



F5SLD's **Free** HAM Magazine - **100% HAM RADIO**

## ANTENNAS FOR LIMITED SPACE



**Antenna for limited space**



**High Voltage Breakdown Tester**



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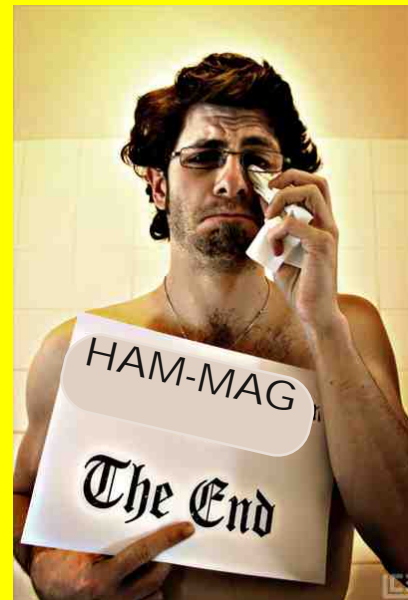
HAM-MAG is one year old. We have now more than 7,500 subscribers all over the world and many more readers thanks to the Web. Actually this is not a great success. We have sent many E-mails to retailers without any answer. No retailers want to collaborate to HAM-MAG. Another danger is the articles... We have not any articles left for the next issue !

**To live this magazine needs ads and articles.**

If we don't find any retailer who trust in this magazine and if we don't receive informations and articles **this issue could be the last.**

The last way shall be to sell the issue but this is not our philosophy and it will be against the Ham spirit.

You must know that I make this magazine during my pastime, this is not my real job, and there are only 24 hours in a day and I have not enough time to find and to make articles.



**So what is the future for HAM-MAG in english ? I don't really know...**

I send to you and yours all my best wishes for Xmas and a very happy new year 2010.  
Take care.

Yours faithfully,  
**Vincent Faucheux - F5SLD**  
**Chief Editor**

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Hola, Amigos:

The FBI says there is no basis of a "Federal Crime" being committed (for the forgeries of USA call signs), so my BIG JOB now is to hopefully MAKE it a "FEDERAL CRIME" via amendment of the FCC Rules.

See download at:

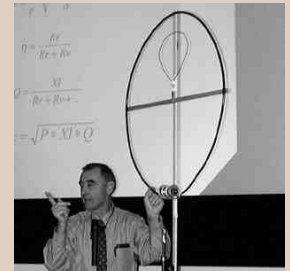
<http://www.k6vva.com/fccpfr>

**FYI & 73...**

**Rick, K6VVA \* The Locust**

# ANTENNAS FOR LIMITED SPACE

By Stan Bourke VK2EL  
([sbourke2@bigpond.com](mailto:sbourke2@bigpond.com))



## Introduction

Many amateurs are faced with the situation whereby they cannot put-up full sized HF antennae. Some of the reasons for this can include: small block size, neighborhood esthetics and/or living in a unit/village environment (with or without body corporate restrictions). So this short article isn't meant to be a suggestion that you should go home and pull down your tri-band beam, or even your G5RV wire antenna. Rather, it is meant to offer some practical suggestions about getting on air from a "difficult" location.

## Background

Up until about four years ago, my XYL, Val and I lived on a good-sized block at Ulladulla on the New South Wales South coast. It was a very good radio site, antennae presented no problems and there was a lear take-off in all directions. However, I am no spring chicken and, like many in our situation, we decided the time had come for us to move to a self-care retirement village. The reason for this is simply the prospect of no more home maintenance, mowing lawns and gardening! We looked at about 20 retirement villages and units, both city and country. The final decision was for Kiama Council's Blue Haven village.

## Our New Life

We moved and now live on the fourth floor of a seven story building. Photograph 1 shows our new home and it meets many of our needs especially the maintenance, mowing and gardening criteria. However, I have been a radio amateur for 63 years, I have thoroughly enjoyed my hobby, and I wanted to be able to continue to enjoy it for many years to come. The big question I faced was: How to get on air from such a location?

Well, VHF/ UHF isn't much of a problem if you have a local repeater or two. We selected a unit on the corner of the building so I only have a neighbour on one side and I have a clear path to the repeaters in the area. But, I like HF DX, especially CW.



## **Antenna Possibilities**

The basic problem of getting back on air from a location such as ours revolves around antennae. Of course VHF./UHF antennae are not a real problem, even if you have only a small balcony and there is a local repeater. However, operating on the HF bands calls for a lot of ingenuity!

So, how do we go about finding a suitable HF antenna, especially one that is unobtrusive, even clandestine? Look at the building features and think about using guttering, downpipes and balcony railings matched to your transceiver with a good antenna tuner.

Try various ideas out. Be innovative. Don't be disheartened and give up if an idea doesn't work. There is almost always something around you that you can use for an antenna.

In my early experiments, one of my best was the aluminium railing along the front of my balcony:- all VK states and ZL1-4, plus A35 and FK8 on six!

Unfortunately in a village and unit environment you will be plagued by RF noise emanating from plasma TVs, computers and other household appliances that are in close proximity. This initially led me to look at loop antennae that provide some noise advantages over dipoles and, because of its relatively small size, I started to consider using a magnetic loop antenna?

## **The Magnetic Loop**

This is a small circular loop antenna (less than a quarter wave in circumference). A five feet (1.5 m) diameter loop can be tuned to 20, 30 and 40m. An antenna this size can certainly be discreetly installed on the average unit balcony. Although small compared to its dipole equivalent, the magnetic loop has a high efficiency and is more efficient than a loaded dipole/vertical (of around the same size). In my installation, I mounted my loops vertically and constructed them from copper tubing.. I fashioned my magnetic loops from the information provided in the references listed at the end of this article.

A magnetic loop needs a good wide-spaced tuning capacitor or vacuum variable to resonate the loop. This capacitor is the critical part of building a magnetic loop and can be made up using a combination of fixed and variable capacitors to obtain the necessary capacitance. However, both the fixed and variable must be capable of withstanding several kV and be suitable for high RF currents.

Two loops were mounted on a common "mast". My magnetic loop antenna is shown in photograph 2. To cover the range from 40 to 10m, I used two loops mounted one inside the other on a common wooden mast. The larger loop tunes from 5 to 12 MHz and the smaller loop tunes 14 to 28 MHz. The feed method is as described in the references and there are separate co-ax coupling loops for each loop (mounted on the circular disks at the bottom of each loop).

The square object at the top of each loop is the mounting for the variable capacitor. The magnetic loop is directional and the whole assembly can be rotated by hand.



The only disadvantage of the magnetic loop is that it is narrow band and require constant retuning to cover any particular band. But for me, this is a small price to pay for being able to once again operate effectively on the HF bands. In use, I manually tune the appropriate loop for minimum VSWR around the centre of where I wish to operate in the band and, by using an antenna tuner, I find I can extend the operating range before I have to retune the loop.

My main interests are on 7 MHz and above; however, I have started to think about a loop for 80m.

If you are one of the many amateurs who cannot get on HF or who have had to give up HF because of antenna restrictions, I hope this short article will give you some ideas and encouragement to get back onto HF.



*Photograph 2*

**73 de Stan VK2EL**

#### *SOME REFERENCES*

<http://vk5bar.qsl.net/vk5bar/>

<http://www.standpipe.com/w2bri/build.htm>

<http://www.kr1st.com/magloop.htm>

[http://qsl.net/mnqrp/Loop/Mag\\_Loops.htm](http://qsl.net/mnqrp/Loop/Mag_Loops.htm)

# LEARNING AND USING CW

## By KA6KBC, Bill I

### ***Learning and Using CW:***

For me my first Rig was a Homebrew 6L6 Transmitter that my Dad (WB6CGN SK) and I built. It was crystal controlled. I put out a blistering 10 watts. As a Novice none of us really knew what we were doing, but it was lots of fun. It took me weeks to make my first CW contact. Back then you got really good at sending "CQ CQ CQ DE CALLSign" over and over again. I started making a few contacts then receiving QSL cards, which was a rush. These were the most thrilling days of Ham Radio for me. I still remember how my heart pumped and my hands trembled. For a my first few QSO's I forgot how to copy Morse Code, but with time I improved my skills. These days the hobby has changed. Morse Code is not required in the US anymore, but I would encourage all Hams to at least give it a fair try. There are some great resources on the Web to help you learn so you are prepare to go live on the Air.

### ***Learn CW Online – For Free:***

"At LCWO you can learn Morse telegraphy (CW) online in your browser. You don't need to install a program on your computer, and you always have your personal settings available, from any computer on the globe with an internet connection. You can also easily track your progress by means of different statistical functions.

LCWO was established in May 2008 by Fabian Kurz, DJ1YFK, hoping to make studying and practicing CW as easy and effortless as possible.

There are already hundreds of training programs, MP3/CD courses and practice aids available, but LCWO follows a radically different concept: While sticking to well-proven methods for learning and practice, all you need for using LCWO is a web browser!

This gives the user the liberty to practice CW wherever an internet connection is available, always retaining the personal settings, scores and statistics.

Currently the site, which is available in 20 languages offers a complete Koch method Morse course, code group practice, callsign - and plain text training modes and also allows to convert random text to Morse MP3s.

A high score list is available to compare results with other users, personal statistics help to track training progress. LCWO.net is a non-commercial project. Creating a free account only takes a few seconds, and you can start practicing CW right away!

Sign up for a free account (or use username "test", password "test" to play around) and start learning or improving your CW today."

<http://lcwo.net/> - Learn CW Online

**73's – Bill Brown – KA6KBC**





# QRPp Transceiver Simple Kit Pixie By KA6KBC, Bill



The Pixie is a small, direct conversion CW QRPp transceiver using just a handful of common parts and is a retail kit for \$10. Most people should be able to build it. This is a Fun little kit. However it might be harder for a first timer, but with some help you can make a working Radio. It is a cheap kit – However the \$10 price is not completely correct. \$10 for the PCB/Parts then \$3 for the Crystal (Plus shipping). Then you have to buy connectors/Wire/Socket/Solder/enclosure. I would guess in a box with the connectors/Switches you will be closer to \$20. But worth the money just based on the learning experience.

The Pixie 2 is an HF CW transceiver, with a standard two transistor transmitter. It's a Colpitts oscillator, left running, and a keyed power amplifier. There is no external mixer used to feed the audio amplifier. The mixing is done at the final amplifier itself with the audio taken off the emitter. Depending on the PA device chosen, RF power outputs of between 100mW and 500mW may be achieved (I had to cherry pick transistors, but you can get about 400 mW with a 9V Cell). The only components which are band critical are in the TX PA output, so modifying for different bands (40M to 80M) can be done. On receive, the TX PA is used as a mixer which feeds the LM386 audio amplifier. This is a bare bones transceiver there's no RIT, a simple switch and cap in parallel, between the crystal will work as an offset though and there's no volume control for the audio. The whole idea here was to make a tiny rig that worked, with room for improvements, using a minimum of parts. In some cases you may also have Hum with an external Power Supply – I'd recommend a Battery and you might also hear some BCI (Broadcast interference). Hams have made many contacts many of them have been over hundreds of miles away. It takes some skills to make contacts, but it can be done. Not a great primary rig, but you will have some fun building and playing with it.

## **CONSTRUCTION:**

You need to be able to solder and trouble shoot a little, but it's worth the time. Also you need to know a little about reading a schematic as some of the instructions could be clearer.

You will need a low wattage soldering iron with a small tip, some rosin core solder, solder wick (for removing parts), small wire cutters, needle nose pliers. Use Eye Protection, while cutting leads.

All the components, except for U1 the LM386, are mounted vertically. I'd recommend to start at one end of the board and work to the other. There are no coils to wind, no alignment either. Once you apply power you should be able to hear the oscillator start up by listening on a near by receiver. Then check for audio at the headphones. If you run into noise/oscillation check the power. Use a new alkaline battery.

