The Radio Collector®

January, 1995

The Receiving Tube Story

Part 1 - Storage Battery and Dry Cell Tubes

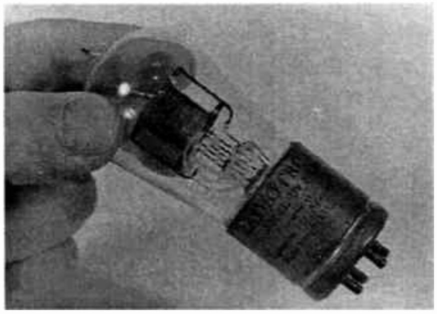
This month we begin a brand-new series of "cover stories" featuring the development of the vacuum tube. It's a potentially vast subject, so let's start out by carefully defining the scope of the discussion.

First of all, we'll avoid delving into ancient origins--beginning our coverage with the earliest types you'll be most likely to come across in the sets you collect. That means we won't be talking about such things as the Edison effect, the Fleming valve or the Deforest Audion. Nor will we be including industrial or special-purpose tubes.

What we *will* be concentrating on are American tube types, beginning with the ones first mass-produced during the early 1920's for use in home broadcast sets. And we'll take the discussion up through the termination of civilian radio production at the beginning of World War II.

Storage batteries used to light early tubes were similar to automotive units.

Though there's no way that every tube type designed during the period can be covered, we will discuss the development of all major families of vacuum tubes (diodes, triodes, tetrodes and pentodes) as well as the innovations in tube "packaging" (physical design of bases, tube elements and envelopes) that took place during these years. And since


One of the first receiving tubes to reach consumers in quantity was the UV-201.

the development of the radio receiver depended on, and paralleled, the development of the vacuum tube, the information you'll pick up in this series will assist you in understanding the sets you find and placing them in the proper historical perspective.

Earliest Common Receiving Tubes

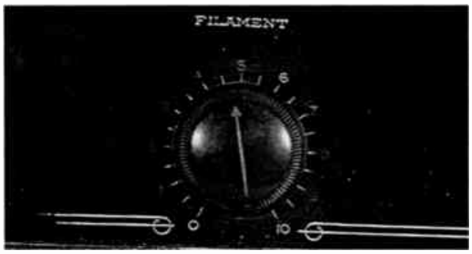
Let's go back to a point just before the excitement of the "broadcast boom" began--the year 1920 to be exact. In that year, the fledgling RCA company placed its first two receiving tubes, the types '200 and '201, on the market. Products of technological advances made during World War I, these tubes were manufactured under a key cross-licensing agreement that enabled the major patent holders to pool their expertise.

Both tubes were *triodes*, which meant that they contained three basic elements: a *filament*, *grid* and *plate*. When such a tube is connected to appropriate external circuitry, the filament generates a stream of electrons (or electric current) which flows, via the plate, through an external load.

The grid (a spiral of wire surrounding the filament and placed between it and the plate) controls the flow of electrons. Small voltage changes on the grid can cause large changes in the tube's plate current--which makes it possible for the tube to amplify radio or audio signals.

The type '200 was primarily a *detector*, designed for the job of separating the audio information in a signal from the radio frequency carrier wave; the type '201 was primarily an amplifier. Construction of the two was virtually identical, except that the glass envelope of the '201 contained only a vacuum, while that of the '200 contained a small amount of argon gas--introduced after the air was pumped out.

A source of direct current (typically an automobile-type storage battery)



Rheostats were used to maintain filaments at proper voltage as battery ran down.

was required to light the tungsten filaments of these tubes. Alternating current, supplied from the power lines via a small transformer, would have been much more convenient and economical--but would have introduced an unacceptable hum into

The Radio Collector®

Volume 2, Number 1

The Radio Collector is published monthly by Marc F. Ellis. Subscription and advertising rates, as well as magazine format, may be revised at any time.

How to Subscribe:

Annual subscription rates are as follows: via surface mail $20.00 (U.S.), $21.50 (Canada--U.S.funds); via air to other countries, $35.00 (U.S. Funds). Make out checks or money orders to *The Radio Collector* and mail to our post office box (see "How to Reach Us" below).

Back issues, when available, are $2.50 each, postpaid.

Classified Advertising

Subscribers may place classified ads in *The Radio Collector* at no cost. See classified section for instructions and limitations.

Display Advertising

Rates and size requirements for display advertising are posted elsewhere in this issue.

Contributions

The Radio Collector welcomes the submission of articles, tips, and/or photos covering any phase of radio collecting. We are particularly interested in contributions that will assist newcomers to our hobby. Submissions will be printed at our discretion and may be edited. Unless special arrangements are made, submissions will not be returned and, if printed, become our property.

How to Reach Us

To order a subscription, or place an advertisement, write ***The Radio Collector*, P.O. Box 1306, Evanston, IL 60204-1306.** Please include full payment for financial transactions, including any fee for extra words. Classified ads should be submitted on a separate sheet from other correspondence. **We can be reached by phone or 24-hour fax at (708) 869-5016** (Fax calls automatically transferred to fax machine; answering machine picks up voice calls after 4th ring).

the signal. The filaments of both types operated on five volts at one ampere.

The operating voltage was selected to work with the six-volt storage batteries of the era. When a battery was freshly-charged, its voltage was reduced appropriately by a heavy-duty *rheostat* (adjustable resistor) wired in series with the filament. As the battery became depleted, the resistance of the rheostat could be decreased to keep the filament voltage reasonably constant.

Birth of the '01-A

The one-ampere current draw of the '200 and '201 filaments was a bit of a problem. Frequent battery recharges were required, particularly if the set contained several tubes.

In 1923, however, General Electric released the '201-A--which was equivalent to the '201 but required only 25 percent of its filament current (.25 ampere). This was accomplished by introducing a small amount of the element thorium into the tungsten filament. The '200-A (thoriated-tungsten filament version of the '200) was not released until a few years later, and never saw wide distribution.

The '201-A (or 01-A, as we usually refer to it) became very widely-used both as an amplifier and a detector. In fact it was probably one of the most-manufactured tubes of all time, having been sold under at least 500 different brand names.

Type numbers and Base Styles

You've probably wondered at the apostrophe we've been using as a prefix to the tube type numbers mentioned so far. That convention is also employed in a lot of early radio literature, with the apostrophe substituting for omitted parts of the nomenclature. Such shortcuts were often taken with the elaborate nomenclature system originally used for tube types. The system was eventually scrapped by the radio industry, and isn't even much used in discussions among collectors, but you should have a working knowledge of it.

In its complete form, a tube type designation included one or two letters followed by a three-digit number. One of the letters and the first digit of the number were arbitrarily assigned by the manufacturer and had nothing to do with the characteristics of the tube. The other letter (or in some cases, the absence of same) served to indicate the base style. The final two digits of the number always identified the tube type.

