FEEDBACK

The OFFICIAL Newsletter of the

Georgian Bay Amateur Radio Club Inc.

VE3OSR 146.940 -

Nov. 1997

GBARC Meetings:
4th Tuesday of each month except July and August at the Owen Sound Yacht Club 7:30 P.M.

Breakfast Meetings:
2nd and last Saturday of each month at the ROCKFORD ESSO 9:00 AM.

Information: Write to GBARC Box 113, Owen Sound, N4K5P1
Packet is found on 145.630 under the call of VE3IJD

From the Editor

Well the Christmas season is upon us and the shopping lists are made. with all the extra people on the roads I hope everyone is driving carefully. Remember at this holiday season that drinking and driving don't mix.

A reminder to all that the Christmas dinner is on the 16th of December at 7:00 pm. Dinner is at the marine view restaurant, located just above the georgian yacht club. You are invited to meet at 6:00 pm at the yacht club for a social hour and are invited to return there after the meal.

It has come to my attention that there is some confusion as to the repeater frequencies in the area. With the changes our repeater system has been through I can sympathize with everyone.

Repeaters as of Nov 1997 are as follows

Frequency	Offset	Location
146.940	neg	3 km south of owen sound on highway 6&10
146.730	neg	14 km east of owen sound on highway 26
145.119	neg	2 km east of walkerton on highway 4
147.165	pos	4 km north east of paisley
146.820	neg	on the watertower in port elgin
147.375	pos	north west of meaford
146.790	neg	top off blue mountain
146.610	neg	on watertower in kincardine

73 John

Minutes for October 21,1997

Meeting was called to order at 7:30 by V.P. Gary VE3IOD
There were 21 members and 5 guests. Bill VE3AR and XYL Helen, George VE3PEB, John VE3EJN, Ivan VE3DO.

The minutes from the September meeting were read by Kim VE3DXE. One change was the Amateur Radio Course postponed to March. Brad VE3RHJ moved that we accept the minutes as read. Seconded by Marvin VA3ACI.

Treasure's Report: Jim VA3CJM reported that the balance of the account was $2530.44, a cheque has been issued to VE3TWK for trophy work. Insurance has not been paid, it's due November 17th.

Presentation: Jim VA3CJM introduced Bill Loucks VE3AR Chairman of Amateur Radio Program, his wife Helen, John Macanikie VE3EJN and George Fanjoy VE3PEB all from CNIB. Tom VE3TSA presented a cheque for $2730.00 that was raised from the Hobby Market. Bill thanked the club for the donation and explained that the money raised will go towards purchasing equipment for the blind. If anyone knows of persons that are blind and might be interested in Amateur radio, let John know there is a audio tape available. Bernie VE3BQM asked if the club could have a copy of the tape and John thought that it would be a good idea.

Old Business: JOTA was held October 17th to 19th. There were about 40 Scouts in attendance. On Friday evening, VA3JRF, VE3XOX, VA3CJM and VE3IOD set up 20, 40, and 80 meter dipoles. Packet was also set up. Gene VE3IJD flew in and camped the night under the wing of his airplane. The kids seemed to really enjoy the ham radio especially when they got to talk on the air. Thanks to everybody who came out with JOTA.

Christmas dinner, will be held Tuesday December 16th at 7:00 p.m. Remember to bring your spouse. Cost of the buffet is $10.95 per person (drinks and coffee extra). Social hour will be at the Yacht Club at 6:00 p.m.(BYOB).

Nominations: 'Ham of the Year Award' Vote will be held at the next meeting which is November 25th. Brad VE3RHJ nominated Tom VE3TSA; John VE3TXB nominated Brad VE3RHJ.

New Business: Kim VE3DXE read a letter from the Kiwanis Club of Owen Sound asking the members from GBARC to participate in the Santa Claus Parade on November 15th/ VE3RHJ, VE3BQM, VE3TXB, VE3JVO, and VE3IOD volunteered their help.

Fox Hunt will be postponed, Tom VE3TSA mentioned about having it on a Breakfast Saturday. Stay tuned for further details.

A motion to Close the GBARC meeting was moved by Steve VE3XKM and seconded by Tom VE3TSA. The winner of the 50/50 draw was Gary VE3IOD ($15.00). Congratulations Gary. Hope to see you all at the next meeting 73's Kim VE3DXE.

Microprocessors in one lesson

by Brad Rodriguez, VE3RHJ

Every computer contains a Central Processing Unit (CPU), some Memory, and some Input and Output (I/O).