## **Parts kits for the Pixie 2 are available from:**

HSC Electronics, 3500 Ryder St., Santa Clara, CA 95051. The cost is \$9.95 + \$2.00 shipping and handling for the PC board and all board mounted components except the crystal. Chokes will be provided for both 40 and 80 meters. Phone 1-800-4HALTED. <http://www.halted.com/>

You will need the following additional items (not supplied in the kit): 2-RCA jacks, or 3.5mm jacks for key and antenna 1-3.5 mm mono or stereo jack, depending upon your headphones 1-short piece of RG-174 for antenna connection 1-crystal socket or pair of mini-alligator clips - <http://www.amqrp.org/kits/crystals/index.html>

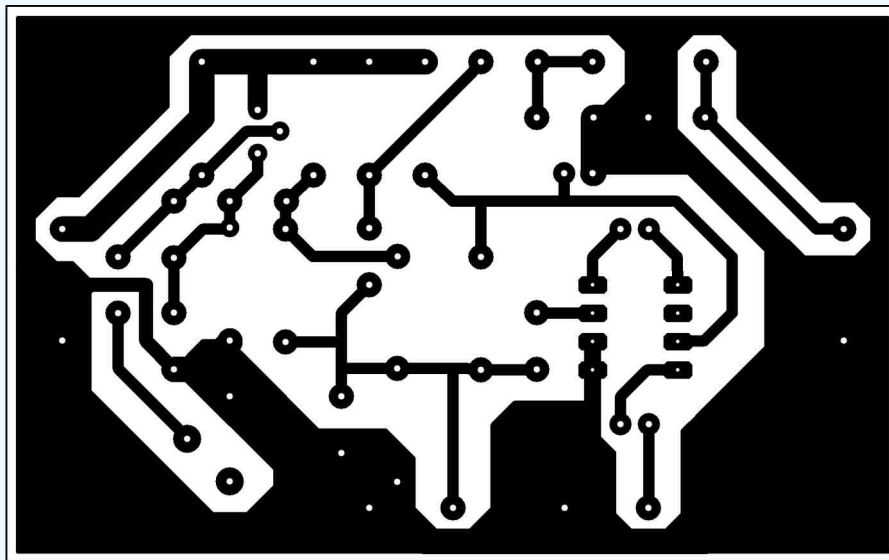
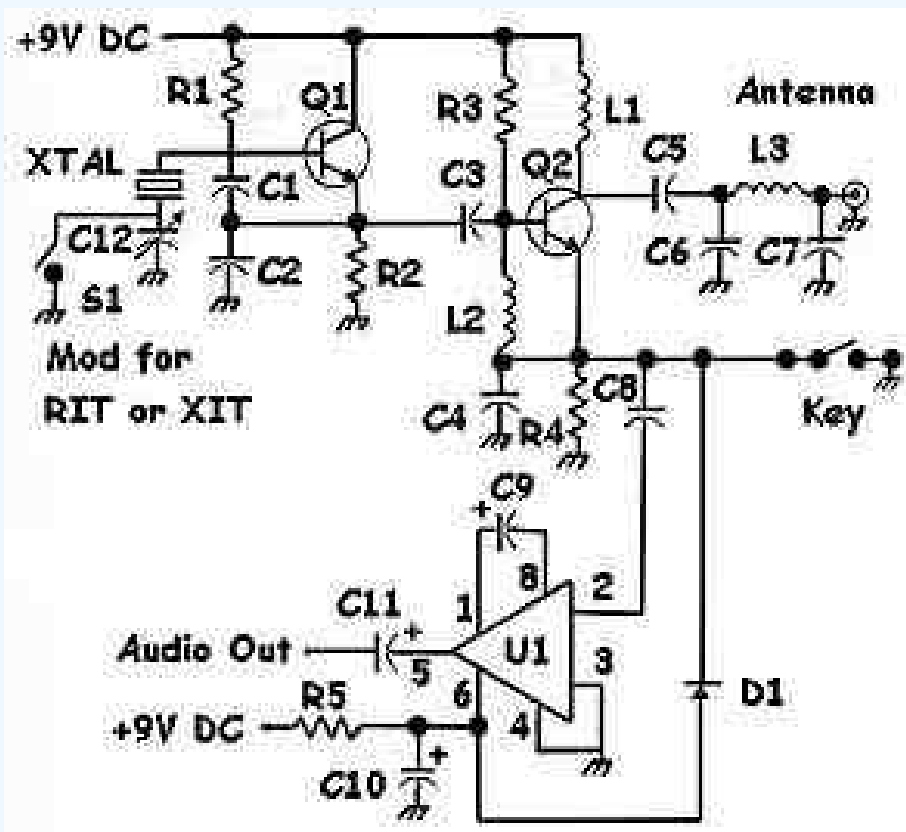
Also there are a lot of good resources on the Web:

<http://www.al7fs.us/AL7FS2.html>

<http://homepage.ntlworld.com/lapthorn/pixie.htm>

**73 de Bill - KA6KBC** (see pictures on next page)





# An Unusual Two Band Magnetic Loop Antenna (for 14 and 10 MHz) By OK1FOU

## 1. INTRODUCTION

This article describes how to build a relatively small loop antenna which can be placed for instance at the balcony. My design is made for modest conditions, e.g. an antenna mounted on a balcony in a block house. It is especially suitable for a two band antenna covering two adjacent amateur radio bands (10/14 MHz, 14/18, etc.).

The antenna was practically tested on 10 MHz band.

The design was inspired by an article by DJ3RW about an unusual design of magnetic loop antenna for 50 MHz band, printed in Funkamateuer 10/97.

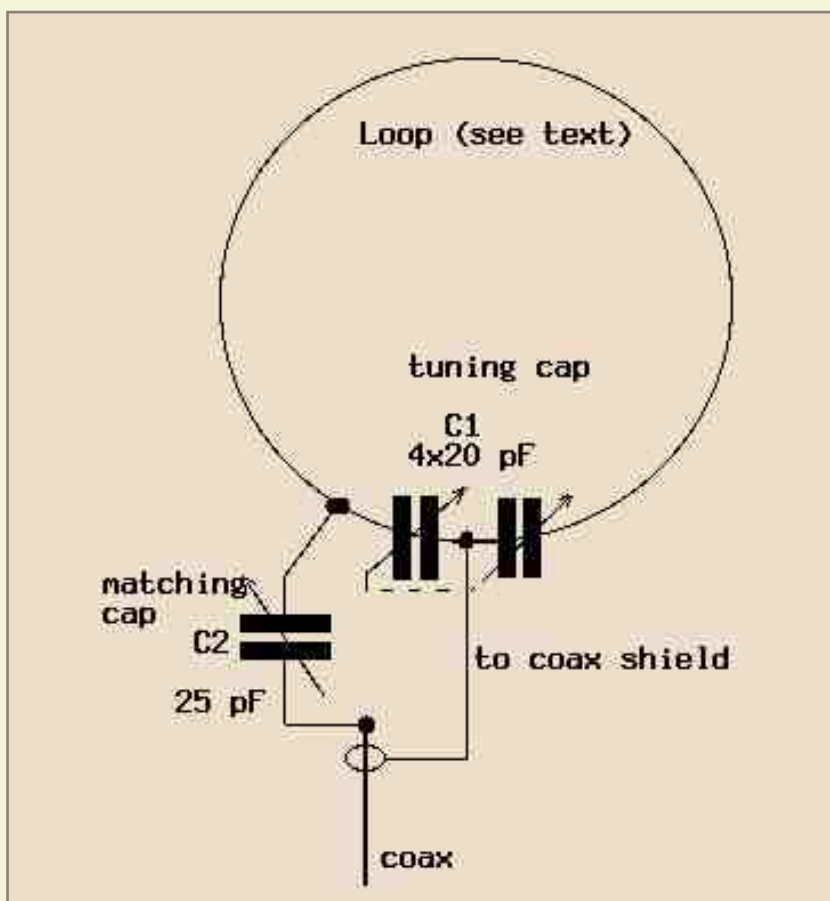
## 2. DESIGN HIGHLIGHTS

The magloop antenna described here has a different feeding than the usual kind with a coupling loop. Also the tuning capacitor is not mounted at the "top" as usually, it is placed at the "bottom", fed part of the loop.

The loop is tuned by a symmetric, two-section variable capacitor with the common rotor connected to the coax cable shielding.

This antenna is "side-fed" directly from the coax center wire through a (variable) capacitor to one of the two "hot" ends of the tuning capacitor.

A picture will say much more:



### 3. INSTRUMENTS

You will need a GDO to check resonant frequency of the loop.

### 4. MATERIAL

Any data in the following list printed in underlined italic indicate measures or values I have tested on my 10/14 MHz loop.

Two wooden pales, about 1 meter long, or similar stuff to hold the loop.

A piece (about 3 meters) of loudspeaker wicker cable. The thicker the better. You might perhaps use a copper tube, too. This is because of the high current in the loop (DJ3RW says 60 A at 100 W output!).

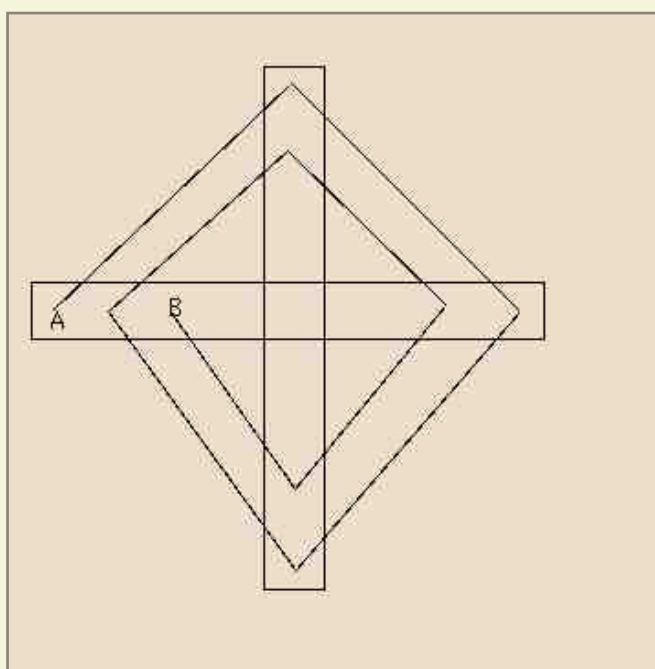
A two-section symmetric variable capacitor (I used 4x12.5 pF)

A variable capacitor for coupling; or two fixed capacitors plus a switch (see below). I used 25 pF fixed capacitor for 10 MHz.

### 5. CONSTRUCTION

First, make a symmetric cross of the two pales. The binding is up to you. I used nails.

Take the wicker cable and make two turns on the cross. Leave 5 cm (2 inch) space between the turns and leave a piece of free cable hanging at the end. See also picture:



Take the GDO and test resonant frequency of an open loop. The frequency should be slightly higher than the highest frequency you want to use.

Bands MHz	Open loop resonant frequency
10/14	16-17
14/18	21-22
18/21	24-25
21/24	26-28

The resonant frequency of your loop will decrease after you add the tuning capacitor and connect the feed!

Mount the tuning capacitor and connect both ends of the loop to its stators. Fix the coax feed and solder its shield to the rotor of the tuning capacitor.

If you test the loop now, it should resonate slightly above the desired operating frequency. When I was testing my 10/14 MHz antenna at this point, it resonated between 11 and 16 MHz.

Mount the coupling capacitor. Connect one end the coax feed core and the other one to either end of the loop.

Now there are two possibilities:

If you use a variable capacitor, you can do it as described above without further changes. Tuning the coupling capacitor is your problem. I did not test this, but it is almost obvious that a servo will be necessary.

You can make it cheaper if you add a dial to the rotor and mark positions for each band.

You don't have to tune the coupling capacitor across one band (unless it's 10 meters). So you can put two fixed capacitors (let's call them CL and CH) in series. CL will be used for the lower band (in my case it's 25 pF for 10 MHz) and should make a perfect match. While CH combined in series with CL has to match the antenna on the higher band. Put a switch or relay across CH and don't forget that the switch is also a capacitor of its kind. When the switch is open or short, the higher or the lower band is coupled, respectively. (Sorry, no picture available) Well done! :-)

## **6. SETUP**

When the antenna is mounted, connect it and test its resonant frequency on your receiver. Loaded antenna will "drop" slightly - mine changed its resonant range from 11-16 MHz to approximately 10-15 MHz over the full variation of the tuning capacitor.

When tuning the antenna, first find the best position of the tuning capacitor by listening. After you have tuned a relatively sharp peak, tune the coupling capacitor (if you have a variable one) for best possible SWR. My antenna has 1:1 SWR on 10 MHz band without an additional ATU. (In fact the loop itself with all the tuning and coupling circuits is an excellent ATU).

## **7. BANDWIDTH**

My antenna has SWR 1:1 almost all over 10 MHz band. The SWR is getting slightly worse near band boundaries, but it is just enough to see the meter taking a very moderate move.

I didn't test 14 MHz because of a missing 2nd coupling capacitor. If it worked on 14 MHz the same way, you should be able to cover the whole CW sub-band with SWR 1:1 and most of the band with SWR better than 1:2 if not 1:1.5

## **8. THE TRUTH - Practical experience**

I haven't heard much of a DX traffic. But my antenna is on the balcony on the third floor, surrounded by 30 meters high concrete buildings.

I have made QSO's mostly with Europe. Sometimes I get reports which are worse by 3S from stations with comparable output. Sometimes the other OM gives me even 1S more than I can hear him, again if the power is roughly the same.

Some examples (all QSO's were on 10 MHz):

RA6WF 559/559 - LA6GIA 559/429 - G0NXA 559/419 - LZ1QK 579/589

I have received some questions regarding calculation, modification for lower bands, radiation pattern, etc. I am convinced that you can get the best answers from competent people who maintain the above mentioned pages. I actually work in a bank and have no measuring equipment at work or at home :) In fact, the above design was a very lucky experiment.

## **9. Feedback**

Please let me know if you try to build this antenna, if you want to make any comments. I am very interested what you think about this article.

In fact, writing this article took me at least three times longer than the time to build the fly-swat. So at least three of you should make some use of it, don't you think so?

