

The Receiving Tube Story Part 3 - Introducing the Screen Grid

In the last issue, we continued the story of receiving tube development through the introduction of the first tubes specifically designed for a.c.-operated (plug-in) radios. The next major innovation was aimed at overcoming a serious problem that limited the amplification available from vacuum tubes operating at radio frequencies. The problem was caused by the internal capacitance that existed between a tube's grid and plate. The unwanted capacitance resulted in feedback that caused instability and self-oscillation.

To combat the problem, early set designers had to either neutralize the oscillation (as in the well-known "Neutrodyne" circuit) or find ways to lower the efficiency of tubes operating as r.f. amplifiers. Either way, the full amplification potential of the tubes could not be realized.

The tendency to self-oscillation increased as the frequency of the signal being amplified was raised. So the heightened interest in short-wave communications--beginning in the late 1920's--intensified the need to solve the problem.

Like so many important technological breakthroughs, the needed solution was arrived at, almost simultaneously, by experimenters

working in different countries. It was found that the internal grid-plate capacitance of a triode (three-element tube) could be reduced several hundred percent through the introduction of an additional grid between the original grid and the plate.

A technical explanation of the effect is beyond the scope of our discussion, but the capacity reduction was achieved through an "electrostatic shielding" effect obtained by maintaining the new grid at a voltage that was positive with respect to the tube's filament or cathode (but generally quite a bit less positive than that on the plate).

This added element was known as the "screen grid" to distinguish it from the "control grid," which carried the signal being amplified. The screen grid actually was a piece of fine-mesh wire screening wrapped into a

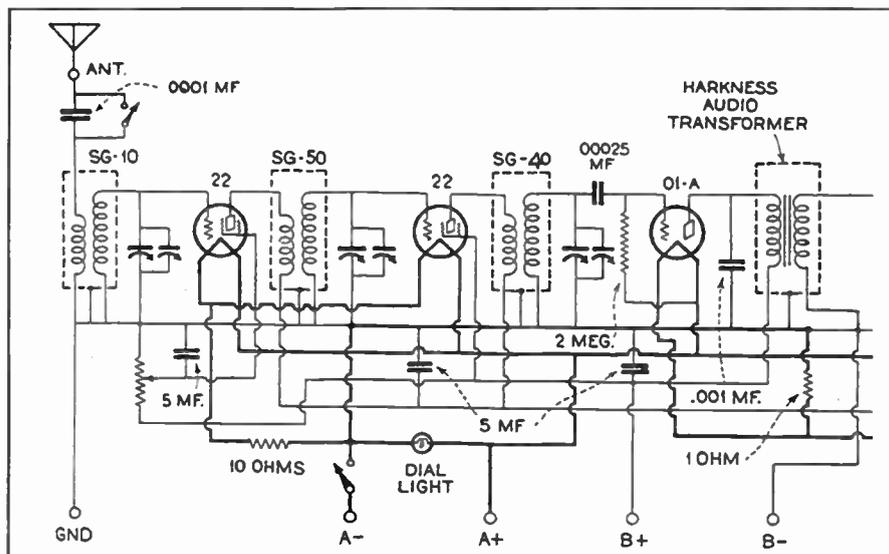
cylindrical shape. Tubes containing a screen grid were known as "tetrodes" (four-element tubes) to distinguish them from triodes.

The first screen-grid tube generally available in this country was the type 22 introduced by RCA. The 22, which was a battery tube, never saw wide usage because it was released as the era of a.c.-operated sets was dawning. In fact, the first true a.c.-operated tube (type 27) was already on the market when the 22 was introduced.

In providing a connection for the 22's extra grid, the designers chose not to alter the standard 4-pin base. Instead, they brought a lead out to a cap at the top of the tube. This was used for the control grid because, by separating the control grid connection from the leads going to the other elements, they could further reduce

grid-plate capacitance. The base pin previously occupied by the control grid was now connected to the screen grid.

The type 22 was quickly superseded by the a.c.-operated 24, released in May, 1929. This was a tetrode containing a cathode and a 2.5-volt heater like that on the type 27. It used the same 5-pin base as the 27, with base pins assigned to the



The "Harkness" battery-operated screen-grid set (1929) used type 22's as first and second r.f. amplifiers. Detector tube was the usual Type 01-A.

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Our voice line is (708) 869-5016; for 24-hour fax, dial (708) 869-5054. Answering machine picks up voice calls after 5th ring.

heater, cathode, plate, and screen grid. As with the 22, the control grid connection was brought out to a cap at the top of the tube. Very soon after the 24 was released, it was replaced by the 24-A, a quicker-heating version of its predecessor.



Most screen-grid sets you'll come across will use the type 24-A. Original issue was pear-shaped; this one has "ST" envelope.

The 24-A saw very wide use, and will be found installed in virtually all of the early screen-grid sets you will come across. Even sets originally equipped with type 24's were eventually re-tubed with the quicker-heating 24-A's. If you have any type 22's or type 24's in your collection, I'd suggest hanging on to them as collectibles. It's not that these tubes are now incredibly valuable. But they are certainly not common, and will be getting more rare as the years pass.

The introduction of the screen-grid tube had an impact at least as great as the introduction of the first a.c. tubes. One contemporary radio historian wrote:

...the improvement in gain and efficiency by this development over the original triode has not been duplicated by any single advancement since that time."

COMMENTS FROM THE EDITOR

IMPORTANT!

The Radio Collector Goes Bimonthly

Starting with this issue, RC is becoming a bimonthly publication; it will be published every other month instead of every month.

Before I explain why I've made that move, let me hasten to say that all current subscriptions are extended so that each of you will receive the number of issues you originally signed up for. Renewals and new subscriptions, however, will be on a six-issues-per-year basis. Subscription prices remain unchanged.

Now for the reasons. When I began publishing *The Radio Collector* last January, I deliberately set the price on the low side in order to build circulation. Your \$20.00 subscription price covered printing and mailing costs with a little bit left over.

