AMATEUR RADIO 73

March 1969

75¢

SPECIAL SURPLUS ISSUE

Giant Catalog of surplus dealers begins on page 97

Surplus Conversion Articles

Electronic Keyer

Extra Class License Part II

73 MAGAZINE

March 1969
Vol. LXIX No. 3

Cover Photo: A Surplus ham shack in operation. Photo by Clarence Snyder W3PYF. Equipment consists of Model 19 Teletype, AN/USN24A Scope, FSA/FSK, and related home-brew equipment constructed from surplus parts.

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73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S.

Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

OK, I finally allowed the camera to take a picture of the Editor. So . . . stop nagging, already. On the left is the camera eye's view of your editor. A benign, friendly, motherly gal. On the right is a cartoon I found taped to the file cabinet next to the drafting table here at 73. This shows what at least one of my fellow workers sees in me! Perhaps I should mend my ways?

For years, our annual surplus issue came out in June. At the request of many of the surplus dealers, we advanced it to March. The complaint is that June is not a "project" time. Perhaps October would be even more appropriate, since with the advent of the long winter months, those living in the north abandon boats and other outdoor activities, and begin planning for inside building projects.

In any case, there is a dearth of surplus articles coming across my desk. Following World War II, the conversion of surplus constituted much of our amateur equipment. These days, there doesn't seem to be much new material. Most of it finds its way into the MARS programs, and much apparently is simply destroyed, since it is highly classified. I wonder if amateur radio may not be nearing the end of another era?

It is becoming increasingly evident that the number of new hams is decreasing each year. It is also evident that the number of hams who are going for the higher class licenses, is not up to the expectations of either ARRL or FCC. This brings us to speculate on various reasons for both situations.

There was a time when one could walk into an FCC Field Office and request to take the exams. There was a later time, when mornings were available each day during the week for those wishing to take the exam. Now, you look at the list of FCC offices and times of examination, and the restrictions are pretty grim. In many cases, you have the choice of getting to the office at 0800 the third Friday of the month, or not taking the test.

This is a hardship. For the person who lives in a large town which has a Field Office, perhaps it is not too bad. I live 80 miles from the nearest FCC office. This is 80 miles, for the most part, of winding country roads where the speed limit is about 40. This means a two hour drive on a work day morning, arriving in a state of physical and psychological exhaustion from fighting the morning traffic, and facing the noise and confusion of perhaps 50 other examinees in one room.

I haven't copied code with a pencil for many years. I use a typewriter. In a crowded room, a typewriter makes more noise and confusion, so FCC says I can't use one. I've been using a typewriter for so long that I can hardly write anymore. At least not so anyone can decipher my scrawl. So, I have to go back to learning how to use a pencil before I can qualify for the Extra.

I do not advocate easier exams. I do think it would be a not too difficult task for the local Field Offices to make examining conditions more relaxed and less restricted.

I suspect if the FCC offices were not so full, there would be fewer failures.

. . . Kayla—W1EMV

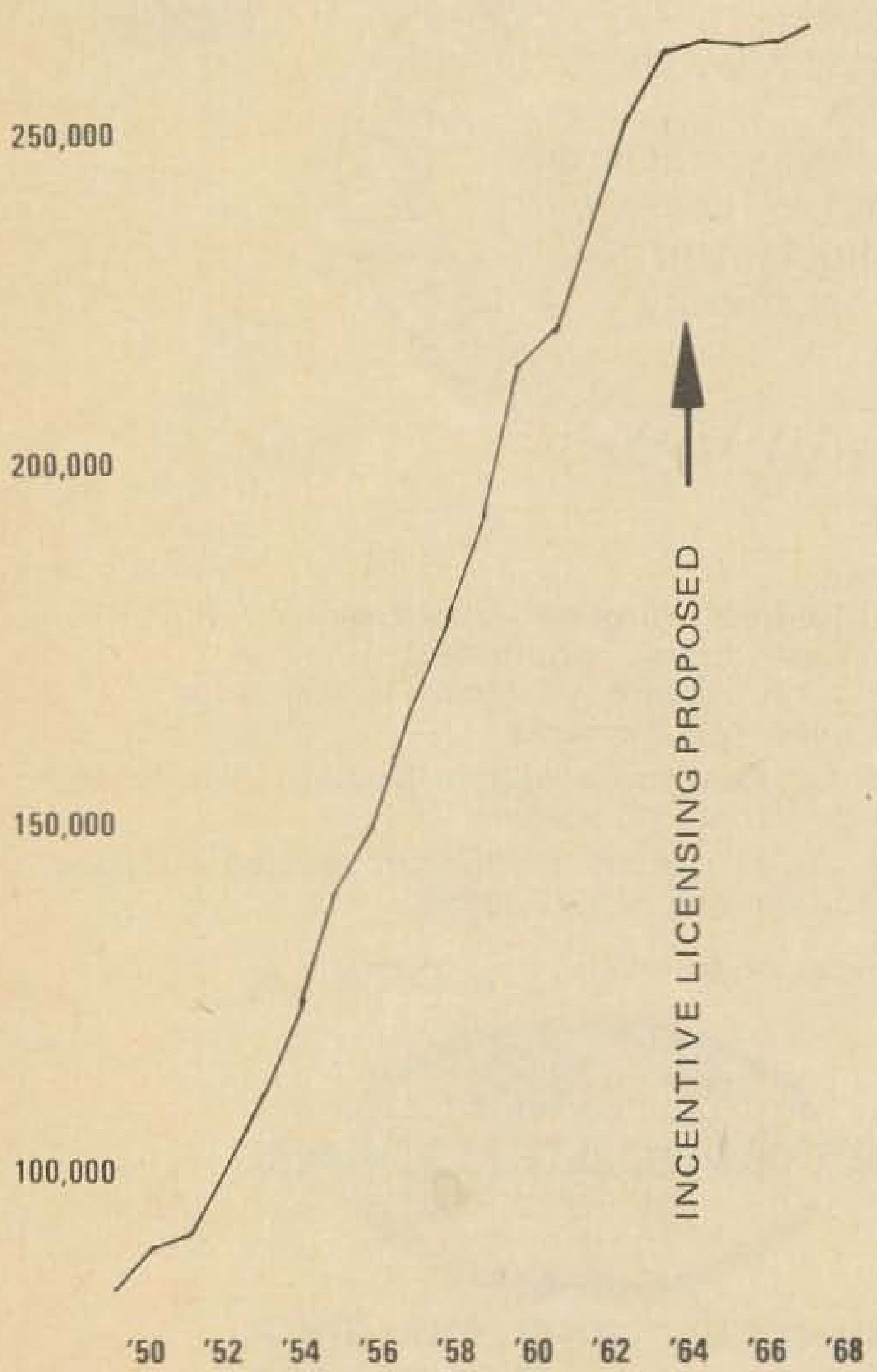
...de W2NSD/1

Wayne Green

The chart below is based upon the FCC figures for the number of amateurs licensed each year for the last twenty years. As you can plainly see, the amateur ranks were swelling at the rate of about 13,000 per year fairly regularly until 1964, when the growth virtually stopped.

While the sudden stunting of amateur growth is strangely coincident with the announcement by the ARRL of their Incentive Licensing proposals to the FCC, I realize that I have been perhaps a bit tedious in my finger pointing at this particular outrage (in my view) and that there may be other factors which brought about the results which I predicted.

Be that as it may, there are several reasons why it is important for us to get that growth curve back on the track. Though portions of our lower bands are reasonably active, there are wide areas of our higher bands that desperately need more activity.



We have acres and acres of room for growth in VHF bands. And if we don't start growing into these frequencies there is not the slightest question that we will start losing them. I don't know if it is necessary to open up the top end of ten meters to the Novices, but I do know that we darned well better do something to get some activity up there or else it could turn into another Citizens' Band, or even worse. Well, it probably couldn't be worse. Ten was a lot more active ten years ago at the time France made a major try to get the ITU to authorize them to use the top megacycle of ten meters for local low powered communications with the proviso that amateur radio could continue to share the band as long as it did not interfere with their communications. Fortunately this rule change was voted down at the time.

Pardon my digression, but I wanted to show that every one of our frequencies is badly wanted by other services and you can bet that they are ready to pounce on anything we leave unused for any length of time.

The use of our frequencies is only one part of the protection we can give them. Frequency allocations are a political matter, unfortunately, and it is important that we recognize this and act accordingly. We all realize that amateur radio is of tremendous importance to our country. We know that the electronic industry and the communications industry in our country could not possibly have grown at the rate it has without the hundred thousand or so amateurs who are working in them. We know that our preparation for the last war would have been much much longer if we had not had tens of thousands of amateurs available as radiomen, electronic technicians, and teachers. Communications and radar were of critical importance in our winning the war and these might have taken years longer to press into effective use had it not been for our amateurs.

We need only look around at other countries to see the importance of radio amateurs. Where

(This goes on and on on page 77)

Modernizing the TCS Transmitter

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The TCS transmitter is as fine a piece of workmanship as can be found. However, it suffers from a common problem with surplus gear—it was designed to perform as part of a group of equipment and in a manner useful to the military. Herein are some simple changes which will fit this fine instrument into typical amateur patterns of operation. The word simple must be stressed. There is no point in spending days stripping the entire circuitry and building a whole new transmitter in the frame. These modifications will require about four to six hours and very little in the way of parts or machining.

There are four logical steps to the conversion of the TCS. First, if you do not have the companion power supply, one must be built. Obviously, this will require much more than the aforementioned four hours. But it is likely that a better supply can be built, by the ham with a typical stock of "junk" parts, for less than the original version can be purchased. (i.e. under $40.00).

Second, conversion to cathode keying will be covered. As designed, the TCS is keyed by applying and removing B+ on the final tubes, at a keying rate, with relays. In the AM mode, this is a satisfactory method. When using CW, however, this type of keying is completely unacceptable.

The third phase involves modification of the output circuitry to provide optimum transfer of power to a matched 50 ohm line. This is the antenna system used by the author, and therefore, the only one for which specifics can be supplied. The basic concept of the output tank will be discussed in hopes of enabling those using tuned lines, non-resonant antennas, etc., to experiment and find a solution suitable to their particular installation.

As a final phase, we will take a brief look at boosting the audio of the modulation stage, a necessary step if AM use is contemplated.

Power Supply

If you desire to build a supply for your TCS, the first step is to change the power plug, P_{101}, to a common type. Fortunately, the hole occupied by the existing P_{101} is exactly the right size for an octal socket. So, remove the leads from P_{101} and label each by pin number as you move them aside. Secure a male octal plug, the type with a locking ring, and install it in the hole formerly occupied by the multi-pin P_{101}. Re-connect the leads according to **Table I.** In addition, connect a 0.01 mfd disc capacitor to ground from each of the new pins except number 5.

Old pin #	New pin #	New Function
2	1	Final tubes B+
7	2	ac on loop
12	3	ac on loop
13	4	12.6 vac—filaments
15	5	Ground
14	6	Oscillator & Buffer B+
16	7	12.6 vdc—relays
—	8	Relay switching—see "keying mod."

TABLE I.

The remaining leads which are not shown connected in **Table I** should be removed or tied back and insulated. They are not required when the transmitter is used without the companion receiver.

The power supply is straightforward and requires little discussion to supplement the schematic, **Fig. 1.** As designed, the TCS power supply provides 400v B+ on the final tubes. However, this voltage level will not realize full power output, approximately 65 watts, with some output configurations. The 1625 tubes used can easily operate with

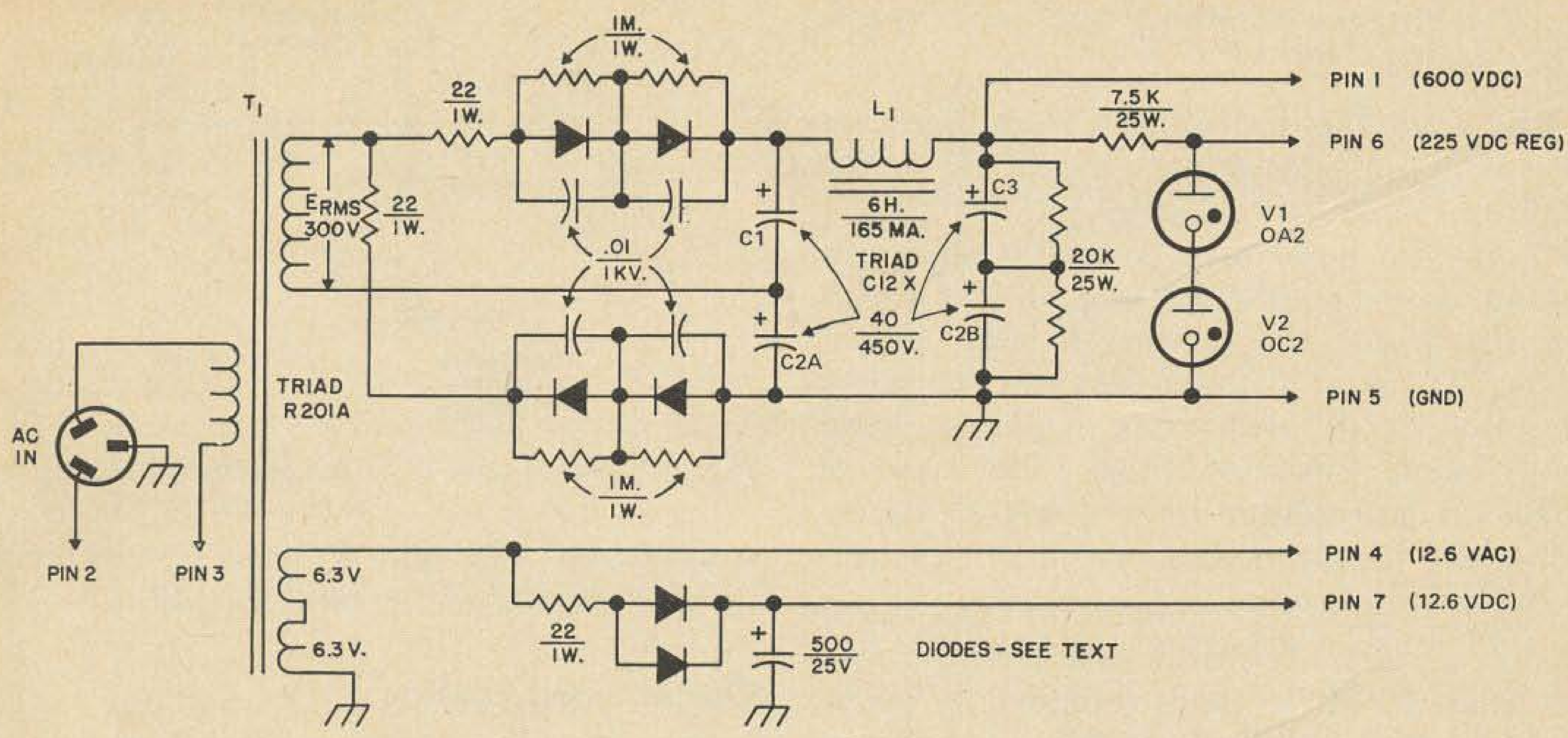

Fig. 1. *Schematic diagram for the TCS power supply.*

600 V on the plates. Therefore, selection of a high voltage secondary for the power transformer may range between the 400 V to 600 V level with output power varying accordingly. The transformer shown in **Fig. 1** uses a voltage doubling rectifier, yielding about 600 Vdc at pin 1. It is an excellent combination of high voltage and filament windings at a reasonable price, but is by no means the only one available.

Medium voltage is regulated at 225 V by V_1 and V_2 in series. The load on the regulated line is constant, therefore VR tubes can be used despite the fact that the load may exceed the rating of the tubes. Note that C_1 and C_3 must be separate units. A common negative, dual type will not do. C_2 may be a common, can-negative type, however.

Since everyone has a different source of the hundreds of types of silicon diodes on the market, a stock number is not called out. When selecting diodes, use the rule-of-thumb:

$$PIV_{total} = 3 \times Vac_{rms}.$$

Thus, using the transformer shown, $PIV_{total} = 3 \times 300 = 900$ V. If your diodes are rated at 400 V PIV, for example, you *must* use three of them in series in each leg. Failure to observe this rule will invariably cost you a diode or two. Place a .5 to 1 megohm, 1 watt resistor and a 0.01 mfd, 1 kV disc capacitor in parallel with each diode whenever two or more are used in series, in order to equalize current distribution and damp voltage spikes. The 22 ohm, 1 watt current limiting resistors in each leg are essential in a capacitor-input power supply.

12.6 Vac is required for the filaments. This particular transformer has two 6.3 Vac windings of equal current rating. If you connect two such windings in series out of phase, there will be no output. Should this occur, simply reverse one winding connection.

The entire supply can be housed in a 4 x 5 x 6 inch minibox and mounted on the rear of the transmitter case.

Keying modifications

Following is a step-by-step procedure for converting to cathode keying. It is an extremely simple operation, literally requir-

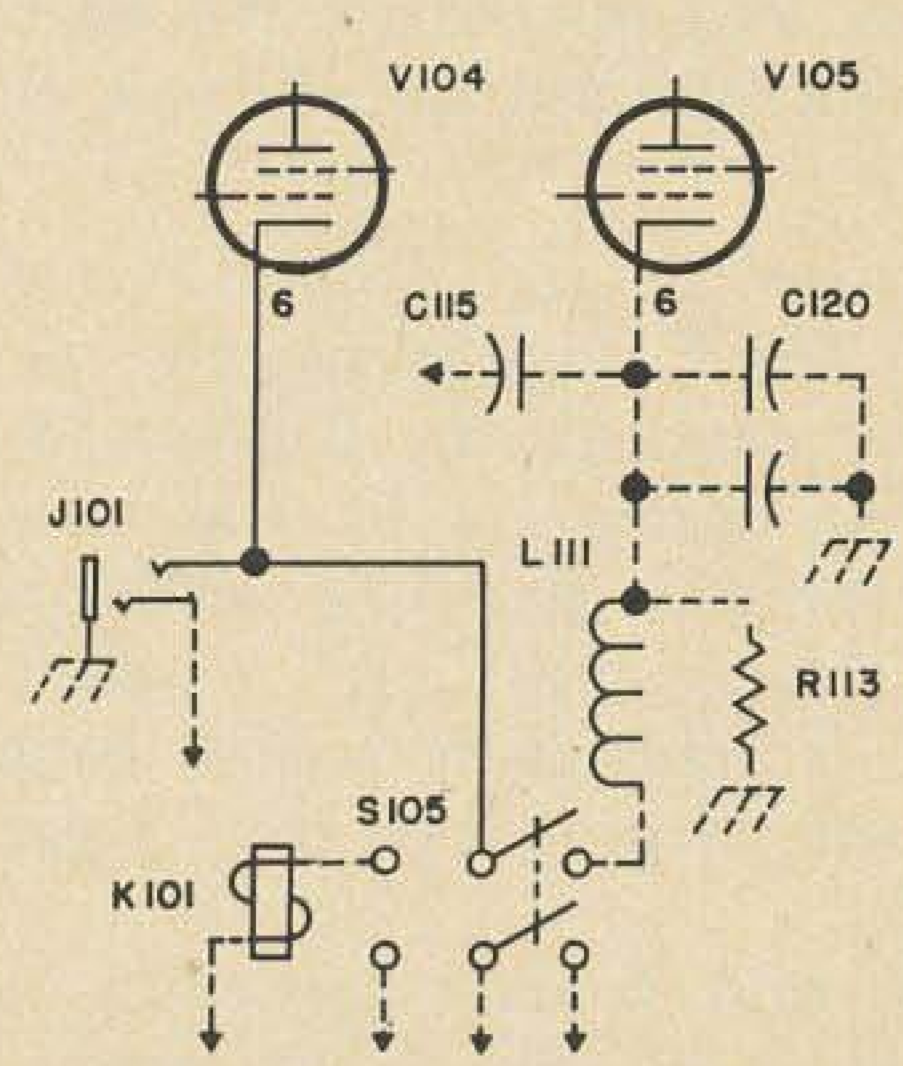

Fig. 2. Converting the TCS to cathode keying. Solid lines show conversion.

ing only fifteen minutes, but well worth while. (**See Fig. 2.**)

1. Remove the transmitter from the case and lay it upside down. locate X_{104}, the socket of V_{104}. Next, locate pin 6. Pins 1 and 7 are the large tube pins—the filaments. Looking down on the bottom of the socket from the front, the left-hand large pin is number 7. Count counterclockwise to pin 6 and unsolder all leads from it. These leads are all heavy bus-wire. Push them clear of the socket and solder them together again. A tie-point is not necessary.

2. Locate the "tip" contact on the three-way "Key" jack, J_{101}, and unsolder the two leads from it. Move them temporarily aside. Now solder a five inch length of hook-up lead to this contact. Route the other end to the "Voice/CW" switch, S_{105}.

3. On S_{105}, unsolder the solid white wire on the center contact of the side *away* from J_{101}. Remove or tie back and insulate this lead. It will not be used.

4. Connect a lead between pin 6 of V_{104} and the contact just vacated on S_{105}. Also solder, at the same contact of S_{105}, the five inch lead from J_{101}.

The cathodes of V_{104} and V_{105} are now lifted from ground and will be keyed during CW operation. On AM V_{104} is turned off and V_{105} will be keyed by a normal PTT operation. All that remains is to provide for the switching of K_{102} and K_{103} when going from receive to transmit and vice-versa.

5. Remove the large ground screw from the front panel. About one inch directly beside this drill a clearance hole for a#10 screw. From the front insert a ½ inch long #10 screw and re-connect the ground leads from the old ground lug. Secure them with a nut.

6. Enlarge the old ground-screw hole to accept a SPST toggle switch. Mount the switch and connect one contact to the new ground lug beside it. To the other switch contact, connect the two leads previously removed from the "tip" contact of J_{101} (Step 2). To this same switch contact, connect a lead to pin 8 of the "Power" plug, P_{101}.

Steps 5 and 6 have added a "Send/Receive" switch to the front panel of your TCS. In addition, pin 8 of the power plug is paralled with it and may be used (in

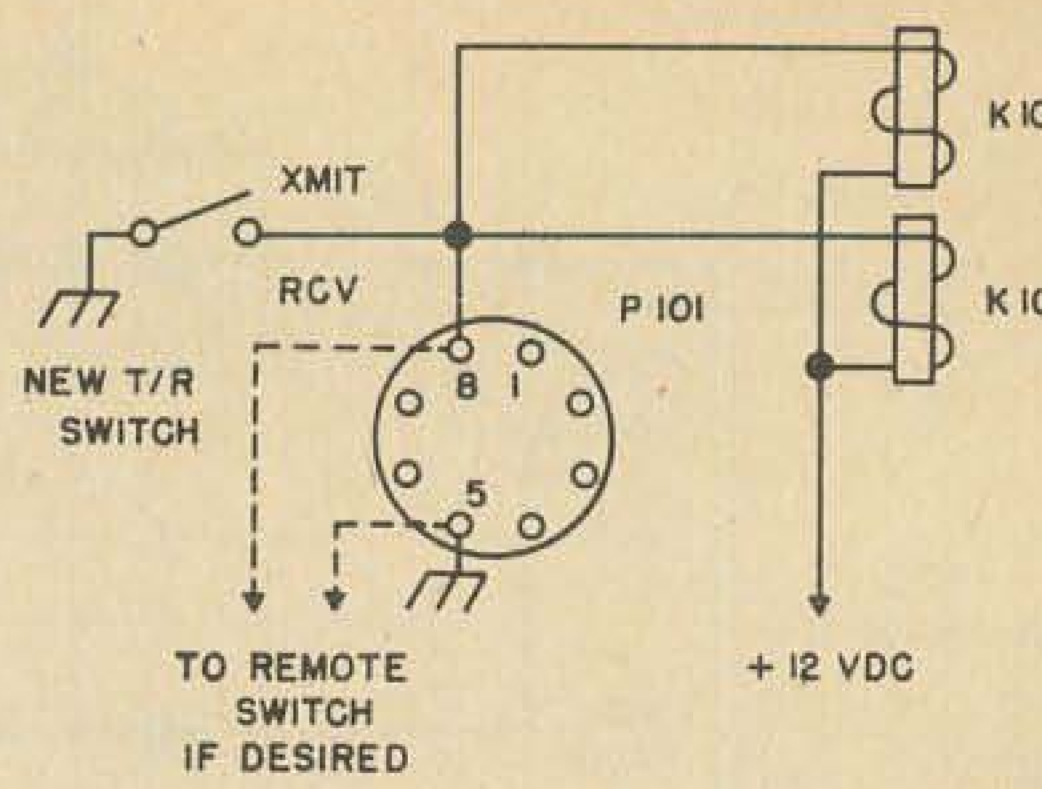

Fig. 3. *Steps* 5 *and* 6 *of keying modification.*

conjunction with pin 5) as a remote switch or relay control of the same function.

Output modification

The antenna circuitry of the TCS is designed to load an unmatched 20 foot whip with single-wire feed. Series inductances are provided, internally and externally, to permit reasonable matching over the frequency range. At best, this is an expedient system and can be vastly improved upon.

At this station, a 23 foot, base-loaded vertical is used with 50 ohm coax feedline. From a space economy standpoint, this is perhaps the most desirable antenna system for the low frequencies of the TCS. Certainly, a more efficient system would be an end-fed long wire. but this requires infinately more room.

7. To begin with the modification, disconnect and remove E_{105} and E_{107}, the "Receiver" and the "Antenna" terminals. Enlarge the two holes to accept coax connectors—type UG-657 (BNC) connectors fit the holes without the need for enlarging. Re-connect the two leads to the new coax connectors.

8. Next, disconnect and remove the roller-coil, L_{108}, marked "Antenna Loading". Temporarily leave the two bus leads (from L_{107} and S_{103}) hanging. The coil is held in place by the four corner screws of the panel-plate, and two screws, in the rear of the roller-coil, attached to a bracket. By removing V_{104} and V_{105}, the latter mounting screws are accessable.

9. Remove capacitor C_{121} and the ceramic stand-off on which it is mounted. In place of this, mount a similar type capacitor with a value of 1000 mmf (i.e. Centralab 858S-1000). This capacitor mounts with one end grounded directly on the transmitter frame. Refer to **Fig. 4** for later connection of the other end of the new C_{121}.

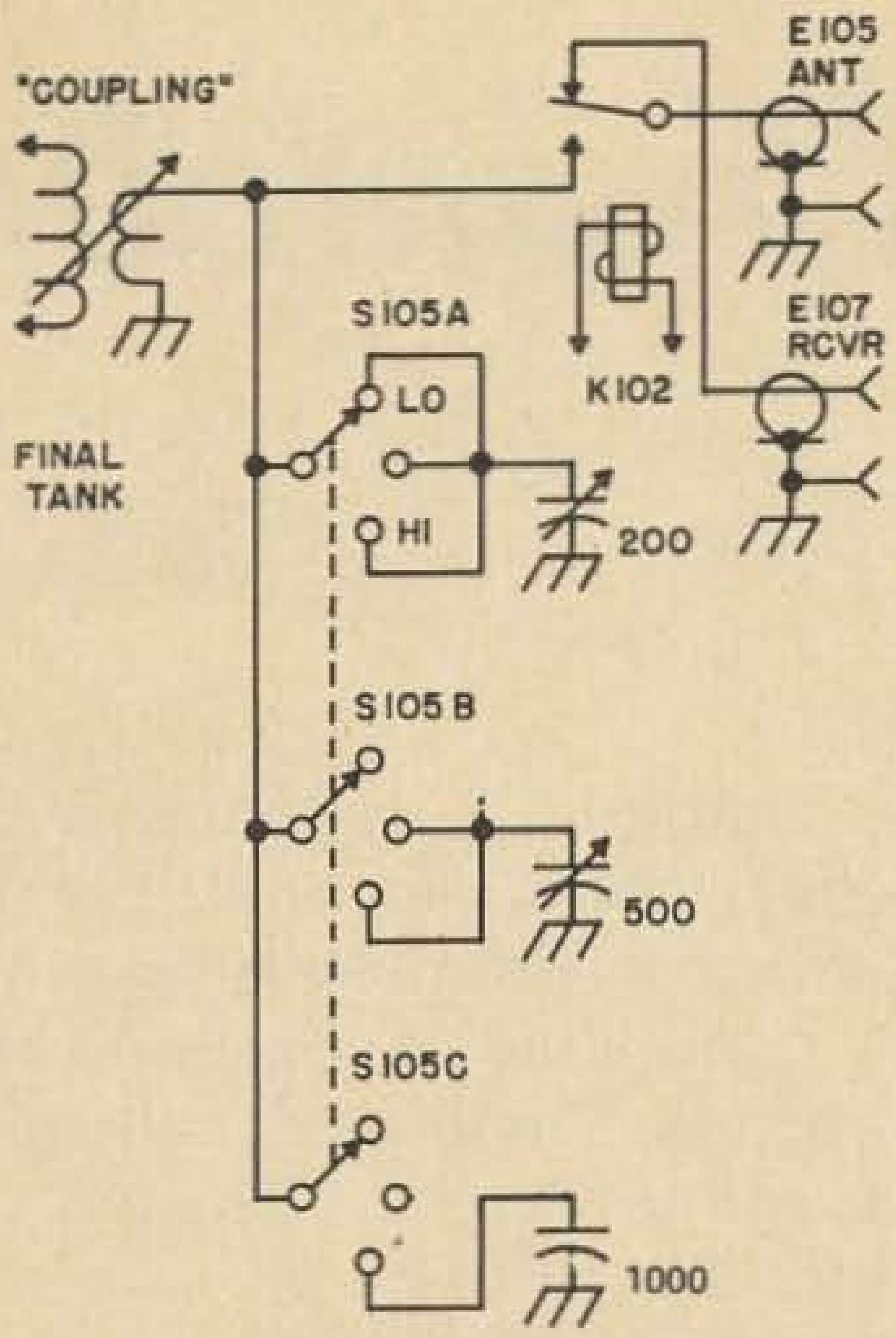

Fig. 4. TCS output modification.

10. Next, using 1/16 or 1/8 inch aluminum plate, fashion a cover plate for the hole from which L_{108} was removed. The faceplate of the roller-coil may be used as a template for the perimeter shape and position of the four corner mounting-screw holes.

11. Secure one of the myriad types of ac-dc receiver tuning capacitors having two gangs. Almost any will do, so long as one section will tune to about 500 mmf and the other around 200 mmf. These values are certainly not critical. Mount this capacitor on the cover plate you have just made, making sure the rotors ground to the transmitter frame. Before mounting, connect about six inches of buss wire to the stators of each section, positioned towards S_{103}, the "Antenna Condenser" switch.

12. Carefully bend the buss lead from L_{107}, left by the removal of the roller-coil toward the relay K_{102}. Solder it to the same relay contact as the lead going to C_{121}.

13. Now, remove all wiring from the "Antenna Condenser" switch, S_{105}. It will be necessary to carefully straighten the buss wire lead from K_{102}, referred to above, in order for it to be long enough to reach the proper contact when rewiring S_{105}.

14. Refer, now, to **Fig. 4** and make all connections at S_{105}.

When completed, this switch becomes a Low-Medium-High capacitance range switch, all in parallel with the antenna link of L_{107}. By proper selection of range, and experimental balancing using the "coupling" control and the new "antenna loading" capacitor, you can obtain optimum power transfer to a matched 50 ohm antenna throughout the frequency range of the TCS.

Essentially, the requirement which must be satisfied is to make the link-output appear as 50 ohms reactance to the load at the frequency in use. The rotatable link does not satisfy this condition as designed, so it is necessary to include a circuit variable which will. Obviously, another approach to the problem would be to remove the link coil, calculate the proper inductance to provide 50 ohms reactance and re-wire the link. However, the removal of this coil seemed to be considerably more of a mechanical problem than the construction of the circuit of **Fig. 4.** In addition, this method offers much more flexibility.

Audio modifications

Most amateurs prefer to use ceramic or crystal type microphones rather than suffer with the poor quality and mechanical problems associated with carbon mikes. Thus it behooves one to add pre-amplification to the audio stage in order to realize sufficient modulation percentage as compared to carrier power.

In summary, after these modifications are complete, you have an efficient, compact, low-power transmitter capable of continuous tuning from 1.5 to 12 MHz. Aside from covering the obvious amateur bands, most of the major MARS frequencies are available, particularly those of Navy MARS which are impossible with most ordinary ham equipment. Ideas will occur to many of you, which I have overlooked, because each of us have different uses for the little rig and diverse systems into which it must blend. This is what makes surplus modification so interesting. . . . K3UUL

A $4 Compressor/Preamplifier

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Mystic, Conn. 06355

By the addition of a few extra components to an inexpensive, already assembled transistor audio amplifier, one can produce a very satisfactory but yet inexpensive audio compressor for use between almost any microphone and AM or SSB transmitter.

The author has constructed many different types of audio compressors and has become convinced that under poor signal conditions and with transmitters lacking effective alc, that they are a definite advantage. The problem in constructing a compressor is that either one must start from scratch, assembling all the necessary components, or search out some piece of equipment to modify. The latter course has been used by the author using a high quality phono preamplifier. However, it certainly was not the cheapest way to proceed although the results were very good.

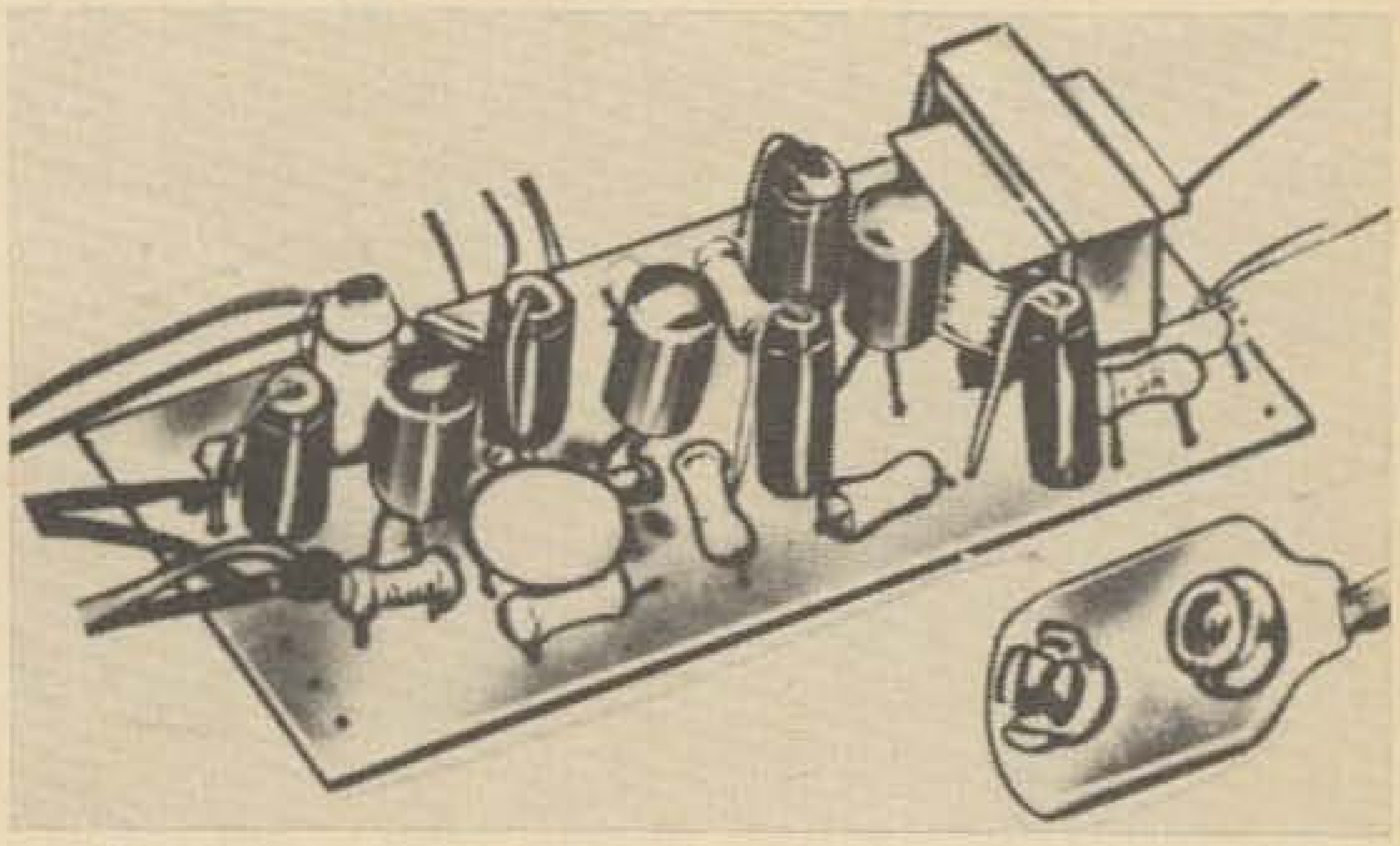
Therefore, the idea came to mind to try to modify one of the small, preassembled 100 to 200 mw audio amplifiers which are readily available at prices from $2 to $4. These imported audio amplifiers were built for use in inexpensive battery-type tape recorders and typically contain 3 or 4 transistor stages with a medium to high impedance input and a transformer coupled output to match a 4-8 ohm speaker. The results that were obtained after such a unit has been modified were indeed surprising. Distortion was quite low—at least in the 300 to 3,000 cycle range—and the compression range of about 14 to 20 db equalled that of many more expensive designs.

Only a handful of components is necessary to effect the change of the amplifier into an effective compressor and they can be readily purchased or are probably even available in most "junk box" collections. The conversion described for the amplifier used by the author is typical and can be applied to any generally similar unit.

Circuit modification

Fig. 1 shows the original diagram of the audio amplifier used, a Lafayette model 99-9039 100 mw output model. To provide compressor action some method had to be used which would allow control of the gain of the amplifier so that it would decrease automatically as the input signal level increased. There are many ways to perform this function.

Fig. 2(A) shows a very simple and effective means employing an absolute minimum of added components. In this circuit, part of the output of the 2SB176 stage is rectified by the IN270 diode. This voltage is used to bias the other IN270 diode which is connected in the microphone lead after the 47 K ohm resistor. Increased amplifier output causes the IN270 in the input circuit to be biased so it presents a low resistance to ground. In conjunction with the 47 K ohm resistor it then forms a voltage divider



Typical small 3 stage audio amplifier. Additional components for compressor control circuit are easily mounted on underside of printed circuit board. Entire assembly may be placed inside transmitter or a small minibox.

network which reduces the input signal feed to the base of the first 2SB113 stage. The value of the 47 K ohm resistor can be varied to provide the desired compressor action and also to work best with a particular microphone. The only disadvantage to this scheme is that compression action starts almost immediately on the input signal rather than at some preset "threshold" level.

This disadvantage can be overcome by the only slightly more complicated circuit of **Fig. 2(B)**. In addition, this modification introduces some degeneration which helps to improve the frequency response and lower the distortion of the amplifier. The operation is somewhat similar to the previous circuit in that two IN270 diodes are used to rectify part of the output from the collector circuit of the 2SB176 and used to control the resistance of another IN270 diode. The latter diode is connected in series with the emitter bypass capacitor of the input 2SB113 stage. In addition, there is a "threshold" biasing circuit consisting of the 100 K ohm and 25 K ohm resistors connected to the diode. Increasing output from the 2SB176 stage causes a rectified voltage to be developed which acts to back-bias the

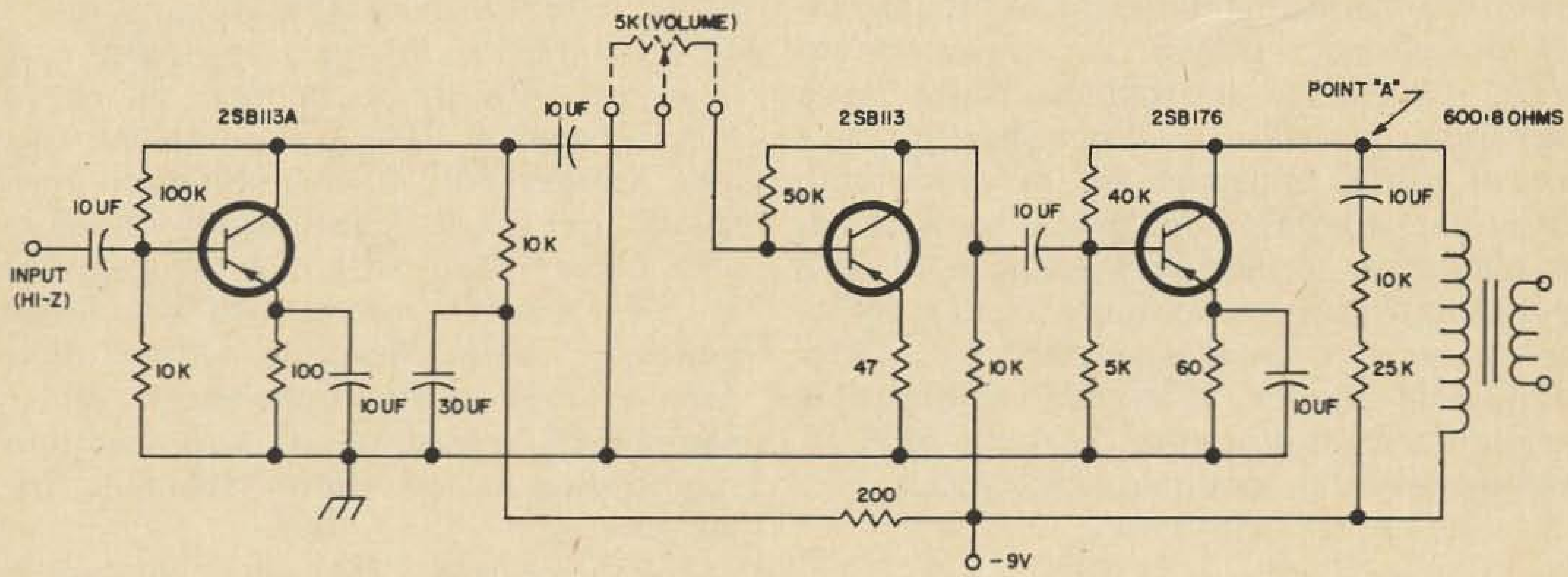


Fig. 1. Schematic of Lafayette 99-9039 amplifier before conversion. Unit is similar to many inexpensive 100 to 300 MW class amplifiers available on market.

diode in the 2SB113 stage emitter circuit and thus nullify the action of the emitter bypass capacitor and reduce the stage gain. This action cannot, however, take place before the rectified control voltage exceeds the "threshold" control voltage developed across the control diode by the 100 K ohm and 25 K ohm resistors. Thus, compression action is "delayed" for very low level input signals and the amplifier essentially operates at full gain for these signals.

A further refinement which is not absolutely necessary but which does provide an additional degree of convenience is to replace the gain control shown in **Fig. 1** with a fixed value resistor and place a 1 to 5 K ohm potentiometer in the emitter circuit of the input 2SB113 stage (in series with the 100 ohm resistor). The potentiometer will then function as a compression control with the amplifier acting as a straight preamplifier without compression action for large

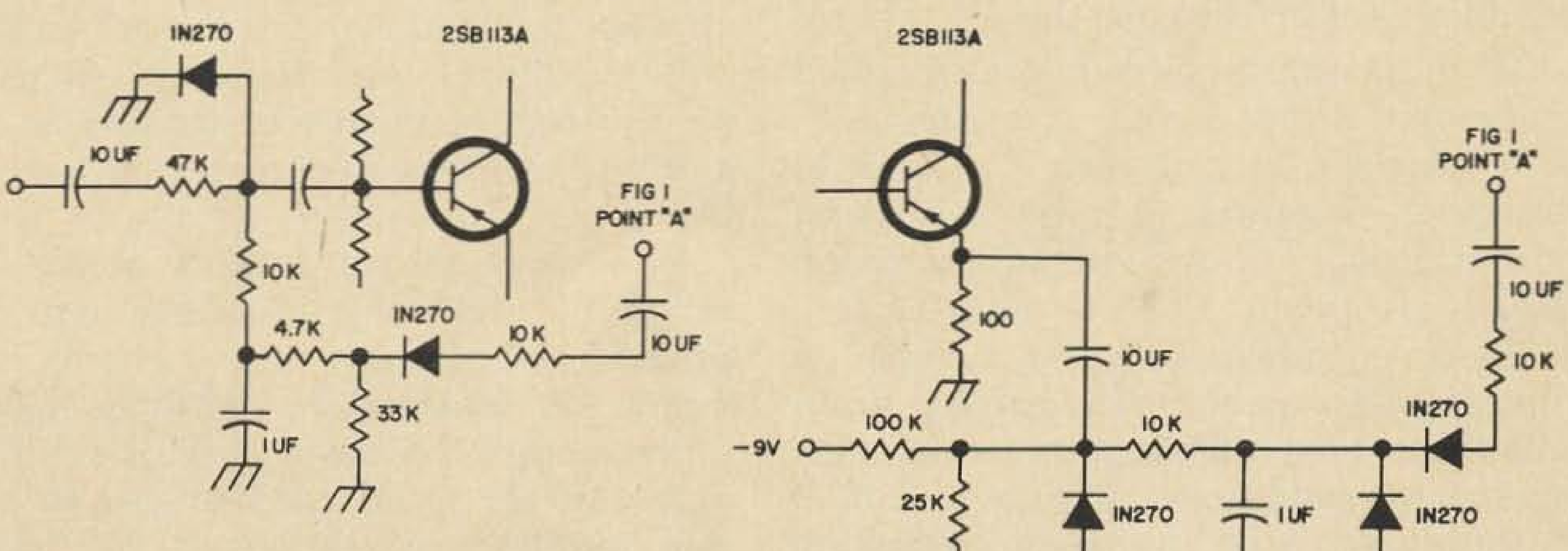


Fig. 2. Simple compressor control circuit (A) and slightly more elaborate circuit (B) providing "threshold" action.

resistance settings of the potentiometer and increasingly as a compression amplifier as the potentiometer resistance is decreased.

In the unit used by the author, output coupling for the IN270 rectifiers could simply be taken from the single-ended 2SB176 stage using the components already available as a frequency compensating network across the output transformer. Using units with push-pull output stages, a similar coupling network consisting of a 10 mF capacitor and 10 K ohm resistor in series coupled to *either* collector lead of the output stage should suffice. The output side of the output transformer is designed to operate into a low impedance load. To operate it into a high impedance microphone input on a transmitter, it will usually suffice to just place a 47 K ohm resistor in series with the output winding. The power available at the output is considerably reduced by this method but this is normally of no consequence for the usual high-gain transmitter microphone input. Otherwise, a matching transformer can, of course, be used to effect a more conventional impedance stepup.

Construction

The addition of the few additional parts necessary to turn the amplifier into a compressor can easily be accomodated on the printed circuit board of the amplifier. No particular placement of the components is necessary and if one takes a careful look at the layout of the printed circuit board, it will usually be found that almost all of the additional components can be placed on the underside of the PC board. Where tie points are necessary, a small hole can be drilled in a clear area on the PC board.

Most of the amplifier circuits are designed to be operated from 9 volt transistor batteries. A rectifier circuit can, of course, be constructed to power the unit as a compressor but usually it will be found to be far simpler to operate them from a battery supply. Since no power output is demanded from the amplifier circuit, the battery drain will only be a few milliamperes under normal operating conditions. Otherwise, if a power supply is used particular attention must be given to adequate hum filtering. The power supply should have an output capacity of 1000 mF as a minimum.

Operation

There are many ways to evaluate the performance of a compressor unit. On the air tests are only useful if they are conducted under weak-signal conditions or properly simulated weak-signal conditions. The latter is sometimes difficult to do on a local contact unless both parties in the QSO understand what objective is being attempted with the compressor. That objective, of course, is to raise the average power output of a transmitter. Thus, if tests are conducted under strong signal conditions with full rf gain control setting on the receiver being used to check the transmission, little or no variation in signal strength may be observed with the compressor in or out of the transmitter. This is because the receiver agc "washes out" the variations in received signal strength as heard aurally. Such a test should be made with the lc gain control on the receiver reduced to the minimum which will allow reception without the compressor used in the transmitter. When the compressor is inserted, a more accurate demonstration of its effect will then be obtained.

In some cases, the effect of using the compressor is readily observed at the transmitter. For instance, in the author's situation an HA-14 linear is used. The plates of the 572 tubes normally appear gray under operation without the compressor. Using the compressor, the plates develop a dull red color. This is due to increased average power input which certainly—assuming no audio distortion—means increased signal strength being radiated.

The increase in average power is difficult to determine exactly without complex instrumentation, but it seems to be in the order of 20 to 30 percent. This may not appear tremendous but, considering that only 4 dollars was invested, there would hardly seem to be any easier way to squeeze a bit of additional power from an existing linear.

The ways shown in this article to convert an inexpensive amplifier into a compressor are certainly not the only methods usable. A multitude of articles have used other methods. However, with a bit of care they can all be adapted to use an inexpensive amplifier as described in this article as a foundation since only the control circircuits are different but the basic amplifier stages remain the same. . . . W2EEY/1

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Amateur net **$395**

P.S. Yes, for our customers who require some of the extra features, there will be a deluxe version of the Cygnet coming soon, which will sell for approximately $495

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Roy W. Palmer K9DRB
Milwaukee School of Engineering
Milwaukee, Wisc. 53201

Reactance or Impedance?

A problem encountered by technical people for many years involves the two fleeting quantities known as impedance and reactance. One never really knows when reading an article or text which one is being discussed due to the ambiguity traditionally associated with these terms. Many publications presently in print speak freely of reactance as having a "phase angle", or impedance as being a simple number quantity. Both of these statements are totally incorrect.

Reactance is a term applied to a quantity having magnitude only with no regard to direction. Impedance, on the other hand, not only implies magnitude, but dictates a particular direction as well. The reactance of an inductor of 1 Henry being operated at a frequency of 60 Hz would be:

$$X_L = 2\pi fL = 2\pi (60)(1) = 377 \text{ ohms}$$

This quantity is called reactance and has a value of 377 ohms, with no consideration given as to direction. If at this point we say that our inductor has a value of 377 ohms at angle (direction) of 90 degrees, we have immediately bridged the gap and developed a new quantity called *impedance*.

Consider the following analogy: A bullet is fired from a rifle at a speed of 600 miles per hour. Only one correct deduction concerning the bullet may be made with the information given; namely, that it is moving fast enough to do physical harm. It would behoove those concerned to also know the direction of travel to avoid an early demise. In other words, the information conveyed by knowing both the magnitude and the direction is most beneficial. The same is true with reactance and impedance. Reactance conveys magnitude information only; impedance denotes magnitude and direction.

In order to manipulate these quantities from a mathematical standpoint, the concept of Complex Notation must be introduced. It should be immediately pointed out that the only thing complex about complex numbers is the name. This is mentioned to overcome mental blocks, which usually arise during the initial stages of development.

A complex number is represented by the sum of two numbers, one called the real part, and the other called an imaginary part. Since both real numbers and imaginary numbers are simply numbers which we use daily (1, 2, 3.9, 2.7, 19, 140.2, etc.), we must somehow distinguish between the two. In order to do this, we introduce the imaginary operator j, which acts as an indicator much the same as a flagman would in traffic. As an example, let us assume we have the complex number: $A = 3 + j4$. In this case, the real part of the complex number A is 3; while the imaginary part is 4. Note that the function of j is only to indicate that there is something "different" about the number 4.

Relating this concept to the realm of impedance, we note that, in general, impedance is also a complex quantity. The real part of impedance is called resistance denoted by the letter R. The imaginary part of impedance is called reactance and is symbolized by the letter X.

Let us now consider a circuit containing only an ideal inductor.

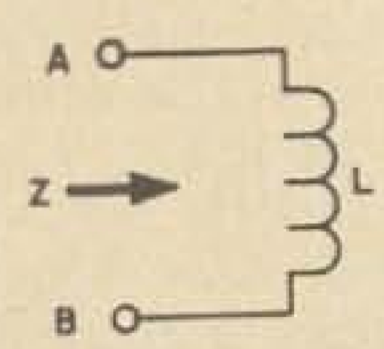


Fig. 1. A very simple inductive circuit. If the resistance is zero the voltage leads the current by 90 degrees and we say $Z = 0 + jX_L$ ohms.

It is the object now to determine the total circuit impedance looking into terminals AB. In the circuit shown there is no resistance (R), therefore, there is no real part in our complex number. The imaginary part of the impedance is the inductive reactance X_L. X_L may be found knowing the inductance (L), and the frequency (f) as was shown in a previous example. The total impedance is:

$Z = 0 + j\,X_L$ ohms, where j indicates the direction.

Since this quantity possesses both magnitude and direction, it is often more easily understood when illustrated graphically on a standard Cartesian Coordinate System. Our real axis is along the horizontal, while our imaginary is plotted vertically. By convention, always plot the real part first and then plot the imaginary in a tip to tail fashion, utilizing the previous example, plotting resistance first $R = 0$. Now add the imaginary portion to the real obtaining the value X_L plotted vertically on the imaginary axis.

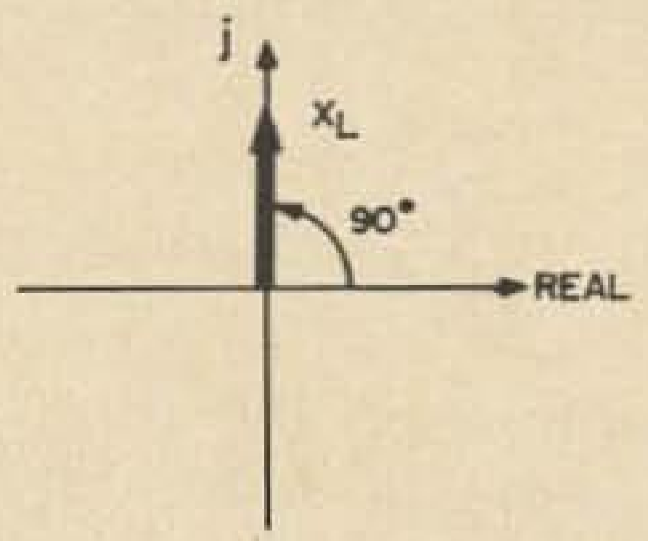


Fig. 2. Here we are saying $Z = 0 + jX_L$ ohms, graphically. The heavy arrow represents impedance. Its length indicates the value of the impedance, which we call reactance.

We will pick the horizontal axis to the right as being positive. All positive angles are measured with respect to this axis when moving in a counterclockwise direction. Returning to our example and measuring this angle with a protractor, we see it to be a positive 90°. The significance of this angle will be discussed later.

As a second example, consider a capacitor only, the impedance of which is to be determined. The reactance of the capacitor is given by:

$$X_C = \frac{1}{\omega C}$$

Now by definition we choose the capacitive impedance to have a $-j$ associated with it. Therefore, the capacitive impedance becomes $-jX_C$, and it is plotted on the graph previously mentioned, vertically downward as shown below:

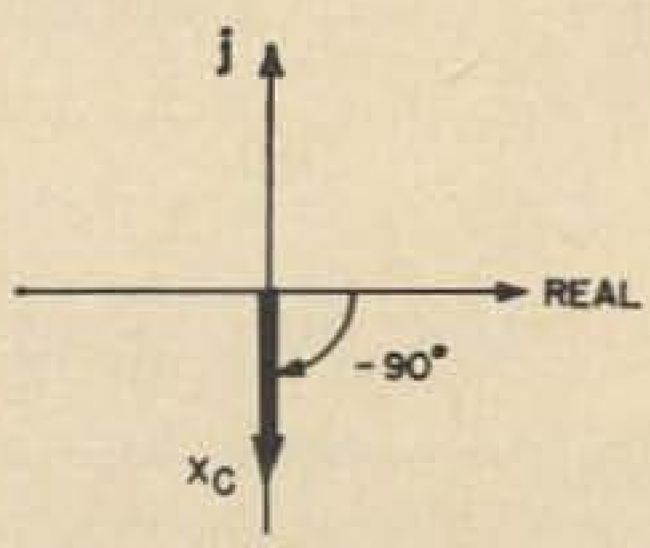


Fig. 3. If we replace the inductor of Fig. 1 with a capacitor, still assuming there is no resistance, the impedance arrow now points downward.

It can be seen by these brief examples that the j designation for the impedances save confusion when writing the values.

Let us now consider a combination of an R, L, C connected in series. It will be our objective to calculate the total impedance in both mathematical forms. Given the circuit in **Fig. 4:**

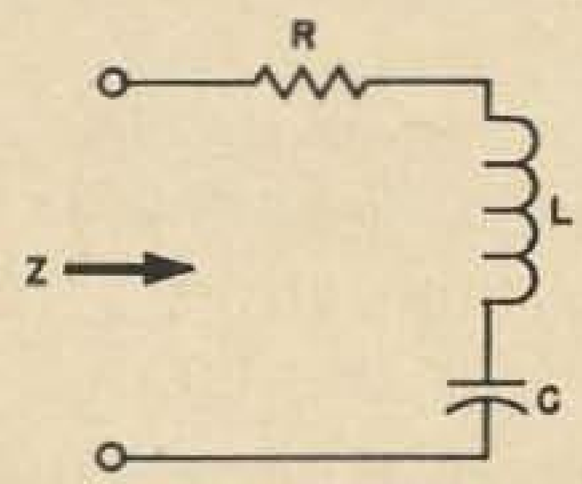


Fig. 4. Here is a more complex circuit. We might find this in a bandwidth-limiting application. What is its impedance?

The reactances of each of the components may be found by the usual manner, X_L and X_C. We will now determine the values of the individual impedances. The impedance of the resistance is the easiest, for it consists of a real part only, that is, $Z_R = R + j0$ ohms. The impedance of the capacitor is $Z_C = 0 - jX_C$ ohms, and for the inductor it is equal to $Z_L = 0 + jX_L$ ohms. Impedance in series add and, therefore, the total impedance is $Z_R + Z_C + Z_L = Z_T$ or $Z_T = R + j0 + 0 + jX_L + 0 - jX_C$ ohms. We can find the sum by adding the real parts and the imaginary parts separately. $Z_T = R + jX_L - jX_C$, but since the j term is common in this case, Z_T becomes $Z_T = R + j\,(X_L - X_C)$. This can be shown graphically by the following:

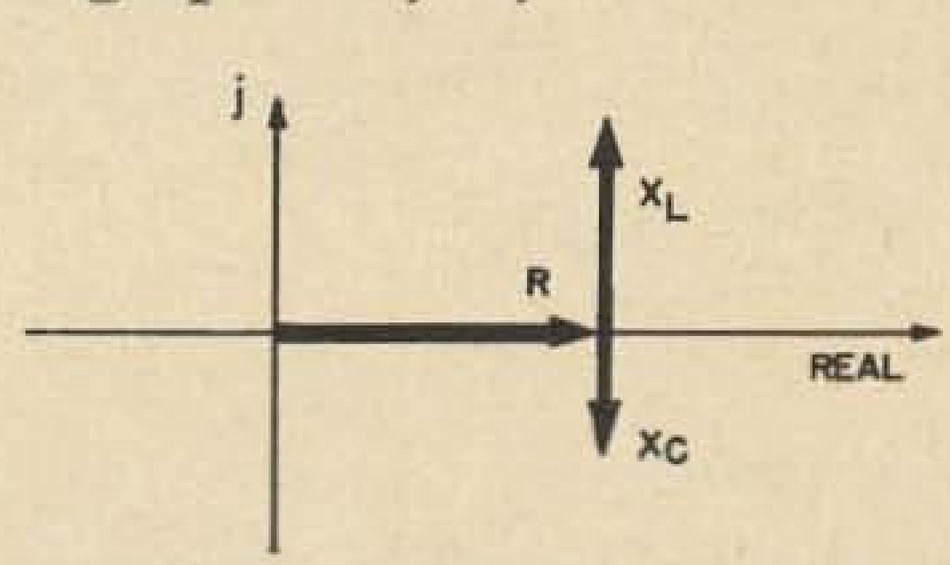


Fig. 5. First we must know the frequency. Then we determine impedance by adding resistance and reactance values graphically, or by math having the same meaning. Remember reactance will vary with frequency, changing the impedance.

Note that R was plotted first, then jX_L and $-jX_C$ in the tip to tail fashion described previously. jX_L and $-\ jX_C$ lie in the same plane, however, in the opposite direction. Therefore, the result of $j\ (X_L - X_C)$ can be found by algebraically subtracting X_C from X_L. The result X_T remains unchanged but X_T is now in the positive direction, this is because X_L is larger than X_C in this example.

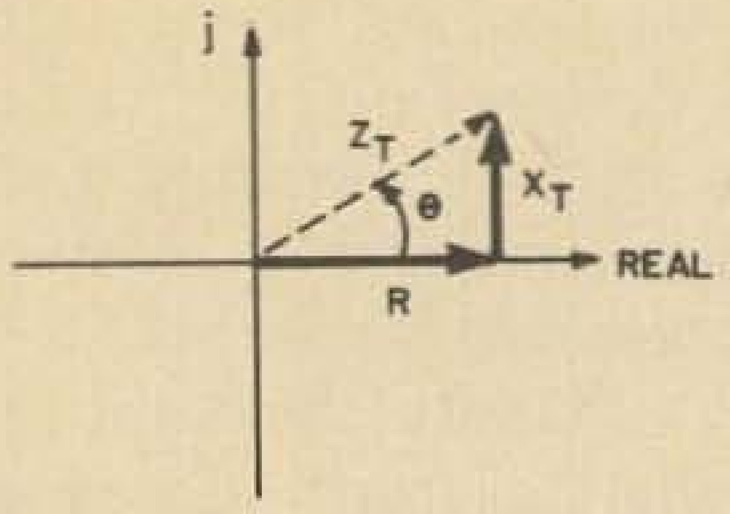


Fig. 6. Taking the difference between inductive and capacitive reactance, the inductive reactance wins this time. At some lower frequency they would cancel, leaving resistance only. And at a still lower frequency the capacitive reactance would predominate.

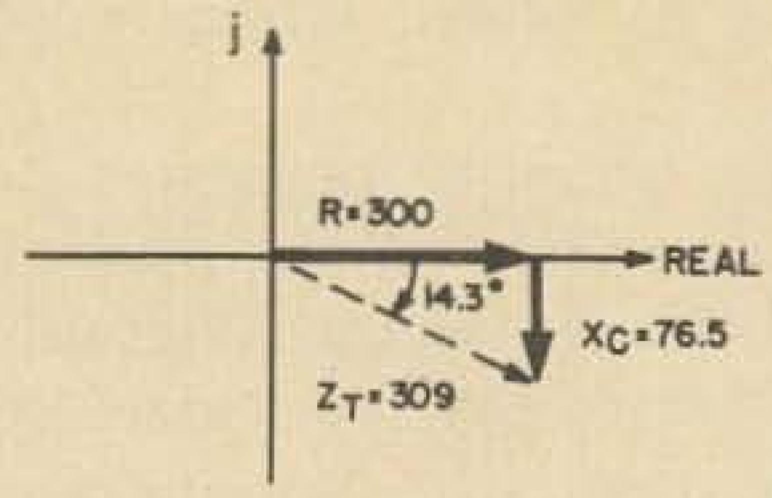


Fig. 7. Working out the circuit of Fig. 4. If we apply a 60 Hz current to this circuit we will find the voltage across its terminals lagging 14.3 degrees. Or if we trigger our scope from the voltage signal the current will appear to lead by the same 14.3 degrees.

If the other case were true (X_L smaller than X_C), the result X_T would point in the negative direction. X_T and R form a right triangle and the line Z_T represents the hypotenuse of the right triangle. Using the theorem developed by Pythagorus which says that the hypotenuse of a right triangle is equal to the square root of the sum of the other two sides squared, the magnitude of Z_T becomes:

$$|Z_T| = \sqrt{R^2 + X^2} \text{ ohms}$$

which is the formula given in most handbooks. However, this is only half the picture; we still must have a direction. The angle θ on Fig. 6 can be found by the formula:

$$\theta = \arctan \frac{X_T}{R}$$

Read, theta is the angle whose tangent is $\frac{X_T}{R}$. Therefore, the impedance may be expressed in two ways:

$$Z = R + j\ (Z_L - X_C) \text{ or } Z_T \angle\theta$$

To summarize, let us now turn our attention to a numerical example. Consider an R, L, C series circuit being used at 60 Hz. The value of the individual components are as follows: R = 300 ohms, L = 0.5 Henrys and C = 10 microfarads.

Calculating the reactances:

$$X_L = 2\pi fL = 2\pi\ (60)\ (0.5)$$
$$X_L = 188.5 \text{ ohms}$$
$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(60)\,(1\text{x}10^{-6})}$$
$$X_C = 265.0 \text{ ohms}$$
$$Z = 300. + j\ (188.5 - 265.)\text{ ohms}$$
$$\text{or}\quad Z = 300. - j\ 76.5 \text{ ohms}$$

See **Fig 7** for graphic illustration.

$$Z_T = \sqrt{(300)^2 + (76.5)^2} = 309 \text{ ohms}$$

$$\theta = \arctan \frac{-76.5}{300} = -14.3 \text{ degrees}$$

The total impedance for this circuit is 309 ohms at an angle of −14.3 degrees.

The angle associated with the impedance in actuality represents an angular (phase) difference between the voltage applied to, and the current in the circuit considered. By definition, if the angle associated with the impedance is positive the voltage leads the current, and the circuit appears basically inductive. Similarly, if the angle is negative, as in the previous sample, the current leads the voltage, and the circuit appears to be predominantly capacitive. The special case of no phase shift occurring between voltage and current, (corresponding to an angle of zero degrees) simply indicates a purely resistive circuit.

On can at this point begin to appreciate the significance of the quantity impedance, and the enormous amount of information conveyed with it, as opposed to the simple quantity reactance.

Whether engineer, technician, serviceman or home experimenter, the blossoming age of electrical technology demands an understanding of the subtle distinction between these two very basic circuit concepts.

