The Radio Collector®

Combined
January-February, 1996
March-April, 1996

Classic Receiver Circuits
Part 1 - The Crystal Detector

In this series of articles, we'll be looking, stage by stage, at the development of the basic circuits of a radio receiver. We won't be going back to look at the circuits that were in use during the earliest days of radio communications. Instead, we'll pick up the story with the technology that was in use during the dawn of public broadcasting. And we'll start by taking a look at the evolution of the circuit, that is really at the heart of a radio receiver--the detector.

Most people date the beginnings of broadcasting from the year 1920, when Pittsburgh's station KDKA reported the Harding-Cox presidential election returns. Back then, before mass production made radio tubes affordable and generally available, the family radio was likely to be a crystal set. The wonderful thing about the crystal set, and the thing that captured the imagination of experimenters long after this mode of reception became obsolete, was that it required no power source.

What a Detector Does

The operation of the early crystal sets depended on the ability of certain mineral crystals to *detect* AM radio signals. To understand what a radio detector does, you first need to know a little bit about the AM radio signal. The wave form of such a signal is crudely represented in "a" of Fig. 1. The horizontal line, located at the zero voltage axis of the wave, represents the passage of time. The regularly spaced vertical lines represent the rapid oscillations of the radio frequency "carrier" generated by the broadcast station's transmitter. Notice that they change direction cyclically, swinging above and below the zero axis.

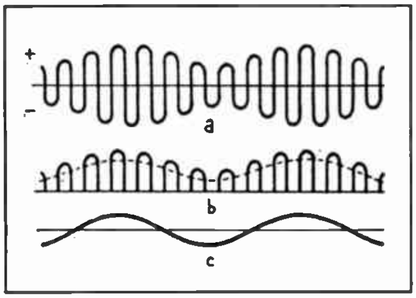

Fig. 1. Simplified waveforms illustrating the detection process.

The slower "undulations" of the audio signal being transmitted by the station are superimposed on the carrier. The superimposition of the audio signal on the radio signal is carried out by a process called *modulation*. Notice that every variation of the audio wave above the zero axis is mirrored by a similar variation of opposite polarity below the axis, a phenomenon inherent in the modulation process.

Detecting a radio transmission means separating the audio information from the radio frequency carrier. But only one of the two "mirror image" audio signals is wanted. Otherwise, every audio variation *above* the zero axis would be matched by a variation of equal amount and opposite polarity *below* the zero axis. The result would be cancellation of the audio; no sound would be heard.

Very early in the development of radio technology, it was discovered that the crystalline forms of some minerals could act as *rectifiers*, allowing current to pass through them in one direction but not in the other. Among the minerals having these properties are magnetite, carbon, molybdenum and galena (lead ore). When a received radio signal is passed through one of these minerals, the result is a waveform similar to "b" of Fig. 1. Note that the half of the signal below the zero axis has been suppressed, eliminating one of the "mirror images."

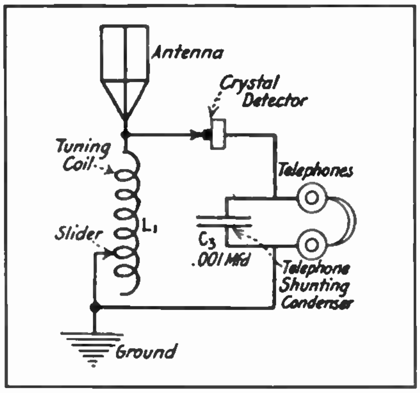

Fig. 2. Schematic of simple crystal set.

In today's terms we'd call the crystal a "semiconductor diode." Using it as a detector to extract the audio signal from the radio carrier was certainly about the first application of solid state technology.

A Simple Crystal Receiver

A very simple receiver utilizing a crystal detector, taken from a vintage hobby publication, is shown in Fig. 2. Notice that the signal selected by the tuning coil and slider arrangement must pass through the crystal detector before reaching the headphones. A lead ore (galena) crystal was most commonly used for this application.

The capacitor across the headphones (labeled "telephone shunting condenser") has the effect of filtering out the rapid radio frequency variations of

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the carrier while leaving the slower impressed audio variations unaffected. The result ("c" in Fig. 1) is a reproduction of the original audio signal used to modulate the carrier at the radio station. In even simpler circuits, the "shunting condenser" is eliminated; its role being played by the inherent capacitance of the headphone cord and the windings of the headphone coils.

To make it suitable for use as a crystal detector, the little mineral fragment first had to be mounted. Typically this was done by placing it in a small cylindrical mold and pouring a molten low-melting-point metal alloy around it. A little bit of the top of the mineral was left open for connection to the circuit.

The mounted mineral was then placed in a cup-like holder in a fixture called a detector stand. Also part of the stand was an adjustable arm on a ball-joint or other type of swivel mount. Fitted at the end of the arm was a springy wire tip, usually referred to as "the cat's whisker," for making contact with the surface of the mineral. The stand was equipped with Fahnestock clips or binding posts for connecting the arm and crystal holder into the radio circuit.

In practice, the radio listener touched the surface of the crystal at various points, looking for a spot that yielded the loudest signals. The adjustment was a tricky one, and usually did not remain stable. Even the slightest jarring of the radio table could cause the volume to plummet, whereupon the listener would have to search for a new "hot spot."

A Brief Heyday

Because of their simple construction, home-made crystal sets were very popular. And many a neighborhood tinkerer acquired god-like stature among friends and acquaintances

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FROM THE EDITOR

Regretfully, it is again necessary to begin an issue with an apology! An increase in the consulting business that brings in our basic family income, coupled with my new duties as editor of AWA's *Old-Timer's Bulletin*, have conspired to delay, once more, the production of *The Radio Collector*.

In order to catch up, I've decided to make this a double issue, combining the January/February and March/April issues. As you browse the 20 pages, you will find that all of the regular features and columns are either double length or appear in two separate installments. In this way, you'll receive all of the material that would have come your way in the two separate issues and I'll get a bit of breathing space!

Of course it's not feasible to give you two sets of back page ads, so I plan to use the extra space to provide, for the first time, an index of the articles and columns in all the RC issues released to date. All of these issues are (so far) still in stock. Those of you who don't have a full set might want to consider filling out your collection now! -- **MFE**

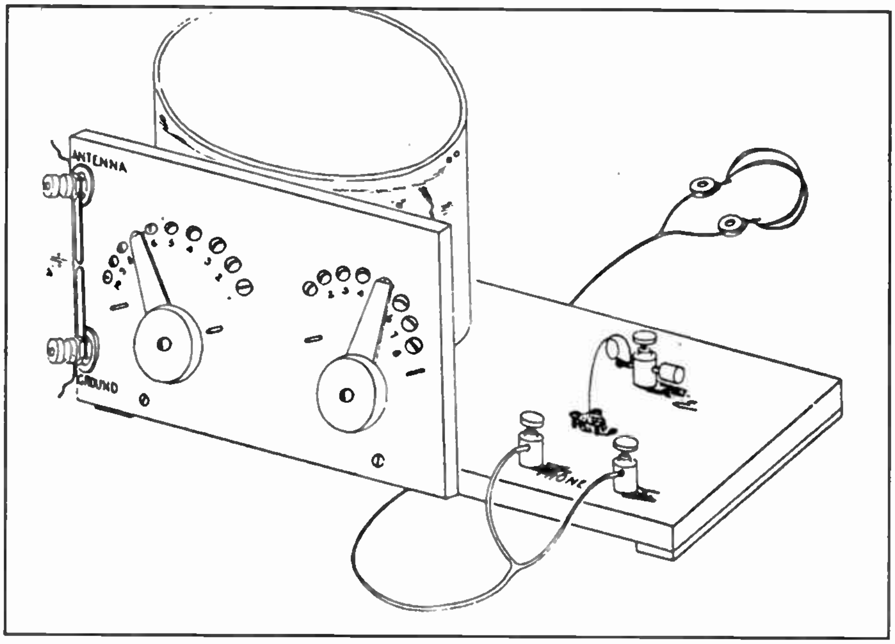

Fig. 3. Starter set designed by NBS sparked the radio broadcasting industry.

PLAY IT AGAIN!

A No-Nonsense Course in Radio History, Evolution and Repair

THE SUPERHETERODYNE: OSCILLATOR AND MIXER STAGES

The operation of the superheterodyne (superhet) receiver is based on the fact that two frequencies mixed together in a non-linear circuit produce two new frequencies equal to the sum and difference between the original frequencies. The new frequencies are called heterodynes or beat frequencies. Superhet receivers use the difference frequency, called the intermediate frequency (IF).

R.A. Fessenden used this principle to make continuous wave signals audible prior to World War I and coined the word "heterodyne" to describe the process. During World War I, E.H. Armstrong developed the principle into the superheterodyne receiving system and sold his patents to Westinghouse.

When Westinghouse joined RCA, it contributed the Armstrong regeneration and superhet patents. The first superhet sold was the RCA Model AR-812 in 1924. RCA used the superhet circuit only for their top-of-the-line models. They vigorously prosecuted others who tried to market superhets and refused to license anyone until forced to by the antitrust settlement of 1930. Beginning in 1931, the superhet quickly displaced all other circuits because its sensitivity and selectivity far exceeded that of the best TRF or Neutrodyne.

The Oscillator Stage

The superheterodyne contains an oscillator as part of the receiver. Tuning of the incoming station and oscillator signals is synchronized to maintain a constant frequency difference between them. These two signals are mixed together and the difference, or *intermediate,* frequency is fed to an amplifier tuned to the that frequency. Since the intemediate frequency amplifier works at only one frequency, it can be very selective and have extremely high gain.

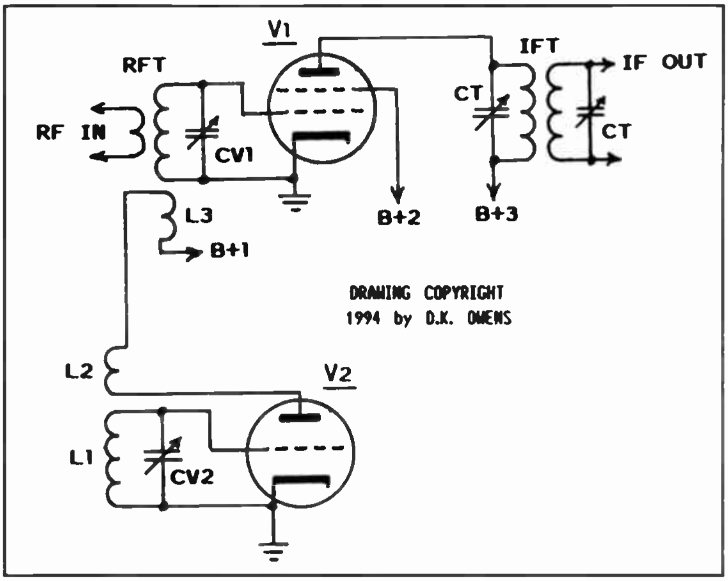

Fig. 1. "Bare-Bones" schematic of early oscillator and mixer stages.

We can generate the IF by operating the oscillator either above or below the station frequency. Designers preferred to operate above the station frequency. Thus, to receive WLW at 700 kHz with an IF of 455 kHz, the oscillator operates at 1155 kHz. There is also a 455 kHz difference with a station at 1610 kHz, but even one stage of RF tuning easily separates 700 from 1610 kHz. This spurious response at twice the IF is called an image.

The Mixer stage

A "bare-bones" diagram of an early oscillator-mixer circuit is shown in Fig. 1. Only the essentials are shown, so don't try to use this diagram for servicing; there are too many variations. V1 is a typical screen-grid RF amplifier operating on the non-linear portion of the plate curve. V2 is a standard "tickler-coil" oscillator resembling a regenerative detector. The RF transformer, RFT, has a third winding, L3, which couples the oscillator signal into the grid circuit of V1 where it mixes with the incoming station frequency. Four frequencies appear at the plate of V1: the station, the oscillator, the sum and the difference (IF). The IF transformer, IFT, is tuned to the IF with trimmers, CT, and rejects the other frequencies. Variable capacitors CV1 and CV2 tune the incoming station and oscillator respectively. They are ganged together on a common shaft and trimmed so as to maintain a constant frequency difference. Old texts refer to V1 used this way as the "first detector".

The Pentagrid Converter

In 1934 the oscillator and mixer were combined into a single tube called a pentagrid converter (2A7, 6A7). A typical circuit is shown in Fig. 2. The circuit is still a "tickler-coil" oscillator. Numbered from the cathode, grid 1 is the oscillator grid. Grid 2 acts as the oscillator plate while allowing the electron stream to pass through. Grids 3 and 5 are connected together internally to form the screen grid which is always bypassed to ground for RF. Between them is grid 4, the control or signal grid. This configuration shields the control grid to prevent interaction between the signal and oscillator sections. Mixing occurs in the electron stream as it is modulated both by the oscillator and the signal. To avoid loading the oscillator grid, it is coupled to the tuned circuit through C (~50 pF) and returned to

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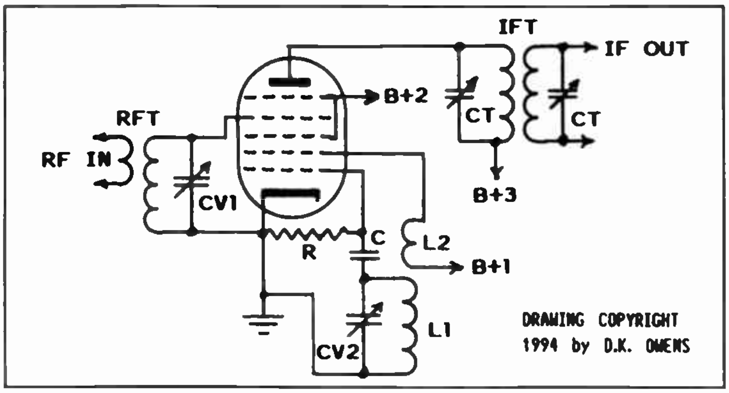

Fig. 2. Simplified circuit of a typical pentagrid converter.

