GE Electronic TUBES

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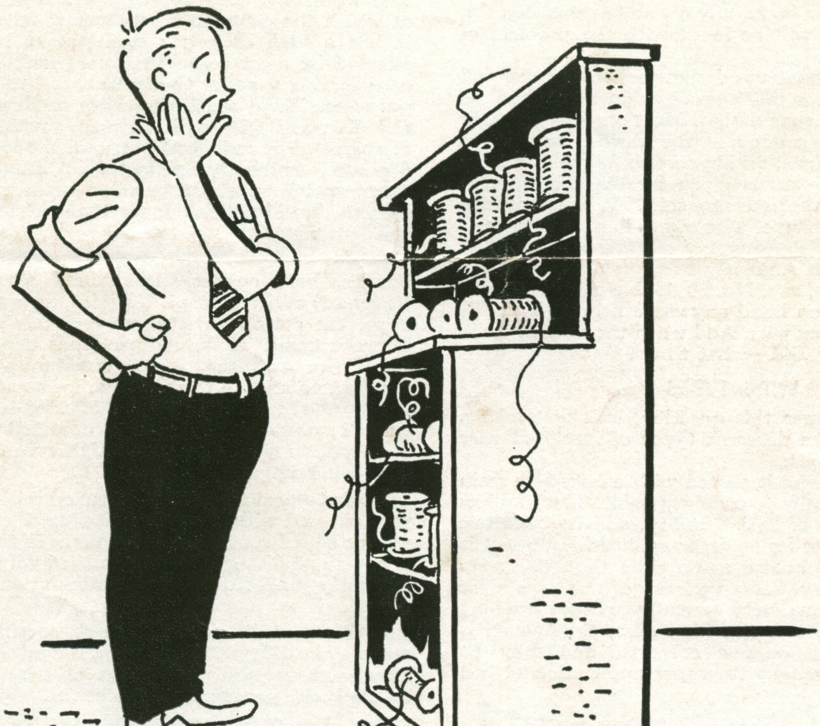
7/21/57 6E Allan C. Mueller

Allan C. Mueller

TIPS ON WINDING COILS



Contents

Tips on winding coils

One of our readers recently made a Dioplex (HAM NEWS, Vol. 8, No. 3) and swore up and down that he copied everything exactly as described but the thing wouldn't work properly. Come to find out, he had made what he thought were unimportant substitutions. In the first place, he used a ceramic trimmer—which has a much lower Q than the mica trimmer specified. Secondly, and more important, he used a different size wire—the "nearest thing on hand"—in winding the coils.

Now, inasmuch as the Dioplex has relatively low capacity, this "slight" substitution of wire size resulted in additional distributed capacity which, percentagewise, was relatively large. However, when the coils were re-wound to proper specs, the Dioplex worked fine.

The incident prompted us to talk with an expert on the subject and so here are a few words of wisdom from W2PFU.

—Lighthouse Larry

COIL WINDING

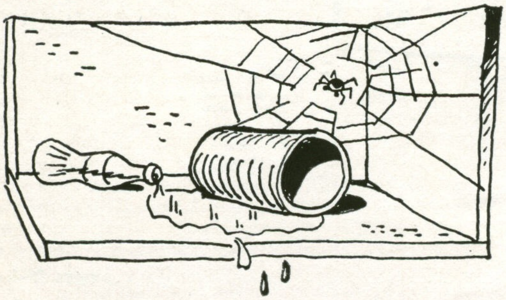
Almost all of the radio apparatus the average amateur uses involves wire-wound inductors, known generally as "coils." And unless the amateur has enough spending money to buy all of his equipment, and no interest at all in construction (definitely not an "average ham"), sooner or later he will be faced with the problem of winding such coils.

Now, very few amateurs design their own coils, and it would take far too much space to go into all of the factors involved in such design. Most of us pattern our gear after circuits printed in the various handbooks and radio publications, taking care to follow as closely as possible the directions given for the construction and the winding of the necessary coils. This is not always easy, however, as magnet wire comes in a great variety of wire sizes and with a number of different insulating materials. It not infrequently happens that when the coil design calls for, say, No. 29 double-cotton-covered wire, all we have on hand anywhere near that size is some No. 30 Formex wire. And when the nearest radio store is practically DX—what to do?