As cases in point, the RCA UX-201-A and Cunningham CX-301-A were identical--as were the RCA UV-201-A and Cunningham C-301-A (NOTE:absence of the "V" in the Cunningham number is *not* accidental). Eventually, however, RCA's prefix letters came to be used generically to represent a tube's base style.

As originally manufactured, the '200, '201 and '201-A had a standard base with

(continued on p. 8)

COMMENTS FROM THE EDITOR

As this first issue of our second year of publication goes to press, it seems appropriate to take stock of where we've been and think about where we're going. During the first 12 months of The Radio Collector's existence, our thrust was to develop an editorial style for the magazine. We were fortunate enough to be able to recruit, early on, some very dedicated and knowledgeable individuals to be serve as columnists. With their help we've been able to bring you a professionally written and produced journal that, I think, has shown definite improvement with each successive month of publication.

With the editorial format of the magazine well established, a major thrust of the coming year will be to encourage more contributions from readers. We actually began this initiative late in 1994 in conjunction with our subscription renewal drive, and you folks out there really rose to the occasion! Thanks to the increased reader participation, we've been able to keep our extra center sheet (increasing the page count from eight to ten) for the third issue in a row. And I think you'll agree that these contributions have really made the magazine come alive!

To make it more convenient for many of you to send in your letters, articles and classified ads, *The Radio Collector* is now fax-equipped. Access this 24-hour service through our voice number (708/869-5016); fax calls will be automatically routed to the machine. We also want for you to be able to contact us by e-mail, if you'd like to

Arrangements are in the works, and will be announced when completed.

To provide you with a further incentive for sending in your material, we do plan to offer a modest reward for suitable articles. We'll be looking for short pieces about the size of one of our regular columns (or maybe a little longer) and longer ones about the size of our cover stories. A good contribution of the shorter type will earn you a Radio Collector Coffee Mug Award; a good longer one nets a two-month subscription extension. Awards will be retroactive for articles we've already printed. Check this column next month for details on kind of material we're looking for, physical standards for the articles and other information.

Several readers have asked us for help in contacting others with similar interests and/or who are close to them geographically. In response to this need, we will now accept classified ads with an *I'd Like to Contact* heading to be used for networking among our readers. Ground rules for this category will be the same as those for the *Wanted* and *For Sale* ads (see announcement under the CLASSIFIED ADVERTISING heading on the last page). I'll break the ice on the new category with an ad of my own in this issue!

I've about run out of space, but I want to call your attention to the small, but important, modification made in our slogan at the bottom of page one. More about that next month! **MFE**

PLAY IT AGAIN!

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

TUNED RADIO FREQUENCY AMPLIFIERS

The basic regenerative receiver we discussed last month was amazingly sensitive considering its extremely simple construction. But now let's consider what approach might be used to improve its performance further.

Since the two stages of audio amplification we added last month did make the signal louder, you might think we could add more audio stages, as needed, to get unlimited amplification for weak signals. But we can't. Every tube and component adds random thermal noise to the signal. The noise gets amplified also, and a lot of audio stages in series would result in overwhelming noise. Moreover, detectors have poor sensitivity to weak signals, so no matter how much audio amplification we use, that problem remains.

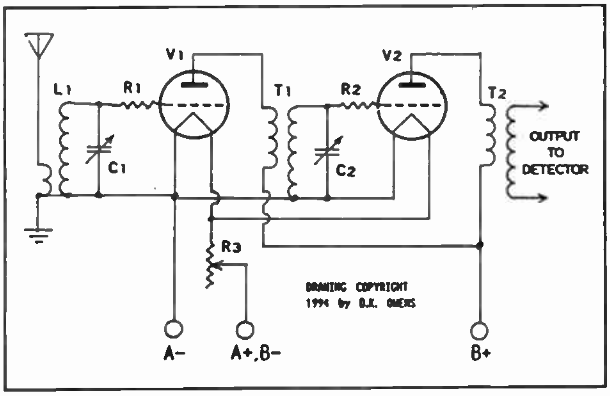


Fig. 1 Two stages of TRF amplification (V1 and V2)

TRF Amplifiers

The solution is to amplify the radio frequency signal *before* it reaches the detector. That way, the signal to noise ratio is improved, and the detector can be given a signal at the level where it is most efficient. Since each stage of RF amplification as well as the detector is tuned, selectivity (ability to discriminate between stations on nearby frequencies) is greatly increased.

The tuned radio frequency (TRF) amplifier was patented in 1913 by E.F.W. Alexanderson of General Electric and became part of the RCA patent pool. From 1924 to around 1930, millions of TRF sets were sold including the popular Atwater Kent battery and AC radios as well as the RCA Radiola 16, 17, 18 and 33.

A TRF amplifier is shown in Fig. 1. This is the circuit favored by Atwater Kent. The antenna coil, L1, has more secondary turns than primary, so it steps up the signal voltage to the grid of V1. C1 tunes this stage. The amplified signal from V1 goes through a RF transformer, T1, where it is stepped up again to the grid of V2 and tuned by C2. The output of V2 is stepped up once more through T2 and fed to a grid leak detector. Not shown is a third tuning capacitor for the detector. Voltage gain in the RF transformers is typically 1:4. R3 is the usual filament rheostat. The purpose of R1 and R2 is explained below. Note that the grids are returned to A- like the audio amplifiers we discussed last time.

Taming Oscillation in triodes

Triodes (three-element) tubes used as RF amplifiers have a serious problem resulting from their significant grid-to-plate (g-p) capacitance. Remember that we said the signals at the grid and plate are 180° out of phase *when the plate load is resistive*. When reactive components like coils are in the plate and grid circuits, there are frequencies where the signals are in phase and will feed back through the g-p capacitance.

When this happens, the set oscillates and squeals. One stage of RF amplification can usually be made stable by shielding, careful attention to wiring layout and mounting the coils at right angles to each other, but 2 or more stages are difficult. Resistors R1 and R2 damp the oscillations and prevent them from building up to the point of squealing. There is a penalty; the resistors reduce the gain of the amplifier.

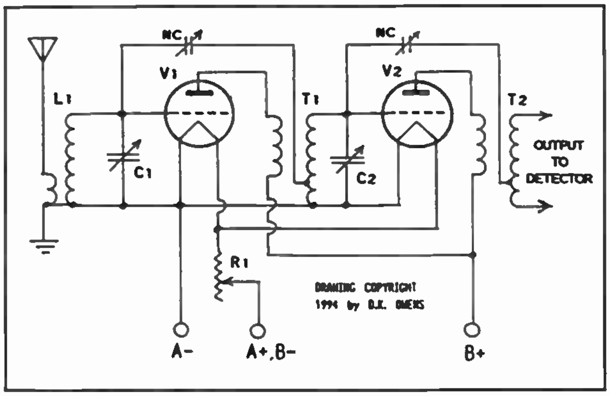


Fig. 2 Two stages of neutralized TRF amplification.