**73 de Jindra, OK1FOU**

[http://www.qsl.net/ok1fou/e\\_main.htm](http://www.qsl.net/ok1fou/e_main.htm)

# High Voltage Breakdown Tester

## By K8CU

### Real hamradio.com

- Necessary for testing of any high voltage component
- Tests vacuum tubes, high voltage capacitors, vacuum relays, etc.
- Testing components BEFORE circuit operation prevents equipment damage
- To use, just hook up component, adjust the high voltage with panel variac, then read leakage current on panel meter.
- Easy to make at home. Requires a block of wood for the base and Plexiglass for the panel and enclosure.

#### **Introduction**

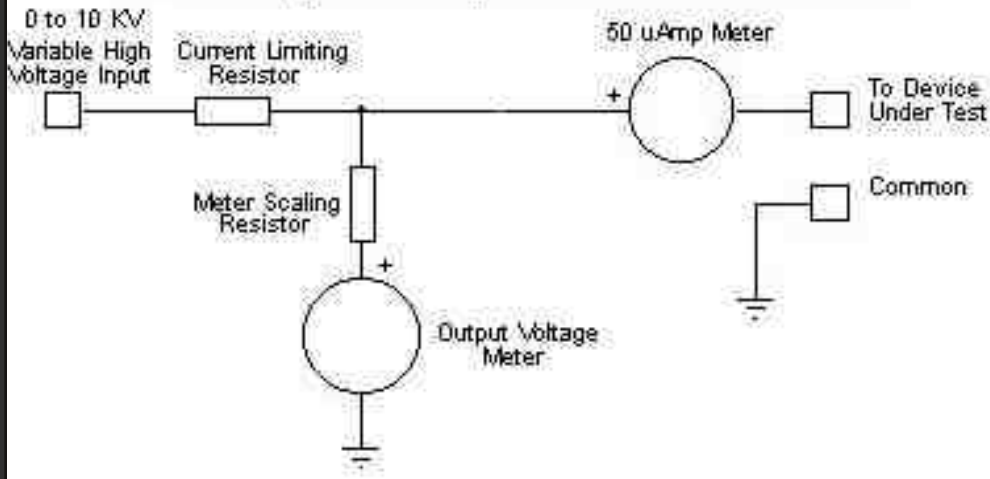
Many components used in Amateur Radio home projects are used or may have been in stock for years prior to purchase. It is important to have a method to test these parts prior to installation in equipment. This is especially true for components that will be used in high voltage circuitry, where the potential for catastrophic component failure is highest. During an amplifier project, it became necessary to test new old stock Russian military surplus vacuum tubes.

Since commercially available high voltage testers are relatively expensive, I decided to build a low cost version suitable for home workshop use. Testing a variety of high voltage components like vacuum tubes, vacuum capacitors, vacuum relays, high voltage diodes and transistors would then be possible. This project can be described as a junk box effort. To increase the chances of successfully completing this project, two different circuits are offered that generate the variable DC high voltage.

Always test newly acquired tubes and high voltage components with a tester before use. A simple Ohmmeter test is not enough.

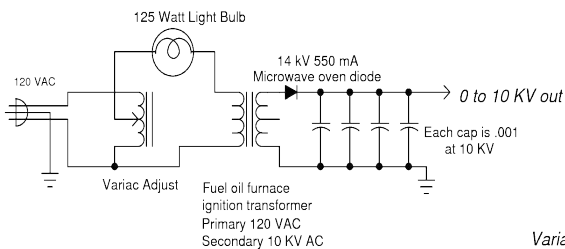


# Basic High Voltage Tester Schematic



Either voltage source is suitable, only one is required.

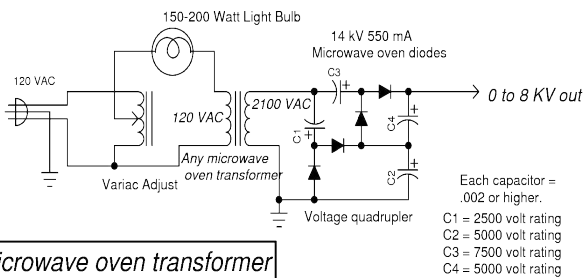
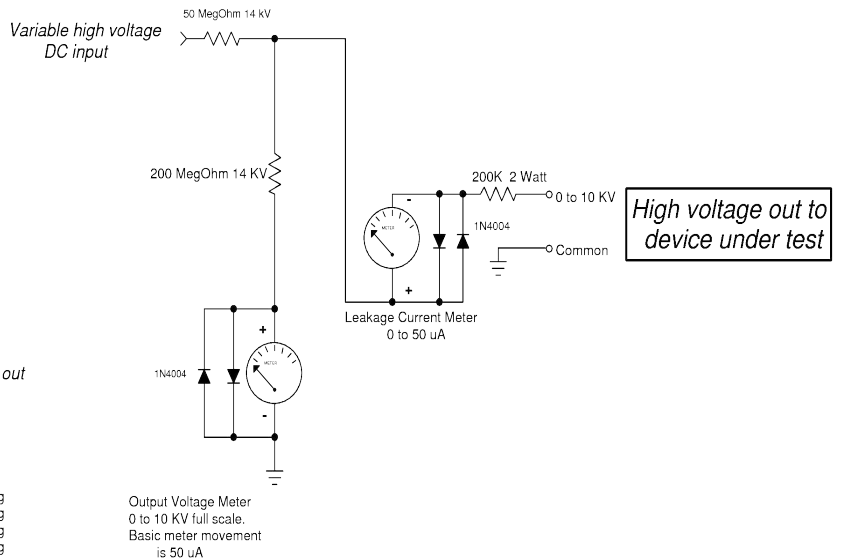
## DANGER HIGH VOLTAGE



CAUTION: secondary center tap is connected to transformer case.

Fuel oil furnace ignition transformer voltage source

High voltage leakage detector and metering circuit



Microwave oven transformer voltage source

Lower wattage light bulbs will glow brightly and inhibit greater voltage output with the microwave oven transformer at around 8 KV out. This varies with each transformer, and is caused by the relatively high saturating current typical of this kind of transformer. To increase the output voltage without excessive current limiting, simply increase the light bulb wattage.

### High Voltage Breakdown Tester

DRAWN BY: Bill Jones K8CUJ	
PAGE 1 of 1	DATE: 5-17-2002

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## ***High Voltage Tester Basics***

Dielectric breakdown is where a voltage increase causes an "insulator-to-conductor" transition in a material. It typically is an irreversible effect permanently damaging the element, unless current limited by the circuit. If conduction takes place in a gas (air) then this post-breakdown conduction is called an electrical "arc" or "spark". 1

The basic idea of a breakdown voltage tester is to apply current limited high voltage to an insulator, and raise the voltage until the desired voltage test level is reached, or until a small amount (1 to 2 micro Amps) of leakage current flows. If the insulation does break down, the test instrument limits the current flow, and the process can be stopped without destroying the item under test.

Some commercial test units have an automatic circuit that will cease application of the high voltage when a selected leakage current occurs. In a Go-No Go production test environment, this helps relatively untrained operators decide if a component is good or bad. Typically a relay circuit will trip, a loud buzzer will sound, and the test is stopped. A front panel reset button starts everything over.

Some commercial units have a "burn" mode. This allows a current limited arc to continue. This is helpful to physically determine where a fault is located. For amateur use, the automatic trip circuitry may be eliminated. Instead, the test equipment operator will observe the leakage measurement and then turn the voltage down and stop the test if breakdown happens. Also, a manual "burn" mode is possible by simply allowing the current limited arc to continue while checking for the location of the fault.

### ***Circuit Description***

A voltage level of about 8 to 10-kV is useful for testing many amateur radio components. The circuit schematic shows two alternative methods to get a variable high voltage source. One method uses a common fuel oil furnace ignition transformer. This transformer has a 120 Volt AC primary, and a 10-kV secondary, with the case being the transformer secondary center tap. This means that the transformer case is electrified with 5-kV AC, and must be insulated from the mounting base. Also, take care to not come into contact with this case during operation of this instrument. A simple Plexiglas shield will keep you at a safe distance. The high voltage tester I have uses one of these transformers. It was originally a flea market find at a bargain price. Sure, it was rusty, and needed some paint, but the internal voltage windings were intact. The fuel oil ignition type transformer will generate 10-kV DC at the tester output electrode. A common neon sign transformer will also work.

A small adjustable AC primary transformer called a variac is used to vary the input voltage to the high voltage transformer. I used a small panel mounted type of variac on my tester. Since these are expensive if purchased new, you may not want to dedicate an individual variac to this test instrument. In this case, consider using an external variac you may already have in your workshop as a variable voltage control.

The other method of generating the variable high voltage source uses a microwave oven transformer. This transformer was obtained from a bad microwave oven. The output of this transformer is about 2100-Volts AC, with a 120-Volt AC primary. Nearly any microwave oven transformer will do, even the ones from the relatively small ovens are satisfactory. Old ovens may have a useful diode too. A voltage quadrupler shown in the circuit diagram boosts the voltage up to about the 8-kV range.

The light bulb in the primary of the high voltage transformer is an old but good method of limiting the current to the transformer primary in the event of a major component failure. For example, if the primary of the high voltage transformer completely shorts, all that happens is that the lamp will burn at full brilliance. The idea behind this is not new. It has been used for years, so it is well proven. It also gives a visual indication of the relative amount of current flow into the transformer. Under normal use, the bulb may glow some at the higher end of the voltage output range.

Note that when using the microwave oven transformer circuit, the light bulb may glow much more brightly as the primary voltage approaches 120-Volts AC. This varies with each transformer, and is caused by a relatively high saturating current. This is typical of the microwave oven transformer.<sup>2</sup> If you are using this type of transformer, and your measured high voltage output is reduced to less than 8 kV by the limiting action of the light bulb, just increase the light bulb wattage to about 150 to 200 Watts. Otherwise, a light bulb rating of about 125-Watts in the fuel oil ignition transformer circuit works well. Smaller wattage light bulbs will reduce the maximum high voltage output of this tester. Do not eliminate the light bulb from the circuit. It doesn't cost much and is an important circuit protector.

### ***Breakdown Tester Construction***



Since the panel meters are in contact with high voltage, make sure to use an insulating front panel material. I chose common Plexiglas since it was available at a local hardware store, and they would also cut it to size for me. I used a 6-inch by 12-inch piece for the front panel. Plexiglas is also available in various colors, but I chose the basic clear variety since I can see through it to locate any evidence of corona points. The base plate for this tester is also recommended to be an insulator. A good choice here is wood. My tester has a 12-inch by 16-inch painted plywood base 1/2-inch thick. The paint would conduct slightly and give leakage current indications until it became very dry.

Components on the Plexiglas front panel include the small variac, two 50-microAmp panel meters, and two phone plug jacks for the electrodes. Two right angle metal braces mounted on the base plate support the Plexiglas front panel. The high voltage transformer, light bulb current limiter, and a small circuit board occupy the main plywood base support. The circuit board is a small piece of plain perforated fiberglass material, and is supported by four 1/2-inch tall ceramic standoff insulators. The various components on the circuit board are simply wired in breadboard point to point style.

An insulating clear Plexiglas cover that surrounds the tester is used to protect the operator from accidental contact with internal circuitry. The dielectric strength of Plexiglas is 30 kV/mm. A 1/8-inch thickness will then have a dielectric strength of about 95-kV. With the voltages used in this circuit, this gives an insulating safety factor of about ten. The external Plexiglas shroud is assembled with 1/2-inch aluminum angle obtained from a hardware store. Since the front panel meters may not provide adequate insulation, a single clear Plexiglas sheet is mounted in front of both meters. This protects against meter failure and possible accidental voltage contact. The meters used in this tester required a 3.5-inch by 5-inch protective front sheet held to the front panel by two 1/2-inch standoffs.



Pay attention to the voltage rating of the resistors used in this circuit. Most common resistors have a maximum voltage rating of about 300 Volts. You may achieve the necessary voltage rating by simply using a number of resistors in series to arrive at a safe voltage rating for a specific resistance value. For example, two 300-Volt resistors in series results in a 600-Volt rating.

Two high value high voltage resistors are required for this circuit; 50 MegOhm and 200 MegOhm. Sometimes these can be found at surplus outlets or on Ebay.

Since high voltages are involved, it's necessary to build this tester with plenty of open space between components and wiring. Try for at least a half-inch spacing. The use of test prod or high voltage wire rated to at least 10 kV is recommended. Also, the solder joints need to be as smooth as you can get without sharp points. Breakdown voltage is also a function of geometry. These points will encourage corona and will cause slight leakage current indications with no component hooked up for testing.<sup>1</sup> With no component hooked up, just turn the voltage up until you start to get a leakage current indication. Then turn the room lights off. In the darkened room, CAREFULLY look and listen for the small telltale blue corona points in your wiring. Isolate the trouble spots and then correct the wiring connections as necessary.

It may be impossible to remove all stray leakage current indications. To compensate for this, just turn the voltage up to a desired test voltage value, and then note the leakage current indication on the panel meter. This number will become your background leakage current. This number will be subtracted from a leakage current reading taken with an actual component under test. For example, if you have a background of 10 micro Amps, and a component measures 35 micro Amps, your real leakage is 25 micro Amps. Stray leakage current readings become more of a problem as the test voltage is increased.