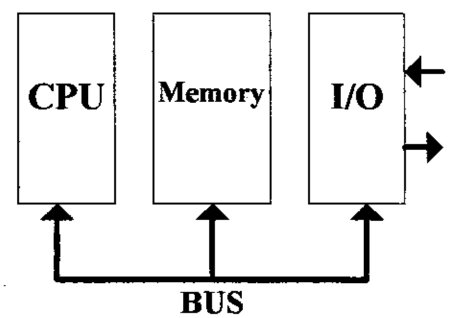
You can think of Memory as a giant wall of post office boxes. Each box can hold a number. Computers use binary (base 2) numbers, not the decimal (base 10) numbers humans use, because the only digits used in base 2 are 0 and 1 ("off" and "on"). A typical memory box ("memory location") can hold a number 8 *b*inary dig*its(bits)* long. These 8 bits could represent a number from 0 to 255, a letter in the alphabet, or a special code.

Each box is identified by a number (just like the post office!). This number is called the *address* of the memory box. So you can speak of storing the number 125 into box number 4095. A small computer might have about 64,000 boxes ("64K"); a large computer may have 32 million boxes ("32 meg").

The CPU runs the computer. It can store numbers in memory, fetch numbers from memory, and operate on numbers (for example, add numbers together). If the CPU is a single integrated circuit "chip", it's called a *microprocessor*.

The actions of the processor are controlled by a series of *instructions*, called a *computer program*. Here's the clever part: the instructions are numbers stored in the memory. The CPU fetches a number from a box, and this number is a code telling the CPU what to do. For example, the binary number 01000011 (which could be the decimal number 67, or the character "C") tells an Intel 8086 CPU to add 1 to memory location AX.[1] A different model of CPU may interpret this number to mean something entirely different.

Memory whose contents can be changed is called *RAM* (Random Access Memory). The contents of RAM are lost when the power is shut off. There's also permanent memory, called *ROM* (Read Only Memory), which never forgets. ROM is used to hold the computer's start-up or *bootstrap* program, which runs when you first turn the machine on.



Numbers flow to and from the CPU over a *bus*, which is just a bundle of wires (actually, traces on a printed circuit board). This bus has two parts. The CPU sends a number on the *address* bus to identify which box it wants. Then a number can be sent to or from that box over the *data* bus.

Input/Output devices look a lot like memory boxes, but they communicate with the outside world. For example, if the CPU stores a number to a *parallel port*, the 8 bits appear as "on" or "off" voltages on 8 wires. Similarly, a parallel *input* port could read the settings of 8 switches and convert them to an 8-bit number. Other devices can send and

[1] Most CPUs have some "built-in" memory. On the 8086, these locations are given special names, like AX and BX, to distinguish them from the normal "external" memory.

receive streams of bits on a single wire (*serial port*), or output a variable voltage (*digital-to-analog converter*), or cause pixels to appear on a screen, or cause the bits to be written to or read from a disk. To the CPU, it's all numbers.

Programming is the art of writing instructions for a computer. The individual instructions may seem fairly stupid, but a common computer might perform a million instructions per second! ("High speed idiots," indeed.)

Because the instructions computers understand are so limited, and so unlike the way humans think, *programming languages* were invented. For example, in the BASIC computer language you could type the statement

PRINT "HELLO THERE"

instead of the hundreds[2] of CPU instructions that are needed to print this message on the screen. A *compiler* program converts this statement to the CPU instructions. (Bonus: if you switch to a different CPU, you don't have to learn a new set of instructions, you just need to buy a new compiler!)

Specs

The speed of a CPU is related to the speed of its internal clock, which is measured in MHz.

Processors are also measured by the size of data they can handle. A 32-bit processor can add two 32-bit numbers with one instruction. An 8-bit processor would need to add the number in four pieces, taking four instructions, and (other things equal) taking four times longer.

This is not the same as the *bus size*, which refers to how much data can be transferred to or from memory in a single operation. You can have a 32-bit CPU with a 16-bit bus...but it'll be slower than the same CPU with a 32-bit bus.

The microprocessor in ham radio

The "stored program computer" is so versatile and inexpensive, it is replacing older technologies such as relays and digital logic chips. With the invention of Digital Signal Processing, computers can even replace filters and other analog components. So it's no surprise that microprocessors are appearing more and more in ham gear: transceivers, repeater controllers, TNCs, add-on filters, keyers, *et cetera*.