However, over the past year, costs have been steadily rising. Postage, printing and mailing envelopes have all gone up to the point where outgo almost exactly equals income. And our subscription base is not yet at the point where I'd be justified in charging much more for advertising than the modest rates now in effect.

Obviously there's little point in running a subscription drive if all the new funds that are received must be earmarked to pay the out-of-pocket costs of fulfilling the subscriptions. So my options were to either raise the price or reduce the number of issues. I chose to do the latter primarily because getting RC out every month has been taking increasing amounts of my time, leaving little left over for developing promotional ideas or exploring new editorial approaches.

One of the things I'd like to do is make RC a 12-page publication, which will require developing additional editorial content. You can certainly assist by contributing articles, as outlined in this column last month.

To sum it up, then, I hope this strategy will help me make RC a better magazine and one that is more widely circulated. And I hope that all of you will stick with me while I work to accomplish these things. My goal is to go on publishing *The Radio Collector* for many years to come!

See You in Dayton

Are you planning to attend the giant hamfest and electronic flea market at Dayton, Ohio this year? The world-famous event, officially known as the Dayton Hamvention, will be held on April 28, 29 and 30 at the Hara Arena Conference and Exhibition Center. The outdoor flea market has well over 4,000 spaces and is obviously a mecca for browsers. *The Radio Collector* will be exhibiting at space 1948 this year, so keep an eye out for our booth! It won't be attended 100% of the time because I'll be working alone and definitely plan to do a little browsing

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(continued on p. 9)

PLAY IT AGAIN!

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

APPLYING POWER TO A BATTERY SET

Last month, we took you through step five of a methodical procedure for troubleshooting and testing the Atwater Kent 20C, a simple radio of the mid-1920's. This month we'll complete the procedure, applying power to try out the radio.

Up to this point, we have tested all major components in our example radio including the audio transformers. But we haven't yet talked about what to do if one of these is found to be open. In the 20C, the audio transformers are housed in round cans. Repair is not practical, but a bad transformer can be removed from its can and a small, modern unit installed inside. Suitable 3:1 turns ratio transformers are sold by many antique radio parts suppliers.

6. Transformer Replacement

In order to avoid mistakes later, make a sketch of the original connections to the bad transformer. Then unsolder the leads, unbolt the can, and put it upside down in a pie pan. Heat in the oven at 250-300°F until the potting compound is soft enough to pull out the contents. Put your new transformer in the can and pour enough potting compound back in to hold it in place. When it has cooled, bolt it back on the chassis and connect the wires.

On modern transformers, the primary leads are red and blue. Red goes to B+ and blue goes to the plate. The secondary leads are green and black. Green goes to the grid of the next tube and black to ground or C- depending on the circuit. This completes our component checking and we are almost ready to power up.

7. Speakers

Table radios did not have built-in speakers until around 1930. Prior to that time, the speaker was sold separately as an "accessory". Most were high impedance magnetic units, interchangeable among different brands of radios. You need a speaker to test your set. Even if you own a vintage horn or speaker, don't use it for testing. You risk damage if something unsuspected is wrong with the set.

Get an old tube-type AC/DC radio with a permanent magnet speaker. Remove the speaker and the output transformer connected to it (it's usually attached to the

speaker). Build a box to house these items and attach a long 2-conductor cord to the primary leads from the transformer. I use lamp cord. Most old radios have binding posts or tip jacks for the speaker connections, so solder phone tips on the free ends of the cord. You can get tips from parts sources listed earlier (October, 1994 issue). Now you have a good, high-impedance test speaker.

8. Powering Up

If you are restoring a battery radio, you will have acquired a battery eliminator from one of the sources listed in last October's column. Now it's time to connect the set to your eliminator. Some sets use binding posts for the battery connections, but the 20C uses a permanently attached cable. Such cables are usually in poor condition with the wire colors faded. Make sure the insulation on the cable leads is good. You may need to trim the end of the cable to get to good wire.

Trace out each wire with your ohmmeter to determine where it connects to the set, then mark it with a paper tag. This set has 6 wires in the cable, and we'll begin by connecting up only the A+ and A- leads (the ones running to the filaments). These are usually heavier than the other leads.

Measure the filament output of your eliminator and adjust it, if necessary, to 6V. Now connect the A+ and A- filament wires to the appropriate terminals on your battery eliminator. **Do not connect anything else at this time.** Insert a set of good 01A tubes, turn on the eliminator and the radio's power switch, then advance the filament rheostats. The filaments should light.

If not, measure the voltage at each tube socket between the two large pins (1 & 4). If you do not read 5-6V, you may have misidentified the cable wires or there may be something wrong with the switch or rheostats. A broken cable wire or poor solder connection in the set may also be the cause.

If the filament circuit is OK, remove the tubes and connect the rest of the cable wires to the appropriate voltage terminals on the eliminator. Turn on the eliminator and use your meter to verify that the correct B and C voltages are present at the proper points in the set.

The reason for this elaborate procedure

is simple: it is easy to get the B+ connected to the tube filaments, especially when you are not familiar with the set. It happened all the time in the 1920's and resulted in blowing a set of 01A's. Given the scarcity and price of antique tubes today, we can't be too careful.

Turn off the eliminator and the radio's power switch; turn the rheostats fully counter clockwise (off). Install the tubes and connect the antenna and speaker. If you don't have an outside antenna, string 10-20 feet of wire around the room. Sets operated from batteries required an earth ground to complete the antenna circuit, but battery eliminators usually have enough capacitance to power line ground to make an earth ground unnecessary.

Turn on the eliminator and the set, and advance the rheostats about 2/3 of full rotation. You should hear some noise in the speaker. Set the tuning dials at 0, then rotate the center and right hand dials together about 10 divisions. Now turn the left hand dial to the same setting. Continue doing this until you hear a station, then adjust each dial individually for maximum volume.

If the filament output of your battery eliminator is 6V (some give only 5V), do not turn the rheostats more than necessary to get 5V on the filaments. Use your meter to measure it and note the rheostat settings. Higher filament voltage shortens tube life without improving performance. Remember that the rheostats also serve as volume controls, so use the *lowest* rheostat settings which give adequate volume.