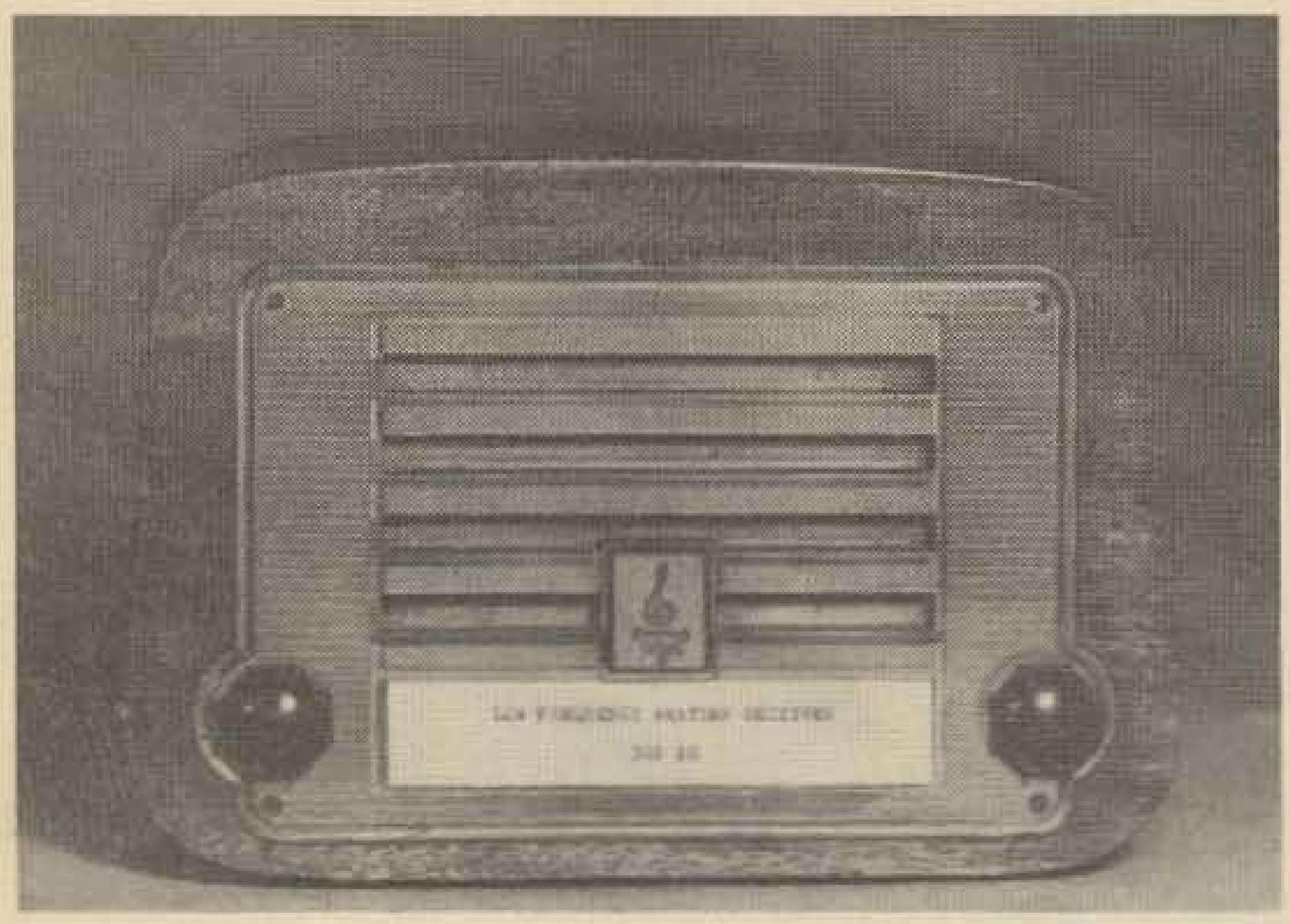
. . . K9ZPZ . . . K9DKB

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

WEATHER SNOOPER

Alton E. Glazier
3154 *Jordan Road*
Oakland, California 94602



Of all the surplus receivers available, probably the easiest to come by, and most neglected, are the ac-dc broadcast receivers. They are not the most sophisticated, but certainly they are reliable. These receivers will give years of service.

Here is a conversion project that should take under a half hour, and give hours of listening pleasure. The conversion will give you a low, fixed frequency weather monitor receiver. The Federal Aviation Administration broadcasts reports for fliers, usually start at 5:00 A.M. and continue untill 11:00 P.M. There is a projected weather report and a current report that is changed hourly. Pick the weather station nearest to you from the list. You will hear the identification in MCW, below the verbal report.

Step 1. First, be sure the receiver is receiving the broadcast band normally.

Step 2. Disconnect the receiver from the ac source and remove the chassis from the case.

Step 3. Turn the variable capacitor to maximum capacitance (fully meshed) then solder the shaft to the frame, thus locking the variable capacitor. Use at least a 100 watt soldering iron.

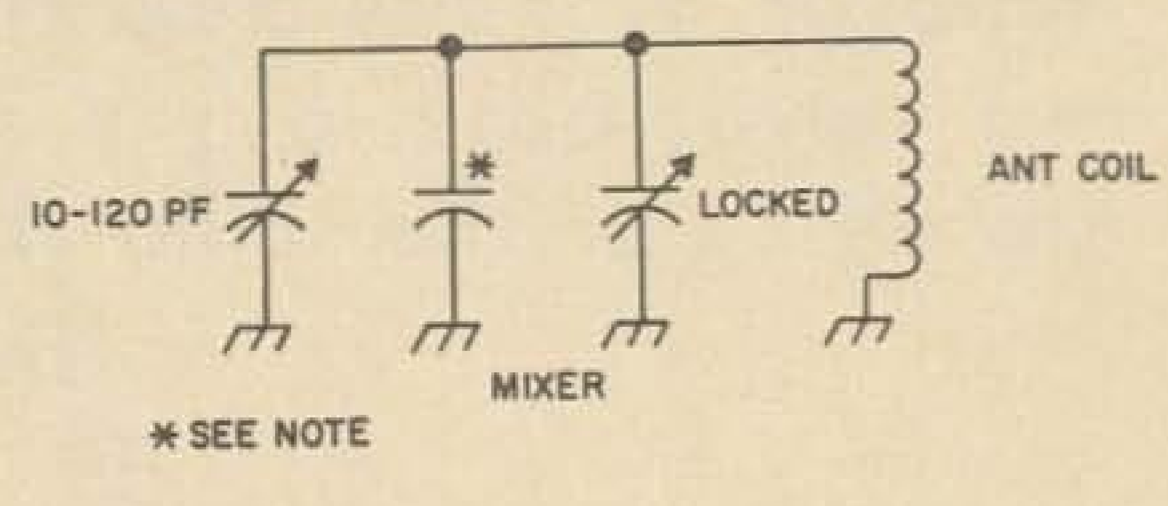
Step 4. Solder a variable capacitor, 10-120 PF, across the oscillator section. The oscillator section can be identified by the fact that it has the least number of plates. Solder the ground side of the capacitor to the frame of the original capacitor. The other terminal goes to the tab of the oscillator capacitor.

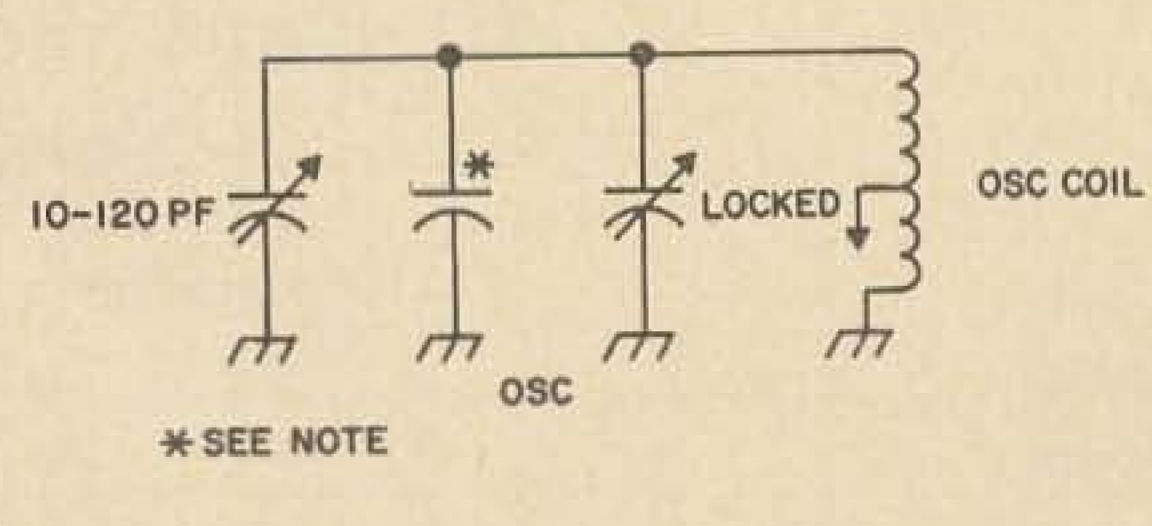
Step 5. Connect a fixed 300 pF* capacitor, plus a 10-120 pF variable across the converter section of the original capacitor. One side of the fixed and variable capacitors is soldered to the frame, the other sides are connected to the tab of the original capacitor. Connect a 10 mF 25-volt capacitor across the cathode resistor of the last stage of audio.

Step 6. Remember, all ac-dc receivers are dangerous to the point of being lethal when removed from their insulated cases. If you have an isolation transformer, now is the time for it; if not, check the polarity of the 115-volt plug, so that the chassis is not on the high side of the ac line (I would hate to lose you at this stage).

Step 7. Now with the set turned on, and the volume up, with an insulated tool, tune the variable oscillator capacitor until you hear the weather station. Now tune the converter variable capacitor for the loudest point.

Step 8. Remove ac power source. Install the chassis in case, be sure to use the original insulated knobs.





Note:
*For weather stations down to 350 kHz, use 300 pF capacitor across mixer capacitor.
For weather stations down to 295 kHz, use 650 pF capacitor across mixer capacitor.
For weather stations down to 220 kHz, use 1,400 pF capacitor, and in addition, use a 100 pF capacitor across oscillator capacitor at this low frequency.

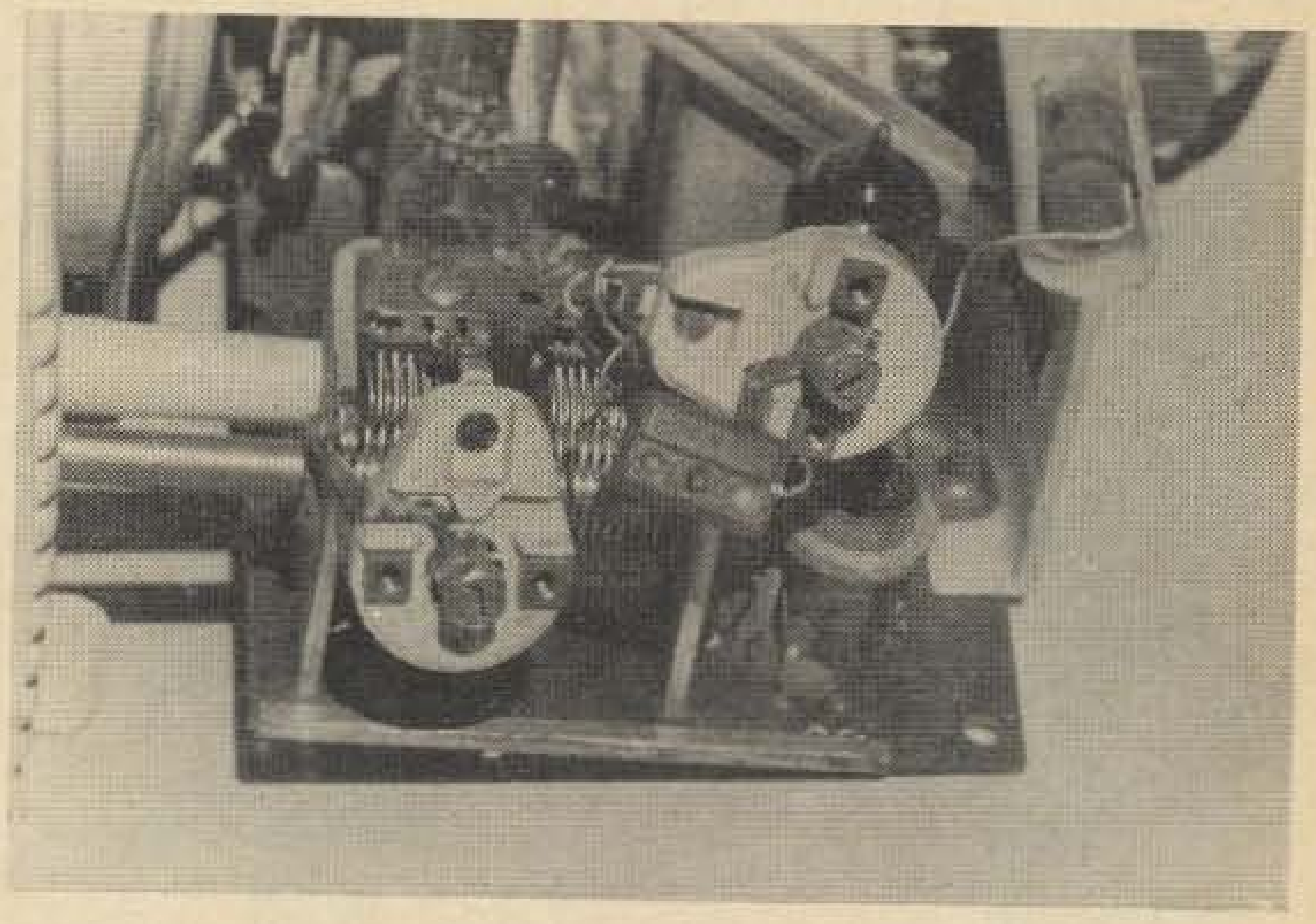
Photos by Les Toth

Step 9. Conversion is now complete, and the receiver is as safe as it ever was.

True, we can do very little to change the weather, but at least we can keep informed and know what to do to prepare for it. ■

Airport Weather Report Frequencies
As of 10-1-68

Alabama	
Birmingham	224 kHz
Arizona	
Phoenix	326 kHz
Tucson	338 kHz
Arkansas	
Little Rock	353 kHz
California	
Blythe	251 kHz
Fresno	344 kHz
Los Angeles Int.	332 kHz
Oakland	362 kHz
Colorado	
Englewood	379 kHz
Trinidad	329 kHz
Florida	
Jacksonville	344 kHz
Miami	365 kHz
Pensacola	326 kHz
Tallahassee	379 kHz
Tampa	388 kHz
Georgia	
Atlanta	266 kHz
Idaho	
Boise	359 kHz
Idaho Falls	350 kHz
Illinois	
Chicago	350 kHz
Indiana	
Indianapolis Muni	266 kHz
Kansas	
Garden City	257 kHz
Wichita Muni	332 kHz
Louisiana	
Grand Isle	236 kHz
Shreveport	230 kHz
Maine	
Millinocket	344 kHz



Massachusetts	
Boston	382 kHz
Michigan	
Detroit	388 kHz
Houghton	277 kHz
Sault Ste. Marie	400 kHz
Traverse City	365 kHz
Minnesota	
Duluth	379 kHz
International Falls	356 kHz
Minneapolis	266 kHz
Mississippi	
Jackson	260 kHz
Missouri	
Kansas City Intl.	359 kHz
St. Louis	338 kHz
Springfield Muni	254 kHz
Montana	
Billings	400 kHz
Bozeman	329 kHz
Great Falls	371 kHz
Missoula	308 kHz

(Johnson Bell)

Nebraska	
Omaha	320 kHz
Nevada	
Las Vegas	206 kHz
New Jersey	
Newark Muni	379 kHz
New Mexico	
Albuquerque Sunport	230 kHz
Roswell Industrial	305 kHz

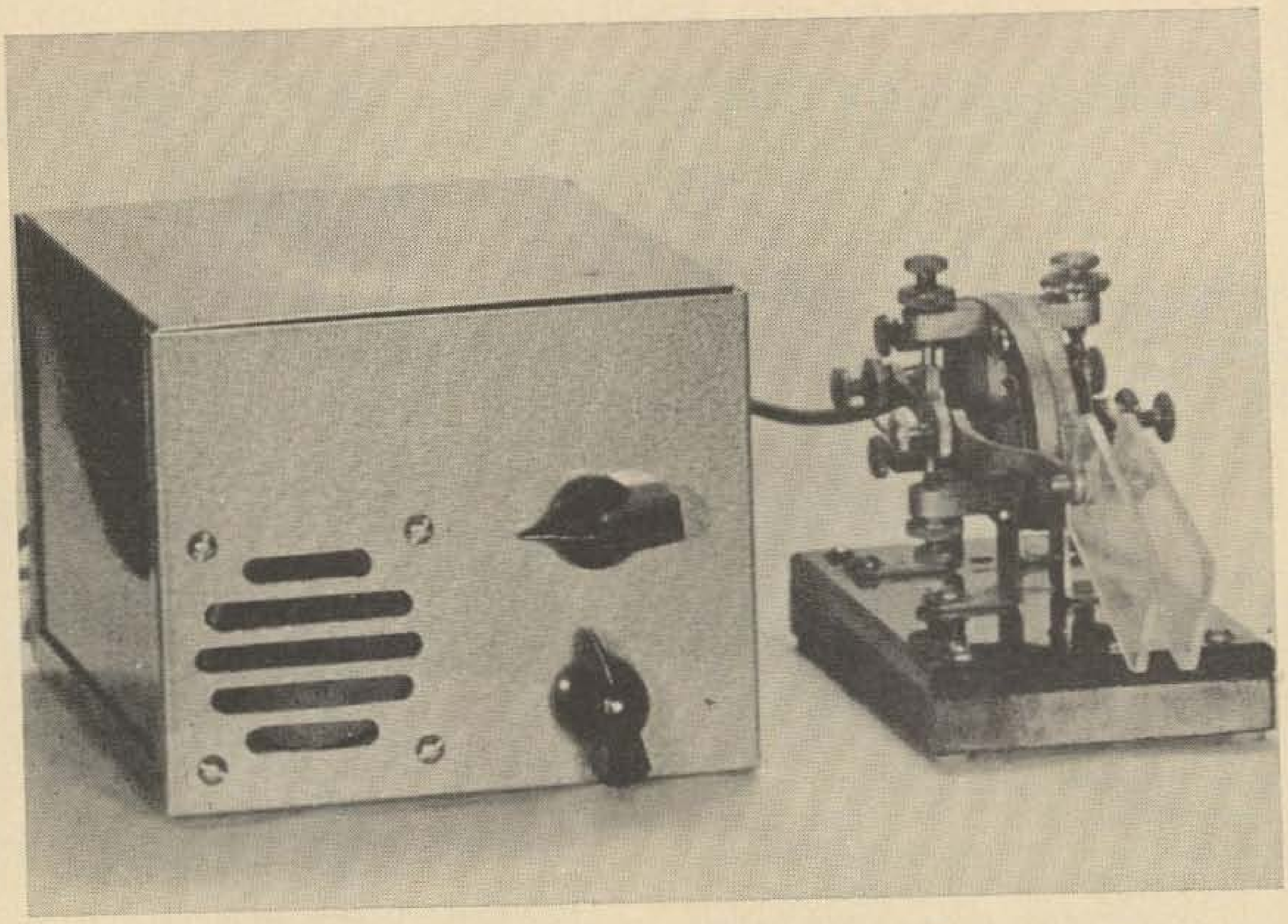
Air Center

New York	
Elmira	375 kHz

North Carolina	
Raleigh - Durham	350 kHz
Ohio	
Cleveland (Hopkins Intl.)	344 kHz
Oklahoma	
Will Rogers World	350 kHz
Tulsa Intl.	245 kHz
Oregon	
Pendleton	341 kHz
Portland Intl.	332 kHz
Redmont	368 kHz
Pennsylvania	
Pittsburgh (Allegheny County)	254 kHz
South Carolina	
Charleston	329 kHz
Spartanburg (Downtown) Memorial	248 kHz
South Dakota	
Rapid City	254 kHz
Tennessee	
Knoxville	281 kHz
Memphis (Metro)	371 kHz
Nashville (Metro)	304 kHz
Texas	
Amarillo	251 kHz
El Paso Intl.	242 kHz
Meacham Field	365 kHz
Midland Odessa Regnl.	326 kHz
Utah	
Delta	212 kHz
Ogden	263 kHz
Vermont	
Burlington Muni	323 kHz
Virginia	
Roanoke Muni	371 kHz
Washington	
Seattle	362 kHz
Spokane Intl.	365 kHz
Walla Walla	356 kHz
Wisconsin	
Milwaukee	242 kHz
Wyoming	
Casper Air Terminal	269 kHz
Rock Springs	290 kHz

The Charmin' Keyer

Richard Schwanke W9HXM
235 Cumnor Avenue
Glen Ellyn, Illinois



Nowadays, if on operates CW without a squeeze keyer, he is not a member of the *in* group. The squeeze keyer presented here is, to the best of the author's knowledge, the first unit which will perform either of the two popular forms of squeeze keying.[1,2] When desired, it can be used as a conventional keyer. With a single lever, it has very agreeable timing and is rather forgiving of operator errors.

The circuit diagrams are presented. **Fig. 1** is drawn with NPN transistors and will be used in all of the rest of the article for discussion of logic. **Fig. 13** is drawn with PNP transistors for those with a large supply of PNPs and for those who would like to modernize a keyer circuit published in 1962[3] which has many of the same components.

It would have been much easier to design this keyer with integrated circuits, but the cost to noise margin ratio is much more favorable in the discrete component version.

1. Gensler, Harry, Jr., "The Iambimatic Concept," QST, Jan., 1967.
2. Moss, Jimmy, "The WØEPV Squeeze Keyer," QST, July, 1967.
3. Muir, Dave, "The Penultimate Electronic Key," QST, March, 1962.

Brief description

Fundamentally, this keyer consists of a dot generator with a binary counter which is used to fill in the spaces between two dots to form a dash. Several control paths are used. One path (R_{50}) controls the dot generator directly and combines with feedback from the output of the dot generator (R_{51}, D_{12}) giving self completion. A second path (R_9, D_2) sets the Dash FF enabling the binary counter via R_{43}. A reset signal is provided to the Dash FF via C_2, D_4 every time the relay opens. A third path (R_{53}, Q_{13}) sets the Dot FF if and only if the Dash FF is set. A fourth path (D_5, D_6, R_{21}) allows the Dot FF to be rest if and only if the Dash FF is NOT set thus providing Dot Memory. A fifth path (Q_{14}, R_9, D_1 R_{10}) prevents setting the Dash FF if the Dot FF is set or a dot is in progress. A sixth path (R_{18}, R_{24}) keeps the Dot Generator running when either the Dot FF or the Dash FF is set.

The final result of these controls gives a keyer which can remember one dot that was called for during a dash with no critical timing and will either give alternate dots and dashes when both dot and dash

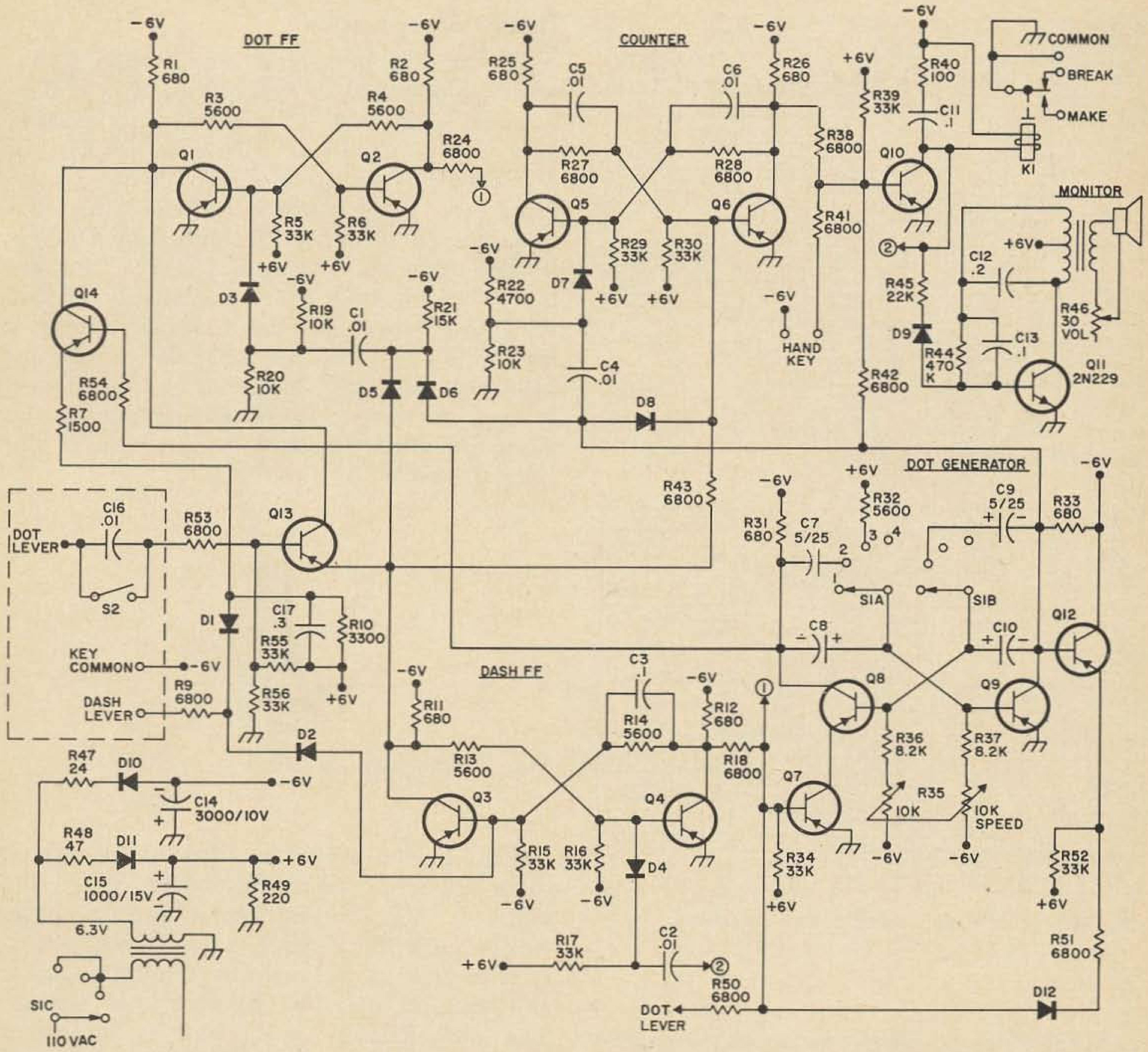


Fig. 1. Complete circuit using NPN transistors. K_1—500 ohm relay. Q_1-Q_{10}, Q_{12}-Q_{14}—NPN (2N2923). Q_{11}—PNP (2N4126). D_1-8—Germanium 1N90. D_9—Silicon. D_{10}-$_{11}$—Silicon 50 PIV, 100 mA. S_1—3 pole 4 pos. rotary switch (Mallory 3134J). S_2—SPST.

levers are held or insert one dot in a string of dashes. The use of two independent key levers which may be squeezed to produce additional combinations is required to realize all of the potential benefits.

When switch S2 is closed, a squeeze will produce a continuous string of alternating dots and dashes thus making characters such as C and AR almost effortless. The timing required by the operator is very uncritical and one need only follow the instructions on the chart (**Fig. 2a**) supplied to learn the new technique in one or two evenings.

If switch S2 is opened, the operator will feel as though he has an entirely different keyer and a chart (**Fig. 2b**) shows the details of the second technique which the author calls single dot insertion (SDI). With SDI, one and only one dot will be produced during any single squeeze.

Alert readers (and those who have already studied the charts) have figured out that one set of characters is very easy with the alternating option, and an entirely different group is very easy with the SDI option. It is believed that this is the first

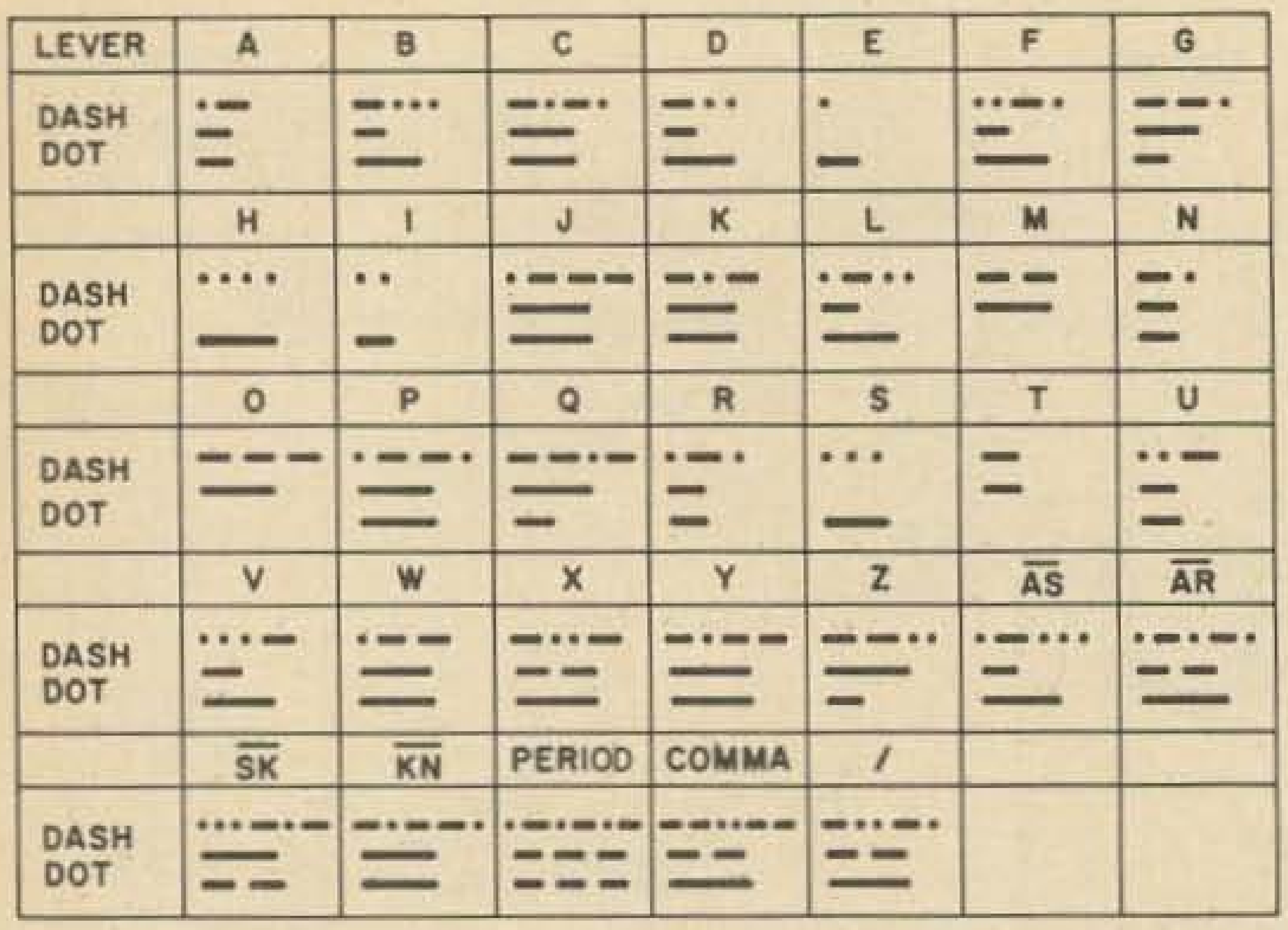


Fig. 2A. Keying chart (S2 closed). Alternate dots and dashes with dot memory.

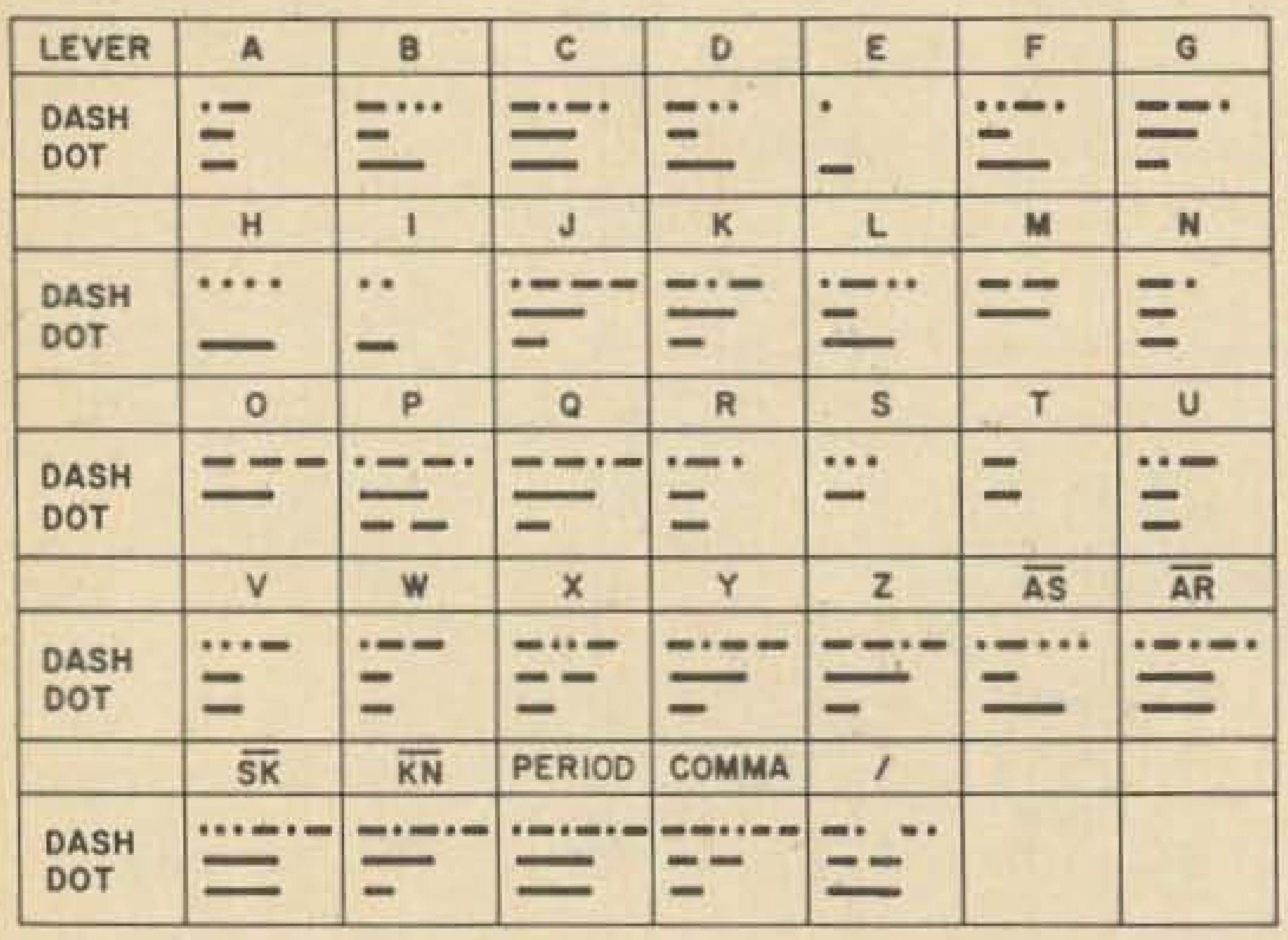


Fig. 2B. (S2 open) Single dot insertion.

published design where the operator can try both methods and make an intelligent choice after he has spent his money instead of tossing a coin beforehand and later being sorry. He can even change his mind years later at no additional cost.

Numerals are not listed in the charts as they are merely extensions of J, V, B, and G. The keyer will operate in the conventional way with a single lever while retaining the advantages of DOT MEMORY.

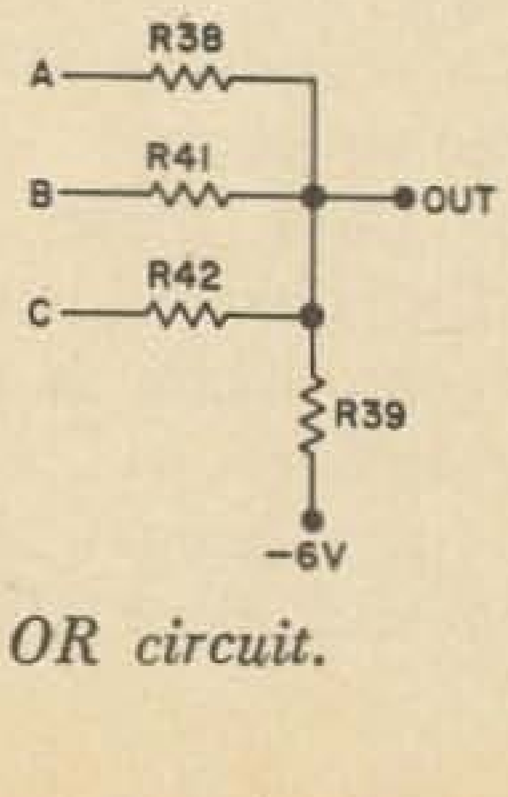


Fig. 3. Resistor OR circuit.

Theory of operation

The circuit presented here, while somewhat complicated in appearance, is a collection of basic logic circuits each consisting of a small number of elements. In **Fig. 3,** a resistor OR circuit is shown. If any of the inputs (A, B, or C) is UP (True), then the output is UP. If all of the inputs are DOWN (False), then the output is DOWN. Nothing more complicated than a voltage divider with low resistance input resistors and a high value bias resistor is needed to accomplish this function. The resistor OR is used to turn on the clock and for combining the clock and binary counter in the base of the relay driver.

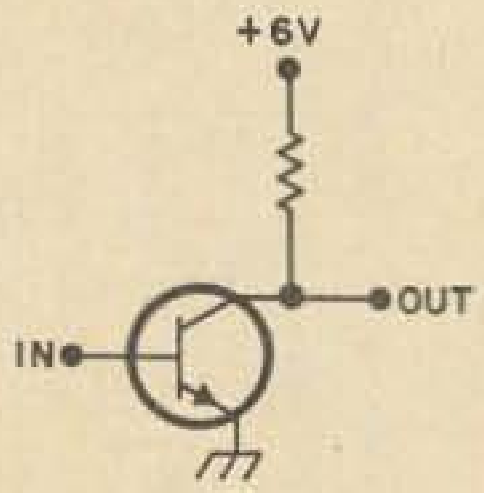


Fig. 4. Transistor inverter.

Fig. 4 is a transistor inverter of which there are ten used in this keyer. When the input is UP, current flows in the base-emitter junction causing a much larger current to flow in the collector-emitter junction and thus through the collector load resistor. The amplification of current is important and must not be forgotten, but the most important point in this discussion is that when the input is UP, the output is DOWN, Thus inverting the signal. This is commonly referred to as the NOT function. Combining the resistor OR with the transistor NOT forms a logic block called a NOR circuit which will not be treated further here.

When the output of one Inverter in **Fig. 5** is used as the input to a second Inverter and the output of the second is used as the input to the first, a FLIP-FLOP is formed. A FLIP-FLOP can be thought of as a teeter-totter, a long board with its center of gravity somewhat above its pivot point such that it will stay on one side or the other but is unstable in the transition. The FLIP-FLOP is also called a bistable multivibrator and is used for temporary memory. For example the DOT FF remembers a dot to be generated and the DASH FF remembers a dash is in progress.

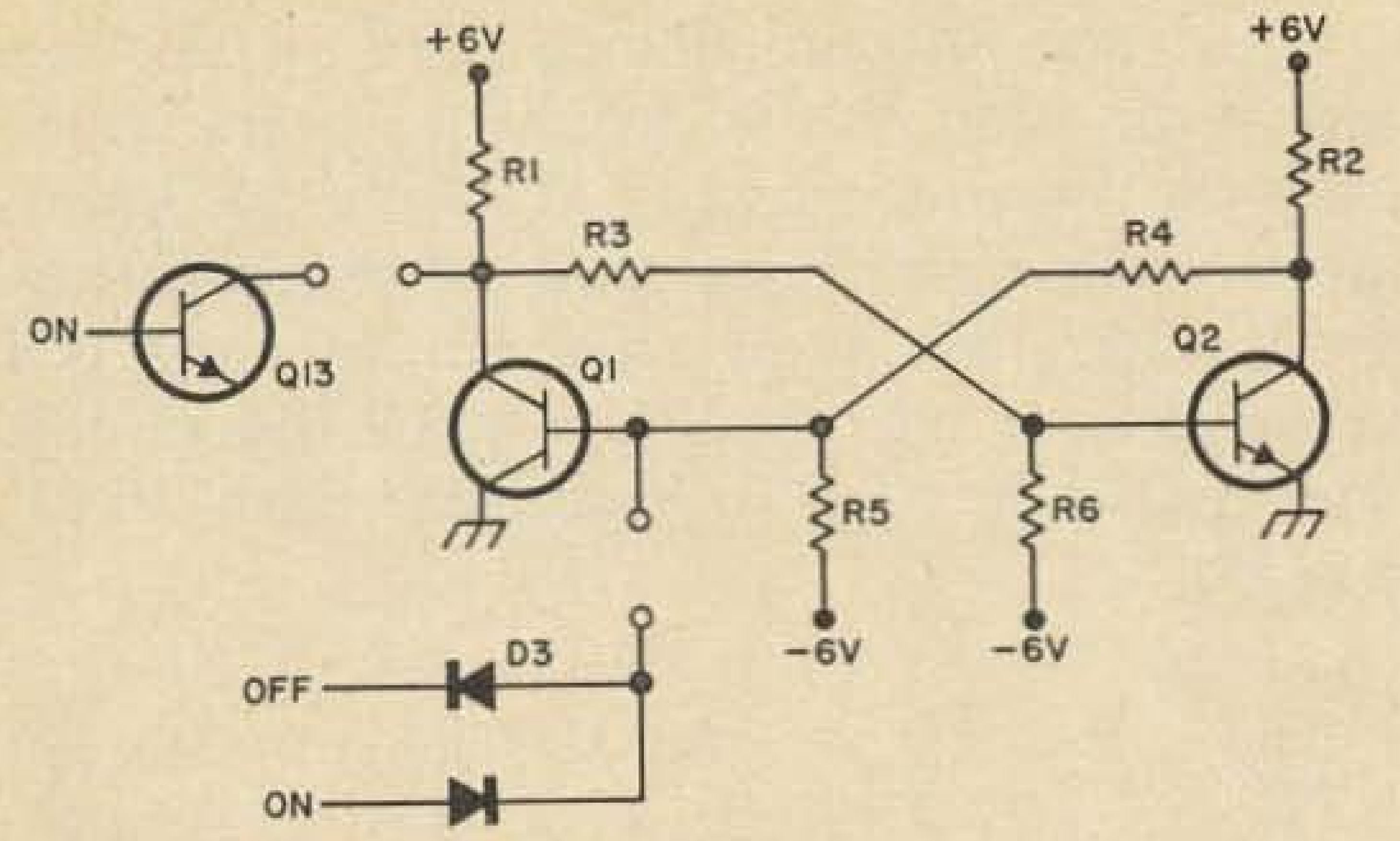


Fig. 5. Bistable Multi-Vibrator Flip-Flop.

A FLIP-FLOP can be made to change states by 1) pulling down on the collector of the off or UP side (Q_{13}), 2) forcing the off transistor on at its base (R_{43} and R_9, D_2), or 3) forcing the on transistor off at its base (D_3). Emitter triggering is not used here.

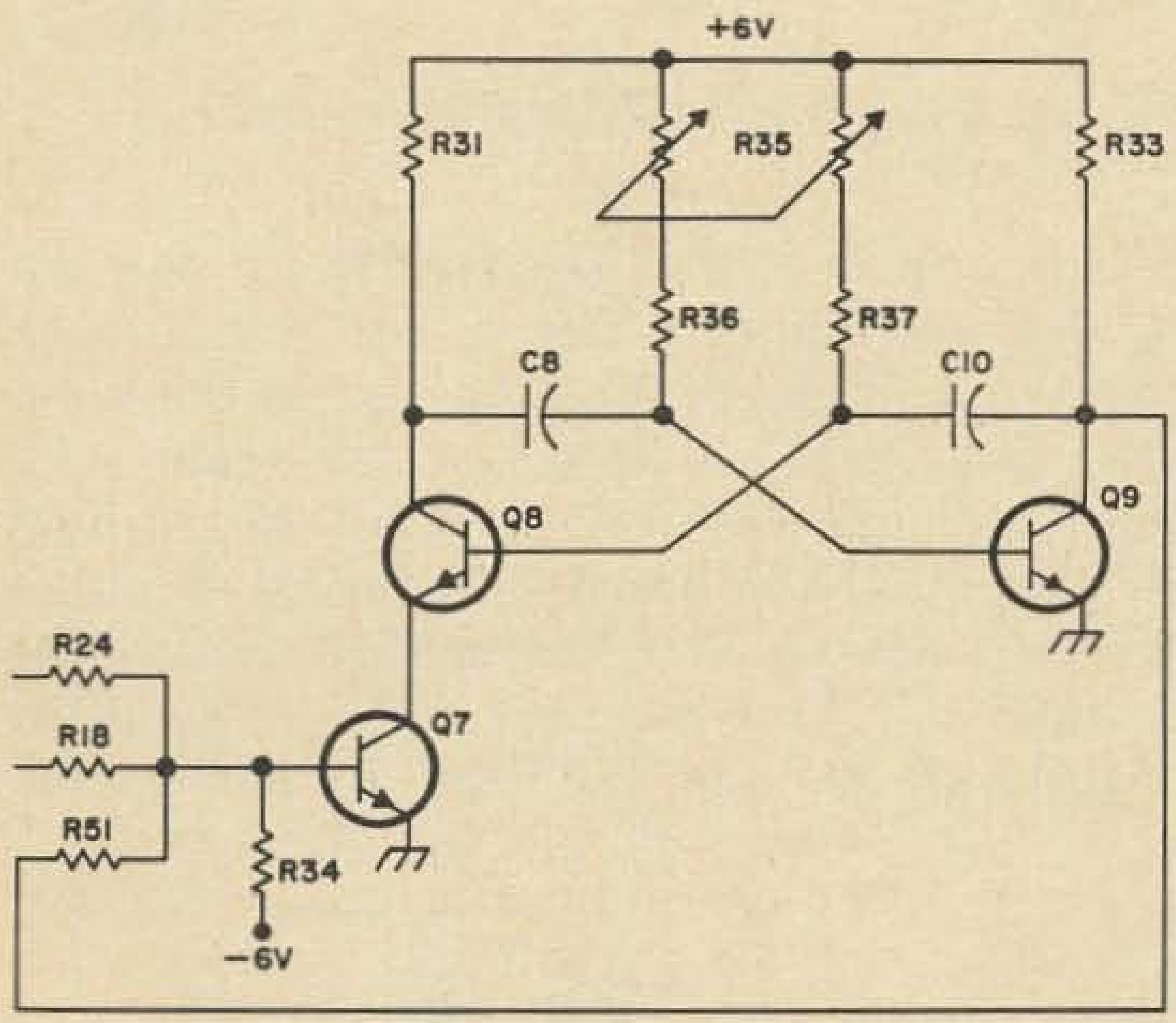


Fig. 6. Astable Multivibrator

The astable multivibrator in **Fig. 6** is similar to the FLIP-FLOP except for the feedback paths which are primarily (or in this case entirely) ac instead of dc. The astable multivibrator will change quickly from one side to the other and remain as long as the charge on a coupling capacitor holds one transistor off. When this charge finally bleeds to a small enough value, the OFF transistor will turn on and, through the other coupling capacitor, force the formerly ON transistor off. The result is a regular oscillation which is square wave in nature. Observation in an oscilloscope (**Fig. 7**) shows that the transition from UP to DOWN is much faster than the transition from DOWN to UP and is more useful for forming pulses.

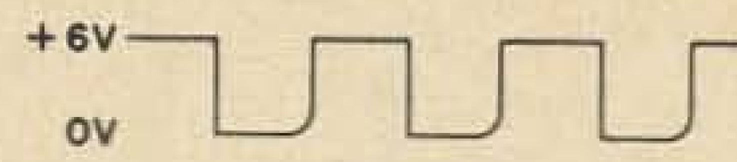


Fig. 7. Waveform at Collector or Astable Multivibrator.

In this circuit, as astable multivibrator is used as the main clock and DOT generator. Such an oscillator may be turned on and off with predictable results by inserting a transistor inverter (Q_7) between one emitter and ground thus serving as a switch. Once started, completion of one cycle can be guaranteed by using the output of the oscillator (with proper polarity) as one of the inputs to the OR gate controlling the switch (Q_7).

When loading becomes a problem, it is sometimes necessary to use an emitter follower which will enable driving many more circuits than a FLIP-FLOP alone or an oscillator alone can handle. This device is used on the oscillator (Q_{12} in **Fig. 1**).

Pulses can be obtained from a square wave by differentiating in an RC network where the pulses can be given a suitable dc base line by choice of voltages and resistors as shown in **Fig. 8.** The positive or negative going pulses may be selected by means of diodes. Time can be changed one half cycle by using the other side of the oscillator. Pulses from the oscillator are used to trigger the binary counter and, with suitable gating, reset the DOT FF.

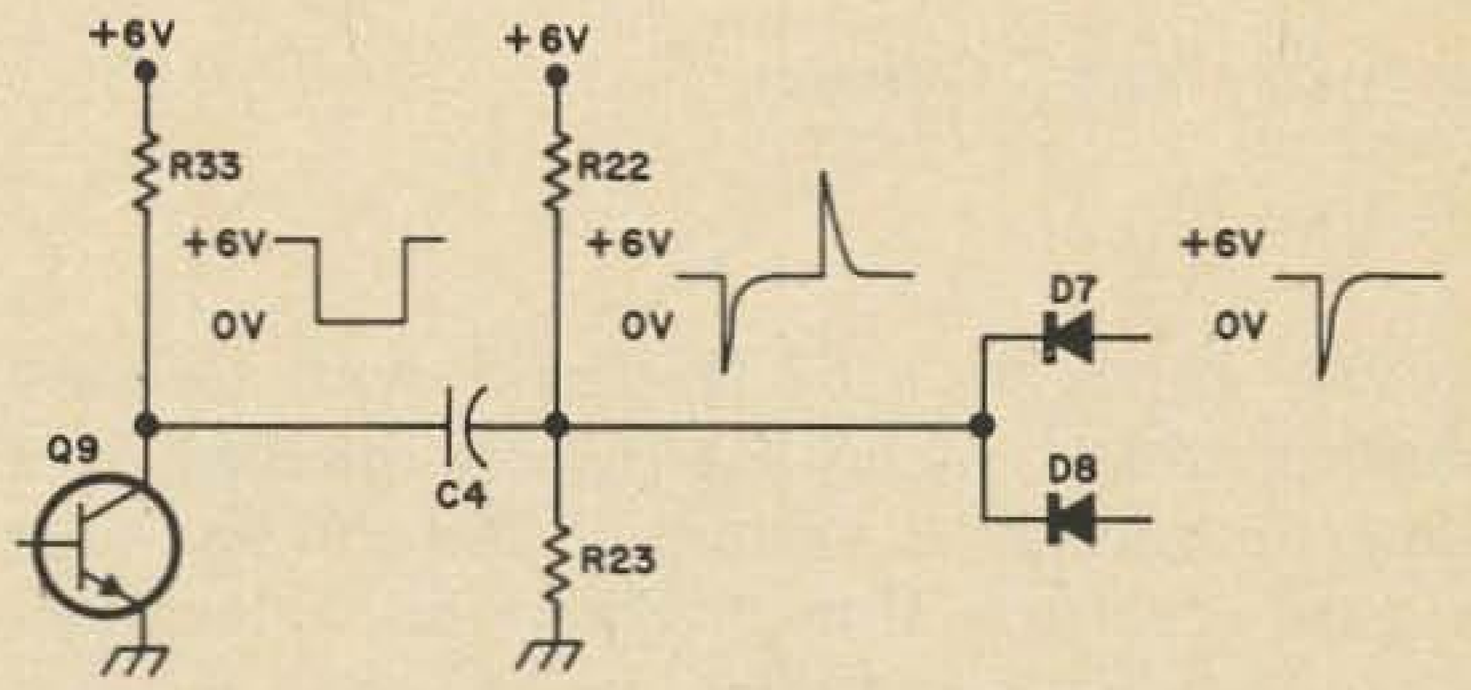


Fig. 8. Pulse formation and selection from a square wave.

A two transistor AND circuit with inverted output is shown in **Fig. 9.** This is commonly called a NAND logic block. When the inputs to both transistors are UP, the output is DOWN thus setting the DOT FLIP-FLOP shown in **Fig. 1** since R_1 is common to both circuits. The DOT FF is set if and only if the DASH FF is set.

There is one other feature worth noting here. All FLIP-FLOPS (or multivibrators) have two outputs. When one of these is

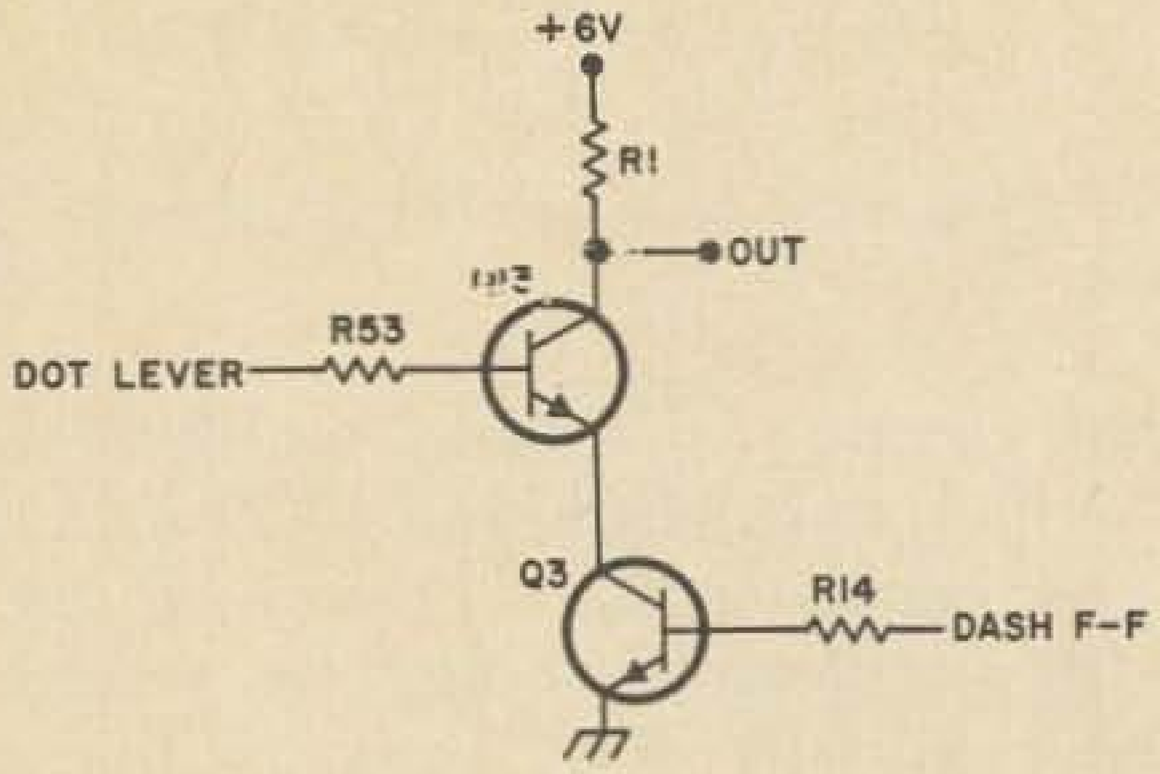


Fig. 9. Transistor NAND.

arbitrarily called True (UP) then the other output must be False (DOWN) and is referred to as the complement of the chosen output. A bar over the signal name is the usual notation for the complement of a signal.

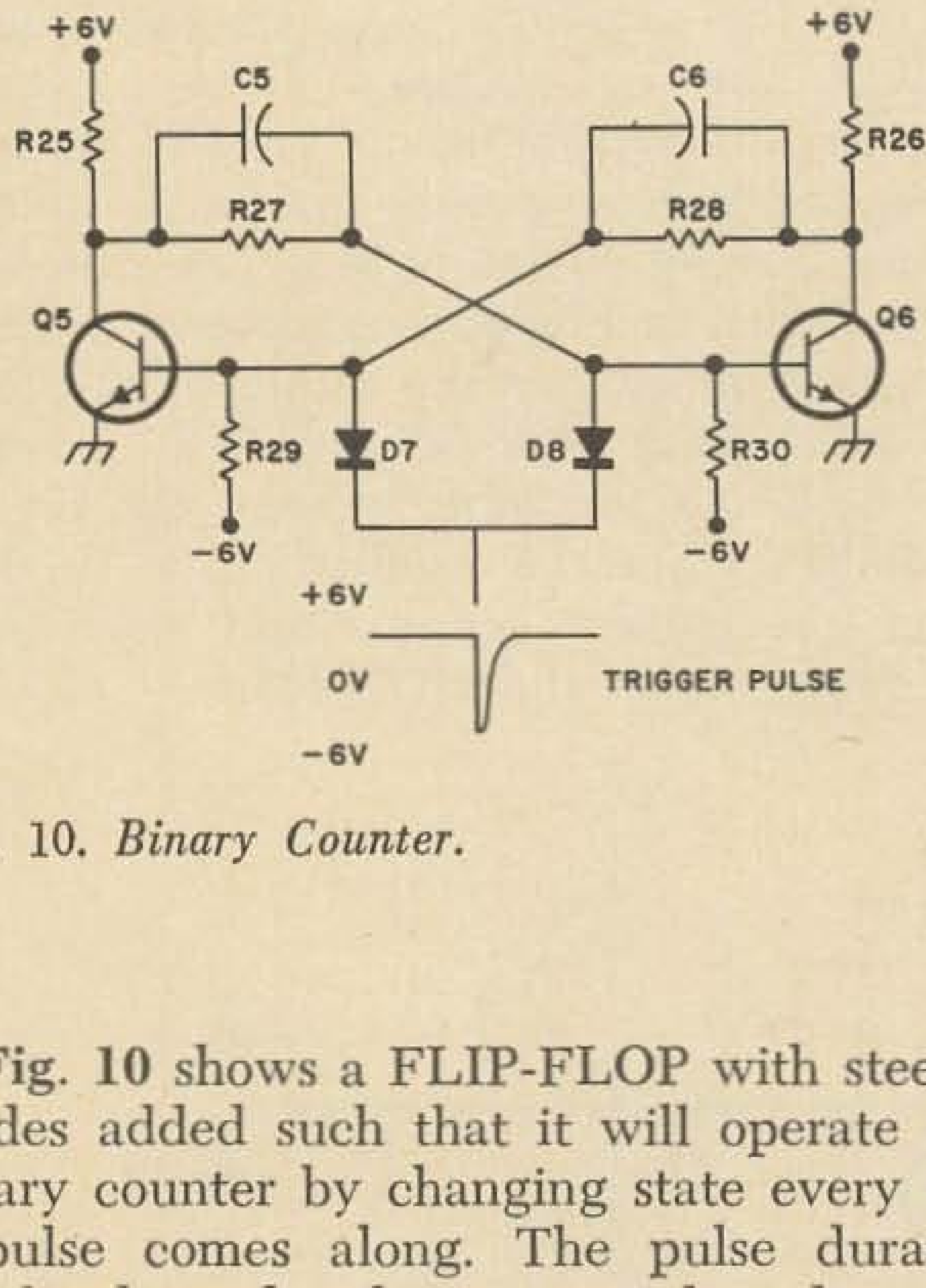


Fig. 10. Binary Counter.

Fig. 10 shows a FLIP-FLOP with steering diodes added such that it will operate as a binary counter by changing state every time a pulse comes along. The pulse duration, amplitude and polarity are selected so that whichever transistor is ON will be turned off. (Obviously the transistor which is OFF will not be affected by this pulse). As the ON transistor is turning off, the voltage at the collector rises rapidly so that a new pulse is ac coupled to the base of the OFF transistor thus turning it on. Due to the rc constants used and the delay between the first and second pulse, the second pulse will be larger than the first and will be definitely in control when it arrives. The binary counter fills in the spaces between the dots when combined with the clock in an OR gate, thus forming a dash.

One very unusual device used in this circuit is the inductive kick which occurs whenever the current flowing through an inductance such as a relay coil is stopped suddenly. **Fig. 11** shows the circuit and the voltages seen at three points in the circuit. This pulse is used to reset the dash FLIP-FLOP.

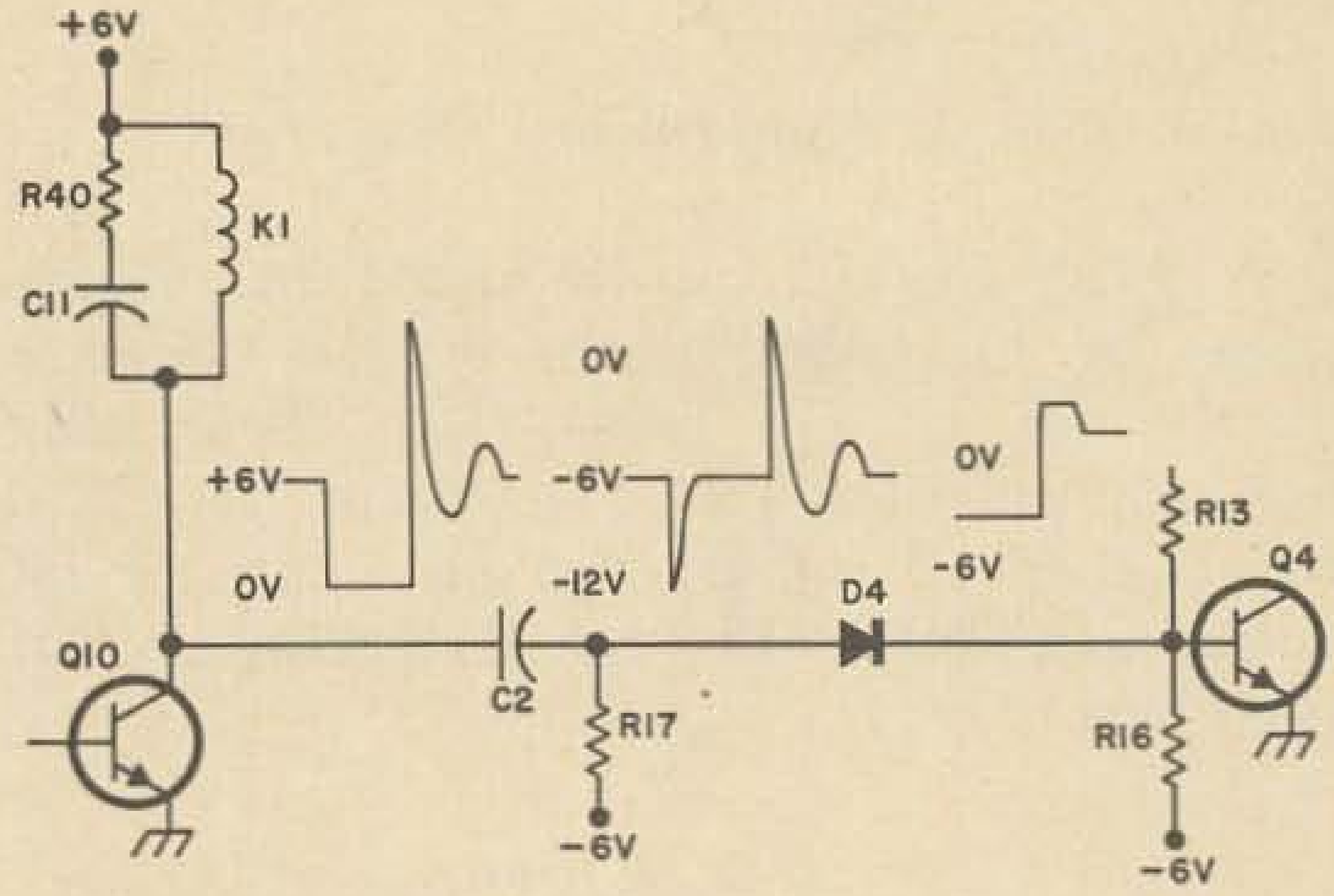


Fig. 11. Waveforms in Dash F-F reset circuit.

It is necessary that the DASH FF can not be set any time a dot is in progress or being remembered. **Fig. 12** shows the solution. Q_{14} and R_{54} form an OR gate with negative logic. Only when A and B are both UP can an UP at Dash turn on Q_3 If either A OR B are DOWN the DASH signal goes through D_1 and R_{10} to —6V and Q_3 is unaffected. D_1 and D_2 form an AND gate.