Fortunately, microprocessors are cheap, and easy to experiment with... right in the tradition of ham radio! Assembled microprocessor boards can be purchased new for as little as US$50. Vintage home computers (like the Commodore 64) can be found for even less and pressed into service. For the die-hard experimenter, CPU, memory, and I/O chips can be found for a few dollars each, and wired up "breadboard-style" into a working computer.

Good references

The book most recommended is The Art of Electronics by Paul Horowitz and Winfield Hill. It has two chapters on digital logic, and two more on microprocessors, including a complete design for a microprocessor board. Another interesting book is Build Your Own Intelligent Amateur Radio Transceiver, by Randy L. Henderson.

Good magazines for microprocessor projects are The Computer Journal, Nuts & Volts, and Circuit Cellar Ink. ARRL's QST and QEX magazines sometimes have microprocessor projects too.

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[2] More likely thousands, when you consider how much work is required to draw a character on a modern video display.

Remote HF operation by HamLink a boon to blind hams

By George Fanjoy, VE3PEB

Remote operation of modern HF transceivers from touchtone telephones is now readily possible. This article explains how the Canadian National Institute for the Blind (CNIB) Amateur Radio Program accomplished this task for the benefit of blind and visually impaired amateurs in the Toronto area. Its design was also developed for general use across Canada especially by those clubs and individuals helping the blind.

In summary, AEA (Advanced Electronic Applications Inc.) (1), have marketed a product called HamLink which is relatively inexpensive, about $400. It works well and allows remote access from a touchtone telephone to most control functions of a modern microprocessor-controlled HF radio.

This is tailor-made for blind amateurs, many of whom live in apartments with the difficulty of erecting and maintaining antennas, and other blind amateurs who either have no radio or find radio operation complex.

It has the advantage of simplicity. Many of the modern HF rigs are complex to a sighted person. Consider the difficulties facing the blind even when voice readout features are present.

The Amateur Radio Program owns and operates an excellent amateur station, VE3NIB/VE3AW, using the Kenwood TS-450 S/AT, a 10/15/20-metre, 7-element rotatable beam and a 40/80-metre inverted V. While this station is under-utilized, remote operation will markedly increase its use to everyone's benefit, especially those blind amateurs without access to a radio or antenna.

This article covers the Amateur Radio Program itself, the design of our HamLink system, and our operating experience.

Canadian National Institute for the Blind Amateur Radio Program station VE3NIB with Dave Ogilvie, VE3XVR, a whitecaner and author of the software, at the mike. The HamLink system is the logging computer behind Dave and the Kenwood 450 with HamLink on top of it on the left of the operating desk. The Kenwood 450 on the right is for local use. On the right, at the front of the desk, is a Perkins Brailler.

THE AMATEUR RADIO PROGRAM

The CNIB Amateur Radio Program is operated to foster amateur radio as a hobby for the blind and visually impaired across Canada. I do not have to explain to fellow amateurs the value of our hobby to handicapped people who otherwise could be effectively isolated in their homes.

The program aims to improve the hobby's availability to the blind across Canada by providing help and instruction, making equipment available through sale or lease, providing audio tapes of newsletters and selected publications and making amateur stations available for use by the blind. A limited number of Kenwood 450s are loaned free-of-charge to needy blind amateurs.

The program is sponsored by the CNIB but is managed and financed completely independently. Donations are the only source of funds and are always welcome.

Currently there are about 500 blind amateurs across Canada registered with the program. A course suitable for use by an instructor that has been used successfully over the past five years is available in audio tape, large print, Braille, and computer forms if needed by any group in Canada.

It is available in French in paper and computer forms. Annual audio tape newsletters are sent out to each blind amateur. *TCA* on audio tape is available on request. Several nets for the blind are in operation across Canada under local leadership.

The program has placed 207 high-quality modern transceivers in the hands of blind amateurs through direct purchases, leases, and loaners. It has annual expenditures of about $60 000.