If your set still doesn't play after all this, you will have to employ the method we use with more complex sets - that of stage analysis. Next time we will show you how.

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 query. The correspondence will be also be printed in R.C.'s "Information Exchange" column so that all readers can benefit from it.

FILAMENT DROPPING RESISTORS

A Practical Method For Replacing 3-Wire Line Cords

By Walt Curry

This article is from the May, 1994 issue of the SCARS Gazette, published by the Southern California Antique Radio Society (14841 Archwood St., Van Nuys, CA 91405), and is reprinted here with permission. It is an update of the author's original article on the same subject, which ran in the Gazette's November, 1989 issue.

Reader Tony Jacobi, who had been following the discussion on 3-wire line cord replacement in our Information Exchange column, called the original article to our attention and Gazette Editor Fred Braddock provided us with the update.

Author Curry's story pulls together, and expands on, so many of the ideas discussed in the Information Exchange letters that I felt our readers would really benefit from seeing it.--Ed.

The Problem

The depression days of the 1930's forced manufacturers to develop simple, cheap table sets. One costly item to eliminate was the power transformer. Connecting the filaments in series directly across the power line was the answer and a series of tubes were developed with equal filament current ratings of 0.3 amperes. Of these, the output and rectifier tubes had the greatest filament power requirements so 25 volt filaments were developed for these tubes. Typical examples were types 43, 23A6, and 23L6 power output tubes and 25Z5 and 25Z6 rectifiers.

Four to six tube chassis using these tubes were designed as cheaply and compactly as possible and crammed into the smallest, cheapest cabinets that would hold them.

The heat dissipation from the filaments alone varied from about 19 watts for a 4 tube set to 23 watts for a 6 tube set. This may not sound like much, but it was enough to build up heat in the small cabinets and roast components causing reliability problems, notably with capacitors.

These 0.3 amp. filament strings would typically require only 62 to 78 volts, therefore some manufacturers installed a power resistor or a ballast tube in the cabinet to drop the line voltage resulting in an additional 14 to 22 watts being dissipated inside the cabinet. It didn't help if a "candohm" resistor was used with the chassis as a heat sink, since there was nothing to sink the chassis itself.

The Thirties Solution

Faced with this problem, manufacturers thought of using capacitors to drop the voltage while dissipating little power, but the size and cost of the capacitors made them impractical. About the only possibility left at the time was a line cord resistor which took the dropping resistor power dissipation completely out of the cabinet. It consisted of a regular line cord with one insulated wire spiral wrapped with resistance wire. These cords failed regularly due to overheating and resultant wire breakage and insulation breakdown. People would leave them coiled up or trail them past a steam radiator instead of stretching them out in a cool place.

Some of the early line cords still survive in working condition since the insulation was made of woven fabric rather than

plastic and it has retained its flexibility

Figure 1 shows an ad from a 1941 catalog and shows that line cord resistors were still an accepted method of powering filaments even though by this time 150 milliampere filament strings adding up to 121 volts were becoming commonplace in new production models

The Restoration Problem

What choices does the collector have if the line cord resistor has failed? These line cords are no longer being manufactured and most new old stock cords the author has seen had brittle and failed insulation. Removing one from its box and unraveling it is accompanied by ominous crackling and crunching sounds from a bad case of rigor mortis.

The restorer must therefore use a regular line cord while keeping heat out of the cabinet. This rules out putting a power resistor on the chassis unless the set will only be run for short periods to prevent overheating. Since these small cheap sets are now riding the crest of the art-deco craze, there is some urgency to this problem.

A Solid State Solution

A solution using a series diode is offered here using parts from Radio Shack or elsewhere costing about \$1 total. The two or three parts required can easily be tucked under the chassis.

Although a diode in series with the filament string is not a new idea, the author has yet to see an accurate analysis of its application. Analysis shows that the heating or RMS value of 1/2 cycle of line voltage is equivalent to .707 times the RMS value of a full cycle of line voltage. Thus with a 117 volt line the theoretical heating value that could be delivered by a diode to the filament string is 83 volts RMS. Observed diode and wiring losses reduced this to about 78 volts.

There is a problem concerning the pilot light. As tubes heat up their resistance can rise to a value 6 to 10 times that when cold. Tube filaments are designed to withstand a high cold surge current, and do so in all sets with power transformers. However pilot light filaments are more fragile and heat up faster than tube filaments, resulting in over voltage and pilot light burnout in a series string if surge current is not limited as with a line dropping resistor.

The solution is to shunt the pilot light with a Zener diode to limit the voltage across it during warm-up. A practical circuit is shown in figure 1, with Radio Shack part numbers for the diodes. Note that the diodes are oriented to conduct on

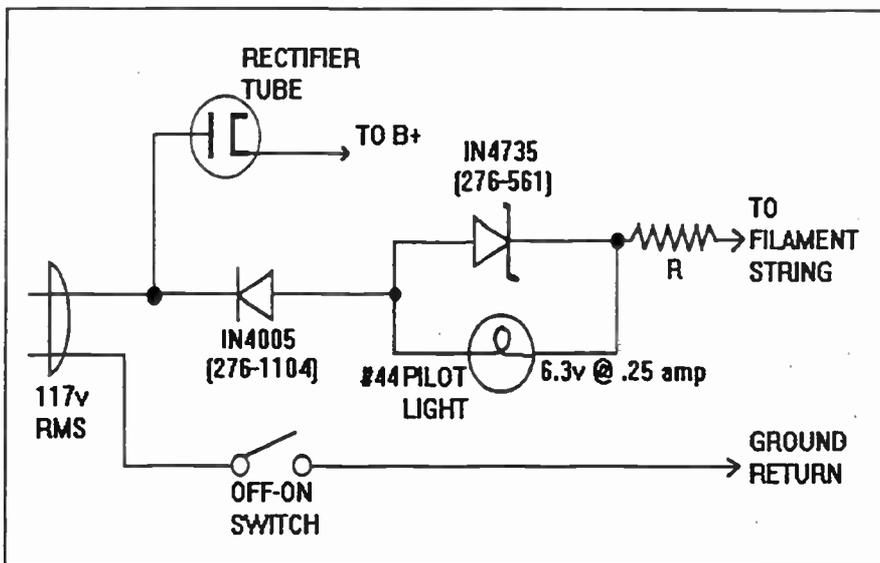


Fig. 1 Schematic of 3-wire line cord replacement circuit. See Fig. 2 for value of R.