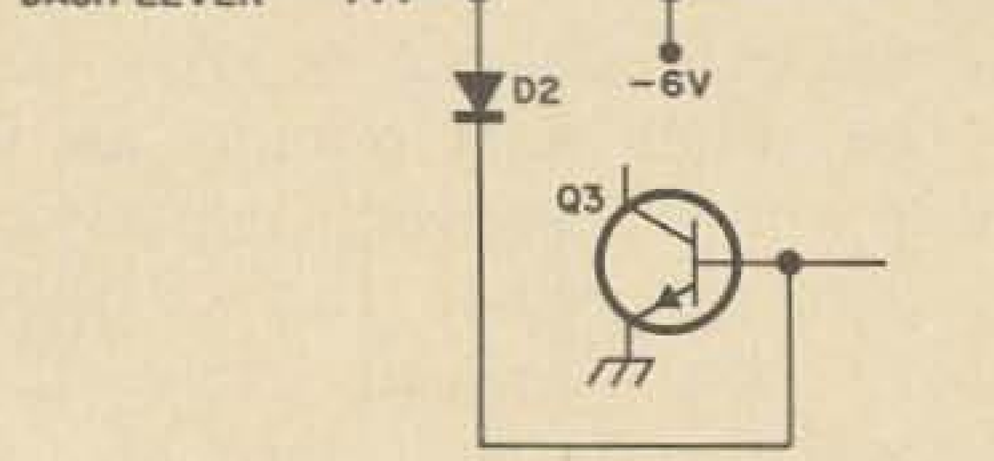
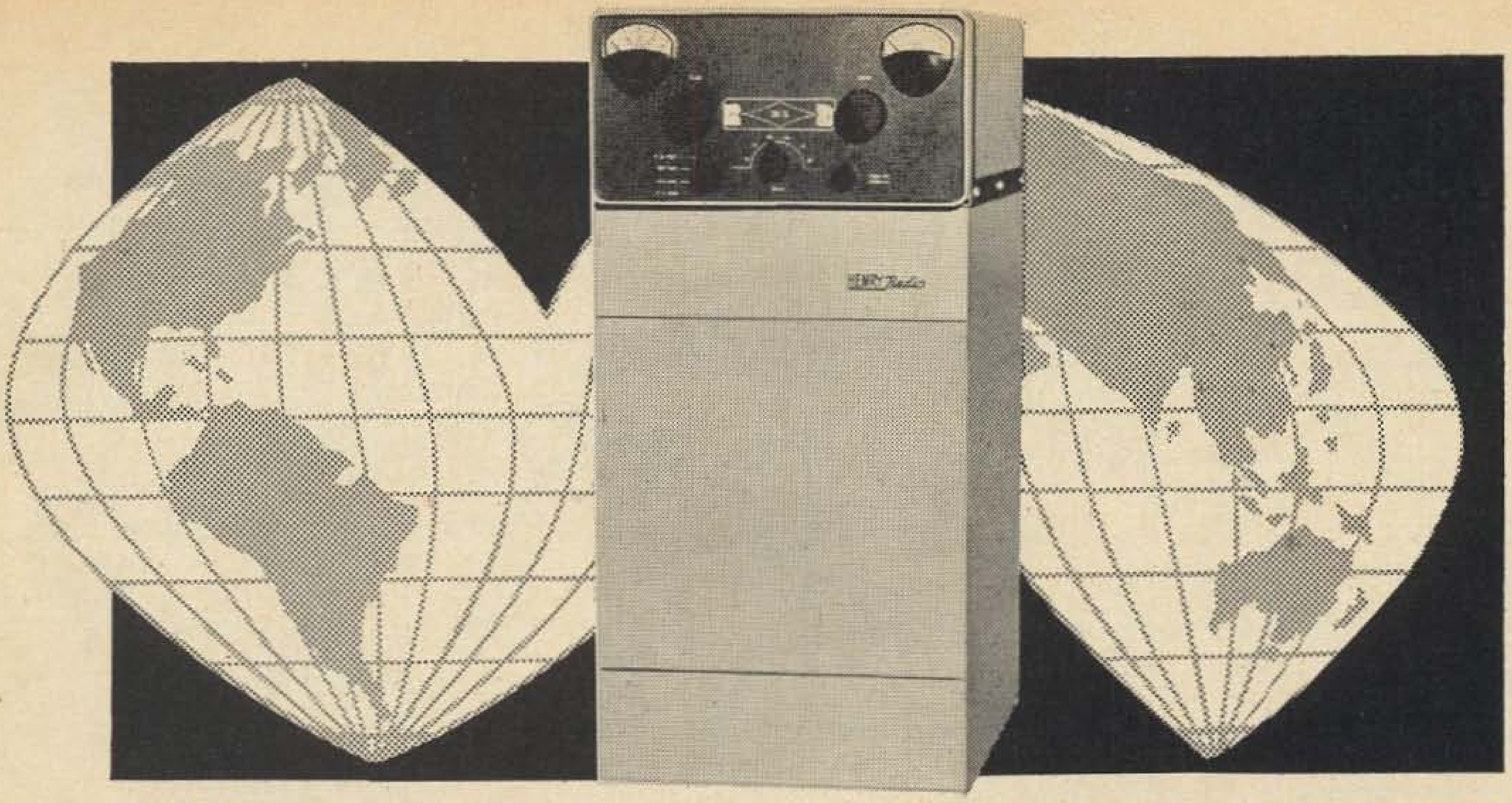


Fig. 12. Dash F-F-Set circuit.

Components

The circuit design presented here is not tied to any particular transistor number or category. The chances are very good that



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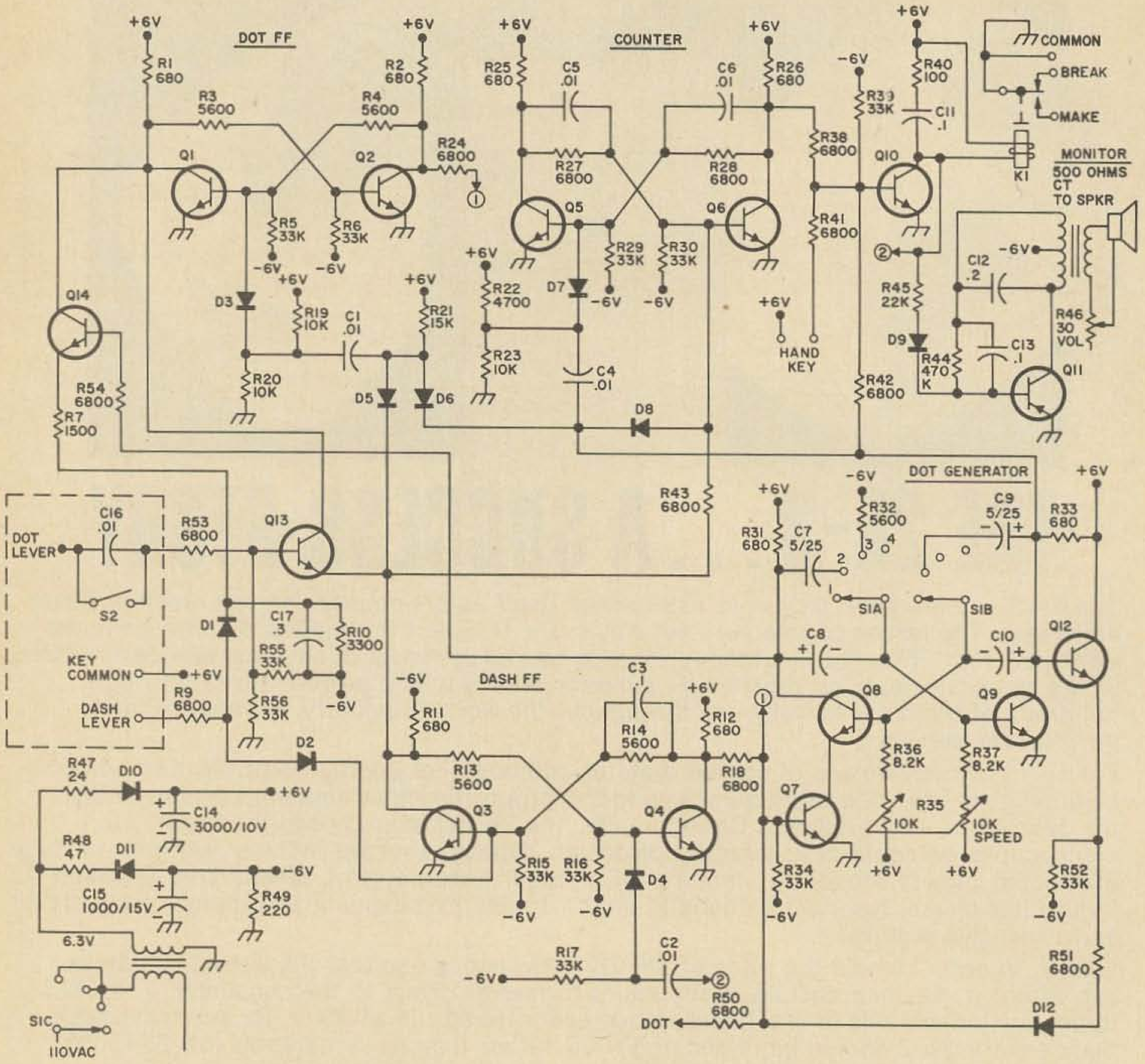


Fig. 13. Complete circuit using PNP transistors. All parts values same as Fig. 1. except $Q_{1\text{-}10}$, $Q_{12\text{-}14}$ are PNP (2N363), and Q_{11} is NPN (2N227).

components removed from old computer circuit cards can be substituted directly. Even though the voltages were different and the collector load resistors and base resistors are different, the chances are excellent that they can be used. However, it is a good idea to observe the relationship of the collector load resistors to the base resistors and the back biasing resistors in **Fig. 1** and not depart widely from these ratios.

There are a couple of areas where trouble can occur. Old germanium transistors have a tendency to get just a little bit sick, and thus erratic, but not sick enough so that they can be spotted easily. If you plan to use anything doubtful, it is a good idea to install sockets so that substitution is not a chore. The inductive kick in the relay circuit is surprisingly large so that a good healthy transistor is in order here.

It is recommended that a rough check of the gain and leakage be made if nothing is known about the transistors to be used. Leakage is a measure of the collector current with several volts applied and the base open and should be almost undetectable on a 1 mA meter. Gain is only a little more difficult. Assuming a 6 volt supply, choose a 300 ohm collector load resistor so that 10 mA will give a 3 volt drop across the resistor. Now find a base resistor which will cause 10 mA to flow at the collector and calculate the base current. The ratio of collector current to base current is an approximation of gain when leakage is low and must be at least 20 (much better 40). A pair of transistors used in a flip-flop should be within 25% of each other for ultra-reliable operation although no problems have been traced to this source.

Almost any germanium signal diodes can be used. (Silicon diodes should also be useable but have not been tried.) Germanium diodes will have a forward voltage drop of about 0.3 volt with a few ma flowing while silicon diodes will have a forward drop of 0.6 volt and will usually be painted black to eliminate the photo diode effect. Check the back resistance which should be at least 200 k ohms.

A reed relay is recommended for reliable, quiet high speed operation. However, there are some more economical types which are quite reliable at speeds below 30 wpm. If the relay is a little too slow it will give short dots. This can be fixed by unbalancing the oscillator to compensate. (R_{36} or R_{37} in **Fig. 1** may be reduced to 4 k ohms for balancing purposes. Do not go below 4 k oms or excessive base current will result).

If high gain transistors are used in the oscillator, a greater speed range can be obtained with a larger valued dual potentiometer. The upper speed limit can be raised by using smaller capacitors. The components listed will go from 5 to about 40 wpm.

The power supply voltages are not critical except that the positive and negative voltages should be nearly the same and if much different from that required by the relay, a dropping resistor may be needed somewhere to make things work out right. R_{47}, R_{48}, and R_{49} may be altered to adjust the positive and negative voltages. It is most important that power supply ripple be within reason or a phenomenon known as collector triggering will cause erratic timing in the dot generator. This is unlikely to happen with the components listed unless the electrolytic capacitors are defective.

Construction

The author has built many circuits of this type on perforated phenolic board with completely satisfactory results. The kind with closest spacing of the holes will allow a considerably smaller package. Eyelets can be very helpful if a setting tool is available, otherwise use flea clips or other push in terminals as needed.

This particular circuit has also been built on a printed circuit board which was laid out to accept a wide variety of economical components in either the PNP or NPN configuration.

Getting it to work

Before installing Q_7, use a voltmeter as an indicator with a probe on one of the collectors of a FLIP-FLOP while applying a 6.8k resistor from V_{cc} (+6V) to first one base and then the other base. The output should remain high or low depending on which transistor base was last touched. This test should be used on the DOT FF, the DASH FF and the COUNTER. Any of these that do not work should first be checked for wiring and then for components.

Next, hook up Q_7, the transistor controlling the oscillator. The output of the oscillator should be down. Now closing the dot lever should make the oscillator start. A voltmeter at the oscillator output should average half the supply voltage. An ohmmeter applied to the relay contacts should vibrate near half scale. If not, look for wiring errors or faulty parts in the relay driver. The oscillator should also operate when the dash lever is held. If not, look to see if the Dash FF is being set and if it is properly connected to the transistor controlling the oscillator. An ohmmeter connected to the relay contacts should now read about three quarter scale. If it still reads half scale, the counter is not working. Check wiring and then components. Make sure the counter is connected to the relay driver.

The dots and dashes should stop when the levers are released. If the dots fail to stop, check the emitter follower on the oscillator and the resistor and diode going to the control transistor. Also check for reseting of the Dot FF. If the dots work OK but the dashes will not stop, the most likely cause is in the components going from the collector of the relay driver to the Dash FF. Look for the diode to be in backwards or routed to the wrong base. Try changing C_2 to .02 mfd.

Now the squeeze feature can be checked. Set the keyer at its lowest speed and hold the dash lever closed. Tap the dot lever at random times. A dot should occur between two dashes each time the dot lever is tapped. If errors occur, the Dot FF is not being set. Check the wiring to the Dot FF. With S_2 closed, holding or squeezing both levers should cause alternate dots and dashes. With S_2 open, holding both levers should cause one and only one dot and a string of dashes. The specific location of the dot will be determined by the precise time the dot lever was closed in relation to the dash lever.

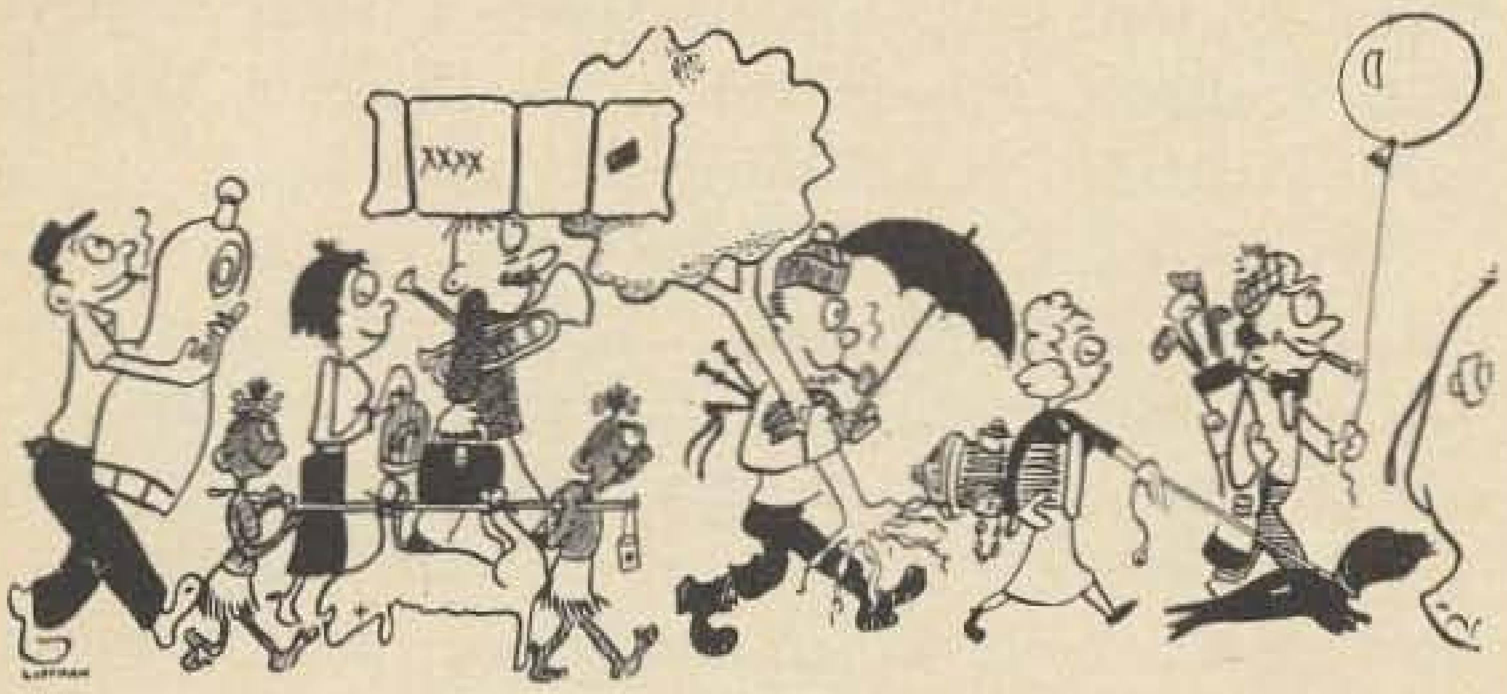
It is quite probable that the monitor note will be rough or the wrong frequency. Improvements can be had by experimenting with R_{44}, C_{12}, and C_{13}. If a sine wave is achieved, it will likely be accompanied by chirp which is also annoying. The monitor is a compromise as it does not contribute anything to the keyer operation and a better one would cost considerably more.

In one of the early models built with transistors of unknown quality, erratic operation was traced to low gain of Q_3 Thus it is suggested that the highest gain transistors be used at Q_8 and Q_9 while the next highest gain be used at Q_3 If new silicon transistors are used, no selection should be needed as the lowest gain likely to be supplied is more than adequate.

Conclusion

It is believed that many good circuits have fallen into disuse because they have some minor defect when it would be quite profitable and satisfying to rework one of them to meet current requirements. The keyer presented in this article is completely new in its philosophy, logic, and timing, yet is was created from a 1962 model[3] by the deletion of one part and the addition of twelve new ones at a cost of less than three dollars.

Those who build the CHARMIN' KEYER will soon become unhappy with older keyers including some that cost twice as much and they need have no worries about operating close to a high powered linear. . . . W9HX



Moving? Please Let Us Know!

Amateur Radio Knows No Borders

Last fall, when Wayne Green and his wife, Lin, were vacationing in Europe, they met Fernand Dubret, HB9PJ, of Geneva, Switzerland. Mr. Dubret told them of his role as an amateur radio operator in saving the life of a Polish child who was dying of Wilm's tumor, a malignant tumor of the kidney.

Recently, Mr. Dubret sent his personal account of his arranging to send requested medication across the iron curtain. With his account were several photographs, and copies of congratulatory letters from the Polish Ambassador in Geneva, and from the International Amateur Radio Club. The material presented is based primarily upon his account.

On February 24, 1968, at 4:00 p.m. Fernard Dubret, HB9PJ, a French citizen who lives in Geneva, received a distress message on 14080 Kcls from SP3AUZ, Julius Schmidt, of Poland.

"CQ HB, CQ D, CQ G Medical SOS Mayday Please help for a dying four year old Polish child. We need within 24 hours a rare drug called Cosmegene from Firma Merck and Döhme. Please send the drug to Nowa Sol, Poland, immediately, please help."

Immediately, Mr. Dubret, who is an official with the International Telecommunications Union, responded and began to seek assistance from several doctors who were on call (some who were unfamiliar with the drug), and from several pharmacies, which were

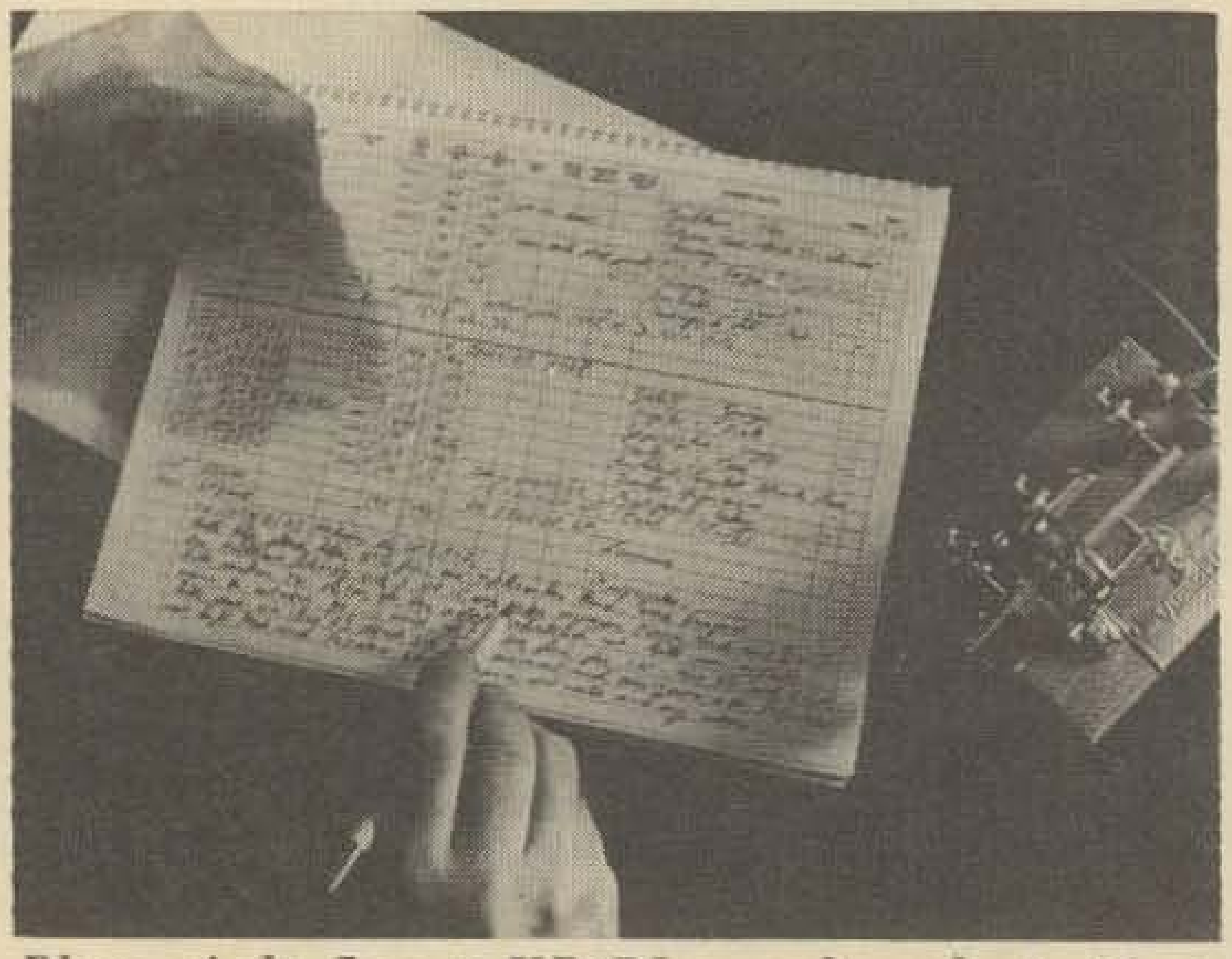
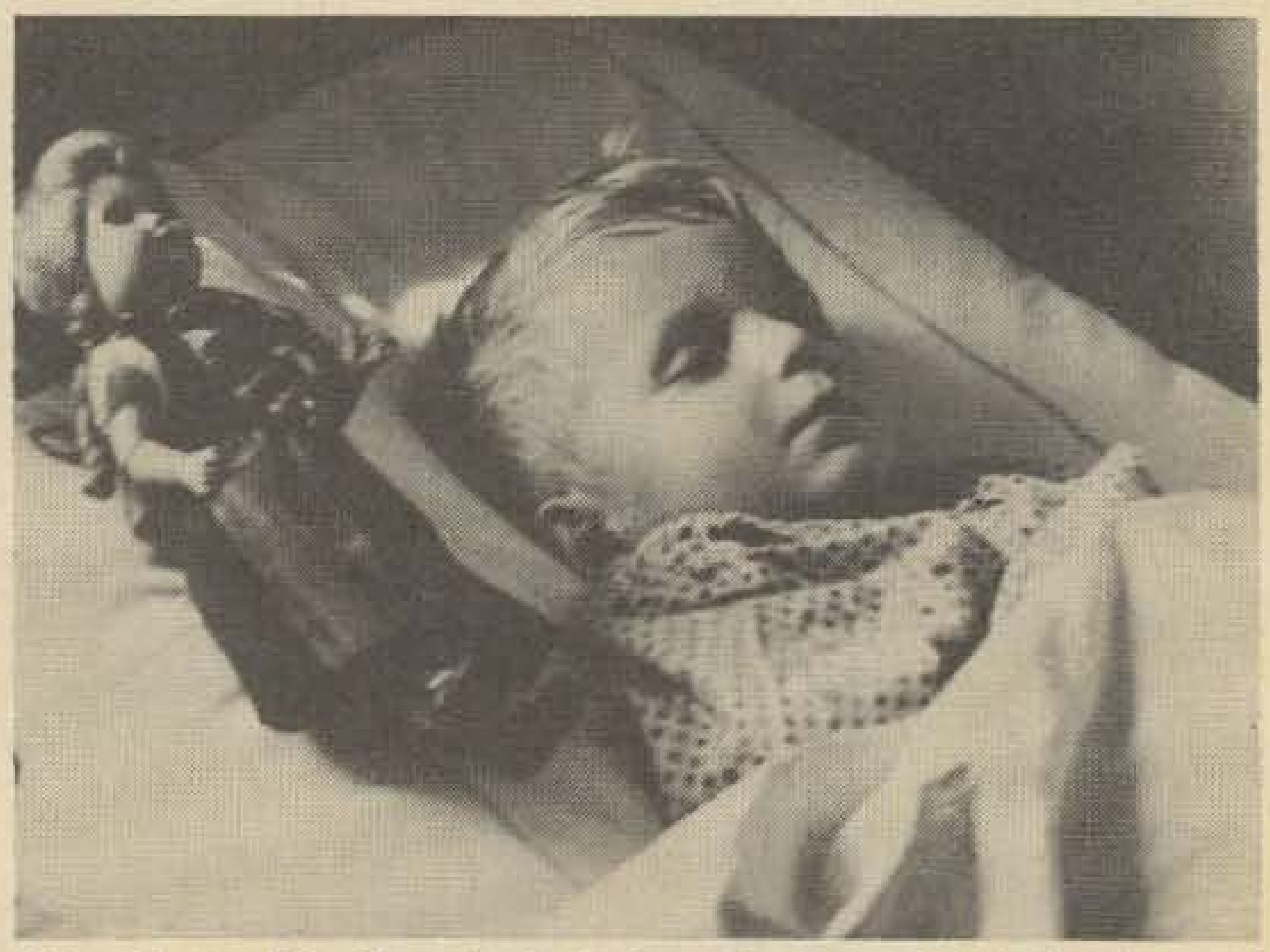


Photo of the Log at HB9PJ recording the incident.

Fernand Dubret HP9PJ. In his shack near Geneva, Switzerland.

Julek Schmidt, SP3AUZ. In Poland.



Marek in his hospital bed prior to the injection of the drug.

unable to supply the medication without a prescription. He alerted the Red Cross. He telephoned airports in Switzerland, France, and Germany seeking a plane which would be able to transport the drug once it was obtained. He discovered that the last flight from Switzerland to Poland would leave in an hour, so he alerted the Swiss police to arrange rapid transportation to the plane. By 5:30 Dubret had been unable to locate the drug, so he called the newspaper "La Swisse" where reporter, Raoul Reisen, responded to the request for assistance in obtaining the drug. Riesen called several pharmacies, and finally he called the pharmacist of Geneva Hospital, Albert Rochat, at his home. Arrangements were made to supply the drug from the hospital, but first it was necessary to contact SP3AUZ once again to obtain additional information regarding the exact chemical composition of the medication in relation to the age of the child. Within fifteen minutes of finding the drug, contact was made with Nowa Sol. SP3AUZ, Julius Schmidt, telephoned the hospital at Zielna Gora, which was twenty kilometers from Nowa Sol. Twenty minutes later, under conditions which were very difficult: static, interference, changing propagation, the formula was on the desk of Dubret. Contact had finally been reestablished on a different frequency.

By 6:15 p.m. the medication was ready. Unfortunately, the last flight to Poland, which had been held until the last possible moment, had just taken off.

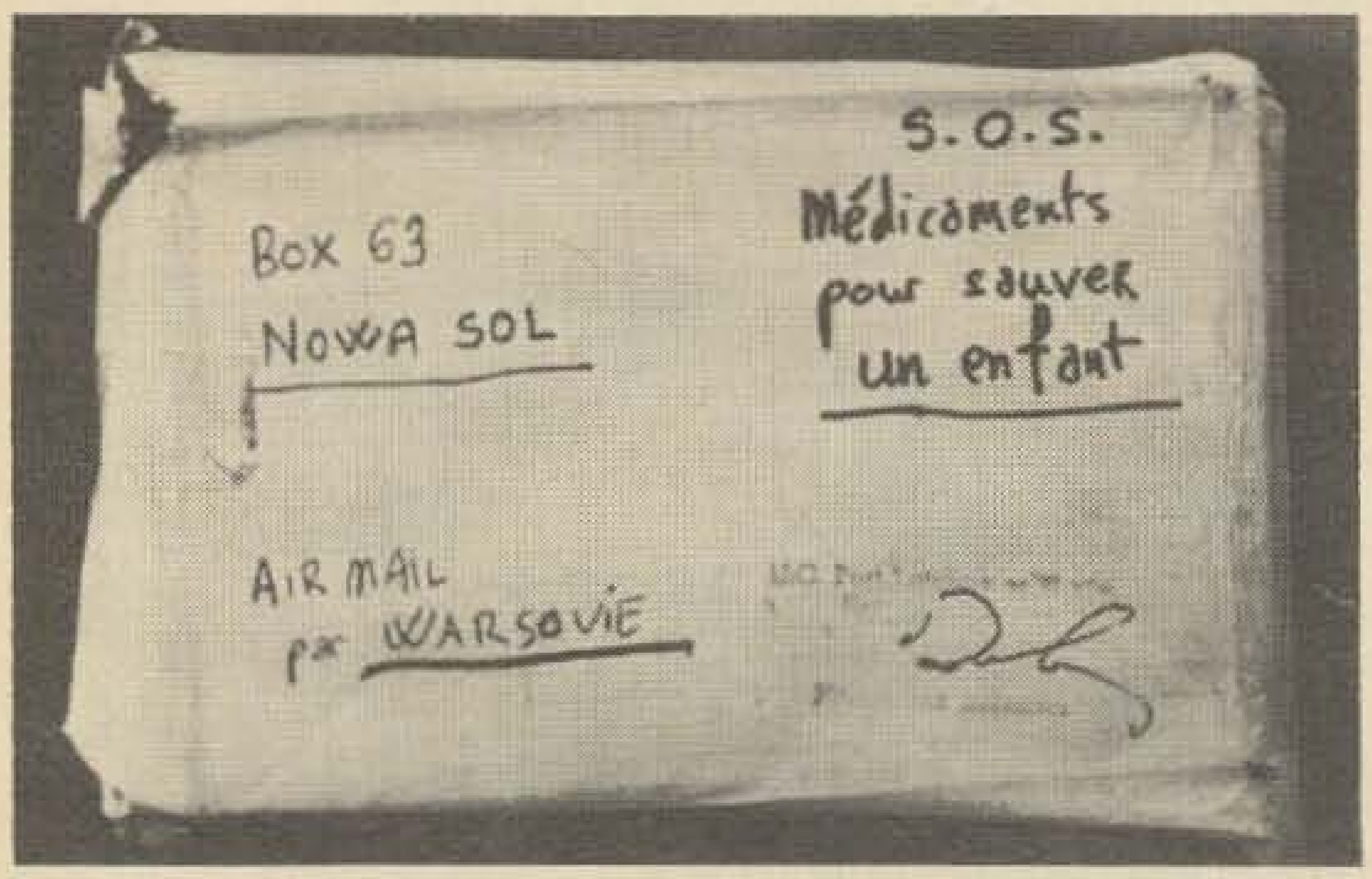
Dubret immediately instigated another search for a flight to Poland; again reporter Reisen assisted. This time the Public Relations Department of Air France responded. Two stewardesses from Geneva and two at Orly were requested to deliver the medication from Geneva to Paris, and to the crew of Flight 724: Paris, Varsovie, Moscow. By 9:00 p.m. the packet was enroute from Geneva to Paris, and by 9:00 a.m. Paris confirmed that the medication was on its way to Poland.

Because of the difficulty in delivering the drug across the iron curtain Dubret had called the Polish Delegation assigned to the United Nations in Geneva, requesting their support in the safe delivery of the drug. The Delegation sent telegrams to the ambassador from Poland in Paris, and to the ambassador in the USSR. Dubret was

Dr. Kuchincki who saved Marek by diagnosing the illness and ordering the drug.

Railway station at Zicklova Gora, where the drug was passed from the engineer to Marek's father.

Hostess Amik Renouf giving the medicine to a member of Swissair to be flown to Geneva.



The original packet containing the drug. This package is now kept as a souvenir in the hospital where all say that Marek was saved thanks to radio amateur network.

The Polish group consisting of SP3CW, SP3AUZ, SP3BES, with Marek's father, Eugen Maziarz.

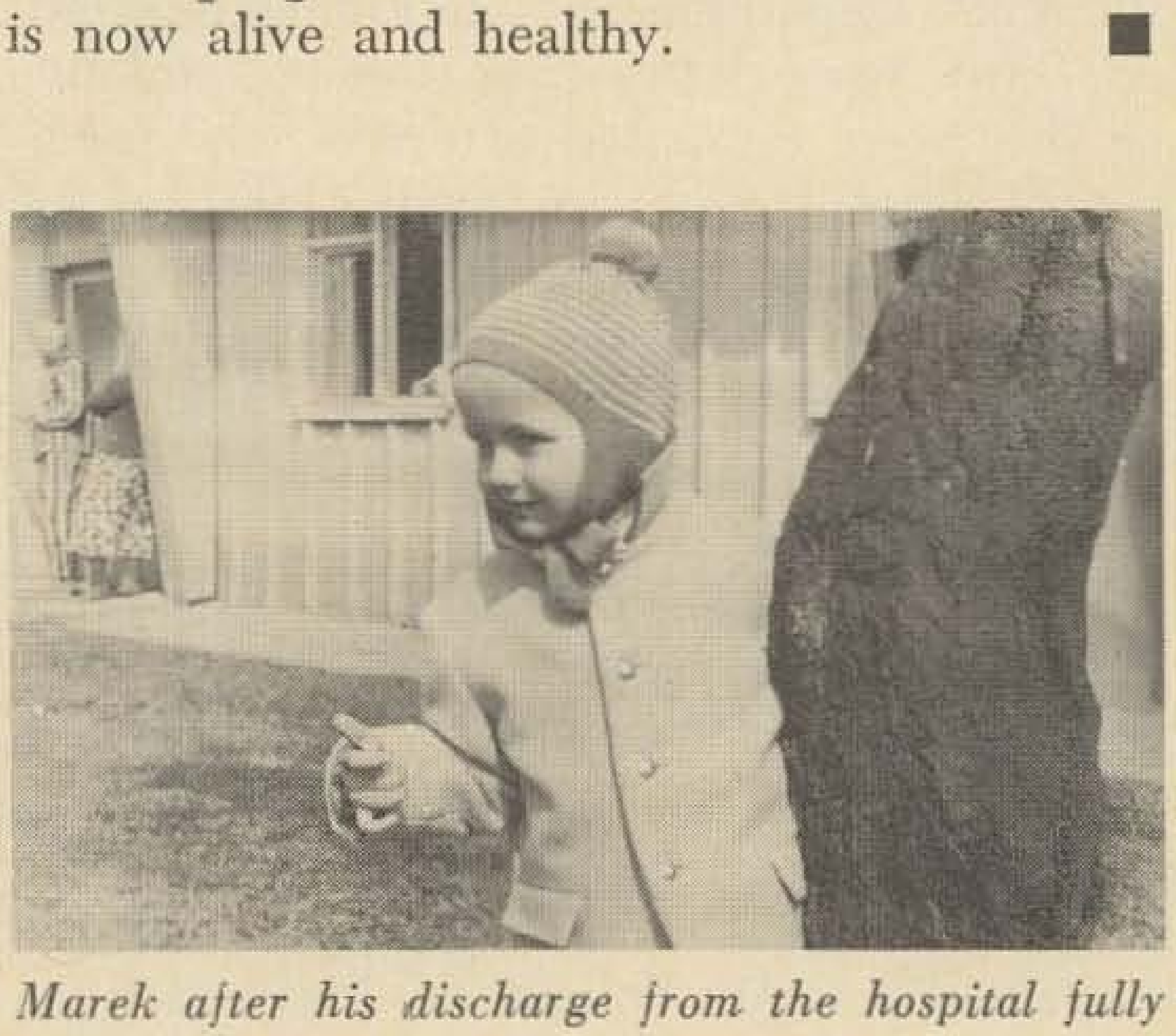
assured that the pilot of Flight 724, who would make only a short stop at Varsovie, would be authorized to leave the medication.

Between 10:00 and 11:00 a.m. Dubret broadcast to radio amateurs in Varsovie requesting that they go to the airport. (He also alerted amateurs in England and Sweden, for their propagation toward Poland was much more favorable.)

At the airport in Varsovie the response was amazing. There were numerous volunteers and well-wishers awaiting the arrival of the packet, eager to be of assistance. When the medication arrived, radio amateurs took charge, sending one part by police car, and another by train where it was entrusted to the engineer. Thus the medication was rushed from Varsovie to Nowa Sol.

By 2:00 p.m. Dubret had learned that the delivery had progressed as planned; and by 6:00 p.m. Polish amateurs informed him that the child, Marek Maziarz, had received his first injection within one hour of the appointed critical time. The medication was scheduled to be administered at regular intervals thereafter.

The next day while he was at work, Dubret received the news that the attending physician had stated that "without the Cosmegene, which arrived in time, I would have been able to do nothing; now the child will be saved." Following this the child's father thanked Dubret personally by radio and informed him that Maziarz, himself, had received one packet of medication from the engineer of the Varsovie - Nowa Sol express. Dubret received a report on the child's progress from the father. The child is now alive and healthy. ■



Marek after his discharge from the hospital fully recovered.

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A Better Balanced Modulator

Balanced modulators have been a vital part of amateur transmitters ever since development of interest in single-sideband. Although improvements have been made from time to time, most circuits still require resistive and capacitive balancing by means of adjustable elements. Unfortunately, the long-term and temperature stability of this approach is dependent on the characteristics of the pots and trimmers used. Temperature effects can be minimized by use of compensating elements but the whole process now becomes very involved. Circuit unbalance means not only carrier leak but greater distortion for a given audio input. The purpose of this article is to provide an introduction to a circuit capable of providing the same order of carrier rejection as conventional modulators with much better temperature and time stability. It can do this with absolutely no initial or routine maintenance type adjustments.

I claim no originality for development of the basic circuit since it is widely used in industrial and military equipment. All measurements performed and the resultant data were done by myself in the process of implementing the circuit in a home project.

The circuit shown in **Fig. 1** can be recognized as a ring modulator whose operation is adequately described in the literature[1]. T1 and T2 are usually wound in trifilar form on toroidal ferrite cores since this provides close coupling and more uniformity than other types of construction. Randomly selected diodes will provide about 15 or 20 db of carrier suppression below the double-sideband output. This figure can be increased to about 30 db at *if* frequencies with careful matching of the diodes. It is soon evident to the experimenter that any further improvement can only be obtained by the addition of balancing adjustments. The reason for this threshold is a basic limitation of the trifilar winding coupled with the method used for driving the transformer. Due to the single-ended input, one side of the secondary has more capacity to ground than the other. This unbalanced capacity has increasing effects as the operating frequency is raised.

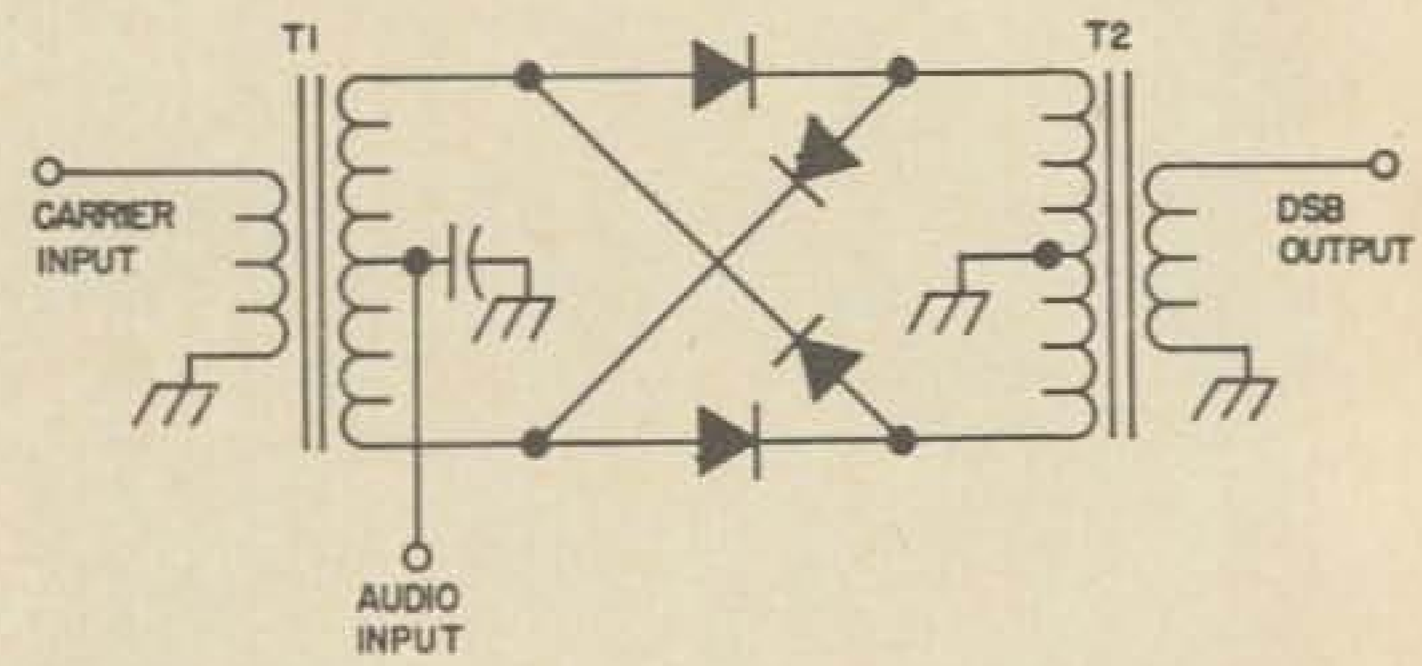


Fig. 1. Conventional ring modulator.

The easiest way to neutralize the effect of this unbalanced capacity is to isolate the return side of the primary from ground. This can be done by the arrangement shown in **Fig. 2.** T1 is a bifilar wound transformer with unity turns ratio which serves to isolate the primary return to T2. It may not be immediately obvious, but there is no loss of power in this transformation. The requirements that must be met are that the turns ratio be unity and the coefficient of coupling must approach unity. The mathematics used to prove this are not presented here since they are not common knowledge to most amateurs. The above requirements can be realized by the use of a bifilar winding on a toroid core.

The complete schematic of a practical modulator for use in the range of about 2 to 30 MHz is shown in **Fig. 3.** No tuning is used since T1 through T4 are broadband in nature with the impedance levels shown.

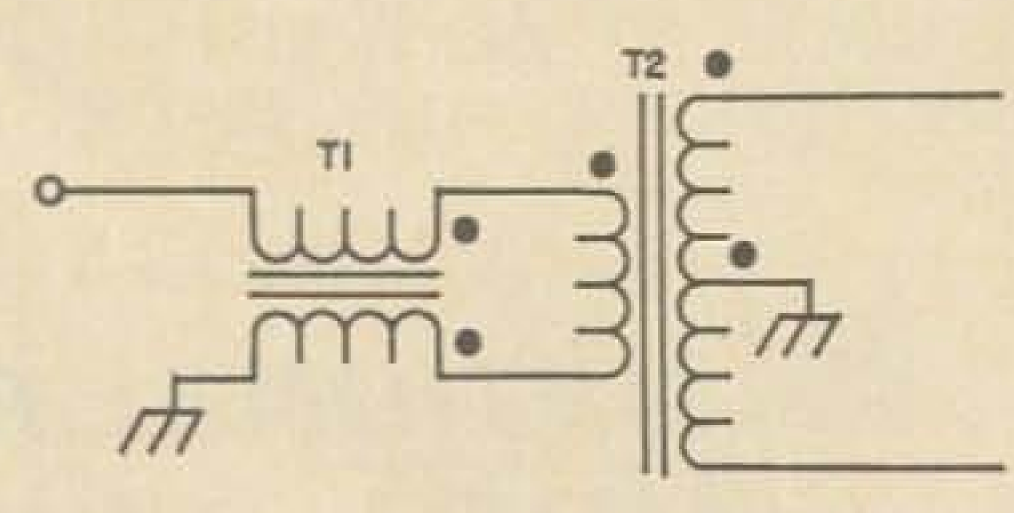


Fig. 2. Method of reducing effect of unbalanced capacity to ground in T2. Dot markings are explained in Fig. 4.

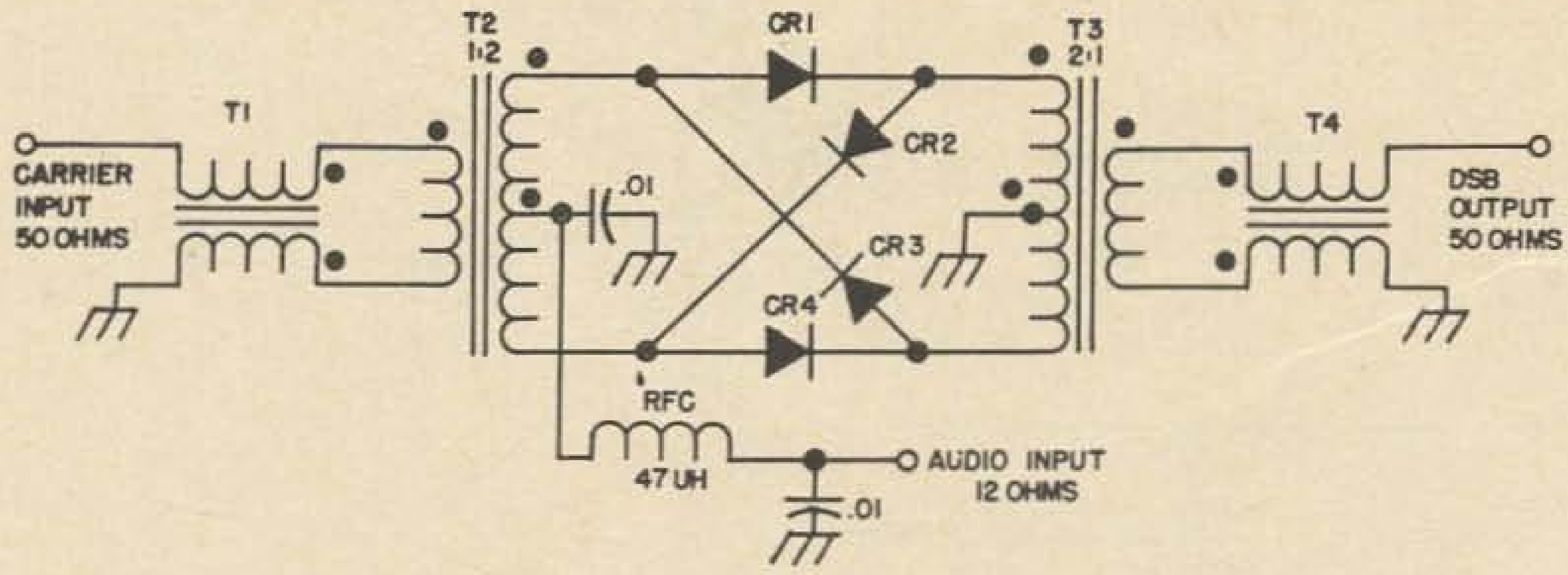


Fig. 3. Schematic of the wideband balanced modulator. The dots indicate winding polarities. Bifilar and trifilar winding is discussed in the text. Coil data: T1, T4-20 turns #32 enamel bifilar wound on 0.23 inch o.d. Ferrox cube toroid core (3D3 type ferrite). T2. T3- 30 turns #32 enamel trifilar wound on same core as T1 and T4. CR1, CR4- hot carrier or high speed silicon diodes.

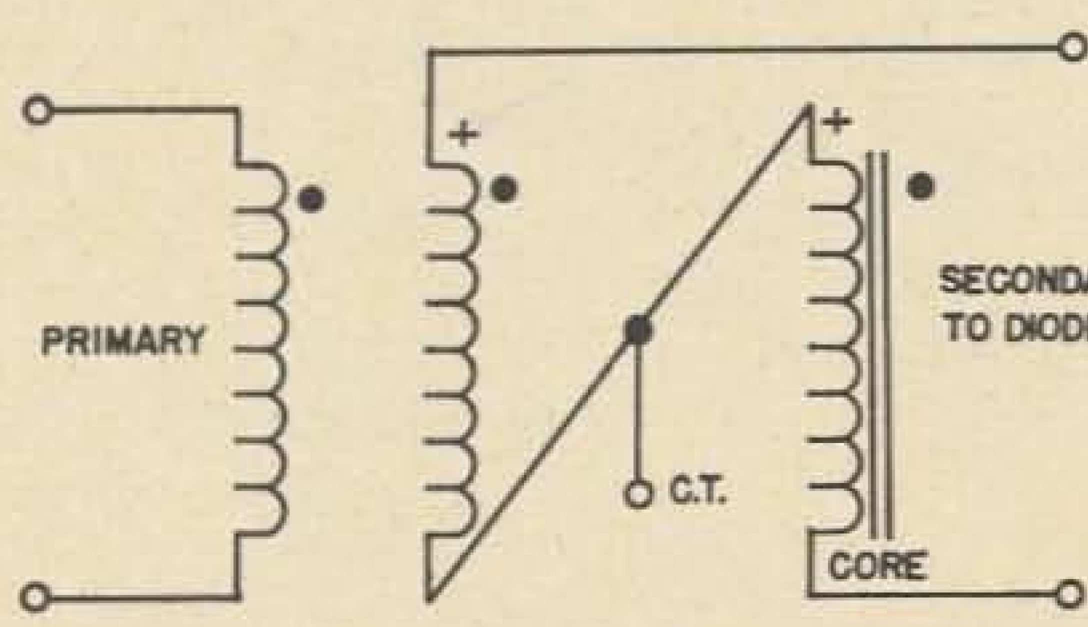


Fig. 4. Detailed illustration of the trifilar transformers, showing hookup of the three windings. The dots indicate that a current entering the primary in the direction shown will induce positive voltages at the ends of the secondary windings marked by the dots.

When terminated with a 50 ohm load at the output, the impedance looking into the carrier input is 50 ohms. With 1 volt rms of carrier injection, the impedance at the audio input is approximately 12 ohms. From the impedance levels it can be seen that this circuit is suited to transistorized circuitry but can be adapted for tubes.

Measurements were made at frequencies of 3 and 9 MHz, corresponding to the usual range of *if* frequencies used in amateur equipment. Equipment used consisted of an HP-606 *rf* generator, wto HP-200CD audio generators, an *rf* millivoltmeter, an *af* millivoltmeter, and a Singer spectrum analyzer. Optimum carrier injection at both frequencies is about 1 volt rms. Optimum audio level at this point is about 200 millivolts rms total (140 millivolts per tone for a two-tone signal). At 3 MHz, these operating conditions result in a double-sideband output of 137 millivolts rms with the carrier suppressed by 52 db below either tone. Intermodulation distortion is better than 50 db down. At 9 MHz, DSB output is 130 millivolts rms with a carrier suppression of 45 db and IM rejection of better than 50 db. At 30 MHz these figures will be degraded by a few db. High frequency performance can be improved by using fewer turns on the transformers. A higher carrier level will result in lower distortion but less carrier suppression. Less carrier injection will have the opposite effect. The figures given above seem to be a good compromise.

For those interested in using the circuit, a few construction hints are in order. It should be evident that the circuit can be stuffed into a very small space and hidden on a printed circuit board or in a corner of a chassis since no access to it is needed. An unclad epoxy board should be used to minimize unbalanced coupling to ground. The circuit layout should be symmetrical. Actually, the schematic gives a good physical layout and was used in the experimental unit. T1 and T2 should be placed at electrical right angles to eliminate mutual coupling. The same goes for T3 and T4. The close proximity of the cores makes this necessary as will become evident to anyone who experiments with the position of the cores while monitoring the carrier suppression.

The bifilar winding is formed by taking two pieces of wire, each of sufficient length to wind the required number of turns on the core, and twisting them together to form a twisted pair. This composite wire is then wound evenly around the core. The trifilar winding is exactly the same, except a third piece of wire is added to form a twisted triple. Referring to **Fig. 3**, 20 turns bifilar wound actually means 10 turns of a twisted pair. Similarly, 30 turns trifiler wound means 10 turns of a twisted triple.

The diodes should be matched by choosing

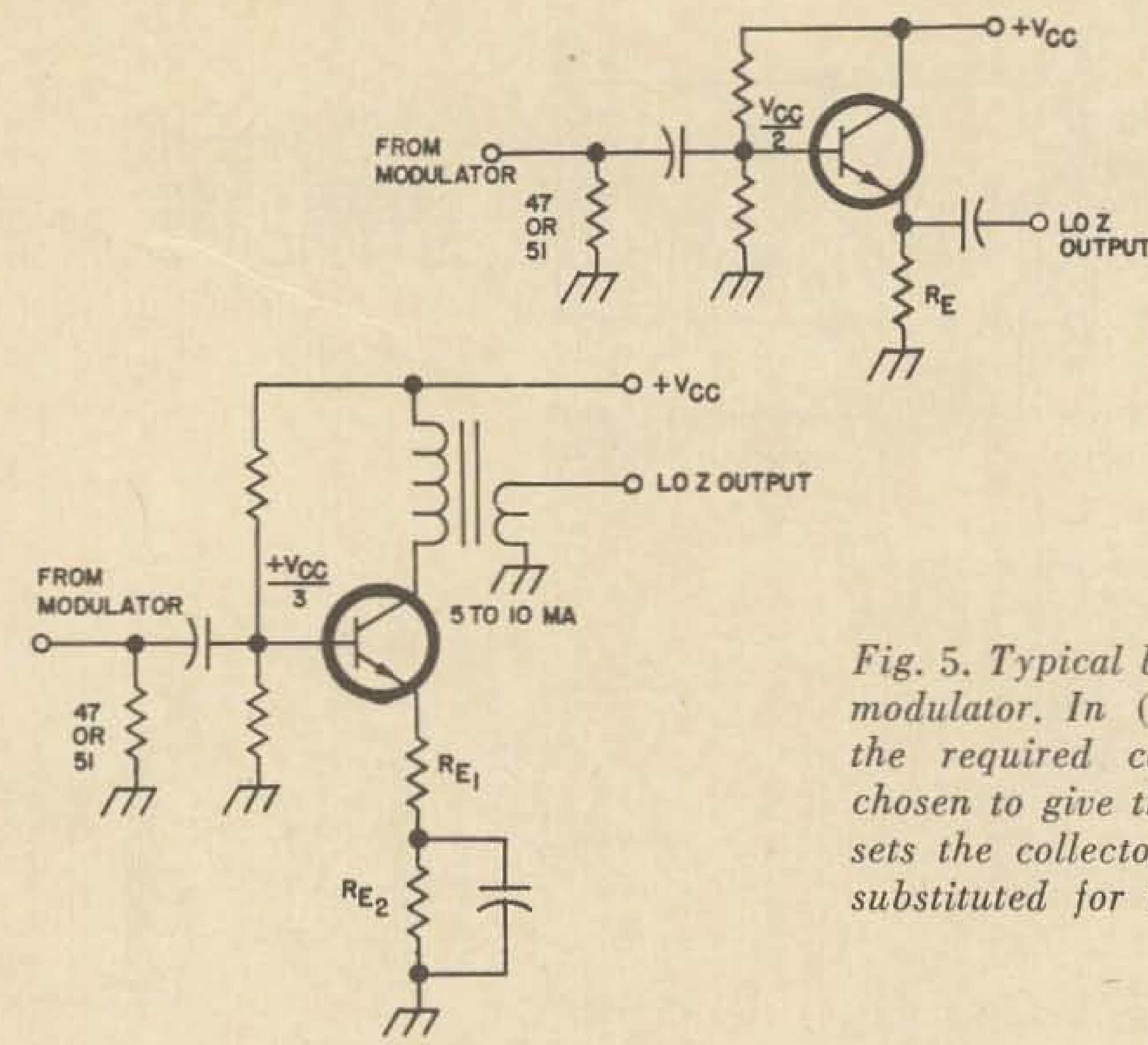


Fig. 5. Typical buffer amplifiers for terminating the modulator. In (A), Re should be chosen to give the required collector current. In (B) Re_1 is chosen to give the required voltage gain, while Re_2 sets the collector current. A tuned circuit may be substituted for the broad-band output tranformer.

those with the closest forward resistances on the X1 ohms scale of a VTVM or TVM. Those with lower forward resistances are better from an efficiency standpoint. Most any silicon diode will have much higher back resistance than is necessary for proper operation. The zero-basis capacity is a more important consideration and should be no more than a few picofarads. The lower the better. Germanium diodes should not be used since their characteristics are not suitable for use in this circuit as regards efficiency and distortion. Hot carrier diodes have proven themselves more desirable at the higher frequencies. Another good choice for the diodes would be the RCA CA3019 which is an integrated circuit diode array. The advantage of using a unit like this is the excellent matching and temperature tracking of the diodes.

The modulator can be unbalanced by inserting a variable dc voltage of 0 to about ± 1.5 volts at the audio input. This should be fed through a choke of 200 mH or more to avoid disturbing the audio frequencies. It is also worthwhile to mention that the load resistance at the output terminal should be kept in the vicinity of 50 to 100 ohms for proper operation with the circuit constants shown. Probably the most reliable way of obtaining a constant 50 ohms is by shunting the output with a 50 ohm resistor and using a buffer amplifier. **Figs. 5a** and **5b** will illustrate.

This circuit is not limited to use as a balanced modulator. It functions very well as a low distortion product detector by adding a step-up transformer at the audio terminal to bring the impedance level up to 10 or 20K ohms. With an *if* input of about 100 millivolts rms, a few volts of audio will be pro-

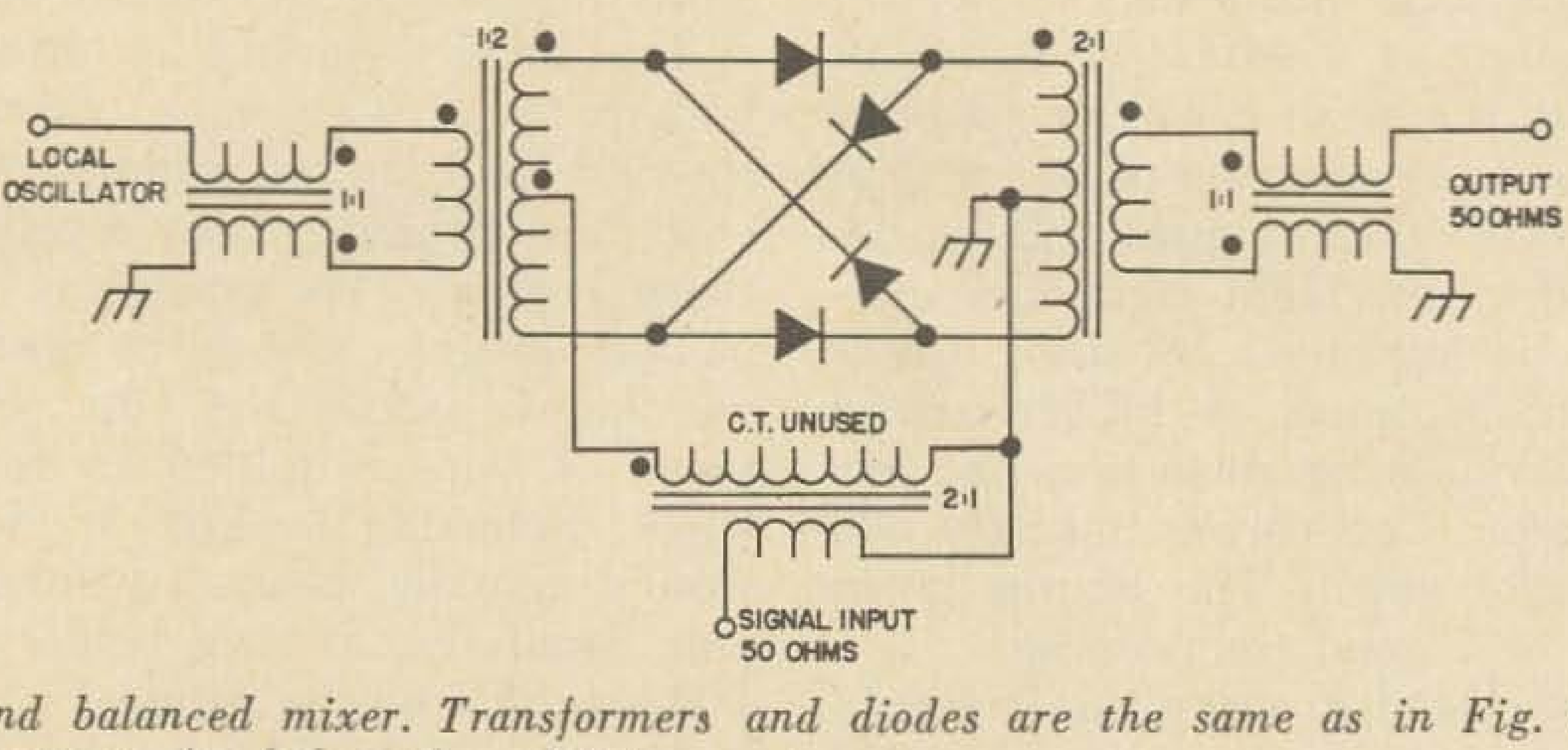


Fig. 6. Wideband balanced mixer. Transformers and diodes are the same as in Fig. 3. Signal levels should be the same as for balanced modulator service.

duced at the secondary of the matching transformer. This can be fed directly into a power output stage using a pentode. A lower step-up from the detector should be used for a transistor output stage. The dynamic range of this detector is on the order of 130 db. The addition of a third trifilar transformer makes the circuit useful as a well-balanced mixer over the range of 2 to 30 MHz as shown in **Fig. 6.** Dynamic range is about 130 db with suitable diodes (hot carrier or very high speed switching types). Of course, a filter is needed after the mixer to remove the unwanted sideband. A voltage-controlled attenuator can be realized through the use of a variable dc voltage applied to the audio terminal. The *rf* signal to be controlled is fed into either of the other ports and is taken out from the port which is left. Signal input at the *rf* ports should not exceed a few hundred millivolts to avoid distortion. A little thought will reveal many other applications of this circuit.

I hope the information presented above will enable the homebrew artist to make his gear a little more up to date and at the same time get rid of that unpredictable carrier balance control.

. . . WA1FRJ

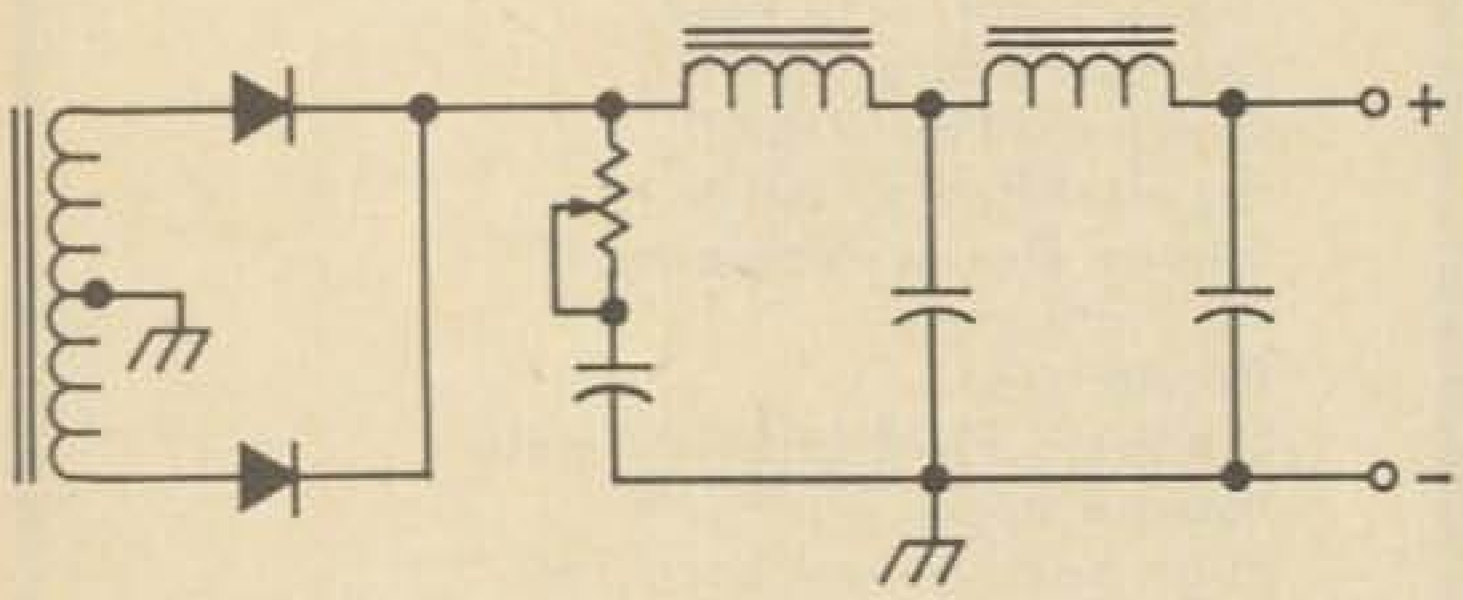
Reference:

1. Pappenfus, Bruene, and Schoenike, Single Sideband Principles And Circuits, McGraw-Hill, Inc., New York, 1964.
An excellent treatment is given in Chapter Five.

Here we go again —
The FCC vs Sam Snell.

An Adjustable High Voltage Supply

William P. Turner WAØABI
5 Chestnut Court
Saint Peters, Missouri 63376



I am sure that every ham who ever built a power supply has had the sad experience of coming out with a voltage which was too high or too low for the project at hand. The usual practice is to try changing from a capacitor input filter to a choke input, or the reverse, in order to raise or lower the available voltage. Sometimes this works, that is if the voltage requirement is not too critical. Other times it doesn't, and we resort to expensive, power consuming, and poorly regulated voltage dividers.

As an example of a much more satisfactory method, let me relate my recent experience with a transceiver power supply. I had bridge rectified a TV transformer for high voltage and intended to take the low voltage off the center tap of the same transformer. The high voltage came out exactly right, the low voltage, which was to have been 250 volts under a 100 ma. load, came out at 230 volts with a choke input filter. An attempt at changing to a capacitor input failed miserably. 350 volts was much more than the rig could endure. It looked like time for the 20 watt resistors and all of that nonsense.

It would seem from the above that what was required was a filter which would operate somewhere between the choke and the capacitor input conditions, and this what I ended up with. In the diagram you will note a resistor in series with the positive lead of the input filter section. This resistance, when fully in the circuit, seriously limits the ability of the capacitor to charge and as a result the output voltage is reduced almost to the value of a choke input. On the other hand, when the resistor is reduced in value, the input filter charges to a more normal voltage and the output reflects this change. As may be seen from these two examples, it is possible to adjust the output voltage by merely adjusting the series resistor for the desired voltage at the required load.

It would be desirable to substitute a rheostat or adjustable resistor for setup purposes and replace it with a fixed resistor when the exact value is known.

I would suggest that values below 1000 Ohms would be most useful. In the example cited above a 500 Ohm, 10 watt resistor was used. Try it, it works like a charm.

"Henry is Spending the day in bed with a code."

Save Your Money!

Ralph Steinberg, K6GKX
110 *Argonne Ave.,*
Long Beach, Calif. 90803

Don't throw away those audio and power transformers when they develop a defect. You might be able to repair them without much difficulty, or salvage them for other uses.