HAMLINK

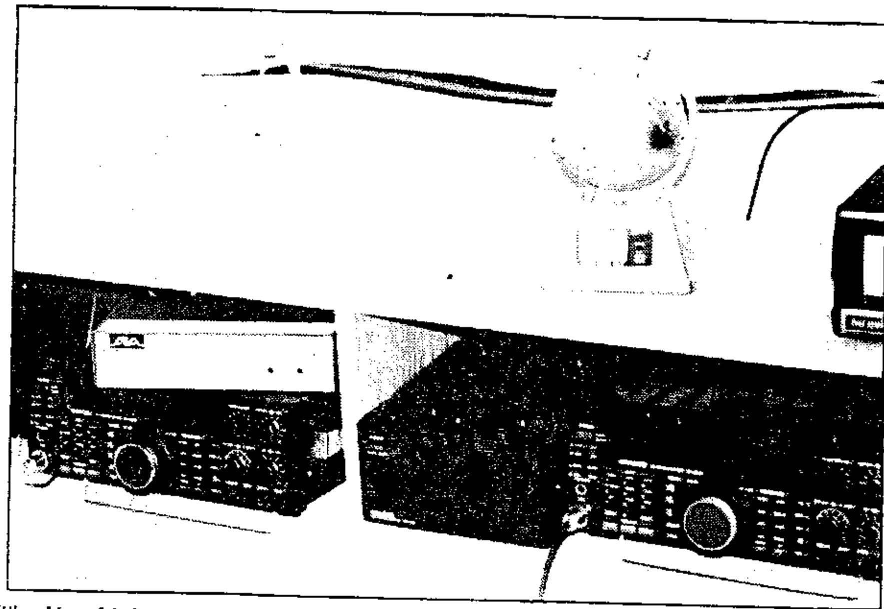
The VE3NIB overall system consists of a Kenwood 450 S/AT, HamLink, a computer for logging users and a dedicated telephone line. Fundamentally, only HamLink, a transceiver, an antenna and a telephone line are required. We chose to include a logging computer to ensure we had good records of users. In addition, it also provides training lessons on HamLink in the form of audio recordings as explained below.

HamLink itself is the heart of the system. Its design is excellent and reflects some brilliant thinking by the designers. HamLink works with most modern HF rigs in addition to the Kenwood 450. Various easily learned touchtone codes allow remote control of:

- four-digit access code;
- band and frequency changes, either change to a defined frequency or tune up or down;
- mode change, SSB lower or upper, AM/FM, CW, or RTTY;
- VFO selection;
- memories or VFO scan;
- frequency and mode audio announcement;
- push-to-talk that can also be used for CW;
- user-supplied relays to power up the radio and to control antenna tune, antenna selection and rotor control.

We felt the computer was mandatory to log each user and provide audio training lessons. Most of our development time has been in this area. The computer itself is a DOS 286 machine, 640 kb RAM and a 20 mb hard drive. After some study, we purchased the BigmOuth (2) hardware/software voice messaging package. All of us have experienced voice messaging where a computer voice answers the phone and directs us to enter numbers. BigmOuth is such a system and does the following:

- answers the telephone on one ring and greets the user;
- prompts the user to move through several "pages" of instructions on how to use HamLink. The user can repeat all or selected pages as many times as he/she wants;
- if the user needs no training, input of his/her personal access code can be done immediately. We use four digits for simplicity. BigmOuth will support up to six digits if additional security as needed;
- sends ringing signals to HamLink through the serial port followed by the touchtone codes via the telephone line to start it up. These touchtone codes are generated by BigmOuth and are not known by the user;
- logs all the above and hangs up the telephone. HamLink and the Kenwood 450 are now fully operational and are alone on the telephone line with the user. The user can hear the radio



The HamLink system sits on top of the Kenwood 450 at left. The Kenwood at right is for local use.

receiver.

The BigmOuth software itself is powerful but not difficult for a computer-literate person to learn. It allows execution of DOS commands. Getting the computer to control HamLink was rather more interesting.

We needed DOS programs to operate through one of the serial ports for two purposes: provide the ringing signal to start HamLink and recognize a separate signal coming back from HamLink when it is in operation. When the latter signal ceases the computer recognizes the event and logs the end of the QSO.

Finding this software was the most challenging task we had. We knew that modems do it all the time and everyone we talked to agreed it was feasible. However those with the knowledge didn't have the time and those with the time didn't have the knowledge! However, Dave Ogilvie VE3XVR, a computer consultant and himself visually impaired, came to our rescue and wrote the programs.

In parallel with finding computer programs, we had to design how to get the ringing signal into HamLink. Generating the 85-105 volt normal ringing signal seemed a poor idea. John Bishop, VE3JWB, came up with a design for an extra isolator chip to be soldered inside HamLink's ringing circuit. AEA reviewed the design and thought it would work. It did. To avoid conflict, the computer answers on one ring and HamLink answers on two.

Those familiar with Call Display will question why we didn't use it. There is lots of logging software on the market. Briefly, I wanted to do this but the office building we are in has a PBX switch between the ham shack and the outside world that removes the Call Display information.

After much investigation of alternatives with the telephone companies, I gave up, especially when we discovered we could not afford a direct line. In addition, our system design has the advantage of providing audio training lessons.