WIRE TYPES

To begin to answer this question, let's first take a look at some of the different types of insulated wire that are used for coils:

Black enamelled wire is coated with a baked-on resin film similar chemically to ordinary paint. This film has a moderate degree of heat stability, and its dielectric strength is adequate for amateur applications, but it is considerably more brittle and fragile than the resin film on Formex wire. Some varieties of this wire must be handled and wound very carefully to avoid cracking or peeling of the insulating film. Also, the enamel is easily softened by organic solvents, and may be accidentally removed by improper application of coil varnishes.



". . . susceptible to moisture and dirt . . ."

Formex is the registered trade-mark for G-E magnet wire enamelled with a very tough golden-colored plastic known as "formvar." This material is really tough; the wire can be pulled, beaten, bent, and twisted to a remarkable extent without breaking the insulating film. The insulation does not deteriorate at temperatures at which the common black enamel fails rapidly, and it has a high dielectric strength. It is not greatly affected by most organic solvents and, all-in-all, it is considerably superior to black enamelled wire for most purposes. There are four grades of Formex wire—F, DF, TF, and QF—with successively thicker coatings of enamel. For radio coil purposes the single thickness F grade is eminently satisfactory. A sample of No. 30F Formex wire, on which the enamel film was only .0003-inch thick, did not fail under 1250 volts in a dielectric strength test.

Double-Cotton-Covered wire (d.c.c.) is, as the name implies, bare copper wire wound with two layers (reversed) of cotton cord. Until impregnated with a coil dope, the cotton covering serves merely as a spacer between turns. Thus, undoped coils close-wound with d.c.c. wire are susceptible to moisture and dirt which may act to change the effective inductance and lower the Q of the coil. This type of wire is used mainly where some spacing between turns is desired, since such construction gives somewhat higher values of Q than close-winding.

Single Cotton Enamelled wire (s.c.e.) is black enamelled wire covered with a single wrapping of cotton. Except for the added spacing between turns in the wound coil, it has no advantages over enamelled wire, and may be adversely affected with contamination unless varnished.

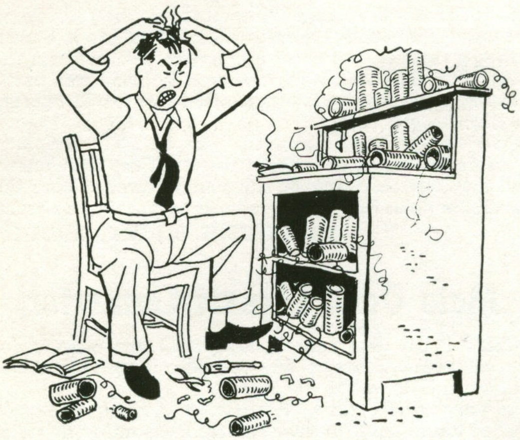
Silk Covered wire (d.s.c.) is rarely specified nowadays, and may be difficult to obtain. It is doubtful if the small advantage in using this type of wire over cotton-covered wire justifies its extra cost.

Bare Wire or **Tubing** generally is used for coils with widely spaced turns, such as high-power transmitting inductors, in which there is no likelihood of turns being displaced and shorting.

HOW ABOUT SUBSTITUTIONS?

To find out something about the operational differences between the various wire types and the difficulties one might get into by making substitutions, several test coils were wound on ¾-inch polystyrene forms and measured on a Q meter.

Coils A and B were wound on ¾-inch Amphenol forms with 102 turns each of No. 30 black enamel wire and No. 30F Formex wire, respectively. Since the



". . . can really get into trouble."

thickness of the enamel layer was nearly the same on both types of wire, the over-all lengths of the windings were close, $1\frac{1}{16}$ inches for coil A and $1\frac{1}{8}$ inches for coil B. At a frequency of 2 megacycles, coil A required 59.5 micro-microfarads to resonate, its Q was 122, and the distributed capacity was about 3.5 micro-microfarads. At the same frequency, coil B resonated with 60.5 micro-microfarads, its Q was 128, and the distributed capacity was about 2 micro-microfarads. All this means is that although Formex has slightly lower dielectric losses and a slightly lower dielectric constant than black enamel, the two types of wire are closely similar and could be used interchangeably except under more rigorous conditions of handling and operation where the superior physical properties of Formex would make it more desirable. Of course, using a wire with a thicker insulation, such as No. 30 TF, would change the above figures somewhat. The inductance of coil B was calculated to be 99 microhenries at 2 megacycles and actually measured 100 microhenries.