CLASSIC RECEIVER CIRCUITS

Part 2 - Grid Leak and Regenerative Detectors

During most of the 1920's, the radio most likely to be found in the family living room was a battery-powered vacuum tube set. And virtually every one of these radios used a *grid-leak* detector. Regenerative detectors, to be considered separately later on in this article, also work on the grid-leak principle. To many hobbyists, the working of this widely-used circuit and the meaning of its colorful name remains a mystery. We'll try to throw some light on it here.

For a review of what a detector must accomplish in a radio receiver, review the discussion of the detection process in "Crystal Detectors" (Part 1 of this series). Now we'll take a look at how the grid-leak detector does this job. Refer to the vintage receiver circuit in Fig. 1. When no signal is present on the grid of the tube, a steady stream of electrons (which are negatively-charged particles) is emitted by the filament. That electron stream flows, unimpeded, past the grid and is attracted to the positively charged plate (it is a basic law of physics that there is an attraction between oppositely-charged bodies and a repulsion between bodies of the same charge).

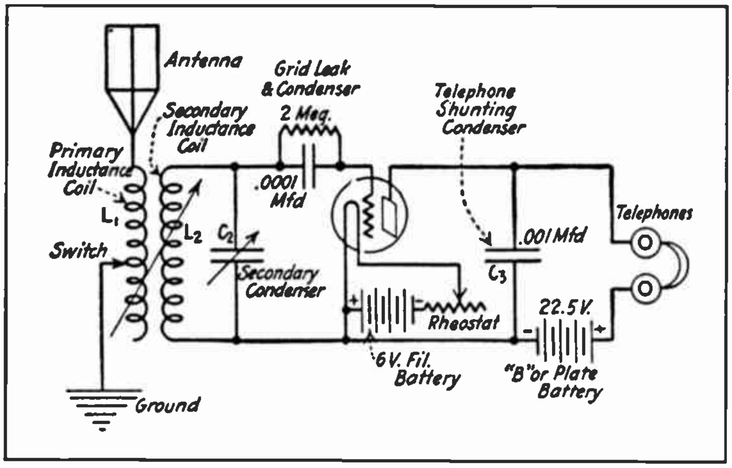

Fig. 1. Vintage schematic diagram of simple grid leak detector circuit.

Now let's see what happens when a modulated radio signal (Fig. 1a of Part 1) is picked up by the receiver. The signal appears across the tuning capacitor (labeled "Secondary Condenser" on the schematic). Note that the upper end of the capacitor is connected to the grid of the tube via the paralleled grid leak resistor and capacitor (labeled "grid leak & condenser").

Trapping the electrons

As you know from part 1, the radio signal becomes alternately positive and negative over time. When the upper end of the tuning capacitor is positive, the electrons emitted by the filament are attracted to it and flow towards it. Of course they are prevented from reaching that point of the circuit by the insulating material between the plates of the grid capacitor. (The grid leak resistor has a very high value--on the order of a few million ohms, so the electrons cannot readily flow through it.)

When the upper end of the tuning capacitor becomes negative, the electrons that had previous been attracted toward it are now repulsed. But they can't re-enter the electron stream flowing in the tube because that has a negative charge and also repulses them. Hence they are trapped on the right plate of the grid leak capacitor. When the signal becomes positive again, more electrons pile up--and are trapped on--the right plate of the grid-leak capacitor.

Rectification and Filtering

If the grid-leak resistor were not present, the number of "trapped" electrons would continue to build up, giving the grid a strong enough negative charge to repel all of the electrons being emitted by the filament. With no electrons reaching the plate, the tube would stop functioning. However, the excess electrons slowly "leak" through the grid leak resistor and, passing through the "Secondary Inductance Coil," return to the positive side of the filament circuit.

The current passing through the grid resistor moves in one direction only: from grid to filament. It is direct current, and constitutes the "rectified" or "detected" radio signal. The strength of this current at any given time represents the strength of the original radio wave as modulated by the audio signal being carried. If it were not for the grid capacitor and "Telephone Shunting Condenser," the current would still have the high frequency oscillations of the radio carrier superimposed on it as in Part 1, Fig. 1b. However, these capacitors tend to filter out the oscillations (see explanation in part 1), so the signal looks like Part 1, Fig. 1c and is a reproduction of the original audio signal used to modulate the carrier.

Besides separating the audio signal from the radio frequency carrier, the tube also functions as an audio amplifier. The small current variations in the grid circuit control the much larger current flowing through the earphones in the pate circuit, causing that current to vary in a matching pattern. The result is a much stronger audio signal, giving comfortable headphone volume.

Regeneration

Many sets of the 1920's were *regenerative*. The regenerative design, invented by the legendary radio genius Edwin Armstrong, squeezed an amazing amount of performance out of a single tube. The secret lay in the fact that some of the signal coming out of the detector tube was fed back into it. This feedback arrangement meant that the radio signal was amplified over and over again, resulting in tremendous gain.

The schematic diagram of a simple regenerative receiver is shown as Fig. 2. An arrow joining a set of coils means that the coils can be adjusted so that they are closer together or farther apart. The circuit looks very similar to that of Fig. 1 except for an additional coil: the *Tickler Coil*. Energy from the output (plate circuit) of the tube flows through it and, when this coil is close to the *Secondary Inductance Coil*, the energy is fed back to the tube's input (grid circuit). The

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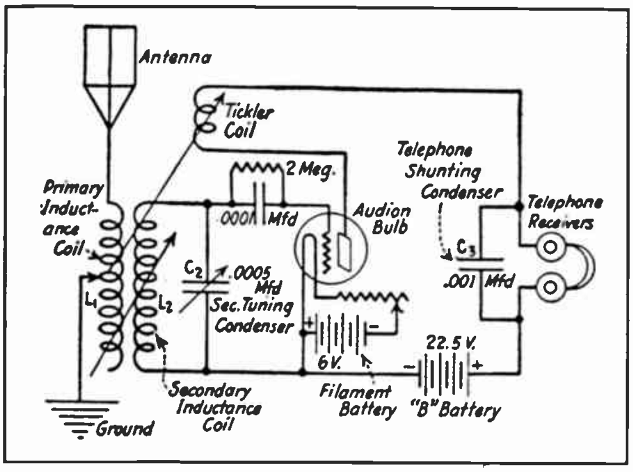

Fig. 2. Tickler coil initiates regeneration by feeding part of the signal at the plate of the tube back to the grid.

PLAY IT AGAIN!

A No-Nonsense Course in Radio History, Evolution and Repair

THE SUPERHETERODYNE: IF AMPLIFIER, DETECTOR, AND AVC

The IF Amplifier

Last time we learned how the superhet converts the incoming station frequency to an intermediate frequency (IF). The IF is then fed to the circuit of Fig. 1A (left of the dotted line) for amplification. This is a straightforward RF amplifier with one exception: it is tuned to a single frequency, the IF, by the trimmers, CT. With 4 tuned circuits, this amplifier is very selective and rejects all frequencies but the IF. The grid is returned to the AVC bus instead of ground. Ignore that for the moment; I'll explain it later. One IF stage is normally sufficient for the AM band, although expensive sets sometimes had 2. Designing more than 2 IF stages is very difficult. Only makers like Scott used more than 2. V1 is a remote cutoff (super control) pentode used for its ability to handle a wide range of signal strength without overloading.

The grid-leak detector reigned supreme until ~1929 when the high-gain screen grid tube made the "power" or "plate" detector practical. This detector consists of a tetrode biased almost to cutoff so that it doesn't respond to the negative cycle of the RF wave. This non-linearity makes it a rectifier. Its advantage is its large output requiring less subsequent amplification. Both types of detector suffer from high distortion and inability to handle strong signals.

Detector Circuits

Around 1930, designers resurrected the diode detector. It can handle large signals with low distortion, but won't amplify like the other detectors. There had been no diode tube since the days of Fleming, so designers tied the grid and plate of a triode together to make a diode. They also realized that, unlike other detectors, the diode produces a DC voltage proportional to signal strength which can be used for gain control. The tube industry responded in 1932 with the Type 55 which combined a pair of diodes and a triode amplifier in one tube. The diodes and triode shared a common cathode. The circuit of Fig. 1B immediately became popular. Note that Figs. 1A and 1B connect together as shown by the arrows.

The diode detector functions the same as we learned earlier. The IF transformer output goes to the diode plates which are tied together as a half-wave rectifier. As with any rectifier, the cathode is positive and the bottom of the coil winding is negative. A negative DC voltage modulated by the audio appears at this point. C2 blocks the DC component, but passes the audio to the volume control, VC. From VC the audio goes to the grid of the triode section for amplification. R2 provides self-bias for the triode. The audio signal also appears on the cathode and must be bypassed to ground with C3 which is in the range of 8-10 μF. If your set plays at fair volume even with the volume control turned all the way down, check C3. If it is open or dried out, it will cause this condition. R3 is the diode load resistor.

Automatic Volume Control

The negative voltage at the bottom of the IFT winding still has an RF component which is filtered out by C4. The audio pulsations are filtered out by R1 and C1. The filtered DC which varies with signal strength is used to bias the grid of the IF amplifier. A strong signal results in a larger negative voltage which reduces the gain of the IF amplifier. This process was named "automatic volume control" (AVC) by Philco who is credited with first using it in the Model 95 of 1930. If C1 is open, the set may squeal due to RF feedback. If it is shorted, there will be no voltage on the AVC bus.

AVC doesn't mean you never have to touch the volume control. The action is not perfect, but it's a vast improvement over sets without AVC. The control is sufficient to keep strong stations from blasting out when you tune across them, and AVC will compensate for slow fading. Note that the AVC bus is shown continuing to other stages. In sets without an RF amplifier (the antenna goes directly into the mixer/converter), the mixer/converter is normally under AVC. If there is an RF amplifier, it is put under AVC, but the mixer/converter normally is not. The mixer/converter performs better if its voltages do not vary. Only more expensive sets have RF amplifiers.

Many circuit and tube developments in the 1930's were the result of economic pressures. The Great Depression drastically reduced the public's disposable income. To stay alive, the radio industry had to cut costs and selling prices without sacrificing the performance which the radio listener had come to expect. Use of the superhet circuit and the development of multi-function tubes like the pentagrid converter and the diode-triode cut costs by reducing tube and parts count while maintaining set performance.

Further cost reductions were achieved by eliminating the audio and power transformers. Next time we will study resistance coupled amplifiers and the AC/DC set.

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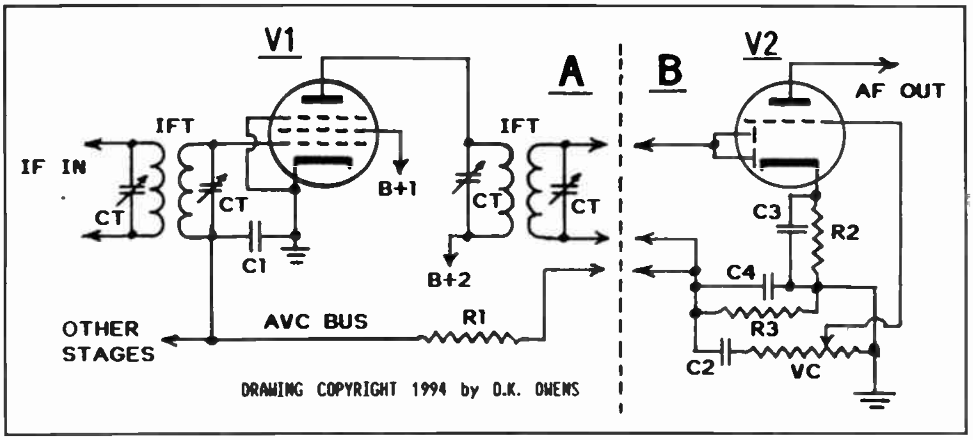

Fig. 1. Signal from IF amplifier (V1) is fed to detector/ AF amplifier (V2).

Ken will be happy to correspond directly with readers who have questions about radio theory or repair. Please include a long SASE with your query.

THE EARLY DEVELOPMENT OF WIRELESS COMMUNICATION

Part III: Why Marconi Was Successful

By Leonid N. Kryzhanovsky and James P. Rybak

The achievements of Heinrich Hertz, Oliver Lodge, and Alexander Popov, together with the early work of Guglielmo Marconi, were discussed in Parts 1 and 2 of this article. In addition, some reasons were given concerning why Hertz, Lodge, and Popov did not develop practical wireless telegraphy systems.