Most transformer troubles are shorted, or open, windings, shorts between separate windings, or shorts to the core. In a number of cases you will find some of these defects at the terminal points of the primary or secondary windings. It is best to remove the outer metal shell of the transformer and inspect the terminals for a broken wire or loose solder job. Should the terminal leads of the windings be of covered wire, it is best to check them as the heat from the equipment sometimes causes these leads to get brittle and break.

With center-tapped windings, an open will occur if the common connection is broken. Filament and high voltage windings are frequently center-tapped by bringing the two leads from the windings through a piece of spaghetti tubing and soldering the two leads together at the end. Sometimes this center-tapped lead may be cut too short when being assembled at the factory and may break the common lead and create an open. A repair can be made by stripping the insulation on the center tap lead and resoldering the two wires. This same proceedure should be used with tapped modulation or audio transformers.

A short to the core can usually be repaired without too much work. In numerous cases it is common practice to ground one side of the transformer as, for example, the filament plus winding. If a short should occur, all that is necessary is to reverse the leads of the filament windings. Should a short be found at some other point on the windings of the transformer, check it over visually, as the insulation may have worn off the wire and is grounding against something on the transformer. When the short is located, repairs can be made by using varnish or electrical tape. With internal shorts in the windings, it is best not to try to make repairs unless you are an experienced hand on re-winding jobs.

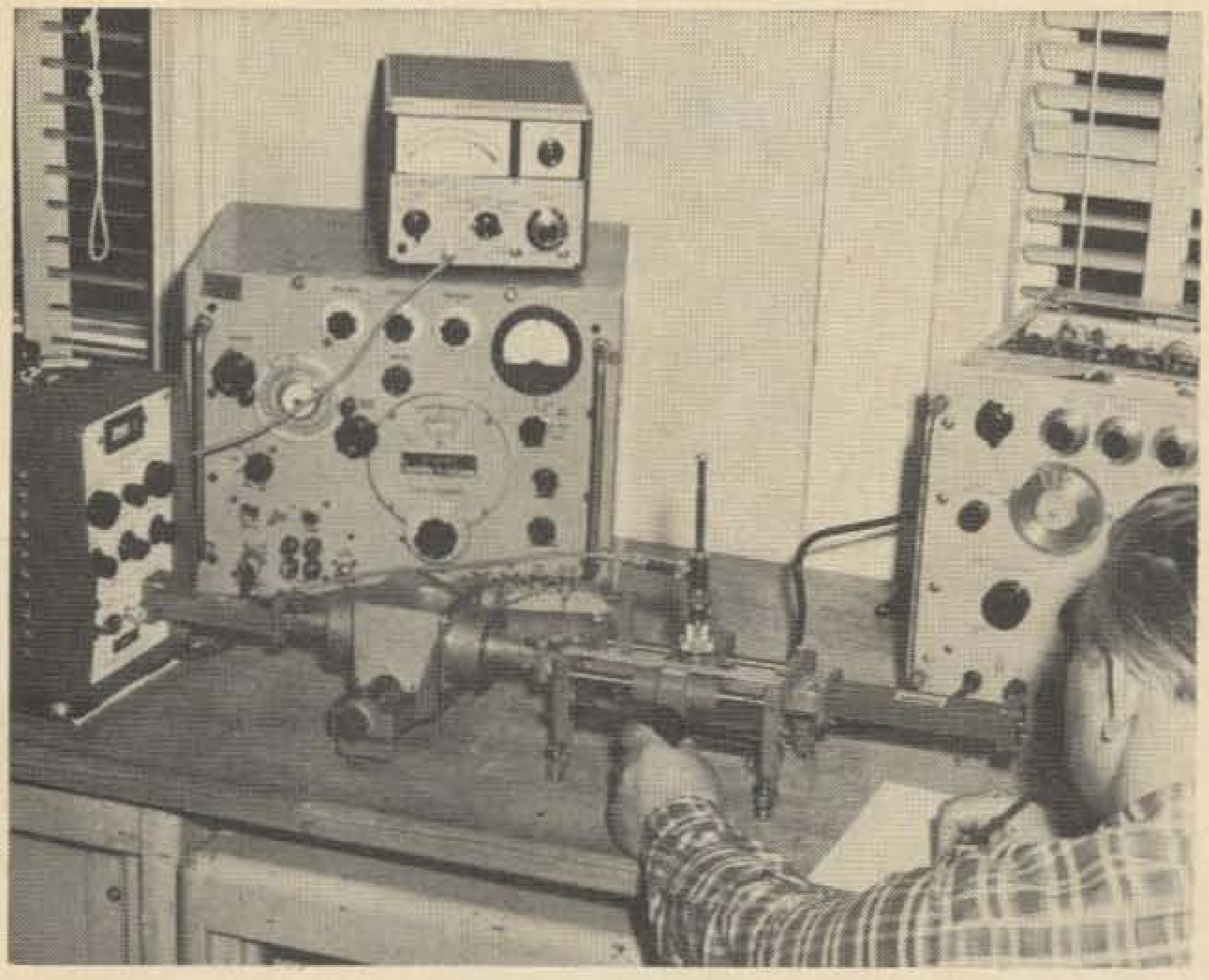
Now for some ideas to salvage those transformers in your junk box. A power transformer with an open high voltage secondary can be used as a filament transformer or a filter choke. When used for a filter choke, use only the primary leads and tape the secondary leads for safety. If the filament windings of the secondary are open, you can still use the transformer for the high voltage. With the primary winding open you can get surprising results by using the transformer for audio output. Connect the high-voltage secondary as the primary and the five or six volt filament winding as the secondary. Experiment with both sets of leads for best results.

Suppose you have a low power rig and need a cheap and easy way to modulate it. Dig that audio frequency output transformer with the open secondary winding out of your junk box and use it. Why not try Heising screen modulation? It may not be the best modulation but it will work well in any emergency. All you need is the primary of the transformer and a few inexpensive components and you are in business. Any ARRL Handbook will give you the circuits; transformer-coupled or clamp tube arrangements.

You can always use those small audio output transformers for small power supply chokes. All you do is cut off the secondary leads and use the primary. You will be surprised how many other applications these small transformers have if you try them in some of your pet projects.

Where transformers are beyond repair and can not be used for any of the ideas suggested in this article, salvage the wire from the coils. This will give you a good stock of wire to use for inductance coils. You can sell the iron core to the junk man.

Although this article refers to power and audio transformers, the same ideas can be used for salvaging interstage or modulation transformers. A word to the wise is sufficient; SAVE MONEY. . . . K6GKX



One of our technicians doing VSWR measurement using Hewlett-Packard and PRD Xband scource

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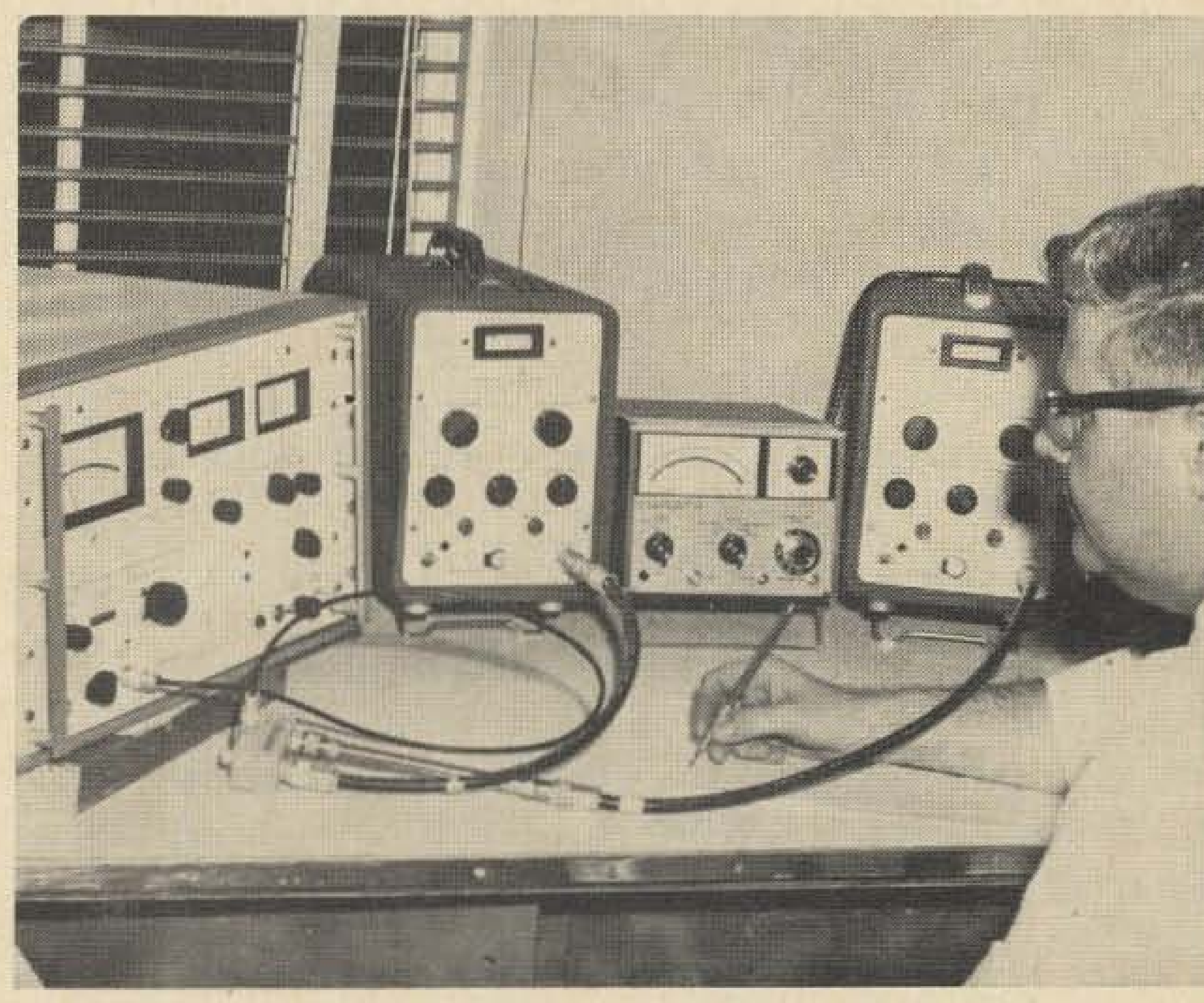

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Many pieces of amateur radio equipment —transmitters, receivers, test equipment and the like use oscillators in one form or another. These circuits generate ac voltages at fixed points across the entire communications spectrum. The signals generated by these devices are the heart of all communications systems.

In the beginning, amateurs used the spark gap as a rather crude method of generating *rf* energy. Frequencies were unimportant then and methods of detecting the energy sent by a transmitting station were also rather crude. The development of the vacuum tube made possible the generation and detection of signals with much improved quality and more precise control of frequequency. Through the years many tube oscillator circuits were developed with each having its own advantages with regard to stability and the frequency range to be covered. Indeed, even today a large percent age of amateur equipment in use still uses vacuum tubes.

During the last five or ten years, the transistor has begun to creep into amateur designs and a few commercial pieces of ham gear have become entirely solid state, except maybe for the last power producing stages of amplification. The semiconductor approach to communications equipment design offers a number of advantages over vacuum tubes in terms of power requirements and thermal considerations. This article describes and diagrams a number of solid state oscillator circuits which can be used to generate energy over a very wide frequency range. Each circuit, of course, has particular merits over a given band of frequencies.

Resonators

The dictionary defines the verb oscillate as "to swing to and fro like a pendulum." This definition is obviously directed at mechanical devices and might not seem to apply to electrical circuits. Not so. An electronic oscillator produces a signal which behaves in just such a way. The energy generated is in the form of an ac voltage which changes alternately between positive and negative potentials with respect to a zero reference level at a constant rate per unit time. This is the same as the motion of a clock pendulum swinging back and forth across a vertical line. The electrical analogy of this sort of mechanical system, of course, is the resonant or tuned circuit. It has a natural period of vibration so to speak in terms of the voltages and currents in its elements at a given time. A tuned circuit can be used in an oscillator to generate alternating current energy at its resonant frequency.

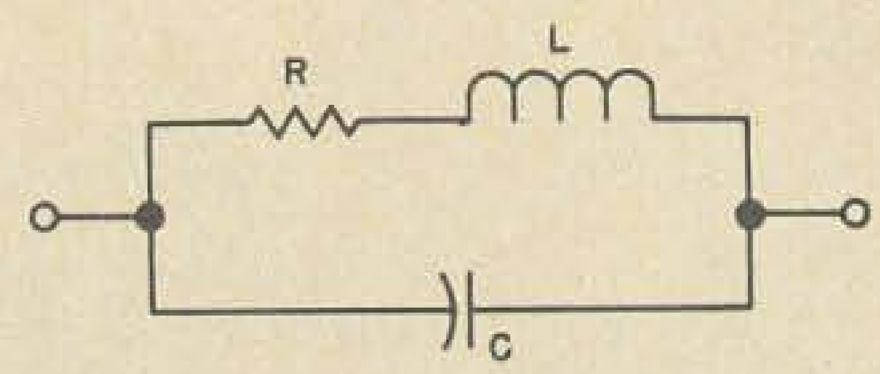


Fig. 1. *A parallel tuned circuit.*

To go back to the pendulum of a clock, it can be noted that the clock must be rewound periodically in order to keep it going. Because of the frictional losses in the various parts, the pendulum will not continue to swing forever once it is started. To keep the pendulum going over a long period of time it is necessary to give it a little kick with the spring mechanism in the clock each time it completes a swing. Electrical resonant circuits are exactly the same. A parallel resonant circuit is shown in **Fig. 1.** The inductance and capacity in the circuit produce the effect of making the circuit sensitive to oscillatory electrical vibrations at a particular frequency, and the resistance R is analogous to the frictional losses in the clock mechanism. Indeed if the resistance were zero (this is physically impossible) the circuit would oscillate and generate ac energy forever once it was pulsed with a signal at its natural resonant frequency. Maybe this is fortunate since if the resistance were not present, the tuned circuits that we devise would produce incessant oscillations excited by signals from broadcast stations, etc.

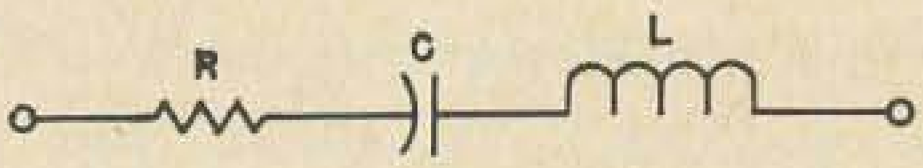
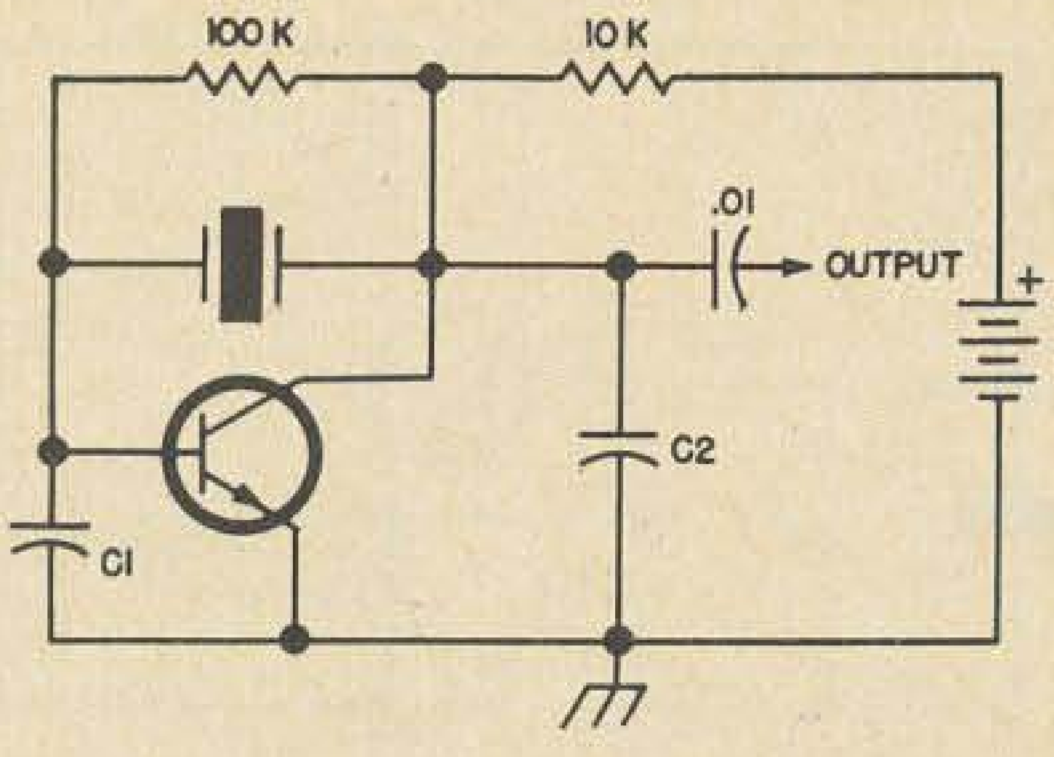


Fig. 2. A series resonant circuit.

Oscillators in general

An oscillator circuit adds the "kick to the pendulum". The active and passive elements of the circuit combine with the resonant circuit to keep it oscillating as long as power is supplied. Turning on the power produces enough noise (kick) to start the circuit oscillating. This brings up the matter of "Q" or quality factor of the tuned circuit. Q is defined as the ratio of the stored energy in an oscillating system to the energy lost per cycle of oscillation. In electrical circuits it can be thought of conveniently as the ratio of the ac reactance to the dc resistance in the circuit. Circuit losses make up part of this resistance and must also be taken into accounty. For example, placing a coil close to a ground shield may increase the coil loss, and thus the effective resistance, lowering the coil Q. The subject of Q is really quite involved, but it is only important to realize that it is necessary to furnish a little energy to a tuned circuit or oscillating system after each oscillation in order to compensate for the system losses to keep it in oscillation.

Almost any circuit with a resonant network will oscillate as many of us have discovered when trying to build devices which are intended for uses other than producing *rf* energy. This comes about because an oscillator is just an amplifier with the appropriate elements to produce oscillation. To provide the "kick" to the resonant circuit, it is only necessary to return a little bit of the energy from the output of the amplifier to the input in the proper phase relationship. Under this condition the amplifier will generate a signal at the natural resonant frequency of the network. In order to do this, of course, the gain of the amplifier must be greater than unity so that some power is left over to return to the input to keep the system going. The amount of power required to keep the oscillator excited depends upon the Q of the frequency determining circuit. The lower the Q, the more returning or feedback power required.



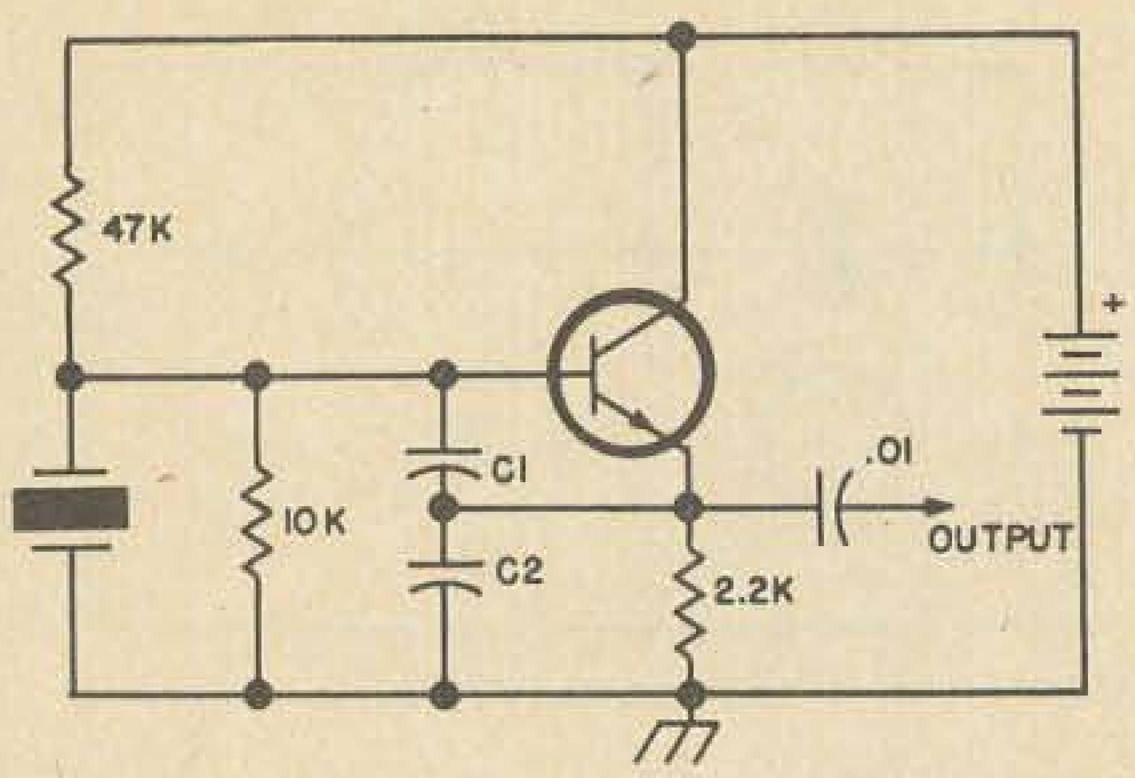
FREQUENCY RANGE	C1	C2
200 KHZ – 1 MHZ	1000 PF	470 PF
1 MHZ – 5 MHZ	680 PF	390 PF
5 MHZ – 30 MHZ	220 PF	180 PF

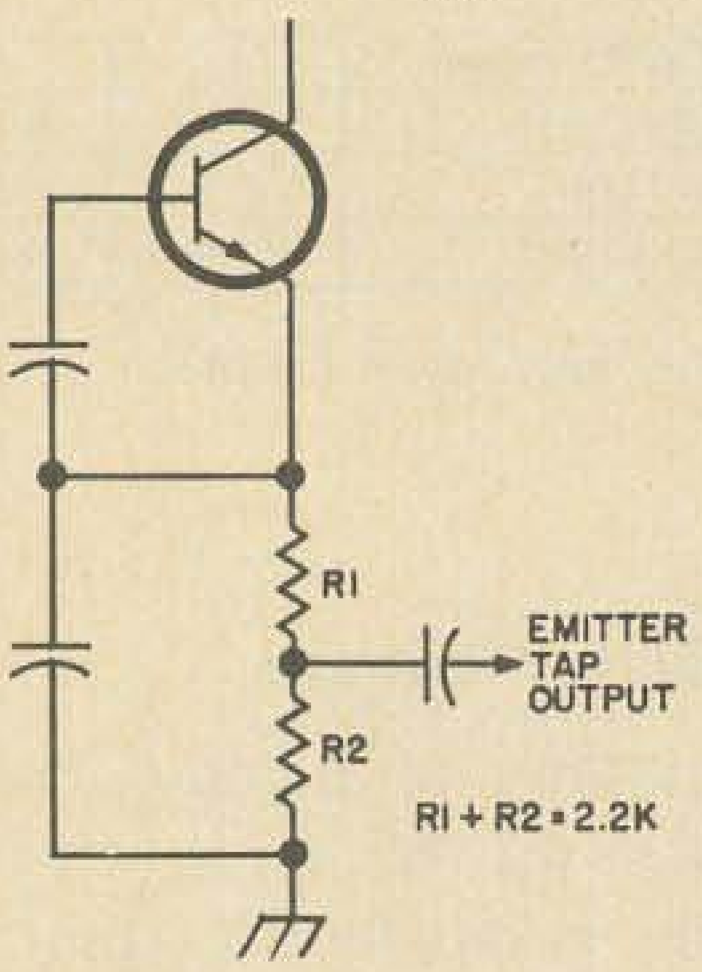
Fig. 3. Pierce oscillator circuit.

Crystal oscillator circuits

The resonant circuits for oscillators are usually made up of coils and capacitors. However, the piezoelectric quartz crystal is commonly used in amateur equipment, and this type resonator will be discussed first. A crystal is really the same as an LC network and such networks can replace it in almost all frequency determining circuits. The crystal has the very distinct advantage of having a very high Q and can be used to generate signals of much better stability than a coil-capacitor combination. Here it might be well to mention that most crystal oscillators use parallel resonant tuned circuit operation. This is the connection shown in **Fig. 1.** Some circuits make use of the series resonant condition shown in **Fig. 2.** Here the network presents only the circuit resistance at the resonant frequency while the parallel circuit of **Fig. 1** presents an extremely high resistance at resonance. A crystal not only acts like a tuned circuit; it can look like a parallel resonant circuit (**Fig. 1**) or a series resonant circuit (**Fig. 2**) depending upon how it is connected in the oscillator circuit. A complete discussion of why this is so is beyond the scope of this article, but information on crystals may be found in the literature. In the circuits to be described, the crystals are operating in a parallel or anti-resonant mode unless series operation is especially noted.

All of the circuits and values are designed around a good quality silicon npn transistor such as the 2N706. This device will work well in oscillators up into the vhf range. Other types are useable and type number is not too important as long as the





FREQUENCY RANGE	C1	C2
1-4 MHZ	820 PF	390 PF
4-10 MHZ	470 PF	220 PF
5-30 MHZ	220 PF	100 PF

Fig. 4. *Alternate* 1-30 *MHz oscillator.*

transistor is rated for the frequency to be generated. Supply voltage polarity is for the npn configuration and can be between 6 and 15 volts. Nine and 12 volts are good nominal battery values. For the circuits that require capacitor value changes with frequency, nominal values of capacitance are tabulated. Bias resistor values are nominal and some experimentation with R and C values may be needed for optimum results depending upon frequency and the circuit involved. In general the values indicated will produce good results.

Crystal oscillators for 200 kHz - 30 MHz

An old standby vacuum tube oscillator is the Pierce circuit with the crystal connected between plate and grid. A transistor version of this circuit is shown in **Fig. 3.** Here, as in the vacuum tube version, the crystal is connected in the same relative position, i.e. between collector and base on the transistor. It will be noted, however, that the semiconductor version of this circuit has some capacity added between the "hot" elements and ground. Transistors just don't have the interelectrode capacitances that vacuum tubes do and their low impedance nature makes these capacitors necessary. They provide the feedback to make the transistor oscillate. Suffice it to say that this circuit will work from 200 kHz to 30 MHz.

Another circuit for about the same frequency range is diagrammed in **Fig. 4.** It will not work down as low as the Pierce, but will produce good results in the range from 1 to 30 MHz. This circuit is similar to the Clapp vfo circuit described later. The feedback capacitors in series from base to ground should be as shown to achieve a proper feedback ratio for the design frequency. This circuit is about the same as **Fig. 3** except that the transistor is operated in a grounded collector connection. Output can be taken from the emitter directly, or some isolation can be realized by splitting the emitter load into two resistors and taking the output from their common connection.

Crystal oscillators for frequencies above 30 MHz

At higher frequencies, crystal design dimensions become such that it is necessary to use quartz resonators in an overtone mode. Indeed crystals with fundamental frequencies up to 30 MHz or so are built, but their thickness dimensions reduces to only a few mils. Above 30 MHz it is easier to use a piece of quartz of more convenient dimensions and excite it on its 3rd, 5th, or 7th overtone (harmonic) in the oscillator in which it is used. The overtone frequency is not an exact multiple of the fundamental frequency of the crystal, but that is not important here. **Fig. 5** shows a circuit for use with overtone type crystals. It is a Hartley oscillator and the transistor is used in the grounded base configuration. The tank circuit in the collector should resonate at the overtone frequency of the crystal. The ratio of the capacitors across the tank coil determines the amount of feedback, and making the capacitor at the bottom end of the coil smaller will increase it. Here the output can be taken from either the collector or emitter of the transistor. This circuit makes use of the series resonant (short circuit) properties of the crystal to excite the amplifier. Here there is no phase reversal between emitter and collector and the crystal feeds back energy to the emitter in phase by virtue of its low impedance at the series resonant frequency.

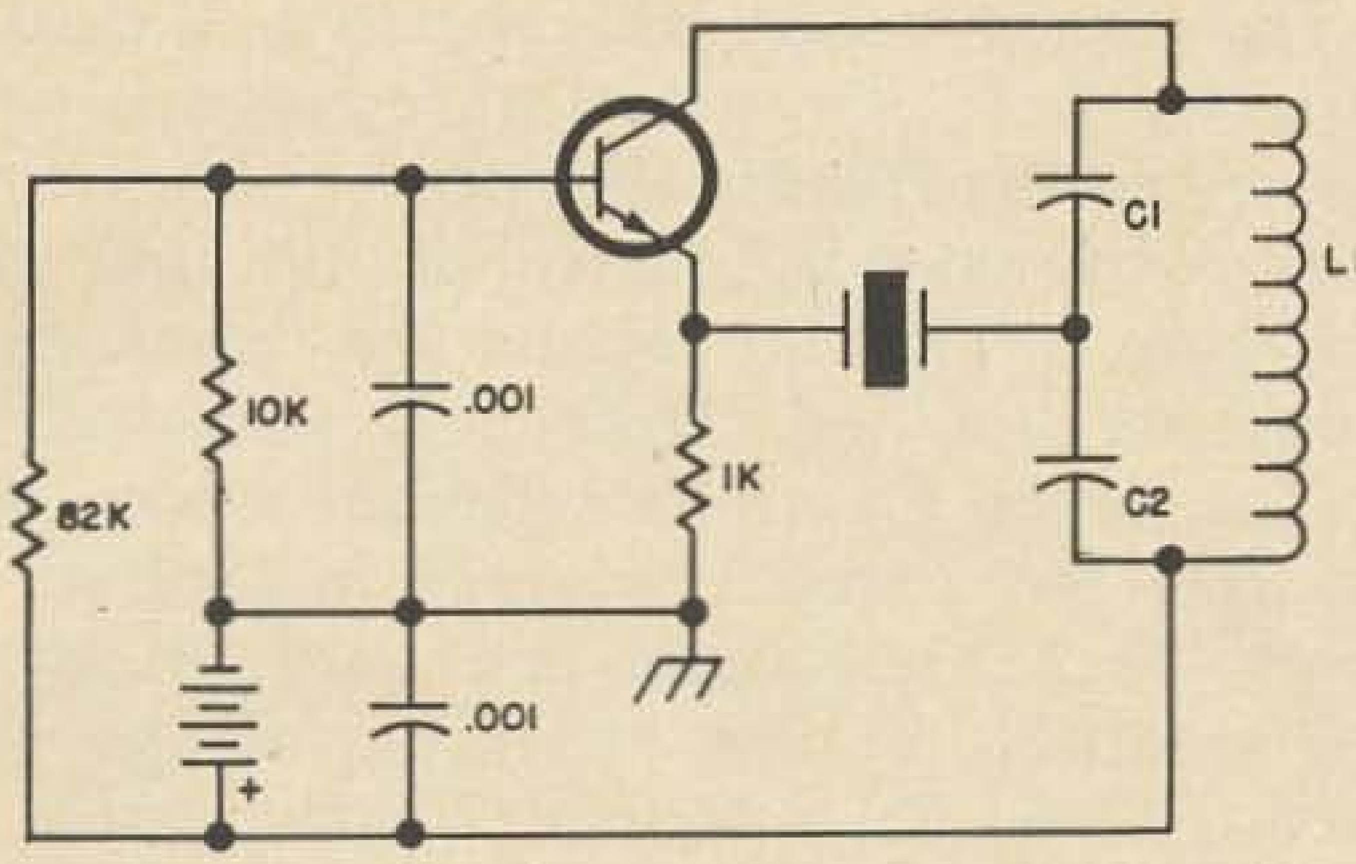


Fig. 5. *An overtone crystal oscillator.*

Low frequency crystal oscillators

Crystal controlled oscillators at 100 kHz are very useful for spot frequency checks in amateur receiving equipment. Transistors can be used at this frequency quite easily with the proper circuitry. The range from 20 to 200 kHz can be generated using the circuit of **Fig. 6.** A close look will show that this is the same circuit as **Fig. 2** except that an LC tank has been added to increase feedback to overcome the higher resistance of the lower frequency crystal. The tank circuit values can be computed from the formulas for the crystal frequency to be used. The coil can be an *rf* choke of about the right value and the tuning adjusted by C1.

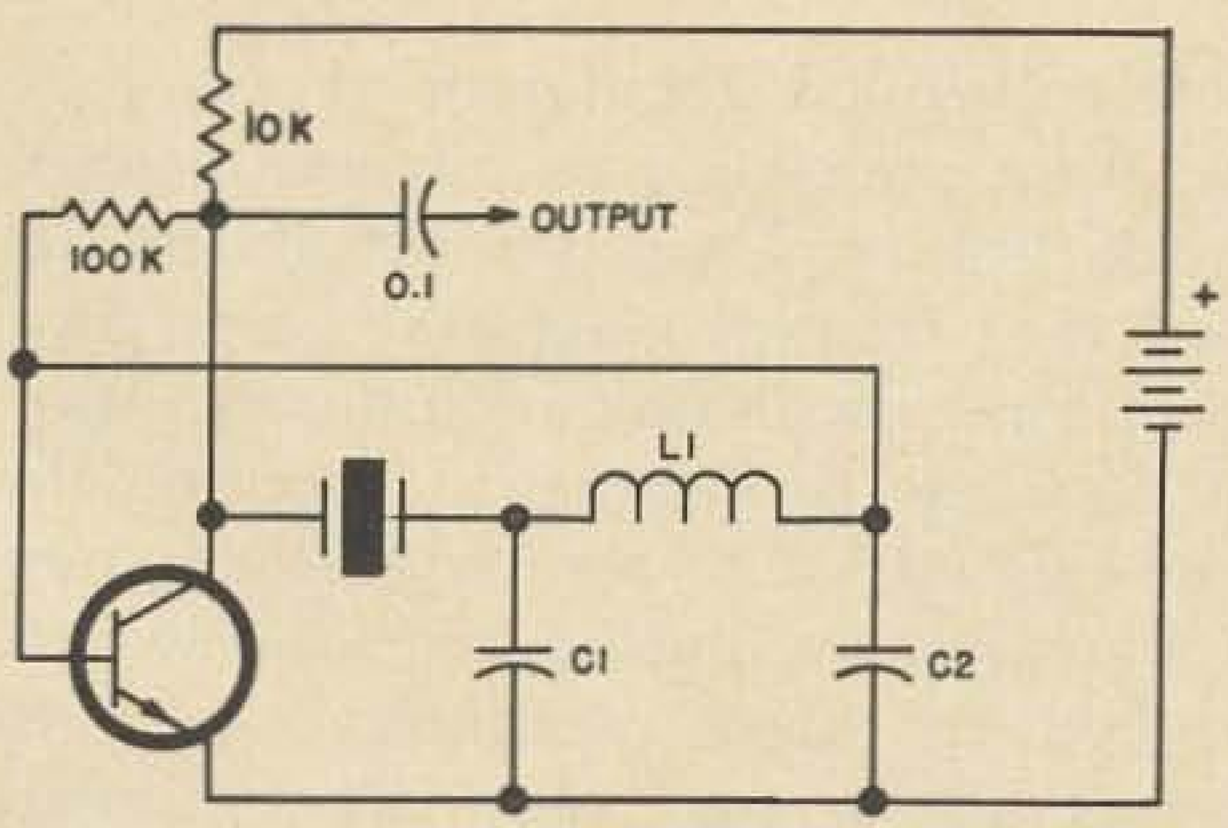


Fig. 6. *A low frequency crystal oscillator.*

An alternate circuit for low frequency use is shown in **Fig. 7.** It has the advantage of not using a coil and good results can be obtained with the values on the diagram from 20 to 200 kHz.

These crystal oscillators will give coverage from 20 kHz to 150 kHz with the proper crystal, adjustment and tuning. Before passing on to self controlled oscillators which can be moved about in frequency, it might be well to comment on the frequency accuracy of crystal oscillators. As has often been mentioned in the past, the marking on a crystal does not mean that its frequency is that plus or minus zero. Its oscillating frequency is determined primarily by its physical dimensions and finishing, but it is also affected by the oscillator circuit it is used in. All crystals are designed to work into a specific load capacitance (usually around 32 pF) for parallel or anti-resonant operation. To provide this load capacity it is important to put a small trimmer capacitor in series with the crystal in each of the anti-resonant circuits above if exact frequency

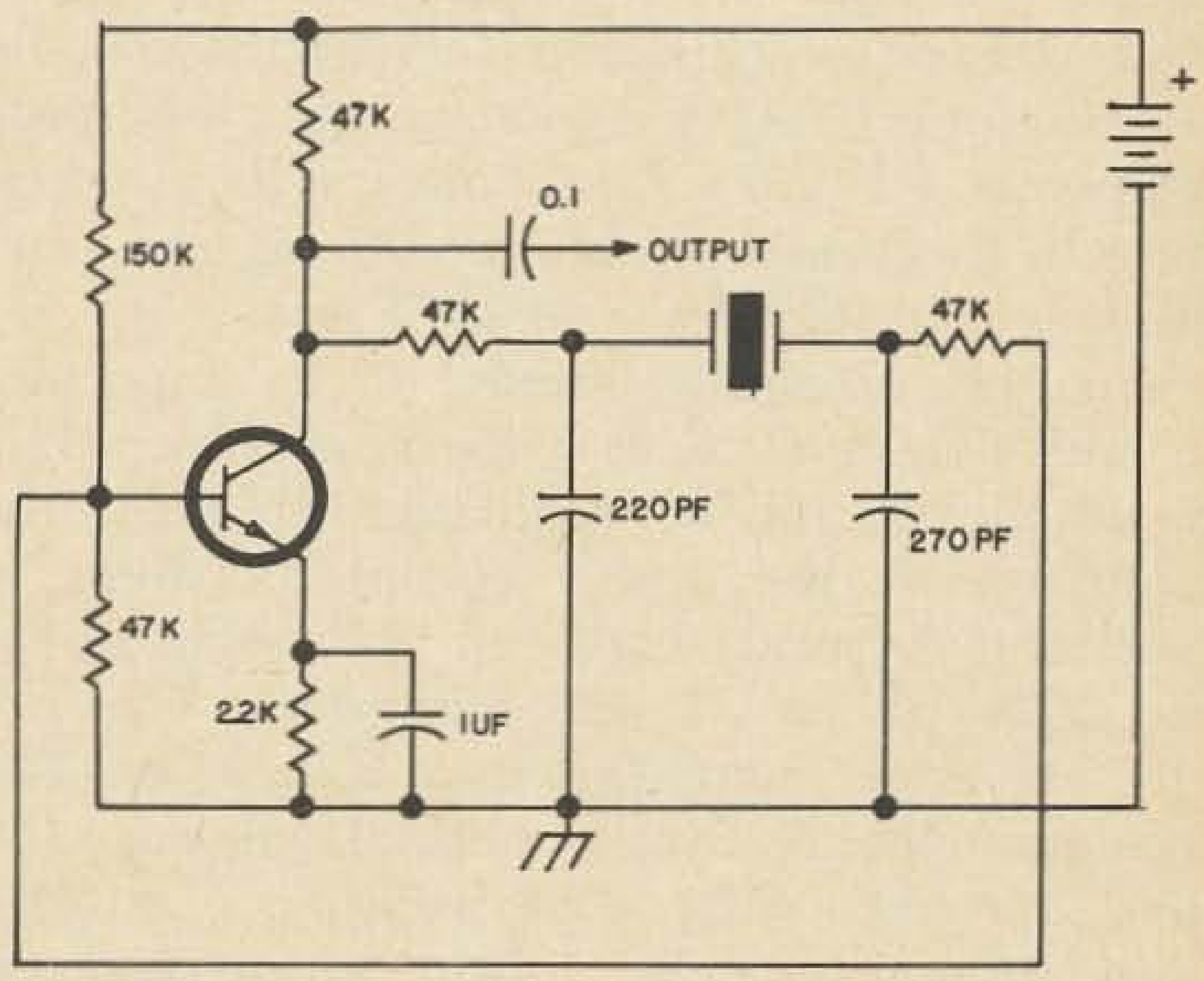


Fig. 7. *Alternate low frequency crystal oscillator.*

adjustment is necessary. In cases where a frequency error of a few kHz is not important, the trimmer can be omitted. For 100 kHz standards etc., it is a must.

Variable frequency oscillators

Crystal oscillators are extremely useful for generating precise spot frequencies, but the high Q of the crystal makes the adjustment range quite narrow. Where a wide band of frequencies is to be covered by a single oscillator a tuneable device is necessary. In the circuits just described, the crystal can be replaced with an LC resonant circuit which can be adjusted to the frequency desired. The stability of such an oscillator is not as good, but the ability to adjust the frequency over a wider range is quite useful. The variable circuits below are a bit different in schematic form, but their operation is identical to the crystal oscillators.

A circuit that is often used in amateur transmitters is the Clapp vfo. Its semiconductor version is shown in **Fig. 8** and, as noted, is similar to the crystal controlled

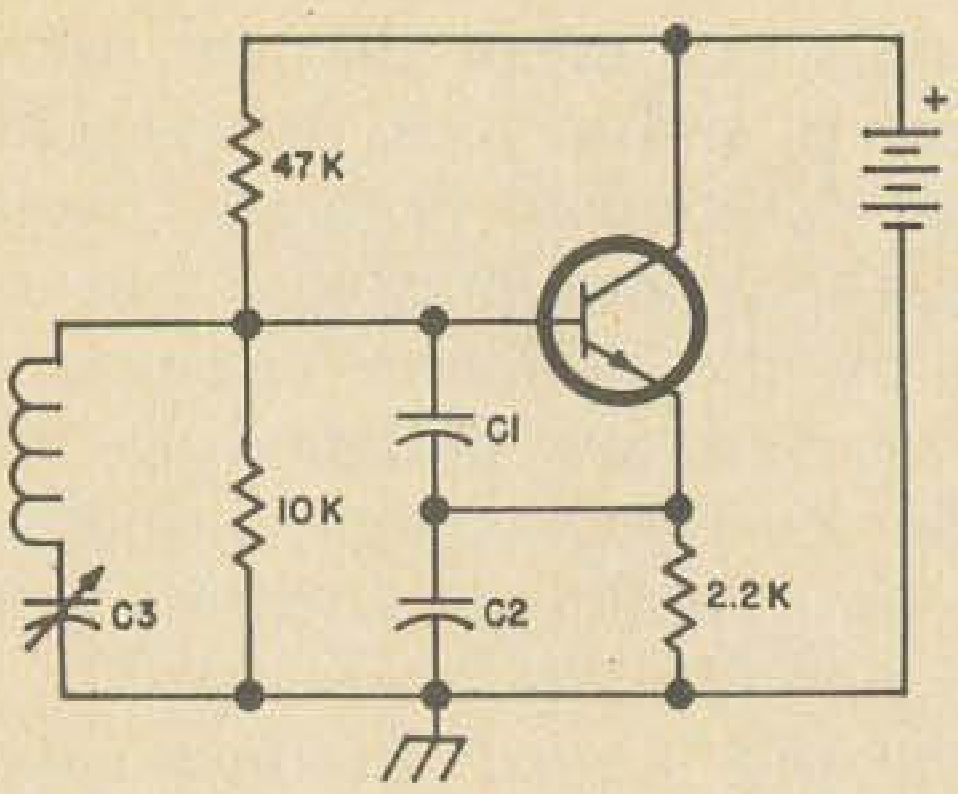


Fig. 8. Clapp VFO oscillator.

circuit of **Fig. 4**. The coil, and the series combination of capacitors across it, resonate at the operating frequency, and the large values at C1 and C2 provide for loose coupling to the tuned circuit producing good frequency stability for use in a vfo.

In the tuneable circuit, it is important to make C1 and C2 as large as possible while maintaining reliable oscillation to keep the coupling to the active circuit as small as possible. Typical values at 3.5 MHz might be 2000 pF at C1 and 820 pF at C2. For vfo use, experimentation here is in order. The tuning capacitor C3 is a normal type for vfo's and toroidal coils lend well to transistor construction projects. Output can be obtained as in **Fig. 4**.

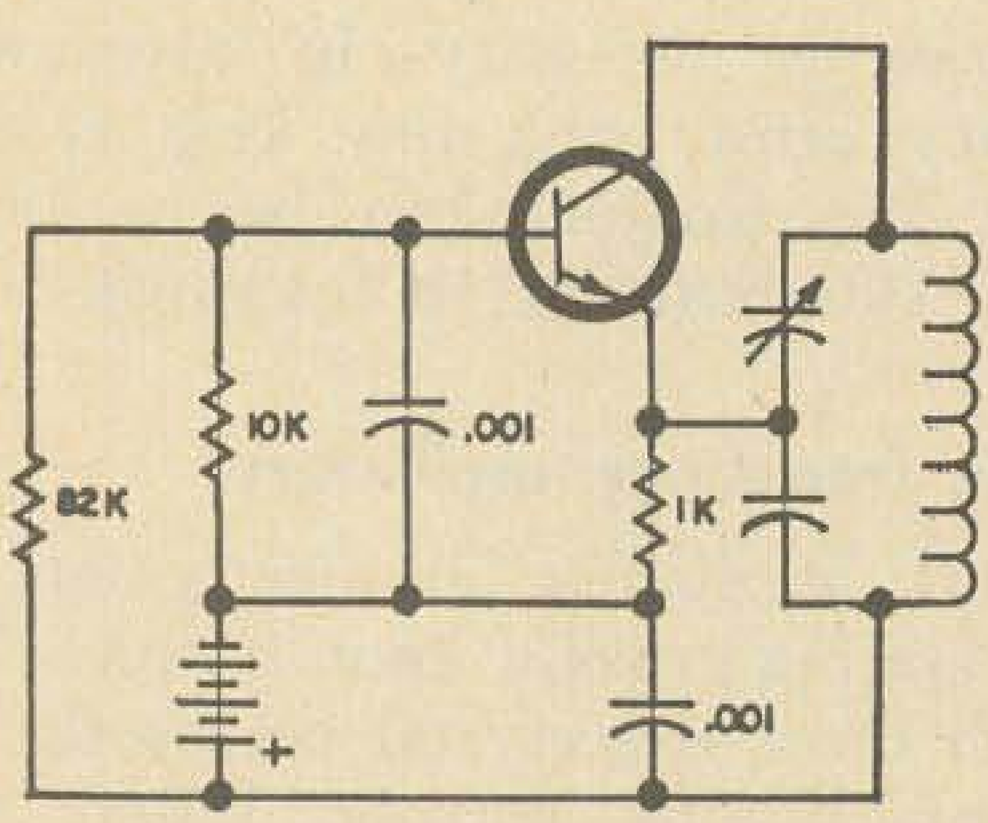


Fig. 9. A general purpose oscillator for use up to VHF.

The circuit just described will provide most of the rf frequencies for ham vfo use, but the circuit of **Fig. 9** can be used up to 200 MHz in test equipment, etc. It is of the same configuration as the crystal oscillator in **Fig. 5**. In the tuneable version of this circuit, the crystal is simply replaced by a short circuit and the tank circuit values in the collector control the frequency of oscillation. Without the crystal in the circuit the frequency stability is degraded, but this oscillator can be used up to vhf in a grid dip oscillator.

The circuit in Fig. 10 is shown as a matter of interest. It has no exact counterpart in the crystal oscillators described, but it will work well from 3.5 MHz on up into the vhf range. The transistor is connected grounded base and feedback is provided by the capacitor C1 from collector to emitter. C1 can be a small trimmer capacitor of about 30 pF maximum and used to adjust the feedback at the frequency range desired. L1 and C2 determine the frequency of oscillation.

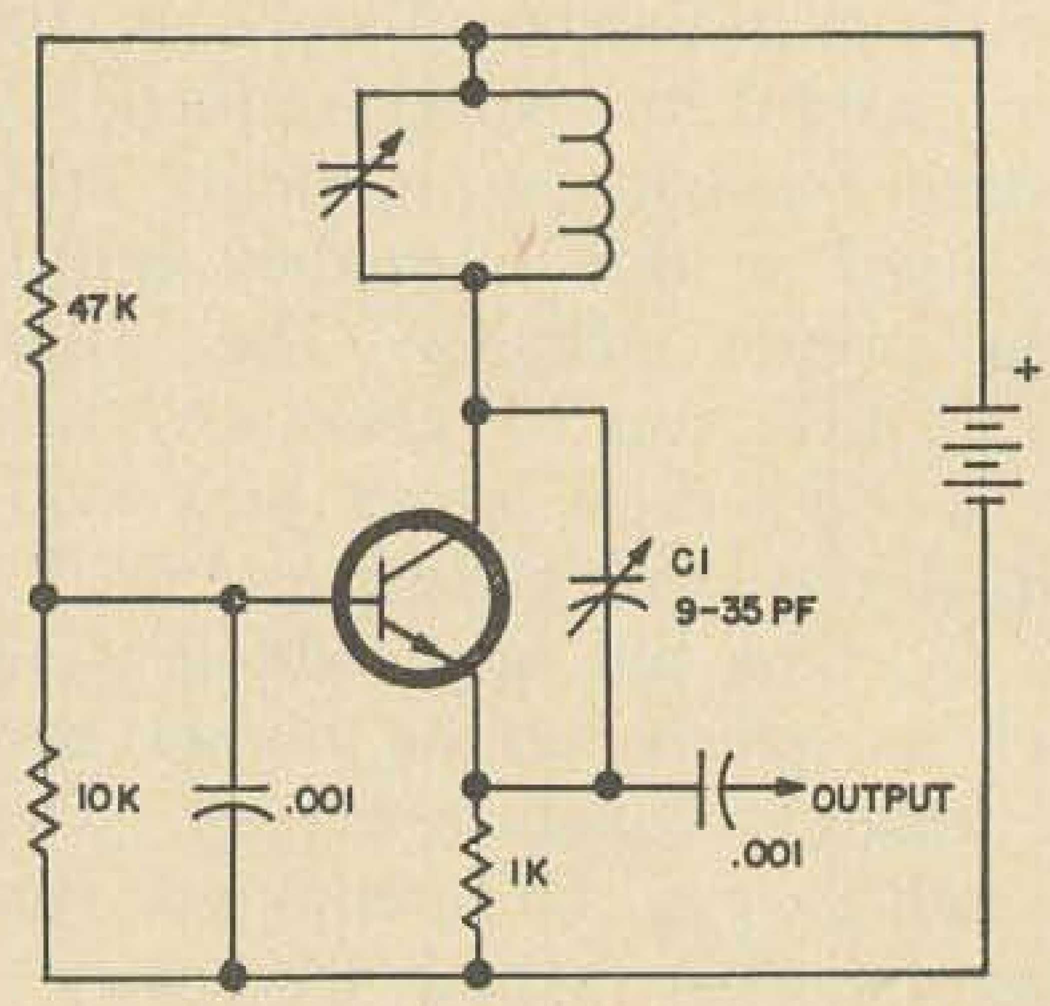


Fig. 10. Another general purpose oscillator.

Self controlled oscillators at the low and audio frequencies can be devised using tuned circuits, but their circuits are so many and varied that they are omitted here. At these frequencies oscillators commonly use RC time constant properties to produce the required signal; e.g. multivibrators, unijunction transistor oscillators, etc. The waveforms produced by these oscillators are more or less rectangular and they are intended for keyers and other timing circuits. The sinusoidal oscillators outlined in this article will give frequency coverage over the entire spectrum for amateur use and should be adequate for most purposes.

In closing it might be well to note again that the circuits and values shown are general. The usual ham method of "cut and try" may have to be used if the circuit doesn't oscillate at the first connection of power. Variations in crystals, tuned circuits and transistors are inevitable. The circuits and values shown provide a good starting point, and in most cases little adjustment will be necessary. . . . W9ZTK

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Write ATV Research, Dakota City, NB, 68731.

Dear Kayla,

As an RTTY enthusiast, I was pleased to see several articles on the subject in the January issue. I feel I must comment on the WA8DCE article on page 42, however, as several statements are not only misleading, they are erroneous.

First ham radio pioneers did NOT develop "Frequency Shift Keying." We didn't even get on ham RTTY until after WW II, and "f.s.k." was in use soon after WW I by commercials.

The author mentions that 2975 is the "Mark" frequency, and that 2125 is the "Space" frequency. Not true, this is backwards, with mark always being the lower of the two, viz. 2125. The part that confuses most newcomers revolves around the use of lower sideband for receiving. The transmitted "r.f." is actually lowered for space, which then changes the tone in the speaker higher for audio. This is confusing, and most unfortunate, but that's the way it got started and remains to this day. You can listen on upper sideband, of course, but then the tones come out backwards in the speaker from normal. "H.F." and "V.H.F." techniques are identical, and the use of lower sideband for receiving on h.f. then gives the proper relationship of mark and space tones in the speaker (and also the RTTY demodulator).

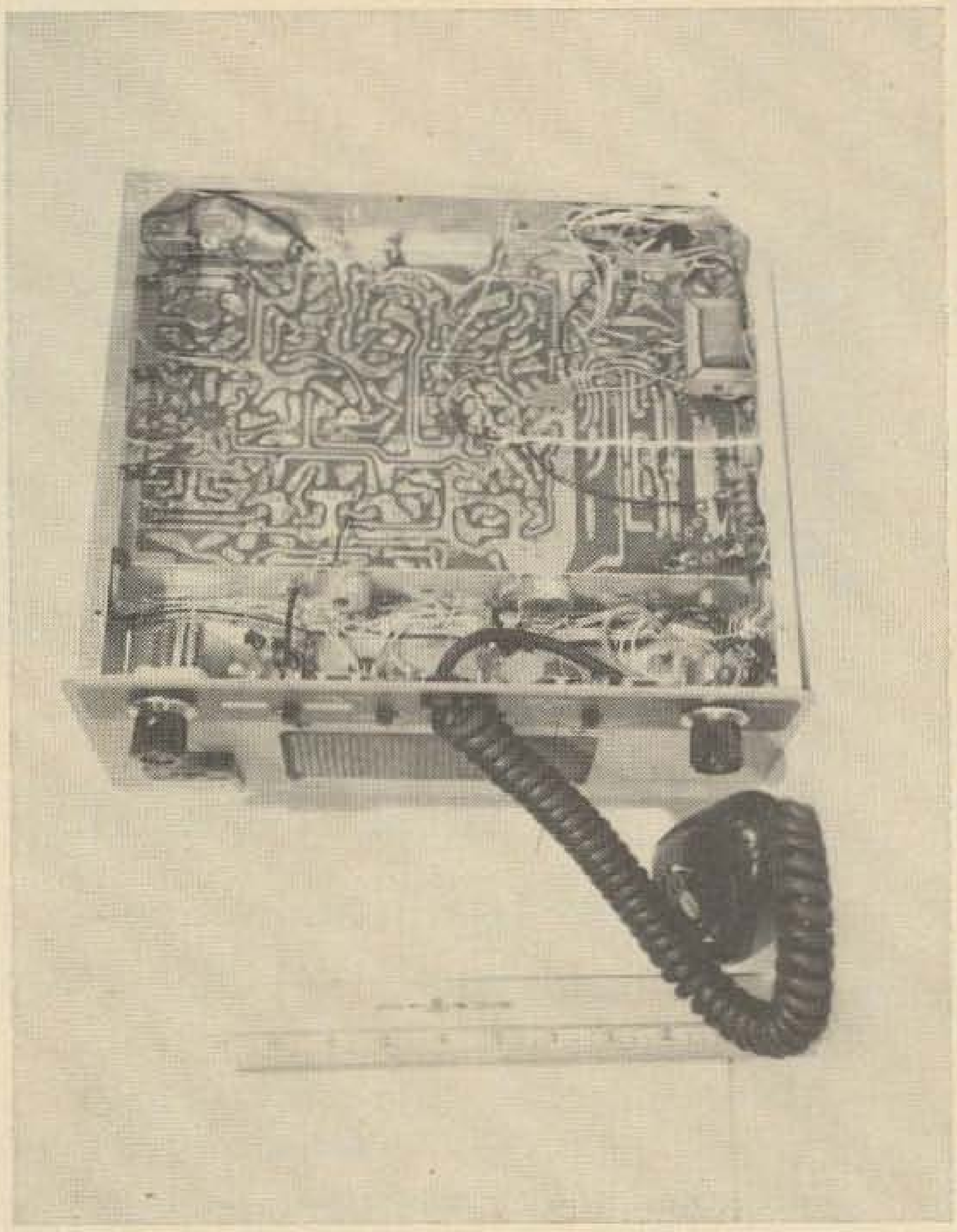
When he spoke of the tones generated by the "a.f.s.k." unit into the mike input, he was correct–again, "lower sideband" position on the transmitter is used if it is a "s.s.b." type with suppressed carrier.

I hope this clarifies the situation, which is confusing enough even when understood perfectly.

Irv Hoff, W6FFC

Ralph Hanna W8QUR
3023 *Emmick*
Toledo, Ohio 43606

Heathkit HW18-3 160 Meter SSB Transceiver



Toledo has always been a town that was active on 160 meters. This goes back to the very early days when mobile operation was not permitted except on 5 meters. W8HSW and several others got together during this time and put a 160 meter rig in an automobile. The whole amateur fraternity of Toledo was really shook when they proceeded to come on the air one Saturday morning and moved all over town operating as a portable. Someone got so upset they called the FCC in Detroit to complain only to find out that W8HSW had written the FCC as required and advised that they would be operating portable from about 20 different street intersections.

As soon as the 160 meter band was opened for mobile operation, Toledo was quick to do something about it. It was easy to get the car BC receiver to tune to 1800 and not lose too much of the broadcast band. A simple two or three tube transmitter crystal controlled was easy to build. The end result was that Toledo had an awful lot of mobiles on 1812 kHz plus at least 5 boat mobile to say nothing of the home rigs that could operate on 160.

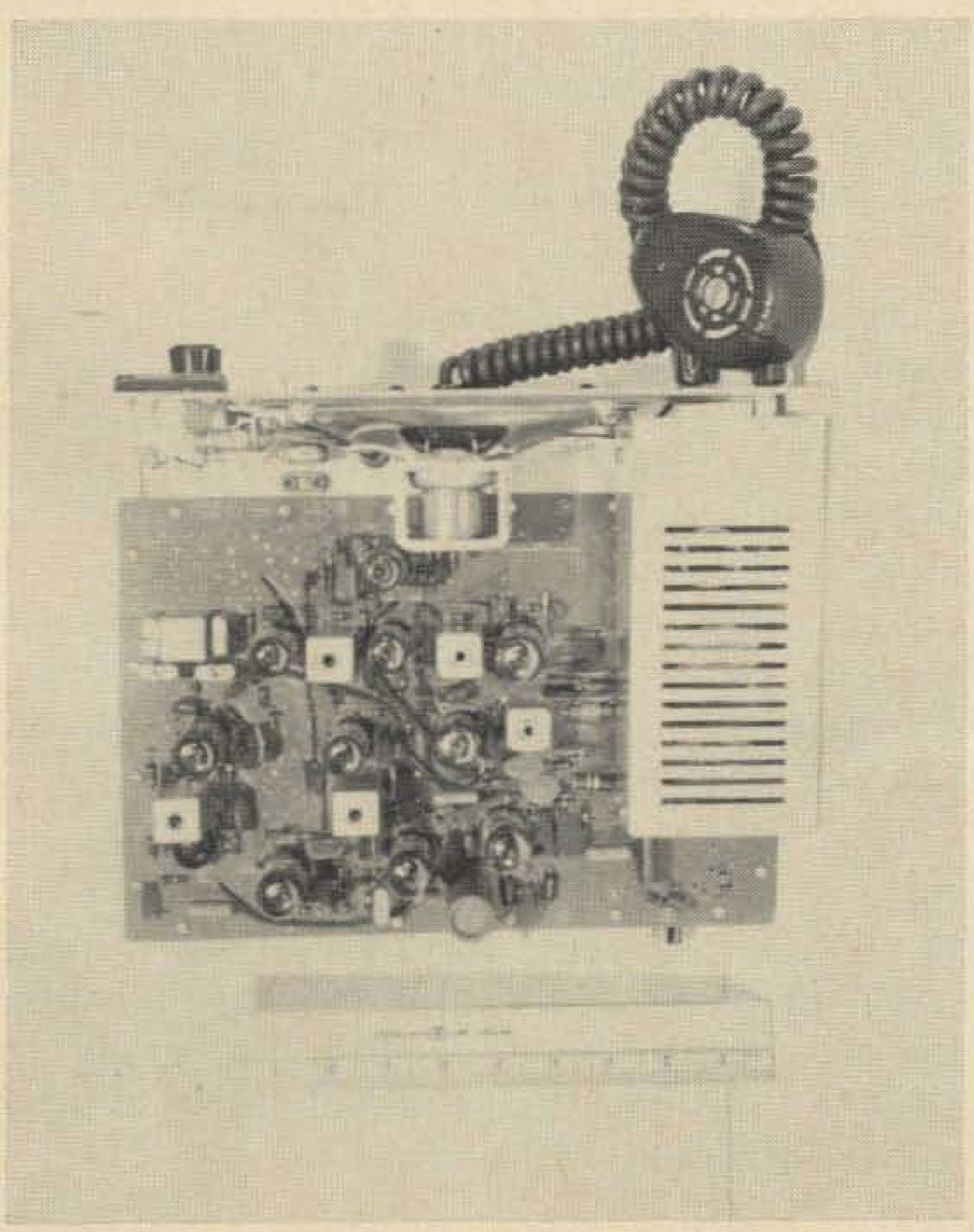
With this interest on 160 it was only natural that I should be interested when Heath Company announced they were going to put out a 160 meter Single Side Band transceiver. Very few of the SSB exciters covered 160. Down converters to go from 40 meters to 160 seemed such a waste of power.

The kit was a little longer coming than I had planned and arrived a couple of days before we were to leave on four weeks vacation on our boat. I took the kit along so I could work on it on a rainy day and in the evening when all was quiet. I can now have great sympathy for those fellows who put a kit together in an apartment. I am used to a large work bench in the basement so this was a new experience for me. Pick up all the parts and put them away when Virginia had lunch ready, put them all away when we got ready for bed and be sure to store them real good so they would not upset in rough seas on the next day's run. Anyhow it went together in the usual fun way that all Heathkits have a habit of doing.

Sometime along the way the FCC changed the portions of the band that could be used in various areas and also changed the input power limits in many cases by a considerable amount. As a result of this, interest in 160 has increased. I'll bet there are people on 160 that haven't been on since before World War II.

I was glad that I had the HW18-3 because I was in there with the rest of them with no trouble at all. The SSB or AM feature was sure good too. The two crystal control frequencies were OK but too often the other station would not be transmitting on same frequency as he was receiving. When it was explained that you were crystal controlled, it was no problem to get him to zero beat your frequency. The clarifier could then take care of any slight drift. It was surprising though how many of the fellows were crystal control, especially the mobiles.

It didn't take me long to find out that a VFO would make operation real fun. It also took even less time to find out the LMO in the SB100 tuned the exact range of frequencies needed for the VFO in the HW18-3. A simple coax cable with a crystal socket on one end and an RCA plug on the other and I was in business with a real fine VFO. The only drawback here was that the dial runs backward but you can easily get used to this. Any VFO that tunes 5.2 MHz to 5.4 MHz will work very nice. The instruction book tells all that is required for a VFO and anyone who wants to go this route should have no trouble.



Operating was real fun and contacts were made like back when I first got my ticket many years ago. Actually with sideband it didn't seem so crowded. Maybe this was due to the sharp crystal filter in the HW18-3. Enough of the operation of the rig, so now on to the technical.

Enough has been said in the past on the ease of construction of a Heathkit that I won't to into it here. No trouble was encountered in tuning and adjusting. The only trouble was that the HW18-3 takes 250 volts on the low side and both my power supplies were wired for the 300 volts. Since I wanted to use the same supplies for both rigs a switch was installed in both the ac and the dc supplies. By the way, a newer HP23A supply has the switch already installed.

One point that sticks out is that there is no relay used to go from receive to transmit. It's like magic, no relay clatter, the receiver goes dead and as soon as you talk into the microphone the meter swings. This is accomplished with several diodes. The first of which is a clever T-R switch in the antenna circuit where the diode is back biased to cut off so no rf can get to the receiver in the transmit position, but in receive the diode is like a short circuit. I checked with a calibrated signal and found no difference with the diode shorted out or with it in the circuit. While transmitting, the unused portion of the receiver is also biased quite high so that it is completely cut off. A T-R amplifier tube is controlled by the PTT switch on the microphone and this places the high positive bias on the T-R diode. This same portion of the PTT switch also control the negative bias on the receiver tubes, which are cut off when transmitting.

Except for the control system mentioned above, the circuitry is pretty much a standard dual conversion filter type transceiver. The *if* is the usual Heath 3395 kHz. A four crystal lattice filter gives good selectivity of about 2.1 kHz.

The transmitter ends up in a pair of 6GE5 beam power tubes. "Sylvania News" tell us that these tubes can be run in SSB service 1.25 times their regular rating which would be about 175 watts for one of them. Since Heath only runs them at 100 watts (200 PEP) they are not working too hard.

Provision is made to run in the AM mode by a front panel switch. In the AM position a minimum of 40 watts is run in the final and this is single sideband with carrier so that it appears much stronger than 40 watts of straight AM. The ALC action is a bit stronger here than on SSB.

As mentioned above, ALC is incorporated. This is accomplished by picking off any positive audio swing of the grids of the final caused by too much grid drive. The audio is rectified and filtered and used to control the transmitter *if*, mixer and driver tubes. The same circuit was high negative bias applied in the receive position which effectively cuts off the transmitter.

The tune up and alignment was so simple you wouldn't believe it. Adjust the slugs in the *if* coils for highest S meter reading and that is it for the receiver. The transmitter was just as easy. Set the bias, adjust a couple of slugs, then adjust the carrier null.

There is no final adjustment for the transmitter as this is all pretuned to match a 50 ohm antenna.

Checking the output on SSB showed that with a single tone signal, the unwanted sideband was down 47 db and the carrier was 46 db down after the balanced modulator was touched up just a bit. The output was just a bit over 105 watts PEP. On AM with no modulation the output was 20 watts and the modulation increased it. Good on the air reports were received from everyone when using either mode and, of course, the SSB signal was much more potent.

The receiver performance is really something, I thought that the all band receiver I have been using was good but this one is better. You would be surprised at how much the noise is reduced with the sharp 2.1 kHz filter. I didn't think it possible that the 4 crystal filter would be this sharp but I couldn't prove any different. The sensitivity was better than the 0.5 microvolts that Heath claimed by about .01 microvolts.

With the new FCC changes for 160 meters there should be a lot of activity this year. Here is quick easy way to get there and much better than a transverter. My antenna leaves a lot to be desired so I'm going to have to do something about that, maybe a vertical on top of the tower.

. . . W8QUR

COOL IT!