Sometimes coil designers specify length of winding only—rather than number of turns—and here is where the amateur constructor can really get into trouble.

Coil C was wound to the same length as coil B, but with No. 31F Formex, only one wire size different and almost identical in appearance. It had, however, 112 turns in the length of $1\frac{1}{8}$ inches. It required only 49.8 micro-microfarads to resonate at 2 megacycles, had a Q of 130, and a distributed capacity of about 3.5 micro-microfarads. Admittedly, the difference between 60.5 micro-microfarads and 49.8 micro-microfarads does not seem large, but remember that at amateur frequencies, considering stray capacitances, tube capacitances, and the distributed capacity of the coil itself, this difference might be significant in the operation of a particular apparatus. When ten turns were removed from coil C (leaving 102 turns), it resonated at 2 megacycles with 65.1 micro-microfarads; closer, but still over 8 percent off. Using a wire two sizes removed from the specifications and winding to equal length would result in a much larger departure from the specification described by the designer.

Coil D was wound to a length of $1\frac{1}{8}$ inches with No. 30 double-cotton-covered wire. It had only 62 turns, and required 173.5 micro-microfarads to resonate at 2 megacycles. The Q of this coil was 132, and the stray capacitance was about 3 micro-microfarads. This coil is almost hopeless as a substitute for coil A. It very possibly could not be made to resonate at the design frequency with the specified capacitance; and the chances are that if it could, the resulting impedance mismatch would result in impaired performance. (This mismatch would be almost 3 to 1, assuming that coil A was designed to match the circuit.)

The moral is clear—for a given coil diameter, the number of turns is the more important factor, and the coil length is of secondary importance. (The coil diameter is important too, but that is another matter.) So, if the circuit description says "take a 1- by 3-inch coil form and wind on 2 inches of No. 24 d.c.c. wire," you'd better get some No. 24 double-cotton-covered wire—unless you want to make the calculations to determine what other coil dimensions, together with what wire you may have, are necessary to match the inductance of the specified coil. The formulas can be found in a number of technical books, including the A.R.R.L. Handbook.

COIL WINDING HINTS

Incidentally, if you do have to design your own coils, here are a few handy hints:

1. The optimum shape of coil for a given inductance is neither a very long coil of small diameter nor a short wide coil, but one of intermediate proportions. A ratio of length-to-diameter of about 3 to 1 seems to be good practice. Most coils in commercial equipment can be taken as examples of reasonable proportion.

2. Although there will be a particular wire size best suited for a given frequency (highest Q), it generally is a safe procedure to use the largest wire size that can be wound with the required number of turns in the space available. Coils wound with some degree of spacing between turns generally have higher Q values than close-wound coils, but for many amateur applications the difference may not be very important. Optimum spacing is about equal to one wire diameter between turns.

3. Ordinary round wire is the best shape for the amateur frequencies. Stranded wire or "Litzendraht" is better at the broadcast frequencies, but poorer at amateur frequencies.

4. Application of a good coil varnish, such as the cement made under the G-E registered trade-mark Glyptal or Duco cement, to coils wound on low-loss forms will not appreciably change their performance, and generally should be made to protect the coils.

Preserving Antenna Components

If you want to protect wooden parts of masts, beams, and other structures from rotting—or if you want your antenna ropes to last almost indefinitely—try treating them with a strong solution of pentachlorphenol ("Pentide") before putting them up.

I had the unpainted bottom end of a 2x4 mast that had been soaked with this solution standing in swampy ground for over three years with absolutely no trace of rot or deterioration. I also soaked the antenna rope in the solution, letting it dry thoroughly before installation. It was just as strong after several years of exposure to the elements as the day I bought it.

DAL HURD, W2PFU

One Cure for Ignition Noise

The following trick for curing ignition noise brought to mind the article on noise elimination (QST, April, 1952) by W9DPI, supervisor, Engineering Research Department, Delco-Remy Division, General Motors Corporation. We asked his opinion. Following are both the trick of W9THD and comments by W9DPI.