The work which made possible Marconi's 1901 trans-Atlantic transmission is discussed in this concluding installment. Some of the principal reasons for Marconi's successes as well as some interesting information concerning the "official" view of the former Soviet Union concerning the work of Popov also are presented.

Marconi's Commercial Interests.

In contrast to Popov and Lodge, Marconi immediately decided to pursue the commercial applications of his wireless experiments. Marconi's achievements were indeed impressive. As early as September of 1896, he had transmitted and detected signals over a distance of 2.8 kilometers. In comparison, it was April of 1897 before Popov had succeeded in signaling over a distance of 1 kilometer. (Some sources report the distance as 1.5 kilometers.) By March of 1897, Marconi had succeeded in transmitting and detecting signals over a distance of 7.5 kilometers and by May of that year he had increased the distance to 14 kilometers. Intent on pursuing the commercial applications of wireless telegraphy, Marconi established "The Wireless Telegraph and Signal Co., Ltd." (later to become "The Marconi Wireless Telegraph Co., Ltd.") in July of 1897.

Early Marine Tests

Marconi's goal was to demonstrate that wireless telegraphy could be used to communicate with ships. He returned home to Italy in 1897 where he demonstrated very convincingly that wireless could be used to communicate between a land station and ships as far away as 18 kilometers, even when the ships were below the horizon. By the end of that year, he also demonstrated that a wireless station located on the Isle of Wight in the English Channel could communicate reliably with ships to a distance of 30 kilometers.

On March 27, 1899, Marconi showed that wireless could be used to establish a communications link between England and the European Continent when he sent a message from a station he had built at Wimereux in France to his English station at South Foreland. The distance between the two stations was 50 kilometers.

In the summer of that same year, the British Navy invited Marconi to install and operate wireless stations on three warships engaged in naval maneuvers. Signals from a land based station were received to a distance of 160 kilometers while signals between two ships were exchanged reliably to a distance of 110 kilometers and occasionally to 136 kilometers. Not only did these tests show that wireless telegraphy was vital to modern fleets, it now was unquestionably clear that wireless signals could be received at great distances beyond the horizon.

Tuning

The transmitters and receivers used by Marconi at that time lacked any sort of effective tuning. What was needed was some way to enable the transmitters to generate only one frequency and to enable the receiving stations to respond only to the signals desired. Otherwise, hopeless interference occurred when two or more transmitters were operating simultaneously.

Marconi was aware of, and refined, some of the tuning or "syntony" principles which Oliver Lodge had demonstrated as early as 1889 and which Lodge had improved and patented in 1897. Lodge's tuning system, like Marconi's early attempts, provided only a moderate amount of selectivity.

Experimentation by Marconi directed toward achieving increased tuning continued. By 1900, Marconi had developed an effective aerial coupling circuit which featured a tapped inductor together with a capacitor which could be varied. Marconi's system provided for tuning both the oscillator circuit in the transmitter and the coherer circuit in the receiver.

The Trans-Atlantic Test

Marconi still believed that the shipping industry would provide the first significant commercial market for wireless telegraphy. In 1900, he told the directors of his newly formed "Marconi International Marine Communication Company" that he wanted to build two high power wireless stations with the goal of having signals span the Atlantic Ocean. Marconi was convinced that trans-Atlantic signalling would be possible if sufficient transmitter power were used.

Before long, Marconi altered his plans and settled on attempting one way trans-Atlantic signalling between a transmitting station he was building at Poldhu, on the southwestern tip of England, and a receiving station in Newfoundland, the closest North American land mass. He employed John Ambrose Fleming to design the high power transmitter needed.

Marconi and two assistants sailed for Newfoundland in November of 1901 to locate a suitable reception site and to set up the necessary receiving equipment. The Poldhu station was instructed by cable message to have its Fleming-designed 25 kilowatt transmitter send the letter "S" in Morse Code continuously for several hours each day beginning on December 11.

On the afternoon of December 12, 1901, Marconi heard the faint but unmistakable repetitive sound of three clicks followed by a pause on three separate occasions. It was clear to Marconi that his goal of establishing a worldwide system of wireless communications now was attainable. However, it would require six additional years of experimentation and development until the first reliable commercial trans-Atlantic communications system was established between Clifden, Ireland and Glace Bay, Nova Scotia in Canada.

Marconi's Contribution

It should be noted that Marconi, himself, "invented" or "discovered" relatively few things in his early work. Basically, he initially used Righi's transmitter, Branly's coherer, Lodge's resonant circuits, as well as the grounded vertical aerial suggested by Nikola Tesla (1856-1943) and others. Marconi did, however, make numerous very important improvements to each of these elements of his wireless system. He had the necessary ability to "make things work" thanks not only to his talent but also to his single-purposed devotion to the idea of using Hertzian waves for long distance communication.

To the general public, however, Marconi's name soon became associated with *all* aspects of the "invention" of wireless. The reason for this is simple. The "world" typically gives its acclaim to those who produce exciting results which it (the "world") can understand.

The "world" did not understand what Maxwell, Hertz, Lodge, Popov, and others had done because most of their achievements were of interest largely to scientists, and these achievements had not been widely publicized in the non-scientific press. In contrast, the "world" could easily understand what Marconi had accomplished because the basic concept (signalling at a distance) was simple and Marconi had made sure that his achievements were well publicized. Consequently, Marconi received virtually all of the popular acclaim for having "invented" wireless telegraphy. However, Marconi himself believed that the priority for "the whole theory, or all practical applications, or all the instruments" of wireless cannot be attributed to only one person.

Additional Reasons for Marconi's Successes

Both Marconi and Popov wanted to use electromagnetic waves for wireless signalling. What reasons, in addition to those already mentioned, likely were responsible for the differences in their levels of success?

Thanks to his successful demonstrations for officials of the British Post Office and Admiralty, which had been arranged by Preece, Marconi had obtained financial and engineering support from British authorities in 1896 (later on, he also obtained support from the Italian government). The Russian Ministry of Navy, on the other hand, did not support Popov until the summer of 1897. If one wishes to compare Popov's and Marconi's achievements, one must also take into account the socio-economic background in both Russia and England at that time. The development of a new technology such as radio did not, and could not, take place as rapidly in Russia as it did in England, an industrial leader.

Giving Credit Where Credit is Due

Lodge was the first to demonstrate a receiver which could have been used as part of a wireless signalling system. At the time, Lodge did not publish the technical details of his equipment. The publication priority for a workable receiver which was used not only for limited distance wireless signalling experiments but also for meteorologic purposes belongs to Popov. In addition, Popov's lightning recorder may be regarded as the world's earliest applied radio-engineering apparatus designed for practical applications resulting from the detection of electromagnetic waves. (It was used for purposes other than wireless communication, however.) Marconi, of course, received the first patent for wireless equipment and achieved the first truly practical long distance wireless telegraphy system.

There have been controversies concerning the priority of the "invention" of radio for almost a century. Any attempt to identify only one to whom all the credit should be given is incorrect, however, as pointed out in Part 1 of this article. It also should be noted that the "struggle" for establishing the priority of invention for propaganda purposes typically is characteristic of totalitarian states. Thus, Mussolini's fascist regime presented radio as an "Italian invention," and concurrently with exalting Marconi's accomplishments, the "invention" of the coherer was attributed by that regime to the noted Italian physicist T. Calzecchi-Onesti (1853-1922).

Similarly, in Russia (and later the U.S.S.R.) after the turn of the century, Popov became known as *the* "inventor" of wireless telegraphy (in more recent times, he has been called the "inventor" of radio or of radio communication). Interestingly, even in the early days of this century, not everyone in Russia shared this viewpoint of Popov's achievements. It is also important to note that Popov himself never claimed that title.

In 1908 D. Sokoltsov, an instructor at the Military Electrotechnical School, called the popular Russian version of the invention of wireless (by Popov) an "old patriotic tale." Under Stalin's rule, however, the popular Russian version of events became canonical. Everyone in the U.S.S.R. writing or speaking on the history of wireless was expected to adhere to the official version of "history." Any deviations from it were dangerous in the Soviet era.

Thus, when Matvey Bronstein (1906-1938), a young Leningrad scientist and science writer, refused to "correct" his brochure entitled *The Inventors of Wireless Telegraphy*, he was asking for serious trouble. Even the title of his work ran counter to the official version, i.e., the single-handed invention of wireless by Popov. Eventually, Bronstein's book, which was on the verge of publication, and Bronstein himself were destroyed (he was shot down in the basement of a Leningrad prison).

The risks associated with deviating from the official Soviet version of history did not end with Stalin, however. There also was a case known to one of the authors where the editor-in-chief of an engineering journal in which had been published an allegedly "biased" article favorable to Marconi was dismissed from his position and the author of the article was deprived of the right to defend his D.Sc. dissertation. The year was 1974, the centennial of Marconi's birth. This former editor-in-chief is still an active writer in Russia. After "perestroyka" (1985), he became an open and biased "anti-Popovian." This occurred despite the fact that, as has been mentioned in Part 2 of this article, Popov himself never claimed the title of "inventor" of wireless telegraphy.

No matter what Popov's overall international importance in the development of wireless was, he must be given credit for his outstanding contributions to the development of wireless telegraphy in Russia. Popov truly was Russia's wireless pioneer. In addition to his achievements already mentioned, Popov set up Russia's first facility to manufacture wireless equipment, organized the training of wireless personnel, and established relations with European specialists in wireless equipment.

Of special significance was Popov's cooperation with the French scientist, engineer and businessman Eugene Ducretet (1844-1915). Ducretet manufactured and sold wireless receiving equipment based on Popov's design. This cooperation coincided with the Russo-French rapprochement which occurred at the turn of the century. From 1899 until 1904, the Ducretet Company supplied electrical equipment, including wireless apparatus, to the Russian Navy.

There were many throughout the world who contributed to the development of wireless. Marconi gets, and deserves, the lion's share of the credit for the development of practical long distance wireless telegraphy systems but it must be remembered that many others also made important contributions. Alexander Popov's name and achievements are not well known in the West. Nonetheless, the significance of Popov's work, like that of Lodge and others, must never be underestimated in the annals of communication technology history.

"We see here scientists' disinterested work and engineers' and technicians' more purposeful efforts come together just as brooks born in different countries flow together to form a big river, scientific discoveries and industrial inventions have joined to bring about great accomplishments in radio." Louis de Broglie (1892-1987).

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THE SUPERHETERODYNE OSC/MIXER STAGES

(continued from p. 3)

ground through R (~22KΩ). Everything else works like Fig. 1.

The 6A7 and metal-octal 6A8 had 8 active connections, but the single-ended metal-octal tubes of 1939, provided only 7 connections (one pin grounds the shell). The screen grid wasn't available as the oscillator plate in a tickler circuit because it has to be grounded for RF, so the circuit of Fig. 3 was developed. A tube oscillates when there is positive feedback from output to input and the gain is greater than unity. Instead of getting feedback from the plate, this circuit gets it from the cathode by connecting it to a tap on the grid coil. The bypassed screen grid can serve as the oscillator plate because it is not part of the feedback circuit. Mixing occurs in the electron stream and all other parts function as in Figs. 1 and 2.

Separate oscillator and mixer tubes (Fig. 1) continued in use for expensive multi-band sets long after the introduction of the pentagrid converter because of better stability and high frequency performance. Next time: IF amplifiers, diode detectors and AVC.

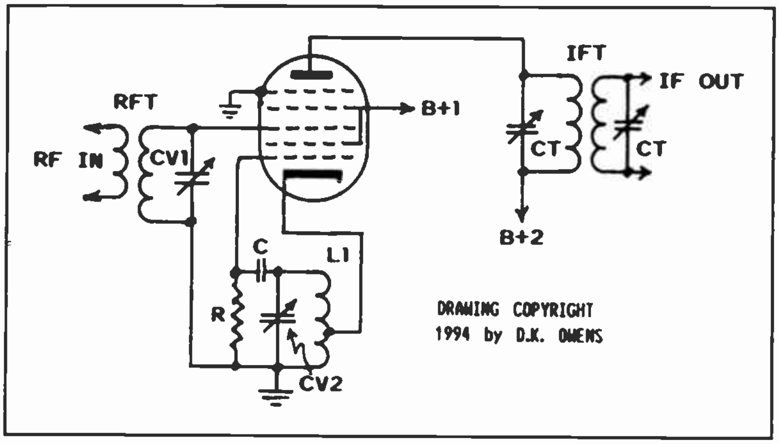


Fig. 3 (superhet). Pentagrid converter revised for cathode feedback (see text).

Conducted by Ken Owens
478 Sycamore Dr.
Circleville, OH 43113

Ken will be happy to correspond directly with readers who have questions about radio theory or repair. Please include a long SASE with your inquiry.

THE CRYSTAL DETECTOR

(continued from p. 2)

because of his ability to "pluck sounds from the ether" using a roll of double cotton covered wire, a Quaker Oats canister and a few odd parts.

The National Bureau of Standards published a set of plans for an ingenious little set requiring no store-bought parts other than the crystal. All of the hardware, including the crystal holder and the coil tap switches could be fabricated by anyone handy with tin snips and pliers. The little NBS set was enormously popular, and many credit it with catalyzing the broadcast boom of the 1920's.