Typical damping resistors were wirewound and had values of 400-1000Ω.

Another approach to the feedback problem is shown in Fig. 2. This is the famous Neutrodyne circuit invented by Prof. Alan Hazeltine in 1922. It works by tapping a small amount of RF signal from the secondary of the RF transformer at a point where it is opposite in phase to the g-p feedback and applying it to the grid of the preceding tube where it cancels the signal coming through the g-p capacitance. The neutralizing capacitor, NC, adjusts the amount of out-of-phase signal to be exactly equal to the undesired signal for complete cancellation.

Tuning a "3-Dialer"

The Neutrodyne circuit was used in high quality receivers until around 1929 when the introduction of the screen-grid tetrode vacuum tube, with its extremely low g-p capacitance, made triode RF amplifiers obsolete. These early sets had 3 independent tuning dials, and are appropriately known as "three-dial" sets. All three dials had to be tuned to receive a station, and that was not easy. The setting of the second and third dials was usually the same. However, the setting of the first dial was different because the uncontrolled antenna capacitance was reflected into the grid circuit. Most people kept a log of dial settings so that once a station was located, it could quickly be found again.

Incidentally, the filament rheostats originally intended to adjust for excess battery voltage have an added bonus. They also act as volume controls and are often labelled as such.

Next time we will put everything together into a complete receiver and get started on how to troubleshoot one of these old battery radios.

Conducted by Ken Owens
478 Sycamore Dr.
Circleville, OH 45113

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

AUDIO OUTPUT TRANSFORMERS

Part 1—Determining Specs for a Replacement Transformer When Manufacturer's Data is Not Available

By Anthony P. Jacobi

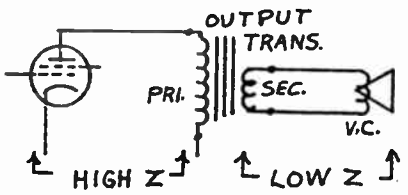
If it hasn't happened to you yet, it's bound to someday. I'm talking about a restoration project stalled by a defective output transformer. You might or might not be able to get the specs from the manufacturer's literature. but even if you can, where do you locate the proper unit? In the days when tube radios were in common use, you could go to any radio service supply store and order one by input and output impedance. Today, you can check the catalogues of antique parts suppliers and surplus sources. But the choices are more limited and prices can be high.

Tony Jacobi has come to the rescue with this two-part article that will help you spec out the transformer you need and then find a replacement among those unmarked units in your junkbox. Failing in the latter, you'll be able to identify a suitable part in your dealer's catalogue, even if it happens to be marked for a different input and output impedance.

So read and enjoy! If you're not familiar with the concept of impedance, you might want to prepare yourself by scanning an elementary electronics text. And don't be put off by the simple math! It involves nothing more complicated than taking a square root--something you can easily do on your calculator. But if you don't even want to get that close to an equation, Tony has even provided a handy chart that will do the work for you!--Ed.

What Output Transformers Do

Let's begin with a quick review of what an output transformer is all about. Electrical theory tells us that in order to transfer energy efficiently from one circuit to another, it is necessary to match the impedance (symbol "Z") of the two circuits. Maximum energy transfer occurs when the output and input impedances are equal.



Output transformer matches Hi-Z tube plate circuit to Lo-Z speaker v.c.

In the case of the audio output stage of a tube radio, we have the problem of matching the high impedance of the output tube to the low impedance of the speaker voice coil. This is best accomplished by using an output transformer (see Fig. 1).

With the transformer in place, we have two circuits to match: the tube to the transformer primary and the transformer secondary to the speaker voice coil. Ideally, the tube's load resistance should be equal the transformer's primary impedance and the transformer's secondary impedance should be equal to the impedance of the voice coil.

An output transformer is strictly a coupling device, and is *not* a load in itself. When the speaker is connected across the secondary, *then* a load impedance is reflected back to the primary. This reflected impedance is determined by the impedance of the voice coil and the *turns ratio* of the primary and secondary windings.

Impedance is reflected as the *square* of the turns ratio (T.R.). For example if the primary has 25 times as many turns as the secondary (25 to 1 turns ratio), then the impedance ratio will be 625 to 1. This means that a 3.2-ohm speaker voice coil will reflect a load impedance of 2,000 ohms back to the primary.

This can be expressed mathematically as:

$$Z_{tube} = Z_{v.c.} \times (TR)^2$$

Where Z_{tube} is the impedance reflected back to the output tube, $Z_{v.c.}$ is the impedance of the speaker voice coil and T.R. is the turns ratio.

Doing some simple manipulation on the above equation, we come up with:

$$TR = \sqrt{\frac{Z_{tube}}{Z_{v.c.}}}$$

Using this relationship, we can calculate the turns ratio required for an output transformer if we know Z_{tube}, the impedance to be reflected back to the output tube and $Z_{v.c.}$, the impedance of the speaker voice coil. To determine Z_{tube}, determine the output tube type and look up its load resistance (*not* its plate resistance) in a tube manual.

In some cases, different load resistances will be given for different plate voltages. Pick the resistance listed for the plate voltage closest to that used in your set. If your set uses a pair of output tubes in push-pull, then the load resistance figure should be doubled.

The impedance of the speaker voice coil is usually given on the set's schematic or parts list. If you don't have access to this

(continued on p. 9)