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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.

ANSWERS TO QUESTIONS

Grounding Lore

In the December, 1994 issue, reader PV Petrosino (Oceanside, CA) asked for some coverage on grounds and grounding arrangements. Two of our regular columnists replied, and here are their comments.

If you can find a *real* old-timer, he'll tell you how they achieved a good earth ground way back when. They buried an old automobile radiator, with ground wire attached, as deep as they could, outside the window closest to the radio--running the ground wire in under the window sash. It worked well. All those copper fins adding area to the ground connection sure didn't hurt. However, the EPA would surely frown on all that lead (used to solder the radiator together) leaching into today's ground water.

For many years, I supervised installation of large CNC (computer numerical control) machines. We grounded them by driving an eight-foot-long, 3/4"-diameter copper rod into the earth next to the control. The rod was connected to the control with a piece of heavy copper wire. These copper rods, with the necessary clamps and wire, can be obtained very inexpensively at any good electrical supply store.

Stand on a stepladder as you begin driving in the rod. If you use a sledgehammer, you'll be able to drive the rod through almost an ground that is not severely infested with ledge or large boulders. **Caution!** Make sure there are no buried utility lines, gas pipes or water pipes in the vicinity.

The next best ground can be obtained by simply clamping a wire to a *metal* cold water pipe where it enters your house. For best results, use a large wire. I consider #18 to be minimum, #16 better, #14 even better, etc. *Never* connect your ground where a utility, telephone or building ground is connected.

If you live in a building that has wiring more modern than knob and tube, and the building's outlet boxes are metal, there's a good chance that you can find a decent ground by attaching a wire to a screw that holds a wall plate to a box.

Modern wiring may make use of plastic outlet boxes, which may not be grounded. Electrical codes stipulate that one pin of a two-pin outlet be returned to neutral, or ground. And, of course, modern three-pin outlets should have the third pin returned to neutral, or ground. Can you depend on this when looking for a "radio ground"? Absolutely not!!! Outlets can be wired backwards, without grounds, etc.

Hardware and electrical supply stores sell inexpensive indicating adapters that plug into outlets and, by a series of lamps,

will tell you what the problem is, if any, with any outlet. I highly recommend that every reader add one of these gadgets to his or her tool box. It could possibly save someone's life by revealing a fault that might otherwise never surface.--Dick Mackiewicz, Coventry, CT

Crystal and battery sets seem to require a ground connection more than a.c. sets. This is probably because, in a.c. sets, the signal finds its way to ground through the a.c. line. A good ground connection can be made by attaching a wire to a cold water pipe or radiator. A very good ground can be made by pounding a rod or pipe, preferably made of copper, as deeply into the ground as possible. Copper plates buried in the ground are excellent.

The soil should be kept damp at all times. Salt mixed into the soil will also increase conductivity (but is not good for surrounding plants). The connection between the wire and the pipe or rod, be it indoors or out, should be clamped tightly and soldered, if possible. If there is any chance of lightning (and this involves most of the planet), a lightning arrestor (best) or an antenna grounding switch (you have to remember to throw it) is required. A ground separate from the set's ground, and outside the house, is attached to the arrestor and the antenna lead-in is attached to the other side of the arrestor.

Three things about grounds are very important: (1) The ground for the lightning arrestor must be separate from the ground for the radio. (2) AC/DC sets should *never* be connected to ground (one side of the a.c. line is attached to the chassis; if the hot side of the line gets sent to ground, you can imagine the result. (3) Never assume that the extra wire sticking out of the back of a set is the ground. If it is not, the results could be disastrous.

Experiment with grounds on a.c. sets that have provisions for ground connections. Sometimes reception is improved, sometimes not. If the above-mentioned grounds are difficult to implement, one can try the third connection in a three-wire outlet or the screw that attaches the outlet cover to the box. These methods will work if, and only if, your house is properly wired. However, sometimes you get too much noise from the house wiring.--Paul Bourbin, San Francisco, CA

GENERAL INFORMATION

Hook-Up Wire Source

Keep your eyes open for discarded *older* telephone cables. They contain a wealth of wire that is very useful in radio work. The wire comes in a wide variety of color code patterns and, if you are lucky, you may even find some that is tinned.--Ray Larson, West Los Angeles, CA.

The samples Ray included with his letter contained solid, tinned wires that looked heavy enough to use for many applications in tube radio work. Most newer telephone cables contain lightweight wire useful only for solid-state projects.

Antenna Substitute/Cap Testing

The comment about the shielding effects of aluminum siding in last month's correspondence column reminded me of an "antenna substitute" idea that folks with such a problem might find useful. Run a wire from a metal plate placed under your desk phone to the set's antenna terminal. If you have an old dial phone, you don't need the plate. Clip the wire to the finger stop instead.

Regarding the suggestions on capacitor testing in last month's Information Exchange, here's my method: I always test for grid voltage on those tubes which have a capacitor coupled to the grid. If a positive voltage is found, I disconnect the grid end of the capacitor, fire up the radio and measure the d.c. voltage on the free end of the cap. If present, the cap is replaced. Usually positive voltage on the grid of the output tube will cause distortion.

I do this type of testing with a high input impedance or multimeter, analogue or digital. And I do it on all repair jobs, even if was something else, such as a bad tube, that stopped the set from playing.

Many people don't like digital instruments, especially for alignment testing, because the digits bounce around. However, some digital readouts avoid this problem by including a supplementary bar that grows or shrinks as the reading increases or decreases.--Stan Lopes Concord, CA

With his letter, Stan included an interesting 5-page flyer listing lots of old radios, parts, test equipment, literature, etc. at reasonable prices. He didn't give me any details, but I'm assuming that he'd be glad to send out a copy to anyone who will send a long SASE. Write him at 1201-74 Monument Blvd., Concord, CA 94520.