Commercially made crystal sets were also available of course, but they were never made in great numbers. Not only was there competition from home-brew sets, but also, by the time the broadcasting industry had become big enough to create a mass market for radio receivers, the crystal set had become obsolete. Commercially made crystal sets of the early 1920's are highly-sought-after collectibles today.

What caused the demise of the crystal set was, of course, the vacuum tube. Tube technology had progressed rapidly in response to the communications demands of the First World War. By the early 1920's, with peace at hand, tubes were being mass-produced for the consumer market. They were much more expensive than crystals and, because they required battery power, cost a lot more to operate.

But there was really no contest. Not only was the tube a much more reliable detector then the crystal, it could also be hooked up to be an amplifier. Using tubes, the received signal could be amplified to provide loudspeaker volume. Now listeners would no longer have to be tethered to their radios by headset cords.--MFE

GRID LEAK AND REGEN DETECTORS

(continued from p. 4)

closer the coils, the greater the feedback.

To obtain maximum efficiency, the amount of feedback had to be carefully regulated. In the design shown here, this was accomplished by adjusting the relative position of the "Tickler" and "Secondary Inductance" coils. With the coils too close together, there would be too much feedback. The tube would then go into oscillation, emitting a radio signal that would interfere with reception throughout the neighborhood. But with feedback set just short of this point, the radio would deliver its maximum sensitivity.

Fig. 3 is a pictorial drawing of the circuitry of a Crosley one-tube regenerative set (the Type V, later marketed--substantially unchanged--as the Model 50). Notice the pair of basketweave coils just to the right of the "multistat" (filament control rheostat). The right-hand coil, with all the taps, is the tuning coil. The smaller coil at left is the "tickler." Moving the control knob in or out changes the position of the coils with respect to each other. The tuning capacitor (extreme right) is known as a "book" type; its capacitance is changed by moving the "leaves" (which are hinged at one end) closer together or farther apart.

With regeneration properly adjusted, the feedback loop results in a several thousandfold amplification of the radio frequency signal prior to detection by the grid leak circuit. So now our single tube is performing *three* functions: detector, a.f. amplifier *and* r.f. amplifier.--MFE

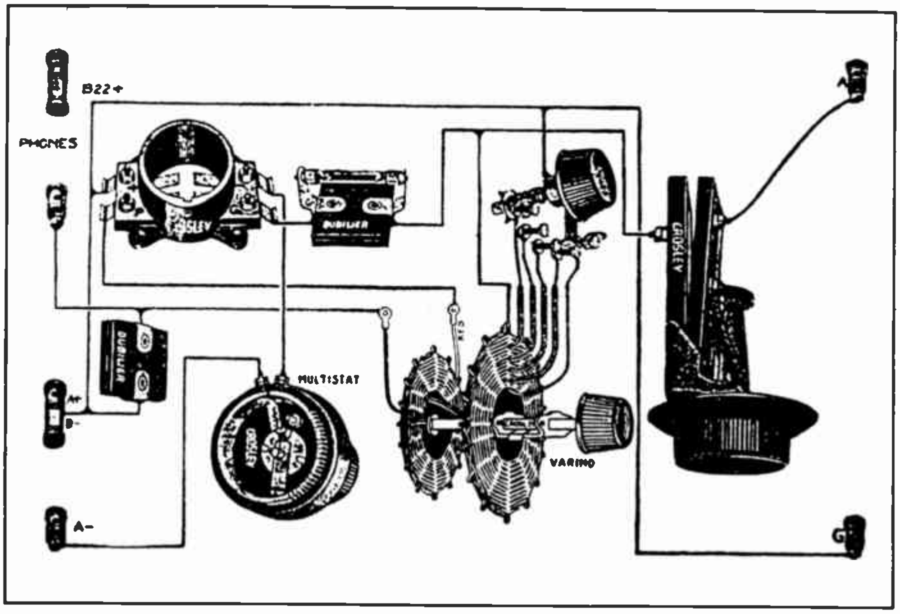


Fig. 3 (Grid Leak/Regen). Pictorial diagram of Crosley 50 shows mechanical, electrical construction.

CORRESPONDENCE FROM OUR READERS

letters may be paraphrased, shortened, or otherwise edited so that everyone gets a chance at the floor!

A Catalogue That's a Little Different!
SECRETS! Lindsay's Technical Catalogue, Lindsay Publications, Inc.; PO Box 538, Bradley, IL 60915-0538; 64pp; free.

Lindsay's Technical Catalogue is unlike most such books that you will come across. Like all catalogs, it is a list of books that the publisher would like to sell to you. There, the comparison ends.

It is a matter of the *kinds* of books that Lindsay offers. These are technical, mainly, and of a sort that are not generally found in the shops. Many of them are books that were originally published 50 to 70 years ago. Lindsay has reproduced and published numbers of these, with the complete original texts and illustrations. The many subject areas covered include electricity and radio, mechanics, optics, and chemistry.

Readers of *The Radio collector* will be immediately interested in *1001 Radio Questions and Answers*, published in 1924, as well as the 1922 *The How and Why of Radio Apparatus*. You'll also find *Loud Talkers: How to Build Them* (1923); *Radio Builder's Manual* (1935); *Short Wave Radio Manual* (1934) and much more.

Another very interesting little item, not easy to classify, is *Silliman's Electrical Machines* (1865). This is a really antique work with beautifully illustrated pages. But not all of the titles are vintage reprints; many come from smaller or specialized publishers and are not easily available.

In the realm of old-time electricity brought up to date, Lindsay's offers numerous volumes describing static electricity and high frequency experiments, Tesla coils, Van de Graaff generators, vacuum techniques, Wimshurst machines and other devices. Some of the books, reprinted from an earlier, more carefree time, bear Lindsay's warning: "I do not endorse the methods or plans offered here. Some are dangerous. . .this is a bookstore, not a school. Be very careful. Use good judgement. . ." So much for the Occupational Safety and health Administration!

If the radio collector wants a real change of pace, he or she might consider *Building a Wood Strip Canoe* or even the 1934 *Ditch Blasting*--showing quick, easy and *maybe* safe, ways to make holes in the ground. More practical, perhaps, is the contemporary *Auto Repair for Dumbbells*. After all, admitting you're a dumbbell is the first step towards gaining knowledge.

It's plain to see from perusing *Lindsay's Technical Catalogue* that this is a catalogue packed with interest for anyone who likes to "work with things." Certainly, the price is right. In a light-hearted postscript to the list, Lindsay writes, "Please buy books from this catalogue. . . " It's an invitation that's quite hard to resist!--Julian N. Jablin, Skokie, IL

Another Tube Manual
Regarding Alan Douglas' letter on the GE tube manual, you might also mention the manual I have just about worn out over the years: *Tung-Sol Electron Tube characteristics Manual*, 20th, Edition, copyright 1954 by Tung-Sol Electric, Inc., Newark 4, NJ. It also lies flat and contains info on crystal diodes, obsolete tubes, dial lamps, resistor and capacitor color codes, transformers, numbering codes for ballast tubes, and cathode ray characteristics. Finally, there is a handy tube substitution chart. 1954 was the 50th anniversary of Tung-Sol electric, Inc.--Charles T. Mooney, Bowie, MD.

Start-Up Power Supply
I really enjoyed making and using Ray Larson's "Start-Up Power Supply" (Sept/Oct 95 issue). Since I had the power supply and Variac form a junker chassis, the cost was nominal. Could we see power supply circuits, suitable for tube portables, that would provide a range of "A" and "B" voltages and be considerably cheaper than purchased commercial units? Keep up the good work, you've got a *great* magazine.--Samuel Zuckerberg, New York, NY.

Anyone want to jump in with a circuit for Sam?

Vintage Radio Museum
Among the smaller, semi-private electronics collections is the Vintage Radio and Communications Museum of Connecticut. Based on the extensive collection of John Ellsworth and enhanced by additional items, the museum in 1995 moved to larger quarters and increased its public support.

Exhibits include radio, television, telephone and other communications items, plus advertisements and other related memorabilia. The collection has a strong educational orientation; Ellsworth and the staff offer field trips by schools and other groups. The collection provides a resource for research on radio history and related subjects.

Many of the displays are rotated, since the facilities include more items than can be accommodated at once. Exhibits featuring special aspects of communications history are featured from time to time.

The Vintage Radio and Communications Museum of Connecticut is located in East Hartford, at 1173 Main St., telephone 860-675-9916. Hours are: Thursday and Friday, 10:00 a.m. to 2:00 p.m.; Sunday 1:00 to 4:00 p.m. Adult admission is 4.00; senior citizens $2.00; students $1.50; children under 12, free.--Julian N. Jablin, Skokie, IL.

"Chinglish"
What follows is probably misplaced in a magazine for radio collectors, but it is something that tickled me and, exercising my prerogative as Editor, I've decided to share it here. A couple of years ago, I had an opportunity to attend of the joint Harvard-MIT radio club swap meets. I was able to pick up a couple of interesting antique radio items there, but I also needed an extra serial port for my computer.

Eventually I spotted a pile of I/O cards, new and boxed, for $7.00 each. Opening one up to look at the documentation, I found a small sheet of paper densely printed with virtually incomprehensible instructions. When I asked the proprietor if he had some better info on the card, he looked at me with a smile and said that he had other I/O cards with understandable instructions--for $15.00. But the $7.00 cards all had instructions in "Chinglish."

Now I hope nobody considers this an ethnic slur but, having done my share of trying to decipher the fanciful English instructions originating in the Asian countries that bring us so much of our electronic equipment, I really did find that remark amusing! Being a bit of a miser, I bought the $7.00 card and, after some puzzlement, was able to make it work.

Recently I upgraded my computer again and, as I slipped the little cooling fan for the CPU chip out of its box, the little bit of promotional copy printed on the back of the container caught my editor's eye:

This cooler responds with the utmost of ease, with quietness and most strict balance calibration, instinctively reacting to all its surroundings.

With this cooler and CPU in perfect harmony, overheat has been taken over freely. Approach the peak of CPU potential.

Put the cooler on the surface of CPU. It has to be clipped on one side first, then press the both sides of heat sink with CPU to make sure the heat sink and CPU have been combined tightly.

Like the I/O card, and most other pieces of reasonably priced imported electronic equipment I've put into service, the fan worked perfectly and, as we speak, is doing its cooling thing "in perfect harmony" with my CPU.--Marc Ellis

(*continued on p. 10*)

DICK'S CORNER

Tips and Tidbits from the world of Antique Radio Collecting and Restoring

Stubborn Set Screw Strategies

Sooner or later, just about every radio collector will encounter a set screw type knob that can't be released from its shaft. Typically the set screw will have a slotted screwdriver head, an Allen head or a Bristol head. The slotted screwdriver head is the most common, and is self-explanatory; the Allen has a recessed hex head; the Bristol head is much like the Allen, but has splines as the gripping element rather than a hex shape.

Before attempting to loosen any knob retained by set screw, direct a flashlight beam into the set screw hole and examine it with a magnifying glass. After you determine the type of head you are dealing with, be sure you use only the proper driver or wrench on it. Xcelite makes both Allen and Bristol wrenches in sets designed to fit into a screwdriver-type handle and are *ideal* for radio work.

Use only ordinary finger pressure on your screwdriver, Allen wrench or Bristol wrench. If ordinary pressure doesn't do the job, *please* resist the urge to use a screwdriver or wrench on the tool. This will usually break the screw slot or round out the Allen or Bristol recess. Maybe you will find that a previous "service master" has already created this problem and left it for you to solve.

Another problem is created by prolonged exposure to moisture. When set screws and shafts are steel (which is usually the case), moisture will cause them to rust together. When the screw won't loosen using ordinary pressure, or the screw head is broken or stripped, follow this procedure:

Turn the knob so that the set screw hole faces up and fill the hole with penetrating oil. (I prefer the original Liquid Wrench in the small squeeze can.) Let the oil stand in the hole for two or three days. Then, supporting the bottom of the knob with a wood block placed on your bench, insert the proper tool (screwdriver or wrench) into the set screw and tap down on the tool smartly with a plastic or wood mallet. Now attempt to loosen the screw.

If this doesn't work at first, try the procedure two or three more times--each time giving the penetrating oil sufficient time to work in. *Note*: If the Allen screw head (which is normally standard SAE) is rounded out, try a slightly larger size from your metric Allen set. In the case of a rounded-out Bristol head, try both SAE and metric Allen wrenches to see if you can get a proper fit

Should all of these attempts fail, it will be necessary to drill out the set screw. Use a new or newly-sharpened 1/8" drill bit adding a masking-tape depth gauge to keep from drilling too deep. A Sears or Dremel Moto Tool makes a great driver for this purpose. (By the way, the Sears tools are made by Dremel, but cost considerably less.) Afterwards, you can tap the bushing in the knob for a larger set screw.

Care and patience are *essential*! I have spent a month or more soaking parts in penetrating oil and *gently* working them to get them apart. So far, so good. I wish you the same!!!