In the interests of brevity the actual means of controlling the Kenwood 450 from a remote telephone is not covered here. The HamLink manual is complete and explains the methods clearly. We simplified ours considerably so the needed codes can be readily memorized.

OPERATING EXPERIENCE

The computer system works almost flawlessly. HamLink does a good job but is not perfect. Like any piece of equipment, HamLink takes some training. Our experience is that it takes about a week to get used to it. The touchtone buttons cannot be held down too long or too short.

Sometimes HamLink says it doesn't understand, and it responds with three beeps to tell you so. Repeating the instruction usually works. Interestingly enough, sighted people have more trouble than the blind. We sighted people are used to seeing the radio work and have trouble dealing with not being able to see it.

Operating tips are included with the audio instructions in the computer to help users. One specific operating tip is worth mentioning. When one is near a transmitter one can normally recognize it is transmitting by hearing the transmit/receive relay and the cooling fan. With HamLink the only way you know you are transmitting is that you hear silence. It takes some getting used to. Having the computer to start up HamLink is mandatory in our application. We have found that HamLink does not recognize touchtones as well as the computer. This seems to be unique to our location. Others do not have this problem and AEA could not find anything wrong with our HamLink when we returned it for checking. I suspect the PBX switch is the source of the problem. Certainly, when we access HamLink from within the building it works almost flawlessly.

We have several enhancements under consideration:

- filtering and/or amplifying the telephone signal to improve control code recognition;
- adding relays for radio power up, antenna tune, antenna selection and rotor control;
- programming BigmOuth to reset frequency and mode to default settings after each QSO.

FINAL COMMENTS

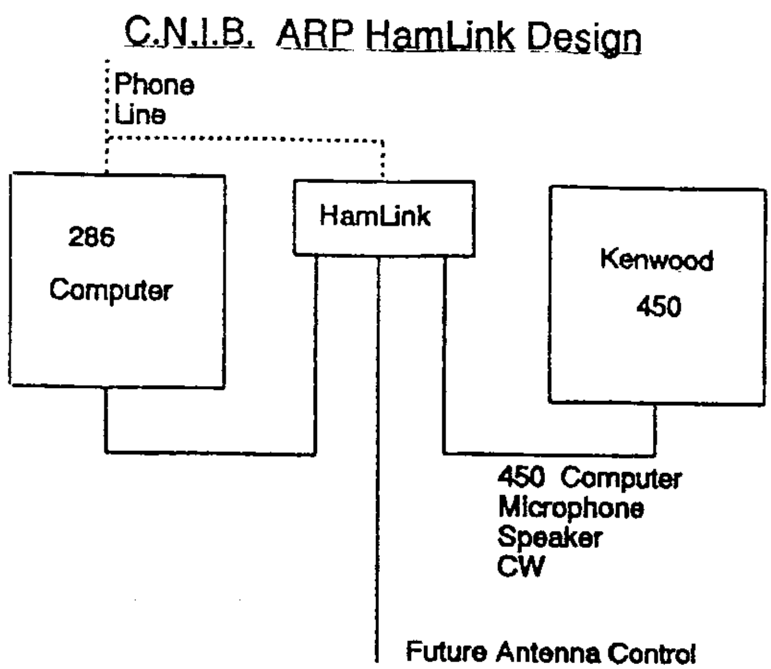
The BigmOuth/HamLink system provides a usable and useful way for the blind to get on the air. It allows remote operation from touchtone phones in the local calling area and indeed can be used from anywhere if the user pays the long distance charges.

Audio training lessons are available and logging for each user is automatic. The system meets all objectives originally defined. If readers wish further details of the computer programs, HamLink modifications, operating instructions etc. in our application, a SASE to the author will result in a response. If an amateur, especially those helping the blind, wants the computer programs please include a formatted 3 1/2 inch disk.

ACKNOWLEDGEMENTS

The author would like to extend his thanks and those of the Amateur Radio Program to the following who have made this system possible:

- AEA Inc. for the donation of HamLink.
- Kenwood Electronics Canada Inc. for modification of the Kenwood 450 to allow access to the antenna tuner control.
- Al Valiunas, VE3VJK, for donation of the 286 computer.
- Skywide Amateur Radio Club for donation of the BigmOuth computer package and advice and help from many members.
- John Bishop, VE3JWB, for design and installation of the isolator chip in HamLink.
- Dave Ogilvie, VE3XVR, for the computer programs.
- Several blind amateurs for their help debugging the system and providing advice.