Cure For Slipping Dial Cord

I really enjoy *The Radio Collector*. The latest issue was just great. I read it the first day I get it and then wish there was more.

Here is a repair tip I discovered while working on a Philco set. The drive shaft for the dial cord on this radio had--at one time--been coated with a non-slip material. But that had deteriorated over the years and become ineffective. The cord would slip no matter how much I increased the spring tension.

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CORRESPONDENCE FROM OUR READERS

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

More on Rechargeables

Here's an addition to the discussion of rechargeable batteries in last issue's *Receiving Tube Story*. There were rechargeable "B" and "C" batteries. The "B" batteries resembled wooden soda bottle cases, with small glass battery jars in the dividers. The "C" batteries (and there were also "A" batteries that were similar) were composed of either two or four of these glass jars with a black Bakelite top that held the jars together.

Furthermore, Willard (and probably others) made an A-B-C battery composed of banks of glass jars. The Willard jars were in a metal divider case which somewhat resembled the old bottle carriers used for home delivery by milkmen.

All of these jar-type batteries could be charged with an a.c.-line-operated charger. I have examples of all of them, along with the original paper work on the Willard unit.

You couldn't play your radio with any type of charger connected to the batteries. The batteries had to be charged when the radio was not in use. And oh, did those batteries *smell* during charge! Never mind the mess when one tipped over, or "boiled over" during recharging, and the acid ate through the rug.

Many early radio men would pick up, recharge, and deliver the lead-acid (auto-style) "A" batteries. They would also rent you (for 25 cents or so) a battery to use while yours was being recharged. These entrepreneurs set up regular pick-up and

delivery routes much like the old milkmen.--Dick Mackiewicz, Coventry, CT

More on Early Full-Wave Rectifiers

Being a long-time tube collector and researcher, your ongoing story on vacuum tubes caught my interest. Since you had never seen an actual application for the UX-213 full-wave rectifier, I've enclosed a copy of an RCA ad for a B battery eliminator that used the tube.

Another interesting full-wave rectifier tube that appeared on the market in the same year that the UX-213 was released (1925) was the Westinghouse UV-196. It was developed for the Dubilier Co. for use in their "Super Ducon" B battery voltage supply. The '196 had only one plate, but full-wave rectification was made possible by the fact that it had two filaments (requiring two separate filament windings on the power transformer).

Since the two filaments occupied all four base pins, the plate was connected to the brass tube base--requiring the use of a special tube socket. Why this "inside-out" tube design was used is unknown.--Lauren A. Peckham, Breesport, NY

Mini-Quiz Answers

Last month, I was going to send in the name of Dr. Arthur Korn as the one who had sent still photographs from Rome, Italy to Bar Harbor, ME. Much earlier, in 1922, a picture of Korn was sent from Munich to Rome. On July 6, 1924, the

first radiogram was sent from New York to London. Signals were sent by wire from New York to New Brunswick, NJ, then by radio to Brentwood, England, then to London. A few books on the subject:

Facsimile, by Charles R. Jones (Murray Hill Books, 1949).

Radio Facsimile, Volume 1 (RCA Institutes Technical Press. Oct. 1938)

This month's quiz answer is John Logie Baird of Helenburgh, Scotland.

I like your new publication and think it fills a real need for many, especially the new collectors. Hope someday to write an article or two and send them to you. I started working on radios as a boy in 1943. I few years later, at age 15, I began attending electronic classes at the Technical Institute of the College of William and Mary. After completing high school and the Technical Institute, I taught radio for a few years (1949 to 1955), then went to California to work for Ramo Woodridge (new TRW Electronic Systems Group). Moved to Collins Radio to work on the Apollo project (1962) and stayed there until 1970--moving back to TRW until I retired in 1992. Have always worked in design and development of receivers/transmitters and systems.

I've been a collector of electronics books and material since the 1940's, getting into old radios in the mid 1980's. Eventually began specializing in test equipment and now have about 1200 items--including tube testers, general radio equipment and old 1920's radio service equipment.

Thanks for your new publication and keep up the good work!--Charles F. Brett, Colorado Springs, CO

Glad you enjoy RC, Charles, and I hope you come up with those articles soon. With your background and extensive collection, you'd certainly have a lot to say!

Needs Home-Study Radio Course

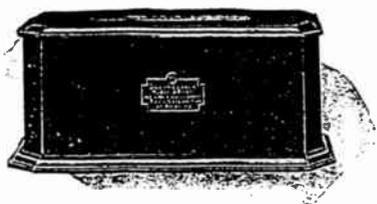
I'd like to locate a complete home-study course on radio and repair like the one offered by NRI.--Claude Jordan, Augusta, GA

Anyone who can supply such a course should contact Claude directly at 3010 Acorn Rd., Augusta, GA 30906.

Servicing By Sight And Sound

Referring to Tony Jacobi's article on output transformers (*January and February, 1995 issues--ED*): yes, it's true. When a speaker is connected to the secondary, it reflects its load into the primary.

When I worked in a radio store in the years right after World War II, we had a quick initial test for "All American five" ac-dc sets that came in with no sound.



RCA

Duo-Rectron "B" Battery Eliminator

DOU KNOW what a change there is in the performance of your radio set whenever you renew your "B" batteries. Your signals are stronger, sharper, clearer--and there is vitality and reserve power in your set that was not there before.

With an RCA Duo-Rectron you have the effect of new "B" batteries every day--but without the expense and without the bother of disconnecting and connecting.

The design of RCA Duo-Rectron takes into account the requirements of all types of broadcast receivers. It also takes into consideration the heavy current drain of experimental types of multi-tube sets which sometimes draw as much as 30 or 40 milli-

amperes in the plate circuit. Thus taps are provided giving plate voltages of 22½, 45, 90 and 135 volts. The maximum current obtainable is 50 milliamperes.