Curing Open Coils

It is not uncommon to discover an open antenna coil in an old radio. Outdoor antennas were the norm throughout the 1930's and were in common use even in the 1940's. Many of these were not protected by lightning arresters, so one good thunderstorm could send several sets to the local radio repair shop with complaints of weak or no reception. Open oscillator coils also turn up from time to time.

An exact replacement coil will be nearly impossible to find. A junker chassis with a useable substitute coil may also be difficult to obtain. The so-called "universal" replacement coils may result in poor tracking as well as loss of frequency coverage on the high or low end (or even both ends). And adding extra trimmer or padder capacitors to try to compensate for this problem usually doesn't work. By far the best solution is to re-wind the defective coil.

Here are the basic steps in re-winding a coil: (1) Make a pictorial diagram of the wiring to the coil, marking the wires with wire labels and using different color fine-tip felt markers to code the coil tabs. (2) Identify the type of wire used in the open winding. (Example: enamel, single silk covered, double cotton covered, etc.) (3) Identify the size of the wire. Inexpensive wire gauges will work, but I favor using a micrometer to measure the exact diameter of the uninsulated wire, then referring to a wire size table in a standard reference such as "Reference Data For Radio Engineers," Federal Telephone and Radio Corp. (4) Unwind the bad winding. *Carefully* count the number of turns. Note: if you are lucky enough to find the *only* break in the wire just a few turns in, you can probably strip and resolder this wire to the proper lug and save any further work. Your ohmmeter will be useful here. A loss of more than 10% of the winding will definitely require a complete rewinding. (5) Obtain a sufficient unbroken length of the proper wire and re-wind the coil. That length will be: number of turns x diameter of coil x 3.14. Allow a bit extra for multi-layer coils and leads.

Of course, if your coil happens to have a good winding over the bad one you are replacing, you will have to *carefully* unwind the good winding and save that wire on a smooth round spool. You can then repair or replace the inner winding and follow-up by rewinding the outer one using the original wire. Occasionally, you may find that the outer winding was wound on a separate core and slipped over the inner one. Check for this before unwinding! If there is a separate core, you may be able to separate the coils after applying gentle heat from a heat gun.

Never use solvents on coils. If you should dissolve the enamel or other insulation between turns, you've ruined the coil.

You may find that the coil you want to unwind was dipped in wax. Try using the heat gun to melt it off it (being careful not to apply too much heat). You don't need an expensive commercial model for this work. I purchased a nice two-speed unit (mainly sold for stripping paint) at True value for $20.00. It does a fine job on shrink tubing, also!

To replace the wax after rewinding the coil, purchase a cake of canning wax and melt it in a pan on the stove at fairly low heat. Dip your coil in the melted wax, rotating it for even coverage. Just enough wax will cling to the coil to preserve it. Another good coil sealer is Q dope, a clear, brush-on, cement and preservative. But if you can't get your hands on a bottle of Q dope, clear nail polish makes a fair substitute.

Conducted by Dick Mackiewicz

CORRESPONDENCE
(continued from p. 9)

WEAF Sidelight

Reader Charles Brett (Colorado Springs, CO), who frequently sends interesting documentation along with his responses to our mini-quiz questions, forwarded a page from "His Master's Voice in America" (General Electric Co., 1991) dealing with the birth of NBC. Here's a brief quote relating to the purchase of WEAF.

" . . .David Sarnoff recognized the need for a regular, professional program service as early as 1922, when he suggested a nationwide capability via networking.

RCA, GE and Westinghouse took action to make the vision a reality. On July 1, 1926, they purchased rival station WEAF (on lower Broadway) from AT&T for $1 million. This became the key station for the planned network. On September 9, the National Broadcasting Company, Inc. was organized as a subsidiary of RCA. The joint venture was owned by RCA, GE and Westinghouse on a 50/30/20 percent ratio, respectively."

INFORMATION EXCHANGE

This is an open forum for interaction among our readers. Here you can ask questions about some aspect of our hobby, answer a question that's been posed or pass along other information of general interest. Send your questions, answers and information to **The Radio Collector**, P.O. Box 1306, Evanston, IL 60204-1306. Submissions may be edited or paraphrased.

QUESTIONS TO BE ANSWERED

Some Good Questions

Resistors may be 20% tolerance (no color band), 10% (silver) or 5% (gold). How do I know which tolerance to use when replacing resistors? Are there some circuit applications where tolerance is more critical than others?

When replacing capacitors, if I do not have the exact value required, is it better to use a replacement of higher or lower capacitance? How much variation can be used before performance is degraded? Are there some circuits where values are more critical than others?

I have a tube tester that does not include either sockets or charts for older tubes like the 42, 77 or 80. Do I have to buy another tester or can I make an adapter and use the one I have? If making an adapter is practical, how would I go about doing this?--Gerry Van Santen, Springfield, VA.

Transformer Transplant

I acquired a Philco console model 41-315X that had been stored in an open shed for an unknown number of years. On checking it over, I found it was definitely going to need a lot of attention. The chassis needed cleaning; the electrolytics were all bad; the output transformer was open on the primary;, and there had been some crude repair attempts that would have to be reversed.

Worst of all, the output transformer was a special one that had a tap on the secondary to provide negative feedback. Searching for a replacement to no avail, I decided to take the transformer apart to see if it could be repaired. I found that the primary was heavily damaged and was not repairable. But I was able to take advantage of the fact that the secondary winding was the outside one.

I bought a similar transformer (but without the tap) that was made for a pair of 6V6's (close enough, in my book, to the 42's in my set). Carefully removing the secondary of the bad transformer, I wound it on the replacement transformer in place of that transformer's secondary. Space is limited, so tight winding is necessary when one attempts something like this. Hint: to separate the iron core leaves in order to get the transformer core out, soften the varnish with acetone in a ventilated area. Be careful, though, acetone is toxic and very flammable.--Alton A. Dubois, Jr., Queensbury, NY.

Capacitor Changeouts

Victor Commisso writes to tell of his AK Model 55 which had good, original filter capacitors. My AK 55 is also happily playing on the original caps. When I recommended automatic replacement of filter caps, I pointed out that this referred to *electrolytic* caps. The major manufacturers used *paper* filter caps until around 1931. I said that paper filter caps should be further tested with reduced voltage.

Over the years, you learn what to expect from the products of various manufacturers. I have never seen bad caps in the RCA sets with separate power supply chassis (like the Radiola 17, 18 and 33). On the other hand, the 1928 AK models (like the 40, 42 and 44) frequently do have shorted caps. AK must have changed something in 1929 because the 55, 56, 60, etc. generally have good caps. It's all a matter of experience.

Replacing paper caps potted in tar is such an awful job that I don't do it unless I have to. Some sets like the RCA R-11 put *every cap in the set* into a single can. Because the caps are connected inside the can in a complex way, you cannot simply cut the wire to a shorted section and wire in a replacement. If one cap is bad, the whole contents of the can must be replaced. This is a huge and unpleasant job.

In my article on paper capacitors in the *Old Timer's Bulletin*, Vol 35, No. 2 (1994), I showed that the development of leakage and shorts in paper units is due to chemical action among the wax, foil and paper. It doesn't matter whether the caps have been used or are new. It's a matter of age. If the materials had certain qualities, the caps lasted. If not, they went bad. Unfortunately, the manufacturers didn't know what these qualities were in 1928. Some were lucky - some weren't.--Ken Owens, Circleville, OH

Quick Coupling Cap Diagnosis

Regarding the coupling cap from the first audio tube plate to the output tube grid: if it's a paper capacitor and looks original, change it! There's a good chance that it leaks. If you would like confirmation of a leakage problem, here's a quick way to get it: Connect a meter to indicate the voltage from the cathode of the output tube to ground. Then briefly short the plate of the first audio tube to ground. If the voltage drops when the short is applied, the cap leaks.--Ray Larson, West Los Angeles, CA.

Curing VTVM Drift

We recently received a note from *Play it Again* columnist Ken Owens responding to Alan Douglas' mention of the perennial zero-drift problems connected with inexpensive VTVM's. Ken suggests a method for dealing with this problem that was used by NRI (National Radio Institutes) to "quiet down" the drift in the VTVM's it sent out with its mail-order radio servicing course.

The drift, Ken explained, is largely caused by very small amounts of gas in the VTVM amplifier tube (usually a 12AU7). During manufacture of a typical vacuum tube, most of the air and other gases are removed by exhausting the tube to a very high vacuum. What remains is absorbed by the "getter" a chemical coating (typically evaporated metal) inside the glass of the tube.

The minute quantity of gas remaining is not enough to cause problems in most vacuum tube applications. However, it can be most bothersome in a VTVM. The outer electrons in the gas atoms are frequently

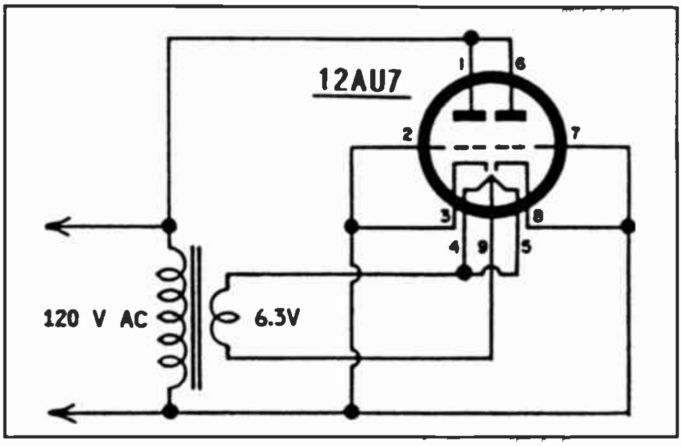


Fig. 1. Hookup for "cooking" 12AU7 to reduce free gas content, minimizing zero drift in VTVMs.

(continued on next page)

INFORMATION EXCHANGE
(continued from previous page)

knocked loose by the electron stream emitted by the cathode of the tube. The gas atoms then become positively charged *ions*, some of which are attracted to the negatively charged grid of the tube. At the grid, the ions take on electrons--becoming neutral atoms once more.

The continuing removal of electrons from the grid causes a small current, varying slowly and randomly, to flow in tube's grid circuit. In the case of a VTVM, the grid circuit contains a very high resistance (11 megohms). Even a very tiny current running through such a high resistance will cause a significant voltage drop (remember your Ohm's law: E=IR). This voltage, which varies with the current, upsets the zero reading of the meter and occasionally needs to be cancelled out with the zero adjuster.

The trick used by NRI was to plug the tube into the circuit of Fig. 1 for eight to ten hours. The transformer is any small unit capable of lighting the tube's filament. To use a 6-volt transformer connect the two halves of the 12AU7 tube in parallel as indicated. If you have a 12-volt transformer ignore the filament center tap (pin 9) and connect the 12 volts across pins 4 and 5. As you can see, the a.c. line is connected across the tied-together plates and the tied-together cathodes and grids.

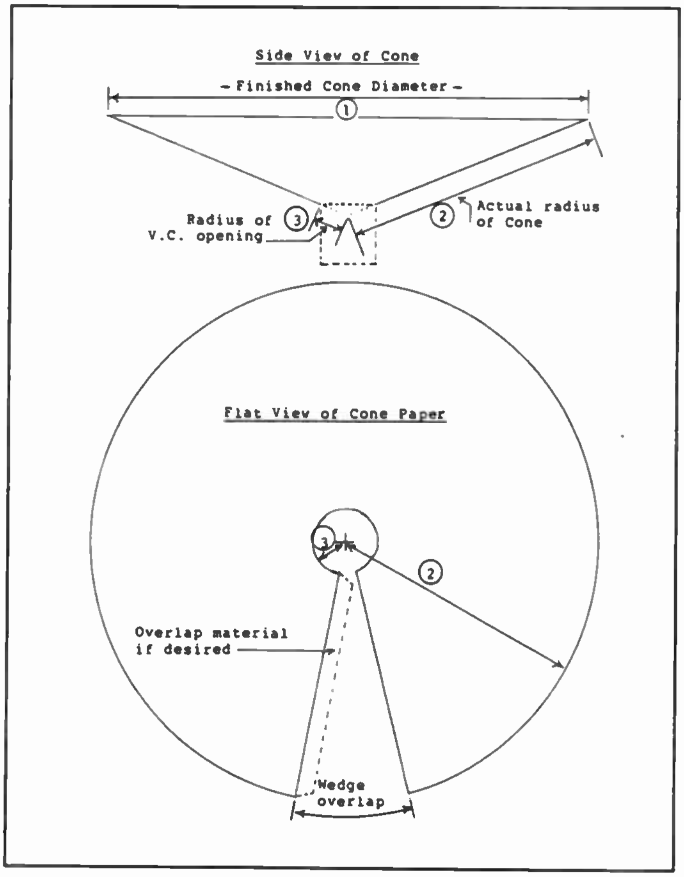
Connected this way, the tube acts as a rectifier, passing current only on alternate-half cycles. But the important thing here is that the tube becomes very hot; hot enough to enhance the "gas trapping" action of the getter compound but not hot enough to damage the tube. After "cooking" in this circuit, your VTVM tube will likely exhibit much-reduced drift. If not, put the tube aside for use in a less critical circuit and try treating another 12AU7.

Ken points out that zero drift can't be cured simply by leaving the VTVM on overnight, though many people do try this expedient.