OPERATION

User dials the computer. BigmOuth answers and voice announces any training the user wants.

User enters own personal access code.

BigmOuth logs the call, starts up HamLink and hangs up.

User shuts down HamLink, computer recognizes, logs the end of the QSO and returns to wait state.

REFERENCES

1. HamLink Model HL-60. Advanced Electronic Applications Inc., P.O. Box C2160, 2006-196th St., SW, Lynnwood, WA 98036.

2. BigmOuth Talking Technology, 1125 Atlantic Ave. Suite 101, Alameda, CA 94501

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George Fanjoy, VE3PEB

George Fanjoy, VE3PEB, graduated from Royal Military College and Queens University in Kingston, ON in 1954 and 1957 respectively in electrical engineering. He retired from Ontario Hydro in 1992 after a career contributing to the operation Ontario's nuclear generating stations. Since 1988, he has been instructing an amateur radio course to blind students in Toronto. Since 1992, he has been a member of the Board of Directors of the CNIB Amateur Radio Program. ♦

Noise

Noise is a serious problem in all radio receivers. Several different types of noise, each characterized by a particular type of sound and by a particular cause, have been given names. Among these are hum, a steady low-frequency note (about two octaves below middle C) commonly produced by the frequency of the alternating-current power supply (usually 60 Hz) becoming impressed onto the signal because of improper filtering or shielding; hiss, a steady high-frequency note; and whistle, a pure high-frequency note produced by unintentional audio-frequency oscillation, or by beats. These noises can be eliminated by proper design and construction. Certain types of noise, however, cannot be eliminated. The most important of these in ordinary AM low-frequency and medium-frequency sets is static, caused by electrical disturbances in the atmosphere. Static may be due to the operation of nearby electrical equipment (such as automobile and airplane engines), but is most often caused by lightning. Radio waves produced by such atmospheric disturbances can travel thousands of kilometers with comparatively little attenuation, and inasmuch as a thunderstorm is almost always occurring somewhere within a few thousand kilometers of any radio receiver, static is almost always present. Static affects FM receivers to a much smaller degree, because the amplitude of the intermediate waves is limited in special circuits before discrimination, and this limiting removes effects of static, which influences the signal only by superimposing a random amplitude modulation on the wave.

Another basic source of noise is thermal agitation of electrons. In any conductor at a temperature higher than absolute zero, electrons are moving about in a random manner. Because any motion of electrons constitutes an electric current, this thermal motion gives rise to noise when amplification is carried too far. Such noise can be avoided if the signal received from the antenna is considerably stronger than the current caused by thermal agitation; in any case, such noise can be minimized by suitable design. A theoretically perfect receiver at ordinary temperatures can receive speech intelligibly when the signal power in the antenna is only 4×10^{-18} W (40 attowatts); in ordinary radio receivers, however, considerably greater signal strength is required.

Power Supply

A radio has no moving parts except the speaker cone, which vibrates within a range of a few thousandths of a cm, and so the only power required to operate the radio is electrical power to force electrons through the various circuits. When radios first came into general use in the 1920s, most were operated by batteries. Although batteries are used widely in portable sets today, a power supply from a power line has advantages, because it permits the designer more freedom in selecting circuit components. If the alternating-current (AC) power supply is 120 V, this current can be led directly to the primary coil of a transformer, and power with the desired voltage can be drawn off as desired from the secondary coils. This secondary current must be rectified and filtered before it can be used because transistors require direct current (DC) for proper operation. Electron tubes require DC for plate current; filaments may be heated either by DC or AC, but in the latter case hum may be created. Transistorized radios do not require as high an operating DC voltage as did tube radios of the past, but power supplies are still needed to convert the AC voltage distributed by utility companies to DC, and to step up or step down the voltage to the required value, using transformers. Airplane and automobile radio sets that operate on 12 to 24 volts DC often contain circuits that convert the available DC voltage to AC, after which the voltage is stepped up or down to the required voltage level and again converted to DC by a rectifier (*see* Rectification). Airplane and automobile radio sets that operate on 6 to 24 volts DC always contain some such device for raising the voltage. The advent of transistors, integrated circuits, and other solid-state electronic devices, which are much smaller in size and require very little power, has today greatly reduced the use of vacuum tubes in radio, television, and other types of communications equipment and devices.

History

Although many discoveries in the field of electricity were necessary to the development of radio, the history of radio really began in 1873, with the publication by the British physicist James Clerk Maxwell of his theory of electromagnetic waves.

