miniaturization; with my construction method, you can't put the receiver in a cigarette box, etc.

I divided the receiver into eight parts as shown by dotted lines in Figs. 2 and 3 and built each part as a separate module. For each module, I used the square block method, which means cutting the copper side of a piece of PC board into squares and mounting the components on the squares. For later modules, I drilled holes through the board, mounted the components on the bare side, and soldered the leads on the copper side. This is illustrated in Photos A and B. Each module was mounted vertically with Terry clamps on the bottom of a homemade cabinet. Photo C shows the inside of the cabinet. The module method has the great advantage that you can change a component on a module or replace a module with another one with the greatest of ease.

A form of slow-motion drive for the tuning capacitor is essential. Lady Luck sometimes, just sometimes, smiles toward the building ham. Here it was my turn, and from the deepest part of my junk box, I dug up a very old slow-motion drive—but a beauty! You can't buy such things in South Africa. With this slow-motion drive, I cover the 80m band (3500-3800 kHz in South Africa) with 25 turns of the knob. It works out at 12 kHz per turn, which is just about ideal. If no slow-motion drive is available, a 20-pF variable capacitor can be put in parallel with the main one and used to fine-tune an SSB signal.

Photo D shows the front part of the receiver. The few extra switches and sockets are for interfacing with a small 5-Watt DSB transmitter.

Inductances L2 and L5 are wound on toroids. I shall give no details on the number of turns as I have no idea of the characteristics of the toroids I used—they are unmarked and came out of an unmarked cardboard box in the corner of a local radio shop. As always, it is best to use a gdo to determine resonance. Links L1, L3, L4, L6, L7, and L10 can be 5 or 10 turns to start with. L8 and L9 also are wound on toroids and can have an inductance of, say, 50 to 100 mH. Transformer T1 is described fully by Rollema. I won't repeat it here, except to say that it has a step-down voltage ratio of 3 to 1 and the secondary impedance is 50 Ohms. An ordinary toroid with the right turns ratio will probably work just as well.

Results

I was genuinely surprised with the performance of this receiver. To quote the words of Rusgrove, "A well-designed D-C receiver will provide a certain, pleasing clarity and depth of sound . . . signals seem to stand out against a nearly noiseless background." Also, the words of Rollema: "It is a real pleasure to operate the D-C receiver."

I did not have a calibrated signal generator to measure the sensitivity of this receiver, but it compared very well with my FT-301. Selectivity is just a little bit worse than that of the FT-301.

In conclusion, I have used my D-C receiver now for over a year and it still gives me a deep sense of satisfaction to tell the chap on the other side, "Equipment on this side is home-built, old man."■

References

1. J. Rusgrove W1VD, "A 20-meter High-Performance Direct-conversion Receiver," *QST*, April, 1978.

2. C. O'Grady WA5WWN, "Quazar QRP 40-meter DSB Transmitter," *73 Magazine*, January, 1970.

3. D. Rollema PA0SE, "Second Thoughts on the Direct-Conversion Receiver," *Ham Radio*, November, 1977.