—*Lighthouse Larry*

After trying all the usual stunts in removing ignition noise from my mobile receiving setup in the family gas buggy, I tried the following trick which proved so effective I am now able to receive most signals with my noise limiter switch in the off position.

First, remove the distributor rotor from the distributor. This is made accessible by disengaging the distributor cap clamps, laying the cap to one side and pulling the rotor from the shaft (it just pushes on the shaft like a push-on radio knob). Lay the metal tab (from which the spark is distributed to the various plug wires) on a flat steel anvil or dollie block and peen out with a small hammer. Repeat this until the tab just barely leaves a mark on the metal contacts inside the distributor cap checking it frequently so as not to "beat" the tab out too much.

This whole operation only takes about five minutes but it sure makes a world of difference in the noise in the receiver. In fact, most of my ignition noise comes from passing cars now.

GILBERT VOYLES, W9THD

We have never found an installation where all of the ignition noise originated in the rotor gap, which must have been the case in Mr. Voyles' car. In such a case, the solution he has evolved undoubtedly would greatly reduce the noise.

There are reasons why his procedure may be a dangerous one. The cap inserts are held in place by a thin plastic section. If extreme care is not used, the cap may become cracked in making the rotor insert longer. Manufacturing dimensional tolerances are such that in most cases the center of the insert radius is not exactly at the same point as the center of rotation of the rotor. This fact would lead us to conclude that quite a large amount of metal would have to be removed from some inserts to ensure a wipe contact on all. Removal of enough metal would further increase the possibility of breaking the cap, or of breaking the rotor.

In the higher compression modern engines, the ignition voltage requirement is greater than in older models. Since the frequency and wave front is essentially the same as has been used in ignition systems for some time, this means that a longer time has elapsed between the instant the breaker points separate and the instant the ignition voltage is great enough in magnitude to fire the plug. When plugs become aged they accumulate a deposit of relatively low resistance in parallel with the plug gap. This parallel resistance causes a loss in energy that is a function of

$$S^t \frac{e^2}{R} dt$$

where e is the instantaneous voltage across the plug, R is the resistance across the plug, and t is time measured from the instant voltage is impressed on the plug. Since the voltage is not impressed until the rotor gap is broken down, a reduction of rotor gap length will increase the factor "t." The loss in ignition energy could well cause missing in an automobile that otherwise would operate satisfactorily.

We should recommend the use of 5000-ohm suppressors at each of the output towers of the distributor, and a 10,000-ohm unit at the center tower to cure the particular noise Mr. Voyles reduces by peening his rotor.

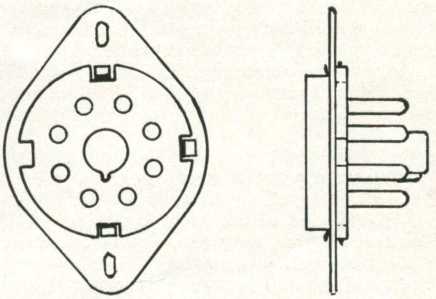
BROOKS H. SHORT, W9DPI

Male Octal Chassis Connector

Here is an idea that I have used successfully for several years. I would like to enter it in Tricks and Topics in G-E HAM NEWS.

A very good octal male chassis-mounting connector can be made from the wafer base from an octal metal (or metal-based glass) tube, and one of the metal mounting plates supplied with retainer-ring mounted tube sockets and 110-volt connectors made by Amphenol.

These plates have a $1\frac{1}{8}$-inch diameter hole with a lug in them. This lug is filed down a bit, and the lug bent to one side of the plate a bit (perhaps 15 degrees or so). Then the wafer base is inserted in the hole, with the lug fitting into one of the notches where the tube skirt was originally crimped. The base is inserted into the side of the plate towards which the lug was bent. It will now be found that the other three notches appear as short slots on the other side of the plate. Into these slots little strips of thin metal, about $\frac{1}{8}$ by $\frac{3}{8}$ inches are inserted, bent back on both sides of the plate, and crimped flat with pliers. That's all!