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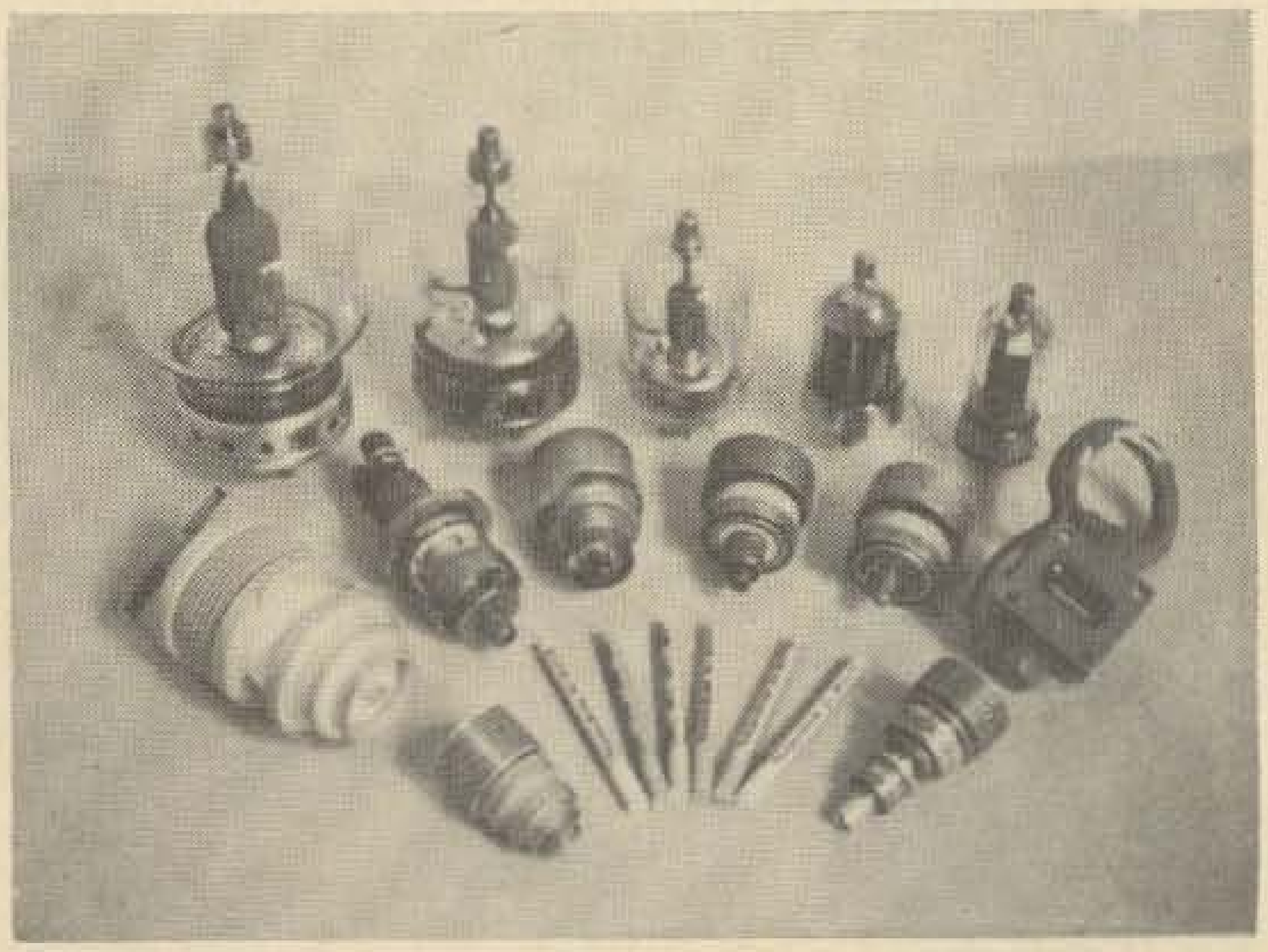
Glen Ellyn, Ill. 60137

When constructing any piece of electronic gear that requires cooling, the average ham often does not have available to him the equipment or information to do a first class job. Even with the proper blowers available, if improper techniques are used, inadequate cooling may result in tube and circuit damage. Math as applied to air flow is fine but unfortuantely few hams have the patience or associated equipment to use it. The following article was written with the hope that it will put and keep more hams on the air with their favorite VHF rigs.

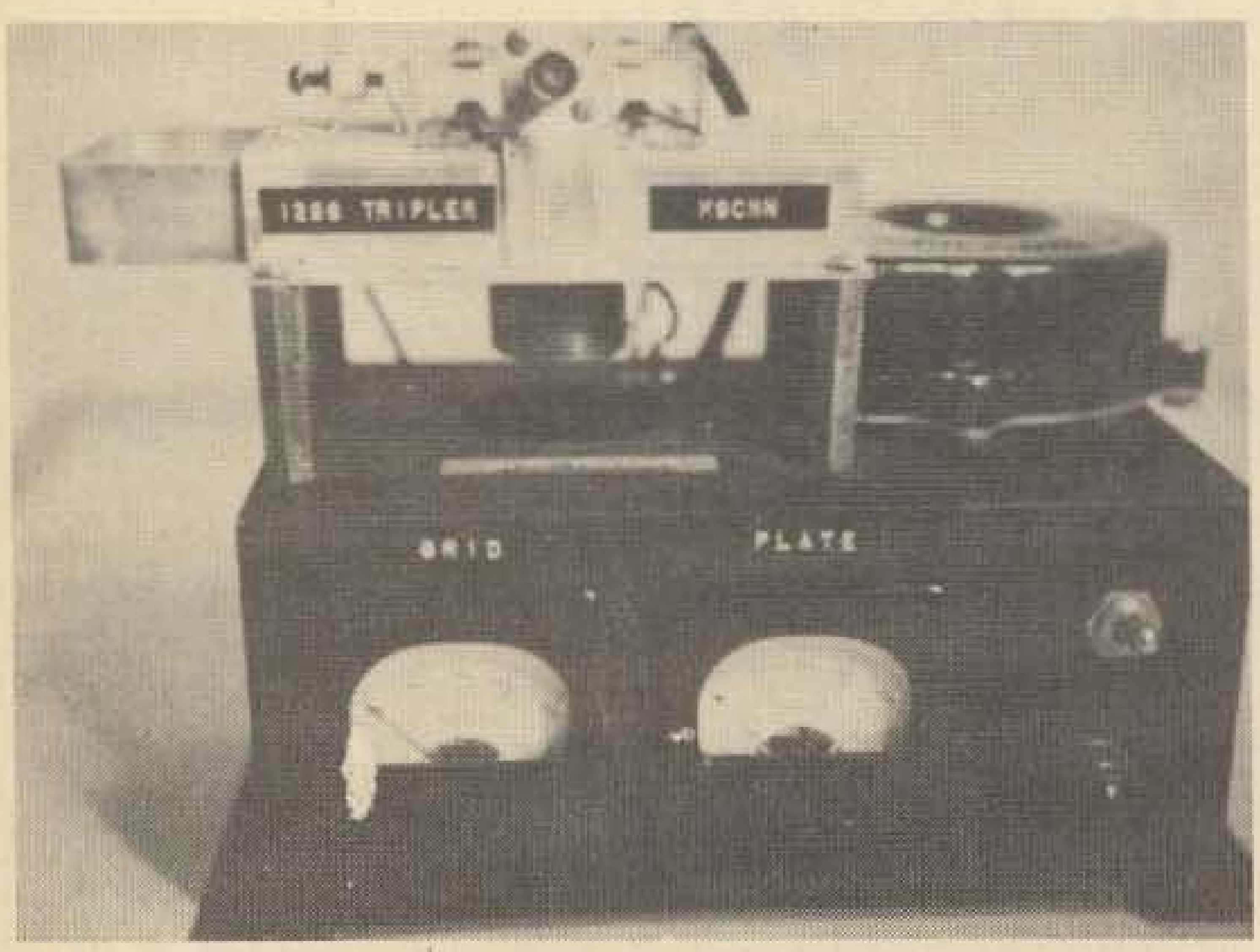
At hamfests, auctions and surplus stores be on the lookout for blowers of various types. Do not be afraid to use large size blowers if mounting is practical. Squirrel cage blowers are to be preferred over dc high rpm surplus types. The high rpm blowers do not last very long in continuous service and also produce a terrific racket. This is the price paid for small size. Higher RPM cage types are to be preferred over lower rpm blowers for cooling VHF tubes with special air system sockets such as the 4X250 series.



Some VHF tubes requiring forced air cooling. Top left to right; 5D22-4-250, 4-125, 4-65, 6146, 2E26, *can be cooled by low velocity type blowers.*

Middle row; 6283, 6383 (*water cooled*), 8119, 4CX250K, 4CX250, BL800 *klystron* (*may be conduction cooled also*).

Bottom row; 6884, *Thermochrom temperature indicator crayons*, and* 2C39. *These tubes are best cooled by medium to heavy duty high speed blowers of the squirrel cage type and may take up to* 1/6 *HP motors with speeds from* 1800 *to* 3600 *RPM.*



A 1296 *MC tripler using a favorite cooling method here. No back pressure is produced by blowing the air across the cooling fins of the* 2C39. *Running in tripler service with* 800 *volts on the plate and in excess of* 10 *watts RF out, the tube and blower are both cool! This would not be possible with this small blower in an enclosed cavity construction. The blower is mounted on rubber grommets to avoid "blower modulation" of the tube. This may happen with high frequency tubes because of the close element spacing required.*

Flexible tubing and clamps of all types can be useful in making connections from the blower to the area to be cooled. A central air box with several outlets of smaller tubing can be used to cool several small tubes. This eliminates the necessity of making a pressurized chassis which is sometimes inconvenient.

Small holes in sheet metal boxes can be very conveniently plugged with epoxy cement which will stick to almost anything. Be careful not to put epoxy on any screws you might later want to remove as this could prove a calamity!

A good "poor man's" blower can be made from a phonograph motor, using a small fan blade mounted in a tin can with the ends removed. Brackets can be used to mount the can near the tube to be cooled. Rubber grommets should be used to mount the motor to minimize the vibration. This arrangement makes a neat little wind tunnel that is easy to handle for small cooling jobs.

Screening over open areas for rf tight enclosures must be chosen with care. Small mesh screening is to be avoided as it will slow the air flow. Pre-punched aluminum screen is to be preferred, or even make your own covers with 3/16 to 1/4 inch holes for the air to escape. Remember that the larger the area to be cooled the more air flow you need. The more obstructions to the flow such as sockets, chimneys and tubes, the more high speed air you will need to do the job.

Your blower may speed up after installation is complete and all plates are in place for an air tight compartment. This is an indication of too much back pressure and will cause blower overheating. A larger blower is in order or this condition may be relieved by partially blocking the air *intake*. This will slow down the blower to its normal speed but will decrease the cooling efficiency of the system. The best solution for a situation like this is a blower that will handle higher back pressures, and this is not necessarily cured by the size of the blower.

Rules for cooling—

1. Don't add on the blower as an afterthought. This will complicate construction of a rig enormously and the blower selected sometimes will not fit at all!
2. Get the blower as close to the tube as possible for best cooling.
3. Use a small enclosure in preference to a big one; make an enclosed box for the tube to be cooled with input *and output* holes.
4. Avoid, at all costs, right angle bends or corners unless the blower picked for the job is more than adequate. A straight shot from blower to tube to vent is the best way to cool.
5. Take advantage of "convection construction" whenever possible; let the heat rise and not be trapped in enclosed spaces.
6. Bypass blower leads for minimum "hash" interference; use brushless type motors whenever possible.
7. The quieter the blower the better. Other hams do not relish hearing loud blower sounds modulating the carrier with vibration and mike pick-up.
8. Be sure to allow adequate screened opening for the air exhaust, to avoid building up unnecessary back pressure.
9. Use temperature indicators if in doubt of final tube temperature. Observe all safety precautions while measuring temperatures when final is operating.

Top left to right, squirrel cage brute 1/6 HP, squirrel cage puller type (draws air into cage).

Bottom row, squirrel cage with "phono" motor (very limited cooling capability), and last the DC motor surplus special. This operates at 28 *V DC,* 1 *amp. and* 15,000 *RPM. At half speed the noise is terriffic! Motor life due to brush wear is also poor. This type of blower produces much electrical interference and also requires a separate DC supply to operate it.*

Proper air cooling for your final will pay off in fewer breakdowns and more hours of carefree QSOs. Now—pick up your best blower and start building that favorite VHF rig.

. . . K9CNN

*Temperature indicating crayons are available from Thermochrom, Curtiss Wright, Princeton Division, Princeton, New Jersey. When the temperature of the crayon rubbed on the tube surface is exceeded the color changes. In no case should the tube temperature exceed the manufacturers rating, and any temperature above 250°C means trouble.

Dear Wayne,

How much tongue in cheek is involved in your de W2NSD/1 in January I don't know, but I like it anyway. The second paragraph on page 4 is a real honey. Please note that several channels on 20 meters have been occupied as you suggest for a long time. 14,336 is the Independent County Hunters Net. We are on 7 days a week, almost all day. We have a common interest and we really get along as good friends. On 14,332 is the International Single Sideband Net. They have a great comradship and even put out a lovely little magazine once or twice a year. Of course 14,340 is the CHC Net with ole K6 Bad Xample. When 50 or so hams, all interested in the same thing, gather on one channel together it leaves lots more room for individual QSO's.

Bertha, WA4BMC

A New Support for That Beam

Peter D. Black K1MYV
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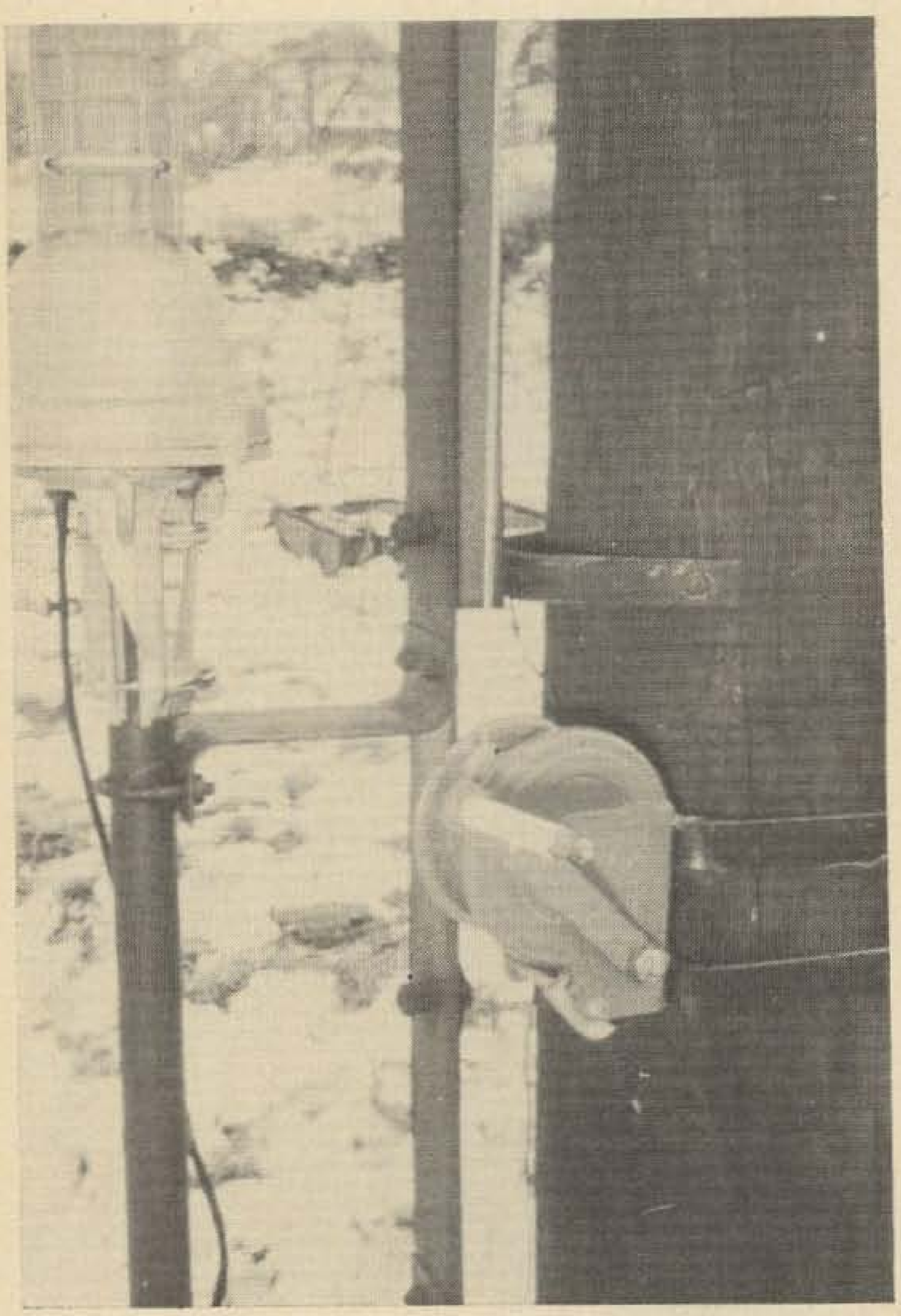
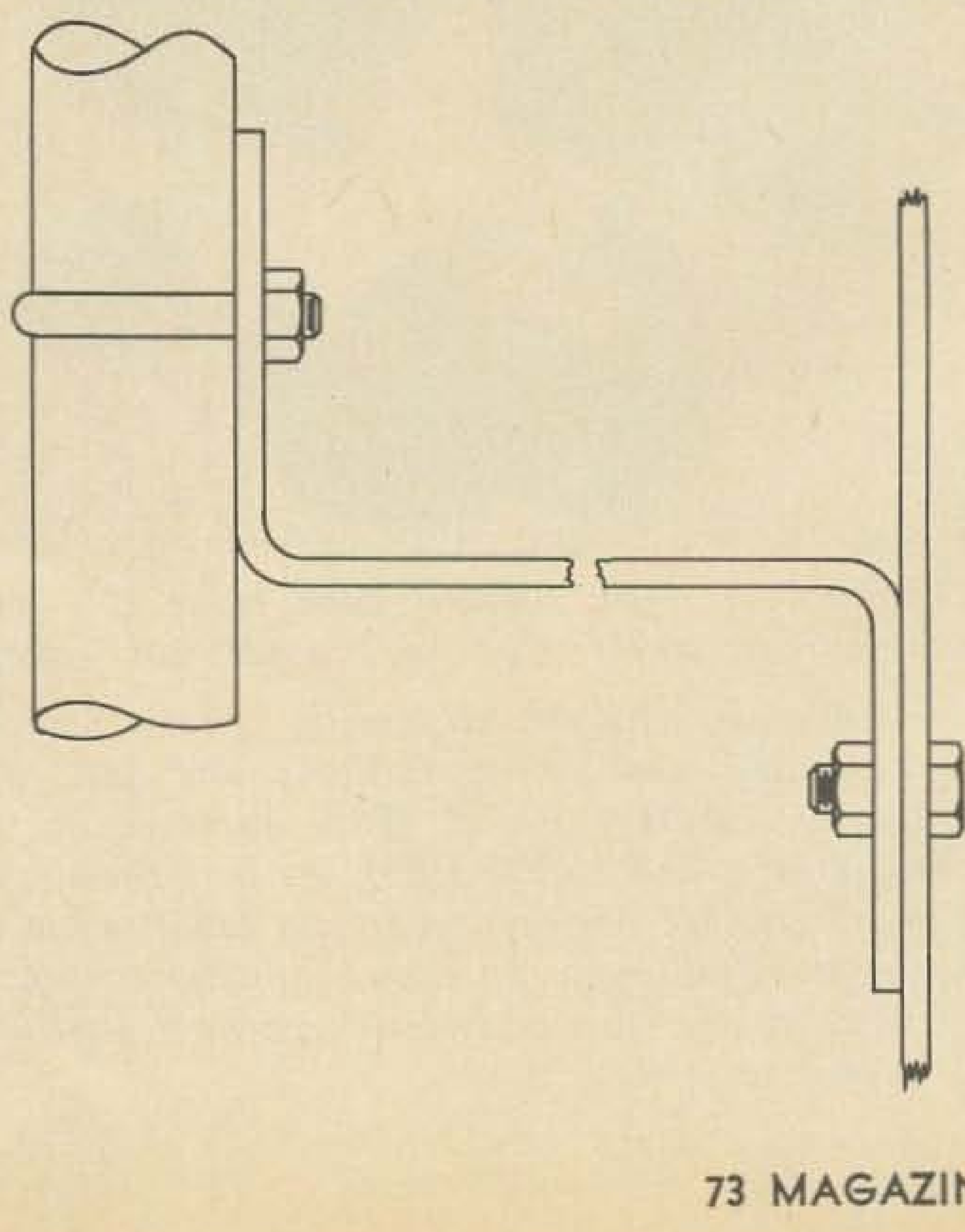
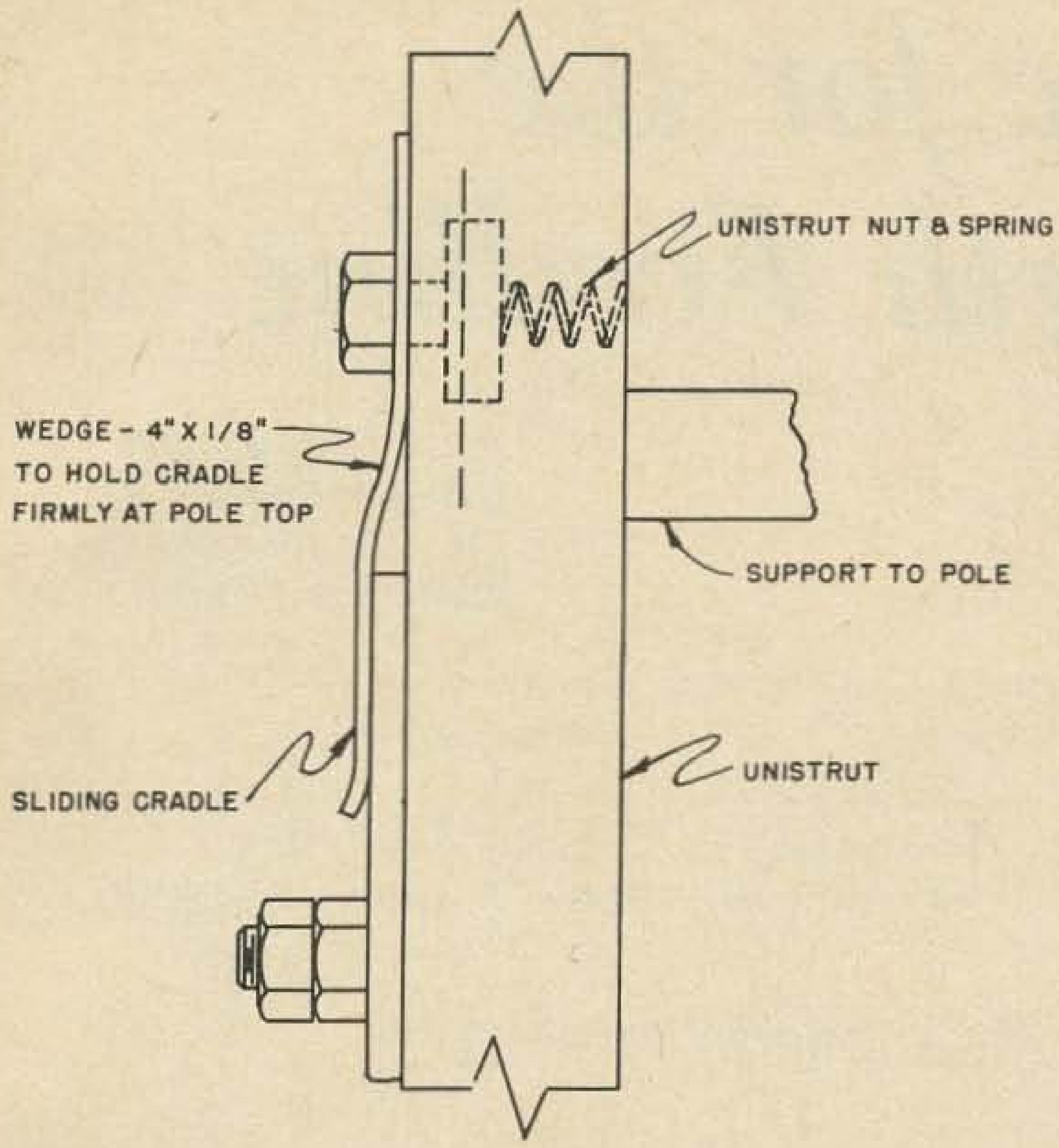


There is almost always more than one way to skin a cat, or even to support a beam, so here is what I believe to be a slightly different approach. Having reached the age of reason or cowardice, whichever you prefer to call it, my ideas were concentrated on bringing the beam down to me for adjustments or repairs rather than climbing up to it. Also being oriented, by reason of employment, to supporting wires on poles, my thoughts naturally turned to that method, so how to run a beam up and down a pole was the problem.

From somewhere I remembered that a product called Uni-strut looked a good deal like a track and was quite strong. Here's the result which has been through two full years with the beam in place, and has been raised and lowered many times with the greatest of ease. All the fabrication was done at a workbench in my cellar with only a portable electric drill (⅜") and the typical assortment of hand tools.

The attached picture and sketches are almost self-explanatory. The pole is a 45 foot, class 5, treated hard pine, which was obtained from a pole treating plant about ten miles away and delivered to the site by the supplier. I was permitted to pick out a nice straight one from the yard. The attachment of track, winch, etc. was done in my yard very close to the appointed place of setting. The track is standard Uni-Strut channel (1⅝ inches square) which came in 8 foot lengths. The brackets which attach the track to the pole are ¼ inch x 1¼ inch flat iron, bent to shape with a vise, and fastened to the pole with ⅜" x 2" lag screws. Sections of the track are fastened together with the same ¼ inch x 1¼ inch flat iron. The cradle which supports the rotator and slides up and down the track is ⅛ inch x 4 inch flat iron, again bent cold at the vise in the cellar. Bending of both the brackets and cradle pieces was accomplished quite easily by clamping the piece





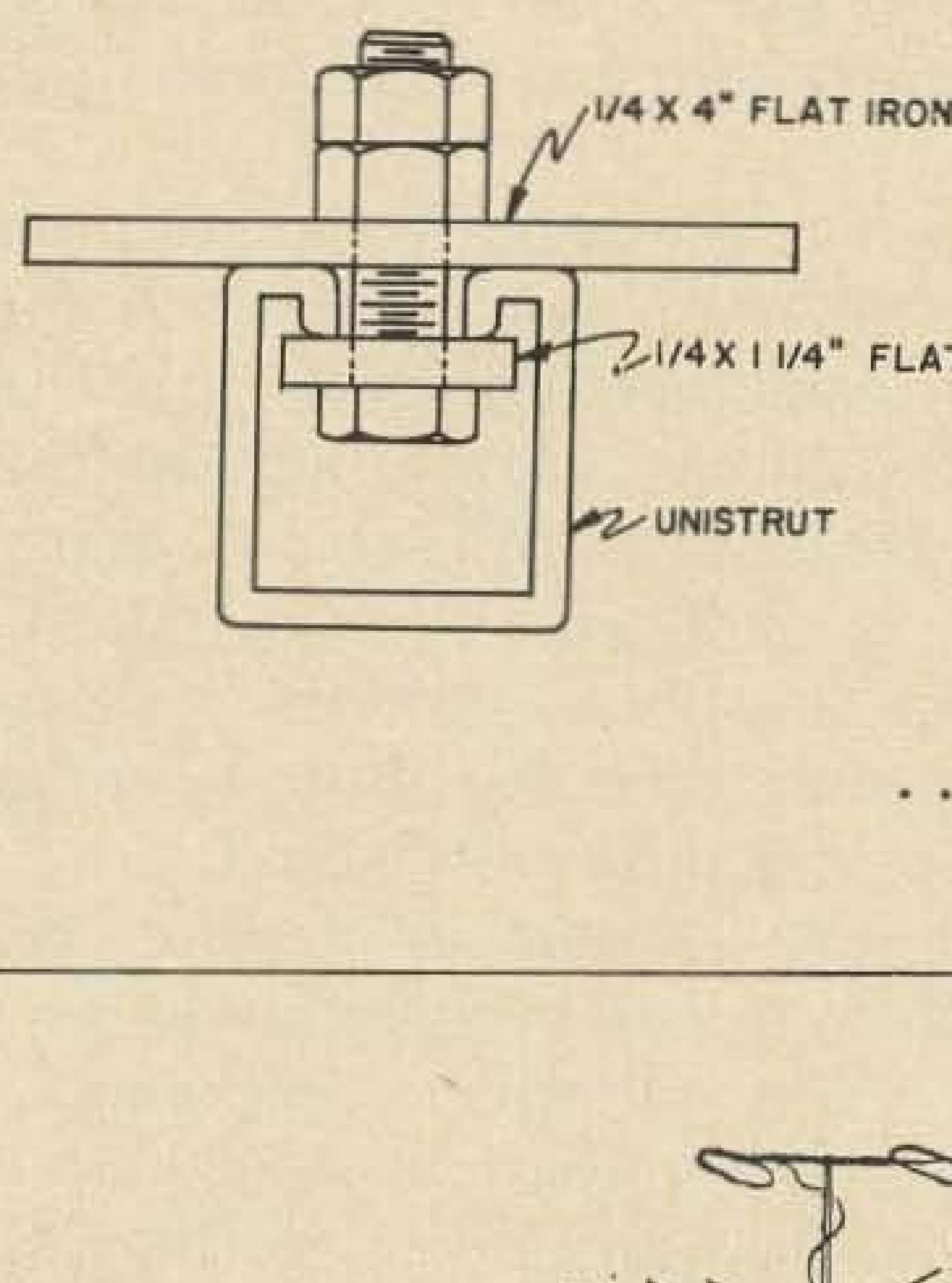
in the vise and attaching a three foot piece of two by four to the protruding piece to be bent, using "C" clamps. The bends produced are square and sharp enough. Near the top of the track, a piece of the same ⅛" x 4"iron is attached to the face of the track and bent as shown to provide a slot into which the cradle is pulled up, thus holding the cradle tightly against the track at the top. This seemed necessary because the three bolts which hold the cradle to the track must be a little loose to permit the cradle to slide on the track. There should be one of the track brackets to the pole near this slot.

Above the top of the track, I mounted a pulley wheel of fair size (four to six inches diameter) attached to the sides of this track with the aforementioned ¼" x 1¼" iron. I bent this in a loop over the pulley, close enough so that the steel cable over the pulley could not get out of the groove of the wheel. The winch, again mounted on ¼" x 1¼" iron, fastened to the pole with lags, is a small boat winch, designed for 1600 lbs. pull, and picked out of the catalog of a famous mail order house. The cable is fine strand flexible steel rated at 700 lbs. breaking strength. The combined weight of cradle, rotator, and three element beam to be lifted is less than 100 lbs.

The pole was set about six feet in the ground after complete assembly but with the cradle and beam temporarily removed. The cable was in place over the pulley at the top. Lacking complete confidence in my own work, I did step the pole for climbing but have not had to go up yet. The steps are at 90° instead of 180°, as is customary, to permit the beam to clear coming down. In my case the control cable and feed line are supported at about 20 feet above ground on the trunk of a tree about 25 feet away from the pole, and a slightly slack loop maintained to the cradle when at the top. This permits the cradle to be dropped without disconnection of these feeds. It can be lowered only in one position where all beam elements clear the pole and steps in coming down.

Work out your own details of construction, gentlemen, and I'm sure you can improve on mine. Oh, I forgot to mention—you'll find it real cheap, if you don't count your hours of work in fabricating and assembly.

BOTTOM NUT LEFT LOOSE ENOUGH TO PERMIT CRADLE TO SLIDE ON UNISTRUT.



. . . K1MYV

"What's the beef this time? Interfering with your TV reception again!"

The Case for the ½ Wavelength Feedline

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The antenna, one of the most important elements in a communications system, is often the least understood portion of the radio amateur's station. It has been demonstrated that many antennas, when correctly tuned, produce an increased efficiency of 10 dB or more in receive and transmit signal strength, compared to the amateur's normal tuning method of using a VSWR Bridge. These facts have become apparent in the number of inquiries and comments received by the author in the use of the Antenna Noise Bridge (73, October, 1967). The purpose of this article is to briefly describe the essential features of an antenna system and their optimization for maximum performance.

An antenna is basically a resonant circuit. For maximum performance it must be tuned to resonance for the same reason that the transmitter output circuit must be tuned to resonance. When the transmitter frequency is changed, it is standard practice to "dip the final", and the antenna resonant frequency should also be changed if maximum performance is desired.

The antenna is basically a series resonant circuit with a resistive component, as shown in **Fig. 1.** The resistive component is referred to as the radiation resistance. Maximum current flow will occur in the resistance only at the resonant frequency. The value of the resistive component is a function of antenna height, ratio of physical to electrical length (loaded antennas) and other factors. The resonant frequency is a function of the physical characteristics of the antenna and proximity to other objects. The major problem, when looking at the overall system, is that the antenna must be physically separated from the transmitter, hence the need for a feedline. This article is concerned with coax feedline. If an antenna tuner is used, this line is short and the antenna is virtually moved into the shack. The normal procedure for amateur antennas is to use a coax line length just long enough to go from the transmitter to the antenna, and herein lies the problem. If a random length of feedline is used and the antenna does not have the same radiation resistance as the coax characteristic impedance (nominally 50 ohms), the power doesn't get to the antenna due to losses in the mismatch and to radiation from the coax. For this case, the coax becomes part of the antenna system. On the other hand, if a half wavelength of coax (or multiple) is used, the effect of the coax may be disregarded. The coax itself is the equivalent of a series resonant circuit. When the coax and the antenna are connected, if the line length is proper, the antenna feedpoint is virtually moved to the transmitter end of the coax.

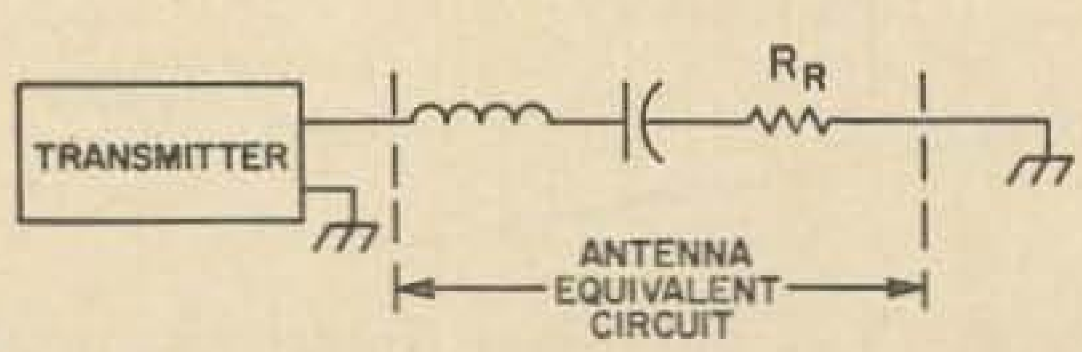


Fig. 1. Series resonant circuit.

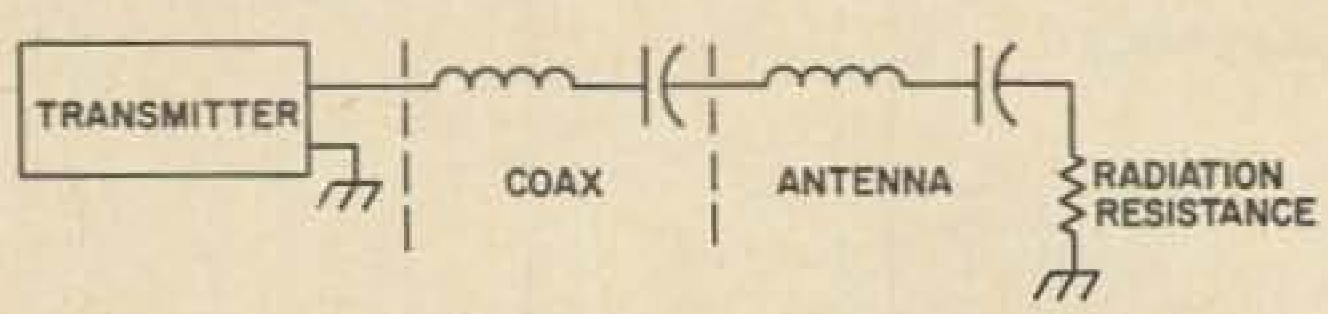


Fig. 2. Simplified antenna system.

With reference to **Fig. 2,** note that the entire antenna system can be simplified to the resonant circuit of the coax and the resonant circuit of the antenna, with the radiation resistance (feedpoint impedance) as the desired "load" for the transmitter. If the coax is a half wavelength long (or multiple), it effectively will be series resonant and thus a short circuit. If the antenna is also resonant at the same frequency, maximum current will flow in the radiation resistance and hence maximum antenna efficiency.

If the coax is not a half wavelength, changing the length of the antenna can cause the entire circuit to be resonant, but the effect is to cause the coax to be part of the resonant circuit and hence radiation from the coax occurs. In addition, the antenna itself will not be a resonant circuit; hence, the resultant high impedance of the tuned circuit will prevent maximum current flow in the radiation resistance. This is not true if the antenna radiation resistance is the same as the characteristic impedance of the coax. Another effect is that the value of radiation resistance measured at the transmit end of the coax is not the same as the value at the antenna if the coax is other than ½ wavelength and the radiation resistance is other than 50 ohms.

The problem is aggravated by the fact that the antenna is resistive only at the true resonant frequency of the antenna. A few kHz from the antenna resonant frequency, the value of capacitive or inductive reactance reaches a high value for the antenna itself. Hence, the coax is no longer properly terminated, even if it were 50 ohms at the resonant frequency. The effective bandwidth of the antenna will be greatest if a matching network is used.

Most amateur antennas, particularly 80 or 40 meter dipoles and mobile antennas, have a low value of radiation resistance. These antennas will have low efficiencies unless a matching network is used to overcome losses in the antenna conductor. (See the ARRL Antenna Handbook.) Most beams use a matching network and are extremely difficult to adjust properly using a VSWR Bridge. The WSWR Bridge has the basic limitation that it cannot differentiate between resistive and reactive components. Most amateurs, not realizing this limitation, operate their antenna at the frequency of lowest VSWR, *which is not necessarily the same as the most efficient frequency.*

If a system is tuned using the following steps, maximum efficiency will occur:

(1) Use half wavelength coax, or multiple thereof, or locate the Bridge at the antenna feedpoint.
(2) Tune the antenna to the desired frequency.
(3) Adjust the matching network for 50 ohms.

If this procedure is used, minimum VSWR will occur at the frequency of optimum efficiency. If the coax is other than ½ wavelength (during tune up), the antenna is not properly tuned, or if the radiation resistance is not the same value as the characteristic impedance of the coax, minimum VSWR will not occur at the frequency of highest efficiency.

If the system is operating properly, changing the length of coax will not affect the VSWR reading. (Use ¼ wavelength coax for worse case measurement.) Thus, when adjusting an antenna using a VSWR Bridge, if the coax line length is alternately changed between measurements, eventually a proper combination can be reached. This is a tedious process and does not give an indication as to what to do to adjust the system. For this reason, an *rf* bridge is required to measure independently the resonant frequency and radiation resistance to allow tuning the antenna to the desired frequency first then to allow adjusting the matching network. Many *rf* bridges are available for this purpose, including the Heath Kit Antenna Scope, the Millen Bridge, General Radio Bridges, and the Omega-t Antenna Noise Bridge.

A mobile antenna, particularly on 40 or 80 meters, must utilize a matching network. The nominal radiation resistance is typically very low and when the system is operated at the frequency of minimum VSWR without a matching network, the resonant frequency will be out of band and the antenna will not give maximum efficiency.

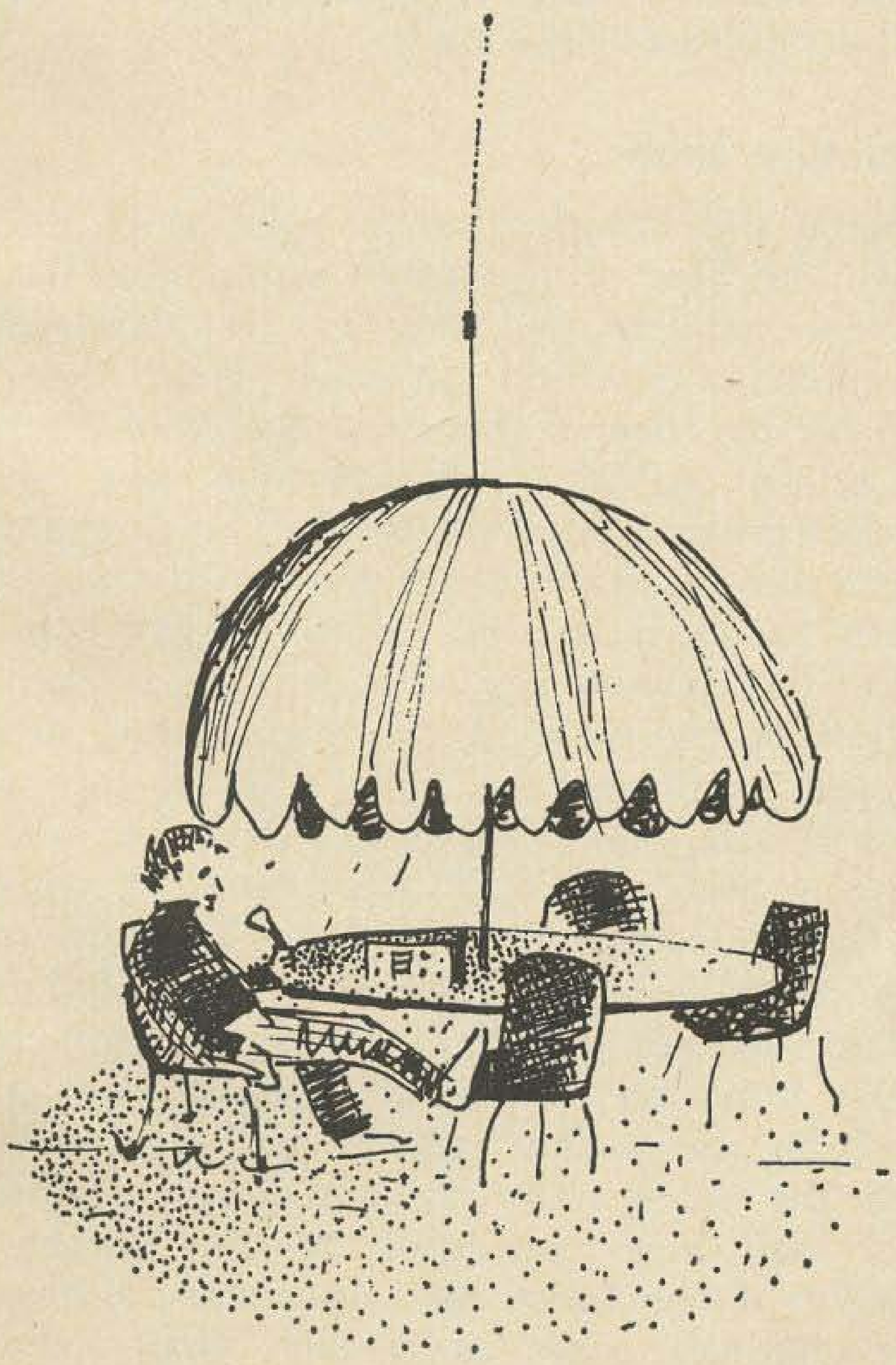
The same comments hold for beam antennas. Here again, minimum VSWR does not necessarily mean that the antenna is resonant and the matching network is adjusted properly. Also, if a coax line of other than ½ wavelength is used, the entire system may be "down in performance" by many db.

When using a multiband antenna, the coax length should be chosen for a multiple of ½ wavelength for all bands. Example: For a 10-15-20 triband beam a ½ wavelength coax on 40 meters (approximately 44 ft. RG-8U) gives 1 wavelength on 20, 1½ wavelength on 15, and 2 wavelengths on 10. If this is too short, the next length would be 1 wavelength on 40 (approximately 88 ft. of RG-8U) which gives 2 λ on 20, 3 λ on 15, 4λ on 10 meters. If this is too long, it is better to coil up the excess in the corner rather than cut it off and not have the proper electrical length of feedline.

To achieve maximum antenna performance these considerations should be applied to all amateur antennas in addition to the normal choice of antenna type, height above ground, etc. These considerations do not rule out the case of using ¼ λ lines for matching networks.

As an example of the relatively critical tuning of antennas, the antenna conductor forms the inductive component of the tuned circuit. The capacitive component uses air as the dielectric, and the capacitive component is distributed along the conductor. If the dielectric constant changes, the resonant frequency of the antenna will change. Among other factors, the relative humidity of the air is influential. A 40 meter dipole has been observed and changes of 200 kHz in the resonant frequency are not uncommon from dry air to measurements made while rain is falling.

Before you purchase the linear, tune up the antenna. It's cheaper and the results will be about the same. Then, if you add the linear, the rest of the crowd will move over when you come in. . . . W5QJR



Putting Creativity to Work

D. E. Hausman VE3BUE
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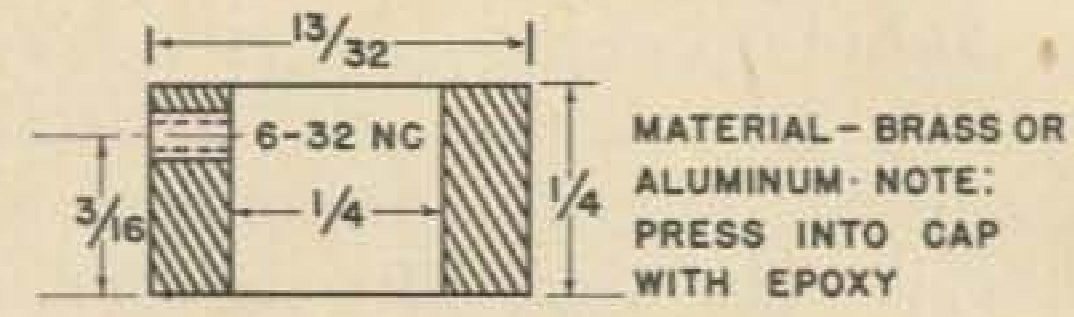
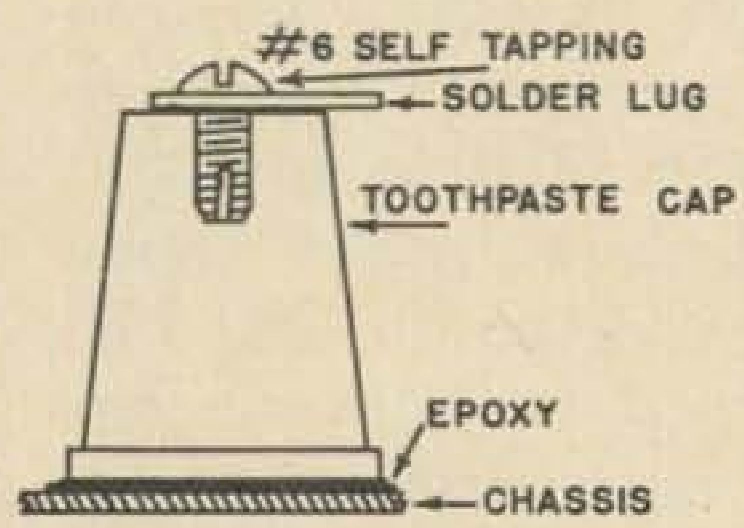
Kitchener, Ontario, Can.

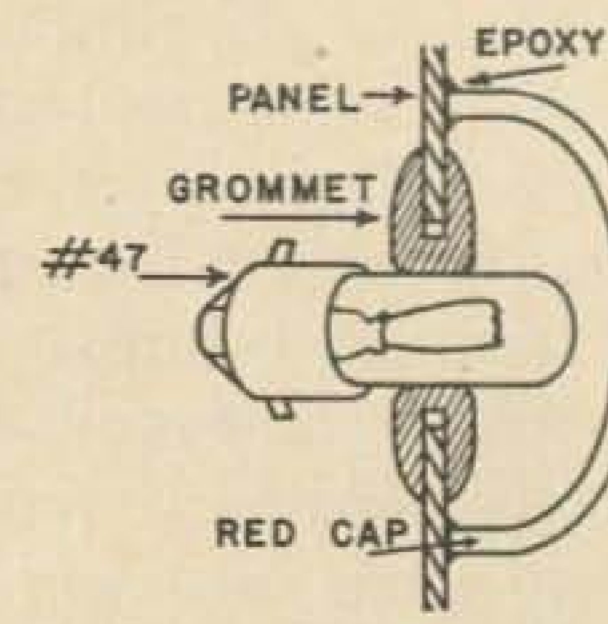
The purpose of this article is to show how the radio amateur can use his creativity for his benefit. As an example of what I mean by creativity, I shall describe several ways of using such common items as toothpaste tube caps and the like. In all cases it will be readily apparent that the cost ofconverting these inexpensive caps into useful and needed items is small, the conversion is easy and the new item is in some cases difficult and expensive to get commercially.



FERRULE FOR KNOBS



STANDOFF INSULATOR



DELUXE WARNING LIGHT

Stand-off insulators

Small caps, especially those from toothpaste tubes, can make dandy stand-off insulators. The diagram shows how a solder lug is held by a #6 self-tapping screw. More than one lug can be used if necessary. The completed insulator is attached by means of epoxy glue or similar adhesive. The use of these insulators is not recommended in high-voltage circuits for obvious reasons.

Deluxe warning light

Do you want your "warning" lights to command the attention they deserve? The cap from a detergent bottle, etc. will make a large dome that, when illuminated even by a #47 bulb, will command far greater attention than those small "jewels". It is perfect for the B+ pilot light in a linear amplifier or high power transmitter. A red cap will, of course, be best for this application. The diagram shows how the pilot lamp is held by a grommet and how the cap is cemented over the lamp with epoxy glue. A commercially available lamp socket can be used, however, at a greater expense.

Protective feet

And when you finish that new construction project, you will need some protective feet to protect your operating bench from mars or scratches. A common toothpaste tube cap comes to the rescue with no modifications. Simply glue these caps to the bottom of your project, and there you are. These caps are surprisingly strong and will support quite a heavy load.

Miniature knobs

Since the introduction of solid state devices, the size of electronic equipment has become smaller and smaller. If standard size knobs are used on such gear, there will be no room in-between the knobs for the fingers. Again, toothpaste tube caps can be converted into small knobs. The diagram shows how a brass or aluminum ferrule is made to fit inside the knob. Epoxy glue holds this ferrule securely. A hole is then drilled in the side of the cap and a tap is used to thread the hole. A 6/32 tap is a good size. The dimensions given in the drawing are "universal" and will work with nearly all toothpaste tube caps. The easiest way to make the ferrule is to use a lathe. If this is not possible, get some ⅜-inch brass from an industrial supplies dealer (look in the yellow pages) and after cutting the stock into ¼ inch lengths, drill a ¼ inch hole concentric to the circumference of the brass. In some cases, miniature controls come in ⅛ inch shafts and suitably sized knobs are difficult to get. If you use homebrew knobs it will be no problem making this smaller hole. The set-screw is a 6-32 x ½ inch screw with the head cut off and a slot cut in the end with a hack saw. If you need an index line, take a toothpick and after dipping it in a bottle of India ink, darken one of the ribs along the side of the cap.

Although this may be redundant; get your wife to save up all the caps she gets. So there you have it; it's not that hard to use your head and come up with some mighty useful items.

. . .VE3BUE

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

CLUB SECRETARIES NOTE

Your club can round up some extra funds by imploring, cajoling, convincing, or forcing your members to subscribe to 73 Magazine. Never mind the cries of anguish, just remember that you are doing what is best for them—and the club.

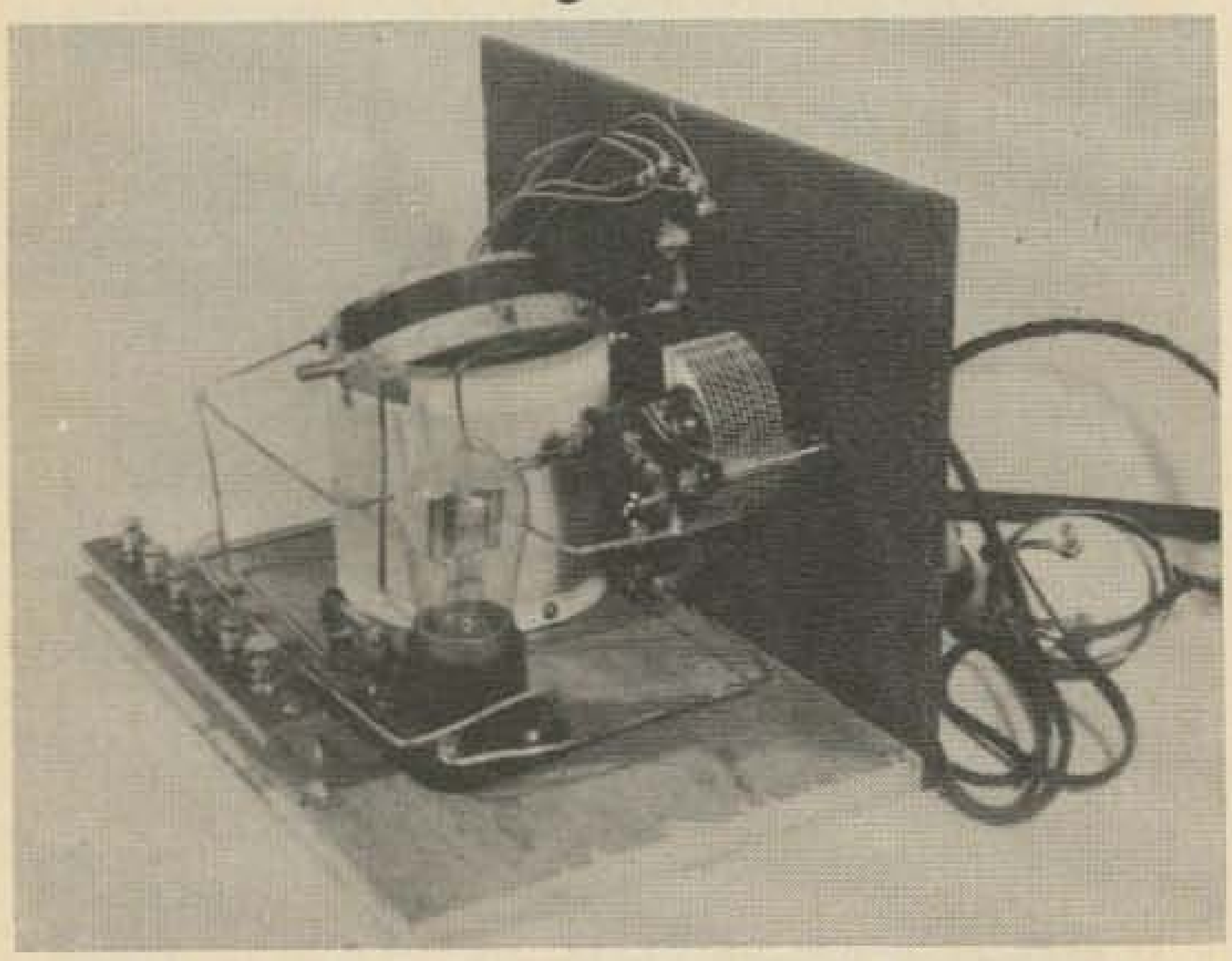
Subscriptions to 73 are normally $6 per year. The special club rate is exactly the same: $6. The only difference is that the club treasury holds 25% of the loot and sends the rest to 73. Send us $4.50 for each one year subscription, in groups of at least five subs. Just think, if your club has 10,000 members you can quickly get $15,000 for the club on this deal!

Send the subscriptions to us on 3"x5" cards, giving the name, call, address, city, state and zip code of each subscriber. If the subscription is a renewal please include the address label from a recent 73 wrapper. Indicate all renewal subscriptions so we won't start a second sub. We have been known to do that.

Send to: Club Finagle, 73 Mag. PETERBOROUGH, N.H. 03458

The Lamb Dyer

Ted Woolner WA1ABP
30 *Cedar Rd.*
Shrewsbury, Mass.



It's hard to start a story that many will not believe, but, I'll have you know, that better than half the lies I tell are true. This all started when I was studying to become a ham in 1963 . . . The teacher allowed as how it would be impossible for me to remember how to make a receiver such as I had made in 1921 when I was a "Child radio nut." We were all called "Radio Nuts" in them there days and we all made our own receivers and invented enormous lies about stations we had heard the night before. The red ears were not a sign of shame about these lies, but merely head-phone-itis. We loved our radios and here was a teacher that had the unmittigated gall to say I couldn't do it now!

It took a lot of time and a lot of attic searching but finally 1 had all the parts—including the U V 200 Radiotron detector tube! The work started. Being older and having a better supply of tools than a twelve year old country boy, it went along fast and the finished product, a one tube regenerative, using a vario-coupler tuned with both "Taps" and a variable condenser across it. One end of a tickler coil to the plate of the tube and the other end to the headphones created the necessary feed-back or "regeneration."—I was, again, a care-free boy of thirteen! That is the way I felt! Now, hook up the storage battery and the "B" battery, place the headphones (Brande's) on the head and slowly, with bated breath turn the rheostat on. Aaaaaah, the old tube lights up a little, turn it up a bit further—it glows brightly and the old familiar rushing sound comes out of the ancient ear-phones . . . By golly, it's gonna work! Flatten out the tickler, move the tuning dial and there is the old familiar whistle. Now, tip the tickler just to the breaking point of oscillation. There it is, a dance orchestra playing a number from out of the past—Lime House Blues! Gosh, it had been many years since I had heard that almost forgotten number. They reached the end of the number and the announcer said it was played by the Silvertown orchestra in Chicago! Well, this couldn't be, I must be imaginning that it what I heard, so I moved the dial a bit and there was a tenor banjo with another orchestra playing, "I'm in Love With You, Honey" . . . The announcer said it was Harry Reeser and the Cliquot Club Eskimos at W G I, Amrad, Medford Hillside! When would I wake up out of this dream—I blinked and swallowed hard—and whirled the dial to, believe it or not—Roxy's gang and little "Gamby" singing, "I've Got a Pain in the Sawdust—" . . . . . My hand was shaking and a voice from another station—yes, from a by-gone time said, "This is Jimmie Gallagher, still hangin' on"—W PG at Atlantic City . . . Next the Miami Beach Hotel—W M B H, then station at Fort Wayne. Holy mackeral, this was too much: I pulled out a cigarette and reached a shaking hand for my lighter on a shelf over the bench. Wouldn't ya know it, it fell from my grasp and hit the tip of the old U V 200 which slowly dimmed and went out and a small spiral of smoke issued out of the broken tip—or did it return to the bottle like the genie I've heard about? I don't know. I've never found another UV 200 and the later U X201A don't seem to do the same. True, I hear many stations on this old time home brew set but since that accident with the lighter—hmmm.

. . . WA1ABP

Accurate if Alignment

Harold Mohr K8ZHZ
5670 Taylor Rd.
Gahanna, Ohio 43020

I hear many hams talk of the troubles they have in accurately aligning the *if's* of their receivers, especially some of the newcomers using a converted surplus receiver. I have been using the procedure listed in **Fig. 1** for years, and find that most receivers will come close to reading correct if the *if's* are set correctly before any *rf* or oscillator alignment.

As all American BC stations use 10 kHz separation and are crystal controlled, I use them to check signal generator settings. For instance, suppose I want to align a receiver with an *if* frequency of 1680 kHz. Setting the signal generator at 420 kHz, its 2nd harmonic should zero beat with a broadcast carrier at 840 kHz. Then it fourth harmonic is within a few cycles of 1680 kHz, and is used for the *if* alignment. To align a 455 kHz *if* accurately, I zero beat the signal generator's second harmonic of 455 kHz against a 910 kHz broadcast carrier, and align from the fundamental.

This approach is very accurate, and the signal generator needs a 30 minute warmup before doing alignment work. If the receiver *if* is known to be far off, I do a rough alignment before using this procedure.

if Freq. of rcvr.	Sig. gen. setting	BC station zero beat at:	Harmonic beat with BC sta.	Harmonic for alignment
260 kHz	260 kHz	780 kHz	3rd	Fund.
262 "	262 "	1310 "	5th	"
266 "	266 "	1330 "	5th	"
455 "	455 "	910 "	2nd	"
915 "	305 "	610 "	2nd	3rd
1650 "	330 "	660 "	2nd	5th
1680 "	420 "	840 "	2nd	4th
1750 "	350 "	700 "	2nd	5th

. . . K8ZHZ

Charlie's Broken Dream

The Defeatist Attitude

David W. Elbrecht WA8VST
8 Saint Clair St.
Norwalk, Ohio 44857

"Where's that garden rake?" mumbled Charlie. It was dark in the basement and he turned on the light. As the naked bulb flashed on. Charlie was momentarily blinded. Then his sight returned. "I must have put it back by the furnace," he answered himself.

Charlie went back by the furnace, near the hot water heater, and turned on another light, this one flourescent. Then he saw it. It returned to his memory again. There on the bench was that fifty watt cw transmitter, general coverage receiver, and speaker. Two coax cables snaked their way upward to the ceiling and out the hole drilled in the window casing. Charlie remembered.

He moved toward the operating position with care, as if approaching a friend after many years, unable to remember his name. "It sees like only a few weeks ago. . .," he mused. Actually, it was years. Charlie sat down, fingering the key lightly, sending out a series of CQ, CQ, CQ. "Pretty good fist," he thought.

Then he wanted to leave, but his hand was drawn to the switch of the receiver. Soon the sound of the 40 meter novice band reached his ears. "The rig still works. I wonder if I can still copy any code?" But he didn't try. Suddenly he was gripped by a feeling of nostalgia for this hobby that once was his. He tuned the receiver up from the novice band to the phone band. There they were: rag chewing, working DX, handling traffic, and there was a phone patch. Then Charlie looked at the vfo he was never able to use, right next to the home-brew modulator which received the same fate.

Charlie's thoughts wandered to the day several years ago when he went to Baltimore to take the general test. He was nervous then, but thought he could pass the exam. "After all," he remembered thinking, "didn't Joe up the street pass it? Why can't I?" But he didn't. He vowed to return in a month to try again. That time he really felt confident. Failed. What was wrong? He had thought about going back a third time, but he never gotten around to it. It was kind of embarrassing.

About a year after his novice license ran out, Charlie thought about selling his gear at one of the local radio club meetings. Somehow he just couldn't bring himself to talk to the fellows, though. It was like he wasn't one of the group. After all, if you don't have a license, you aren't a ham. He had often seen his dipoles for 80 and 40 meters hanging in the back yard and felt they should be taken down. But it was an all day job to climb up that tree again; the garage roof wasn't as sturdy as it used to be, either. The antennas weren't too obvious, so he just pretended that they weren't there at all.

So the rig sat in a dark, unused corner of the basement, hidden behind the hot water and some old snow tires so Charlie couldn't see it, just as his memories of his days on the novice band were relegated to some obscure recess of his mind, along with the dreams of a general ticket. But every few months, Charlie was drawn by fate to the basement where he was forced to remember.

Charlie stood up and viewed the scene. Dust covered logbook, dog-eared handbooks and magazines, cobwebs guarding the t-r switch, and a few crickets scurrying from the transmitter cabinet. Charlie turned off the receiver and shuffled away. "Now, where's that garden rake?"