Late 19th Century

Maxwell's theory applied primarily to light waves. About 15 years later the German physicist Heinrich Hertz actually generated such waves electrically. He supplied an electric charge to a capacitor, and then short-circuited the capacitor through a spark gap. In the resulting electric discharge the current surged past the neutral point, building up an opposite charge on the capacitor, and then continued to surge back and forth, creating an oscillating electric discharge in the form of a spark. Some of the energy of this oscillation was radiated from the spark gap in the form of electromagnetic waves. Hertz measured several of the properties of these so-called Hertzian waves, including their wavelength and velocity.

The concept of using electromagnetic waves for the transmission of messages from one point to another was not new; the heliograph, for example, successfully transmitted messages via a beam of light rays, which could be modulated by means of a shutter to carry signals in the form of the dots and dashes of the Morse code (*see* Morse Code, International). Radio has many advantages over light for this purpose, but these advantages were not immediately apparent. Radio waves, for example, can travel enormous distances; but microwaves (which Hertz used) cannot. Radio waves can be enormously attenuated and still be received, amplified, and detected; but good amplifiers were not available until the development of electron tubes. Although considerable progress was made in radiotelegraphy (for example, transatlantic communication was established in 1901), radiotelephony might never have become practical without the development of electronics. Historically, developments in radio and in electronics have been interdependent.

To detect the presence of electromagnetic radiation, Hertz used a loop of wire somewhat similar to a wire antenna. At about the same time the Anglo-American inventor David Edward Hughes discovered that a loose contact between a steel point and a carbon block would not conduct current, but that if electromagnetic waves were passed through the junction point, it conducted well. In 1879 Hughes demonstrated the reception of radio signals from a spark transmitter located some hundreds of meters away. In these experiments he conducted a current from a voltaic cell through a glass tube filled loosely with zinc and silver filings, which cohered when radio waves impinged on it. The principle was used by the British physicist Sir Oliver Joseph Lodge, in a device called the coherer, to detect the presence of radio waves. The coherer, after becoming conductive, could again be made resistant by tapping it, causing the metal particles to separate. Although far more sensitive than a wire loop in the absence of an amplifier, the coherer gave only a single response to sufficiently strong radio waves of varying intensities, and could thus be used for telegraphy but not for telephony.

The Italian electrical engineer and inventor Guglielmo Marconi is generally credited with being the inventor of radio. Starting in 1895 he developed an improved coherer and connected it to a rudimentary form of antenna, with its lower end grounded. He also developed improved spark oscillators, connected to crude antennas. The transmitter was modulated with an ordinary telegraph key. The coherer at the receiver actuated a telegraphic instrument through a relay, which functioned as a crude amplifier. In 1896 he transmitted signals for a distance exceeding 1.6 km (more than 1 mi), and applied for his first British patent. In 1897 he transmitted signals from shore to a ship at sea 29 km (18 mi) away. In 1899 he established commercial communication between England and France that operated in all types of weather; early in 1901 he sent signals 322 km (200 mi), and later in the same year succeeded in sending a single letter across the Atlantic Ocean. In 1902 messages were regularly sent across the Atlantic, and by 1905 many ships were using radio for communications with shore stations. For his pioneer work in the field of wireless telegraphy, Marconi shared the 1909 Nobel Prize in physics with the German physicist Karl Ferdinand Braun.

During this time various technical improvements were being made. Tank circuits, containing inductance and capacitance, were used for tuning. Antennas were improved, and their directional properties were discovered and used. Transformers were used to increase the voltage sent to the antenna. Other detectors were developed to supplement the coherer with its clumsy tapper; among these were a magnetic detector that depended on the ability of radio waves to demagnetize steel wires; a bolometer that measured the rise in temperature of a fine wire when radio waves are passed through the wire; and the so-called Fleming valve, the forerunner of the thermionic tube, or vacuum tube.

20th Century

The modern vacuum tube traces its development to the discovery made by the American inventor Thomas Alva Edison that a current will flow between the hot filament of an incandescent lamp and another electrode placed in the same lamp, and that this current will flow in only one direction. The Fleming valve was not essentially different from Edison's tube. It was developed by the British physicist and electrical engineer John Ambrose Fleming in 1904 and was the first of the diodes, or two-element tubes, used in radios. This tube was then used as a detector, rectifier, and limiter. A revolutionary advance, which made possible the science of electronics, occurred in 1906 when the American inventor Lee De Forest mounted a third element, the grid, between the filament and cathode of a vacuum tube. De Forest's tube, which he called an audion but which is now called a triode (three-element tube), was first used only as a detector, but its potentialities as an amplifier and oscillator were soon developed, and by 1915 wireless telephony had developed to such a point that communication was established between Virginia and Hawaii and between Virginia and Paris.