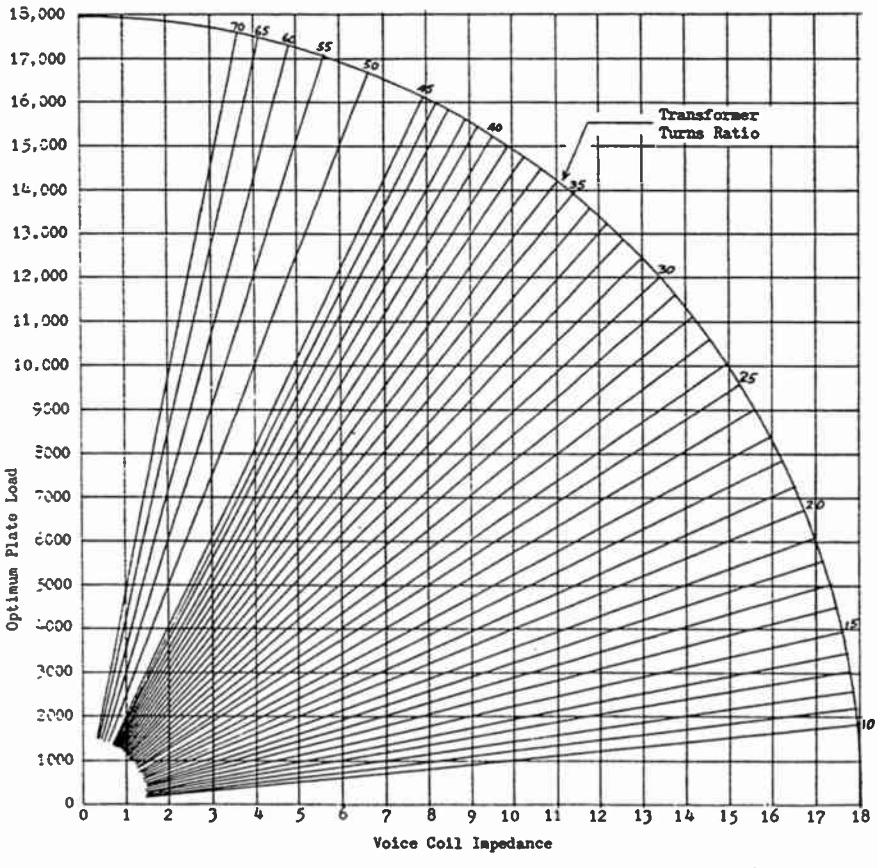


Chart for determining turns ratio of audio transformers--see page 9.

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.

GENERAL

Antique Radio on the Internet

In August, I mentioned a tentative newsgroup being formed on the Internet devoted to antique radio and phono, and you printed the information in the August issue. The newsgroup is now up and running, and it is MOST interesting. Its name is rec.antiques.radio+phono. There are many new questions and answer daily, and there are complete month by month archive files available via FTP.--C.R. (Bob) Zinck, Halifax, N.S., Canada

Please inform your readers that there is now an Internet news group devoted specifically to antique radio and related topics: "rec.antiques.radio+phono" (no spaces). There has been lively discussion on a wide variety of old radio topics (including repair and restoration techniques, radio history, etc.) in recent weeks. A comprehensive source list for parts and literature, as well as answers to frequently-asked questions from "experts," are regularly posted to the group. There is also an FTP archive of all previous postings. For more information, contact: a.field@uicvm.uic.edu (e-mail address).--Aaron S. Field, MD, Chicago, IL

More on Bakelite, Wrinkle Paint

Several materials were used for early radio panels and parts that were *not* genuine Bakelite. Examples are: Ebonite, Mahoganite, Vulcanite, and several forms of hard rubber. Bakelite can be identified as follows: attempt to push a heated pin into the surface, choosing a spot that will not affect the appearance of the part. If the heated pin penetrates the material, it is *not* Bakelite! As Ken Owens pointed out, Bakelite is virtually indestructible. It can be safely cleaned with non-abrasive household cleaners.

Readers may be interested in this sidelight on cleaning plastics. Barbie dolls are one of today's hottest collectibles. Many were (and still are) sold in plastic "blister packages." Supposedly, cleaning this plastic with warm water will remove some of the "sheen" from the plastic--which defect can be detected by sophisticated collectors, who will then severely de-value the item.

Regarding the issue of getting a good wrinkle paint finish, heat is the biggest factor. The dedicated collector can build a plywood box (four feet square will be sufficient for almost any project) with a hinged front to allow placing the freshly-painted object inside. Make a cutout in the rear to allow an electric heater (with fan and thermostat) to circulate hot air in the box. Drill a hole in the top to accommodate the probe of an inexpensive meat thermometer. Heat the box to about 160 degrees, paint the part and place it in the box. Regulate the heat using the thermometer and the thermostat control on the heater.--Dick Mackiewicz, Coventry, CT.

ANSWERS TO QUESTIONS

Substituting for 3-Wire Line Cords

The questions raised last month by P.V. Petrosino (on grounding) and David Hofeld (on 3-wire line cord replacement, dynamic speaker replacement and capacitor checking) have drawn thoughtful answers from several experienced collectors. Following are the three answers received on line-cord replacement, and it's very instructional to have the benefit of their different points of view. Next month, we'll continue printing some (or all, as space permits) of these very interesting comments.

Here's a little general background on the line-cord issue. One of the cost-cutting measures taken by radio designers in creating cheap midget radios for cash-starved Depression families was to eliminate the power transformer--obtaining all plate and filament voltages directly from the a.c. line. Deprived of sources of low-voltage to light the filaments individually, the engineers placed all filaments in series to make the required voltage as high as possible. Eventually, enough high-voltage filament types were introduced so that the total filament voltage requirement equaled the nominal line voltage of 115.

At first, however, the total voltage required by the series string fell far short of the line voltage, and the difference had to by dropped by some form of series resistance (dissipating considerable heat in the process). One way of providing this resistance was to build it into the line cord as a third wire, which dissipated the heat nicely and kept it out of the set. The resistance wire became brittle with age and use, and is quite often found broken by today's collectors. 3-wire line cords are no longer available, except as new old stock. and I've heard reports that even these unused cords have brittle resistance wire, which is easily broken. The usual solution is to substitute a two-wire cord and a separate high-wattage resistor.

As you'll see, the calculations necessary to determine the size of the required resistor are quite simple, involving the equations for Ohm's law (E = IR) and power (P = EI). If you are uncomfortable using these relationships, review the concepts in an elementary electricity text. The equations used by Alan Douglas in his discussion of the silicon diode as a voltage dropping device are a little more advanced; look for more background in the same text under "RMS (root mean square) voltage. And now, on to the letters!--ED

Three wire resistance line cords can be replaced with two-wire cords provided a resistor is installed inside the radio to replace the third (resistance) wire in the original cord. This resistance drops the line voltage to a lower value for operating the tube filaments. As this resistor may sometimes have to dissipate 25 watts or more, I advise installing it on <u>top</u> of the chassis (as far away from other components as possible) rather than underneath. In this case, I believe it may be better to spoil the original appearance of the chassis rather than allow the dissipated heat to "cook" components to s slow and sure death.

In order to determine the resistance needed, first determine the total voltage of the filament "string" (filaments are wired in series in a set of this design). For example a set with four 6-volt filament tubes and a 25-volt tube has a total filament voltage of 49. This should be subtracted from 115, the nominal line voltage, to find the voltage that needs to be dropped in the resistor. In our example, the difference is 66 volts.

Now look up the specified filament current for any one of the tubes (all of the filament currents must be the same in a design of this kind). Let's say it is .3 amperes. Using Ohm's law (R=E/I), we can determine the value of the resistance needed; it is 66/.3, or 220 ohms.

To find the necessary power rating, multiply the voltage drop of the resistor times the current through it (P=E X I). This is 66 X .3 -- or 19.8 watts. A standard 25-watt resistor will work nicely in this application.--Dick Mackiewicz, Coventry, CT.

Can you replace a 3-wire resistor line cord with a 2-wire cord? Yes, provided that you substitute something for the missing resistor. Let's say your radio has two 25-volt and three 6-volt tubes; that adds to 68 volts, while the line voltage is (nowadays) 120. The leftover 52 volts must be dissipated in a resistor or in some other way. Using Ohm's law, the value of an appropriate resistor would be 52/.3 or 173 ohms (assuming the filaments draw .3 amperes).