. . .WA8VST

Propagation Chart

MARCH 1969

ISSUED JAN. 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	14	21	21	21
ARGENTINA	21	14	14	14	7	7	14a	21a	21a	21	21	21
AUSTRALIA	21a	14	14	7b	7b	7b	7b	14b	14a	14	21	21a
CANAL ZONE	21	14	7a	7	7	7	14	21a	28	28	28	21
ENGLAND	7	7	7	7	7	7b	14a	21a	21a	21	14	7a
HAWAII	21	14	14	7	7	7	7	7b	14	21	28	28
INDIA	7	7	7b	7b	7b	7b	14	14a	14	7b	7b	7
JAPAN	14a	14	7b	7b	7b	7	7	7	7b	7b	7b	14
MEXICO	21	14	7	7	7	7	7	14a	21a	21a	21a	21
PHILIPPINES	14	14	7b	7b	7b	7b	7b	14b	14b	14b	7b	7b
PUERTO RICO	14	7a	7	7	7	7	14	21	21a	21	21	21
SOUTH AFRICA	14	7	7	7	7b	14	21	21a	21a	21a	21	21
U. S. S. R.	7	7	7	7	7	7b	14	21a	21	14	7b	7
WEST COAST	21	14	14	7	7	7	7	14	21	21a	21a	21a

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	14	7	7	7	7	7	7a	21	21a	21
ARGENTINA	21	14	14	14	7	7	14	21a	21a	21	21	21
AUSTRALIA	21a	21	14	7b	7b	7b	7b	7b	14	14	21	21a
CANAL ZONE	21	14	14	7	7	7	14	21	28	28	28	28
ENGLAND	7b	7	7	7	7	7	7b	14	21	21	14	7a
HAWAII	28	21	14	14	7	7	7	7	14	21	28	28
INDIA	7b	14	7b	7b	7b	7b	7b	14	14	7b	7b	7b
JAPAN	21a	21	14	7b	7b	7	7	7	7	7b	7b	14a
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21a	14	7b	7b	7b	7b	7	7	14b	14b	7b	14
PUERTO RICO	21	14	14	7	7	7	14	21	21a	21a	21a	21
SOUTH AFRICA	14	14	7	7	7b	7b	14	21	21a	21a	21	21
U. S. S. R.	7b	7	7	7	7	7b	7b	14	14	14	7b	7b

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	14	7	3a	7	7	3a	7	14	21	21a
ARGENTINA	21	21	14	14	14	7	7	14	21a	21	21	21
AUSTRALIA	21a	28	28	14	7a	7	7	7	14	14	21	21a
CANAL ZONE	21	21	14	7	7	7	7	14	21a	28	28	28
ENGLAND	7b	7b	7	7	7	7	7b	7b	14	21	14	7b
HAWAII	28	28	21	14	7	7	7	7	14	21a	28	28
INDIA	7b	14a	14	7b	7b	7b	7b	7b	7	7	7b	7b
JAPAN	21a	21	14	7b	7b	7	7	7	7	7b	7a	21
MEXICO	21	14a	7	7	7	7	7	14	21	21a	21a	21a
PHILIPPINES	21a	21	14	7b	7b	7	7	7	7	14	7b	14
PUERTO RICO	21	21	14	7a	7	7	7	14	21a	28	21a	21a
SOUTH AFRICA	14	14	7	7	7b	7b	7b	14	21	21a	21	21
U. S. S. R.	7b	7b	7	7	7	7b	7b	7b	14	14	7b	7b
EAST COAST	21	14	14	7	7	7	7	14	21	21a	21a	21a

A. Next higher frequency may be useful.

B. Difficult circuit this period.

Good: 1, 2, 5, 6, 9-13, 15-20, 26-28, 30

Fair: 3, 4, 7, 8, 14, 21, 24, 25, 29

Poor: 22, 23

(Kluge Tube)

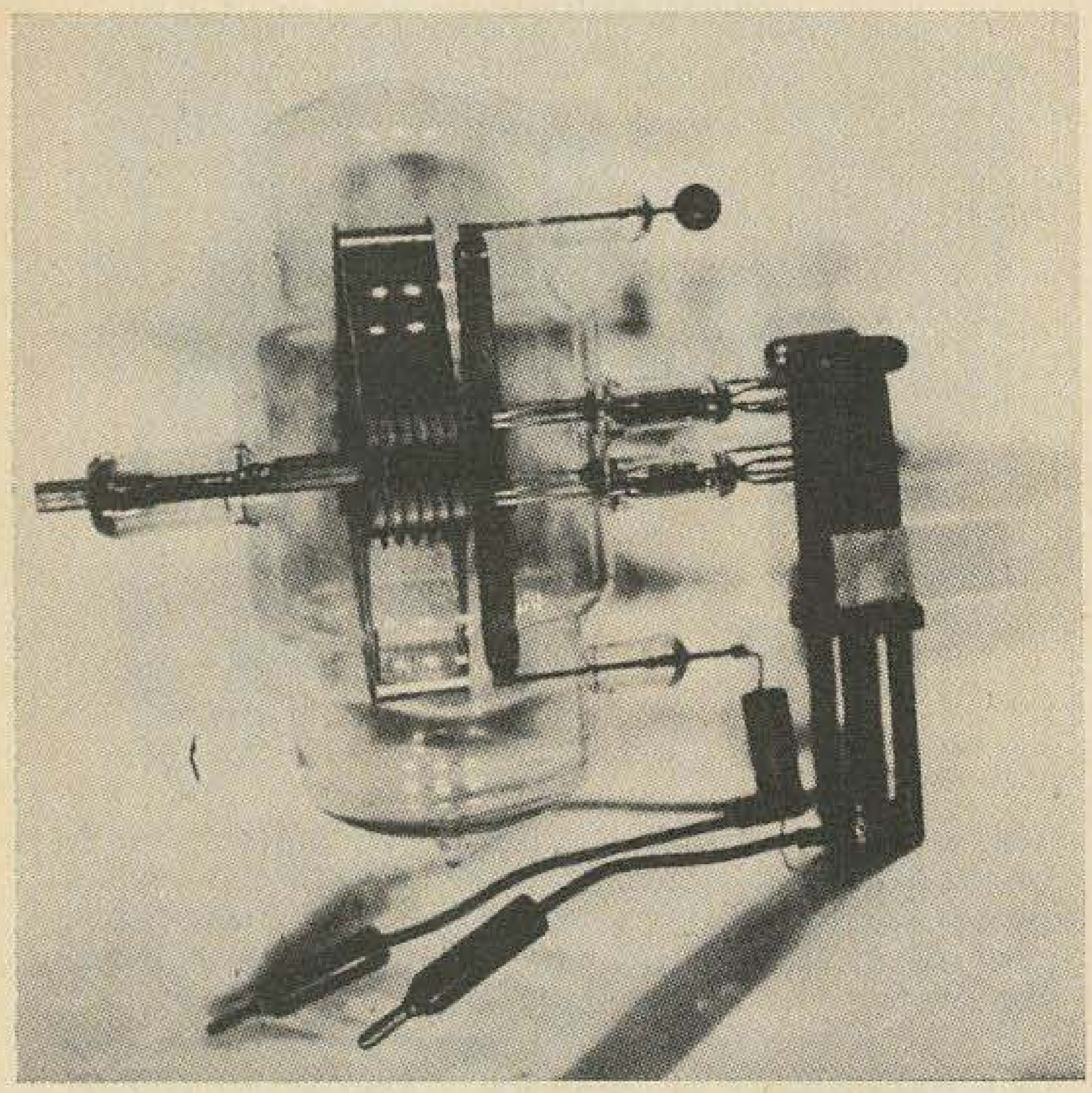


Fig. 1. The remarkable radar tube. From the dimensions of the quarter-wave lines that provide electrical and mechanical continuity, it appears this tube is designed to oscillate around 1200 *MHZ. It comes with an* 80-*ohm grid resistor, far too low for amateur applications.*

There is a term for something big, odd, and not very useful. I heard it recently; it is "kluge.' Since I am writing about a thing properly called a kluge, naturally this is a bit of kluge copy.

But hold on a minute . . . a good idea is still a good idea even though it may be out of date, or obsolete a few times over. See **Fig. 1.** Here is our kluge, and it certainly is one of the most awesome things I've ever pulled out of a big box.

This thing is a VT-158. Developed just before or early in WW 2, it is a UHF oscillator tube, with about two-thirds of the oscillator circuit inside the tube envelope. At peak powers in the 250 kw range and at frequencies in the order of 1000 MHz, the tube simply could not be constructed in an orthodox way. All that is a very interesting story, in which the development of the tube opened new technological fields, and the tube itself affected the course of WW2.

But what can you do with it now?

Maybe you can set it on your mantle as a conversation piece. (keep it away from children; it's full of vacuum and sharp edges) A museum might be interested, or it's a rather fantastic thing to look at. Something like reading a chapter of a book on high-frequency techniques. It's a lesson in itself to simply work out why this tube is built the way it is. But how about this?

Taking a fresh look, let's recall some vacuum tube theory. If we go to a lower frequency or think in dc terms for a bit, this amounts to one triode with the same amplification factor as any of the four triodes inside the envelope (since they are all similar) but with one quarter the plate resistance.

We will have to measure the plate resistance, but the mu is simply a measure of the effectiveness with the grid competing with the anode in controlling the anode current. A ballpark figure is available by looking at the tube; since the accelerating field at the heater surface is the sum of the grid and anode fields, and the grid is about three times closer than the anode, the mu is about two or three.

This tells us cutoff bias for class C operation will be terrific. At 800 volts on the anode, grid bias should be in the 400 volt ballpark. Remember we aren't using this as

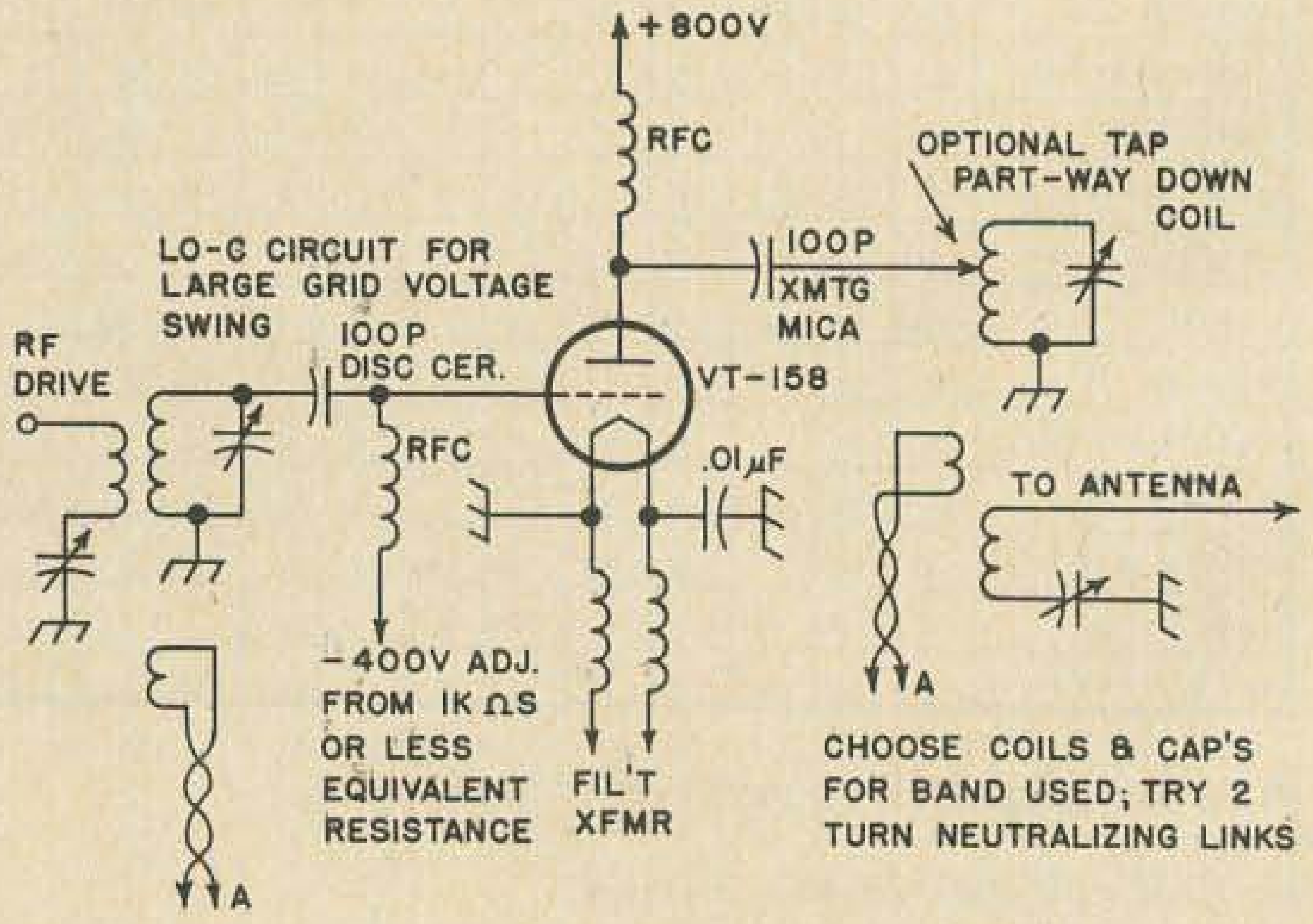


Fig. 2. Suggested schematic for an old idea power amplifier. Operating class C it should generate TVI as well as anything on the air, but it may be possible to operate linear quite effectively.

the manufacturer intended! That means we can use the same power supply for grid and anode, taking a little minus straight off the high voltage winding.

We don't want to try a really high voltage because with the greater heater area and fantastic emission capabilities (250 kw peak) the anode resistance is probably quite low once we've defeated the space charge. Can we make an amplifier out of this?

I think so. Its internal structure is a bit of an obstacle, and so we cannot use it in a tuned-line circuit. But on the lower bands the four triodes will get by as one, and you can even go to link neutralization again. Heater power is a bit high, but, after all, you can pare that down if you don't reduce the emission too much, and this old broadcast engineer's trick increases the life of the tube.

Anode dissipation is a big question. It is probably several hundred watts, and the grids can run approximately white hot, so should be durable enough in amateur service. Just keep on remembering those 250 kw peak power ratings!

A proposed schematic appears in **Fig. 2.** Remember, this hasn't been tried, yet, and is based largely upon an eyeball estimate of what the tube might do. Let us know how it works out!

The VT-158 is available from United Radio. See ad on pg. 61. ■

Amphenol Opens Up the Parts Market

As you walk in the door of your local parts distributor you may intend to buy a single component. But the distributor must bear many costs and wants to sell you ten or a hundred, all the same. This conflict of interest was resolved very nicely several years ago, by the idea of "amateur privilege." That is, anybody with a ham ticket in his pocket could go to nearly any wholesaler and pick up what he needed at wholesale prices.

Those days are gone. Discount stores selling to anybody who walks in the door, rising prices and costs, the advent of big money in the TV, hi-fi, CB and automotive electronics fields have jointly confused the idea of "amateur privilege" until at this point anybody under 30 or so probably has never heard the term.

Faced with competition and a growing consumer market, a few wholesalers and retailers have tried packaging as an answer to the sales problem. "Sell a pack of several; it's not hundreds but it's a sale which somebody is going to make" is the idea, and a bit of modern technology has provided an answer to the problem of inexpensively packaging things. The answer is the Blister-Pak.

Previous efforts have not been successful because the packages cost too much. But the Blister-Pak system has emerged as a fast, automatable system which packages items at the least possible cost. Prices need not be much above those of the fellow down the street who sells the same parts out of a dirty old box. And useful circuit data can be included in the package, compensating for the slightly higher prices and making up a very salable item.

The result of this new approach, which is based on two years of market research, is appearing in the form of rotating self-service racks in distributors' showrooms. If you need something, you go to the appropriate rack and choose what you need or a reasonable substitute, and when you're done shopping you make just one trip to the counter. This Blister-Pak idea is likely to prove a really big boost in the parts sales business, and will offer greatly increased convenience to shoppers.

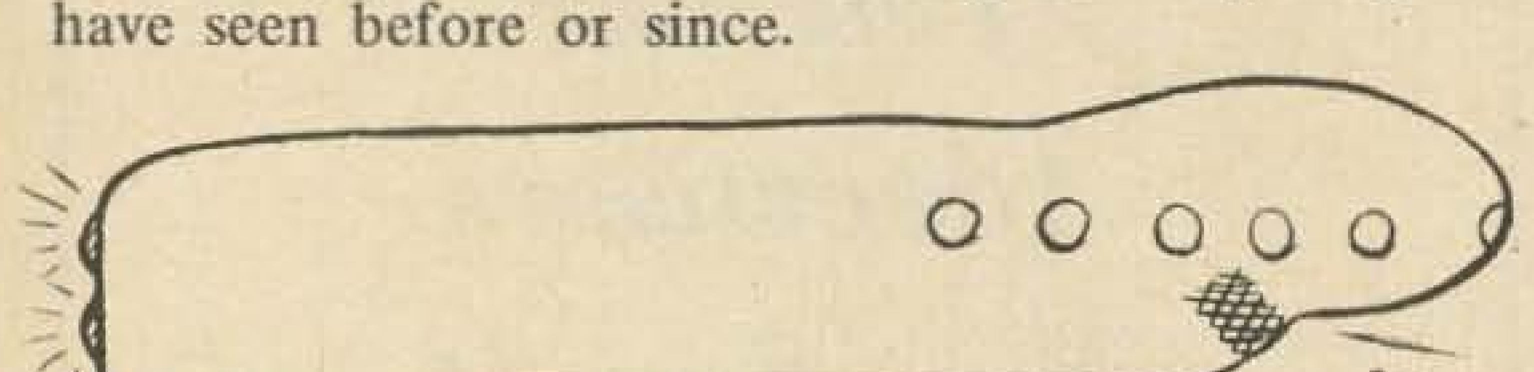
Amphenol is presently marketing 53 different blister-packaged components, including a variety of connectors, directed to the needs of radio amateurs, stereo and hi-fi fans, and even CB'ers. There are also audio adapters, and even in-line lightning arrestors, with more to be added later. Free hobbyist booklets, provided on the displays, are designed for handy workbench reference. For more detailed information, contact Amphenol Distributor Division, 2875 South 25th Ave., Broadview, Illinois 60153. ■

LETTERS

Dear Wayne,

On July 21, 1968 I was working on the 4-12 shift. I left Bartow, Florida to return home in Lakeland at about 12:15. This trip takes about 15 minutes at normal speed, so I judge that it was near 12:35 am when I got home. I parked at the house and stepped out into the drive to take a look at the weather. It was very quiet and I could hear a strange noise as if there was a sharp breeze coming in. I looked up in time to see the cause of this swishing sound. I saw a disc about 20-25 feet across traveling from south west to north east at about 100-150 feet up. It was inclined slightly lower on the forward direction with a slight tilt to the right. It appeared to be of a fairly bright metal much like annodized aluminum. It had a black or dark ring about 4-5 feet in from the edge that looked to be about 2-3 feet wide. I got a good look at it for it was not going at a high speed. There was no other sound than the wind caused by the passage of this object through the air. Had it not been so quiet I would not have been able to hear it at all. There was no light coming from it at all, but it was plainly visible in the reflected light of the street lights. Apparently I was the only person to see this one so I can only give an unverified report on it.

I can give a verified report on an earlier sighting together with a drawing made by the four people at the time. I was the manager for the Bordon plant in Lakeland and attended a sales meeting in Clearwater with my office manager, sales manager, and the supervisor from the plant. When we were driving back we saw a very bright blue light approaching from the east. It appeared to be coming lower and the light got very bright. There was a very bright full moon and the road was almost empty of cars. As this object appraoched we stopped the car, shut off the motor and got out. It passed about 500 feet south of the road at an altitude of 500 feet. I could plainly see the curved band of very bright blue light just aft of the nose on the lower front. A series of very bright portholes extended at midpoint of the body and appeared to go completely around the nose. There were two pale glowing domes on the rear of the body. This object made no noise at all and THERE WERE NO WINGS. It passed between us and the moon. Our observation point was between Tampa and Plant City on what is known as Dover Flats. As we watched the object which was traveling very slowly (perhaps 20 mph), it speeded up and disappeared in just a few seconds. We decided to each draw what we had seen without discussion. Below is the drawing as it appeared to us. Our estimates were very close. I have seen many odd shaped planes and blimps, but this was nothing like anything I have seen before or since.



120-135 feet long
girth: 25-30 feet

Andy Anderson W4IDK
Lakeland, Florida

Dear Wayne,

Very seldom do I write a letter to anyone, especially to thank them for a service rendered. The service I am thanking you for is the much enjoyment 73 has provided me over the past few years. I take all the popular amateur publications and I must say that 73 is by far the best. It seems as if the articles are very timely with projects I would like to build or information that I need on one of my own ideas. Just keep up the good work and print what hams want to know.

Bob Budsong WA4SLG
College Park, Georgia

Dear Kayla,

Sorry, but just hafta send another one of those nice letters! 73 was the first publication that I got acquainted with after getting my Novice, although I had seen the others. I really appreciate 73, both editorially and technically. I realize that thousands of readers have a like number of ideas or desires, but I like the basic policy that 73 is for us and not trying to establish some kind of ecclesiastical headquarters. My two desires are that you continue to keep us advised as to what is pending in ham radio and stuff that we can read and build in order to advance ourselves. My only complaint is that 73 comes only once a month and should be twice as large! Hi! One other comment: whatever you do for the Novice and new General now will be remembered when we are Extras. Thanks so much for the efforts of the staff.

L.E.Thompson
Eau Claire, Wisconsin

We could publish twice as many articles if the advertising would support it. It is entirely up to you, the readers, to impress on the manufacturers and distributors that you are looking for their ads in 73 and not in the other magazines.

Gentlemen,

I wish to take this opportunity to compliment the entire staff of 73 Magazine for their efforts and dedication to Ham Radio, by the absolutely excellent series of articles, "Getting A Higher Class License." These articles have helped me personally and I'm sure untold thousands of other Hams in really understanding the "hows and whys" of our equipment. Keep up the good work.

James Hall WA8SED
Miamisburg, Ohio

Dear Wayne:

To kill some time, I happened to page through "The Index to Articles Appearing in 73 Magazine in 1968." Articles such as "Tuning in on Bonadio's Satellites," "An Invisible Antenna," "How to Write for Service Information," "I Rode With the (excuse the expression) CB's," and "A Space Communications Odyssey" really turned me on. In my mind, these types of articles are the ones that make your magazine very worthwhile and interesting. However, to keep you from getting a big head, I feel your construction articles usually are somewhat in left field, and I'm an Extra Class ham that likes to homebrew things.

Leland L. Bahr, W9DRC
Park Forest, Illinois

Open Letter

The annual ARRL Board meeting will be held in May. It is now time to advise your Director of your wishes regarding matters to be acted upon at this meeting.

There is an international telecommunications conference scheduled for late 1969 or early 1970. This meeting concerns the UHF/VHF. It is expected that all amateur bands in that spectrum will come under extreme scrutiny and perhaps some drastic changes (or possible losses) will result.

It is of vital importance that the usage of the UHF/VHF be increased, and that the results of amateur communications on these bands be widely publicized, in all media. This is the year of VHF/UHF if we expect to hold these frequencies now allotted to us.

It may be already too late, but the effort must be made by ARRL and the amateur body.

Probably the most effective demonstration of these frequencies can be made thru EME communications. This 1969 ARRL Board of Directors should act to place ARRL in the strongest possible position in this vital field of amateur endeavor. This 1969 Board must act, and quickly!

In 1967, the ARRL Board allotted the piddling sum of $1500 for an "ARRL Space Station." This ridiculous amount for such a worthwhile and necessary project is actually an insult to the fine VHF/UHF work being done by others.

ARRL should appropriate whatever is needed, even if it costs a hundred or more thousand dollars, to equip and to staff an adequate EME ARRL station--if ARRL is to live up to its self-appointed role of leadership in amateur radio.

ARRL must have such a station now to help others in this work and prove that ARRL is actually interested in UHF/VHF work. ARRL's attitude toward these frequencies has been less than enthusiastic in recent years.

A state-of-the-art, legally-powered EME station operated on a 24-hour basis by ARRL would surely focus attention on these activities and would serve all amateurs world-wide in their efforts on EME--if only to listen to ARRL's EME station, such as many do to W1AW.

It is pathetic that ARRL with its many kilobucks in stocks and bonds has not already acted to build and staff an adequate EME station. However, it appears that ARRL Board action will be necessary to force HQ into action (there has been no visible result of their 1967 directive) to put ARRL into the VHF/UHF field. Such ARRL participation, long overdue, should be immediate and totally effective--and 1969 is the year to do it.

It is typical of ARRL HQ disinterest and lack of action that most of the marvelous work done on EME and other significant VHF/UHF work has been done by individuals or small groups without vast monetary resources, such as the ARRL has available.

The 1969 ARRL Board should take action to force HQ to support the NASTAR project (to place a ham station on the Moon on the first or second manned landing) which has NASA approval. ARRL should contribute money (in substantial amounts), as well as technical and publicity aid to NASTAR. (Note: There is no reason why it should require Board action to get HQ to do such things, but since it does--it is up to the Board to take whatever steps are necessary.)

If the ARRL Board does not take action (1) to provide funding for a meaningful ARRL EME facility (2) to provide substantial monetary aid and support of NASTAR--then this Board will be short-changing the ARRL membership and amateur radio. If ARRL is ever to take a positive stand on VHF/UHF, it is now, 1969. And, this Board must see the job done properly!

Second only to the ARRL Space project is the long-overdue staffing of an ARRL's Field Representative department. This was ordered done by a past Board but nothing has been heard of this directive since. There is a vast gap between ARRL HQ and the ARRL membership (in personal contacts) and an even wider credibility gap exists between ARRL and non-member amateurs. This gap is widening.

ARRL HQ (through Board action, if necessary) can subsidize (through partial or total payment of personal expenses) the attendance of incumbent and former ARRL elected officials such as SCM's, directors or vice directors, at every ham gathering from a local club to a hamfest or convention.

An ARRL representative must be present to officially "show the flag" at every type of gathering where amateur radio and ARRL should be discussed. There are plenty of incumbent or former ARRL officials to handle this, and they should be accredited and equipped to do so. These ARRL Field Reps could collect information to be passed on to HQ or the respective ARRL officials, they could pass out ARRL literature and in general "pass the word" regarding ARRL.

At the SAROC in Las Vegas this January, there were over 1000 persons registered from 33 states, Canada and even some DX. The Pacific Division ARRL Director was present, circulated around, and held a meeting which was listed on the program. There was no ARRL booth or recognition on the display floor of ARRL or QST. ARRL QST was conspicuous by its absence in the presence of well-staffed booths operated by 73, CQ and HAM RADIO, plus QCWA, OOTC and MARS. There were no ARRL publications on sale at SAROC. The other magazines had elaborate displays and material for sale.

There are far too many licensed amateurs today who have little or no contact with ARRL. They do not even subscribe to QST, nor care about ARRL! They are ignorant of ARRL and it is ARRL's fault in that it is not officially represented at all ham gatherings.

What can you do about these matters? If you agree that something should be done--write a letter to your Director and send copies to your Vice Director and to ARRL HQ--attention Secretary. Request that your Director-representative take every action necessary to secure the adoption and success of these two important features--in 1969.

Also, request that your director second or support measures brought up by other Directors at the Board meeting that will lead to a more progressive attitude and total effort by ARRL and ARRL HQ.

A recent check at 73 revealed that only three of the sixteen ARRL Directors subscribe to 73 Magazine so it is necessary for you to call these matters to their attention. Editorials in QST repeatedly state that the Directors are "your representatives and that they welcome your suggestions." If this is true, and you make requests concerning this, then some action should result at the 1969 Board meeting that will be meaningful.

A. David Middelton, W7ZC
Former ARRL Director

. . . more Letters

Dear Miss Bloom and Mr. Green,

Since you have accepted an unsolicited article submitted by me, I hope that you will also accept this unsolicited compliment. The speed with which you reviewed and came to a decision upon my piece is something amazing in the annals of publishing. Needless to say, I consider your payment more than adequate and perhaps about twice what the article is worth. Your timing was perfect, as earlier in the day your check arrived I had committed myself to a new transmitter. The article won't pay for it, but it does make a tidy down payment on it.

Again, thanks for your prompt consideration and decision. I shall probably submit something in the future when I feel I have something to say and shall look forward to your efficient editing, even if you have to tell me it isn't worth its weight in sand.

L.B.Cebik, W4RNL
Athens, Georgia

Dear Wayne and Kayla:

I don't know if the shortage of articles on FM is due to a lack of editorial interest, or a lack of contributors. I personally think that FM as a mode of operation and things like repeaters will be the salvation of the ham world above 30 MC. At the N. E. Michigan hamfest, I attended an FM talk which included a slide show and recorded tape presentation about the Tulsa Repeater. As a ham who, until recently, has had little or no use for the VHF and UHF bands, I was astounded with what the Tulsa group had accomplished.

The recently formed "Great Lakes Repeater Association" has (or will shortly have) a repeater for the metropolitan Detroit area members. I recently obtained a Motorola 2M FM rig, and find that there is more to it than bolting it in and hooking it up. There is not a lack of talent in this area for putting it in operation. I expect to have it in operation soon.

But what about hams in other areas? How about a two or three month series on "Basic FM Theory?" True, there are conversion and schematic digests available from various sources, but they cover specific pieces of surplus gear. They are sadly lacking in basic information which applies to all FM gear.

So may I suggest a few basic articles on FM theory, or at least a few questions and answers in the staff articles on getting the higher licenses. It would be a step in the right direction, and another chance to get ahead of QST!

Keep the fine magazine coming every month.

Ralph O. Irish, Jr., WA8GDT
Utica, Michigan

(Authors take note)

Dear 73 Staff,

I was fortunate to have several of your 73's available to me with the study guide for higher class licensing. By using them along with other material, I did pass the Advanced test with very little trouble. I cannot praise your articles enough. They are written in a language that even I, a common housewife, can understand. I especially appreciated the humor along with the serious. I thank you very much.

Lyla KL7CSR
Spenard, Alaska

Dear Madame,

On or about January 1, 1969, the premises of the Grumman Amateur Radio Club were broken into and the following listed equipments were stolen:
Collins 32S-1 transmitter, Serial No. 10891
Collins 75S-3 receiver, Serial No. 10779
Collins 312-B-4 station control, Serial No. 52496

Publication of this information will be appreciated. It may be instrumental in the recovery of the loss. Please notify the undersigned or the authorities of any information leading to the recovery of these items.

Emmett Goodman, Sr., WA2JFA
Grumman Amateur Radio Club

Dear Wayne,

Just a note to applaud your suggestion of a UFO net! Ham radio has needed something like this. If this doesn't get picked up and something done about, we'd all better become CB'ers and give our ham bands to the highest crass commercial bidders.

Waldo Boyd
Geyserville, California

ODE TO A HAM

I notice when some fellow dies
No matter what he's been
Some saintly chap,
Or one perhaps
Who's life was stained with sin
His friends forget the bitter words
They spoke but yesterday
And now they think of a multitude
Of pretty things to say.
Perhaps, when I am laid to rest
Someone may bring to light
Some noble deed
Or kindly act
Long buried out of sight.
If it's all the same to you, my friends,
Just give to me instead
A clear frequency while I'm living
And the QRM when I'm dead.

Pete Fragale W8AEN
Clarksburg, W. Va.

UFO BOOKS

UFOs: A New Look, published by NICAP. This book gives dozens of well documented recent sighting cases and tells the inside story of the Condon "whitewash" report. If strange little men in "space suits" are not visiting our planet, then a lot of reputable people have suddenly made up similar tales in many parts of the world. Absolutely fascinating book. $3.00 in U.S., $4.00 foreign. NICAP, 1536 Connecticut Ave., N.W., Washington, D.C. 20036.

The UFO Evidence (1964, 128 pages). Published by NICAP at $5 U.S. and $7 foreign. Hundreds of carefully researched UFO sighting cases. This is the definitive book on UFO sightings by responsible observers. Can anyone remain a sceptic after reading this report?

The UFO Investigator, a newsletter published bimonthly by NICAP. $8 per year, including membership. This is the most unbiassed report on UFO sightings and events. Each issue is worth its weight.

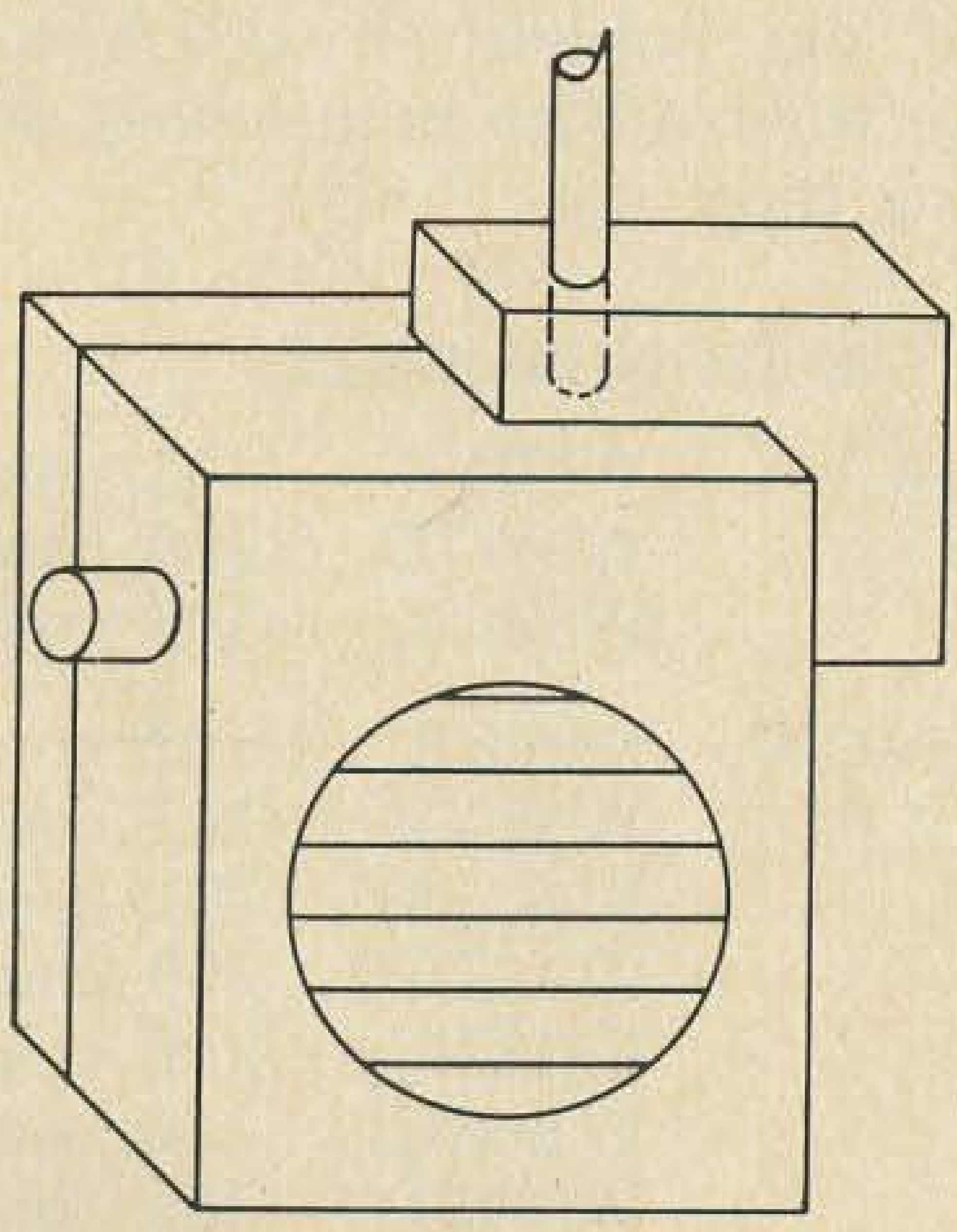
Projects Grudge & Blue Book Reports (USAF case histories and analyses) published by NICAP. $5 in U.S. and $7 foreign. One can only ask how, with reports like this to work from, our Air Force can pretend that UFOs aren't there.

For Those Who Think Small

and Other Hints

David B. Cameron WA4VQR
324 S. Riverhills Dr.
Temple Terrace, Fla. 33617

Hams have found that "walky-talkies" can be converted, with a little Yankee ingenuity, into low power 10 meter mobile units, transmitter sniffers for hunts, monitors, and other similar gear that doesn't need much punch. A popular source of these mini-rigs for the money minded ham has been imported oriental gear that can often be bought on special sale for as low as five bucks a unit. Unfortunately, many of these units share a common structural flaw. In an effort to produce the units as cheaply as possible, many manufacturers have the antenna screw in at the top. For the ham who parks his gear in the shack all day, this is fine, but the poor fellow who takes his out may find that that long light antenna grabs for trees and bushes like they were home. The next thing he knows he has an antenna broken off at the bottom or a plastic case cracked where the threaded antenna receiving piece is attached. All he can do is mutter that God shouldn't have made trees, electronics, or the Japanese. There is something that can be done before this happens (or after if you're really stubborn). Take a piece of plastic, ¾" thick, cut it as shown in **Fig. 1**, and drill the required hole where the antenna will fit. The antenna support will help some if just set into position, but will be stronger if



cemented there. Two things to watch, the distance from the antenna to the side of the unit must be measured accurately to insure a good fit, and the hole for the antenna must be large enough to allow a sliding fit without much play. This may mean that if your antenna is an odd size, you will have to drill a small hole and enlarge it with a rattail file. Now, on the other hand, if you want a beam antenna, you're on your own!

. . . WA4VQR

Soldering Tip Top

One of those necessary parts for the ham shack that is hard to remember when you are in the parts store is a new soldering tip. Like many hams, I have, for a long time, used short scrap pieces of large diameter bare copper wire (#10-#14) instead of commercial soldering tips. With the invasion of transistors in ham technology, I was faced with the choice of either burning my fingers with one of these constant heat soldering pencils or overheating the components with my large gun because the tips were too big and too hot for the circuits. I solved the problem by making tips with # 12 wire, then taking about a two inch length of the same size wire, wrapping half of it around the end of the tip and leaving the other half protruding. This forms an indirectly heated tip, with a lower temperature that can be varied by adjusting the length of the single wire that extends beyond the end of the loop, just as the temperature of the old-fashioned electrical soldering irons is controlled by sliding its moveable tip in and out. The tip can go into the smallest circuits, but won't sit on the bench smoldering when not in use.

David B. Cameron WA4VQR

A Report on the WTW Award

Since Gus is leaving for another DXpedition soon, Dave Mann K2AGZ will be the new custodian of the WTW. Files are in the process of being transferred at this time. Address all WTW correspondence to Dave at 1 Daniel Lane, Kinnelon, N.J. 07405

Gus Browning W4BPD

For those of you who are not familiar with our WTW rules. In brief they are basically:

1. All QSO's must have been since May 1, 1966, 0001GMT
2. All QSO's must have been on one band & mode (SSB, AM, NBFM all considered phone)
3. Separate WTW Certificate for the following:
   a. 100 countries on CW-28Mc WTW-100-28 Mc CW certificate
   b. 100 countries on Phone-28 Mc-WTW-100-28 Phone certificate
   c. 200 countries on CW 28Mc WTW-200-28-CW certificate
   d. 200 countries on Phone 28 Mc WTW-200-28 Phone certificate
   e. 300 countires on CW-28Mc WTW-300-28-CW certificate
   f. 300 countries on Phone-28Mc-WTW-300-28Mc Phone certificate
   h. 350 countries on CW-28Mc WTW-350-28Mc CW certificate
   I. 350 countries on Phone-28Mc WTW-350-28Mc Phone certificate
4. You can qualify for the above certificates on each ham band. But I have my doubts how long it will take someone to qualify for that WTW-350-CW on 28 Mc! But it is possible for a real go getter to earn, lets say, 4 certificates on 10, 15 and 20 meter bands.

In looking over the claimed scores that are being submitted to me for our honor roll I can see the interest building up in quite a number of different bands and modes. With the very FB conditions on the various bands I can see a number qualifying for their next higher WTW award—One certain fellow is getting very close to WTW-300 and I think he probably will have the cards on hand by next month and a couple of other stations are just behind him, so you see fellows—it's possible to make WTW-300 in just a little over 2.5 years of operation and "going after" QSL cards.

Any of you DX stations let me again remind you that there are many W/K stations that would like to become your QSL manager and many of these QSL managers actually pay to have your QSL cards printed themselves. The idea of DX stations getting a stateside QSL manager should solve the problem of QSL card's once and for all time. So pass the word around to your DX friends and tell them the many advantages of having a QSL manager. This would automatically eliminate the burdens of QSL's to those who have trouble with both money and time in sending them out.

THE WTW HONOR ROLL

7 MHz–CW:	W4BYB	151 countries
	W3WJD	100 countries
	W8ZCK	100 countries
14 MHz–CW:	K4CEB	102 countries
	W8EVZ	102 countries
	W4CRW	101 countries
	WA2DIG	100 countries
	K8IKB	100 countries
	WB6SHL	100 countries
	W9HFB	100 countries
	WB6NWW	100 countries
	W5ODJ	100 countries
	WB2TKO	100 countries
	WA9KQS	100 countries
	W1ETV	100 countries

	K5BXG	100 countries
	K4ASU	100 countries
	WA6GLD	100 countries
	W2UGM	100 countries
14 MHz–Phone:	K8YBU	291 countries
	WB2WOU	266 countries
	W4NJF	261 countries
	WA5LOB	247 countries
	W6MEM	245 countries
	W3AZD	226 countries
	XE2YP	209 countries
	WB2NYM	204 countries

Following all at 200 countries: W1MMV, K6CAZ, K3YGJ, W3DJZ, W2PV, PY3BXW

	W8BVF	192 countries
	WA5DAJ	187 countries
	W9KQS	161 countries
	VK3XO	153 countries
	W6YMV	150 countries
	WB2RLK	138 countries
	K2QOU	125 countries
	WB2NSG	122 countries
	K4GXO	120 countries
	K1SHN	111 countries
	W1SEB	110 countries
	W4TRG	106 countries
	WA4OPW	105 countries
	SVØWL	105 countries
	WØSFU	104 countries
	W3SEJ	103 countries
	CN8FC	103 countries
	VE3ELA	102 countries
	VE6AKV	102 countries
	K4VKW	102 countries
	W6OHU	101 countries
	W8WAH	101 countries
	WAØOAI	101 countries
21 MHz–CW:	W4OPM	100 countries
	WB2UDF	100 countries
	VE6TP	100 countries
	WA6GLD	100 countries
	WØRRS	100 countries
	WA9OTH	100 countries
21 MHz–Phone:	W4OPM	220 countries
	W6MEM	161 countries
	WA2FQG	155 countries
	WA5LOB	154 countries
	WA5DAJ	130 countries
	W9NNC	125 countries
	W8WRP	106 countries
	W2PV	104 countries
	WB2RLK	103 countries
	K5HYB	101 countries
	W2VBJ	101 countries
	K4VKW	101 countries
	WB2OBO	101 countries
	K9PPX	100 countries
	W6YMV	100 countries
	WA4WTG	100 countries
	WAØOAI	100 countries
	WA1EUY	100 countries
	WA8VFK	100 countries
28 MHz–Phone:	WA5LOB	136 countries
	W6MEM	129 countries
	WA5DAJ	117 countries
	W2PV	106 countries
	W2VBJ	104 countries
	WB2RLK	100 countries
	W4GJO	100 countries
	W5YPX	100 countries

Great starts here for some very interesting battles in DXING. If I have your score wrong please drop me your latest CLAIMED SCORES—not QSL cards—BUT WHEN you hit the next plateau in the WTW then you are to submit QSL cards to your WTW QSL check-point—if no point send them to me.

We now have a WTW Check point for W2/K2 land: Peninsula Amateur Radio Klub, Foot of 25th. Street, Veteran's park, Bayonne, New Jersey 07002.

MAIL ADDRESS: P.O. Box 531, Bayonne, N.J. 07002.

Still looking for a good Club in W1/K1 land—How about it fellows? Next month we will give the whole list of WTW check points.

. . . W4BPD

(...de W2NSD/1 continued from page 4)

amateur radio has been stifled, the country has suffered tremendously from a lack of engineers and technicians and has found it difficult to develop their communications and electronics industries.

In numbers we have strength and we need that strength badly. The time is drawing near when we will have to either fight for our frequencies or else watch them dwindle away as they have in the past. The time is here right now when we must organize our effort. What would our bands be like today if earlier amateurs had only made an effort to hold our allocations? Through complacency and laziness our "leaders" managed to lose 70% of the 40 meter band and 65% of the 20 meter band. Both of those bands used to be a megacycle wide, you know. They were given up without a battle and look at the mess that is left of them today!

What Can Be Done?

Every amateur who has the interest to try and help can do something to keep us from losing more frequencies. Something can be done right now, today! As a matter of fact, a month from now may well be too late. If every reader of 73 got on the air and talked one or two more amateurs into helping, the result would be a wave that could not be ignored.

If we are going to get amateur radio back into a growing institution we must make a major effort to interest more youngsters in our hobby. We need growth. We need to sell high school students on the fun of ham radio. This can be done in several ways.

First and foremost we need a strong campaign of national public relations and publicity. We need to have articles telling about the fun of ham radio appearing in Life, True, Look, Playboy and other national magazines. There are plenty of good ham writers and a wealth of material; all that is needed is one good man with PR experience and connections to organize the project. A good man will not be inexpensive, of course, and this means that an investment has to be made.

Perhaps you feel as I do that national publicity for amateur radio is a responsibility of the ARRL. They have the money right at hand to fund the project. They have the PR material at hand. They would seem to be the logical organization to work for the growth of ham radio. If this seems reasonable to you then why not get in touch with your ARRL Director and tell him that you want him to see that the League sets up a PR man or company to promote amateur radio. This is a very good time to dip into that over a half million dollars that is just sitting there in the bank and make it work for the survival of our hobby.

The next Board of Directors meeting is in early May, so you have only a few weeks to make yourself heard by your director. You actually only have a few days because your Director is supposed to send all proposals that he is going to make to HQ 60 days or more before the meeting. There is only one Board meeting a year so if you put off getting in touch with your Director for a few days then it won't make much difference and you will have lost your chance to have your say and make things happen

Perhaps you are not an ARRL member or the chap you work on the air turns out not to be a member. This is indeed likely, since only about 30% of the amateurs are ARRL members. This makes no difference. You can still have your say. Check in QST for the name and address of the Director of your area and call him or write to him and tell him that you are not a member, but that if you get the action you want, that you will think a lot more about becoming a member. Everyone works a lot harder for the dollar he doesn't have yet, believe me. The League is hurting and hurting badly for members. I think they will listen to you.

Writers like Jean Shepherd, K2ORS, who has won the Playboy prize for three years running for humor, could be egged into writing wonderful articles extolling amateur radio. But someone has to organize the effort and see that the stories and articles are placed where they will do the most good. Bandel Linn, K8LAP, who has done cover cartoons for us and occasionally scabs a cartoon for QST, is a nationally known cartoonist and could turn out ham-oriented cartoons which would help make ham radio a household word.

One good PR man with a reasonable budget could change the direction of our growth chart from the disasterous to the unprecidented. The ARRL Directors have for years been putting money aside for a rainy day. Is it going to get much more rainy than it is right now? If they just spent the money their nest egg *earned* each year for PR things would spurt ahead. The stock market, on the average, has been advancing at about 12% per year for many years now. 12% of $575,000 (last reported ARRL statement) would give $69,000 per year.

The money is there to use and now would seem to be one of the best times to use it. The question is, can you talk your Director into getting off dead center and getting this money working for ham radio? It is up to you to move your Director. Call him. Write to him. Talk to him if he sticks his nose into a club meeting in your area. Put on the pressure. And if you don't get some action, give serious thought about getting someone into the position next year that will listen to you. With just a little interest and effort on your part you can make things happen.

Washington Office

For many years I have pointed out that amateur radio is weak because we have no representation in Washington. We are so far out on the FCC organization chart that most Commissioners are not really aware that we exist, much less are important. When the Incentive Licensing proposals were sent in by the ARRL and hundreds of amateurs went to the trouble of writing in their opinions of the action to be taken, how much consideration did we get? The League Board wrote to the FCC asking for "leadership and guidance" and what did they get?

We got just what we paid for and deserved. We got shrugged off. Our problem was farmed out to someone who knew little of our problems and who, apparently, cared less. There is no sign that the hundreds of comments filed on Docket 15928 were even read or noted. The end mish-mash was an amalgam of the RM's filed and reflected little of the comments on the RM's.

The services of an attorney to file proposed rule changes with the FCC are needed and we have them in the body of the ARRL Counsel, W3PS. But amateur radio needs more than that. Far more. The seat of power in our country is in Washington and the seat of power in Washington is in Congress. The FCC works under the direction and funding of Congress and don't think that one person on the FCC staff forgets this for a minute.

The system that is being used for getting action in Washington now is one that works and works well, whether we approve of it or like it or not, and that is the lobby system. Any group that has a common interest that they want to seriously protect goes to the trouble and expense of having someone represent them to Congress. Most hobby groups that depend in any way on government legislation or direction have a strong lobby working for them in Washington.

You know very well about the work that the National Rifle Association has been doing. You have undoubtedly heard about the Aircraft Owners and Pilots Association. I remember a few years back when AOPA decided that they wanted a law made so that foreign pilots could use their radios when in the U.S. In a matter of weeks they had the new legislation through Congress. It took us years and the personal friendship of Barry Goldwater to get a similar bill through for ham reciprocal licensing.

Lobbying is tightly controlled by law and it is highly illegal for the ARRL Counsel to lobby for amateur radio in Congress. We need a registered lobbyist in Washington for our own protection. We don't need anyone terribly expensive. There are probably dozens of hams in the area that have had many years of experience in working with our government that would be proud to work in our behalf as lobbyists. I know that if I had managed to round up something on the order of $20,000 a year with the Institute I could have had someone working full time for us in Congress and also with the other government agencies that influence our future.

The next ITU frequency allocation conference is coming over the horizon and there are a great many things that amateur radio should be doing in preparation. One of the key points of pressure at a conference such as this is a solid U.S. delegation. This means that the delegates from our country must have orders from their agencies that amateur radio is to be protected. We did not have this support at the last conference. Amateur radio was *last* in line for frequency protection. Oh, there was a lot of beautiful oratory about the value of amateur radio, but when it came down to who got what in a frequency exchange, we came last every time. If we have Congress behind us you can bet that our order of importance will be much higher.

What Can Be Done?

Tell your ARRL Director that you and

your club want him to see that the League opens a Washington office, even if it is in the bedroom of a local ham. Tell your Director that you want to be represented in Congress. Tell him that you want action now, not a study of the feasibility or any other put-off. Point out to him that all of the other users of radio frequencies are in there putting on the pressure not only to hold what they have, but to take as much of our channels as they can.

Explain to your Director that with everyone else pushing against us and us not pushing back, there is only one way that things can go. Let him know that you remember that this happened to us before in the past and that despite repeated assurances that everything would come out all OK, our amateur bands were cut to shreds. Ask any old timer what it was like when they lost the major portions of 20 and 40 meters.

Remind your Director that at the last ITU meeting in 1959 most of the nations of the world officially requested serious cuts in our amateur bands and that only a most remarkable circumstance enabled us to put off the day of reckoning. Remind him that since that day the Asian and African countries have gained control of the ITU and they are not amateur radio oriented. Remind him that India requested that the amateur radio bands be reduced to 20 kHz width. Tell him that the time is here, right now, for him to speak up at the Directors meeting in May and demand that amateur radio have a lobby in Washington.

The ARRL is the *only* organization you have. You decided that it should be this way when you supported only one organization. Now make that chosen organization work for you. The Directors are supposed to run the ARRL and make the decisions. You are supposed to guide the Directors in their actions. Guide... be heard...get action.

SAROC

After hearing how much fun everyone has had in the past at the SAROC Convention in Las Vegas, I decided that I'd better throw caution to the winds and make the trip. It turned out to be true...I did have fun. So did Lin. We laughed ourselves silly at Buddy Hackett and his dirty jokes...Lin won a few dollars on the nickle machines...I lost it back on the crap tables. We wandered all around Las Vegas, gawking at the giant Freudian extravaganza signs, unable to identify at all with the flashing lights and plastic. We got furious at the Brooks Rent-A-Car...oooooh, those scoundrels!

The Convention was nice. I got a chance to talk with a few old friends and sold a few subscriptions. Everybody there turned out to already be a subscriber.

On the way back to New Hampshire we stopped off at Aspen, Colorado for a little skiing. I do believe that they normally have the best skiing conditions in the world there at Buttermilk Mountain. Aspen is an old mining town and the prices are mining town prices. They have more top notch restaurants per capita there than any place else I know, so perhaps it is worth the price. We skiied all day, soothed our sore muscles in a sauna in the evening, ate luxurious dinners and had a wonderful time.

Back in New Hampshire we found the ski slopes worn to ice and dirt patches, the inserting machine for renewal notices jamming, the furnace out, the plumbing frozen, the offset press on its last legs, and other normal catastrophies.

Your Club

The club code and theory classes probably need a lot more customers to keep busy. Where to get them? The obvious place is the local high school. You can interest fellows in joining the club and learning about amateur radio by inviting them to come to your club meetings. Have one of your club members in the school put meeting notices on the school bulletin board asking all interested to come out to a club meeting and learn more about amateur radio. And don't forget to offer refreshments.

Not all CB'ers are bad people and you might do well to get the club members who have CB rigs to check the channels for good prospects to come to club meetings.

Once you have interested newcomers in coming to your club meetings you must do all you can to make them welcome and make arrangements for them to quickly get to know more about our hobby. Have members with good stations invite them over for a demonstration. Show them some phone DX work, some VHF, and perhaps some RTTY. Let them see some of the gadgets that your members have built.

Once your club gets into the swing of interesting new blood into our hobby, more and more ways will develop for getting interest stirred up. Pass along the ideas through the pages of 73 so everyone can benefit.

.....**W2NSD/1**

Rules for the 1969 I.A.R.C. Propagation Research Competition

(A DX Contest with a Purpose)

CONTEST PERIODS: This year the contest will be run in two sections. CW/RTTY from 0001 GMT 01 March to 2400 GMT 16 March. Phone from 0001 GMT 29 March to 2400 GMT 13 April.
OBJECTIVE: Work as many stations in as many different CPR Zones as possible. Countries do not count. Work your own Zone only once for Zone credit.
BANDS: All bands, 1.7 through 30 MHz.
EXCHANGE: RS or RST report plus your CPR Zone number.
DUPLICATE QSO'S: You may work the same station as often and for as long as you wish. When a single QSO exceeds 6 minutes a new log entry shall be made for each 6 minutes or part thereof.
LOGGING: Use GMT only. QSO's may be made with stations not in the contest if all necessary information is logged.
SCORING: 1 point for each QSO except in your own Zone. Multiplier 1 for each Zone on each band, including your own Zone. Total score is the sum of all contacts multiplied by the total Zones for all bands.
CLASSES: Single operator–single band; Single operator–all band; Multi-operator–all band; RTTY–all band; Mobile–all band; All events–all band.
AWARDS: Winners in each category will receive a suitable certificate or other award. All entries of 100 or more valid QSO's will receive a CPR Certificate.

Logs and summary sheets may be obtained from IARC, Box 6, 1211 Geneva 20, Switzerland, or from L' Rundlett, 2001 Eye NW, Washington DC 20006. Logs must be posted by 1 June 1969 to Mr. Rundlett.

Linear Systems Acquires SBE

Linear Systems, Inc., of Watsonville, California, well known in amateur radio for its' "Century" and "Commander" mobile power supplies, has recently acquired the SBE amateur transceiver line. The acquisition of SBE is in line with the company's objective of becoming a principal factor in the amateur market. An improved version of one of the foremost products in the line, the SB-34 transceiver, will be available in early 1969. Linear Systems intends to introduce other new transceivers, power supplies and accessories for the amateur market during the coming year, however the SB-34 will continue to be an important part of the line for a considerable time to come.

RAGS HAMFEST MARCH 29TH

The Radio Amateurs of Greater Syracuse annual hamfest will be Saturday, March 29th, at the Song Mountain Ski Center near Tully. 10AM 'till 9PM; flea market, contests, tech talks, snacks, plus buffet dinner and main speaker. Come and have fun!

Testing The Minilab

Since we, as amateurs, are supposed to be able to make reasonable repairs on our equipment by ourselves, it behooved us to have enough test equipment on hand to find out what has gone wrong when disaster strikes. This can lead to a whole workbench full of expensive gear if it gets out of hand.

A recent ad in 73 for The Minilab seemed worthy of investigation. When our unit arrived for test we found that it was the usual VOM size, but that it had a printed circuit board and solid state circuits which made it not only a fine volt-ohmmeter, but also an rf field strength meter, an rf signal generator, an af signal generator and a substitution box for resistors and capacitors.

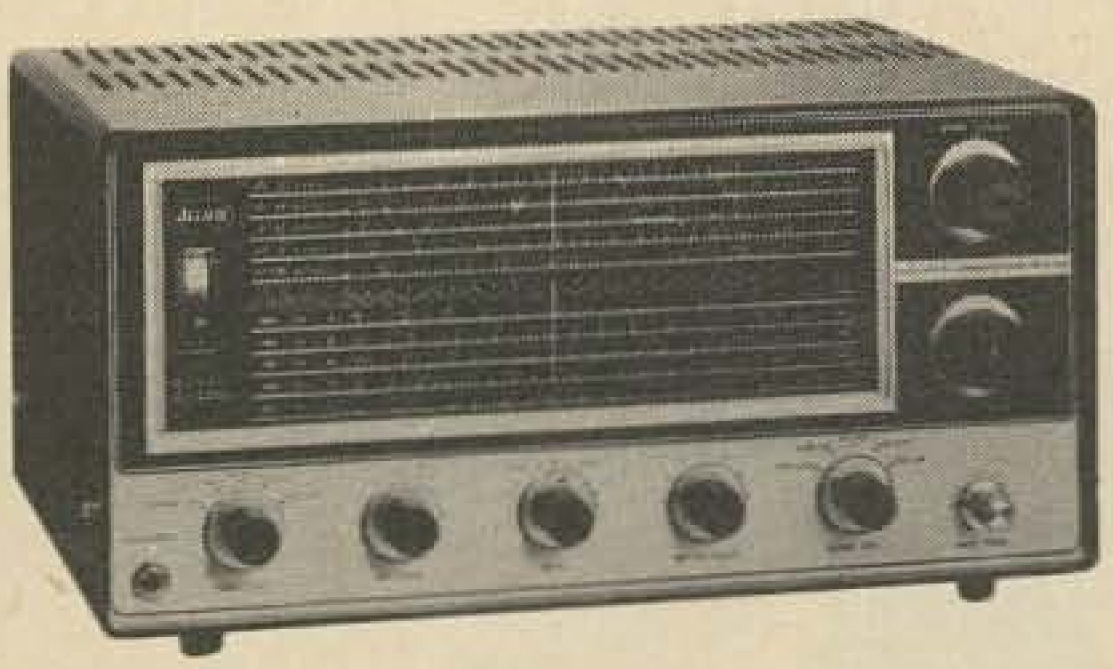
The af generator makes it possible to check out any audio circuit quickly, whether it be in a transistor radio, the transmitter speech equipment, a hi-fi amplifier or preamp, or a commercial sound system. The rf generator is tuned to 455 kHz and permits checking out the i-f system of most receivers. This oscillator can be retuned to 500 kHz if desired. This also is useful in providing a bfo injection for receivers which lack this function and will make even the little transistor short wave receivers capable of tuning in sideband signals or cw for you. The stability of some of these units can be something else though.

Once you think you've located a faulty part it is invaluable to be able to switch in a sample replacement to see if it makes the circuit work right. The Minilab has these substitution components built in.

Checking out a transmitter? Between the af generator and the rf field strength meter you can get a good idea of what is going on. There is a 9v battery output for testing transistor gear.

The Minilab is extremely well built. It uses a standard 9v transistor battery for powering the solid state circuits and two pencil light batteries for the ohmmeter function. The price of $25 seems quite reasonable for a package like this. Quite reasonable. Available from DGP, Box 431, Jaffrey, N.H. 03452.

NEW PRODUCTS



Allied Solid-State Receiver

This Allied Receiver, model A-2515, is designed for use by Short Wave listeners as Hams. The 5-Band AM/CW/SSB unit, featuring advanced solid-state circuitry, tunes all Amateur bands from 80 to 10 meters, international short wave, aircraft, marine and other short wave broadcasts and the standard AM broadcast band. Bands covered are 150-400 KHz, 500-1600 KHz, 1.6-4.8 MHz, 4.8-14.5 MHz and 10.5-30 MHz.

Of the 24 semiconductors in the circuit, two are Field Effect Transistors in the RF stage to provide exceptional sensitivity and low noise level. Four mechanical filters are used for sharp station separation; noise limiter and automatic volume control reduce noise, blasting and fading. Built-in variable BFO and Product Detector give clear reception of code and single sideband. Visual tuning is made easy with an illuminated S-meter. The illuminated slide-rule dial has calibrated band-spread for 80-10 meter Ham bands.

Other features are a push-pull audio stage with thermistor for low distortion, receiver muting connections and a headphone jack for private listening. Equipped with dual power supplies, 117VAC and 12 VDC, the receiver can be operated from house current, cars, boats, trailers and at camp sites. Price of the receiver is $99.95. A separate speaker is priced at $9.95. Allied Radio Corporation, 100 N. Western Ave., Chicago, Ill. 60680.

New 4-400A!

Amperex has stolen the lead on the industry with their new model of the popular 4-400A tube. There are two big improvements in this new tube. First is the new mesh cathode which is not only significantly stronger than the older cathodes, but eliminates noise caused by vibration and reduces hum to better than −60 dB. Second is the anode made out of graphite instead of sheet tantalum. The high thermal capacity of graphite virtually eliminates any possibility of damage to the tube due to temporary overload. Tantalum-sheet anodes are easily damaged by local overheating.

The glass base model of this tube is the 7527A and the metal shell base tube is the 8438A. Both have the Amperex sintered glass base for strength and better heat distributing characteristics. Write Amperex, Professional Tube Div., Hicksville, NY 11802 for complete data. Please mention 73.

K3QDD Receives Scholarship

Twenty-one amateur radio clubs in the Washington-Baltimore-Northern Virginia area have provided funds to the Foundation For Amateur Radio, Inc., for a $500 scholarship award. Richard Tavin, K3QDD, was awarded the John W. Gore Memorial Scholarship on the basis of his amateur radio activities and his high scholarship standing at MIT. Most laudable.

New Books

Semiconductors: From A to Z by Dahlen. Published by TAB at \$4.95 paper and \$7.95 cloth bound. 272 pages, over 300 illustrations. Here it is, theory and practical application of every known type of semiconductor, right on up through Integrated Circuits. Covers diodes, FET's, MOSFET's, tunnel diodes, varicaps, photo-FET's, light sensitive and emissive devices, unijunctions, field-effect diodes, SCR and zener diodes, etc. Written for the average ham rather than the engineer. TAB Books, Blue Ridge Summit, PA.

Handbook of Transistors, Semiconductors, Instruments and Microelectronics, Thomas. Published by Prentice-Hall, Englewood Cliffs NJ at \$20 in cloth. This is more for the engineer, the circuit designer or the laboratory technician. It is a practical guide to semiconductor operation, formation, ratings, characteristics, circuitry and applications. If you work with semiconductors this book is important to you.

There are 62 specific symptoms of trouble in a TV set, 14 color, 44 monochrome, and 4 sound. The **TV Servicing Guidebook: Problems & Solutions**, by Art Margolis, published by TAB Books, Blue Ridge Summit, Pa., at \$3.95 in paperback and \$6.95 in hard cover, describes 30 separate trouble-shooting approaches which those 62 symptoms call for. Service TV sets quickly, eliminate waste motion, cut trouble-shooting time to the bone. This is a practical how-to-do-it book, lavishly illustrated. 176 pages and over 100 illustrations.

104 Ham Radio Projects for Novice & Technician by Bert Simon, W2UUN, published by TAB Books, Blue Ridge Summit, Pa., at \$3.95 paperbound and \$6.95 hardbound. These are, for the most part, relatively simple circuits that will not strain the junk box severely. There are projects for 80, 40, 15, 6 and 2 meters, as well as UHF projects for 220, 432 and 1296 MHz. There are antenna projects, audio circuits, CW, preamps, preselectors, converters, and plenty of accessories. If you like to build or even think you would like to build, then this book will keep you busy for a long time.

Transistor Circuit Guidebook

Bad luck? Thirteen headings and up to 21 circuits per heading hardly qualifies as bad luck. More likely it is good luck for the purchaser, since anybody purchasing this book should find interesting material in it.

The circuits are supplied as schematics with parts lists and accompanying text. Their complexity ranges from a simple "rf Booster" circuit to complete systems for radio reception, hi-fi or counting and control purposes. Many of the entries are based upon manufacturer's literature showing applications for recent solid-state products.

Very complete information is included with some of the circuits, but others will require a bit of research before construction. Many of the circuits appear instantly adaptable to new projects. Ideas may be generated by looking, for instance, at schematics for 50 and 100 watt transistor rf amplifiers, an FM tuner front end circuit which could be adapted to six or 2-meter operation, an IC IF amplifier, or a common-base dip oscillator.

The intergrated-circuits application schematics (there are several of these) include a remote-control system, a low-noise amplifier, and three counter circuits. A decimal counter uses four bistables and ten NOR gates, but some ingenuity or careful reading may be needed to choose the appropriate IC's for this one.

A total of 104 circuits are presented in this handy 224 page book. Tab' #470 Transistor Circuit Guidebook is available at your dealer's or from TAB Books, Blue Ridge Summit, Pa. 17214. Price is $6.95 hardbound or $4.95 in paperback.

Electronic Circuit Design

Modern Electronic Circuit Design, by James D. Long. 284 pages; 170 illustrations. McGraw-Hill, $12.50.

Something very interesting is happening in electronics. The business is getting very complicated, and so is the hobby, but modern writers are finding better ways to present the subject. One change appearing in recent years is the development of approaches to the subject that are intermediate in difficulty between the no-math elementary approach (almost useless to anybody working at a level above that of wire-man) and the thorough-going network- and systems-analysis engineering approach.

Here is an example of this trend. The first real-circuit problem appears on page 3, and after two additional chapters of introductory material your attention is brought to one of the most basic facts of practical design: the behavior of real components. How are they different from their ideal counterparts? In many ways: parasitic properties, humidity effects, ageing, for instance. One valuable but not very obvious example is the difference between tolerance and stability of a capacitor.

Later chapters deal with equivalent circuits, transistor limitations, operating-point stabilization (a vitally important matter, if the circuit is to be reliable), and finally amplifiers and switching circuits.

Long's approach requires less math than good technicians are expected to understand, and the book contains many worked problems chosen to resemble real design problems. If you are feeling frustrated by experiences with circuits you've picked out of a book, or would like to work up something that's really your own development (and this is easier than you may believe) this book deserves your attention.

Test Instrument Projects

101 *Easy est Instrument Projects,* by R. Brown & W. Kneitel. From H. W. Sams & Co., 1968. $3.95 in paperback.

If you are interested in simple test instrument projects, here are a hundred and one suggestions complete with three handy substitution and color code tables.

Their complexity ranges from a simple battery-and-lamp continuity tester or a very basic signal tracer circuit through a more elaborate transistor checker and some power supplies to a metal locator, several test oscillators, and frequency calibrator circuits.

The projects listed in this book really are easy. All are simple, and additional data provided by the authors includes some hints and suggestions on parts substitutions.

FM Receivers

Frequency Modulation Receivers, by A. B. Cook and A. A. Liff. Prentice-Hall Inc., 1968.

This 527 page book is a thoroughgoing discussion of wide-band FM circuit technology. It is based upon an unusually small math background, not including any calculus, which will make it accessible to many radio amateurs and to service workers interested in this key part of the commercial electronics field. Wideband FM is a very effective system for conveying speech and similar signals, and after looking at this book I begin to see some of the reasons for its good reputation.

Most of these appear in the first three chapters of the book. These are, respectively, "Introduction," "Interference," and "Noise." Following this opening the writers proceed to discuss, one part at a time, the basic circuit sections common to all FM receivers (good designs are invariably superhets, but there is some variety of FM detector circuits). The last three chapters deal with tuning indicators, some miscellaneous topics, and with stereophonic broadcasting. Coverage of all topics is quite complete.

If you are interested in wideband FM for communications purposes, as a hobby, or if it plays a part in your career, this book certainly deserves your interest.

Bench-Tested Communications Projects

What is the difference between a bench-tested communications project and another project that is not bench-tested? Maybe it is in the excellent photography, or perhaps in this book's good choice of subjects that are interesting, useful and not too hard to build. That is a rather hard mix to achieve, in real life.

The book is broken into four general sections: Experimenters' Delights, a set of six assorted circuits of general interest; Communications Capers, several projects interesting to hams and to CB'ers; Better Listening six circuits useful to anybody who is listening on the ham or shortwave bands, and Workbench Wonders, three test circuits and some good suggestions on using subassembly construction when making up new gear.

All the circuits described in this book have been published previously, and its editor, Julian Sienkiewicz of Radio-TV Experimenter and Elementary Electronics, has personally worked with them. This complete collection of construction articles is available from the Hayden Book Co., Inc., 116 West Fourteenth St., New York, N.Y. 10011 and is very reasonably priced at $3.25. Ask for their book #0788, *Bench-Tested Communications Projects.*

Data Book

Data Book for Electronic Technicians and Engineers, by John Lenk. From Prentice-Hall, $7.25.