Crafting a Cone

After reading Alton Dubois' struggles to make the right size cone for his speaker (RC Nov-Dec 95), I am compelled to relate my method for a similar situation--and it's a lot easier. It takes longer to explain it than to do it.

Look at the upper section (side-view drawing) of my figure, and take the indicated measurements from the cone you are going to replace: (1) the diameter of the finished cone (2) the distance from the center of the voice coil along the slant to the cone's edge (3) the distance from the center of the voice coil to the outside edge of the voice coil opening (in other words, the radius of the opening). Now, using measurements (2) and (3) use a compass and ruler to draw out the full size design on your cone paper.



Key measurements for constructing replacement speaker cone.

From measurements (1) and (2), you can now determine the circumference of both the finished cone and the cone paper. (Remember, circumference is diameter times 3.1416). Subtract the smaller from the larger figure--which gives you the circumference overlap you need to use. Without any deeper math, just carefully measure around the edge of the paper circle and mark the wedge overlap edges.

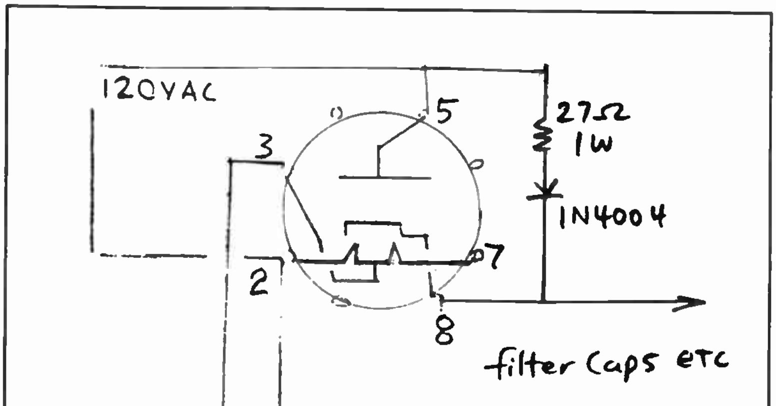
Some cones have the edges butted together with another strip of material glued over the joint. Others used a small overlap, depending on the size of the cone. The finished outside edge is usually sewed or glued to a felt ring to provide a flexible rim. If you can still find some oldtime felt weather stripping, that works great. The center opening is usually glued to the voice coil or, in older type cone speakers, fastened to a magnetic driver rod.--Anthony Jacobi, Ralston, NE.

Still More 35Z5 Lore

Reading the comments on 35Z5 pilot lamp circuits, etc., in the last couple of issues, I thought I would pass along a couple of tricks I've been using. First of all, I've been "cheating" for some time in AC-DC sets by putting a 1N4004 diode in series with a 27-ohm 1-watt resistor across the 35Z5 (plate to cathode). This conserves the tube by taking most of the load off it and, after all, there are fewer and fewer of these tubes around.

I also provide a regulated source for the pilot light by connecting a small bridge rectifier across pins 2 and 3 (see schematic). A series-connected group of 6 or 7 diodes is then wired across the rectifier's output, providing a regulated 4.3 volts (6 diodes) or 5 volts (7 diodes) for the pilot light. Most any half-amp silicon diode will do for use in the bridge and regulator. This even works with 35Z5's having the pin 2 to pin 3 heater section blown. If you have one, you can substitute a single 4-volt Zener diode for the series-connected group across the rectifier output.

When recapping filters on AC-DC sets, I recommend using 200- or 250-volt units in place of the original 150-volt ones. Today's line voltages can easily take rectified DC past 150 volts, especially when the diode+resistor plate to cathode bypass is used.--Ray Larson, W. Los angeles, CA



Ray Larson's modifications to take load off 35Z5 rectifier tube and provide regulated voltage for pilot light (see text).

VINTAGE BOOK REVIEWS

Books from the era when vintage radios were new! Look for them at swap meets, flea markets and used book stores.

DAVID SARNOFF by Eugene Lyons. Published by Pyramid Books, New York, 1967. 431 pages. Paperback. Hardbound edition published by Harper and Row, 1966.

David Sarnoff lead the Radio Corporation of America during most of its years of greatness. He emigrated from Russia as a boy and eventually became a wireless operator for Marconi (a predecessor company to RCA). He eventually worked his way up to the Presidency of the government-formed monopoly that became, at one time, the largest corporation in the electronics industry. How this poor immigrant got to this position, and what he did when he got there is a most interesting story. Many books and a documentary have been written about him.

This book was written by Eugene Lyons, a relative of David Sarnoff. This has both a good and bad side. One can get a more intimate look into his family and personal life than in some other biographies. However, the other side is that the book is unashamedly pro-Sarnoff. Sarnoff and RCA achieved much of their greatness by stepping on the backs of others. In the cold world of capitalism, this is fine. Sarnoff was doing his job, making RCA the best it could be.

RCA started with the advantage of controlling almost all of the major radio patents in the United States. When other people or companies tried to find ways around the RCA monopoly, they would be persuaded to sell to RCA or be forced to spend much of their resources fighting RCA's relentless pursuit. RCA enjoyed tremendous power in the industry for the first decade or so of its existence until the government forced it to ease off. Under Sarnoff's control, RCA succeeded in gaining control of super-regeneration and FM broadcasting from Armstrong and was threatening to wrest FM multiplex from him when he died. Even the government was not immune. When the Columbia color wheel system of color television was set as the standard for color television in the United States, Sarnoff (to his credit) fought for the RCA system (a much better system) that we still use today.

This book also serves to perpetuate the myths that Sarnoff made about himself. Sarnoff said he was the wireless operator who was the only one allowed to work the Carpathia after the tragic sinking of the Titanic. Research (including a tape recording of the true operator, Joe Danko, published by the CHRS) shows that he was not. A paper explaining a "Radio Music Box", which was supposed to be his prophetic look at radio broadcasting has been shown to be written after broadcasting started. Unfortunately, others who use this book for information continue to quote these passages and further reinforce this mis-information.

The book is pleasant enough to read. It was a best seller and is one of the easiest biographies to find. It does give interesting insights into his personal and family life. I suggest that you read other biographies as well before forming any opinions about the man. He did achieve a lot. You will have to decide if he was the ruthless builder of an empire or, as this book says, a candidate for sainthood.

RADIO FOR THE MILLIONS Prepared by the Editorial Staff of Popular Science Monthly. Published by Popular Science Publishing Company, New York, NY. 1943. 192 pages. Hardbound.

Radio For The Millions was a book containing reprints of articles from various issues of *Popular Science Monthly* magazine. There are eighty-nine projects, spanning a wide range of interesting radio and related areas. While most radio collectors are aware of the set building craze that occurred from the earliest days of radio through the twenties, not all realize that, especially amongst younger people, set building has continued to this day. Heathkit and other kit companies supplied kits until quite recently. Some people do not get as much satisfaction from buying and building a complete kit. They want to build something from scratch and derive much pleasure from tinkering. Yet, often these people lack the knowledge or skill to design a device from the ground up. It was this group that *Radio For The Millions* hoped to reach.

This is especially relevant when one considers that the book was published in the middle of World War II. There were no consumer products available; so if someone wanted something, he had to either pay a lot for a used one or make it himself. Most of the projects in this book could be made from simple parts scrounged from the junkpile or scrapped from something else that could not be made to work. A lot of people who got started in electronics by building these and similar projects went on to successful careers in the field.

A majority of the projects consist of instructions for building simple to moderately complex radio sets using four or fewer tubes. Many of the sets were in novel cabinets or configurations such as: a twin bed radio that could be tuned from either side, a radio built into an existing floor lamp and a mailable "letter" radio. Many of the sets are portable. There are also shortwave and FM sets. Another series of projects cover what might be called ancillary projects. These include: power supplies, PA units, test equipment, and remote controls. There are numerous phonograph and amplifier projects and a few on transmitters and telegraphy. Throughout the book, there are radio servicing hints. These were very important because they helped people keep their sets going during the war.

This book is different from most of the post-twenties books that we have reviewed in that it was written for the hobbyist, not the serviceman or engineer. The projects range from easy ones for the beginner to moderately complex ones for the experienced. There are many drawings and photographs. In fact, the builder often has to rely on them for most of the necessary information. Almost all the projects have parts lists and the parts are generic in nature. This reflects the build-with-what-you-have theme of the book. Most of the projects can be built with commonly available handtools, but a set of Greenlee chassis punches will be extremely helpful. The articles are one to three pages long; so there is not a lot of construction detail given. The editors presuppose that the builder knows about alignment, wire placement and other construction and electronic skills.

Radio For The Millions is a book that is often found at swap-meets and used book stores and is usually inexpensive. It is worthwhile acquiring, just for the fun of reading through the projects. The book also explains some of the weird stuff we find at flea-markets and garage sales. The service hints are useful (and show some of the repairs and modifications that had to be done during the War) and who knows? You might find a nice winter project and use for some of that stuff in your junk box.

RADIOTRON DESIGNER'S HANDBOOK, edited by F. Langford-Smith. Published by The Wireless Press for Amalgamated Wireless Valve Company Pty, Ltd., Sydney, Australia. Reproduced and Distributed by RCA Victor Division, Radio Corporation of America, Harrison, NJ. Fourth Edition, 1952. 1482 pages. Hardbound.

The fourth edition of *Radiotron Designer's Handbook* has long been looked upon as the "Bible" for those interested in vintage tube

(continued on following page)

VINTAGE BOOK REVIEWS
(continued from previous page)

electronics. It is probably the most comprehensive book ever written on vacuum tubes and their circuits. With the current interest by audio enthusiasts in designing and building new tube audio equipment, this book has achieved a status almost equal to the Holy Grail (and almost as hard to find!).

Radiotron Designer's Handbook consists of thirty-eight chapters in seven parts. While most books have one Table of Contents, this book has two. The first is called "Chapter Headings" and lists the parts and the titles of each chapter within each part. The second, called the "Contents" covers the sub headings within each chapter. It is as detailed as some indices in lesser books.

The first part discusses Radio Valves and herein is a general, but thorough introduction to vacuum tubes: their types, characteristics and methods of testing. The second part covers the general theory and components: networks, inductors, feedback, modulation and tuned circuits. The third part is devoted to audio frequencies and includes circuits to modify as well as amplify audio signals. There is a chapter devoted to loudspeakers and one for audio measurement.

The fourth part handles radio frequencies in the same thorough manner and covers all of the related circuits. Part five deals with rectifiers, rectification, filtering and hum. All types and components of power supplies, regulators and filters are covered in great detail. Finally the sixth part brings it all together and goes through complete receivers: the types of AM receivers, design of FM and superheterodyne AM receivers and the testing and measuring of receivers and amplifiers.

Sundry Data is the title for the seventh part and indeed it is! There are nearly 100 pages of tables, charts and other information of interest to anyone who works with electronics. The Index is extremely thorough and makes looking up a specific topic quite easy. After the index, there is a supplement containing additional references for each chapter.

This book is not light bedtime reading. It was written for electronic engineers and is quite complex. Despite its great girth, the type is quite small. The book is filled with many drawings and huge piles of formulae requiring a strong grasp of mathematics. Each chapter concludes with a reference section so that the reader can search for even more detail.

Although *Radiotron Designer's Handbook* seems to be oriented towards radio, it is one of the most detailed books available for those who want to understand and design circuits used in High Fidelity equipment. There is no information on use of vacuum tubes for computers, industrial uses (like machine control) or television.

For those who have the ability and desire to use what this book has to offer, there is no better. Those who want a more general discussion on vacuum tube electronics, have little interest in designing equipment or who are not interested in solving an equation on almost every other page should look elsewhere. The electronics neophyte should read other books first ever if he has the mathematical background to follow the material in this book.

Because *Radiotron Designer's Handbook* was written for a relatively small audience (engineers and designers), it had a limited print run. Then, many copies were discarded with the advent of the transistor. Now sought after, especially by people who design their own audio equipment, this book has become scarce and fairly expensive. For those who really need it (and you know who you are), the book is a must and is well worth the expense and the search.

Please note that the above review is for the FOURTH Edition of the *Radiotron Designer's Handbook*. It is quite thick with a light red cover. There are earlier editions which are thinner, have blue covers and a larger page format. Those books are very, very different. The preceding, third edition, is a very good reference for vintage radio enthusiasts. In fact, it is in many ways better as well as a lot cheaper. The third edition is not of much use for the audiophile, however. When purchasing a copy, especially through the mail, make sure which edition you are getting.

RADIOTRON DESIGNER'S HANDBOOK, Edited By F. Langford Smith. Published by The Wireless Press for Amalgamated Wireless Valve Company Pty. Ltd. Distributed in USA by RCA Victor Division, Radio Corporation of America. Third Edition, May 1946. 352 pages. Hardbound.

This black-covered third edition of *Radio Designer's Handbook* is about one-third as thick and currently has one fifth the value of the red-covered fourth edition. The demand by audiophiles for the fourth edition has made it expensive and difficult to find, while the third is almost ignored. This is an advantage for the radio collector in that the third edition contains most of the information useful to him at a much more reasonable price and availability.