You might put a resistor on the chassis, but it will produce almost 16 watts of heat (52 X .3)--which is quite a lot--added to the 25 watts or so that the radio already throws off. That's why the resistor was put into the cord originally, to get the heat away from the radio. Although modern capacitors and components are more heat-tolerant than the old ones were, the cabinets aren't.

(continued on p. 9)

CORRESPONDENCE FROM OUR READERS

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

Practical Repair Reference

Regarding the questions raised by David Hofeld (*Correspondence*, December, 1994), I'd think the following book, through out of print, is the perfect reference guide: *How to Repair Old-time Radios* by Clayton Hallmark, published by TAB Books. Copyright 1979, ISBN 0-8306-1148-7. It can be found in your local library (a couple in my area have it) or at radio meets. The book does not delve much into radio theory or require an investment in electronics gear (a VOM is the only piece of test equipment needed). The book deals with troubleshooting and repair techniques for electric sets, and answers all the questions in Mr. Hofeld's request.

This quote from the preface of the book describes the author's goals in writing it:

This book is a culmination of years of experience in troubleshooting and repairing radio equipment and teaching others to do the same. It is as clear and simple and practical as I can make it. It is not a book on radio theory because I realize that the collector is more interested in getting a worth while old radio to work than in how it works.

Basic chapter contents include: tubes and functions, understanding schematics, troubleshooting, specific circuits and problems, testing tubes and parts, repairing parts, common problems, substituting unavailable parts, receiver tune up, advanced radio theory and tube data charts.--Andrew Mooradian, Winchester, MA.

Dash Dilemma

A couple of comments on your newsletter. You use a double dash -- instead of the M dash —. The M dash is the proper one to use. The double dash belongs to the days of typewriters. Yes, I know the newsletter is about vintage radio, but what you are doing is the equivalent of making computers with tubes.

I assume you are still using WordPerfect. In WP5.1 for DOS, to produce an M dash press CTRL V and at the prompt enter 4,34. In WPWIN5.2, press CTRL W and choose the M dash from typographical symbols. These can be inserted automatically with the Replace feature.

My other comment is that since you are using a proportional font there is only one space after punctuation (i.e. only one space after the period).

When teaching my class in DTP/newsletter design, I show yours as an example of what can be done with WordPerfect. Keep up the good work.--Allan Brown, Woodlawn, Ontario, Canada.

Yes, I am still using WordPerfect (5.1 for DOS). It's truly amazing what can be accomplished with this versatile program, even on my 286 computer. WP5.1 does have some annoying characteristics, some of which, I'm sure, are caused by the speed and memory limitations of my machine. An upgrade to a faster 386 with more memory is in the works. It will be interesting to see how the program performs then! I'm trying to break myself of the habit (acquired from years of pounding a typewriter) of putting two spaces after a period. I think I'm doing pretty well, but WP5.1's justification function often adds space after periods, anyway.

I do tend to be impatient with all of the keystrokes it takes to create am M dash--and the result looks wimpy to me in print. You may have to accept my reactionary use of the double dash as a personal peccadillo!

Headphone Sensitivity

In reference to the comments on headphone sensitivity in last month's *Correspondence* column, any sensitivity figures would be virtually meaningless unless stated as an input/output relationship. I do intend to make some of these measurements and I *do* have some N.I.B. 1920's phones, with magnets that should be as good as new, to compare with phones of the same brand that were obviously in use for some time.

There are several ways in which the permanent magnets in headphones might become weakened: through mechanical shock (such as dropping phones on floor); through proximity to a severe a.c. field or the passing of a strong a.c. current through the phones (of course the latter would probably burn out the coil windings); and (most likely cause) the passing of a strong direct current of opposite polarity through the phones *(most phone cordsets have a red tracer on the lead that should be positive if the phones are to be placed in the plate circuit of a receiver--ed.)*.

But I doubt that weak magnets would cause a loss of sensitivity . I *do* expect that frequency doubling, and the resultant distortion associated with this phenomenon, would be the most significant result of weak permanent magnets in headphones.

The unusual sensitivity of Baldwin phones resulted from a unique patented design that employed a "lever action" acting upon the diaphragm (aluminum, fibre and mica in various models). Because of the mechanical advantage of the levers, Baldwin phones could push a larger column of air for a given mechanical displacement of the electromagnetic structure. Baldwin phones are still regarded as some of the best for use with crystal sets or one-tube rigs. However, they *did* have a reputation for overloading on very strong signals!

I have been collecting and researching headphones for several years. I presently have over 350 models, and sincerely welcome correspondence with anyone interested in this important facet of early radio.--Dick Mackiewicz, 1549 N. River Rd., Coventry, CT 06238. (203) 742-8552.

Phones and DVM's

Comment on the sensitivity of Baldwin phones: years ago, I didn't own any Western Electric models but I've found since that they're just about the same as Baldies.

I like Orval's comment (December, 1994 *Correspondence*) about technology "following me home." Yes, I checked at work where we have both BK Precision and Fluke DVM's, before buying mine. The Flukes hold their calibration better and that's all we buy, now, although the one my own bench at work is a BK.

I just finished calibrating a Hewlett-Packard 410C from the flea market ($25) for those times when I need an analogue readout. I guess it qualifies as a VTVM since it has one tube and a bunch of transistors.

I gave up on my old Knight-Kit that drifts all over and never was very accurate. I'd be very happy to give away a pair off those horizontal Heath VTVM's, and some RCA models (and the Knight!) to anyone who wants them!--Alan Douglas, Box 225, Pocasset, MA 02559.

Schematic Substitutions

Some years back, I was working on an old Hallicrafters and discovered that several resistors had values which were quite different from those called out in the schematic. I did some checking with friends in the business, who suggested the following scenarios.

(1). Changes were occasionally made, after a design was in production, to improve performance. Manuals that were published before the changes wouldn't show the new values.

(2). The manufacturer may have had a rush order for a particular model and, being short on inventory of a specific component, substituted one that was "close enough."

(3). The manufacturer may have had a stock of components, from a discontinued model, that were "close enough" in specs to use up on a current model.

(4). Ditto, except that the manufacturer made a fortunate buy on the "close enough" components.

And so on. In the radio under question, it seemed that any close approximation to the value--either on the schematic or of the resistors to be replaced--was "close enough." The radio worked. The moral is that the published schematic is not a holy book!--Julian Jablin, Skokie, IL.

Help For the Asking

I would be more than willing to help readers living in Southern California (or elsewhere) with their restoration problems.

(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.

RADIO FOR EVERYBODY, by Austin C. Lescarboura. Published by Scientific American Publishing Co., 1922. 334 Pages. Hardbound.