If you are working in electronics, or have more than a passing interest in designing and building your own circuits, you might examine a copy of this book. Its writer has tried to sort out from all the thousands of possibly interesting or useful facts, charts, tables, and equations, the ones that are basic or specially interesting. He doesn't claim to meet all requirements, but has tried to supply a generally useful collection. I would say he has succeeded.

Chapter 1 is a review of the appropriate mathematics. It is not difficult mathematics, and the pages are not cramped full of tightly packed little bits of information. Following this are sections on passive circuits, and the components used in passive circuits. One chapter goes to AC concepts, another to antenna and transmission line data. Vacuum tubes are covered well, but transistors are hardly mentioned. There is a large appendix of tables, symbols, and some math functions.

Placing equations and other data very close to diagrams representing the system described is a nice idea that could get more frequent application. There is an unusual amount of explanatory text in this book, and that is a successful variation, too from some common practice.

The book is oriented to the needs of communications, rather than of industrial or control type circuit workers.

Tell our advertisers you Saw it in 73

Modern Electronic Troubleshooting

Would you like a really complete book on troubleshooting electronic circuits? A book which is written to be used? Probably most technicians and engineers who are working with electronics gear could use a look at this remarkably thorough book which manages to convey a lot of basically useful information without getting very theoretical. It starts with some ideas about checking diodes and transistors, spends a chapter on printed circuits, another on capacitors, and then goes into more general material.

This includes TV circuits, of course, and transistor radios. Two-way mobile gear is well covered, too. Certain types of problems receive special attention, and the entire text is scope-oriented simply because the oscilloscope is an indispensable tool for any serious serviceman. Since not all workers can invest large sums in the modern triggered sweep scopes, one chapter describes the installation of a transistor circuit for conversion of any inexpensive repetitive-sweep scope to a triggered-sweep instrument. There are chapters on other items of test gear, as well, adding up to 23 chapters in all. The illustrations are very good.

The price is $4.95 in paper but serious workers will probably prefer the $7.95 hardcover edition, which will stand more use. This book is a Best Buy, ask for their book #474, *Modern Electronic Troubleshooting,* from TAB Books, Blue Ridge Summit, Pa. 17214. But before you send for it, check your local distributor's shelves.

Modern TV Waveform Analysis

Should you be interested in TV servicing? Yes, and there are two good reasons. If there is any clear example of a complex technology appearing in people's homes, it is TV circuits. Those who feel TV programming is deficient in value must agree the technology that brings it into the living room is a remarkable achievement.

And another reason is that many amateurs are becoming interested in TV and TV-type transmissions. A study of the appropriate theory, even a careful and complete study, cannot develop the familiarity that comes when you try to understand what happens when the circuits do *not* work. This is the acid test. It sorts out the fellows who read one book so many times it's engraved on the skull, from those who look around more generally and find out how the circuits work.

One good book for the serious TG worker is *Modern TV Circuit & Waveform Analysis*, by Stan Prentiss. Stan's key idea is, what do you see if you look at the circuit with a good scope? Appropriate test gear is assumed throughout, which is a necessary assumption for the serious worker and a simplifying one for the man who is seeking a better background.

Chapter 1 discusses the basic waveforms and the circuits in which these waveforms are observed. Eight following chapters discuss the operation, adjustment and servicing of the basic circuit groups in TV sets. The color TV circuits should have received stronger emphasis in the Table of Contents since a quick glance could suggest the book does not treat this subject. Actually, it comes up in several chapters and Chapter 9, Chroma Circuits, is entirely devoted to this subject.

And Chapter 10 discusses troubleshooting solid-state circuits. It starts with notes on circuit design and continues to sections on locating defective parts and general troubleshooting procedures. Finally, several charts suggest approaches to common problems, and some schematics of solid-state TV sets are also included.

Ask for TAB book $476, *Modern TV Waveform Analysis*, at your local dealers' or from Tab Books, Blue Ridge Summit, Pa. 17214.

Hayden Books Catalog

Where do all the good books come from? If you have been surprised by seeing a specially valuable book on somebody else's shelf or offered by some distributor you do not visit very often, maybe you would like to find out more about what is available for your use. It could be very important, in fact, in today's highly competitive world. If you have a catalog, then you can discover what to ask for.

The Hayden Book Co's catalog carries entries in twenty-seven different categories, and 15 of these could be interesting to an advancement minded electronics worker. Mathematics and mechanical technology, radio operation, space technology, electronics, electronics servicing, and computer technology are only a few of the headings you might look under, depending upon your interests and business needs.

Each book listed in the catalog is described in the standard library style, and this is followed by a paragraph or more discussing the subject matter you will find in the book. In smaller print, there is a list of the chapters in the book. You can usually determine if the book will be useful to you, after a careful reading of this material.

There are two indexes at the back of the catalog. One is a listing of the books by title, and the other a listing by author. For instance, a book by Pullen is probably worth investigating, if you are interested in circuits. Looking on page 89, we find Hayden lists two of his books.

Ask for the Hayden Books Catalog, available from your dealer's or from Hayden Book Co., Inc.,

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 921 Isabelle Dr., Anderson, Indiana 46013. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland, Oregon 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements. ■

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Surplus Conversions

Hardly a week goes by without receiving many requests from readers asking where to find information regarding a particular piece of surplus gear they have picked up without a manual or any conversion information.

In addition to the following literature, *73's Index to Surplus* should give all the information as to where to find conversion for almost any surplus equipment. This handy reference is available from 73, Peterborough, N.H. 03458 for the modest sum of $1.50.

Editors and Engineers

Editors and Engineers, P.O. Box 68003, New Augusta, Indiana, have published three *Surplus Radio Conversion Manuals* by Evenson and Beach and the *Surplus Handbook, Vol. I* by W6NJV and W6NJE. Each costs $3. Here are the pieces of equipment covered in each manual:

Surplus Radio Conversion Manual, Vol. I. BC-221, BC-342, BC-312, BC-348, BC-412, BC-645, BC-646, SCR-274 (BC-453A and BC-457A series), SCR-522, TBY, PE-103A, BC-1068A/1161A.

Surplus Radio Conversion Manual, Vol. II. BC-454, AN/APS-13, BC-457, ARC-5, GO-9/TBW, BC-946B, BC-375, LM, TA-12B, AN/ART-13, AVT-112A, AM-26/AIC, ARB.

Surplus Radio Conversion Manual, Vol. III APN-1, APN-4, ARC-4, ARC-5, ART-13, BC-191, BC-312, BC-342, BC-348, BC-375, BC-442, BC-453, BC-455, BC-456-9, BC-603, BC-624, BC-696, BC-1066, BC-1253, CBY-5200, COL-43065, CRC-7, DM-34, DY-2, DY-8, FT-241A, MD-7/ARC-5, R-9/APN-4, R-28/ARC-5, RM-52-53, RT-19/ARC-4, RT-159, SCR-274N, SCR-508, SCR-522, SCR-528, SCR-538, T-15 to T-23/ARC-5, URC-4, WE701A.

Surplus Handbook, Vol. I. This book, subtitled, *Receivers and Transceivers*, is composed of schematics and pictures of the following gear. It doesn't give conversions. APN-1, APS-13, ARB, ARC-4, LF and VHF ARC-5, ARN-5, ARR-2, ASB-7, BC-222, BC-312, BC-314, BC-342, BC-344, BC-348, BC-603, BC-611, BC-624 (SCR-522), BC-652, BC-654, BC-659, BC-669, BC-683, BC-728, BC-745, BC-764, BC-779, BC-794, BC-923, BC-1000, BC-1004, BC-1066, BC-1206, BC-1306, BC-1335, BC-AR-231, CRC-7, DAK-3, GF-11, Mark II, MN-26, RAK-5, RAX, RAL-5, Super Pro, TBY, TCS, VT tube cross index.

CQ Handbook

CQ has two handbooks on surplus out. They can be ordered from CQ, 14 Vanderventer Avenue, Port Washington, N.Y. The first book, the *Surplus Schematics Handbook*, by Ken Grayson W2HDM, costs $2.50, and contains schematics and short comments about this gear: APA-38, APN-1, APR-1, APR-2, APS-13, ARB, ARC-1, ARC-3, ARC-4, ARC-5, ARC-5 VHF, ARJ-ARK-ATJ, ARN-7, ARR-2, ART-13, ASB, AS-81-GR, ATK, BC-AR-231, BC-189, BC-191, BC-221, BC-312, BC-314, BC-342, BC-344, BC-348, BC-375, BC-438, BC-474A, BC-603, BC-610, BC-611, BC-620, BC-640, BC-645, BC-652, BC-653, BC-659, BC-683, BC-684, BC-728, BC-733, BC-745, BC-779, BC-794, BC-906, BC-969, BC-1000, BC-1004, BC-1023, BC-1206, BC-1335, BN, BP, C3, CRC-7, CRO-208, CRT-3, DAE, F3, GF-11, GO-9, GRR-5, I-122, I-177, I-208, JT-350A, LM, Mark II, MD-7, MN-26, PRC-6, PRS-3, R-174, RAK, RAL, RAO-7, RAS, RAX, RBH, RBL, RBM, RBS, RC-56, RC-57, RDC, RDR, RDZ, RU-16, SCR-274, SCR-284, SCR-288, SCR-300, SCR-506, SCR-522, SCR-578, SCR-585, SCR-593, SCR-608, SCR-610, SCR-624, SCR-628, SPR-1, SPR-2, TBS, TBW, TBX, TBY, TCK, TCS, TG-34, TS-34/AP, TS-251/UP, VRC, VVX-1.

The other CQ book, the *Surplus Conversion Handbook* by Tom Kneitel K3FLL, ($3) contains conversion on these pieces of gear: ARC-1, ARC-3, ARC-4, ARC-5, ARC-36, ARC-49, ART-13, ATA, ATC-1, BC-191F, BC-224, BC-312, BC-314, BC-343, BC-344, BC-348, BC-375E, BC-453, BC-454, BC-455, BC-457A, BC-458A, BC-459A, BC-603, BC-604, BC-620, BC-624A, BC-625A, BC-659, BC-669, BC-683, BC-684, BC-696A, BC-779, BC-794, BC-946, BC-1004, BC-1068A, CBY-52232, PE-73, PE-103, R-129/U, RAX-1, SCR-177, SCR-188, SCR-193, SCR-274N, SCR-399, SCR-499, SCR-508, SCR-509, SCR-510, SCR-522, SCR-528, SCR-542, SCR-608, SCR-609, SCR-628.

SURPLUS CATALOG

Quick Index to Surplus Dealers in Your Area

GOV'T-INDUSTRIAL

SEND FOR OUR VERY UNUSUAL INTERESTING 68 PAGE CATALOG

GYROSCOPE–WORLD WAR II FAMOUS

Drift Meter Gyro— Use it as a Camera Stabilizer or for a Science Fair project — has a high momentum. Gyro wheel 4" Dia. & turns @ 11,500 RPM. AC input at 400 Hz, but will run on 12VDC with a 400 Hz power supply. A similar Gyroscope Camera Stabilizer is sold at over $800.00 in large camera stores. Has on-off switch & caging provision to lock movement when required. Has a machined mount to attach to item to be stabilized. Power Supply Kit for this unit $2.50 when with Gyro.

4K Gyro..$10.00 postpaid.
Power Supply – P.S. Gyro..............$2.50 postpaid.

D.C. TO 400 CYCLE POWER SUPPLY KIT

This is an indispensable item if you want to run Gov't Surplus aircraft or missile electronics. It will convert 12VDC or 6VDC to 110 volts, 400 cycle 35 watts. The kit includes a high quality potted transformer, transistors, resistors, diodes and instructions. No cabinet or hardware is provided. The output waveform is square, rather than sinusoidal, but our experience has been that this will not make any difference since military equipment is insensitive to waveform distortion. 400 Hz Power Supply Kit.....$4.90 p.p.

DUAL TRANSISTOR IGNITION SYSTEM

This system was made by Canadian Tire to sell for $35.00. These are Brand New fully wired surplus, not rejects. The extra high voltage coil provides smoother running at high speeds and longer plug life, and the lower current through the points makes for longer point life and faster winter starts. Special connector allows instant changeover to conventional ignition. Fully Guaranteed, with instructions ready to install for 6 or 12 volt negative ground car. CLOSE OUT SPECIAL: DTI........................$10.00 p.p.

750 Watt Electronic Lamp Dimmer Kit

Enhances lighting effects, and versatility and professional effects to general and unique lighting circuits with this solid state dimmer kit. You can create special lighting effects such as candle light for dining, entertaining, better TV watching. For 120V 60 Hz and 750 watt max incandescent lamp only.

Kit complete including instructions. You must supply the housing. ELDKC............$2.50 p.p.

MINI-BOX HEAT SINK

Made of gold anodized aluminum. Designed for transistor ignition systems. It is the very best heat sink assembly we have seen. Inside dimensions are 1¾ wide x 3-5/8 long x 2-3/8 high. 2 shelves inside for mounting transistors & diodes. Brand new with hardware. Use it in your next project to give it that professional look.

MHBS..$2.00 postpaid.

DIGITAL VOLTMETER KIT

Would you believe a Digital Voltmeter for $50.00? Would you believe $25.00 or $19.50.

We supply a large 6 Digital Numeral Precision Counter, a IN 420 Precision Reference Zener Diode, a 10 turn 0.25% Linearity. Potentiometer, A.D.C. Motor, and a precision gear train with mounting, for $19.50. You must beg, buy, borrow or steal a $10.00 operational amplifier (Analog Devices, Nexus or equal) & you're ready to roll. Schematic, instructions included. List price of components we supply is over $175.00.

DVM KITS ....$19.50 P.P.

15,000 Volt - 1.0 MFD CAPACITOR (G.E.)

Use this capacitor for flash tubes, exploding wires, power supplies, filters, lasers or energy storage. G.E. net price is $90.00. You'll get a big bang out of this one if you short it while its charged. These have high energy storage capacity and are useful for many things including spark gaps. Wt. 35 lb.

15 KV Caps.$9.50

5.5 RPM PERMANENT MAGNET MOTOR

5.5. R.P.M. Permanent Magnet Motor - Reversible, continuous duty, Ball Bearing various mfg. - globe, etc. A planetary gear reduction motor with a 10 oz. in. torque. Motor will efficiently operate with input varying between 3 VDC & 35 VDC producing an output speed between .3 & 5.5 RPM. Motor will serve many useful functions as telescope drives, turntables, and other slow speed drives. Dim: 1-3/8 dia. x 3-5/16 LG, Shaft Dim: 5/16 dia. [lg.

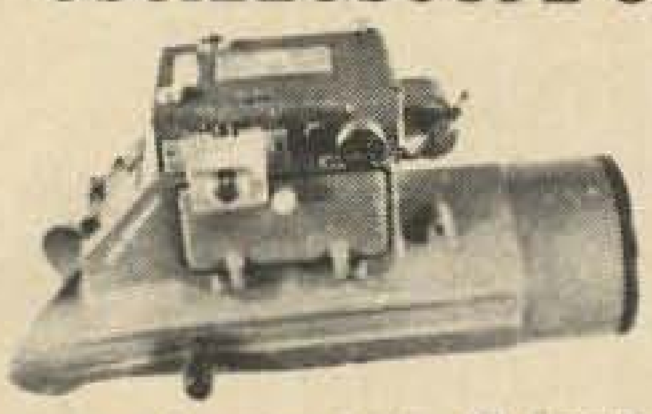
G.M.D.C. $4.95 P.P.

BF *Enterprises*
P.O. BOX 44, HATHORNE MASS 01937

SURPLUS BARGAINS

OF SURPLUS BARGAINS 25¢, FREE WITH AN ORDER. P.P.

DUMONT TYPE 295 OSCILLOSCOPE CAMERA



This camera uses Wollensaks finest F: 1.5 Oscillo Raptar lens. Fairchild Dumont net price $760.00. May be hand operated for single exposures. Uses regular 35 mm film and will mount on any 5 inch Oscilloscope. Only a few available, so hurry...............................$88.00 p.p.

GEIGER COUNTER-GOV'T SURPLUS

"CD" Type Radiation Survey Detectors are in like new condition, with instruction manual, and straps. Picture shows typical unit. Bright yellow plastic case, waterproofed. Meter readings may be made from 0.01r/hr. to 50r/hr. Units are clean, and are offered untested, as is at a low price of $10.00 less batteries, battery price about $1.50. With life of 400 hrs. or intermittent operation.

CD MD. No. 710..GC 710 .... $10.00 P.P.

Similar unit to above, but a later model with a more sensitive circuit and cast aluminum case painted bright yellow. In good used condition. LTD QTY. CD Model No. 720

GC 720 .... $14.50 P.P.

D.C. MULTI-VOLTAGE REGULATED POWER SUPPLY KIT

Here is a kit that should be received enthusiastically, because of its versatility and low price. We include in the kit the following items: 1) 1 each Power Transformer with 2 windings 40 volts center tapped at 4 amperes, 2 windings 24 volts center tapped at 4 amperes. Primary is 115 VAC 60 cycles. 2) 4 Power Transistors, 2N1137B. 3) 4 Zener diodes 10 volts, 1 watt. 4) 2 Reference Zener IN429, 6 volts. 5) 2 Capacitors 2000 MFD, 65 volts. 6) 4 1 Ampere rectifiers, 800 PIV. 7) 4 Rectifier-Heat Sink assemblies 25 amperes. 8) 4 Each trimpots 105v 1 watt.

With this kit we supply schematics of different regulated and unregulated supplies which can be built with this material. You can tailor the combination of windings you use to produce four or more different output voltages as you may require for whatever you are building. Particularly useful for stereo amplifiers, etc.

RPSK .... $20.00 P.P.

SOLID STATE BARGAINS

- *Items $1.00 Each P.P. or 6 Items for $5.00 P.P.
- *1N429 Zeners (RUE) .... 3 for $1.00
- *10 Volt Zeners (RUE) .... 6 for $1.00
- *65 Volt / 90 Watt PNP Power Transistor (RUE). 2N1137B .... 3 for $1.00
- *Silicon Diodes 1 Amp 800 PIV (RUE)........... .... 6 for $1.00
- *Bourns Trim Pots 10 ohm (RUE)....... 4 for $ 1.00
- *Computer Grade Cap. (RUE)
  - 2000 MFD-65V ea. $1.00
  - 4000 MFD-50V ea. $1.00
- *Silicon Diodes 2 Amp Mixed Voltages (RUE)....... ....6 for $1.00
- *2 25 Amp 200 PVI Silicon Diodes in heat sink (RUE) $1.00
- *Terminal Boards - 4"X5" with 75 terminals each side (RUE) .... 3 for $1.00
- *Xformer in 120 V 60 Hz out 6.3 V 1 Amp (RUE) .... ea. $1.00
- *Amphenol Connector — Quick — Disconnect — 32 circuits (RUE) .... ea. $1.00

(RUE) - Removed from unused equipment.

PSYCHEDELIC LIGHTING

Sylvania type R4336 Strobe Light Tube used for Airport lighting. This is the biggest tube Sylvania makes, rated at one 400 watt-second flash every three seconds, or faster flashing rates at lower power. 50 million peak lumens output. Sylvania circuit for flash tube included. Use for laser pump source psychedelic lighting, marine beacons, etc.

R4336 $15.50 P.P.

SYNCHRO-TAPE CONTROLLED TYPEWRITER

Remington Electric Typewriter, Tape Reader, Tape Punch and Control Unit.

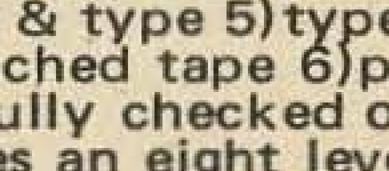
This is an amazing value! For far less than the usual price of a used electric typewriter, tape reader, punch or control unit, you can buy all four units, integrated into an operating system.

With this system you can eliminate the tedious chore of retyping information. For instance, to send personally addressed letters, punch one tape with names and addresses, the other with the letter. Feed thru the first tape, which will automatically stop at the end, then continue with form letter tape-----and create a personalized letter. This unit will function for many other uses in automatic data systems, and can be tied into computors. The units operate on 115 VAC 60 cycle. To reiterate with these units you can: 1)punch tape and type 2) punch tape only 3)copy tape 4)copy tape & type 5)type from punched tape 5)type from punched tape 6)punch & read info on side of cards. Fully checked out, good condition--

The system uses an eight level code & has a milkey board. Just the thing for "NC" machines or as a back up machine. Qty. Ltd.

STC $175. $25.00 crating charge. FOB. Peabody, Mass.

POCKET TRANSIT



The army used this transit for roughing in gun emplacements. But any one who needs quick and accurate surveying information will appreciate the precision and convenience of this instrument. These transists are selling at least 50% below current retail prices. We do not expect the supply to last long. For quick, accurate surveying, this transit functions as a sighting compass, prismatic compass, hand level and clinometer. Convenient for topographic and preliminary surveys of all kinds. With case and operating instructions.

BPT $24.50 P.P.

1000 MFD-TANTALUM CAPACITOR

Buy a brand new high capacitance Tantalum capacitor for less than the price of an equivalent aluminum foil unit. You gain the advantages of small size, high reliability, infinite life, and high temperature operation. Don't let the Electrolytic Capacitor be the largest size and least reliable component in the next home project or replacement. Regular net price of these units is $72.00. Brand new Tantalum Capacitors:

1000 Mfd @ 50 VDC-TC1000.........$2.00 postpaid.

400 Mfd @ 75 VDC-TC 400.........$2.00 postpaid.

BF Enterprises

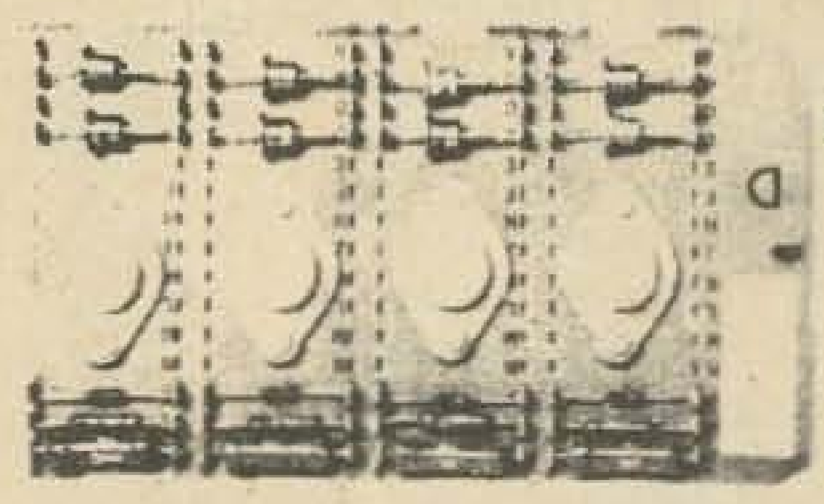
P.O. BOX 44, HATHORNE MASS. 01937

JOHN MESHNA JR.

19 ALLERTON ST., LYNN, MASS. 01904

COMPUTER GRADE CAPS

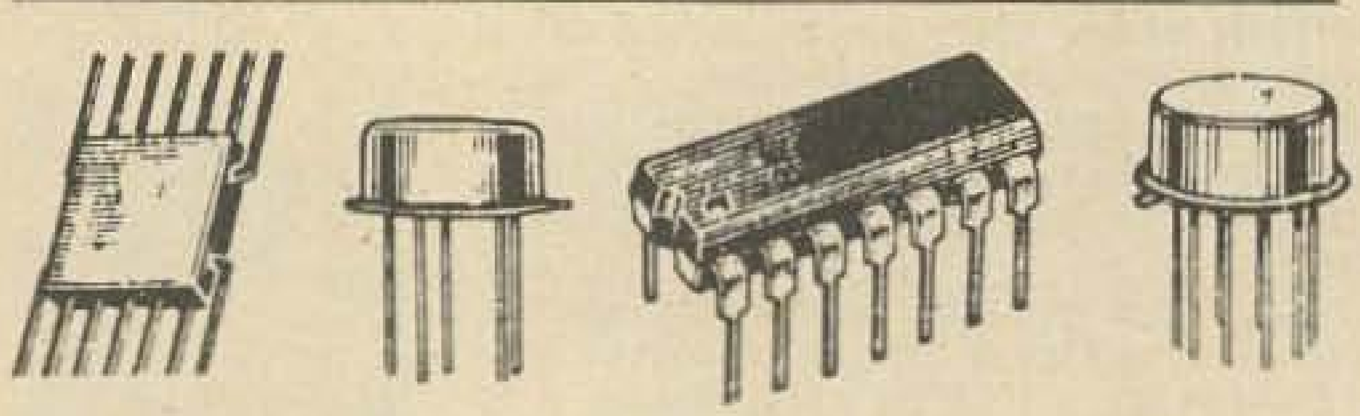
4,000 mfd at 50 volt ... $1.00 ea., 12 for $10.00
6,500 mfd at 18 volt ... $1.00 ea., 12 for $10.00



$ Bargain $

60 WATT TRANSISTORS 80 VOLTS

From computer assemblies, board with 4 each power transistors 2N1137B, 60 watt, 80 volt PNP power ... **$1.25 per board**



IC GRAB BAG $2.00 DOZEN

Mixture of one dozen units, some marked, untested. 10 pages of RTL & DTL specs to aid in identifying. All configurations, TO-5, TO-85, Flat-Pack, Dual Inline. At this price you can't lose. 12 for $2.00

RF FILTER

From HAWK MISSILE termination contract. Good for 5 amps, 600 volt, 10 cycles to 500 mc, insertion loss 60 DB-plus, low pass pi-network type, excellent as feed-thru filter in converters, transmitters. Hermetically sealed inside are 2 toroidal chokes and 4 low induct. caps. #41102 ... **$1.00 each, 6 for $5.00**

PISTON CAPS

Corning glass, direct traverse type, min. Q at max. C—500 at 50MC. 500 volt breakdown. Capacitance range 1-8 uufd. Brand new military surplus ... **3 for $1.00 or $3.00 per doz.**

SOLID STATE REGULATED FILTERED
29 VOLT 50 AMP DC REGULATED

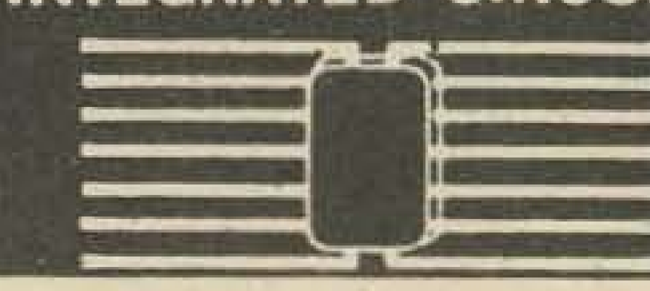
Operate on 115 volt 60 cycle input with output of 29 volts DC 50 amps filtered and regulated. Solid state components with standard 19 inch rack panel mounting. Excellent condition. Shipping wgt. 175 lbs. $75.00

GEIGER COUNTER, MLTRY SURPLUS

like new with book, untested
SURPLUS SPECIAL ... **$10.00**

FACTORY NEW

INTEGRATED CIRCUITS



Manufacturer's name withheld, but you will find it marked on every unit. Manufactured to Fairchild 900 RTL Series. All first grade, spec sheets included. A really amazing buy. Never previously offered by anyone at these ridiculous prices.

1.00 each or $10.00 dozen

Buffer	900
Dual Input Gate	2-903
JK Flip Flop	923
Dual JK Flip Flop	2-923
Dual 2-Input Gate, Dual Expander	1-914, 1-925
Dual 2-Input Gate Expander	925

VARACTOR SIMILAR TO MA4060A

Good for 40 watts at 432 MC, ea. tested in circuit, w/diagram for 432 MC tripler. **$5.00 ea.**

IBM WIRED MEMORY FRAMES.

Removed from high priced computors. Exlnt condition.

GIANT VALUE

4,000 Wired Core Plane	$ 9.00
4,096 Wired Core Plane	$12.50
8,000 Wired Core Plane	$13.50
8,192 Wired Core Plane	$15.00
16,384 Wired Core Plane	$19.00

$10 TRANSISTOR IGNITION $10

Complete electronic 2 transistor dual ignition system for cars, boats, trucks. Fully wired harness, dual primary coil, instant changeover from transistor to conventional or back. Neg. ground, 6 or 12 volt system. Complete with instructions, ready to install. Original price $35, now only $10.00 postpaid.

INTEGRATED CIRCUITS
FAIRCHILD

711 Dual Comp. Amp. ... 2.00 ea, 12/20.00
926 JK Flip Flop,
hi speed 923 (20MHz) ... 1.50 ea, 12/15.00
910 Dual 2-Input NOR ... 1.50 ea, 12/15.00

MESHNA SURPLUS BARGAINS

REFLEX CAMERA American made, takes 16 pics 127 film $1.50

GEIGER COUNTER complete w/meter, 550 volt transistor supply, less probe tube. #410....$4.00

ANALOG TIMER w/sync motor, DC motor, 8 hr. input to 10K output via gear train. Made by Veeder Root. #VR $1.50

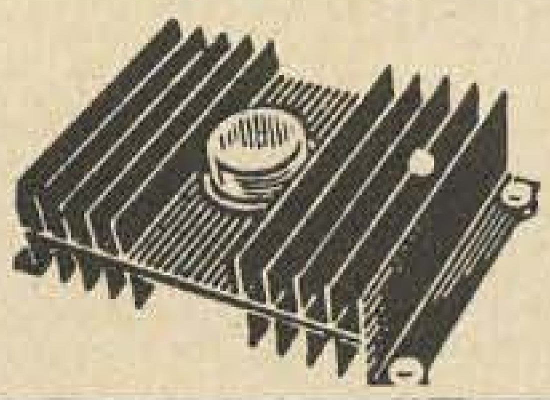
POLICE-FIRE converters. Kit when wired makes your car radio into short wave receiver. High band 100-200 mc or low band 25-100 mc. Either kit $5.00 or both kits $9.00

SNOOPERSCOPE TUBE see in dark, late model 6032 w/spec sheet $6.50

SUN CELL, make electricity from the sun, jumbo size w/leads & sheet ....75¢

FIRE ALARM HEAT SENSOR, any setting from 50 to 300 F. Make your own alarm system for fire alert. ....75¢ ea. 6/$3.00

EXPERIMENTERS RELAY package, 4 relays with instructions using as RF noise gen., telephone ring-blink indicator, AC buzzer........#418 1.00



HI-CURRENT TRANSISTOR AND HEAT SINK

100 Watt Transistor **$1.00**

NI-CAD battery cell 1.25 volt 6 amp hours $2.00

POLAROID FILTER, demonstrate polarizing theories 2 sheets 5x5 inch $1.00

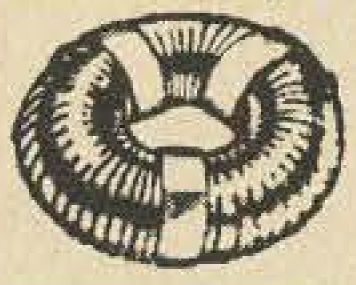
BATTERY CHARGER kit, 3 amps 6 & 12 volt output. #207 $4.00

FAIRCHILD CAMERA F-56, 20 inch focal length. In trunk w/film mags, cables, viewfinder, etc. Manual or electric. Package weighs 150 lbs., cost Gov't $2,500.00 each. $100.00

POWER SUPPLY KIT output 6-12-24 volts DC 6 amps from 115 volt house current. Used for powering surplus gear, plating, charging.....#340 12.00

GUN CAMERA, standard Air Force AN-6. Takes 50 ft. 16 mm. Xlnt. #447 ....$17.50

Open style
50c each, 12/$5.00
88 MH TOROIDS.



MICROAMP METER, brand new 100 microamps GE. #435 $1.50

METER w/thermocouple & sun cell demonstrates electricity from sun or heat. #435K $3.00

COMPUTER PC Salvage Boards 6/$1.00

Note from Meshna:

You have only yourself to blame if you are procrastinating on sending for our 84 page catalog of super-stupendous bargains, the choice of the surplus market, all hand picked by Meshna hisself. With todays shrinking dollar, you want all your shrunken buck will buy. We have a helluva job keeping up with catalog requests now. But we want our mailing dept. to keep sweating and we want you to have an opportunity of selecting the choicest bargains you ever found in the surplus market. Send 25¢ for our latest catalog #69-1 now in preparation. The 25¢ you send does not cover costs but does show a sincere interest on your part. As soon as 69-1 is printed, you'll get one.

SPECIAL HEAVY DUTY

HIGH CURRENT

Variable Voltage Transformer from unused Military equipment. Just the thing for your Linear. Variable from 0-130 volts good for 22.5 amps. Input of 115 V 50/60 cycle. ....new $28.00 each

SNIPERSCOPE M-3, complete, operational, less battery. See in dark $225.00

LENS KIT, 12 Eastman Kodak cells with experimenters sheet. #222 ....$1.00

EXPERIMENTAL VARACTOR DIODES

Package of 20 units with experimenters circuit explanation. Pack of 20 ....$1.00

RBA-RBB-RBC POWER SUPPLY $25.00
For 115 volt 60 cycle AC use, brand new in cartons, powers any of the above sets.
Cable with AC plug for above $4.00
Cable with Rec.-Power supply plugs $7.50

2N697 TRANSISTORS unmarked .... 12/$1.00

FILAMENT TRANSFORMER $2.50
115V 60C in, output 5.1 V 14.5 amp
12 KV insulated, wgt 25 lbs. 5.1 V 43 Amps.

866A SOLID STATE TUBE REPLACEMENT

1 year guarantee $10.00

1 AMP MIDGET SILICON DIODES

1000 PIV 35¢ each 12 for $3.50
1600 PIV 60¢ each 12 for $6.00

FILAMENT XFMR 2.5VCT 20 AMP
UTC, 10KV insulated. NEW $3.00

TELETYPE TEST SET I-193C, no tools, govt renewed $10.00

10 amp **TRIACS**

SALE

PRV	100	200	300	400
Sale	1.40	1.75	2.25	2.60

Customer pays all shipping

JOHN MESHNA JR.
19 ALLERTON ST. LYNN, MASS. 01904

IMPORTANT NOTICE!

DOCTOR'S ORDERS—store hours 11:00 AM to 2:00 PM Monday, Thursday & 9:30 AM to 2:00 PM Saturday. For other times, PLEASE write in advance, or call me at home 312 SU4-4426.

VARIABLE CAPACITORS—LARGEST STOCK—GREATEST VARIETY—ANYWHERE.

5 gang 402 pf/sec.	For OUTPUT side Pi-Network. All have ⅜" shaft, ½" long. Total 2010 pf. Will load 160 meter, without any inductance. 3¼" w. 2¼" h, 6" l. (3 LBS.) NEW	**$3.00 ea.**
3 gang	As above, but take-outs, good clean.	**$2.50 ea.**
	2 sections, 520 pf/sec. 3rd is 465 pf. total 1405 pf. 3½" w, 2⅜" h, 5" l. (3 LBS). NEW	**$2.50 ea.**
35 pf to 1017 pf.	GIANT Bread and Cheese Slicers. CARDWELL, 3500v. Micalex insulation. 5¼" w, 3½" h, 10" l. + 2¾" for ⅜" shaft, with threaded bushing. (10 LBS). 4/$25	**$6.50 ea.**
DUAL 30 to 211 pf.	CARDWELL, split stator. 6500v. Micalex insulation. 5¾" w, 3½" h, 11" long + 2½" for ⅜" shaft with threaded bushing. (10 LBS). NEW. 4 for $25.00	**$6.50 ea.**
DUAL 37 to 305 pf.	EFJ #152-504, 7000v. Split Stator. 5½" w, ½" h, 16¾" l. + ¾" & 1½" for two, ¼" shafts. (9 LBS). NEW. 4/$31.00	**$8.50 ea.**
DUAL 35 to 308 pf.	EFJ #152-852. 4500v. Split Stator. 5½" w, 7½" h, 11¼" l. + ¾" & 1½" for ¼" shafts. (6 LBS). NEW. 4 for $27.50	**$7.50 ea.**
13 to 353 pf.	EFJ #154-2 2000v. 2¾" w, 2½" h, 3½" l. + ¾" & 1½" for ¼" shafts. 2 LBS). NEW. 4 for $17.00	**$4.50 ea.**
12 to 244 pf.	EFJ #154-1.2000v. 2¾" w, 2½" h, 2¾" l. + ¾" & 1½" for ¼" shafts. (2 LBS). NEW. 4 for $11.50	**$3.00 ea.**
12 to 151 pf.	CARDWELL or MILLEN. 3000v. 2¼" w, 3" h, 5¾" l. + 1" for ¼" shaft. (2 LBS). Removed from new sets. 4/$13.00	**$3.50 ea.**
18 to 75 pf.	CARDWELL, 3 KV. Micalex insulation. 2½" w, 1⅜" h, 3½" l, + ¾" for ¼" shaft. (L LBS). NEW 4 for $6.50	**$1.75 ea.**

EFJ sub-miniature APC. All have 3/16" slotted shafts, with threaded bushings. NEW.
#160-102, 1.5 to 5 pf; #160-104, 1.8 to 8.7 pf.
Choice 4 for $1.75 .... **50c ea.**
#160-107, 2.3 to 14.7 pf; 1.1 to 15 pf (not EFJ).
Choice 4 for $2.60 .... **69c ea.**
#160-110, 2.7 to 19.6 pf. 4 for $3.00 .... **79c ea.**
#160-111, 2 to 11.5 pf. 4 for $2.25 .... **60c ea.**
#160-130, 3 to 32 pf. 4 for $3.25 .... **89c ea.**
#160-203, 1.5 to 3.1 pf butterfly. 4 for $2.60 .... **69c ea.**
#160-208, 2.3 to 8 pf; #160-211, 2.7 to 10.8 pf.
butterfly. 4/$3.25 .... **89c ea.**
#160-308, 2.3 to 14.7 differential. 4 for $3.25 .... **89c ea.**
#189-5, 1.7 to 11 pf, for P.C. boards, screw driver adjust. 6/$2.25 .... **50c ea.**

TRIMMERS, PADDERS, PISTON, CERAMIC. NEW

1 to 12 pf Piston, glass, by LRC. 4 for $2.60 .... **69c ea.**
1 to 5.7 pf ERIE NPO. 5 on bakelite board.
4 boards for $2.75 .... **75c bd.**
8 to 50 pf ERIE N 750. 3 to 30 pf. ARCO.
Choice 6 for $1.00 .... **18c ea.**
3 to 36 pf ARCO #33064. 6 for $1.00 .... **18c ea.**
7 to 100 pf CRL. or 10 to 125 pf. CRL padders.
6 for $1.00 .... **18c ea.**
25 to 90 pf padder, #44062. 7 for $1.00 .... **15c ea.**

TUBE SOCKETS, HEAT SHIELDS, CAPS

4 pin, bayonet base, 25w. For 866, 3B28, 811, take-outs, wired in pairs .... **69c pr.**
7 pin, large, ceramic wafer, for 837, 1625, 3AP-1
NEW. 4 for $1.10 .... **29c ea.**
7 pin, ceramic wafer, for 4-65A, 829B, 832A, etc.
NEW. 4 for $3.00 .... **79c ea.**
7 pin, shield base, septar, for 4-65A, 829B, etc.
NEW. 4 for $3.75 .... **$1.00 ea.**
7 pin, shield base, septar, for 7094, 5894, etc.
NEW. 4 for $3.75 .... **$1.00 ea.**
Octal, ceramic wafer, NEW. 4/$1.10, **29c ea**; octal, ceramic, ring mtd. 7/$1.0. **15c ea**; octal. blk bake, ring mtd., 11/$1.00, **15c ea**; 11 pin blk. bake., ring mtd. for crt., **39c ea**; 9 pin min. ceramic shield base, 5/$1.00, **23c ea**; same blk bake, 7/$1.00, **15c ea.**
Crystal socket, ceramic, for HC6/U crystals. ½" spaced.
11 for $1.00 .... **10c ea.**
Heat dissipating plate caps, aluminum, for ⅜", 807, etc.
4 for $1.10 .... **29c ea.**
Ceramic plate caps, ⅜" or ⅝". Clean, good take-outs,
choice 6/$1.00 .... **19c ea.**
Heat dissipating tubex shields, for 7 pin & 9 pin,
1½" or 2". 4/$1.10 .... **29c ea.**

CATHODE RAY TUBES, NEW

5 BP-1, **$6.50**; 3 EP-1, **$1.95**; 5 BP-1, **$5.50**; 5 CP-1, **$6.50**; 5 RP-1, **$10.00.**
MU-Metal Shields for CRT. to fit.
3 BP-1, new, **$1.75**; 3 JP-1 (hole for anode, take-outs),, **$1.50**; BP-1, **$2.50.**

TUBES, NEW or pulled from unused military sets—GUARANTEED

5763, 884, 6J4, 807, 5933/807W, 1616, 6AK6, 6AN5
6CG8, 5998/6AS7. 4/$3.75 .... **$1.00 ea.**
3B28, 837, 4/$14.00, **$3.75 ea.**; VR-75, 90, 105, 150,
OA2, OB2, 4/$3.00 .... **79c ea.**
6AK5, 6AL5, 12AU7, 12AT7, 12AX7, 6AU6, 5U4G,
5R4GY, 6AC7, 6SN7GT, 6V6GT, 12A6, 4/2.60 ...... **69c ea.**
1625, 954, 955, 956, 957, 958A, 6099/6J6, 12C8,
12J5GT, 1626, 12SJ7, 6/$2.75 .... **49c ea.**

REAL SCOOPS, late arrivals, TERRIFIC BARGAINS

EFJ #124-113	1450 pf, 600v screen by pass for 4 x 150 series tubes. Fits EFJ #124-109 & 124-114 sockets. NEW. 4 for $8.50	**$2.25 ea.**
30 to 50, 152-170 MC FM. rec.	By UTICA, for assigned frequency, trucks, cabs, police, fire, etc. Tuneable, over both ranges, with provision for crystal control, for 1 station, on each band. For 115 v. 60 cycle operation. Complete, in cabinet, but less speaker. BRAND NEW, close-out discontinued tube model. All will need final alignment touch-up, with alignment instructions, booklet. (15 LBS.)	**$50.00 ea.**
144 MC Frequency Meter	Originally made for secret gov't. project. With instructions for converting to 2 meter. RF section, in copper box, 6" sq., 6¼" h. Has dual, split stator 15 pf variable capacitor, coil, 535 & 6SH7 tubes. Also, 115v 60 cycle power supply, 5Y3 GT, VR-105 & VR-150 tubes. 6J5GT mixer. ON-Off switch, pilot light, fuse post, volume control, audio output jack, SO-239 for RF input, 5" velvet vernier. In gray cabinet, 8" w, 11¾" d, 9¾" h. NEW.	**$12.95 ea. (25 lbs.)**
multi tap xfmr.	Feeding 115v into full winding on the center tapped side, output on multi tap side is 0-20, 35, 45, 55, and 120v. Feeding 115v into full multi tap winding yields 100v CT. For 60 cycle, 2.50 VA. 4½" w, 2¼" d, 4" h; 3½" x 4" mounting centers. Terminal board 3½" x 6". (11 LBS).	**$3.50 ea. with schematic**
3½" rd. meters	By COLE of L.A. All are BRAND NEW, with dial face, black figures on white background, divided into 40 divisions, NO NUMBERS, NOT INSTALLED in meters. Ranges as follows: 0-50 ua DC. 4/$11.25 **$3.00 ea.** 0-100 ua or 0-200 ua DC. 4/$10.50 .... **$2.75 ea.** 0-1 ma DC. 4/$9.50 ..... **$2.50 ea.** 0-5 MA or 0-10 MA DC. 4/$8.50 .... **$2.25 ea.**	
85 KC I.F.	Older type, for BC-453, NEW. 4/$3.75	**$1.00 ea.**
	Later type, high-Q, ceramic, for R11. 4/$4.75	**$1.25 ea.**
Range FILTER	A **MUST** for C.W. or RTTY. 3 position switch—RANGE passes 1020 cycles; voice rejects 1020 cycles; both no filter action. Has two jacks, for PL-55; and 6 ft. cable with PL-55. (3 LBS). 4/$8.75	**$2.25 ea.**
NI-CAD BATTS.	5 amp-hr mil specs (8 amp-hr commercial). 2" w, ½" thick, 3" h. + ¼" for terminals. Excel, used. (2 LBS). 4/$9.50	**$2.50 ea.**
88 mhry torroids	Standard telephone type. Two 22 mhry windings, on one core, wire in series. 5/$2.00	**45c ea.**
velvet vernier	2" dial. 8:1 ratio. JAP. NEW (1 LB). 4/$5.50	**$1.50 ea.**
TEST LEADS	60" long, red & black. 4" prods. JAO. 4/$1.85	**50c ea.**

CO-AX CONNECTORS, NEW, current production (*) WWII surplus.

PL-259, 10/$5.25, 5/$2.65, **55c ea**; PL-259A*, 10/$2.60, 4/$1.10, **29c ea.**
SO-39, 10/$4.00, 5/$2.15, **45c ea**; CH-239 (1 hole) 5/$2.25, **50c ea.**
M-359, 5/$2.25, **50c ea**; M-359*, 4/$1.50, **39c ea**; M-358 (T), **$1.95 ea.**
PL-258, 5/$3.75, **79c ea**; DOUBLE MALES, don't bind, 5/$5.25, **$1.10 ea.**
N type, 50 ohm-UG-21/U, 4/$1.50, **39c ea**; UG-58/U 4/$2.60, **69c ea.**

All prices are NET, FOB my store, Chicago. All offerings subject to prior sale, and subject to price change, without notice. Illinois orders, add 5% to cover "sales tax." PLEASE include sufficient to cover postage & insurance; any excess returned with order. Send SASE for flyer.

B C Electronics 2333 S. Michigan Ave.
(312 CAlumet 5-2235) Chicago, Illinois 60616

DUMONT 304-A OSCILLOSCOPE

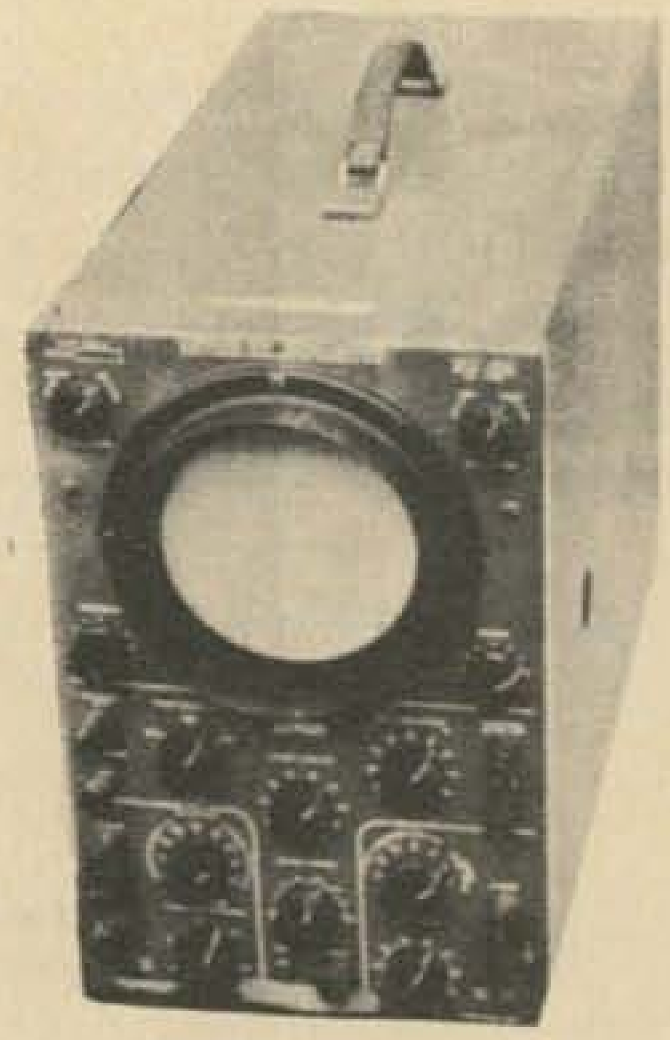
Specifications:

Y Axis amplifier:

Sensitivity: 0.025V pp/inch.
Frequency Response:(DC coupled) DC to 100 kc (down less than 10% @ 100 kc). AC coupled – 10 cy to 100 kc down less than 10%.
Transient Response: Rise time (10% to 90%) – 2 microseconds or less.
Overshoot: 2% or less. Decay: (direct coupled)–none. (Capacity coupled)–less than 10% in 45 milliseconds. Input impedance: 2 meg & 50 pf.

X axis Amplifier:

Frequency and transient response same as Y axis. Sweep frequencies (recurrent sweep) -- 2 cy to 30 kc. (may be reduced to 0.5 sec. sweep time with external capacity). Driven sweep: 0.5 sec. to approximately 30 microseconds. Expansion: to 6 times screen diameter. Built in calibration voltage of 0.1V pp and precision input attenuators allow calibration over entire range. Contains 21 tubes. Shipping weight 70 pounds.



TYPE 304 A.R. SAME AS ABOVE EXCEPT RACK MOUNT. PRICE $99.50

POWERSTAT

Late Model 3 pn 116B 10 amp 120V 60 cycle. Rated 0-140V, 10A, 1.4KVA output. These are the latest type and are about the same size as the older 7.5 amp type. Complete with 3 pin U.L. cord, receptical and on-off switch.

PRICE......................................*$14.95*

TEKTRONIX SCOPES – EXCELLENT CONDITION, Checked and Guaranteed.

Type 511.............................*$99.50*
Type 512.............................*$150.00*
Type 513.............................*$195.00*
Type 517.............................*$195.00*

GENERAL RADIO MODEL 1800B

Vacuum Tube Voltmeter
Voltage range: DC .01 to 150V
AC 0.1 to 150V
Accuracy: ± 2% of full scale
Freq. range: 15 cy to approx. 400 mc ±1db
EXCELLENT, CLEAN CONDITION........
PRICE......................................*$59.95*

TDA-2 RTTY TEST SCOPE

The Selma Telegraph Distortion Analyzer type TDA-2 is a self contained portable unit designed to measure bias and distortion of telegraph start stop signals. Distortion is indicated by vertical pips displayed in a rectangular pattern on the face of a cathode ray tube. Measurements can be made while machine is operating. Measurements can be made on circuits operating at 60, 75 or 100 OPM on 20 or 60 ma neutral circuits or 30 ma polar circuits. Distortion measurements from zero to 50 percent with an accuracy of plus or minus two percent can be made. The set is patched in series with the loop and direct measurements made. No special skills required to make measurements after a few minutes of practice. See your distortion, then adjust and watch it disappear.

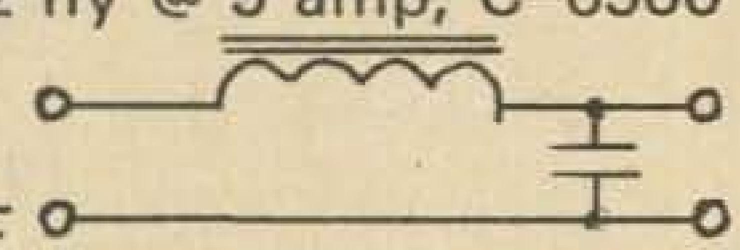
PRICE.....................*$49.50 ...F.O.B.*...........

TRANSFORMERS

110/220V pri, 2000 or 2400V CT sec. CCS. *PRICE*.............................. *$4.95*

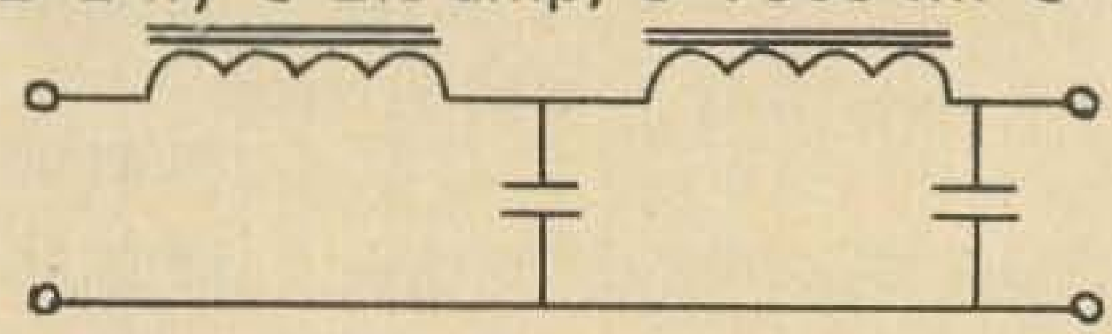
L–C FILTERS

Single Section:
L=2 hy @ 5 amp, C=6500 mf @ 75V



PRICE.. *$1.95*

Dual Section, each....
L=2 hy @ 2½ amp, C=7500 mf @ 40vdc



PRICE..*$2.95*

SORENSON "RANGER" REGULATED DC POWER SUPPLY Model 600B

Specifications:
Output voltage range: 0-600 VDC
Output current: 0-500 ma
% Regulation Line: ± 0.25%
Load: ± 0.25%
Ripple (max RMS millivolts): 3
Fil. Supply: 6.3 VAC @ 15 amps.
Bias Supply: 0-150 VDC
Internal Impedance: 2 Ohms
Cabinet: 17"W, 15"D, 10½"H.
Excellent, Clean Condition. Net wt 85 lbs
PRICE..*$49.95*

INTEGRATED CIRCUITS

MADE BY RADIATION INCORP.

TYPES:
MSV....
BSMV....
Dual & Nor
PRICE....................................*3/$1.00*

All prices are F.O.B. our Philadelphia warehouse. All merchandise described accurately to the best of our knowledge. Your purchase money refunded if not satisfied. Terms are cash. Minimum order is $5.

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LARGE QUANTITIES AVAILABLE
MINIMUM ORDER 10 PCS.
ALL SIZES-- 50¢ EACH
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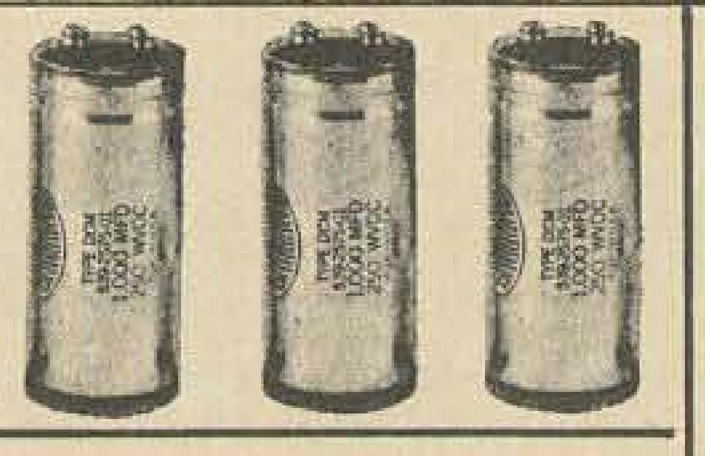


VALUE	SIZE
500 MFD - 200 VDC	2" X 4 1/2"
1250 MFD - 180 VDC	2" X 4 1/2"
1500 MFD - 100 VDC	2" X 4 1/2"
3500 MFD - 55 VDC	2" X 4 1/2"
3500 MFD - 75 VDC	2" X 4 1/2"
5000 MFD - 36 VDC	2" X 4 1/2"
5500 MFD - 45 VDC	2" X 4 1/2"
11,000 MFD - 19 VDC	2" X 4 1/2"
11,500 MFD - 18 VDC	2" X 4 1/2"
12,500 MFD - 16 VDC	2" X 4 1/2"
10,000 MFD - 15 VDC	2" X 4 1/2"
14,000 MFD - 13 VDC	2" X 4 1/2"
15,000 MFD - 12 VDC	2" X 4 1/2"

VALUE	SIZE
15,500 MFD - 10 VDC	2" X 4 1/2"
15,000 MFD - 10 VDC	2" X 4 1/2"
25,000 MFD - 6 VDC	2" X 4 1/2"
30,000 MFD - 10 VDC	3" X 4 1/2"
60,000 MFD - 5 VDC	3" X 4 1/2"
20,000 MFD - 15 VDC	2 1/2" X 4 1/2"
15,000 MFD - 15 VDC	2 1/2" X 4 1/2"
35,000 MFD - 12 VDC	2" X 6"
7,000 MFD - 13 VDC	1 3/8" X 4 1/2"
3, 000 MFD - 25 VDC	1 3/8" X 4 1/2"
2,500 MFD - 45 VDC	1 3/8" X 4 1/2"
3750 MFD - 75 VDC	2" X 4 1/2"

COMPUTER GRADE ELECTROLYTIC CAPACITORS

MO CASE
3/4 X 1 1/16 X 13/16 H

UTC MININDUCTORS
HERMATICALLY SEALED FOR USE WITH TRANSISTOR & PRINTED CIRCUIT APPLICATIONS. MO-.5 & MO-1 ARE FOR MEDIUM LOW FREQUENCIES ADJUSTED AT 1 V, 1 KC. THE MO-2 & MO-5 ARE FOR LOWER FREQUENCIES ADJUSTED AT 1 V, 400 CYCLES. ALL HAVE A TOLERANCE OF PLUS OR MINUS 2%.

TYPE	IND, HY	MADC	DCR OHMS
MO-.5	.5	23	54
MO-1	1	16	130
MO-2	2	8	130
MO-5	5	5	340

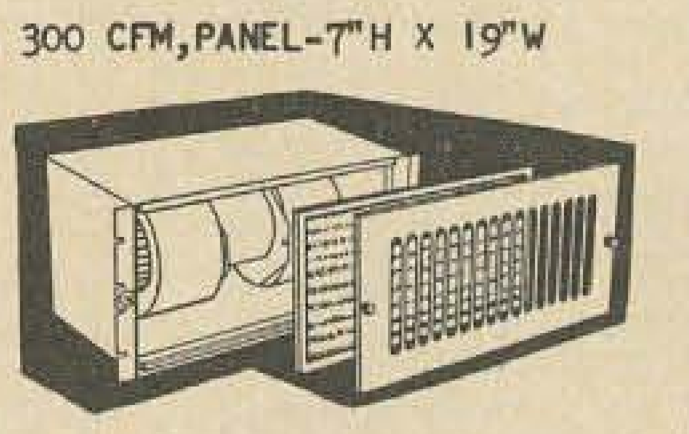
ANY OF THE ABOVE PRICE $2.50

DC PLUG-IN RELAY
MFR. FRED GOAT CO. INC.
COIL..24VDC NOM. 30VDC MAX.
COIL RESISTANCE .. 575 OHMS
CONTACTS .. DPDT, FORM C, 2 AMP, GOLD FLASHED SILVER ALLOY.
PLUGS INTO STANDARD OCTAL SOCKET. COMPLETE WITH CLEAR PLASTIC DUST COVER.

PRICE EACH -------------95¢

BLOWERS-- MCLEAN ENGINEERING LABORATORY
THESE ARE A COMPACT DUAL BLOWER WITH STAINLESS STEEL GRILLES. WASHABLE ALL METAL AIR FILTER WHICH ASSURES DUST FREE AIR.

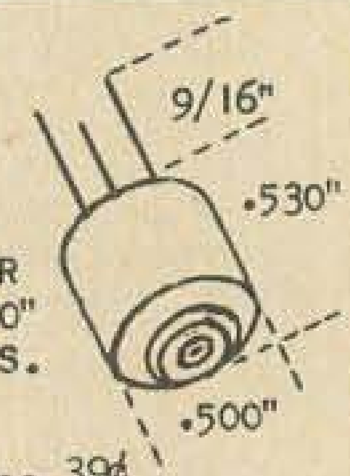
MODEL 2E408A 300 CFM,PANEL-7"H X 19"W



$15.00

A-B Microminiature Pots

ALLEN BRADLEY--TYPE F
250 OHMS, 20%, 1/2 WATT
9/16" LEADS FOR PRINTED CIRCUIT BOARDS. SCREW DRIVER ADJUSTMENT. BODY SIZE-- .500" X .530" LONG EXCLUDING LEADS.
BRAND NEW AND GUARANTEED



PRICE EACH .... 39¢

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT.

QUANTITY DISCOUNTS

1-9	as quoted	50-99	15%
10-49	10%	over 100	20%

ULTRA-MINATURE 2 GANG CV-200 VARIABLE CAPACITOR. MAX CAPACITY ANTENNA-148.1 UUF. OSC--65.2 UUF. TRIMMER CAPACITOR EFFECTIVE VARIABLE CAPACITANCE--6UUF. 40¢ EACH

MONARCH

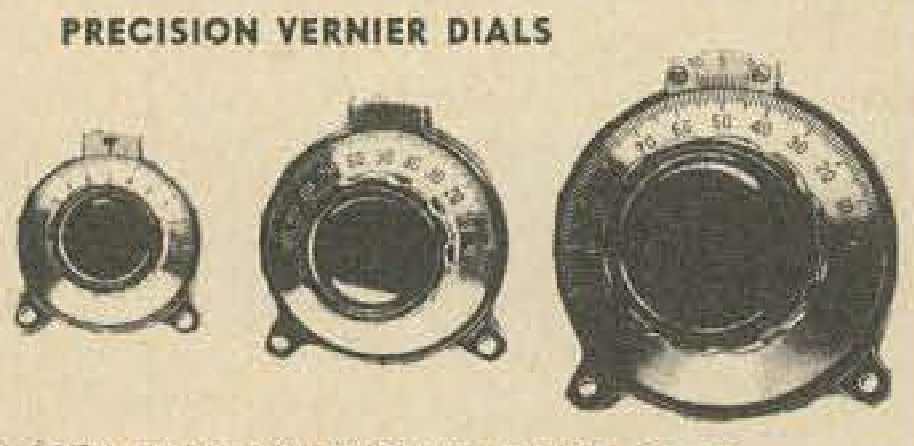
INDICATOR LAMP GENERAL ELECTRIC #2158D
3 VOLT, .013-.017 AMP, BULB STYLE T-1, BASE STYLE-WIRE LEADS. 14,000 PCS AVAILABLE.
PRICE IN LOTS OF A 100 PCS ......40¢ EACH

SOLID TANTALUM CAPACITORS

MFD	WVDC	TOL	MFR	TYPE	PRICE
.47	35	20%	KEMET	CS13B	$ .21
1	35	20%	G. I.	CS13A	.21
4.7	50	20%	KEMET	CS13B	.55
6.8	6	20%	KEMET	CS13B	.21
10	35	20%	KEMET	CS13B	.39
47	6	20%	KEMET	CS13B	.22
47	35	20%	KEMET	CS13B	.76
68	5	20%	KEMET	CS13B	.21
68	15	20%	KEMET	CS13B	.38
100	20	20%	KEMET	CS13B	.64
150	15	20%	KEMET	CS13B	.64
220	10	20%	KEMET	CS13B	.64

THE ABOVE HAVE PLASTIC INSULATING SLEEVE

PRECISION VERNIER DIALS

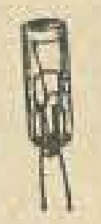


SMOOTH FRICTION VERNIER DRIVE DIALS, WITH CLEARLY ETCHED NUMERALS ON PROFESSIONAL-FINISH SATIN BACKGROUND. CALIBRATED OVER 180° READING FROM 0 TO MAXIMUM SETTING BY CLOCKWISE ROTATION. PLANETARY DRIVE WITH 8 TO 1 RATIO PRECISION BRASS AND BRONZE PARTS ARE MOUNTED IN ATTRACTIVE BLACK PHENOLIC HOUSING. FURNISHED WITH MATCHING BLACK PHENOLIC KNOB. SURFACE MOUNTING FOR ¼" SHAFT.

DIAMETER INCHES	MM	READING	NET PRICE
1 ½"	36	0 TO 10	$ 1.25
2"	50	0 TO 100	$ 1.56
3"	70	0 TO 100	$ 2.12

Lamps

SYLVANIA #10ES INDICATOR LAMP
10 VOLTS, 35-45 MA. 450 FOOT CANDLE 1/4" DIAMETER X 5/8" LONG WITH 9/16 WIRE LEADS. COMPLETE WITH BASE.

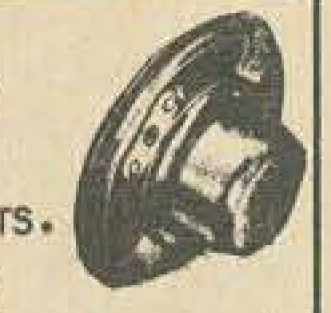


PACKAGE OF 15 FOR $1.00

POWER SUPPLIES

LAMBDA MODEL 29M -- RANGE 100 - 200 VDC 0-100 MA., 1% REGULATION, 5MV RIPPLE. 6.3 VAC FIL OUTLET, RACK MOUNTING. INCLUDES METERS FOR MONITORING BOTH THE VOLTAGE AND THE CURRENT. GUARANTEED.
PRICE EACH * * * * * * * * * $40.00
LAMBDA MODEL C880M -- 0-200 VDC, 0-800 MA REGULATION- .25%, 3 MV RIPPLE. ALSO A 6.3 VOLT OUTLET AT 20 AMPS. RACK MOUNT. INCLUDES METERS FOR BOTH SCALES.
SPECIAL ---------------- EACH $55.00

2" DIAMETER MINIATURE SPEAKER PERMANENT MAGNET TYPE. VOICE COIL- 8 OHMS IMPEDANCE. EXCELLENT FOR TRANSISTOR CIRCUITS.

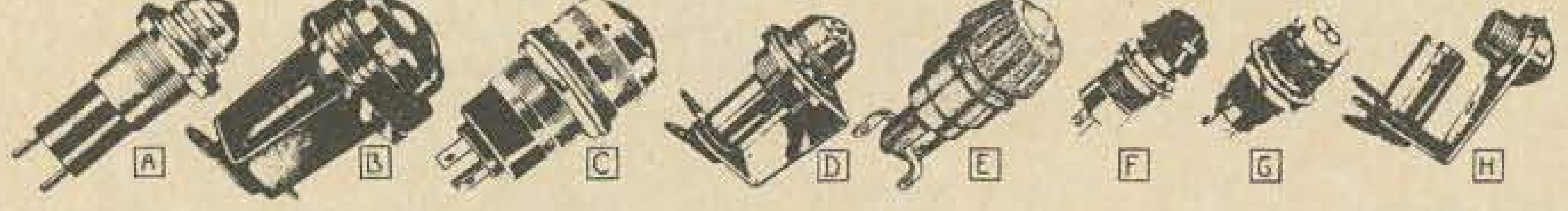


PRICE .... 40¢ EACH

BELDEN #8497 COILED MICROPHONE CORD 3 CONDUCTOR, 1 SHIELDED. NEOPRENE JACKET. RETRACTED LENGTH- 11½". STRETCHES TO 6 FEET. EACH --- 95¢

DC VACUUM TUBE VOLTMETER--TRIO LABS. MODEL-SF1306 0-3.5, 0-35V, MODEL-SF 675 0-3, 0-60, 0-300V, MODEL SF1239 0-150V, MODEL 105-3 0-1,0-3,0-10, 0-30, 0-100,0-300V. EACH -- $29.95

PILOT LIGHT ASSEMBLIES



ORDER BY LETTER AND COLOR OR NUMBER DESIRED. BRAND NEW ...35¢ EACH

* SPECIALS FROM OUR PACKAGE DEPARTMENT *

MINIATURE IF TRANSFORMERS - 455KC, PKG OF 4 FOR $1.00.