### **Testing Components**

***First of all: Switch to Safety!***

***Do not touch ANYTHING except the voltage control while you are testing.***

Before you start testing, remind yourself what you're doing. THINK and LOOK before you touch any part of this tester. All components should be tested on an insulated table. Hook up the component, plug the tester in, increase the voltage to make your test, drop the voltage to zero, and then unplug the tester. Allow plenty of time for the filter capacitors to discharge before removing the component under test. While the current of this tester is limited to about 200-microAmps, a 10-kV jolt is decidedly unpleasant. It helps to use relatively small filter capacitors in this test instrument. The .001 uF capacitors will discharge quickly in a few seconds when the voltage is turned off. If you use relatively large capacitors, like .1 uF or so, the discharge time is much longer. This means that even though the instrument is turned off, touching the output electrode may still shock you. Use the output voltage meter as a guide for how long the filter capacitors have a charge remaining. Remember, the output meter can also fail, so don't depend on it entirely! If in doubt, use a shorting connection across the output electrodes to safely discharge any remaining voltage stored in the filter capacitors.

Diodes: to test PIV values for high voltage diodes apply reverse bias voltage (hook positive terminal to diode cathode, negative terminal to diode anode) until a small leakage current of one to two micro Amps is detected, then stop the test. The point at which current just starts to flow is the PIV value of the diode. Continuing beyond this point may damage the component. It is also possible to test relatively low voltage diodes in the range of 0 to 800 Volts or so. Since the front panel voltage meter has limited resolution, you may carefully use your digital multimeter as a voltage indicator. Many low cost meters have a maximum voltage rating of 1 kV or less. It is easy to exceed this value with the tester front panel control. The voice of experience says that if you apply excessive voltage to a multimeter and then hear a small "snap" sound from inside the meter case, your meter will probably require repair. Be careful.

Transistors: breakdown voltage on transistor specification sheets is usually stated several ways.<sup>3</sup> Some of these ways are:

$BV_{cbo}$  = Breakdown Voltage Collector to Base, with emitter terminal Open.

$BV_{ceo}$  = Breakdown Voltage Collector to Emitter, with base terminal Open.

$BV_{ces}$  = Breakdown Voltage Collector to Emitter, with base shorted to emitter.

Adjust the high voltage until leakage current just starts, and then stop the test. These test methods will also apply to PNP transistors by changing polarities.

#### ***BV<sub>cbo</sub> on NPN transistor***

Hook positive terminal to Collector, negative terminal to Base, leave emitter terminal open.

#### ***BV<sub>ceo</sub> on NPN transistor***

Hook positive terminal to Collector, negative terminal to Emitter, leave base terminal open.

#### ***BV<sub>ces</sub> on NPN transistor***

Hook positive terminal to Collector, negative terminal to Emitter and Base.

Just like the test method of diodes, you can also test lower voltage transistors with a small digital meter if you are careful with the applied voltage levels.

***Air dielectric capacitors***: this type of capacitor is easy to test. Just hook up the voltage terminals from the tester to the capacitor under test. Slowly bring the voltage up until your test voltage occurs or until you hear a slight snap or crack, or see a small blue arc appear. Note the voltage, and immediately drop the voltage back to lower levels. Other components with air dielectric may be tested in this same manner. If you can't see or hear an arc, just watch the output leakage current meter on the high voltage tester. A rapid rise in leakage current is a sure sign of voltage breakdown on the component under test.

***Vacuum capacitors***: these types of capacitors test in a similar manner to the air dielectric types. However, when these components arc across inside, you will hear a small metallic "clink" sound. Just adjust the voltage until you are at your desired voltage range or until you hear a "clink" (whichever happens first), then back the test voltage off.

Test vacuum capacitors with the concentric plates fully meshed. I have purchased ham fest vacuum variables that tested fine with the plates partially out, but that failed with the plates more completely meshed. If you are looking for high voltage components, consider taking this tester along with you to the flea market, but leave it in your vehicle. If you find some interesting capacitors, retrieve your tester and perform the tests. Using this tester in this way will pay for itself very quickly by eliminating the purchase of defective components. Vacuum capacitors tend to be expensive. Why pay for a dud? This tester will also identify and sort out bad parts that you are going to sell.

***Vacuum relays***: test between normally open terminals until your test voltage is reached, the audible "clink" is heard, or a rise in leakage current is indicated.

High voltage bypass and coupling capacitors: these test by advancing voltage to the point where current starts to flow, note the test voltage, and then reduce voltage.

***Vacuum tubes***: Vacuum tubes are checked out of circuit. Hook up the tester electrodes to the two terminals you want to test on the tube. On triode vacuum tubes, I typically test the anode to grid breakdown voltage. I usually apply twice the tube's rated DC plate voltage and observe the leakage current reading. Comparing values from known good tubes is very helpful. On tetrodes or other tubes with more elements, just make several tests using the various tube terminals.

## RF Power Amplifier Vacuum Tube Typical Leakage Current Measurements

Russian GS35B, GS31B Anode to grid leakage current at about 4 kV = 6 micro Amps  
Other tube types (4CX250B, 4CX800A) show similar numbers.

Significantly higher leakage current indicates a shorted tube. One high voltage short was only noticed when the tube was warm. This tube checked well when cold, but failed short after applying filament power for several minutes. When hooking up tubes outside of the normal amplifier, don't forget to provide adequate tube cooling air when running filament voltage only.

-----  
Testing AC components with this DC tester:

To test an AC rated component with this tester, just use this formula: AC voltage times 1.414 to get the effective DC voltage rating. For example, a 2 kV AC capacitor would require 2.8 kV DC to test.

### **73's K8CU**

#### Notes

1. "Dielectric Breakdown and Arcing", ARRL Handbook, 1995, pg 10.14
2. Randy Henderson, WI5W, "Build a High-Voltage Power Supply at Low Cost" QEX, Jan/Feb 1998 Pg. 47-51.
3. Texas Instruments, Inc. "The Power Semiconductor Data Book for Design Engineers", First Edition. pg 1-30
4. Visit Richard Measures, AG6K's technical web site for additional design data on HV testers.

**K8CU**  
Real Ham Radio.com

Amateur Radio projects  
and construction articles  
are described inside

Log Periodic Antennas  
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# Recollections of a Radio Receiver – The W6TC (SK) Adventure 1956 - 2009 A Collection of Observations, Remembrances, Letters and Notes

Format: E-Book on CD-ROM in Adobe Acrobat, 568pp, available from <http://www.w6hht.com/>

Author: Jay F. Helms W6HHT

Reviewer: Gerry O'Hara VE7GUH

What have Tom, Dick and Harry, evening meals, toothpicks, breadcrumbs, 'wobble-wobble', chimneys, a 'two-hand dance', a 'perfect storm', 'scavenger hunting', moaning and even beauty contests to do with an amateur-built radio receiver, a 'WOW' factor and a 'crazy old coot' called 'Cros'? – the answer can be found by reading *Recollections of a Radio Receiver...* by Jay Helms, W6HHT. The book covers (almost) everything you would ever want to know about the 'HBR' series of amateur band receivers first conceived by Ted Crosby, W6TC (SK) in the mid-1950's.

My first encounter with an HBR receiver design was an 'HBR13C' that had been donated to the SPARC<sup>1</sup> radio museum in Coquitlam, BC in 2008, along with a large box of coils and volumes of paperwork relating to its design and construction. I was quite intrigued by this receiver, in terms of the circuitry, mechanical design - especially the plug-in coils - and the quality of workmanship, together with the use of an Eddystone slide rule dial (I am a bit of an 'Eddystone man') – so intrigued that I decided to write a short article on the HBR13C for the EUG website<sup>2</sup>. Soon after, Jay contacted me for permission to use my HBR article and others I had written as reference texts in a book he was preparing on the HBR – in return I unexpectedly received a copy of his book.

I have read many, many books on radio over the years, but this text is a very unusual and interesting tome and I must say, is quite different to what I was expecting before I opened the covers - yes, although the 'e-book' format has a good indexing and hyperlink system, and you can easily search for key words, I found it easier to read and cross-reference by printing it out from the Adobe Acrobat file. The human touch provided by the numerous personal letters presented in the book, often reproduced in original copy and re-typed for clarity or highlighting a particular issue, character descriptions, and interaction of the various 'players' in the story (because it is a story), numerous anecdotes, etc. is a great way of bringing the book to life - so much so that I actually got 'hooked'. Altogether it was a bit like reading a good novel, rather than a textbook that you dip in and out of. Not that you cannot use the book as a technical reference though, as there are all sorts of useful tidbits buried inside for anyone interested in any form of HF receiver construction, from mechanical and circuit design tips to coil winding information and even operating techniques.



<sup>1</sup> Society for the Preservation of Antique Radio in Canada (<http://www3.telus.net/radiomuseum/>)

<sup>2</sup> Eddystone User Group (<http://eddytoneusergroup.org.uk/>).

As an HBR 'newbie' I found many of the technical details very interesting, eg. that the front-end is designed to be regenerative to maximise sensitivity and increase the effective Q of the coils 'for free' (almost invariably, double superhet designs do their best to avoid regeneration in their front ends, and regenerative receivers are simple, low tube-count sets). However, this essential ingredient in the HBR design philosophy was sometimes lost, even by well-intentioned changes to the design by its constructors: the author even admits to a booboo here, where an overly-neat wiring effort in his HBR13C caused it to fail to regenerate properly because of stray pickup in the wiring loom affecting the AGC, resulting in reduced gain and below-par performance. I am sure that other details, eg. the use of a Hartley oscillator to improve stability, or the finer points of coil construction covered in Chapter 5, will mean even more to folks that have built an HBR, own one now (built by someone else), or are thinking of building one from scratch.

The book is divided into three parts: the first contains the major text, the second a series of HBR-specific references (reproduced in the book) and the third containing more general technical references pertaining to receiver design. Part 1 is preceded by notes on using the e-book format and a Prologue that provides a brief introduction to the book's subject, a lexicon of terminology and index of QST articles on the HBR. Chapter 1 opens the story with an introduction to the men who made the 'HBR adventure' happen, the reasons why it did, and the design concept of the receiver. Chapter 2 picks up on this concept, defining the design objective in four 'rules' and then moving onto the set's specifications and the expectations of those constructing the receiver. An interesting reference presented here is part of an RSGB booklet on the contemporaneous GRB Thornley (G2DAF) home-brew receiver design originating in the UK, together with comments on the different methodologies of the two designers. Chapter 3 is the start of the real technical 'meat' – here each of the HBR models is described in a series of 'thumbnails' along with the associated schematics and comments on differences between them, as well as details of some additional circuitry, such as slot and notch filters.



However, the real in-depth discussion on the HBR circuitry and its evolutionary path from 1956 through to 1969 is dealt with in Chapter 4. Here, the regenerative front-end is highlighted, followed by the various circuit elements – mixer stages, IF stages, marker oscillators, AGC, filters, detectors, audio and power supply, concluding in a 'things not to do' section. The all-important plug-in coils are given the entirety of Chapter 5 (over 70 pages), which is illustrated by photographs and diagrams. Achieving receiver stability ('staying put' in 1950's radio jargon) was one of the holy grails of receiver construction in a world without low-cost synthesisers and digital electronics, and Chapter 6 is devoted entirely to this subject. Here you will find discussion on various factors that may affect receiver stability, from power supply issues through mechanical stability, circuit design, components, and thermal effects, including some very good discussion on the use of temperature compensation capacitors, and methods for testing receiver stability. For anyone constructing a receiver from scratch, alignment is one of those things that can be a daunting prospect.

Fear not, as Chapter 7 covers HBR alignment (which is actually quite straightforward) and also includes voltage check tables to help troubleshoot other problems in a newly-constructed or restored HBR. The HBR design is a bit different from the norm, eg. it is the first receiver I have seen that has a mixer gain control, and Chapter 8 provides the reader with some very useful tips on how to operate these rather unique sets. The main text concludes in Chapter 9 with a review of the 'development, 'repose' and 'revival' phases of the HBR story, stretching from 1956 through 2009 (only a year less than me) – an interesting contrast of the driving forces for building an HBR in the late-1950's and in the early-2000's is provided here and even some speculation into the future of the HBR design...

Part 2 includes a chapter on Builders Notes for the HBR14, HBR16, HBR11 and HBR13C, plus many other technical tidbits, notes on the author's 'HBRXX' receiver and details of the popular Eddystone 898 dial mechanism. Part 3 comprises a compendium of ARRL Handbook extracts, information on inductors, including the Meissner 'Radio Coils and Circuit Applications' instruction manual, and even cover and spine inserts if you decide to print the book (or sections of).

My only suggestion as to how this book could have been improved would be that although the text is extremely detailed, there are many times when a diagram or photo would have helped enormously in visualizing what is being described – especially if you do not happen to have an HBR sitting beside you. However, although this addition would enhance the readability of certain parts of the text, their absence does not detract from the overall value of the material presented.