Radio For Everybody was written for the lay reader in response to the many inquiries about radio received by Scientific American. The preface states that this hastily-written *Piece d'Occasion* was a learning experience for the author. Evidently, Scientific American wanted to cash in on the then-current radio boom.

The opening chapter provides the usual explanation of radio theory (with a glossary of radio terms), while the following one traces the history of radio telephony and broadcasting. In the third chapter, "Dot and Dash Broadcasting," the author describes the various services available by radiotelegraph, including crop and market reports as well as time and weather reports.

Chapter four deals with radio receivers. Crystal sets and various one-tube circuits are discussed with the emphasis on how they worked rather than how to build them. Antenna construction is covered in great detail.

The next chapter goes into hooking up the antenna, ground and batteries, operating the set, learning the code and becoming a ham. Chapter six, "The Gentle Art of Amplification," is devoted to the standard radio- and audio-frequency amplifiers of the day as well as horn and electrodynamic speakers.

This is followed up by a chapter on spark-gap transmitters and one on CW, ICW and Radiotelephony transmitters. Chapter nine details other uses for radio such as radio control, radio direction finding and "wired wireless." Chapter ten explains how commercial stations are used to transmit messages over long distances.

The following chapter shows the reader how to construct a simple crystal set and a primitive single-tube receiver, and the final one (Chapter 12) discusses current technology and speculates about the technology to come.

This book provides good general background on radio in the early twenties, but gives little information on construction or contemporary equipment. The explanations, which do not involve mathematics, are quite simple and easy to follow. Perhaps the idea was to spark the reader's interest so he would go out and purchase more advanced books.

Radio for Everybody contains many excellent diagrams and photographs. A large variety of contemporary equipment is shown but, alas, is not identified. The index is useful, but a bit sparse.Area (or any area for that matter) with restoration or repair problems.

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

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

COMPANY CHRONICLES

Brief Biographies of Classic Radio Manufacturers

OPERADIO

J. McWilliams Stone, who founded Operadio in 1922, brought a wealth of practical experience to his new enterprise. Fascinated by wireless communications since childhood, Mac was working summers as a radio operator on Great Lakes steamers by the time he was fourteen. At sixteen, lying about his age to the government Inspector, Stone received his commercial radio license. He spent several of the following summers on shipboard working as a Marconi operator.

Stone served in the Navy during World War I, doing mechanical work at the Fore River Shipyard (Quincy, MA) for most of this time. After the war he earned a BSME from the Armour Institute, then joined the Van Dorn Company--where he developed a widely-used railroad-car coupler. Mac eventually became a Vice President at Van Dorn, but left after a few years to launch Operadio.

Operadio was essentially a one-concept company, best known for its line of "portable," self-contained, receivers housed (complete with speaker and batteries) in suitcase-style cases. The radios featured a distinctive loop antenna constructed in the cleverly-designed removable lid. Some models of this versatile set could be slipped into an optional drop-leaf desk-type cabinet, making them suitable for living-room listening when not in use on trips.

By 1927, Operadio's tricky-to-operate regenerative circuit was both obsolete and subject to infringement suits by Westinghouse--who owned the Armstrong patent. Switching to the more user-friendly TRF circuit was impractical because of high licensing fees being demanded by RCA. Sales slumped and the company went into receivership.

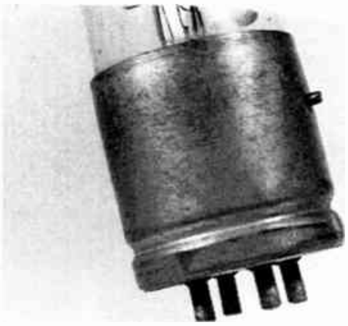
But Stone had already began to develop a line of loudspeakers--for which he must have envisioned lucrative sales opportunities among the many radio manufacturing firms headquartered, like his own, in Chicago. The company stayed in business, reorganizing as the Operadio Manufacturing Company, and soon opened an additional plant in St. Charles, IL. After a disastrous explosion and fire in the firm's original plant, Operadio abandoned the radio set manufacturing business altogether--selling its loop antenna patent to Trav-ler, a competing manufacturer of portables.

Stone's company survived throughout the 1930's as a manufacturer of loudspeakers and amplifiers, and expanded enormously in the mid-1940's thanks to World War II government contracts. By 1946, it was operating six plants in four different locations. After the war, the company diversified into the audio-visual equipment and ultrasonic fields, changing its name to the Dukane Corporation in 1951. After, that the company enjoyed steady growth--reaching $50 million in sales in 1985.

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.

RECEIVING TUBE STORY
(continued from p. 2)

four stubby contact pins at the bottom and a horizontal locating/locking pin sticking out of the side. The latter slipped into a bayonet-style guide in the socket, ensuring correct orientation of the base. It also served to lock the base in place when the tube was pushed down against the socket contacts and twisted to the right (in the manner of an auto taillight bulb). This base style was identified by the prefix "UV" in the tube type designation.



Horizontal locating pin and stubby contact pins are features of the UV-type base.

But in 1925 the standard "twist lock" base style was changed to a "push-in" design, the pins being made longer so that they could slip into friction-type spring contacts via mating holes in the bottom of the socket. Two of the four pins were made fatter than the other two to make sure that the tube could be inserted only one way. These new sockets were much more compact, provided more positive electrical contact and were probably cheaper to manufacture. The revised base design bore the designation "UX."

Long contact pins on UX base slid into matching holes in the tube socket.

For a time, the new "UX" bases retained the locating/locking pin, which was moved to a higher position so that the bases could still be "bayoneted" into "UV"-style sockets even with their longer pins. That meant that a person who had to replace a UV-201-A in an older set could substitute a UX-201-A with no problem.

The Dry-Cell Tubes

When General Electric released the UV-201-A in 1923, another type was released along with it. It was the UV-199, a brand-new design. Like the '201-A the new tube had a thoriated tungsten filament. But this filament drew only .06 amperes at its rated voltage of 3.3. It was designed to be operated from three 1.5-volt dry cells connected in series, with a series rheostat to reduce the 4.5 volts to the value required by the tube.

The dry cells could not be recharged, of course, and had to be discarded when exhausted. But they were much easier to handle than the clumsy storage batteries, being less bulky, less heavy and containing no easily-spilled corrosive acids. Sets using these tubes were much easier to move around than those employing '01'A's, and could even be built (as either "living room" or portable models) with internal storage compartments for all batteries.

It should be noted that the "UV" designation on the '199 is a bit misleading. The UV-199 base is similar in design to the standard "UV" base as used on the '201-A, but is scaled-down in size to match the '199's much smaller bulb size. Interestingly enough, when the UX-199 came out, it was equipped with the large, standard size "UX" base.

Detail from 1920's ad shows standard UV base (top) and smaller version for UV-199.