The first part consists of thirteen chapters devoted to audio frequencies and covers all aspects, circuits and equipment used in them. The second part (eight chapters) provides a similar coverage of radio frequencies, including: RF, IF, and reflex amplifiers, mixers and detectors. The third part covers rectification, filtering and hum and has one chapter devoted to each.

The fourth and fifth parts each have four chapters and cover, respectively, receiver components and tests and measurements. The sixth part contains two chapters discussing valve (tube) characteristics and is a relatively short. It contains mathematic equations and charts describing the operation of tubes in a generic manner. The seventh part is a dry section covering resistance, inductance, capacitance, algebra, trigonometry, vectors and units of measurement. The final part contains graphs, charts, and sundry data useful to the engineer.

This book was written for electrical engineers and requires the reader to have a basic understanding of electronics and a strong knowledge of mathematics. While filled with a large number of graphs, there are no pictures of equipment or tubes. The book is general in nature and it is expected that the user has access to the specifications of the components he wishes to use. Each part concludes with a bibliography, and many of the citations are other engineering books. The book has an excellent index making it fairly easy to look up an area of interest.

People seeing both books together often wonder why the third edition is so much smaller than the fourth. One reason is that, although the third edition was published around the end of WWII, it does not contain much of the information discovered during the war and thereafter. It also (a) does not cover its subject matter in as great detail as the later edition and (b) has a more compact layout.

For the person seriously interested in tube circuit design, the fourth edition is what you probably want; especially if your interest is in the audio field. For the vintage radio hobbyist interested in how and why his sets operate, this edition is just fine. One can grasp many of the concepts without having to go through all the math. However, the new hobbyist should study other radio and electronics books first so as to acquire the background necessary to understand and appreciate the concepts of this book.

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THE INTERNET CONNECTION

Information From and About Antique Radio in Cyberspace

Your Provider's Levels of Connectivity

In the last column, I briefly touched on the various means to connect to the Internet. The various services available to connect your computer to the Information Superhighway may have different levels of "connectivity". The major on-line services like America On-Line, Compuserve, Genie and the like offer a wide range of service for their monthly fee. Whereas "do-it-yourself" starter packages and Internet service providers can offer various sign-up options with, of course different levels of cost. These can be the most economical route to take, especially if your budget is low and you are just starting out.

Below is a list of options, in order of increasing features and level of connectivity, that you may find with an Internet service provider.

1. E-mail only service
2. Dial-up terminal emulation or "shell account"
3. Dial-up direct account or SLIP/PPP
4. Dedicated or permanent account

The first level is just like renting a box at your local Post Office. It's simply an Internet address that you use to address your E-mail to others and which others can use to correspond to you. Some modem and E-mail software usually is part of the package. The next level is the shell account. This software connection package allows your computer to access the provider's computer server for E-mail and possibly some file transfers. Internet access may also include Usenet Newsgroup reading/posting. There may or may not be any graphical interface software which would enable you to view Web pages.

Next is the direct or SLIP/PPP (pronounced "slip-pea-pea-pea") account. This acronym stands for *S*erial *L*ine *I*nternet *P*rotocol/*P*oint to *P*oint *P*rotocol. This level allows multiple network connections. The software package usually offered has many features which allow full Internet access - Web browser, E-mail, Newsgroup reader, Gopher, FTP, etc. This level also, with some providers, can offer the user his or her own Web page on their server.

Finally, the dedicated account is the highest level of connection to the Internet. Such accounts are usually opened by companies rather than individuals. As a company employee, your computer or work station may be part of a local network with access to this account. This would allows you to access the full Internet anytime, just by switching to the proper software or logging into the server. Your local area network manager can tell you what services are provided.

That's about all for this time. Meanwhile here are some interesting links to visit on your next browse through the Web.

Yahoo! One of the Web's "Yellow Pages" directories
http://www.yahoo.com/

Smithsonian's George H. Clark Radioana Collection
http://www.si.edu/organiza/museums/nmah/homepage/lemel/archives/clark.htm

Radio Grille Cloth Headquarters
http://www.libertynet.org/~grlcloth

Zenith Trans-Oceanic FAQ Page
http://www.interlog.com/~kschengi/to_faq.html

Radio Collector's Condition Guide
(part of the Bellingham Museum Site)
http://www.pacificrim.net:80/~radio/old_html/res/condition.html

And last but not least, **Chuck Schwark's Home Page**
http://members.aol.com/caschwark/index.htm

Here's another condensed message thread from *the rec.antiques.radio+phono* newsgroup. Dealing with the causes of open windings on AF and IF transformers, it appeared in October, 1955.

Seems a radio collector had inherited a couple of early 20's battery receivers that had open windings in both AF interstage transformers. He found that the wire in the coil windings had disappeared, leaving behind nothing but greenish copper trails.

One reply to his query was that the tar or wax used back then had a high sulfur content and if the impregnation process did not include a vacuum chamber treatment to remove residual water vapor, the vapor and the sulfur would react over time to form weak sulfuric acid. This would attack the copper windings. One other respondent suggested that acid core solder, which was in common in the 20's, could also contribute to corrosion of the wire. I would also suggest that sets kept in a high humidity environment for long periods might develop similar problems--especially if the windings of coils, RF chokes and/or air-core transformers have a light wax coating.

Finding a Provider Within Your Area Code

In the last few columns we've covered some of the ways and means to get connected to the Internet. This month, I'd like to discuss a useful web page that will help you locate just the right ISP (Internet Service Provider) in your local area. The ultimate goal here is to save yourself money and get the most economical Internet service for your particular situation. But where to search for a provider?

Most web search engines like Webcrawler, Yahoo! and Lycos can find Internet Service Providers by state and/or other geographic location. Analyzing the results may involve a lot of effort on your part since the databases are large and fine-tuning (no pun intended!) your search can become cumbersome. There is an alternative though. Mecklenmedia's Internet World has a web site for locating ISP's within your own areacode! It can be found at

http://thelist.com/areacode/xxx.html

The "xxx" in the above URL should be replaced by the actual 3-digit telephone areacode number you wish to check for service providers.

Example: http://thelist/areacode/312.html (for the 312 areacode listing).

This will generate a listing of providers which have access in the areacode you choose and even the newest area codes are listed. Overall the best "bang for your buck" will be obtained when you can sign-on with an service provider for unlimited access within your local calling radius. Most, if not all, providers have a package deal which offers unlimited access time for a flat monthly rate of $20 to $30 a month. And if an access number local to you is available, toll charges will be minimal or non-existent. This gives you unlimited time on-line without the "meter running".

Whether you just send and receive e-mail or are a full-blown "net

(continued on p. 18)

COMPANY CHRONICLES

Brief Biographies of Classic Radio Manufacturers

Music Master RADIO PRODUCTS

The Music Master brand was first used by the Philadelphia firm of Sheip and Vandergrift, founded in 1908, which had acquired patent rights to a form of wooden phonograph horn. Early in the 1920's, phono-industry sales executive Walter L. Eckardt was struck by the fact that outside horns were becoming essential radio accessories as fast as they were disappearing from phonographs. To take advantage of what he saw as a very profitable marketing niche, Eckardt formed the General Radio Corporation in April, 1922. Though the intent was to deal in both radios and accessories, General's first product of consequence was the Music Master radio horn. Bells for the Music Master were manufactured by Sheip and Vandergrift; drivers by Timmons. Towards the end of the following year, Eckardt re-registered the Music master trademark for use with radio horns and, a few months later, changed his firm name to Music Master Corporation.

The company was now selling 2500 horns per day and becoming quite profitable. But Eckardt had more grandiose plans. Recapitalizing Music Master by selling three million dollars in stock, the hard-driving executive began to branch out. During this period, he was quoted as saying, "I am after fame. I'd like to create the biggest manufacturing concern in the radio business." Early in 1925, he purchased a 30-acre facility in Betzwood, PA (near Valley Forge), where he planned to build his horns and experiment with vacuum tube development. He also intended to market a line of ten radio models ranging in price from $50.00 to $460.00.

Rather than waiting to establish his own production facilities, Eckardt placed manufacturing contracts for the various models with several established manufacturers: Ware, Algonquin, Jones, Sleeper and Thermiodyne. By the middle of the year, the firm's new line was being advertised lavishly and dealers and distributors were being signed up. However, the contract manufacturing plan proved to be a mistake. One of the manufacturers (Ware) turned out to be on the verge of bankruptcy. Deliveries of finished sets were slow and quality control was poor. After Ware's contract was cancelled, the troubled company dumped 15,000-set inventory at a cut price, which was not good news for Music Master's dealer network.

With inventories inadequate to meet its sales obligations, the firm faced a deadly cash crunch. Dealers and distributors deserted, and Algonquin dumped 2,000 units of its model at $25.00 each. Music Master itself began to dump inventory to raise cash, but the end was near. The company was declared bankrupt in May 1926, though it continued operations under the management of a trustee for a few years afterwards. Walter Eckardt was unable to re-enter the radio business under his own name and spent the rest of his career working for others.

SCOTT Custom Built RADIO

E.H. Scott was born in New Zealand and spent his early years in Australia. He was orphaned at age fourteen when his mother died suddenly, his father having died in a railroad accident several years before. During World War I Scott served in the Australian-New Zealand Army Corps. While in the army, he invented and patented a device (the "Telecator") for diagnosing troubles in auto engines. Rights were purchased by the United States Government for a total of $46,000. On being discharged at the end of the war, Scott decided to move to the U.S. and make his home in Chicago.

During his early years in America, Scott wrote a column on automobile care that was syndicated in fifty newspapers in the U.S. and Canada. Becoming intensely interested in radio, he also began writing articles on the construction of radio receivers. In 1922, he originated the pictorial-style wiring diagram, which made it possible for non-technical radio fans to build their first sets. Eventually Scott, working out of a well-equipped laboratory for testing radio circuits, was supplying radio articles to 112 different newspapers.

Scott's entry into radio manufacturing began four years after his move to the United States. Deciding to pay a visit to his native new Zealand, he wanted to take with him a radio capable of receiving U.S. broadcasts. Building a superheterodyne circuit using Remler components, he arranged for two Chicago stations to send him special broadcasts at pre-determined times. The distance involved was over 8,000 miles and the Chicago stations were low-powered (1,000 and 500 watts).

Few radios of the era would have been up to this challenge, but Scott was able to receive the broadcasts from both stations, picking them up for over an hour. In fact, during his thirteen weeks in New Zealand, he was able to log 117 programs from 19 different stations, all at least 6,000 miles distant. This established four world's records for consistent night-after-night reception of stations in this distance range.

Ever the showman, Scott set out to prove that his radio was not a freak, but could be reproduced by any skilled builder. Sending to Chicago for a set of duplicate parts he built another receiver that performed as well as the first. He called this radio the "World's Record 9." Back in the United States, he began promoting the set, selling mail-order plans for its construction.

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POWERING-UP THOSE OLD FARM RADIOS

Rebuild an A and B Power Pack With A Handful of Inexpensive Parts

By Anthoni P. Jacobi

In the good old days of radio, there were many nice battery sets made for customers who didn't have ac power lines to their homes. These sets, generally called "Farm Radios," used either an A-B battery pack or a wet cell battery with a vibrator power supply. Many collectors pass them up because of the expense or mess of using batteries. In this article, we will present one alternative method of powering-up the battery-pack sets. These sets typically used four (sometimes five) 1.5 -volt tubes powered by an A-B battery pack of 1.5 and 90 volts.

As AC power became more available to those remote areas, small AC power packs appeared on the market to replace the batteries. The Perma-Power (or Porta-Pak) Model A seemed to be the most common unit. These packs can still be found at auctions and flea markets. they had an array of sockets on one side that would accept most styles of battery plugs.

Using such a pack is an easy way to electrify a your A-B pack farm set. If you can't find a " Model A" or equivalent, we will show you how to build your own in a forthcoming article. Since these power packs are now 35 or more years old, some updating and repairs will be necessary. They were originally designed for a line voltage of 110, and the norm is now closer to 120; they used selenium rectifiers, which would be unreliable now; and, of course, the filter caps will have "bit the dust" long ago.

The schematic of the Model A is shown in Fig. 1. One of its nice features is that an octal battery socket is included. If the battery plugs on your set have been lost or broken, you can substitute an old octal tube base. A+ goes to pin 1; A-to 4; B+ to 5; B- to 7.

These packs may be updated easily and inexpensively as shown in fig. 2. The filter capacitors (C3 and C4) are changed out, the old half-wave selenium rectifier is replaced with silicon diodes, and an LM317T voltage regulator is added to the 1.5-volt "A" supply. (The filaments on 1.5-volt tubes are somewhat delicate and even a small overvoltage can burn them out.) The high-voltage supply, which is not nearly as critical, is adjusted with series resistor R2.

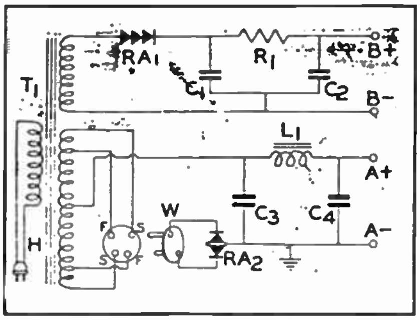

Fig. 1. Original Model A. RA1 and RA2 are selenium rectifiers; R1 is 1800 ohms.