A few notes: Amphenol sometimes supplies a thicker mounting plate. Only the thinner ones can be used here. They seem to be the commonest kind. Also, a vise or pair of pliers can be used gently to push the base into the plate. It is a good snug fit.

The connector can be mounted in a standard socket hole if the plate is mounted on the outside of the chassis. If a hole $1\frac{5}{16}$ inches in diameter is used, the plate can be put inside. Perhaps the base could be put directly into a hole in the chassis without the plate, using the strip of metal in all four notches. I have never tried this as my socket-hole punch is $1\frac{3}{16}$ inches. The base must be a snug fit in the hole.

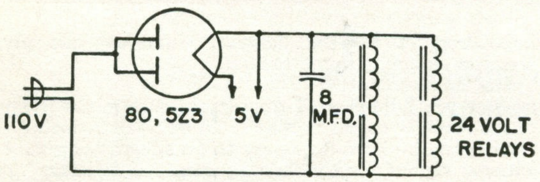
I hope you find this idea interesting. I have used it a lot and found it most satisfactory, especially as it occupies almost no space under the chassis.

PHILIP H. BYRNE, VE3AXX

nd TOPICS

Using 24-volt Relays

I have a trick to submit to your Tricks and Topics section of G-E HAM NEWS. It concerns 24-volt surplus relays which have no doubt been the subject of many tricks. I have been using several in my rig by obtaining power from a 5Z3 or 80 hooked up in a half-wave circuit with their plates tied together. The



output voltage of this supply with one 8-microfarad condenser for filter is about 50 volts or sufficient to operate 2 relays in series, but the current available is sufficient to operate two or three strings of relays.

The high vacuum rectifiers will also supply any extra current necessary to pull in some types of relays which would damage the dry disk type rectifier unless it is well over-rated under normal operating conditions. Most ham rigs will have the necessary 5-volt filament winding already available especially if any surplus transformers are in the rig.

In closing, I wish to thank you for the large amount of enjoyment I have obtained from G-E HAM NEWS.

HUGH E. WHITE, W4NOJ

Easy Way to Tap Poly

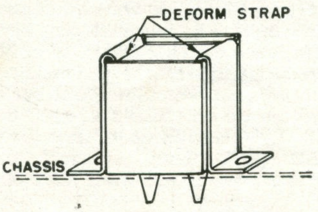
Plexiglas, lucite, polystyrene, and other thermoplastic compounds are easily tapped by means of the following kink. Drill with the proper size drill, fasten a screw of the desired pitch and diameter to one of those "snap on" screwdrivers and heat in a gas flame. The screw will cut a thread as if it were going through butter. Be careful not to get the screw too hot.

JOHN G. LAWTON, W2VYZ

Mounting Can Capacitors

Here is a little kink which may save some of your readers time and energy. It has to do with mounting the rectangular can-type high-voltage filter capacitors after (in true ham fashion) the mounting brackets have been lost or diverted to some other use.

It will be observed that such can-type capacitors have at both top and bottom a bead running all around the edge, and that this bead is about ⅛ inch high. Such capacitors are usually mounted with the terminals projecting through the chassis.



Measure the distance across the capacitor inside the beaded edges, and fabricate, from soft aluminum .040 or .051 thick, a mounting strap to pass over the capacitor. The width of this strap should be slightly less than the distance between the beads on the capacitor. Bend "feet" at the ends of the strap to permit mounting to the chassis.

Punch the chassis to pass the terminals, fit the strap over the capacitor, and bolt to the chassis. It will be observed that some motion of the capacitor is still possible. To eliminate this motion, place the end of a screwdriver blade on the aluminum just inside the corner of the bead and rap smartly with a hammer. Do this at each corner of the capacitor bottom. The screwdriver blade will deform the aluminum, pressing down a small section. These pressed points seize the inside of the bead at each corner and prevent further movement.

HOWARD A. BOWMAN, W6QIR

Low Drain Pilot Lamp System

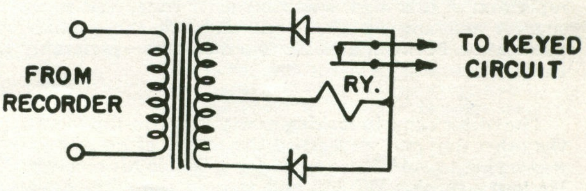
Effective and lower power consumption pilot lamps on 110-volt lines can be economically made with 200,000-ohm resistors in series with NE-2T pigtail type neon lamps.