In conclusion, this is no 'brain dump', no dry technical treatise on a long-forgotten homebrew amateur receiver design, but is a real story, about real people that were dedicated to achieving the very best receiver performance they could with the proven technology of the time. What is more, Ted Crosby's design philosophy included that any Tom, Dick or Harry should be able to replicate his design and achieve similar performance. To this end



Ted spent much of his spare time helping others by corresponding with constructors and by producing simplified and expandable versions of his receiver design. The author must be congratulated for being able to thread the human story, the design philosophy and the vast amount of technical information presented into a coherent, readable book. It is not only useful as a historic piece about the development of amateur radio in the mid-twentieth century, but also as a great technical reference and compendium of information for the HBR constructor, owner, operator and anyone interested in constructing and operating radio receiving equipment – if you are one of these folks, then this is one of the best-value \$10 you will ever spend.

**Best 73's ! Gerry O'Hara, G8GUH/VE7GUH**



ON AIR

# DX NEWS From the Web



## **5P15, DENMARK (Special Event/IOTA)**

Look for special event station 5P15COP from Zealand Island (EU-029) to be active between December 7-18th. Activity is taking place during the big United Nations "Copenhagen Climate Change Conference" <http://www.cop15.dk>

Operators would like to "invite all radio amateurs worldwide to show their concern and care about the environment and climate, by contacting this special event station." Operations will be on 160-6 meters using CW, SSB and the Digital modes. QSL via OZ5BAL, direct or by the Bureau. For more details about the project, QSL card and awards available, please visit: <http://at www.5p15cop.dk>



## **FO/A, AUSTRAL ISLANDS**

German operators Wulf/DL1AWI, Peter/DL3APO and Mat/DL5XU will be active as FO/homecall from Raivavae Island (OC-114, DIFO FO-122, WLOTA L-2581) in the Austral Islands group between January 18th and February 5th. Their focus will be mainly the lower bands 160-30 meters, but will work some higher bands on SSB and RTTY. QSL via their home callsigns, direct or by the Bureau.



## **J3, GRENADA (NA-024)**

Operators Colin/G3VCQ and Sharon/M3VCQ will once again be active as J38CW and J38SW from Beru between March 11-25th. Activity will be on all HF bands and modes. All QSLs are via G3VCQ, direct or by the bureau.



## **J6, ST. LUCIA**

Bill, K9HZ, will once again be active as J68HZ from Labrelotte Bay, Castries, St. Lucia (NA-108, WLOTA L-1336) between now and December 5th. Activity will be on 80/40/20 meters using CW and SSB. Suggested frequencies are: CW - 3550, 7050 and 14050 kHz / SSB - 3770, 7155 and 14155 kHz. He also mentions to watch 40 meters between 2000-2400z daily. Operations from other local islands are possible. QSL via his home callsign.



## **J6, ST. LUCIA**

Scott, NE1RD, will be active as J6/homecall between February 2-10th (2010). Activity will be on all HF bands and modes. QSL via his home callsign, direct or by the Bureau. Logs will be uploaded to LoTW.



## **J6, ST. LUCIA**

Members of the "Buddies in the Caribbean" DXpedition group which specializes in 100 watt or less low power radios and the Buddipole portable antenna system is off again to a new DXpedition site on February 2-11th, 2010. This is an annual effort to demonstrate "ultra- lite" DXpeditioning into magnificent "vista" locations, operate a field portable battery-only radio with backpackable, lightweight antennas and most of all "have fun!"

The nine operators from eight states will have fixed operations from a cliff-top villa and portable operations from various points on the island using CW, SSB, and the Digital modes.

Operators mentioned are: Budd/W3FF, Chris/W6HFP, Scott/NE1RD, Dan/WZ1P, Steve/WG0AT, Mike/KC4VG, Guy/N7UN, Paul/KB9AVO and Wey/K8EAB. Licensing is not yet complete, but each operator is expected to receive their own callsign. QSL via LoTW, eQSL, or mail to operator's home callsign (SASE required). For more details, see:

<http://sites.google.com/site/caribbeanbuddies/home>

<http://caribbeanbuddies.blogspot.com/>



### **J8, ST. VINCENT**

George, K2CM, will be active from the Island of Bequia, in The Grenadines (NA-025), between January 8th and February 12th (2010). Callsign was not provided. Activity will be on 20 meters using CW and SSB, and maybe 40 meters CW. QSL by the Bureau or direct (SASE/SAE) to K2CM.



### **JD1/O, OGASAWARA**

OPDX was informed by Harry/JG7PSJ that Makoto/JI5RPT and he will once again be active from Chichijima Island (AS-031) between Sunday, December 27th, and Friday, January 1st (2010). Their callsigns will be JD1BLY (JI5RPT) and JD1BMH (JG7PSJ). Activity will be on all bands 160-10 meters using CW, SSB and RTTY. QSL via the Bureau to the JD1 callsigns or direct to their home callsigns. Web pages at: <http://www.ji5rpt.com/jd1> <http://sapphire.es.tohoku.ac.jp/jd1bmh>



### **PB500, THE NETHERLANDS (Special Event)**

Look for special event station PB500GT to be active between November 28th and December 13th. Activity is to celebrate the 500th anniversary of the "GREAT TOWER of BREDA" (in Dutch Grote Toren). Operators will operate at a height of 65m from the Great Toren. This Great Tower is located in the middle of the city. Operations will be on 80/40/20/2 meters using SSB and the Digital modes. QSL Manager is Willem, PA1WLB. For more details about the tower, see: <http://www.torenbreda.nl>



### **S2, BANGLADESH (IOTA DXpedition)**

Operators Tutul/S21RC, Manjurul/S21AM, Sohel/S21S and Aminul/S21D are preparing a DXpedition in February 2010 to St. Martin's Island (AS-127) located in Chittagong Region Group. Dates mentioned are February 21-25th. QSL Manager will be EB7DX. More details will be forthcoming.



### **ST26, SUDAN**

Look for the special callsign ST26ASC to be used between January 22-28th (2010). This activity coincides with the 26th Arab Scouts Conference from Khartoum, Sudan. QSL Manager will be ST2M.



### **TJ, CAMEROON**

Lionel, F5PSA, currently active as TJ3SL, will be here until around December 15th. His activity has been sporadic, but he is trying to be active daily, propagation permitting. Operations have been mainly 20 and 17 meters usually between 0930-1700z. QSL via F5PSA.



### **V3, BELIZE**

Wil, PA0WWV, will be active as V31WV from Sarteneja (northern Belize) between now and December 20th. Activity will be on CW and SSB. QSL direct only with 2 USDs plus SAE (NO IRCs).



### **VP2M, MONTSERRAT**

Mike, W1USN, will once again be active as VP2MPR between February 28th and March 13th (2010). Mike will work mainly SSB and PSK31. Bob, AA1M, will also return to Montserrat and will operate mostly CW as VP2MPL between March 6-11th. QSL both operators via their home callsigns.



### **VU, INDIA (News)**

OPDX was informed by Prasad, VU2PTT, that Gopal Madhavan, VU2GMN, who is the President of ARSI - the IARU recognized national organization of India, is reporting he spoke with the "Wireless Planning & Coordination Wing (WPC), India's Ministry of Communications and Information Technology Department of Telecommunications, and they have confirmed that the extra bandwidth (on 40m) has been officially released to VU radio amateurs based on the petitions given by ARSI on April 15, 2009, soon after the band was to be released as per agreement in WRC2003. VU hams can now officially use that extra bandwidth. Gopal also mentioned, "They have also confirmed that the other requests made by ARSI regarding 10 MHz and 50 MHz are also under consideration, so please wait for further news."





**- 2/12 BRITISH VIRGIN IS.; VP2V/DL7VOG NA-023**

from Anegada Island. Activity is on all bands using mostly CW and RTTY. QSL to home call.

**- 3/12 TURKS & CAICOS IS.; VP5/homecall NA-002**

from Providenciales by W7VV, VE7XF and possibly some other operators. Activity will include the CQWW DX CW Contest (November 28-29th) as a Multi-? entry and possibly a special callsign (TBA). QSL route TBA. Operators will be active before and after the contest on all bands (160-6 meters) and modes signing VP5/homecall. QSL via their home callsigns.

**- 6/12 CHESTERFIELD IS.; TX3A**

by AA7JV and HA7RY. The TX3A license for the Chesterfield Dxpediton has been extended. Their priorities will be 160, 80 and 40 meters, in that order. They will be active on the higher bands the rest of the time. The operators will use the same antenna that they used on Mellish Reef, but they have developed a new RX antenna, which they hope will improve their RX capabilities. QSL via HA7RY. Mailing direct -Please include 2 USDs with every direct QSL request for up to three cards per envelope. If you send International Reply Coupons (IRC), please make sure that it is not expired or is not about to expire. DO NOT SEND IRCS that are valid only until end of 2009! Cards are likely to be posted only early 2010. Mailing address: Tamas Pekarik, Alagi ut 15, H-2151 Fot, HUNGARY. \* The preferred way is using the "Online QSL Request Service" (OQRS) on their Web site which they will launch once the DXpedition is over. You can use that form to request your direct QSL and cover the costs of sending the QSL card to you direct by using PayPal. They request a minimum of 5 USDs or 4 EUROS for this service. \* Bureau: They will launch an "Online QSL Request Service" (OQRS) on their Web site as soon as the expedition is over. If you want to receive your QSL via the bureau, please use that form to request the card. They will check your QSOs against the log and send your card to you via the bureau. This method will allow them faster processing, helps them protect the environment and you will receive your TX3A card faster. If you request your bureau card online, please do NOT request a direct card and do NOT send us your QSL card. More detailed information is available on their new Web page at <http://www.TX3A.com/>

**- 7/12 VIETNAM; XV2RZ and XV2JR**

by OH4MDY and OH3JR. Activity is on all HF bands using CW, SSB and RTTY. QSL both calls direct via OH4MDY.

**- 31/12 JAPAN; 8J7M AS-007**

from Honshu Island. QSL via bureau.

**- 31/12 HONG KONG; VR2009EAG**

special event to promote the Hong Kong 2009 East Asia Games. Operations will be primarily on the HF bands from 40-10 meters and VHF on 6 meters. The modes used will be primarily SSB, RTTY, PSK31 and SSTV. QSL Manager VR2XMT: Charlie Ho, PO Box 900, Fanling Post Office, Hong Kong.

**- 2009 WEST MALAYSIA; 9M2TI**

by EA4ATI to work in Kuala Lumpur for the whole year 2009. He will work with 400 watts and a vertical in CW and SSB on 40m/20m/15m/10m. He also plans to take part in all major contests (if possible from stations better equipped). QSL via EA4ATI.

**- 20/2 2010 ANTARCTICA; KC4USV AN-011**

from McMurdo Station by K7MT. He will be on the HF bands on 14243 kHz, Sundays at 0000z. He will also be active on PSK-31 (on 14070 kHz) and CW (14043 kHz) if time permits. He has also mentioned that he will take an Arrow II antenna and his Kenwood TH-7 to work the Amateur Satellites into VK and ZL land. He also has plans to be on APRS VHF/HF with a Kam Plus, so you might just see him driving around on the Ross Ice Sea as K7MT-7 on APRS. QSL via K1IED. Visit his home page for some interesting pictures at <http://www.mt.net/~k7mt/>

**- May 2010 PHILIPPINES; DU9/DL5SDF OC-130**

expects to be QRV from Mindanao Island. He operates CW only. QSL direct to Hans Bohnet, Purok 5, Lower Bon-Bon, Libertad, Butuan City 8600, Philippines or via the DARC bureau to DL5SDF (bureau card requests will have to wait until June 2010, when he will go back to Germany).

**- 12/7 2010 SOUTH AFRICA; ZS1ØWCS**

The next FIFA Soccer World Cup will take place in South Africa in 2010. QSL cards should be sent via the ZS bureau. If you want to send direct please use following address: SARL, PO Box 1721, Strubensvallei 1735, Republic of South Africa.

**- 31/10 2010 CANADA; VA7PX NA-075**

From Mayne Island. QSL via VE7AXU via bureau or direct.

**- 2010 MARSHALL IS.; V73NS OC-028**

from the Kwajalein atoll by WD8CRT, who will have to work here for two years starting on Jan 5, 2009. He will work mostly in CW on 160-6m. QSL via bureau or direct to Neil Schwanitz, PO Box 8341, APO, AP 96557, USA. His website is <http://www.qsl.net/v73ns/>

**- 31/3 2011 ANTARCTICA; VU3BPZ and AT1ØBP**

from the Maitri Base (WAP IND-03) by VU3BPZ. Updates and more details are expected on the WAP Web site at <http://www.waponline.it/>

**- July 2011 FRENCH POLYNESIA; FO**

by F5PHW. Since he is there for work, his on air activities will be limited, but he will try to operate as much as possible. If he lives in a house, Phil intends to be active on all HF bands from 80-10 meters mainly on CW and RTTY (possibly some PSK31) with very little SSB using only 100 watts. His antennas from the house QTH will be: 80-40m - Inverted V + HF6VX (GP), 30m - HF6VX, 20-10m - HF6VX + Spiderbeam (not sure). However, if he lives in an apartment the antenna may only be the HF6VX. QSL via F8BPN, by the Bureau or direct.

**1/12 - 31/1 CANADA; VG7W**

The Vancouver Olympics Amateur Radio Group (VOARG) will activate three special calls to celebrate the Olympic Winter Games and Paralympics which will take place in Vancouver/British Columbia in Feb/March 2010. This is the second special call. A website will go online soon, all logs will be uploaded to the LoTW. QSL cards can be sent via bureau or direct to: VOARG, 9362-206A St, Langley/BC, V1M 2W6, Canada.