RCA Duo-Rectron cannot be judged by any previously existing type of battery eliminator. Regardless of the load placed upon RCA Duo-Rectron the voltage remains practically constant through the provisions of Radiotron UX-874. Any or all of the voltage taps may be used with the same fine results.

Though RCA Duo-Rectron operates from the 110 volt, 60 cycle, alternating current lighting circuit of your home, there will be no trace of alternating current hum in its operation. It has been completely eliminated through a specially designed filter system.

RCA Duo-Rectron, Model AP-937, with Radiotron UX-874 and Rectron UX-213 **\$65.00**

RCA battery eliminator (circa 1925) used UX-213 rectifier tube, also UX-874 regulator.

(continued on p. 8)

VINTAGE BOOK REVIEWS

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

WIRELESS TELEPHONY by Alfred N. Goldsmith. Published by The Wireless Press, Inc., New York, NY., 1918. 247 pages. Hardbound.1

Wireless Telephony was published when the transmission of voice or music by radio was in its infancy. Though the dots and dashes of wireless telegraphy were a fairly reliable form of long-distance communication, the transmission of sounds over the air was much more complex and less developed. This book describes the state of that art as it was just prior to the United States' entry into World War I.

The beginning chapter reviews the important aspects of wireless telephony: its uses; how it compared with conventional wired telephony; its major problems—including distortion, lack of secrecy and susceptibility to interference. The next four chapters deal with the various methods of producing a continuous wave suitable for modulation: arcs, sparks, vacuum tubes and alternators. The design of each type of equipment is carefully explained and illustrated with excellent drawings and pictures.

Then follows a group of three chapters devoted to methods of modulating the continuous wave in order to transmit sounds. The most basic of these methods was to use the varying resistance of the microphone directly to vary the current in the device producing the wave. This often damaged the microphone through overheating. A better method, requiring very little current to pass through the mike, was to use it to modulate the grid circuit of a vacuum tube. The tube, in turn, could control quite a bit of transmitter power.

In the third method, *ferromagnetic control*, modulation was

achieved through varying the flux in an iron core inductor. This was felt to be the only practical way to modulate high-power transmitters.

Chapter nine covers antennas, grounds and circuits for reception—including traditional, heterodyne, regenerative and ultraudion. Also discussed are methods for dealing with "strays" (static) and the distance ranges possible with radio telephony. The following (and final) chapter covers methods of handling radio telephone traffic, including point-to-point and ship-to-shore communication as well as radio-telephone links for wired phone systems. It is interesting to note that radio broadcasting is not even mentioned.

This book is a must-have for the radio historian. It is one of the last volumes of its kind published before World War I changed the face of radio forever. Both the equipment of the time and most of the "major players" in the field (with the notable exception of two California innovators: Herrold of San Jose and McCarty of San Francisco) are well documented. However, component values and other constructional details of the equipment are not covered.

The excellent index and table of contents are a great help to browsers, as are the headers summarizing the contents of each page.

Please feel free to correspond with me at any time about old radio books.

Conducted by Paul Joseph Bourbin
25 Greenview Ct.
San Francisco, CA 94131
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COMPANY CHRONICLES

Brief Biographies of Classic Radio Manufacturers

Stromberg-Carlson

Alfred Stromberg, one of the co-founders of this well-known firm, was born in

Sweden—coming to this country in 1884 when in his mid-20's. He met Androv Carlson, who had a similar background but was a few years older, while working for the Chicago Telephone Company. Both men were experienced inventors and mechanics and in 1894, the year the last of Bell's fundamental patents expired, they formed a partnership to manufacture telephone equipment. The company was successful, becoming a major supplier to the independent Rochester (NY) Telephone Company. Stromberg-Carlson was sold to a group of Rochester capitalists in the early 1900's.

Stromberg formed two new Chicago-based companies about 1906. One became the Stromberg Carburetor Company, and was eventually (1929) acquired by Bendix. The other, Stromberg Products, now makes time clocks.

The original Stromberg-Carlson organization diversified into the wireless field in 1910, initiating a small component-manufacturing operation. The firm made some headsets for the Navy in 1915 and, a little later, began manufacturing audio transformers and other parts. In 1916 Ray Manson, an electrical engineer who held many patents on telephone, radio and phonograph equipment joined the company as Chief Engineer, remaining with Stromberg Carlson until the mid-1950's.

In 1923, the company took out a Neutrodyne license so that it could begin manufacturing complete receivers. At first, Stromberg Carlson made only a limited number of sets, selling them locally (in New York and surrounding states). However, they were heavily

advertised, stressing S-C's quality image. By 1926, wholesale sales were in the \$700,000 range and about 15 percent of the company's approximately 1250 employees were engaged in making radios.

Unlike many other radio manufacturing companies of the era, Stromberg Carlson had no need to circumvent, or dispute, the ownership of radio patents. They simply signed up for whatever key licenses were available, passing the costs on to their customers. When RCA began offering licenses in 1927, S-C acquired the fourth one issued.

Remarkably enough, the company's strategy of offering high quality at a high price proved successful (or at least successful enough to keep the firm from foundering) even through the depression era. Revenues from radio station WHAM (the NBC affiliate in Rochester, NY), acquired by Stromberg Carlson in 1927, also helped during this difficult period.

The company continued to expand its high-quality consumer electronics business over the years, but began deemphasizing this area after merging with General Dynamics in 1955. Radio and television production was discontinued the following year. Radio-phonograph and high-fi component production ceased in 1961. However, the firm is still heavily involved in the telephone business.

The information for this company biography 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.

CORRESPONDENCE
(continued from p. 6)

Looking down into the audio output tube, we checked for a presence of a strange glow besides the glow of the filament. It was the sign that the speaker voice coil had opened, removing the plate load on the tube causing it to draw too much current. Watching for visual signs saved using test equipment until needed.