Space and money can also be saved by mounting the little lamps inside grommets ¼-inch inside diameter. This type pilot lamp draws about 1/25 of a watt—as compared with at least 6 watts drawn by a standard 110-volt pilot lamp.

HERMAN H. ROSS, JR., W6WYF

Transmitting Recorded CW—on CW!

To retransmit recorded CW contacts in the fone bands all you have to do is set the mike in front of the tape or wire recorder and turn on the rig and recorder. But how to retransmit such recorded CW contacts on CW? Here's how I solved the problem of converting the a-f output of the recorder to me-



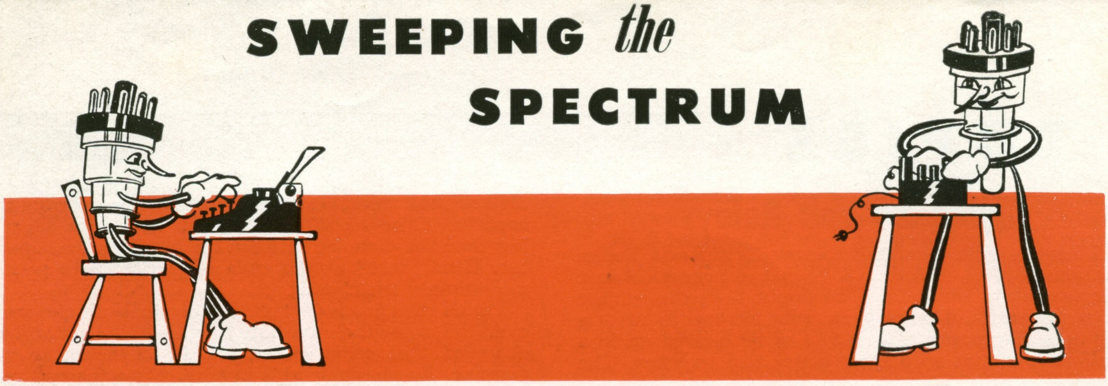
chanical action that will key my transmitter.

As the accompanying diagram shows, all you need is a line-to-grid transformer, a couple of germanium diodes, and a 10,000-ohm plate relay. I use a BK-35 plate relay bought in the surplus market.

GEORGE BEAN, W5DVI

How did you solve that last problem that almost had you stumped? Be it about tubes, antennas, circuits, etc. Lighthouse Larry would like to tell the rest of the hams about it. Send it in! For each "trick" published you win $10 worth of G-E Electronic Tubes. Mark your letter "Entry for Tricks and Topics" and send to Lighthouse Larry, Tube Department, General Electric Company, Schenectady, New York, or in Canada to Canadian General Electric Company, Ltd., Toronto, Ontario. The Companies shall have the right, without obligation beyond the above, to publish and use any material submitted to this column. No entries returned.

SWEEPING *the* SPECTRUM



Quite a few of the editors of radio club bulletins send us copies of their publications and we sure enjoy reading about what the boys in the different sections of the country are doing. If your club puts out a regular bulletin or newsletter of any kind, please tell the editor that we will be glad to exchange publications with him.

And speaking of club newspapers, I'd like to pass on the comment from several fellows to the effect that a club publication—be it the humblest sort of mimeographed job—helps tremendously in keeping the members interested in club activities. It's our firm belief that every club should have one.

The cost is not prohibitive. The principal stumbling block is the work involved. In the first place, it should not be made a one-man job. The load generally is just too heavy for one man. A club bulletin should be run by a standing committee—call it the editorial board if you like. You need at least one member to write news, and the chances are that he could use a helper or two to gather the news. Then you need a member to handle the production—be it mimeographed, hectographed, or printed. And, with a publication of any size, this production man can use some help, too. The third problem that needs careful attention is distribution—which means for the most part, addressing and mailing. At least one member is needed here.

Of course, with small clubs and small bulletins it is quite possible for one member to handle all these items. But while the complete production of one issue of a small publication is not difficult, the tiring part is the repetition of this work load time after time. And so we suggest splitting up the work on even the smallest publication between at least two members—preferably three.