**2/12 - 5/12 NEW ZEALAND; ZL**

from Auckland (logistics, possible activation of some IOTA group)

by IK1PMR, K2LEO/PA3LEO, PA0BWL, AA4NN, OE2SNL, DJ5IW and OZ1IKY are planning a DXpedition to three semi-rare entities (and possibly some other operations) in the Pacific between November 11th and December 13th. Callsigns have not been announced yet. Focus will be on the lower bands, but activity is planned for 160-10 meters using CW, SSB and the Digital modes. The team will use three Elecraft K2/100 with DSP and amps. For more information and updates, watch: <http://www.ik1pmr.com/plans/a3/index.php?s=intro/>

**2/12 - 14/12 VIRGIN IS.; K2V NA-106**

from Saint Croix Island by K9WZB and K7WZB as a special "Christmas Festival" event. Activity will be on all bands 160-6 meters. They will be monitoring 6 meters most of the time for openings to the U.S. and Europe. Operations will be on SSB, RTTY, CW and PSK31. See QRZ.com K2V for more information. QSL direct only via K9WZB (No Bureau QSLs); SAE outside of USA with USDs or 2 Euros...Please no IRCs. A special QSL will be available after their return. Log updates daily at: <http://www.clublog.org/logsearch/K2V/>

**3/12 - 8/12 CAMBODIA; XU7UFT**

by F6AXX and F6HBR. Activity will be on the HF bands, but CW only. QSL via F6AXX, by the Bureau or direct (w/SAE and return postage). Look for direct QSLs to be answered after January 15th, 2010.

**4/12 - 16/12 BRITISH VIRGIN IS.; VP2V/W3HQ**

from Virgin Gorda. Activity will be CW only. Bands will be mainly 160 and 10 meters on weekends, and 30/17/12 meters during the week. QSL via W3HQ. Skeds are welcomed (2 way QRP skeds are preferred). His E-mail address is: [w3hq@live.com](mailto:w3hq@live.com)

**5/12 - 13/12 S. COOK IS.; E5**

by IK1PMR, K2LEO/PA3LEO, PA0BWL, AA4NN, OE2SNL, DJ5IW and OZ1IKY are planning a DXpedition to three semi-rare entities (and possibly some other operations) in the Pacific between November 11th and December 13th. Callsigns have not been announced yet. Focus will be on the lower bands, but activity is planned for 160-10 meters using CW, SSB and the Digital modes. The team will use three Elecraft K2/100 with DSP and amps. For more information and updates, watch: <http://www.ik1pmr.com/plans/a3/index.php?s=intro/>

**6/12 - 12/12 BERMUDA; VP9/AA1AC**

from the Hamilton Parish. QSL via to his home callsign, direct or via the bureau.

**10/12 - 31/12 THE GAMBIA; C5**

SM1TDE is planning an operation. More details should be forthcoming.

**13/12 - 17/12 SINGAPORE: 9V**

by IK1PMR, K2LEO/PA3LEO, PA0BWL, AA4NN, OE2SNL, DJ5IW and OZ1IKY are planning a DXpedition to three semi-rare entities (and possibly some other operations) in the Pacific between November 11th and December 13th. Callsigns have not been announced yet. Focus will be on the lower bands, but activity is planned for 160-10 meters using CW, SSB and the Digital modes. The team will use three Elecraft K2/100 with DSP and amps. For more information and updates, watch: <http://www.ik1pmr.com/plans/a3/index.php?s=intro/>

**17/12 - 6/1 HAWAII; N1CE/KH6 OC-019**

from Oahu Island. He states that his activity will be mobile using a Kenwood TS-480 w/100 watts, and it will be SSB only on this trip. QSL only direct to his home callsign.

**28/12 - 3/1 MADAGASCAR; 5R8HX AF-013**

by G4OHX. Activity will be mainly CW. QSL via his home callsign direct only.

**29/12 - 4/1 AUSTRALIA; VK6 OC-211**

Robertson Island, Houtman Abrolhos. VK6YS is in the process of organizing an IOTA expedition. QSL via VK4AAR. For the time being the team includes VK6YS VK6NI, but they are looking for another two operators to share the costs. Please contact Wally (vk6ys@iinet.net.au) if interested. The Abrolhos were activated for the first and only time by VK9XZ/6 back in January 1996.

**4/1 - 17/1 SOUTH AFRICA; ZS5/G4OHX**

Activity will be mainly CW. QSL via his home callsign direct only.

**5/1 - 26/1 ARUBA; P4ØC or P4ØCG**

by W2CG. Activity will be primarily CW/RTTY on 80-6 meters, usually between 1200-1400z and 2000-2400z, other times as schedule permits. QSL is via the LoTW (prefers), or via his home callsign, by the Bureau or direct (U.S. stations, if not LoTW then SASE via CBA).

**8/1 - 11/1 EASTER I.; CEØ/YV5IAL**

This will be a QRP, portable, holiday style operation. Activity will be on PSK31 digital mode on 14070.15 kHz from 2200-0100z, and occasionally on 40/30/15 meters. QSL via his home callsign.

**10/1 - 24/1 SOUTH SHETLAND IS; XR9JA AN-010**

from Arturo Prat-Greenwich Island-South Shetland archipelago, WW Loc. GC07FQ) by XQ5CIE, CE6UFF, F6DXE and CE5COX. Activity will be on 160-6 meters using CW, SSB, PSK31 and the AO-51 Satellite. QSL via CE5JA. For more information, go to <http://www.ce5ja.cl/>

**21/1 - 28/1 VANUATU; YJØXX, YJØDX and YJØMM OC-035**

from Efate Island by a Croatian team of 9A4DU, 9A6DX and 9A8MM.

Activity will be on 160-10 meters using CW, SSB and RTTY. QSL Manager will be 9A8MM. More details and updates are available at: <http://vanuatu.rkp.hr/>

**21/1 - 21/3 UGANDA; 5X1NH**

by G3RWF. Activity will be on the HF bands. He prefers CW and likes the Digital modes (PSK and RTTY), but may work SSB whenever signals are good enough. QSL via his home callsign.

**February COCOS I.; TI9**

TI2HMG is trying to put together another operation to TI9 which will take place in February of 2010. Look for updates and details on: <http://www.qsl.net/ti2hmg/cocos.htm>

**4/2 - 10/2 HAWAII; N7I**

from Honolulu (Oahu Island HI-008S) by WL7MY and KL7JR. Activity is in celebration of the 16th anniversary of the U.S. Islands Awards program. Main frequency will be 28460 or 14260 kHz. They use a TS-50 and a vertical on mag mount. QSL Manager is KL7JR.

For additional info: <http://www.usislands.org/>

**10/2 - 21/10 KENYA; 5ZØH AF-040 and AF-067**

from Lamu Island and Wasini Island by 5Z4ES, IK8TEO, IK8UHA and IK8VRH are planning to be in Kenya and activate two IOTA islands. QSL via LoTW, by the Bureau or direct to IK8VRH: P.O. Box 173, I-80016 Marano (NA), Italy. Visit the 5Z4H Web page at <http://5z4h.sitonline.it/>

**17/2 - 23/2 BELIZE; V31RR**

by AA4NC. Activity will be on the HF bands including 30/17/12m using CW, SSB and RTTY. His activity will also include the ARRL DX CW Contest (February 20-21st) as a Single-Op entry. QSL via his home callsign or LoTW.

**18/2 - 22/2 NICARAGUA; YN2GY**

by K9GY during the 2010 ARRL DX CW Contest (February 20-21st). Outside of the contest, look for CW activity on 30/17/12 meters. QSL via LoTW or to his home callsign, direct or by the bureau.

**20/2 - 27/2 CHRISTMAS I; VK9X/G6AY OC-002**

by G3SWH and G3RTE. They will operate CW only on 80-10 metres (no activity on 160 metres). Propagation permitting, they plan to have two stations on the air for as many hours every day as is possible. QSL via G3SWH, direct or bureau (requests for bureau cards can be submitted by using the relevant form on. Please visit <http://www.g3swh.org.uk/christmas-island.html> for further information.

**5/3 - 12/3 SAINT MARTIN; FS/KT8X**

This will be a holiday style operation with an emphasis on the 30/17/12 meter bands using CW, SSB and RTTY. However, he does plan to enter the ARRL DX SSB Contest as a Single-Op entry. QSL route will be the "Logbook of The World" (LoTW).

**28/3 - 31/3 OGASAWARA; JD1BNN**

by JF3MYU. He is expected to be there with three other operators who will be staying long (hopefully more details will be forthcoming). He will be focused on the WARC bands. QSL is "OK" via JARL Bureau, but write JD1BNN on your QSL (so it can be sorted easily). Also, you can receive his QSL direct if you send your QSL to his address: Kirk Itaya, 5-1-35, Daikaidori, KOBE, 652-0803 JAPAN. Please enclose SAE plus sufficient return postage. For NA, SA, EU and AF include one new IRC or 2 USDs. For Asia, one IRC or 1 USD.

**10/4 - 18/4 VIET NAM; 3W6C AS-185**

from Con Co Island by HB9BXE and a large group of operators from Switzerland, Germany and Vietnam will be running four stations 24 hours a day. Further information is expected in due course. For the time being, please visit <http://www.3w6c.qrv.ch/>

**19/5 - 23/5 ST. PIERRE & MIQUELON; TO2FH**

by a team of Brazilian operators. More details are forthcoming.

**IOTA-frequencies**

CW: 28040, 24920, 21040, 18098, 14040, 10115, 7030 and 3530.

SSB: 28560, 28460, 24950, 21260, 18128, 14260, 7055 and 3755.

The frequencies are NOT exclusive to IOTA!

IOTA net Saturdays at 1300z on 14260 and Sundays at 1300z on 21260!



# BACK TO 1936 ! A Portable Duplex Radio-Telephone

By W. B. Lewis, Ph. D., and C. J. Milner, B. A. e

**SUMMARY.**—A practical system of duplex radio-telephony on ultra-short waves is described in which each set is made alternately transmitter and receiver at a supersonic frequency. The interrupted oscillation provides super-regenerative amplification which is so great that no additional amplification is required, and the sets are therefore simple and may be light in weight. The quench frequency must be selected according to the distance between the sets. Telephony transmission is effected by modulation of the quench oscillator. Since true duplex communication is obtained without appreciable "side tone," one or both sets may be directly connected to an ordinary telephone line.

The theory of the super-regenerative receiver is reviewed and also some practical aspects of the propagation of ultra-short waves.

Attention is directed to the remarkable facility of synchronisation of the quench frequencies even when signals are weak.

THE system to be described provides in the strictest sense a duplex radio-telephone; that is to say, conversation may pass in both directions at the same time. No manual or voice-operated switches or cut-outs are employed. Further, the radio-telephone may be directly connected at one or both ends to ordinary line telephone circuits. "Subscribers" on these telephone circuits might well be unaware that any radio link was in use.

## Introduction

### (a) Other Duplex systems

The great problem of duplex radio-telephony is to prevent the sensitive receiver from being swamped by the local transmitter. Apart from the obvious methods of spacing the receiving apparatus and the transmitting apparatus as far apart as possible, and of using very different wavelengths for the two directions of communication, it appears that two solutions have been put forward. The first is attributed to C. E. Franklin.<sup>1</sup> In this method the local transmitter is made to act as the oscillator of a super-heterodyne receiver, the supersonic beat frequency between this local oscillation and the received signal being then amplified and detected in the usual way. In the second method each apparatus is made alternately transmitter and receiver at a supersonic frequency. The receiver may then employ this interrupted oscillation for obtaining super-regenerative amplification. This principle is adopted in the system to be described.

The idea of using a super-regenerative receiver for simultaneous transmission and reception seems to have been put forward first in May, 1928, by G. A. Beauvais.<sup>2</sup> Later in the same year a patent was taken out by Lorenz A.G.,<sup>3</sup> and in 1931 a similar system was patented by the Marconi Company.<sup>4</sup> These early systems appear not to have been ideal. In the Lorenz system there seems to have been difficulty in maintaining synchronism between the quench oscillators at the two sets. From our experiments we expect the Marconi system was found to be liable to distortion and background noise.



The duplex  
radio-telephone set  
up ready for use

## (b) The Modulated-Quench Duplex System

The apparatus consists essentially of a super-regenerative receiver employing a relatively powerful radio-frequency oscillator quenched at a supersonic frequency by a separate oscillator. The two sets in communication are exactly similar, and the quench frequencies are synchronised. With a suitable circuit it is found that the two quench frequencies lock to one another in a remarkably stable manner. For example, a signal produced by radiating a quenched oscillation of watt average power on 3 metres wavelength from a  $\frac{1}{2}$  aerial is sufficiently strong when received on a  $\frac{1}{2}$  aerial at a distance of 25 miles, to lock the quench frequency of a similar oscillator with sufficient stability for practical purposes.