The rectifying properties of crystals were discovered in 1912 by the American electrical engineer and inventor Greenleaf Whittier Pickard, who pointed out that crystals can be used as detectors. This discovery gave rise to the so-called crystal sets popular about 1920. In 1912 the American electrical engineer Edwin Howard Armstrong discovered the regenerative circuit, by which part of the output of a tube is fed back to the same tube.

This and certain other discoveries by Armstrong form the basis of many circuits in modern radio sets.

In 1902 the American electrical engineer Arthur Edwin Kennelly and the British physicist and electrician Oliver Heaviside, independently and almost simultaneously, announced the probable existence of a layer of ionized gas high in the atmosphere that affects the propagation of radio waves. This layer, formerly called the Heaviside or Kennelly-Heaviside layer, is one of several layers in the ionosphere. Although the ionosphere is transparent to the shortest radio wavelengths, it bends or reflects the longer waves. Because of this reflection, radio waves can be propagated far beyond the horizon. Propagation of radio waves in the ionosphere is strongly affected by time of day, season, and sunspot activity. Slight variations in the nature and altitude of the ionosphere, which can occur rapidly, can affect the quality of long-distance reception. The ionosphere is also responsible for skip, the reception at a considerable distance of a signal that cannot be received at a closer point. This phenomenon occurs when the ground ray has been absorbed by the intervening ground and the ionospherically propagated ray is not reflected at an angle sufficiently steep to be received at short distances from the antenna.

Short-wave Radio

Although parts of the various radio bands—short-wave, long-wave, medium-wave, very-high frequency, and ultrahigh frequency—are allocated for a variety of purposes, the term *short-wave radio* generally refers to radiobroadcasts in the high-frequency range (3 to 30 MHz) beamed for long distances, especially in international communication. Microwave communication via satellite, however, provides signals with superior reliability and freedom from error.

Amateur, or "ham," radio is also commonly thought of as short-wave, although amateur operators have been allotted frequencies in the medium-wave band, the very-high-frequency band, and the ultrahigh-frequency band as well as the short-wave band. Certain of these frequencies have restrictions designed to make them available to maximum numbers of users.

During the rapid development of radio after World War I, amateur operators executed such spectacular feats as the first transatlantic radio contact (1921). They have also provided valuable voluntary assistance during emergencies when normal communications are disrupted. Amateur radio organizations have launched a number of satellites piggyback with regular launches by the United States, the former Soviet Union, and the European Space Agency. These satellites are usually called Oscar, for Orbiting Satellites Carrying Amateur Radio. The first, *Oscar 1,* orbited in 1961, was also the first nongovernmental satellite; the fourth, in 1965, provided the first direct-satellite communications between the U.S. and the Soviet Union. More than 1.5 million people worldwide were licensed amateur radio operators in the early 1980s. *See also* Citizens Band Radio.

Radio Today

Immense developments in radio communication technology after World War II helped make possible space exploration, most dramatically in the Apollo moon-landing missions (1969-72). Sophisticated transmitting and receiving equipment was part of the compact, very-high-frequency, communication system on board the command modules and the lunar modules. The system performed voice and ranging functions simultaneously, calculating the distance between the two vehicles by measuring the time lapse between the transmission of tones and the reception of the returns. The voice signals of the astronauts were also transmitted simultaneously around the world by a communications network. (article taken from encarta)

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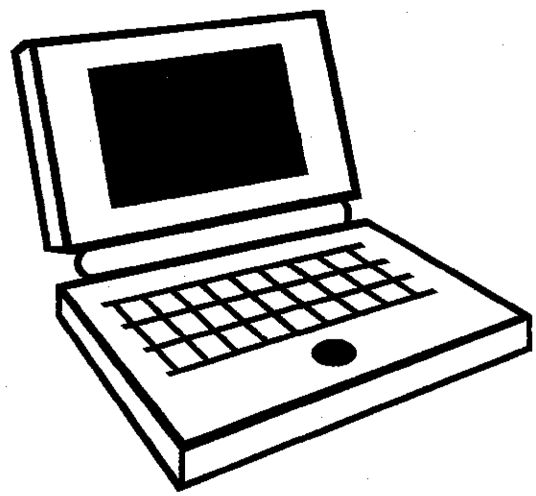

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