⁂ ⁂ ⁂

The editor came in looking pretty down-in-the-mouth the other day and we learned the source of his sadness was trying to substitute a 6S8 for a 6B8 in his receiver. He has a surplus BC-348 and wanted the extra diode in the 6S8 for a noise limiter. This stunt has been used successfully in many mobile installations. But apparently the BC-348 is quite another matter. He never did get to building the noise limiter on that diode because he found that when he changed pin connections and plugged in the 6S8 about 40 different things happened. In the first place, the audio volume nose-dived. He brought this up by changing the cathode resistor associated with the triode section of the 6S8. Secondly, he had objectionable distortion which he thinks he might have eliminated if he had worked on it long enough. But the thing that bothered him most was that apparently one of the effects of leaving the screen connection from the 6B8 hanging was to knock the daylights out of the operation of his CW oscillator.

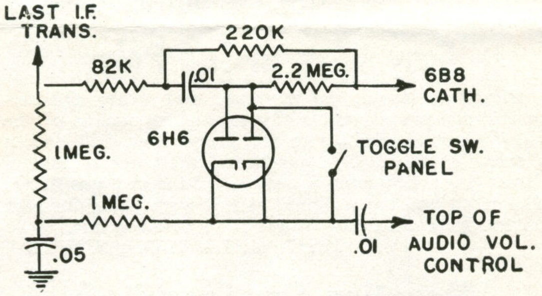
We looked at his schematic and began to list the additional changes he would have to make. For the BC-348, like many good pieces of equipment, is designed as a unit in which all stages and sections are interdependent in varying degrees. Changing one part requires changing many others.

But he interrupted.

"Larry, if you think I'm going to change the design of the receiver to put in a noise limiter, you're nuts."

"If you think you're going to go substituting tubes without regard for the design, then you're nuts," we retorted.

We compromised. He put in an extra tube—a 6H6—for his noise limiter. The reason he didn't want to do this in the first place is that he is still using the original 24-volt filament string with a special transformer he got hold of somewhere and he didn't want to disturb this string with an extra tube. In the end, though, he put in a small filament transformer for the 6H6. Incidentally, we stopped out at his house a few days later and he demonstrated the noise limiter. Works good. In case you're interested, here's the circuit, which he says he got from W2BPU and W2CVF:



⁂ ⁂ ⁂

It seems most of the objections to single-sideband operations come from fellows who say they "tune across an SSB signal and find it just as wide as an AM signal." That complaint precisely points up the purpose of a single-sideband receiver adapter such as the "Signal Slicer" (G-E HAM NEWS Vol. 6, No. 4).

For although you can receive SSB signals with an ordinary communications receiver, you cannot get full advantage of the relative narrowness of an SSB signal without a "Signal Slicer" or the equivalent. And you can't lose by installing a "Signal Slicer" because it will slice out QRM when copying AM, CW or NBFM, too.

To conveniently answer the increasing number of requests for general information about our SSB equipment, I've gotten up an "SSB Package" consisting of copies of G-E HAM NEWS which describe the "Signal Slicer," "SSB Jr.," "Lazy Linear," and "Power Peaker." Let me know if you want a set of these.

—Lighthouse Larry

Again, for 1953

THE EDISON RADIO AMATEUR AWARD

The Award Committee solicits your nominations for 1953 candidates

Here is your opportunity to spotlight the meritorious work of a radio amateur you may know who has served the public by means of his hobby. Enter his name for the Edison Award.

You will be promoting the best interests of amateur radio, and you can win for yourself an expense-paid trip to the city where the Award will be presented. Judges will consider only amateurs who are nominated by your letters.

1952 saw Don Mullican, W5PHP, receive the Edison Award as a result of his outstanding work in the March tornado disasters in Arkansas. Special citations also were given four other amateurs who performed especially notable services.

The acclaim for these five was a tribute to the important and unselfish efforts of amateurs everywhere. The 1953 Award will bring recognition to a new trophy winner—will once more dramatize amateur radio's achievements in the public interest.