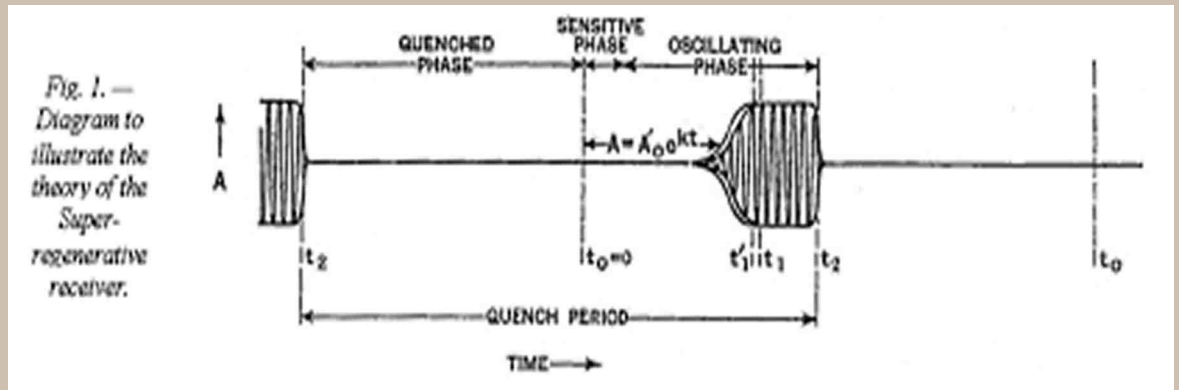
When the relative phase of the two synchronised quench oscillations is suitably adjusted, telephonic communication may be established by a very slight modulation of the quench oscillator.

Before discussing the detailed working of this system, it seems advisable to review briefly the theory of the super-regenerative receiver, 5, 6, 7, as no very satisfactory account appears to have been published yet in English.

### The Theory of the Super-Regenerative Receiver

The super-regenerative receiver consists essentially of a radio-frequency oscillator, the oscillation of which is periodically interrupted or quenched at some high-audible or super-sonic frequency. The oscillation is then allowed to build up again, and it is in this building-up process that the amplification occurs.

**Fig. 1.** —Diagram to illustrate the theory of the Super-regenerative receiver.



In one cycle of this quenching process three consecutive states may be recognised, which may conveniently be termed the "quenched," "negatively damped" (or sensitive), and "oscillating" phases. In the "quenched" phase the oscillation dies to zero or more strictly to a residual E.M.F. in the circuit which is only that due to thermal agitation, shot effect, etc., and the received signal. This quenched phase is followed by the relatively short "sensitive" phase, in which an oscillation builds up increasing exponentially with time, and the amplitude may therefore be written as  $A_0 e^{kt}$ .  $A_0$  therefore comprises the random agitation E.M.F. together with the E.M.F. produced by the received signal. When in course of time  $ekt$  has reached the value 10 or 100, the received signal is such a small part of the oscillation that any modulation of the received signal would be practically without effect on the increasing oscillation, so we may say that we have passed out of the sensitive phase into the oscillating phase. But it is important to note that the oscillation amplitude is still at any time proportional to  $A_0$ , the small received signal and agitation E.M.F. A limit is however reached when  $A_0 e^{kt}$  is the maximum oscillation which the valve will maintain,  $A_{max}$  say. Clearly the greater  $A_0$  the sooner this limit is reached and hence the oscillation persists at the maximum for a longer time, assuming that it is cut off at a definite phase of the quench cycle corresponding to the onset of the quenched phase. This is illustrated in Fig. 1. It should be noted that, if the function  $A_0 e^{kt}$  is plotted against time for different values of  $A_0$ , all the curves appear of the same shape but displaced on the time scale. The same proportional change of  $A_0$  produces the same displacement on the timescale whatever the absolute value of  $A_0$ .

Referring to Fig. 1, the increase of  $A_0$  to  $A_0'$  (of the order of 10-6 cm. on the vertical scale of the diagram, and therefore quite invisible) due to change of amplitude of the signal reduces the time  $t_1$ , at which the oscillation reaches its maximum, to the time  $t_1'$ .

Quantitatively,  $t_1 = 1/k \log A_0 + \text{constant}$ ,

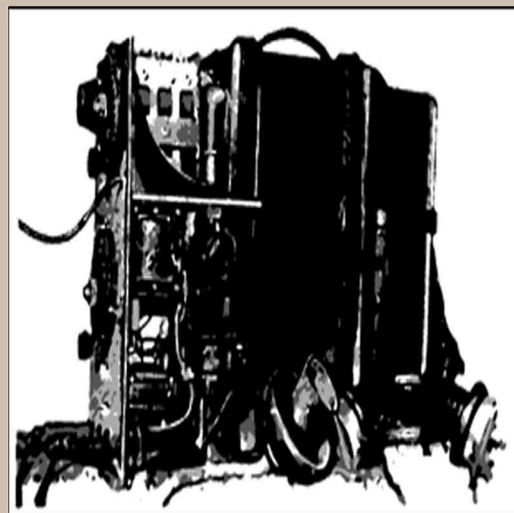
and  $t_1' = 1/k \log A_0' + \text{constant}$ .

Therefore  $t_1 - t_1' = 1/k \log A_0/A_0'$

Also the duration of the full oscillation may be written as  $t_2 - t_1 = 1/k \log A_0 + \text{constant}$ . This expression contains the explanation of the remarkable automatic volume control action of the super-regenerative receiver.<sup>5</sup> For if the current in the anode circuit (i.e. through the phones) changes by  $i$  in passing from the sensitive phase to the full oscillating condition, then the total current through the phones may be written as  $n/k \log A_0 + \text{constant}$ , where  $n$ =quench frequency. The constant current component produces no sound in the phones, the other component is proportional to  $\log A_0$ . If the received signal is so large that the residual agitation E.M.F. is negligible in comparison,  $A_0$  is proportional to the amplitude of the received signal. If this received signal is modulated we may have  $A_0 = A_s (1 + m \cdot \sin t)$  and the current through the phones due to the signal is  $n/k \log A_s \cdot (1 + m \cdot \sin t) = n/k \log A_s$  (which is a constant) +  $n/k \log (1 + m \cdot \sin t)$ . The component due to the modulation is seen to be  $n/k \log (1 + m \cdot \sin t)$ , which is independent of  $A_s$ , the absolute signal strength, but depends only on the depth of modulation  $m$ . Expressed another way, the loudness of the received modulation depends only on the depth of modulation and not at all on the amplitude of the received signal, and this is true provided that the amplitude of the received signal is considerably greater than the residual agitation E.M.F. in the receiving circuit. It may be noted that this perfect automatic volume control is necessarily accompanied by a slight distortion on normally modulated signals, for  $\log (1 + m \cdot \sin t)$  may be expanded as  $n/k (m \cdot \sin t - m^2/2 \cdot \sin^2 t + \dots + \dots)$  if  $m$  is not greater than  $1/2$  ( $m < 1/2$ ), then the distortion terms are  $m/8(1 - \cos 2t)$ .

It is only on short wavelengths that the behaviour of a super-regenerative receiver is in accord with this theory. On longer wavelengths (above about 300 metres) the oscillation does not build up to the full value during the quench cycle, unless the quench frequency is in the audible range. If the oscillation does not build up fully, the automatic volume control action is impaired.

It is characteristic of the super-regenerative receiver that, in the absence of a signal, a rushing noise is heard in the phones. This is clearly due to the oscillation building up from the random disturbance in the circuit. Quite a weak signal of the correct frequency is however sufficient to swamp this disturbance and thus to quieten the background. It will be realised that this effect is due to the automatic volume control action. An exactly similar effect is commonly observed with modern broadcast receivers employing automatic volume control; in the absence of a signal the receiver is most sensitive and brings in background noises. Under some circumstances it might be desirable to apply a system of quiet automatic volume control to reduce the noise in the absence of a signal. Any rational attempt to reduce the background noise when receiving a signal must aim at reducing the random E.M.F. in the oscillatory circuit relatively to the received signal. It is to be noted that no receiver



*A close-up view of the complete set*

can be more sensitive than a super-regenerative receiver unless the random disturbance in its first circuit is less than in that of the super-regenerative receiver. Factors affecting the output of the super-regenerative receiver must be sharply distinguished from those affecting its sensitivity. The output power is proportional only to the change of power dissipated in the anode load between the oscillating and the sensitive conditions, and to the number of interruptions per second (the quench frequency).



It is not yet clear how the effective random disturbance in the oscillatory circuit of a super-regenerative receiver depends on the maximum power which may be developed. But it appears that the disturbance does not increase very rapidly with the oscillator power: a powerful oscillator may still be a sensitive receiver (This is required for satisfactory duplex working.).

From these considerations there is no reason why any audio-frequency amplifier should follow a super-regenerative receiver. It may however be more economical to use a low-power oscillator, followed by an audio-frequency amplifier, than to use a more powerful oscillator.

The amplification provided by a super-regenerative amplifier may be phenomenal, for example a quenched oscillator dissipating from 1 to 4 watts provides amplification of the order of 5.108 expressed as the ratio of the audio-frequency output power to the radio-frequency input power, for a wavelength of 3 metres. It should be noted that this amplification is obtained from a single triode valve.

### Mode of Operation of the Modulated Quench Duplex System

It has already been mentioned that the quench oscillators of the two sets are adjusted to a common frequency. This frequency and the phase relation between the two quench cycles are so adjusted that the pulse transmitted by one set reaches the other in its sensitive phase, and that the oscillation pulse which then builds up in this receiver and is transmitted, reaches the first set in its sensitive phase.

It will be clear that the adjustment will depend on the distance between the two sets, owing to the time taken by the pulses in transmission over the distance. For example, the performance of two actual sets may be quoted. At distances up to 200 yards any quench frequency in the tuning range, 50 to 100 kc/s., might be used. At from 200 yards to ¼ mile, only the lower quench frequencies could be used. For distances of ¼ to ½ mile a high quench frequency is most suitable. For still greater distances the correct frequency must be found by trial. Having selected the quench frequency according to these rules, satisfactory duplex working may be achieved by adjusting quench oscillator anode supply, and by a fine adjustment made at one set only of the quench oscillator tuning, keeping within the range over which the quench frequencies remain locked.

When the theory of operation is considered more exactly, it will be realised that it is necessary for a modulated part of the pulse from each set to reach the other in its sensitive phase. Now by the method of modulating the quenching oscillation, the maximum amplitude is only very slightly changed, but the duration of each pulse is changed, i.e. the ends of the pulses are modulated. For, as was pointed out earlier, a displacement of the instant at which the oscillation starts to build up is equivalent

to a change of the initial amplitude of the oscillation. The same is true of the ends of the pulses: when the set passes from the oscillating to the quenched phase, the amplitude of the oscillation decays exponentially (and very rapidly). A displacement on the time scale is therefore again equivalent to a fractional change of amplitude proportional to the time displacement. The diagrams of Fig. 2 show the sequence of events at the two sets, A and B. (It should be noted that the dotted curves of the amplitude of the received signal are greatly magnified, until they appear to be of the same order as those of the local oscillation.)

Since modulation is effected by displacing the ends of the pulses, the condition for sensitive reception is that the received amplitude should be changing rapidly with time at the sensitive instant of the receiver. This is indicated in the diagrams, where P and Q are sensitive instants of the set A, and R such an instant for the set B.

A partial explanation of the mechanism of locking of the quench oscillators appears from this figure. As drawn, it shows the set A receiving the beginnings of the pulses from set B. Should the interval PQ be longer than the interval between the received pulses (i.e. the quench frequency of set A be lower than that of set B), then the amplitude at time Q, from which the local oscillation starts to build up, is increased: and we have seen that this is

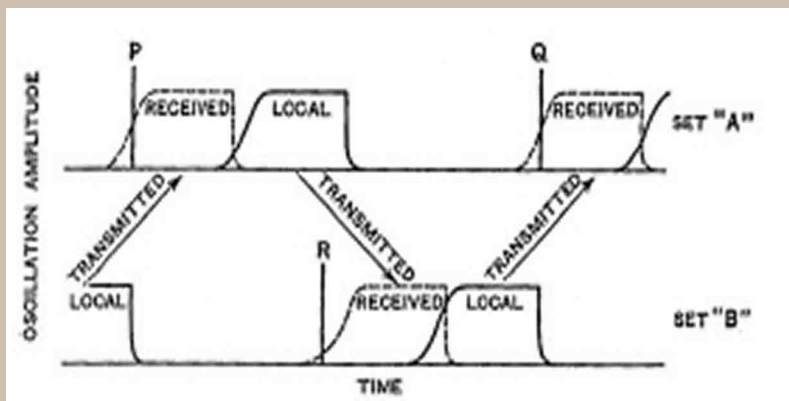


Fig. 2. — Diagrams indicating performance of the two sets.

The "local oscillation" of each set is radiated, and becomes the "received signal" at the other: each dotted curve is therefore a replica of the solid curve of the other diagram, but occurs later by the time taken in transmission. It is evident that the instant R can only be made to coincide with a part of the dotted curve having a steep slope by suitably choosing the quench frequency with regard to the separation or propagation time-interval between the two sets. Duplex working is therefore only possible with certain quench frequencies, which, when set A is being locked to set B, allow the sensitive instants of set B to occur either at the beginning or end of the pulses received from set A.