The UX-120 was released in 1925 as a companion to the UX-199. It looked similar to the '199 and operated from the same filament voltage. Maximum plate voltage was higher, however, and the filament drew more current. The '120 was intended for use as an audio output tube, and could deliver more "punch" to the speaker than a '199. Many '120's have a factory-applied sticker reading "USE IN FINAL AUDIO SOCKET ONLY."

Another variety of dry-cell tube was marketed by Westinghouse beginning in 1922. Designated the WD-11, this tube had a filament designed to be operated from a *single* dry cell--drawing .25 amperes at 1.1 volts. The WD-11 filament was not thoriated as in the General Electric designs; its enhanced electron-emitting performance came, instead, from an oxide coating.

The base of the WD-11 was a bit unusual. First of all, it had long pins designed for friction contact at a time when most tube bases were of the stubby-pin, bayonet-mount variety. Secondly, it had only one "fat" pin, instead of the usual two, to ensure proper orientation in the socket.

The following year, a version of the WD-11 having a standard "UV" base was introduced. It was designated the WD-12. Eventually a version having the "UX" base (the WX-12) was introduced. If the logic of these designations escapes you, you're not alone! The "W" obviously stands for Westinghouse and the "D" for the unique base of the type 11. But it seems that the WD-12 and WX-12 would have been better designated the WV11 and WX11, respectively. I also have no idea why Westinghouse chose not to prefix the type number with the usual proprietary extra numeral (making the '11's full designation "WD-411," or something like that.

See you next month, when we'll continue our tube story.

CORRESPONDENCE
(continued from p. 6)

I've been repairing radios since the days when they were coming out of attics and basements free for the asking. I have a well-equipped test bench, a complete set of Rider's Manuals, and a good supply of tubes and parts.--Harry Alenik, 14003 Judah Ave., Hawthorne, CA 90250. (310) 643-8100.

Why is It?

Why is it that. . .

. . .when you reach for a straight screwdriver, they all turn into Phillips or torque drivers, and just the opposite.

. . .when you drop something on the floor it runs and hides under a ledge , behind a leg, or behind a caster on your chair--only to be discovered when you hear that awful crunch sound.

. . .when you are looking for a tape measure it hides behind a box.

. . .when you are looking for a book, it blends into a pile of other books and becomes invisible.

. . .when you have both hands holding something that you can't put down without losing the work already done, you gotta sneeze or blow your nose, or the telephone rings with someone selling something or it's a wrong number).--Alton A. DuBois, Jr., Queensbury, NY.

DICK'S CORNER

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

The Lure of the Crystal Set

How many of you readers have constructed a crystal set? Sure, most such sets don't look too imposing, and probably won't impress anybody--that is until you demonstrate that the Energizer Bunny is *not* contributing to the sound emanating from the headphones (or horn speaker).

Crystal sets were very popular during the early 1920's. Back then, a clever and resourceful youngster could salvage all of the necessary wire and miscellaneous hardware from some automotive junk. A good crystal could be obtained for about fifteen cents and a telephone receiver (earphone) cost a dollar or so. Compare that to the cost of a single vacuum tube at the time--five to seven dollars! Such a sum was a week's pay for many folks.

Because crystal sets don't require batteries, there was no ongoing expense associated with their operation. Since the sets tended to be very small, many young boys "smuggled" them into bed at night for surreptitious listening!

It's still quite feasible to construct your own crystal set from "junk box" parts. This can be a very satisfying project (perhaps a science fair exhibit) for the younger children in your family. If you are a Scout leader, Big Brother or Big Sister, some of the kids in your group might also enjoy doing a crystal set project. Most young people are fascinated by a radio receiver that seems to work without power, and will want to learn more about it.

Crystal sets generally won't work very well without a good outside antenna and a good ground. But some cautions are in order. Don't put up your antenna where it might contact a power line should it break or blow down. And be sure to install a lightning arrestor (obtainable at Radio Shack) to protect any radio connected to the antenna. It's also a good idea to install a double-throw knife switch for disconnecting the "sky wire" from your radio and shorting it to ground when not in use.

Here are a few sources of crystal set parts and/or information: (1) Modern Radio Laboratories, PO box 14902, Minneapolis, MN 55415-0902 (Catalog $2.00). (2) Leonard W. Gardner, 458 Two Mile Creek Rd., Tonowanda, NY 14150 (LSASE for info). (3) The XTAL set society, PO Box 3026, St. Louis, MO 63130 (LSASE for info). I also have some crystal detectors and parts for sale. These are reproductions of old-time parts. Write me at 1549 N. River Rd., Coventry, CT 06238, including a SASE for info).

Choosing Your Collecting Goals

Many RC readers are newcomers to our hobby. Whatever their reasons for getting involved, most will start with an abundance of enthusiasm.

Not everyone has the storage space to accommodate all of his or her acquisitions. And when space limitations become apparent, your enthusiasm may abruptly decline. To protect yourself from this type of burn-out, make an early appraisal of your facilities.

If you are lucky enough to possess a large basement or barn, that's great! Just make sure that this area is dry enough, and secure enough, for storage of a valued collection. Those with limited space should choose a niche that will allow them to collect happily without becoming discouraged.

Here are a few ideas. How about trying to collect examples of the radios your parents or relatives had when you were young? This would be a challenging goal requiring time and research, but not necessarily a lot of room.

Another niche you might want to consider is the collecting of novelty transistor radios. These are still generally affordable and can be found in all sorts of places from yard sales to discount stores. A great many such sets will fill one bookshelf without overcrowding! A final space-saving suggestion might be to limit your collection to examples of radios made in your state.

There are many, many interesting collecting options besides the traditional "catalins and cathedrals." Whichever one you choose, I urge you to collect with the primary goals of preserving a bit of radio history and maintaining the integrity of this fine hobby.

Conducted by Dick Mackiewicz

INFORMATION EXCHANGE
(continued from p. 5)

Probably the best solution is to put a 1-amp silicon diode (1N4005 or equal) in series with the heater string, along with a resistor. The diode conducts half the time, or passes half the power (Watch out, here comes some theory!) or gives .707 X 120 = 85 volts. (.707 of the voltage causes .707 of the current to flow and .707 x .707 = .5 (or half) of the power is dissipated.)

It's a lot easier to drop to 68 volts from 85 than all the way from 120. The required voltage drop (17) calls for a resistor of 17/.3 = 57 ohms and there is now only 17 x .3 = 5 watts to get rid of. Better use 62 ohms, or even 68, with today's high line voltages (mine is 123). By the way, don't try to measure the 85-volts put out by the diode with your VOM; since it's not a sine wave you'll get gibberish, but it's 85 no matter what your meter says.--Alan S. douglas, Pocasset, MA.

Can a 3-wire resistor cord be replaced with a 2-wire cord? Yes, if the third (resistance) is replaced. Sketch the power supply and filament circuit of the set. You will find that the two non-resistor wires supply the plate of a half-wave rectifier; connect the new 2-wire cord to these points. Now suppose that you've decided to use one or more power resistors of the wirewound type in place of the resistor wire in the original 3-wire cord.