Read the rules at right. Then select your candidate . . . and send your letter of nomination to *Edison Award Committee, Tube Department, General Electric Company, Schenectady 5, New York.*

RULES OF THE AWARD

WHO IS ELIGIBLE: any man or woman holding a radio amateur's license issued by the F.C.C., Washington, D. C., who in 1953 performed a meritorious public service in behalf of an individual or group. The service must have been performed while the candidate was pursuing his hobby as an amateur within the continental limits of the United States.

WINNER OF THE AWARD will receive the Edison trophy in a public ceremony in a centrally located metropolitan city. Expenses of his trip to that city will be paid. As a further token of appreciation, G.E. will present him with a precision chronographic watch to clock DX. In addition, the person responsible for the nomination of the Award-winning candidate will be invited to attend the presentation ceremony, and his expenses also will be paid.

WHO CAN NOMINATE: any individual, club, or association familiar with the service performed.

HOW TO NOMINATE. Include in a letter the candidate's name, address, call letters, and a full description of the service performed. Your letter must be postmarked not later than January 3, 1954.

BASIS FOR JUDGING. All entries will be reviewed by a group of distinguished and impartial judges. Their decisions will be based on (1) the greatest benefit to an individual or group, (2) the amount of ingenuity and sacrifice displayed in performing the service. The judges will be:

E. ROLAND HARRIMAN
President, The American Red Cross

GEORGE E. STERLING
Commissioner, Federal Communications Commission

GOODWIN L. DOSLAND
President, American Radio Relay League

GARDNER COWLES
President and Editor, "Look" Magazine

WINNER WILL BE ANNOUNCED on or before Thomas A. Edison's birthday, February 11, 1954.

Employees of the General Electric Company may nominate candidates for the Edison Radio Amateur Award, but are not permitted to receive the Award.

GENERAL ELECTRIC

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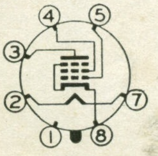
1878 75 1953
YEARS OF ELECTRICAL PROGRESS
Diamond Anniversary

Technical Information **12V6**

GENERAL DESCRIPTION

Another addition has been made to the 6V6 family—the 12V6-GT. This is a 12-volt filament version of the beam power pentode, and was designed for use in auto radios operating on the new 12-volt ignition systems. Amateurs undoubtedly will have occasion to use the 12V6-GT as 12-volt auto systems come into more general use in the next few years.

BASING DIAGRAM



MAXIMUM RATINGS

Heater Voltage (a-c or d-c)	12.5 Volts
Heater Current	0.225 Amp
Plate Voltage	315 Volts
Screen Supply Voltage	315 Volts
Screen Voltage	285 Volts
Plate Dissipation	12.0 Watts
Screen Dissipation	2.0 Watts
Heater-cathode Voltage	90 Volts
Grid Number 1 Circuit Resistance:	
With Fixed Bias	0.5 Megohm
With Cathode Bias	1.0 Megohm

TYPICAL OPERATION

CLASS A_1 AMPLIFIER

Plate Voltage	180	315 Volts
Screen Voltage	180	225 Volts
Grid Number 1 Voltage	−8.5	−13.0 Volts
Peak A-F Grid No. 1 Voltage	8.5	13.0 Volts
Plate Resistance (Approx)	50000	80000 Ohms
Transconductance	3700	3750 Mho
Zero-Signal Plate Current	29	34 Ma
Max.-Signal Plate Current	30	35 Ma
Zero-Signal Screen Current	3	2.2 Ma
Max.-Signal Screen Current	4	6 Ma
Load Resistance	5500	8500 Ohms
Total Harmonic Distortion	8	12 %
Power Output	2.0	5.5 Watts

CLASS AB_1 AMPLIFIER (VALUES FOR TWO TUBES)

Plate Voltage	285 Volts
Screen Voltage	285 Volts
Grid Number 1 Voltage	−19 Volts
Peak A-F Signal Voltage (Grid to Grid)	38 Volts
Plate Resistance (Each Tube)	70000 Ohms
Transconductance (Each Tube)	3600 Mho
Zero-Signal Plate Current	70 Ma
Max.-Signal Plate Current (Approx)	92 Ma
Zero-Signal Screen Current	4 Ma
Max.-Signal Screen Current (Approx)	13.5 Ma
Effective Total Load Resistance (P-P)	8000 Ohms
Total Harmonic Distortion (Approx)	3.5 %
Power Output	14 Watts

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