Later on, I used visual and audible symptoms to speed up servicing TV sets in people's homes. I usually waited until the customer stopped talking and the kids left the room. If I could hear the power transformer hum when I plugged in the line cord with the power switch on, the cord and fuse were ok. If, after that, I heard the vertical oscillator buzz, that was ok. If I heard the horizontal oscillator and high-voltage his, I knew those circuits were ok.

Next I checked the filament of the picture tube and those of any other tubes that were visible, following up with a check of what was on the screen. I'd also often question the customer to uncover other clues about what might have caused the problem—such as a thunderstorm in progress at the time the set went out.

You could cover a lot of ground without unpacking the test equipment and often save quite a bit of time!—Alton A. Dubois, Jr., Queensbury, NY

Radio Memories

When I was a kid 6 or 7 years old, my mom and dad had a General Electric (Model LFC 1118 I think) console radio. Even at that young age, I was fascinated with the set (as well as with all radios and phonographs). I'd sit in front of it for hours listening to my favorite programs or standing on my tip toes to watch the record changer work.

Even more fun was to sit in back of the set looking at the warm glow of the tubes (to this day one of the prettiest sights in the world) in a darkened room while listening to my favorite programs. Listening to the police calls (around 1700 khz at that time) was a special late-night treat.

I now have 20 old radios in my collection—mostly sets that I remember from my youth. I'd dearly love to find a GE LFC 1118 like the one in my old home and a GE H-87 like the one my grandma had.—Bill Miedma, Tower Lakes, IL.

If any reader can help Bill get his hands on one of these sets, please write him at 101 Devonshire Rd., Tower Lakes, IL.

Oops Department

The '26 filament operates on 1.5 volts at 1.05 amperes, *not* 1.5 amperes as indicated in last month's cover article (*Sorry about the typo!—ED*). The reason that this tube could operate on an a.c. filament source without being equipped with a cathode was the "heat inertia" of its heavy, high-current filament. Slow to heat up and slow to cool, it tended to smooth out the pulsations of

the a.c. source.

By the way, if you have an RCA Volt-Ohmmist, check your instruction book. It contains helpful instructions for testing capacitors using the high resistance range.—Orval Parker, Pocono Summit, PA.

INTRODUCING THE SCREEN GRID
(continued from p. 2)

Certainly, the impact on radio listeners, hobbyists and manufacturers was profound and immediate. Listeners marveled at the distant stations they could pull in with the new circuitry, and the magazines and trade papers were full of manufacturer's ads hyping new screen-grid sets. Hobby magazines overflowed with articles explaining screen-grid theory and providing constructional details on receivers utilizing the new tubes.

The development of the screen grid tube made it possible for the tuned radio frequency (TRF) radio design, originally embodied in the old "3-dialer" battery sets and also used in most early a.c. radios, to approach the sensitivity of the much more efficient superheterodyne circuit. This was a boon to the many manufacturers of the era who were reluctant to invest in an expensive superheterodyne license from RCA.

While the development of a.c. tubes had provided new *convenience* for the radio set owner, the development of screen-grid tubes enhanced his *power*—power over the airwaves that distinguished him from less-affluent neighbors who couldn't swing the new equipment.

In an era when almost all types of technology were advancing rapidly, the introduction of the screen-grid radio was just another part of the picture. Switching to one of the new sets was a little like trading in the old 4-cylinder Ford on a supercharged Lincoln V-12. And the physical appearance of a screen-grid receiver certainly fostered that illusion. A

row of three or four 24-A's, each with its top cap connected to the variable capacitor via a heavy rubber-covered wire, projected an image of power and energy—not unlike the ignition system of a high-performance car.

The unique electrical characteristics of the screen-grid tube created an effect called "cross-modulation," which tended to reduce the selectivity of the set's tuned circuits. This was a problem because, by the time the screen-grid sets were being marketed, many parts of the country were able to support several powerful radio stations—all operating in the same metropolitan area.

Once again, the theory here is beyond the scope of our discussion—but the problem was corrected by redesigning the control grid of the tube. The spiral of wire forming the grid was changed so that the distance between its turns was non-uniform. Besides correcting the selectivity problem, the design change provided some important additional benefits.

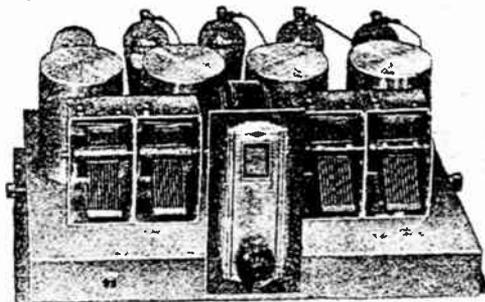
The amplification of a tube equipped with the new-style grid could be smoothly controlled by varying the d.c. grid bias that was applied. This effect would make possible the design of efficient automatic volume control (AVC) circuits. Such circuits reduced the set's sensitivity when strong local stations were being received, thus preventing overloading, while automatically increasing gain to the maximum for the reception of weak, distant signals.

Tubes with a grid having this design are called *variable-mu*, *remote-cutoff* or *super control* amplifiers. The first variable-mu tetrodes became available in 1931. RCA designated its version the type 35, while the virtually-identical tube released by most other manufacturers was dubbed the type 51. Like the 24 and 24-A, these tubes had cathodes and 2.5-volt heaters based on the design pioneered in the type 27. Though

(continued on p. 10)

A New Screen-Grid Tuner

by Glenn H. Browning and James Millen



1929 National Company ad hyped screen-grid tuner by two prominent radio designers.

DICK'S CORNER

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

Rewinding Speaker Fields

Recent articles in RC have discussed repairing/rewinding loudspeaker field coils in order to preserve the originality of the set. If, as sometimes happens, the break is found fairly close to the outer end of the coil, reestablishing continuity can be an easy job. Put the coil back in service and see what happens. But if you've had to unwind a significant number of turns to uncover the open place, don't waste your effort by simply fixing the break and winding the turns back on.

If there was one "weak" spot in the coil winding, there may very well be more. Some areas of the wire might be thinner than others. This might have been caused by irregularities during original manufacture or, perhaps, by excessive stretching of the wire as it was wound on the form. The overload that caused the original break could easily have melted other "thin" sections almost to the point of breaking. It's better to rewind the entire coil, even though the process can be difficult and tedious.