If the resistance wire still has electrical continuity, you can measure it to determine the resistance of the replacement wirewound unit (though you still have to calculate the power rating). But for the sake of discussion, let's say that the cord is missing. And let's also say that your set contains four 6.3-volt, 0.3-ampere tubes connected in series. The total voltage drop across the tubes is 25.2, so if your line voltage is 115, the power wirewound resistor must drop 115-25.2 = 89.8 volts and it must conduct 0.3 amperes. It therefore must dissipate 89.8 x .3 = 27 watts in round figures and its resistance must be 89.8/0.3 = 300 ohms in round figures.

A wirewound resistor should be strongly derated if you want it to last. I'd recommend using a 50-watt unit. It would probably be difficult to find a 300-ohm, 50-watt wirewound, so perhaps three 100-ohm, 15-watt resistors in series would be a good choice. Mount these to allow the air to circulate freely around them, and keep them away from all the other components in the cabinet.

There is an alternative, although it does mean taking the radio a lot further from its original design concept. These days small 6-, 12- and 25-volt transformers are easy to get at Radio shack and other sources. If you power the filaments from one or more of these transformers, rewiring the filament circuit as necessary, the heat dissipation is much reduced. Such a transformer for the radio in the example above needs to handle only about 8 watts and the total dissipation of the set, is (at most) 15 watts--versus close to 35 watts using the resistor.--Claude J. Dellevar, Jr., Sylmar, CA.

OUTPUT TRANSFORMERS
(continued from p. 4)

documentation, you'll probably be safe in using a value of 3.2 ohms for speakers not greater than seven inches in diameter.

With Z_{tube} and $Z_{v.c.}$ in hand, the required turns ratio can now be readily calculated from the equation. However, those who don't care to do the math can use the chart on p. 4. Locate the oblique line closest to the intersection of the Voce Coil Impedance ($Z_{v.c.}$) and the Optimum Plate Load (Ztube). Follow the line out to the Transformer Turns Ratio arc and read the number indicated there.

Next month we'll talk about how to use the turns ratio figure to find a suitable transformer in your junk box or locate one in a catalogue.

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 Combination i.f. oscillator coil for Majestic 15 grandfather clock radio. Also, knobs and pushbuttons for Crosley 02CA console. Joe Bentrovato, 1802 Sagebrush Rd., Plant City, FL 33657. (813) 754-3856.

Wanted Chassis for Philco 16-B. Speaker and tubes not needed, but must be in good condition otherwise. Will pay top dollar, if excellent. David E. Booth, Jr., 831 Fairfield Ave., Westminster, MD 21157-5913. (410) 848-4025.

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 Schematic, output cable make-up & operating instructions for Heathkit Lab Generator Model IG-42. Gladly pay copy & shipping cost. Bill Halstead, 3194 Sugarplum Rd. NE, Atlanta, GA 30345. (404) 938-8730.

Wanted Knight Kit "Ocean Hopper" radio with coils. Bill Miedma, (708) 526-6131.

Wanted Official Radio Service Manuals, Volumes 1 & 2, by Gernsback. Originals w/supplements in good condition only, please. Scott Holderman, 14431 Ventura Blvd, #296, Sherman Oaks, CA 91423. (818) 981-1782.

Wanted Driver for AK horn Model H, dead or alive. Need threaded base and diaphragm as illustrated in AK service manual. Alton A. Dubois, Jr., 67 Peggy Ann Rd., Queensbury, NY 12804.

Wanted Andrea table radios. Stan Lopes, KB6LGV, 1201-74 Monument Blvd., Concord, CA 94520. (510) 825-6865.

Wanted Philco grandfather clock radio parts: clock hands, speaker cloth. Sam Zuckerberg, 578 Fifth Ave., NYC, NY 10036. (212) 354-7407.

Wanted 20's and 30's Popular Mechanics, Popular Science, Science & Mechanics and Mechanix Illustrated. Will trade vintage auto mags 2-for-1. Rich Volkmer, 530 Mignin, Warrenville, IL 60555. (708) 343-1313

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 "The Signal Corps" has purchased the entire remaining assets of a 1950's WWII surplus dealer: radios, radars, aircraft, etc. Catalog #9 54 page, $2.00 US $5.00 foreign. Sam Hevener "The Signal Corps" 3583 Everett Rd., Richfield, OH 44286-9723. (216) 659-3244.

For Sale Radio Collection program for IBM compatible computers. Stores manufacturer, model, year, cabinet style, frequency bands, circuitry type, tube complement, value. Has search mode and supports printer. Send 14.75 to Randy Eppinette, 825 Ouachita 64, Camden, AR 71701.

For Sale Sencore LC53 "Z-Meter" capacitor-inductor analyzer with original manual, exc. condition, $400 (shipping included, U.S. only). H. Goldman, 3 Amy Lane, Queensbury, NY 12804. (518) 792-1003.

For Sale RCA Radiola 17 wooden coffin-A.C. no knobs; Radiola 33 poor shape, hole in cabinet; Radiola 60 poor wood cabinet; Radiola 33 painted green; Eveready radio chassis 8 tube green. $25 each or $100 for all plus UPS. Kevin L. Moe, 616 Lockrem, Ottawa, IL 61350. (815) 433-4598 evenings.

For Sale Radio parts, tubes, test eqpt, service data. 1000's of new and used items for radios. Write wants, LSASE for reply. Krantz, 100 Osage Ave., Somerdale, NJ 08083-1136.

For Sale or Trade A very nice RCA Victor chair with horn and Nipper logo. Great for your office or radio room. $60.00 plus UPS. Paul Fulton, 711 Jacquelyn Rd., Westwood, NJ 07675. (201) 664-5260.

For Sale Send for list of inexpensive (spell cheap) radios, parts, tubes, etc. Example: Silvertone 4506 (GOR 75) restored $85. Stan Lopes, KB6LGV, 1201-74 Monument Blvd., Concord, CA 94520. (510) 825-6865.

For Sale Capacitors, tubes, parts. Thousands in jam-packed illustrated catalog No. 49. Send $3.00 U.S./Canada ($5 overseas) for a heavy-paper limited edition copy. Don Diers, 4276 North 50th St., Dept R2, Milwaukee, WI 53216-1313.

I'd Like to Contact someone who can advise me in selecting good DOS- or Windows-based communications software. Marc Ellis, The Radio Collector, PO Box 1306, Evanston, IL 60204-1306. (708) 869-5016.

1936 Zenith 16A63 "STRATOSPHERE"

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.

In 1928, this German radio engineer transmitted still photographs from Rome, Italy to Bar Harbor, ME.

Answer to last month's quiz: Hertha Ayrton

Correct answer from Alan Douglas

Conducted by Julian Jablin