The duration of the pulses radiated is controlled not only by modulation of the quench oscillator, but also by the received signal. This also follows from the equivalence of a change of initial amplitude and a time displacement of the sensitive instant. The resulting modulation appears to be quite large, and we have found that it may be used to provide a relay action between two sets out of range of one another. When a third set is placed halfway between them, and can "communicate" with each of the others separately, and the quench frequencies of all three are locked together, the three sets can all "hear" one another. Similar "conference" operation is also usually possible when all three sets are able to work to each other in pairs, but the necessary adjustment is difficult and impracticable for mobile sets.

Modulation of the radiated pulses by the received signal is quite efficient compared with that produced by modulating the local quench oscillator. One incidental result of this is that the "side-tone" at the transmitter is perceptibly increased by the re-radiated pulses from the distant station.

Normally the sets are remarkably free from "side-tone," that is to say the speaker scarcely hears his own voice in his receiver. This fact makes it possible to connect the sets to ordinary telephone lines without any trouble from acoustic instability. Alternatively it is possible to use a loud speaker instead of phones for reception without incurring microphone howl.

### The Circuit

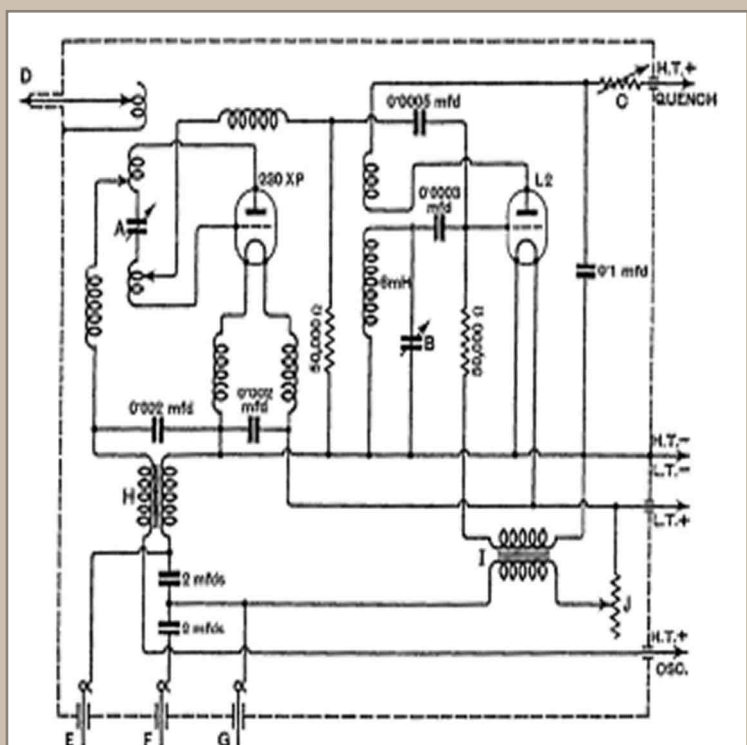
The circuit of the most successful apparatus used is shown in Fig. 3. The essentials are:

(1) An ultra-short-wave oscillator quenched at a supersonic frequency. This in addition to providing the transmitted oscillation also acts as a super-regenerative receiver. It therefore has a telephone transformer in the anode circuit and, also, in order to obtain a reasonably loud audio-frequency output, the grid circuit includes a resistance of about 50,000 ohms. The automatic volume control action characteristic of this type of receiver makes any additional volume control practically unnecessary.

(2) A speech-modulated supersonic quench oscillator. If the quench oscillation is fed to the grid circuit of the radio-frequency oscillator, the quench oscillator may be of lower power.

**Fig. 3. — Circuit diagram of the duplex radio-telephone finally adopted by the authors as the most successful tried. The components of the circuit are as follows :—**

- A, Radio-frequency tuning 0.0001  $\mu$ F;**
- B, Quench-frequency tuning 0.0015  $\mu$ F;**
- C, Quench Amplitude control 50,0000 ;**
- D, Concentric feeder to  $\lambda/2$  antenna;**
- E, Ordinary Line connection or L.R. Phones;**
- F, Line connection with series condenser or L.R. Phones;**
- G, Microphone or Combination Hand-set;**
- H, Telephone Transformer ratio 10:1 ;**
- I, Microphone - Transformer ratio 30:1;**
- J, Microphone Sensitivity Control.**



Further, since only a slight degree of modulation is required, this may be supplied by a microphone and transformer in its grid circuit. The amplitude of the quench oscillation must be adjustable. This is conveniently done by adjusting a variable resistance in the H.T. lead. The frequency of the quench oscillator must also be adjustable over at least one octave, if communication is to be obtained at all distances.

It is essential that the coupling between the quench oscillator and the radio-frequency oscillator be such that harmonics of the quench frequency may be passed back efficiently from the radio-frequency oscillator to the quench oscillator. If this condition is not satisfied it is in practice impossible to lock the quench frequencies with a constant phase difference. Quench oscillators of the multivibrator type have been tried. These locked more readily, as would be expected, but it was found that they were also less stable against other disturbances, and modulation was not so satisfactory.

In other respects the circuit given may be modified as may be convenient. One or two points may however be mentioned. The radio-frequency oscillator should be as efficient as possible. With ordinary valves the circuit given seems very efficient. In this the filament current is led through a radio-frequency choke in which the two wires are wound parallel on the same core and the wires are bridged by a condenser at the end farthest from the valve. The anode and grid circuit leads are fine wires suitably coiled and coupled to the oscillatory circuit to obtain maximum output. The set is mounted in a screened box to avoid hand-capacity effects, which are other-wise troublesome, especially on the quench tuning. It is very convenient to feed the  $\sqrt{2}$  aerial at its mid-point from an untuned concentric type feeder. The outer conductor of this feeder is "earthed" to the screening box, and the feeder is coupled to the oscillatory circuit by a few turns of thick wire adjusted by trial. When connecting the microphone and telephone transformers to a common line, the correct interconnection should be adopted in order to ensure absolute stability. It is also advisable to include a variable resistance in series with the microphone so that the sensitivity may be increased when the set is worked from a long line. The radio-frequency oscillator valve should have a low impedance so that the necessary grid resistance does not cause it to "squegg." There is another important consideration affecting the choice of this valve. It is found that in general the radiated frequency is slightly higher than the frequency to which the set is most sensitive as a receiver. This seems to be due to a change in the effective inter-electrode capacities of the valve between the oscillating and the sensitive conditions, and depends on the type of valve used. In this respect the Cossor 230 XP has been found the most satisfactory of the small-power valves that we have tried. This valve is also convenient as the leads to the electrodes are short and reasonably thick, so that the external circuit for a wavelength of 3 metres is not inconveniently small.

It will be clear that the reason for adopting the ultra-short waves is that this system occupies a wide frequency band. It is, however, to be noted that as the overall modulation is very slight, the audio-frequency interference is small as long as the quench frequency of the receiver is not locked to that of the interfering transmitter. The H.T. power supply to our sets is about 20 mA. at 150 volts (3 watts). The aerial current at the centre of the  $\sqrt{2}$  aerial is then about 40 mA. as indicated by a Weston type 425 thermo-milliammeter. The total weight, including the batteries, need not exceed about 20 lbs.

### **Performance**

The performance of the actual sets may be summarised as follows. Duplex telephony with first-class quality and silent background is obtainable with quite simple tuning adjustments up to a distance of about  $\frac{1}{4}$  mile over reasonably open flat ground. Up to this distance a quench frequency of 50 to 60 kc/s. may be used, and communication may be maintained with one set on a moving car without any necessity for altering the adjustment.

At greater distances the quench tuning adjustment depends on the distance between the sets; and as the signal strength falls off quality becomes marred by increasing back-ground hiss. This is, however, no worse than is observed with an ordinarily modulated transmitter of the same power. At the extreme limit of range, where it might be just possible to catch familiar phrases using a straight transmitter, it is found with the modulated quench system that the quench locking becomes difficult to maintain. The range obtainable with these sets depends very markedly on the sites chosen

With aerials not reaching more than 6 feet high, the effective range over flat ground is found to be about 25 miles. With favourable sites at the top of steep slopes, however, a greater signal strength has been obtained over 25 miles, and reasonably satisfactory duplex telephony has been carried out at this range.

The disparity between these figures is an instance of the surprising characteristics of the propagation of waves of these wavelengths. The main features of the difference from longer wavelengths are explained on the generally accepted hypothesis, 8 9 10 that (1) these waves are too short to be reflected at all from the Heaviside layer, (2) strong reflection, with reversal of phase, takes place from the surface of the ground. The earth behaves as a dielectric at these frequencies, and (for 3-metre waves at approximately grazing incidence) as practically smooth. If the transmitter and receiver are situated at ground level, therefore, the direct ray and the ray reflected at the ground are received almost exactly out of phase and with equal intensity. There is thus a minimum of signal strength along the surface of the ground. As the sets are raised above the ground, a path difference is introduced between the direct and the reflected rays, and the signal strength is increased. (The strength at a fixed height is proportional to the inverse square of the distance, and not to the inverse of the distance, since the path difference is smaller the greater the distance between the sets.) The best site for an aerial is therefore at the edge of a precipice facing the distant station, or at the top of a high mast or building: not only (as is still commonly supposed) because a more distant horizon is obtained from a height, but also because a path difference is introduced between the direct ray and the ray reflected from the surface of the ground. It was stated by Beauvais in 1930<sup>11</sup> that it was most unfavourable for transmission if the waves left the transmitter or arrived at the receiver at grazing incidence over the surface of the ground for even a short distance, while the path of the waves might pass for miles over the surface of the earth or sea, midway between the transmitter and receiver, without much attenuation. The waves are, however, rapidly attenuated below the horizon. These conclusions have been substantiated by all subsequent workers. We may quote briefly the results of one or two of our experiments bearing on these points. (It must be emphasised that the super-regenerative receiver is so sensitive that these propagation phenomena are in evidence even with the low power radiated by our sets.) While signals cannot be received beyond a range of about a mile over flat ground, we have received signals at a distance of 47 miles with the sets at the top of steep hills rising 500 ft. from flat country, one near Folkestone and the other near Eastbourne. In this case intervening hills rose 300 ft. above the line of sight (allowing for atmospheric refraction) for a distance of 2 miles. However, the atmospheric refraction may have been abnormally strong during this test. It is much more certain that diffraction was important when a similar test was made on the Yorkshire moors. Fairly strong signals were received when the transmitter and receiver were well situated at the top of steep hills about 7 miles apart. An intervening table-land rose more than 200 ft. above the line of sight for 3 miles. Signals could not be received at the centre of the table-land: it seems certain that this was due to the destructive interference caused by the ray reflected there from the ground. Trees, buildings, and other objects of dimensions comparable with a wavelength produce very marked standing wave patterns. When an aerial is set up inside a building, it is almost essential to move it to a suitable position which in practice can only be determined by trial. The proximity of trees or buildings is, however, much less detrimental than that of open flat ground.

### **Conclusion**

We have been mainly concerned with the practical aspects of communication on ultra-short-waves with portable sets. Nevertheless, it is hoped that this account may be of interest to those concerned with other aspects, for example the synchronisation of frequencies by radio, and the attainment of true duplex radio-telephony. It may be that the simplicity of the system for working over a fixed range is of more account than its portability. In common with other portable ultra-short-wave apparatus, it is at its best when used for temporary communication in mountainous districts. It seems probable that it will be many years before mutual interference on ultra-short-waves becomes a practical problem in the remoter districts.

<http://www.holmea.demon.co.uk/Duplex/Duplex.htm>

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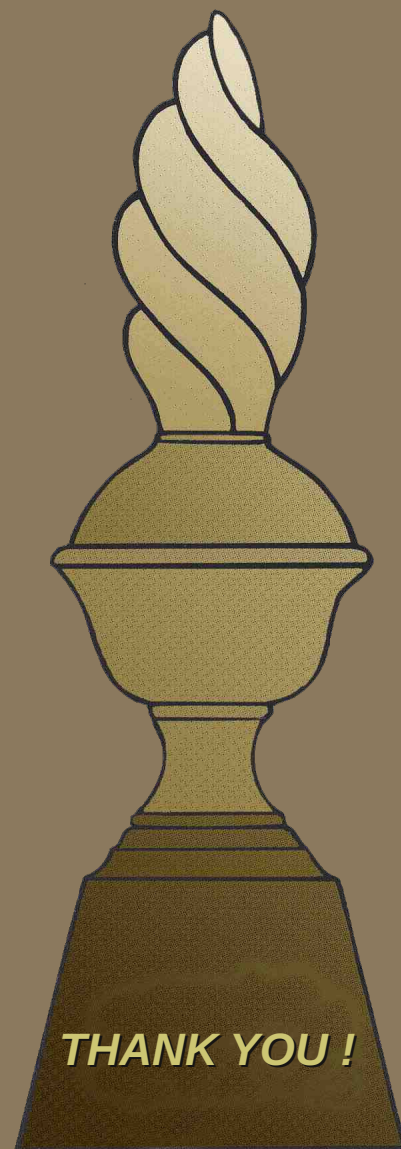
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