Before unwinding a defective coil, determine the original wire size by means of a wire gauge or micrometer. Use a gentle touch on the micrometer to avoid measuring distortion. Count the number of turns (this may be in the thousands!) as you unwind the coil so you'll know how much of the new wire to put on. Alternatively, using the wire size and the specified d.c. resistance of the coil (usually shown on the set's schematic), you can refer to a wire table to determine the number of feet of new wire required.

The d.c. resistance of the rewind coil must match that of the original, or some (or all) of the set's B+ voltages may be off. The speaker field coil is usually part of the set's power-supply filter, where it also acts as a voltage divider. It may even be tapped to obtain the necessary B+, in which case, you'll have to be very

careful to record, and match, the number of turns between the tap and each end of the winding.

Always use the original wire size in your coil. Smaller-gauge wire may not be able to safely carry the current required by your set. Larger wire, even if only one size larger, may overfill the form when enough turns are wound on to satisfy the resistance requirement. Even correctly-sized wire may not fit on the form unless the turns are wound uniformly and evenly--admittedly a very difficult and demanding job.

The clever restorer will find a way to motorize the process, rotating the coil form with a small electric unit adjusted to run at a very low speed with the help of an SCR controller. A simple friction control on the feed wire spool can be adjusted to obtain the proper "drag" for a tight (but not stretched!) and uniform winding.

Finding a source of wire for your new coil can also pose a problem. Most distributors of electronic parts stock magnet wire in small spools only. It may be necessary to deal directly with a wire company to obtain spools of sufficient length to wind a complete coil without splicing. You might also check with a local motor rewinding company. Such concerns purchase magnet wire on huge spools, and may be able to accommodate your needs if they happen to have the proper size in stock.

As you can see, rewinding a field coil isn't something you can accomplish quickly or without careful thought. But please don't be discouraged from doing it! Replacing the whole speaker with a modern permanent-magnet unit, as discussed in the last issue of RC, is certainly easier. But retaining the original speaker will definitely preserve the integrity of your set and enhance its value.

Conducted by Dick Mackiewicz

FILAMENT DROPPING RESISTORS

(continued from p. 4)

the negative half cycles while the typical B+ rectifier conducts on positive half cycles. This will reduce hum. The chart in figure 3 shows the design center values of R for various filament string combinations with 117 VRMS, making allowance for circuit losses. Heat dissipation is typically a couple of watts.

At least this circuit won't crumble with age.

Filament String VRMS	Pilot Light	R
62.6	NO	50Ω/5W
62.6	YES	40Ω/5W
68.9	NO	30Ω/5W
68.9	YES	20Ω/5W
75.2	NO	10Ω/2W
75.2	YES	10Ω/2W
25.2*	NO	175Ω/25W

Value of R (see Fig. 1) for various filament string voltages with and without pilot light.

COMMENTS FROM THE EDITOR

(continued from p. 2)

myself! However I will post times when I'll be present, and would certainly enjoy having the opportunity to meet with RC readers.

New Fax Number

Since announcing our new 24-hour fax service in the January issue, I've noticed that there have been a number of uncompleted calls. I've traced some of the problem to my automatic switch, which is supposed to route voice calls to the phone and fax calls to the fax machine. Apparently some of the incoming faxes have not been preceded by the tone signal that is supposed to trigger the switch.

To get around the problem, I've subscribed to the phone company's "distinctive ringing service," which rings my line in a special pattern when a special number is called. The switch senses the pattern and puts the call through to the fax machine whether or not the tone signal is present. The number, which is (708) 869-5054, should be used for all fax calls. The number for voice calls is still (708) 869-5016.

If your fax does not get through, even on the 5054 number, I'd like to hear about it. I'd be glad to accept collect calls concerning this problem, but am not always around to do that. So if you wouldn't mind leaving a brief message on my answering machine, I'll call back at any time convenient for you.

MFE

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 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.

Wanted General Electric consoles models LFC 1118 and H-87. If you don't want to sell, I would appreciate pictures. Bill Miedma, 101 Devonshire Rd., Tower Lakes, IL 60010-1209. (708) 526-6131.

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

For Sale Pioneer SX-780 and SX-980 AM-FM stereo amps, 1970's vintage, \$50.00 ea. Sencore tube tester TC 136 \$35.00. RCA Sound Products catalogue (1948) copies. 83 pages of amps, mics, spkrs. \$15.00. Kevin L. Moe, 616 Lockrem St., Ottawa, IL 61350. (815) 433-4598.

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 40-year accumulation of old radios, parts, tubes, service data. Cash and carry only. Phone, write. No lists. Krantz, 100 Osage Ave., Somerdale, NJ 08083-1136. (609) 783-0400.

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INTRODUCING THE SCREEN GRID

(continued from p. 8)

the type 51 was discontinued not long after it was introduced, most manufacturers of replacement tubes labeled the type 35 as "35/51"—indicating that it would replace either version. This practice went on for many years, and tubes labeled 35/51 seem to be more common than those specifically designated with either number.

Though screen-grid tubes burst on the radio scene like a skyrocket, their impact was fairly short-lived. The tetrode was replaced, in its application as a radio-frequency amplifier, by a new class of tubes known as *pentodes*--about which, more later!

MFE

INFORMATION EXCHANGE

(continued from p. 5)

My solution was to remove the drive shaft from the radio (after making a diagram of how the dial cord was strung) and dip it in the liquid (sold in hardware stores) for making non-slip handles on tools. After letting it dry per instructions, I reinstalled the shaft and the cord hasn't slipped since.--Bill Miedema, Tower Lakes, IL.

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.

On Christmas eve, 1906, this U.S. engineer broadcast music and voice signals, heard over a wide area by many ships at sea, from an experimental East Coast station.

Answer to last month's quiz--John Baird. Correct answer sent in by Charles F. Brett.

Conducted by Julian N. Jablin



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