If you make the bridge rectifier used to replace RA2 from individual diodes instead of using a molded block, be sure to observe the polarity as shown on the schematic. Choose resistor R6 from a group of several 47-ohm resistors, selecting one that reads at the high end of the tolerance (about 49 ohms). This will give an output voltage between 1.4 and 1.5. Mount resistor R2 in such a manner that it can be changed easily. You may have to tailor its value to fit your set (see below). Note also that resistor R1, originally 1800 ohms, is replaced with a 1500 ohm unit and that a 100k bleeder (R3) has been added to discharge the capacitors when the unit is not connected to a set.

The 317T regulator requires a heat sink. Radio shack's#276-1363 is handy, or you can make your own by bending a 1 1/2" x 2" piece of scrap aluminum into a "U" shape. The 317T's mounting tab is wired internally to the regulator's center terminal, so both it and the heat sink must be insulated from case ground.The B- connection, contrary to usual practice, must also be insulated from ground. Test your rebuilt unit before connecting it to a receiver. The model A has an external 2-pronged plug that can be inserted in two different positions. Originally, this plug provided some control over the filament voltage. It is not needed now; just place it in the position that gives the highest input voltage to the rectifier and leave it there.

Next connect your multimeter to the low-voltage output terminals; it should read between 1.4 and 1.5 volts. To simulate the load of the receiver, temporarily connect a 4- to 5-ohm 1--watt resistor across the terminals. The voltage should not vary by more than .02. You should read about 140 volts across the high-voltage terminals. This should drop to 90-95 volts once the power pack is being used to operate a receiver. If not, adjust by changing the value of R2.

AC OPERATION FOR BATTERY PORTABLES!

1960

A AND B PORTA-PACK

1—Replaces batteries in any portable for economical operation in the home.
2—Saves battery waste in service shops when testing battery portables.

The Porta-Pak replaces both A and B batteries in any 1½ volt receiver. It fits the battery compartment of 98% of all sets. Contains no liquid and may be operated in any position. Costs less than 6c per hundred hours to operate. With a Porta-Pak the receiver is operating at peak efficiency all the time. It is as easily installed as batteries and readily removed in favor of batteries if it is desired to revert to portable operation on occasion. Uses 110 volts, 60 cycle.

Model A—Universal sockets to fit all 1½ volt receiver plugs. 6⅛"x 5⅛"x2¼".

Model B—Same as A except 9⅞"x3⅝"x2" for long, narrow type portables.

EITHER MODEL, List Price $7.50
YOUR COST **$4.41**

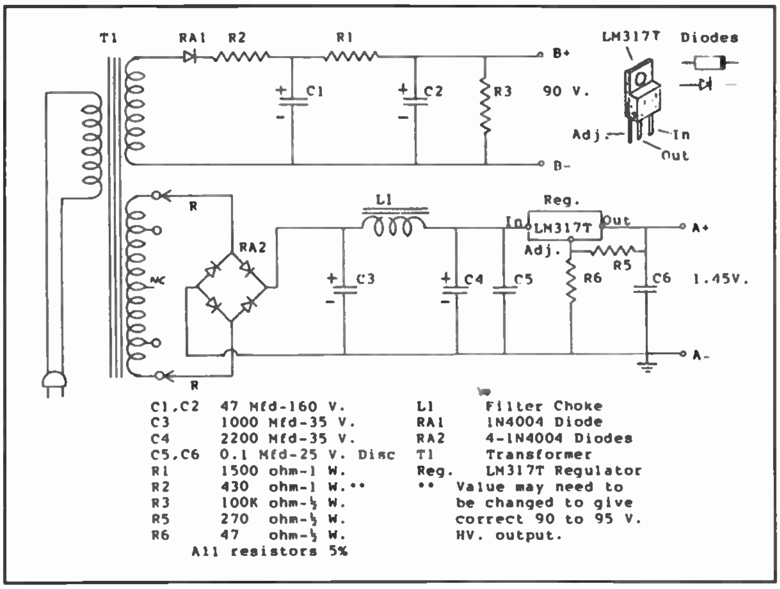

Fig. 2. Revised schematic for Model A power pack.

COMPANY CHRONICLES
(continued from p. 16)

Eventually, he began manufacturing his own brand of high-quality i.f. transformers for the circuit--changing the name of his operation from Scott Radio labs to "Scott Transformer Company."

Scott developed a number of "World's Record" designs, publicizing them in the radio press of the era. All of the designs specified Scott's "Selectone" transformers. Complete kits of parts were available for certain models. Later, as his reputation grew, he relied less and less on selling through designs published in newspapers and magazines and more and more on marketing his own kit models. These models used an ever-increasing percentage of "Selectone" components.

Because he did not have an RCA license, Scott could not legally manufacture completed super-heterodyne sets. So as the public began to lose interest in home radio construction, he had to come up with an alternative marketing plan. The plan was to sell his sets through custom set builders, who would put together the ready-to-play finished product using Scott components. This quote from a 1929 advertisement shows Scott's approach:

. . .there are thousands of people who want the best there is in radio and who know that the best cannot be produced by mass production methods but only thru the custom method of hand building.

This season, Scott products will not be sold direct to consumers nor thru jobbers, but exclusively thru professional custom set builders. We have adopted this policy because we believe in you and recognize the fact that your ability to deliver a far better receiver than any mass-production factory can make, and our protection of your market, will result in the growth of your business and, in turn, the growth of ours. . .

However, by 1930 the Scott ads and mailing pieces were taking a different tack:
A March, 1930 ad pictured the laboratory ". . .*in which all Scott receivers are hand-made to laboratory standards.*" A year later. a brochure offered the 1931 Allwave model to custom set builders at substantial discounts for resale, stating that the sets are "*built only in comparatively small numbers by experienced laboratory workers. . .all must pass Mr. Scott's personal inspection before they leave the laboratory.*" Eventually (1932) RCA did file suit for patent infringement and, though the suit was dismissed, Scott did accept an RCA license. The Scott Transformer Company peaked during the late 1930's and war years. Later, Scott was forced out and sales declined. The company merged with John Meck Industries in 1951, the year Scott died, and was in receivership by 1956. It should be noted that H.H. Scott, the well-known manufacturer of high fidelity equipment, was not related to E.H. Scott, nor were the two firms connected in any way.

The information for these company biographies was obtained from Alan Douglas' three-volume encyclopedia "Radio Manufacturers of the 1920's," published by Sonoran Publishing, 116 N. Roosevelt, Suite 121, Chandler, AZ 85226, and copyrighted 1988, 1989 and 1991 by Alan Douglas.

Complete Your Radio Collector Back Files!

Since this is the (admittedly somewhat belated) beginning of *The Radio Collector's* Volume 3, it seemed like a good time to give you the index presented on the next page. The index covers our first two years of publication, as well as the Pilot issue of September, 1993 (which was tentatively called *Vintage Radio*).

All of the feature articles and columns published during the two-year period are referenced by the date of the issue in which they appeared. Since our publication is so small, it didn't seem necessary also to provide you with page numbers.

I hope you find this index useful in helping retrieve articles that you'd like to refer to or re-read. And those who don't have a complete collection of "RC" will now have the opportunity to look back and see what they've missed.

As of now, complete back files of RC are available in one-year packages. Most issues are also available individually. Prices are as follows:

Complete 1994 plus Pilot (13 issues) — $35.00
Complete 1995 (7 issues) — $20.00
Individual Issues (as available) — $3.50

All prices include shipping and handling. Send your orders to:

The Radio Collector
P.O. Box 1306
Evanston, IL 60204-1306

THE INTERNET CONNECTION
(continued from p. 15)

surfer", it will pay to investigate ways of trimming that large phone bill or extra on-line time surcharges.

In closing, here are some web links related to this discussion.

Webcrawler
http://webcrawler.com

Yahoo! One of the Web's "Yellow Pages" directories
http://www.yahoo.com/

Lycos Searches
http://www.lycos.com

Mecklenmedia's Internet World
http://thelist.com/areacode/xxx.html (xxx = actual areacode number)

Here's this month's condensed message thread, once again from the *rec.antiques.radio+phono* newsgroup:

A radio restorer asked the newsgroup for methods of repairing or replace wood cabinet veneer. He wondered if "doing it yourself" might be a reasonable alternative to going to the expense of having it done professionally. Three other collectors responded with various home methods. Some of the tips were: Run seams with the grain for large areas. Do NOT use white or yellow Elmer's glue--always use contact cement--because the water-based glues will cause the thin wood veneer to warp and buckle. Practicing on a small test object like a cigar box was also recommended. Since veneer is cheap, sacrificing some to develop a good technique is well worth it. If possible use stains similar to the original aniline dyes. Use a shellac stick to fill in seams. Use a grain filler or sanding sealer to give a glass smooth surface to the veneer. Make sure that the underlying wood has been sanded smooth and all cracks, dents and bumps made perfectly flat. This will eliminate bulges and also make the veneer-to-wood bond much stronger. Involve a professional only when all else fails.

Conducted by Chuck Schwark
7454 N. Campbell Ave.
Chicago, IL 60645
e-mail address: CASchwark@aol.com

THE RADIO COLLECTOR INDEX

Feature Articles and Columns by Date of Publication — Volumes 1 and 2

CLASSIFIED ADVERTISING

Subscribers may place one free classified ad, up to 30 words long, in each issue. Count your name, ham call (if desired), complete address and one phone number as six words. Do not count the words in the boldface heading. Additional words are 15 cents each per issue. Non-subscribers pay 30 cents each per issue for all words. Free ads will be automatically run in two issues, but expire after their second insertion unless renewed by mail or phone. Those wishing to run the same ad for extended periods of time may want to use a "business card" space (see Display Advertising Dimensions and Prices table elsewhere in this issue). This is a boxed area in which we can print your business card or any advertising message that will reasonably fit (no charge for setting type). We reserve the right to make editorial adjustments in classified ads without advance notification and to refuse advertising at our discretion. We will reprint, without charge, any ad containing typographic errors, but assume no other financial responsibility.

Wanted Power transformer for Philco 45L (Ramirez p. 60). Philco #32-7226. Will consider junker chassis or trade Model 70 transformer (#5117). Will pay up to $25.00. Chuck Schwark, 7454 N. Campbell, Chicago, IL. (708) 673-0937 days. E-mail: caschwark@aol.com.

Wanted Early Crosley parts and sets, CR-1, Harko crystal, Harko Sr. (regenerative), Lowave, Audion Detector, No. VIII panel and cabinet, working chassis-speaker-knobs for Elf or Widget, Crosley table light (motion) No. 28-25, 2 audios for Tuska amp #226, 1 audio for Deforest Interpanel, speaker for Scott All Wave (2-dial) and duplex pickup. Gilferd L. Baker, Vintage Radio & Phono, Box 139, 1122 Pearl St., Emden, IL 62635.

Wanted Tuning knob w/insert, or just insert, and volume knob, for Emerson 707 Series B. Also tuning knob for Y600 (or similar) Trans-Oceanic. Terry Schwartz, 340 Oakwood Dr., Shoreview, MN 55126-4821. (612) 483-4173.

Wanted #1804 bayonet base panel lamp - stereo indicator lamp for Heathkit AD-19 stereo. Don F. Lehman, 378 Fairway Dr., Columbus, OH 43214-1848. (614) 888-0219.

Wanted Information and data sheets on FETRONS (junction-field-effect devices that replace vacuum tubes) manufactured by Teledyne in the 70's. Have a number of TR1010, TR1126A, TR1008, TR1006 and TS415A. Charles Brett, 5980 Old Ranch Rd., Colorado Springs, CO 80908. (719) 495-8660.

Wanted Old headphones, headphone parts, plugs, adapters, junction boxes, paper. I will purchase any amount, or trade for phones not in my collection. Dick Mackiewicz 1549 N. River Rd., Coventry, CT 06238. (203) 742-8552.

For Sale Reproduction crystal detectors, replacement Philmore domes, new loop antenna wire, grille cloth - more! SASE for details. Do you need some oddball part or information? Drop me a note. I'll try! Dick Mackiewicz, 1549 N. River Rd., Coventry, CT 06238. (203) 742-8552.

For Sale Crystal Radio Kits, complete with face panel, base board, variable capacitor, prewound coil and many parts for old style radio. Remit $22.50, Carl & Grace Ent., 5636 Romeyn, Detroit, MI 48209.

MONTHLY MINI QUIZ

Match wits with our quiz editor! See next month's issue for the answer, as well as the names of all readers who responded correctly.

Quiz For Jan/Feb: A lecturer at University College, Dundee (Scotland), he changed careers to specialize in meteorology and electrical engineering. This led him to radio echo location and in 1935 he began research on aircraft radio detection. In 1942 he was knighted by King George; only years later was it revealed that it was for work as a "pioneer in radio location" (i.e. Radar.)

Quiz For Mar/Apr: The objective tackled by this Canadian engineer was to reduce atmospheric noise (static). In 1919 he theorized (inaccurately) that noise travels in a vertical plane while radio signals travel horizontally along the earth's surface. Despite his faulty analysis, his solid work on the reduction of the static problem won him a lasting place in the history of radio. *Answer to Nov/Dec Quiz: Station WEAF.*

Conducted by Julian N. Jablin