CRYSTALS - 347.50KC, 5.710MC, 1.500MC, 4.4520KC, 51.20KC, 4.500KC, 415.000KC, PACKAGE OF 5 FOR $2.00.

COILS - 27MC, ¼" DIA SLUG TUNNED - PKG OF 10 FOR $1.00

ASSORTED COILS PKG OF 10 FOR $1.00

ASSORTED RESISTOR PACKAGES - ALL SELECTED VALUES - $1.00 PER PKG.

HARDWARE PACKAGES - ½ LB PER PKG - 50¢EA.

SWITCHES - DPDT, SPST, SPDT, ETC. PKG OF 3 FOR $1.10.

NO C.O.D. ORDERS PLEASE,MINIMUM ORDER $5.00. PLEASE ALLOW SUFFICIENT FUNDS FOR POSTAGE.

WORLD'S FINEST SURPLUS BARGAINS

BIG 36 PAGE CATALOG FREE—Send For It Today!

CHECK THESE REAL "BUYS"

- Western Electric 48A Trans. & Rec., 250 watts, 2-18 MC, 30 Channels, 120 V 60 cycle $250.00
- Collins BC-460A Trans. 2-18-MC, 11 preset Channels, 200/400 Watts, 115/230 V 60 cycle $200.00
- TB-142A Transmitter, 275-510 KC, 100/150 Watts, 115 V 60 cycle Halli $100.00
- TB-143A Transmitter Amplifier, 275-510 KC, 750 Watts . . . Erc. Radio $100.00
- Navy Type CFT-52263 Transmitter, 200-550 KC, 133 Watts, 115 V 60 cycle $100.00
- BC-365 Trans. 150-550 KC, 350 Watts, 120/220 V 60 cycle $100.00
- Dumont 303A Oscilloscope 5" $150.00
- Dumont 256F Oscilloscope 5" $175.00
- Dumont 241 Oscilloscope 5" $100.00
- Dumont 275 Oscilloscope 5" .... $ 75.00
- Rutherford A-2 Time Delay Generator .... $ 35.00
- Airborne Noise Figure Indicator Type 74 .... $ 75.00
- Measurements Eng. CFR-I, Freq. Calibrated .... $ 75.00
- Northern Electric AIL Type 392 MTI Evaluator Signal Gen. w/3" scope .... $ 75.00
- Ferris Signal Strength & Noise Meter, 160-350 KC & 550-20 MC, No. P.S. .... $ 50.00
- 619E Heterodyne Detector, 25-5000 .... $ 75.00
- LAF RF Signal Generator 100-800 MC .... $ 95.00
- 700A WRBF Oscillator 50-40 KC; 10 KC-5 MC .... $ 75.00
- 616D Freq. Meter 100 KC-5200 KC .... $ 75.00
- I-107 Volt-Ohm Meter .... $ 15.00
- I-176 Multimeter .... $ 18.95
- I-126 Signal Generator 14-25/180-230 MC .... $ 40.00
- I-203 Power Meter .... $ 15.00
- AN/UPA-IB Detector Amp. Assy. .... Used: $ 30.00
- AM-405 AF-RF Amplifier 1000-1700 MC .... U. $ 50.00
- AN/UPM-40 Range Calibrator .... Re-New $ 75.00
- AN/GPM-17 Transponder Test Set .... Used $ 75.00
- AN/UPM-11 Range Calibrator .... $ 75.00
- AN/UPM-25 Radar Test Set, Freq., Power Spectrum, Bandwidth, etc. .... $ 75.00
- AN/UPM-35 Computer Test Set .... $ 50.00
- TS-62 Radar Echo Box 9200-9630 .... $ 20.00
- TS-69 Cavity Freq. Meter .... $ 25.00
- TS-67C Mod. ILS Signal Generator .... $ 50.00
- TS-89 Voltage Divider .... $ 12.00
- TS-92 Amplifier Alignment Test Set .... $ 20.00
- TS-126 Range Calibrator w/2" scope .... $ 25.00
- TS-224 Signal Generator .... $ 25.00
- TS-280 Echo Box for TPS-3 .... $ 15.00
- TS-497 Signal Generator 200-400 MC $225.00
- BC-610-H Trans. 2-18 MC. 300/400 Watts, w/BC-614 Amp., BC-939 Ant. Tuner, Coils, Oscillator assy. Tuning Units, 115/50-60 cy. op., crystal/MO. $500.00
- BC-939 Receiver 100-156 MC. AM w/115 V 60 cycle Power Supply, rack mounting, used .... $ 75.00
- TDQ Trans. 115-156 MC. AM 50 Watts w/115/230 V 60 cycle, Power Supply .... Used $ 75.00
- BC-797 Trans. 116-126.5 MC. AM 50 Watt Phone, 115 V 60 cycle .... Used $ 75.00
- BC-1000 Trans.-Receiver 40-48 MC, Battery, Pack set for portable use .... Used $ 50.00
- RDR Receiver 225-390 MC, 12 VDC .... New $ 39.50
- NAVY CRV-46136 Receiver 100-1500 KC, 3 Bands, less tubes. Requires external supply—R-N. .... $ 35.00

TELEVISION TELEMETER

Telemeter Pay Television Program Selector—Choice of 3 programs that are tone operated in the VHF band, with provision for depositing the amount of money required for each program as indicated on the coin register that also shows a credit balance when an overpayment is made. A pre-recorded tape will give program information when desired. With tubes: 1/12BH7, 1/6BE6, 1/6BA8, 2/6U8, 4" speaker, coin mechanism, tape magazine, etc. Size: 15 x 7 x 7". Wt.: 25 lbs. #1001/5 .... **$ 9.95**

MOTORIZED COUPLER

ANTENNA COUPLER UNIT PT #331001-110. For remote operation. Jennings variable vacuum capacitor 5-750 MMF, 5000 V motor driven 28 VDC with 2 Autosyn units attached. 115 V 400 cy. Also fixed vacuum 50 MMF 15,000 V. Two section rotary inductance coil approx. 100 Watt motor driven 28 VDC. One heavy duty switching assy., motor driven, 115 V 400 cyc. Blower; also other Motors, Selsyns, Diodes, Cap., Res., etc. In sealed housing. Size: 23 x 9 x 7". Wt.: 35 lbs. FSN 5821-606-0263 .... **$39.50**

TRANSMITTER

T-61/AXT-2 TRANSMITTER—Freq. range 264 to 372 MC. Receives radio & synchronizing signals and Blanking signals; and transmits modulated R.F. carrier which is generated in this unit by means of oscillator and power amplifier. Power req. 750 VDC 225 MA & 24/28 V. With tubes: 4/8025, 2/6L6, 2/6SH7, 1 ea. 5Y3GT, 6SL7GT, 6V6GT, & 955. Size: 9 x 14 x 18". Wt.: 40 lbs. Prices: Used: **$29.50.** Unused **$39.50**

MULTIPLEX

PHILCO CST-2 SIGNALING and TERMINATION UNIT. For use in multiplex systems for transmission of dial or ring-down signaling and terminates a four wire circuit of the multiplex into a two wire telephone circuit. A 3.5 KC tone is used for signaling. Also has controls for proper attenuation of voice level. Operates from 115 V 60 cyc. and is complete with 2/12AU7 tubes, relays, rack mtg. Size: 19 x 4½ x 12". Wt.: 25 lbs. Price: Unused .... **$ 9.95**

VISUAL FLASH LAMP

Used by aircraft or ground units for identification purposes. Designed to deliver extremely bright flash of light, 1 flash per 1½ sec. which can be seen by air in bright sunlight for 3 miles or 1 mile on the ground. Available for 6, 12 or 24 V operation. Consists of a high voltage converter using a vibrator type power supply. Sylvania tube #1073. Complete with 20 ft. cable, manual. Ideal for boats, planes, autos, boat landings, cottages, photographic work, etc. (Can be operated from 115 V by using our DC Power Supplies, listed page 7 in catalog.) Size: 17 x 10½ x 4½". Wt.: 50 lbs. Unused, checked for operation **$29.95**

Above Items in Limited Supply. Prices are Net, F.O.B. Lima, O. 25% Deposit on C.O.D.'s

STORE HOURS: 9:00 A.M. TO 5:30 P.M.—MONDAY THRU SATURDAY.

22 YEARS OF SERVICE IN QUALITY SURPLUS! **Phone: 419—223-2196**

FAIR RADIO SALES

1016 E. EUREKA ST. • P.O. Box 1105 • LIMA, OHIO 45802

JEFF-TRONICS

TUBES **75c** each, 10 for **$6.00**, 50 for **$25**. All tested. 2D21 6AH6 6AK5 6AL5 6AU5 OA2 12AT7 12AX7 12AV7/ 5965 6085

2E25 tubes, new **$1.50** each, 10 for **$10.00**

Dumont photomultiplier tubes, type K-1430, **$7.50** each, **10/$70.**

TS-33/AP radar wavemeter, has 50 microamp meter, new. .... **$ 10.00**

TS-34 scope, ... **$ 35.00**

BC-221 frequency meter, excellent, with xtal & book .... **$ 75.00**

TS-174 freq. meter, 20-250 Mc., excellent with xtal & book, 115 v. AC power supply. .... **$ 95.00**

TS-175 freq. meter, 85-1000 Mc. Have one in exc. cond., but with wrong calibration book. .... **$ 35.00**

TS-13/AP, radar freq. & power meter, x-band, 115 v. 60 cycles. exc. cond. 65 pounds. .... **$ 35.00**

ARC-1 100-156 Mc. transceiver with tubes, schem., conv. info. .... **$ 20.00**

ARC-1 only, less 832A tubes and some other tubes. .... **$ 12.00**

ARC-2, 2-9 Mc. transceiver, very good cond. .... **$ 45.00**

ART-13 transmitter, 2-18 Mc. with tubes. .... **$ 35.00**

"Solavolt", constant voltage transformer with variable output, 0-135 v. 7.5 amps., AC voltmeter. **$ 50.00**

Kay "Marka-Sweep" model RF-P. Sweep & marker generator, covers TV channels 2-13. .... **$ 40.00**

Berkeley model 5500 universal counter-timer. **$250.00**

General Radio 874-LBA slotted line. 50 ohms. 300-5000 Mc. May be extended to lower freqs. by adding lengths of air line. Like new, in wood case. **$175.00**

G-R 1216-A IF amplifier, 30 Mc., 4 IF stages, detector, video amp. RF attenuator, large meter in DB. Power supply self-contained. **$120.00**

G-R 1209-B unit oscillator, 250-920 Mc. **$100.00**

G-R 1215-B unit oscillator, 50-250 Mc. .... **$ 90.00**

Other G-R 874-series coax lines & accessories available.

METERS

All American made, d'Arsonval movements.

0-15 Amps DC, modern design, all plastic face. 2⅞" x 2". Body 2⅛" diam. .... **$ 3.50**

0-25 volts DC, same style as above. .... **$ 3.50**

0-1 DC milliammeter, marked signal meter, S-units 0-9, DB above S-9 to 60. Rectangular all plastic. 2¾" x 2½", 2⅛" diam. body. .... **$ 3.00**

0-100 DC microammeter, as above marked relative field strength, 0-100 .... **$ 3.00**

Smaller S-meter, modern style, 0-1 ma. 1¾" x 1¾" face, 1½" diam. body. .... **$ 2.00**

Same small S-meter in plastic box with zero adj. pot & cable. .... **$ 3.00**

TEST LEAD WIRE. 10 KV. working volts, .230" OD. Red or black. 500 foot rolls, reg. price $21 per roll, our price. **$750** per roll.

POWER TRANSFORMERS

350-O-350 v. 135 ma., 5 v. 3 A., 6.3 v. 3.6 A. Open style. .... **$ 2.00**

125 v. 20 ma., 6.3 v. .8 Amp. open frame mount. **$1.50** ea. .... **10/$12.75**

350-0-350 v. 70 ma., 700 v. 10 ma., 6.3 vct. 3.5 Amps. .... **$ 2.50**

495-0-495 v. 75 ma., 5 v. 2 A., 6.3 v. 5.4 A. open frame. .... **$ 2.00**

Isolation trans., 115 v. to 115 v. 30 watts. .... **$ 1.00**

Scope trans., 2750 v. @ 6 ma., 220-0-220 v. @ 224 ma., 135 v. @ 8 ma. oil-filled. .... **$ 2.00**

Scope trans. 1000 volts, and 2 fil. windings for 2X2. Herm sealed. .... **$ 2.00**

AUDIO TRANSFORMERS

Modulation trans. 3500 ohms ct. to 2000 ohms, encased. 100 watts. .... **$ 2.95**

Input: 400-600 ohm pri., 1 megohm sec. small round case, herm. sealed. .... **$ 1.00**

Input: 600 ohms ct to 20K ct. 1" diam. herm sealed. .... **$ 1.00**

Input: 400 ohms to 50K ct. 1" diam. HS. .... **$ 1.00**

Interstage: 20K ohms ct. to 20 K ohms split. HS. 1½" sq. .... **$ 1.25**

CHOKES

Variable inductor, 1½-12 hy., adjusted by Allen screw in side. 1½" sq. case. .... **$ 1.00**

Filter choke: 12 hy, 150 ma., 251 ohms, 2 Kv. test HS. .... **$ 2.00**

9 hy, 50 ma. 470 ohms, small round HS case. .... **$ .75**

1 hy, 95 ma., small round HS case. .... **$ .50**

15 hy, 40 ma. rect. HS case. .... **$ .60**

10 hy, 100 ma., rect. HS case. .... **$ 1.00**

Stancor C-2688, .01 Hy @ 12.5 amps DC, .11 ohm .... **$ 2.00**

8 hy, 800 ma. 7 Kv. test, 26 ohms, oil filled. .... **$ 10.00**

CAPACITORS

1 mf., 3000 v. Dc. oil. .... **$ 1.50**

6 mf. 600 vdc. oil .... **$ .75**

10 mf. 600 vdc. oil .... **$ 1.00**

2 mf. 600 vdc oil. round or rectangular can. **60c** ea. .... **2/$1.00**

Electrolytic can capacitors.

100 mf. 25 vdc. **25c** 400 mf. 25 vdc. **35c** 20 mf. 50 vdc. **25c** 500 mf. 50 vdc. **60c** 75 x 30 mf. 150 vdc. **40c** 90 x 40 mf. 150 vdc. **40c** 100 mf. 150 vdc. **40c** 25 mf. 300 vdc. **50c** 125 mf. 350 vdc. **75c** 150 mf. 150 vdc. tubular, wire leads, **40c, 4/$1.25.**

VARIABLE CAPACITORS

170 pf. max., 1000 vdc. screw-driver adj. 1¾" sq. x 2¾" long. **60c** each. .... **2/$1.00**

Butterfly capacitor, 40 pf. per section, like used in SCR-522. **60c** each. .... **2/$1.00**

TUBE SOCKETS 10c each

Mica-filled bakelite with snap ring. 4, 5, 6-pin, octal, loctal. octal or 11-pin black bakelite with molded-in mounting ring. 7-pin min. or 9-pin min with shield base, mica-filled. 6-pin ceramic with mounting plate.

Round ceramic socket for 829B-832-4-65A: **60c** each, 2 for **$1.00**

Please include sufficient postage & insurance. Any excess will be refunded.

Send 10c for our flyer listing many more surplus items, and new and used ham gear and test equipment.

JEFF-TRONICS

4252 Pearl Rd. **Dept. M9** **Cleveland, Ohio 44109**

TOROID POWER TRANSFORMERS NEW AND UNUSED

T2—This toroid was designed for use in a hybrid FM mobile unit, using a single 8647 tube in the RF amp. for 30 watts output. Schematic included. 12 vdc pri. using 2N1554's or equivalent. Sec. 1: 500 volts dc out at 70 watts. Sec. 2: −65 volts dc bias. Sec. 3: 1.2 volts ac for filament of 8647 tube. Sec. 4: C/T feedback winding for 2N1554's. 1¼" thick. 2¾" dia......................$2.95 ea, 2 for $5.00

T3—Has powdered iron core and is built like a TV fly-back transformer. Operates at about 800 cps. 12 vdc pri. using 2N442's or equivalent. DC output of v/dblr 475 volts 90 watts. C/T feedback winding for 2N442's..............$2.95 ea, 2 for $5.00

TRANSFORMERS

P4—105-115-125 v 60 cy pri. 6.4 v @ 11A. 205 v @ ½A. 17 v @ 45 mA (relay power). Wt. 10 lbs ....$2.95 ea, 2 for $5.00

P5—Pri. 117 vac/12 vdc. Sec. 1: 295 vdc (v/dblr) @ 85 mA. Sec. 2: 12.6 vac @ 2.6 A & CT winding for vibrator. Double half shell. Wt. 2¼ lbs. ....$2.25 ea, 2 for $4.00

P6—Pri. 117 vac/12 vdc. Sec. 1: 275 vdc (v/dblr) @ 150 mA. Sec. 2: 12.6 vac & CT for vibrator winding. Wt. 4¼ lbs.................................$2.95

SR-42—46 type....................................2 for $5.00

P7—117 vac pri. Sec. 1: 185 vac @ 120 mA. Sec. 2: 6.3 vac @ 4 A. Double half shell mail box type. SX-146 type.........................$2.75 ea, 2 for $5.00

P8—117 vac pri. Sec. 1: 470 CT. DC out of bridge 660 v 300 mA max. Sec. 2: 100 vac @ 10 mA for bias. Sec. 3: 12.6 vac @ .75 A to 6.3 vac @ 6 A. Half shell HT-46 type. Wt. 7¼ lbs..............$3.50

P9—117 vac pri. Sec. 1: 900 vac @ 300 mA. Sec. 2: 100 vac @ 10 mA bias. Sec. 3: 12.6 vac @ 2 A. Double half shell. Wt. 16½ lbs....................$4.50

P10—117 vac pri. Sec. 1: 960 vac CT @ 160 mA. Sec. 2: 415 vac CT and tap at 100 vac @ 10 mA bias. Sec. 3: 12.6 vac @ 4.5 A. Double shell mail box type. Wt. 8¾ lbs...............................$3.75

OUTPUT TRANSFORMERS
59¢ each or 3 for $1.50

OT1—Transistor output TO-3 Power Diamond. 15 ohms primary impedance. Secondary 3.2 ohms. Pri. dc resistance 0.6 ohms, secondary 0.3 ohms.

OT2—Pri. imp. 7000 ohms. Sec. 3.2 and 500 ohm for phones or 70 volt line. 3 watts. Full shielded double half shell.

OT3—Primary impedance 5500 ohms. Secondary impedance 3.2 ohms. SX-122 type.

SEMICONDUCTORS

S1—Integrated Circuit. Rca CA3012 IF amplifier—limiter. Gain 61 dB at 10.7 MHz. 10 lead TO-5 package. With schematic........$ .75 ea, 5 for $3.00

S2—Amperex 2N2671 100 MHz FT. RF amplifier-mixer, 4 lead TO-5 case.........$ .40 ea, 6 for $2.00

S3—Amperex 2N2089 RF amp. mixer oscillator. ....$ .35 ea,12 for $3.00

S4—Delco DTS-413 Silicon NPN planar TO-3 case. 400 Vceo 100 mA continuous. Hfe 20 @ 5 v 500 mA. FT 12 MHz. Used as TV vert. output. ....$1.00 ea, 6 for $5.00

S5—Delco DTS-423 Silicon NPN planar TO-3 case. 700 Vceo 100 mA continuous. Hfe 10 @ 5 v 2.5 A. FT 12 MHz. Used as TV horiz. output. ....$1.00 ea, 6 for $5.00

S6—RCA 1N3754 Silicon Diode 1.3 A 125 piv. Single ended TO-1 case. Used as biasing diode in power amp base to emitter circuit or general purpose....................................$ .15 ea, 8 for $1.00

S7—Fairchild FD-100 ultra-high speed switching 2 nano sec. recovery time. Up to 500 MHz. 75 piv 10 mA. Used as general purpose rf and signal diode. Silicon planar type......$ .25 ea, 5 for $1.00

S8—Texas Inst. 1N746 Zener diode 3.3 v 400 mw. ....$ .50 ea, 3 for $1.00

S9—Sarkes-Tarzian 1N3020 Zener diode 10 v 1 w. ....$ .60 ea, 2 for $1.00

TUBES

The following tubes are made by RCA for a well known manufacturer of ham gear. They are marked with this name. These are NOT rejects, pullouts, or seconds, but are first line quality and are excess stock of a line termination run.

6BA7	$1.50	4 for $5	9 for $10
6CX8	$1.25	5 for $5	11 for $10
12AU6	$0.75	5 for $3	10 for $5

CAPACITORS

C1—Aerovox transmitting capacitors for use in coupling power amps to Pi-nets. High amperage, high voltage (15 kv) type HI-QHPA42BC axial screw terminals ¼-20 with screws. Size: 1¾" by 5/8" long. All silver const. Heavy silver plated terminals and screws. 6800 mmfd. ....$2.00 ea, 3 for $5.00

C2—Plastic Cap Inc. Type "OF" high voltage glass capacitor. .005, 8000 v. Size: 1¾"x ¾"x 8-32 screw terminals.....................$1.50 ea, 4 for $5.00

C3—Mallory computer grade electrolytic capacitors 1550 mfd 150 vdc. Fresh stock for use during 1970. Size: 2"x 4¼" with plastic insulating sleeve. ....$1.00 ea,10 for $7.50

RELAYS

LRY1—Potter & Brumfield latching relay SPST 115v-115v dual coils, horizontal mounting. 1¾"x 3"x 2"..................................$ .75 ea, 5 for $3.00

LRY2—Potter & Brumfield latching relay SPDT 115v-24v/12vdc.....................$ .75 ea, 5 for $3.00

RY1—Sensitive relay for use in transistorized circuits. 1000 ohms. Pull in 5 mA at 5 v. SPST. Can be used as SPDT. 1¼"x 1¼"x 1". ....$ .75 ea, 5 for $3.00

RY2—Sensitive relay for use in transistorized circuits. 2000 ohms. Pull in 5 mA at 10 v. SPST. Can be used as SPDT. 1¼"x 1¼"x 1". ....$ .75 ea, 5 for $3.00

MISCELLANEOUS

CM1—Supersonic condenser microphone, 18-25 kc. ¾" dia. x 3/8". Pigtail leads. $ .35 ea,7 for $2.00

CM2—Same as above with mounting ring 1-1/8"x 7/8"x 3/8" thick. Use for silent sound systems, burglar alarms, control circuits, etc. Originally used as remote TV control...........$ .50 ea, 5 for $2.00

AK1—Automatic keyer. Motor driven 24 v. 3 disc with spare discs. Use for CQ or test purposes and your call. Characters formed by breaking out teeth in plastic disc. Size: 4"x 4½"x 6½". ....$2.95 ea, 2 for $5.00

All prices FOB Racine, Wisc. Orders under $3.00 include 50¢ handling charge. Please allow enough postage, excess will be refunded. All weights are net weights.

tower
communications

922-24 Elm St., Racine, Wisc. 53403 — Phone: 414-632-9014

20 to 120 mmf per sec. Butterfly 8¾" x 6¾" x 5"d ¼ shaft 7500 VAC **$7.50**

12 to 244 mmf Johnson #154-1-5 1800vac **$2.75**

3 section (16 to 415 mmf) (16 to 415)-(16 to 530) **$1.50**

3 Sec 100 MMFD per sec. variable capacitors **$1.00**

MINIATURE VARIABLES

Butterfly 2.7 – 10.8 mmfd .... 75¢

Butterfly 2.3 – 8 mmfd .... 75¢

Butterfly 1.5 – 3 mmfd .... 75¢

Variable 5 – 25 mmfd .... 75¢

MAPC-35 3 – 25 mmfd .... 50¢

500 mmfd 500V Feed-throughs .... 20 for $1.00

Parasitic Suppressors #P-300....15¢..... 10 for $1.25

Telephone handsets $1.75

Wafer switch 4 deck 11 positions .... 75¢

Magnets .... 20 for $1.00

MOTORS

110 volt 60 cy, 2000 RPM .... 99¢

12 volt DC 5000 RPM, 4¼ x 3 .... $1.25

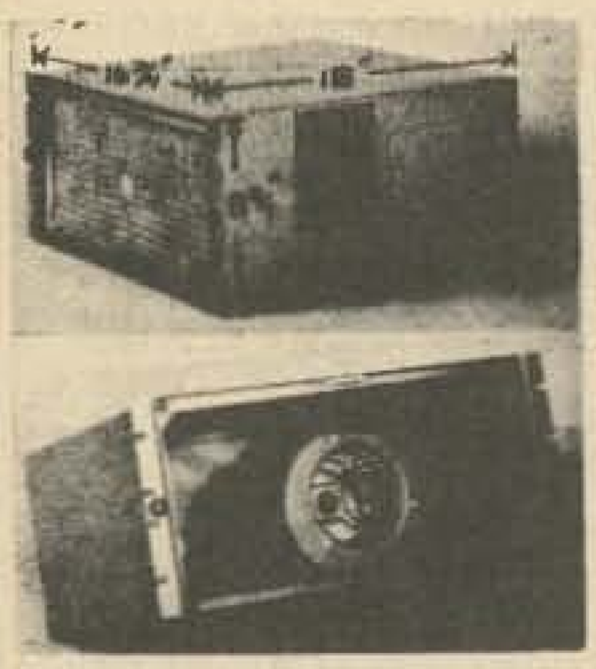
110 volt 60 cy, GE 1/3 HP, 3450 RPM, new $14.95

TRANSFORMERS

115 volt 60 cy input, 24 volt 2 amp out, w/circuit breakers $1.50

120 volt 60 cy input, 6.4 volt CT 4.5 amp out $2.50

120 volt 60 cy input, 12 volt 5 amp out w/circuit breakers $3.00



BLOWERS

standard 19" rack cabinet size; 110v 60 cyc General Electric ⅓ HP 3750 RPM motor with 5" squirrel cage blower. Mfg.: McLean Engineering Lab. with dust filter. 55 lb. shipping wt. MOTOR ALONE WORTH MUCH MORE THAN THIS PRICE

NEW $17.95

ROOM LIGHT DIMMERS

Replaces present room switch, controls 600 watts. List for $7.95.......SALE PRICE........$3.95

TOROIDS 88 MH

35¢ each, 10 for $3.00

Transistor Heat Sink drilled for 8 power transistors, size 12½"L x 4"W x 1¼"H.........NEW........ $2.00

TELETYPE

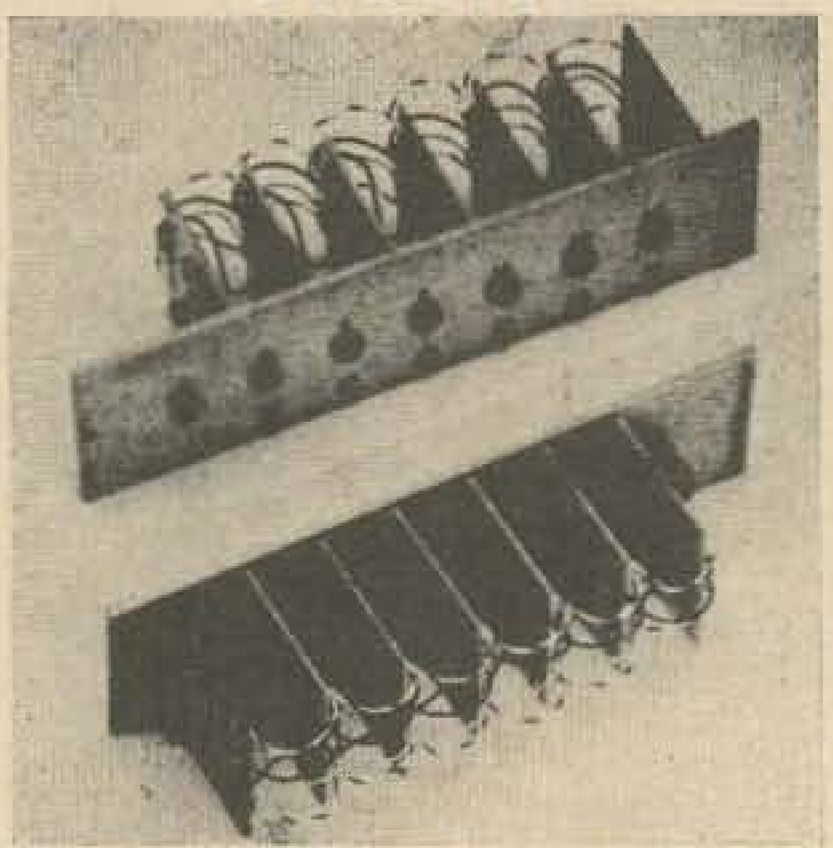
Paper rolls 8½" wide........75¢ each
SALE PRICE........12 FOR........ $4.95

P.C. BOARD ROSIN SOLDER 30 Ft........ 59¢

1000 PIV 1 AMP

diodes, top hat or epoxy....40¢ each ....10/$3.75

LOW COST BINARY COUNTER



Has many uses such as frequency counter, electronic stop watch, frequency meter, event counter, etc.
This unit is a binary counter, the first light reads -1- each lite (stage) you add doubles the count.

Example:

No. of stages	Lite no.	Count
1	1	1
2	2	3
3	4	7
5	16	31
10	512	1023
15	16,384	32,767

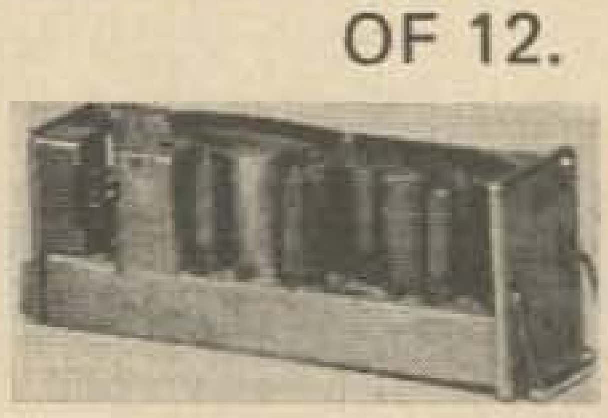
No limit to the stages you can add. The total count is twice the value of the highest numbered light minus —1. Each kit contains one complete stage with instructions for assembly in minutes.
Diagrams for power supplies included.
Printed circuit board measures 2" square*

Kit for stages
$2.49 ea. ...2 to 9 — **$2.29** ea. ...10 or more **$1.99** ea. mechanical trigger or Schmit (electrical) trigger.
Photo shows sample mounting of 7 stages.
Additional information upon request.

Due to excessive popular demand of this item from our Dec. 1968 adv, Please allow 1 week for delivery. Thank you.

COAX CONNECTORS

PL259........45¢
SO239........45¢
M359........30¢
U/175........15¢
T-M358........$1.95
PL258........85¢
Double Male........95¢
UG27C/U........75¢
UG18C/U........75¢
UG349A/U........75¢
R&R DOZEN (13) for PRICE OF 12.



7 Tube 2nd IF Discriminator 455 KC IF 5 stages 2 stages limiting diode discriminator output ± 15 KC .... **$2.50** ea.

CRYSTAL OSCILLATOR KITS

using I. C. UL 914 Stable, harmonic-rich output osc. range 100 KC to 10 MC - Kit includes Fairchild I.C. UL 914, crystal sockets, resistors, capacitor, & PRINTED CIRCUIT BOARD, with instructions for assembly .... **$2.00** per Kit.

100 KC CRYSTAL CALIBRATOR

100 KC CRYSTAL Calibrator stable harmonic rich. Complete with crystal, IC's, etched PC board and all components with instructions for assembly in five minutes........$4.95

VARIACS GENERAL RADIO & OHMITE 60 cyc. Input 120v-output 0-280v 1 amp or Input 240v-output 0-280v 2 amp. Pull-outs in excellent cond. (10 lbs.) **$6.95**

NEW straight FROM FACTORY FAIRCHILD I.C.'s
UL914 with 30 Projects Diagrams ....$1.00 each.....10 for $7.95.....
UL923 J.K. Flip Flop with spec sheet. $1.75 each, 10 for $14.95

COPPER P.C. BOARDS

2 x 2...........10¢ each.......12/$1.00
3 x 6...........25¢ each.......10/$2.25
4 x 6...........35¢ each.......10/$3.25
12 x 12....$1.95 each.... 10/$17.00
FERRIC CHLORIDE etching solution........75¢ a pint.

PC BOARD KIT

3 ea. 3 x 6 copper boards, etching solution and etching resist paint. $1.95

Refrigerator door switch, use in window for burglar alarm switch. 25¢ each........ 5 for $1.00.....

TWO LOCATIONS TO CHOOSE FROM

ELECTRONICS

R & R ELECTRONICS
1953 S. Yellowsprings
Springfield, Ohio
Dept. 7G

R & R ELECTRONICS
247 S. Meridan St.
Indianapolis, Indiana

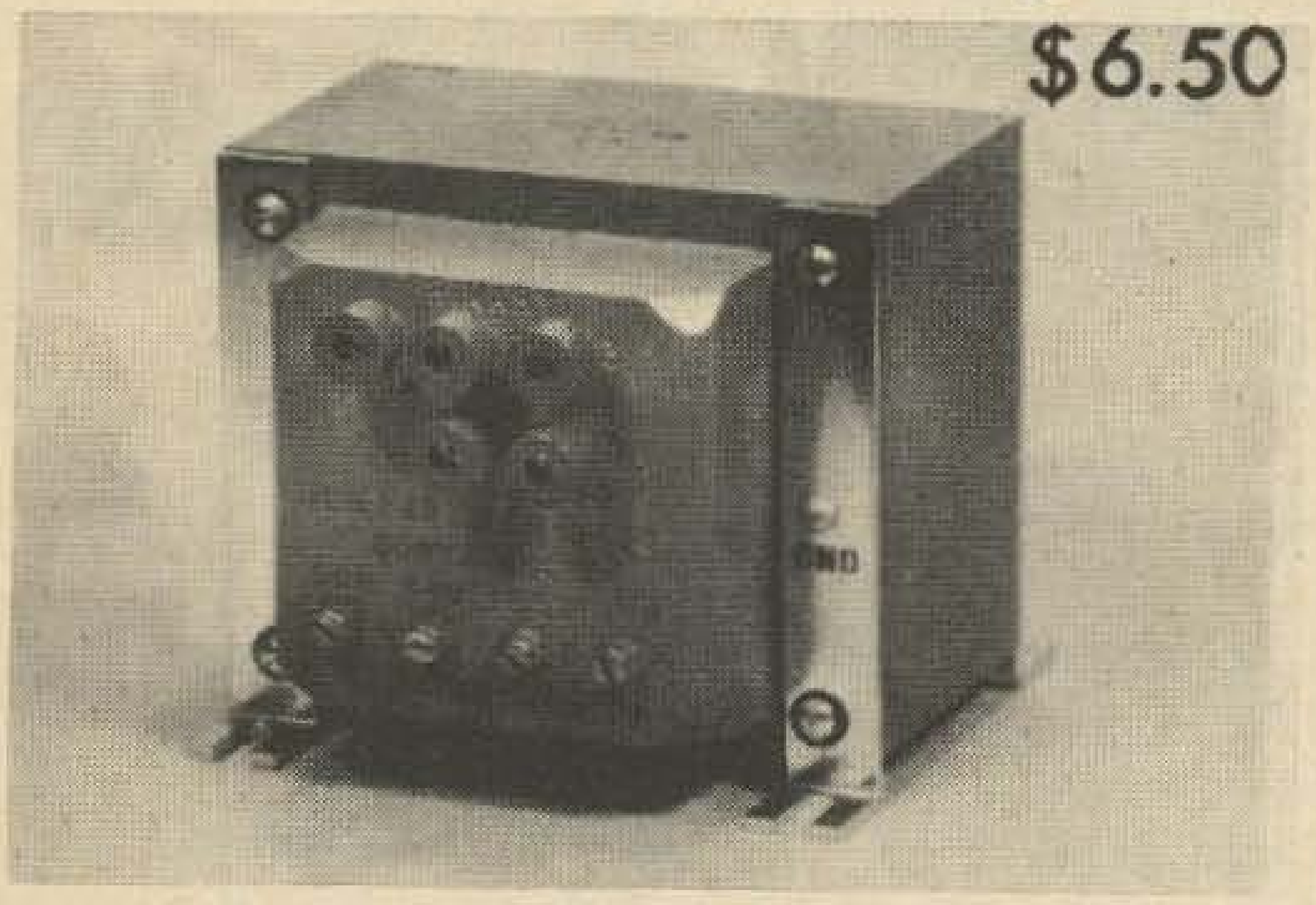
ELECTRONICS

$2.00 minimum order FOB Springfield, Ohio. COD order 25% deposit. Please add sufficient postage, we refund unused amount. Ohio customers add 4% sales tax.

SATISFACTION GUARANTEED ON ALL ITEMS

Please refer all mail order to Springfield store.

TRANSFORMER SPECIAL ~~$17.50~~ $6.50



Primary VAC 115-208-230V @ 500 VA. Secondary VAC 0-34-36.5-39V @ 12.5 Amps. These are computer pulls, absolutely like new. Shipping wt. 23 lbs. Price is FOB LaCrosse, Wis.

—SPECIAL PURCHASE—

COPPER CLAD LAMINATES
for
PRINTED CIRCUITS

VHF & UHF Circuitry
G10 Epoxy Glass
1 oz. copper, 1 side

VFO
Builders Note!

Pkg. Quantity	3/64"	1/16"	3/32"	1/8"
1 9"x12"	$1.50	$3.00	$4.00	$5.50
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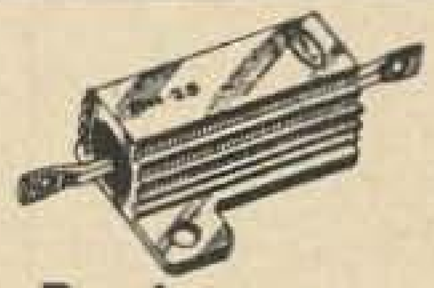

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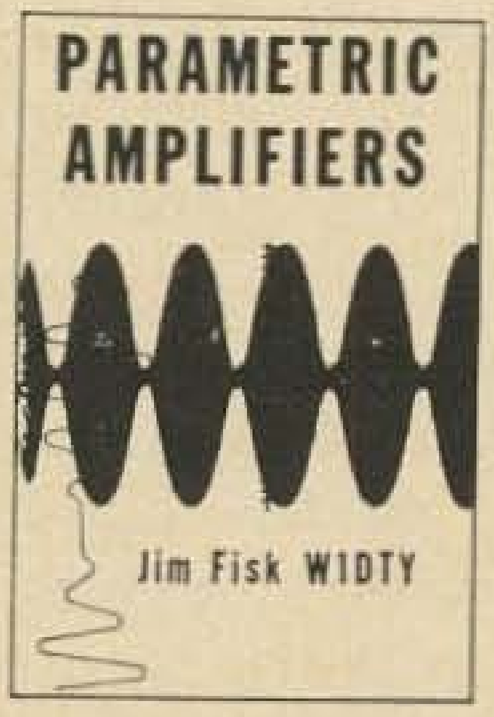

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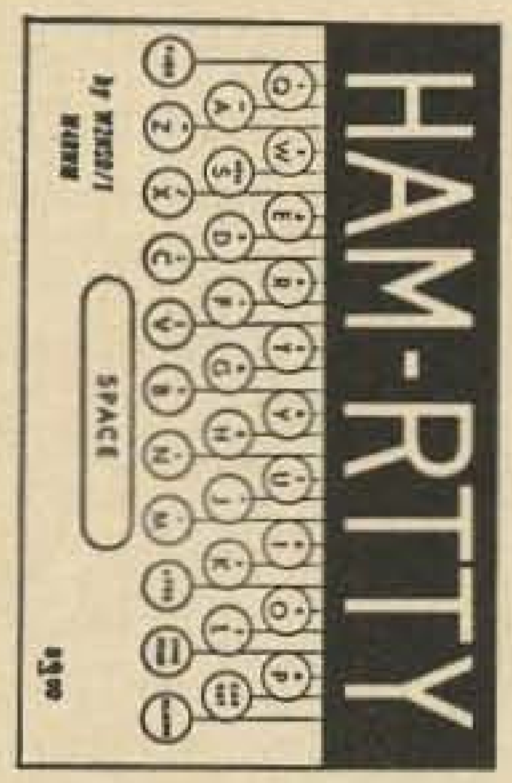

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Getting Your Extra Class License

Part II — Amplifiers

Almost every stage of any radio equipment contains an amplifier circuit of some sort. Understandably, the Extra Class examination includes a number of questions designed to test your knowledge of amplifier theory and its application—and this month we're going to concentrate on them.

Specifically, the questions from the FCC study list which we're going to examine in detail this time are:

6. Why is there a practical limit to the number of stages that can be cascaded to amplify a signal?

42. List Several advantages and disadvantages each for Class A, Class B, and Class C amplifier operation.

66. How are grounded-grid amplifiers used in electronic circuits? List some advantages and disadvantages of their use.

73. What improper operating conditions are indicated by the upward or downward fluctuation of a Class A amplifier's plate current when a signal voltage is applied to the grid? How can this be corrected?

74. What improper operating conditions are indicated by grid current flow in a Class A amplifier?

As usual, rather than approaching these official study questions directly, we'll paraphrase them into several other questions of broader scope, in order to better cover the subject.

The most basic of all questions that can be asked about amplifiers is "How Does An Amplifier Amplify?"—so let's ask it as a starting point. From there, we'll try to learn "Where Can An Amplifier Be Grounded?", which should take care of all the various grounding methods for signal inputs and outputs. Our third question will be "What Limits An Amplifier's Usefulness?", and we'll follow this up with a natural sequel, "How Can The Limits Be Stretched?"

By the time we find the answers to these four questions, we may not be amplifier experts but we should certainly be able to handle any questions on amplifiers which may be on the Extra Class exam, as well as many which probably won't be there.

Ready? Let's get started.

How Does An Amplifier Amplify? Before we can begin to find out how an amplifier amplifies, we must decide "What is amplification?" The answer may turn out to be a bit surprising.

To "amplify" is to make larger or stronger—but even though a transformer may make an ac voltage larger than it was originally, a transformer is not an amplifier.

As it happens, in electronics to "amplify" always means "to add power". While the ordinary transformer may step up either voltage or current, it cannot add power to the signal. Even a perfect transformer can only put out the same amount of power that is fed into it. If the voltage is doubled, the current must be cut in half to meet this power requirement. Similarly, if the current is doubled, it can only be done by cutting the voltage in half. And no transformer is perfect. The best transformers still have at least some losses. This means that in any practical transformer, the power output is always *less* than that put in, never greater. This is why a transformer is not considered to be an amplifier.

Any amplifier, though, does add power to the signal. The gain may appear as a voltage gain—output voltage greater than input voltage—or as a current gain, or as both at the same time, but the output power always is greater than the input power in the amplifying device itself.

Some amplifier circuits are arranged in such a manner that the power gain is somewhat hidden. In some cases this is deliberate, to accomplish the purpose for which the circuit is designed, and in others it's merely incidental. In all of them, though, the actual amplifying portion of the circuit must involve a power gain.

One of the most common amplifier circuits in which the power gain is "hidden" is that type of circuit generally known as a "voltage" amplifier. Since audio amplifiers are usually divided into two classes called "voltage" and "power" amplifiers, respectively, there's a strong implication that there's no power amplification in the voltage amplifier.

While it's true that most voltage amplifiers take *almost* no power from their input sources, they *do* take at least a little. The input power may be as small as a thousandth of a microwatt, but it's greater than zero. The output power, similarly, is there; if the circuit produces a 40-volt peak-to-peak output signal with a ½-milliamp plate current swing, this amounts to about 700 microwatts RMS power. It's not much—and this is why the circuits are called "voltage" amplifiers—but it's there.

And if our example amplifier takes a 1/1000 microwatt input signal up to a 700-microwatt output level, it must have a power gain of 700,000 times. This would be a fantastic figure; the power gain of most voltage amplifiers lies between 100 and 1000 times.

The so-called "voltage" amplifier, then, is just as much an amplifier of power as is the "power" amplifier, but its absolute power output is much much smaller. The power output of a voltage amplifier is useful only insofar as it produces the desired gain in voltage.

Now let's see how an amplifier goes about its business of adding power to a signal.

A moment's thought will reveal that we've already listed several necessities for amplification to occur: we must have an input signal, and a source of power which can be added. Also, we must have some means of getting the amplified output signal out of the circuit.

That's almost the complete list; only one more item is needed. That's a device which can "transfuse" power from the power source into the signal.

The devices we have to do this job don't do it in just that manner. Instead, they use the power of the input signal to *control* the flow of power from the source through the output circuit. It works out to be the same, however.

Two such devices, basically, are all we have with which to amplify ac signals. They are the vacuum tube and the transistor. Both act as electrically-controlled variable resistors, controlling the flow of current through themselves and thus through the output circuit.

The tube's plate current is controlled by the *voltage* on the grid, while the current in the collector circuit of the transistor is controlled by the *current* injected into (or withdrawn from) the base. In either case, the result of applying an input signal is to cause a variation of current flow in the output circuit. This current flow may be used directly, if current amplification is desired, or it may be converted to a voltage variation by a suitable load impedance.

The amount of control over output-circuit current flow which any particular tube or transistor's input signal can have is determined mainly by the geometry of the innards of the tube or transistor. This is the problem solved by the designer of that particular type of tube or transistor. Within certain physical limits, the designer can produce just about any combination of control effects you might want. For some purposes one combination is best, while for other jobs a completely different set of effects is necessary. That's one of the reasons why there are so many different types of tubes and transistors on the market.

When the designer has done his job, and the device is built to accomplish the desired control effects, the results are generally displayed in the form of "characteristic curves" which plot output signal against input signal. Many types of such curves are available; for our purposes we'll concentrate on the grid-voltage/plate-current family such as that shown in **Fig. 1.** This type of curve plots plate current against grid voltage; while **Fig. 1** shows only a single curve, any actual set of curves will have many, because a single tube type has a different curve for each different value of plate voltage which you might apply to it. Transistors have similar curves, not shown here.

Fig. 1 also shows how the electrically-controlled variable resistor called a "tube" is limited by some physical facts. At I in the figure is shown an "ideal" E_g-I_p plot for a perfect resistor. The output current depends

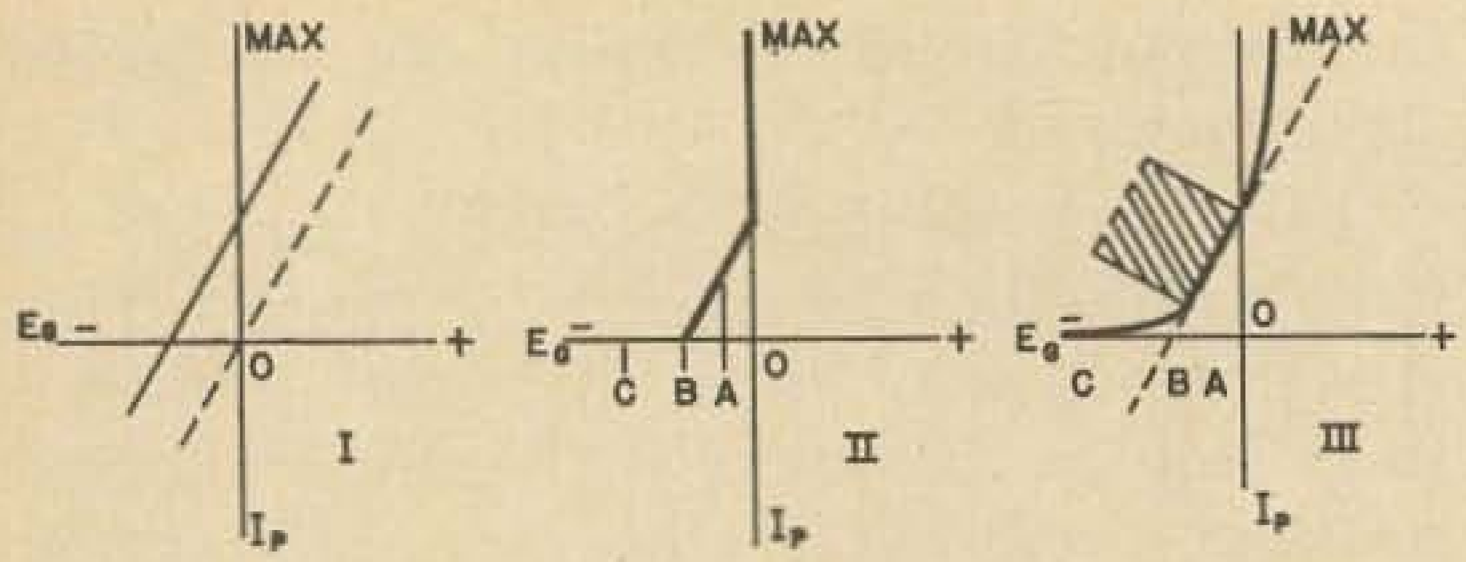

Fig. 1—Characteristics of vacuum tubes are often shown by curves which plot plate current (vertical scale) against grid voltage (horizontal). A completely linear device would produce a plot such as that at I—and the dotted line in this plot is actually the characteristic of a resistor; as voltage goes up, so does current, in a linear manner. Tubes, however, cannot operate with "less than zero" plate current, and when the grid goes positive it acts more like another plate than it does a grid, so the plot shown at II is the best that could be expected from a perfect tube. Actual tubes are less than perfect; their characteristic is curved rather than straight, and looks more like the plot at III. The shaded area in III identifies that part of the curve which is straight enough to act as if it were a straight line—normally called "the linear region" of the tube's characteristic.

only upon the input voltage, and there's no limit on the input voltage in either direction.

However, in a tube, when you've cut the plate current all the way to zero you cannot cut it down any more because there just isn't any more left to cut. This imposes a lower limit on the variable-resistance action. And when you drive the grid voltage positive, the grid then begins to act more like a second plate than it does like a grid, so you lose control at the other end as well. Part II of **Fig. 1** shows this idealized E_g-I_p plot for an actual vacuum tube.

Finally, since the actual control effects are determined by the geometry of the tube's insides, there are no sharp breaks or corners in the effects. Rather, they blend smoothly from one type of action into another. And in fact, the actual performance curve is *never* a straight line as long as current is flowing. It always curves at least slightly. This is shown as part III of **Fig. 1**.

To get perfect amplification, the curve would have to be straight as in the slanted portion of part II. Fortunately, most tubes have a fairly wide region in which the curve is almost straight—so much so that we can ignore the slight curvature—and this is indicated by the shaded region in Part III. For "distortion-free" amplification, we must be certain that we restrict all operation to this part of the curve.

As it happens, not all amplification must be "distortion-free". When we're generating *rf* for use as either an AM carrier or for CW, for example, the only things we're interested in are frequency and power level. If the level should happen to vary at the input to an amplifier, we not only are uninterested in preserving the variation unchanged at the output, but actually want the variation to be washed off by the amplifier so that the output level is steady.

In other cases, we want to preserve the variations in level of the input signal, but we may want more power output than we can get by restricting amplifier operation to the linear region of the tube's curve. If we have some means for taking out the distortion which results from overdriving, we can get the additional power.

These varying requirements which amplifiers are called upon to meet result in the existence of several different "classes" of amplifier operation. They're known as Class A, Class B, and Class C, and in addition to these three classes there's a fourth called "Class AB" which covers the entire range of operating conditions between Class A and Class B.

The definitions of the various classes have become somewhat confused through the years. The "official" definitions set up many years ago by the Institute of Radio Engineers (now a part of the IEEE) are as follows:

"A Class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times.

"A Class AB amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows for appreciably more than half but less than the entire electrical cycle.

"A Class B amplifier is an amplifier in which the grid bias is approximately equal to the cutoff value so that the plate current is approximately zero when no exciting grid voltage is applied and so that plate current in a specific tube flows for approximately one half of each cycle when an alternating grid voltage is applied.

"A Class C amplifier is an amplifier in which the grid bias is appreciably greater than the cutoff value so that the plate current

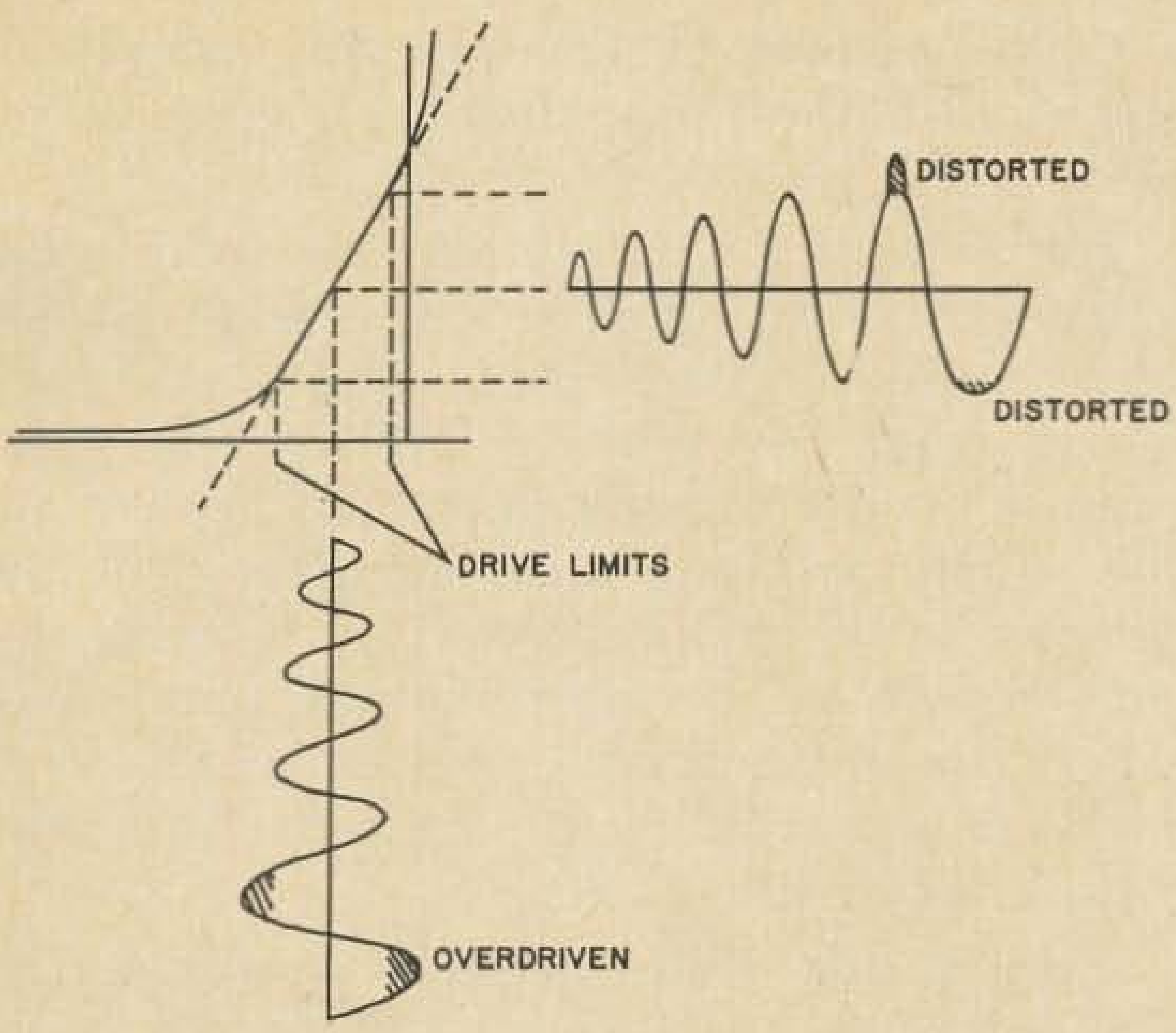

Fig. 2—A Class A amplifier is operated with a grid bias which makes the tube operate at the center of its linear region in the absence of signal. The signal voltage then varies the operating point, and thus controls the plate current. If the input signal exceeds the limits of the linear region, distortion results. The distortion is exaggerated in this illustration.

in each tube is zero when no alternating grid voltage is applied and so that plate current in a specific tube flows for appreciably less than one-half of each cycle when an alternating grid voltage is supplied."

Other definitions which have been offered specify a Class A amplifier as one in which the output is a faithful reproduction of the input signal. This is not, however, a requirement for true Class A operation even though most Class A amplifiers do have this characteristic.

Fig. 2 shows the action of a typical Class A amplifier, by plotting the variation of output current against the variation of input signal. Notice that the tube's characteristic curve furnishes the reference for making such a plot. For this reason, the E_g-I_p curve is often called the "transfer characteristic" of the tube. At any instant, the plate current is determined by the grid voltage. By plotting the variations in grid voltage (vertical waveform beneath the curve) and keeping the time scales constant, the variations in plate current may easily be determined (horizontal waveform to right of curve).

The zero-signal line which meets the tube's transfer characteristic curve in the center of its linear region marks the level of resting grid bias, and also the no-signal plate current which results from this value of bias.

The limits beyond which the input signal cannot be permitted to drive the amplifier are then determined by the points at which the tube's transfer characteristic begins to curve away from the straight line (dotted). If the signal pushes grid voltage past either of these limits as shown in the shaded regions of **Fig. 2**, the output signal will no longer be a faithful reproduction of the input signal—and distortion is the result.

The major advantage of the Class A amplifier is its freedom from distortion when properly operated. Additional characteristics which are sometimes considered advantages, and sometimes are disadvantages (depending upon the particular application) include its constant plate current. While the output signal is obtained only because the plate current varies, these variations occur as an audio rate; so far as dc instruments are concerned, the plate current remains constant with any level of input signal which may be applied. The variations cancel each other out.

The only way in which the indicated plate current can vary is for the dc bias point to change with application of signal. This occurs most frequently because of excessive input signal level. While excessive positive-going input signals may cause grid current to flow, it is not necessary to drive into the grid-current region to cause plate current to shift. Any change of plate current, either up or down, when signal is applied indicates excessive input-signal levels. The cure is simple—reduce the level of the input signal.

In many applications this constant plate current is an advantage, since it makes the amplifier present a constant load to the power supply circuits.

In other uses, the same quality is a disadvantage; for example, in a mobile or portable unit operating from batteries, it's wasteful to burn up power when no signal is being produced.

The major disadvantage of the Class A amplifier, however, is the low overall efficiency of the circuit. Most of the power supplied to a Class A amplifier is used to keep the tube at the chosen operating point. Even with a "perfect" transfer characteristic such as that in part II of **Fig. 1**, you would only be able to get output power over the region between cutoff and grid current. With practical amplifiers, the linear region is much smaller; thus the power output and

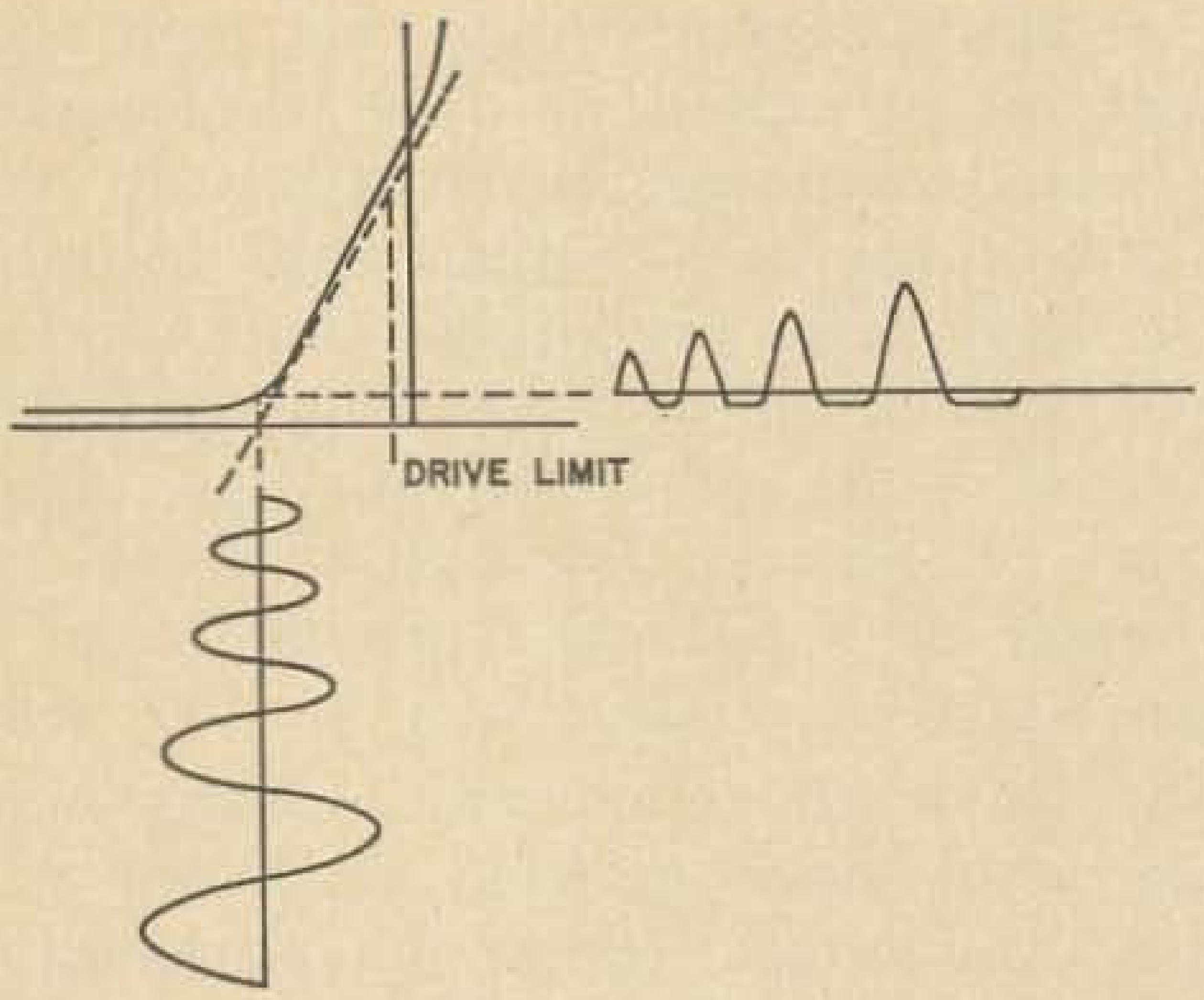

Fig. 3—Grid bias of a Class B amplifier is adjusted so that the tube has essentially zero plate current in the absence of signal. Positive-going half-cycles of the input signal then drive the operating point over to the linear region. Negative-going half-cycles are lost. The output signal is nighly distorted; in an RF Class B amplifier, only the modulation envelope is important and distortion of the individual RF cycles has no effect. In audio Class B circuits, push-pull arrangements are necessary to supply the missing half-cycles. Since the tube is passing no current half the time, it can handle considerably more power on the average.

total efficiency of the Class A amplifier are both kept relatively small. Plate current can swing only from zero up to the positive limit, and this swing must supply both halves of the output-signal cycle.

If, however, we change the grid bias to approximately the cutoff value for our tube, we convert our Class A amplifier into a Class B amplifier. This amplifier's operation is plotted in **Fig. 3.** Notice particularly that the *only* change we made was to move the grid bias level. The circuit itself remained unchanged. The differences between the various classes of amplifiers is entirely a matter of adjustment, not of circuitry!

With the resting grid bias at approximately the cutoff value, almost no plate current flows in the absence of input signal. When a signal is applied to the grid, the negative-going half-cycles of the signal merely bias the grid even farther into cutoff and stop all plate current, but the positive-going half-cycles move the tube's operating point up into the linear region.

As a result, the positive-going half-cycles are reproduced faithfully in the output signal, at the cost of the negative-going halves of the signal.

The output signal of a single-tube Class B amplifier is highly distorted, and such an amplifier cannot be used in this simplified version if faithful reproduction is what we're after.

However, if we simply add one more tube and feed it the same input signal—except in reversed phase—then the "positive" halves from one tube will fill in the gaps caused by the missing "negative" halves of the other, and our total amplifier will be relatively free of distortion. This is the push-pull circuit in its most natural form, and any Class B amplifier used for audio must be in a push-pull circuit to keep distortion within acceptable limits.

Additionally, tubes designed especially for Class B operation are preferable for such applications. These tubes are built to have the sharpest possible "knee" between the cutoff and linear regions ,to minimize "cross-over distortion" which occurs at the "cross-over points" between one tube and the other.

The Class B amplifier provides greater power from the same tubes than does Class A operation. Not only is twice the current swing available (Class A must get the whole cycle into the current swing between zero and maximum, while Class B need get only a half-cycle into the same current swing), but the fact that each tube is cut off and thus "resting" for half of each cycle permits us to pour more power into the circuit without damaging the tubes.

Where the overall efficiency of a Class A power amplifier lies between 25 and 30 percent in practice, with a theoretical limit of 50 percent, that of the Class B amplifier runs between 30 and 50 percent in practice and the theoretical limit is 86 percent.

This increased power is the primary advantage of Class B operation. A secondary advantage is the fact that most of the current drawn from the power supply goes into the output signal; no power is wasted keeping the tube at a fixed operating point. The variation in current with signal may sometimes be a disadvantage, though, since such an amplifier presents a varying load to its power supply, and the power source must then be capable of accomodating a wide range of load conditions.

The major disadvantage of Class B operation is the increased distortion and requirement for push-pull circuits. The push-pull requirement is not present in a Class B amplifier used for "linear" amplification of *rf,* since there we don't care about distortion in the individual *rf* cycles. What we want to keep "linear" in such an amplifier is the modulation envelope of the signal, and the Class B amplifier preserves this nicely in its single-tube version.

A secondary disadvantage is the fact that a Class B amplifier requires more careful adjustment to obtain the proper operating point. Grid bias, especially, is extremely critical in this one.

The Class AB circuit was developed primarily to overcome these disadvantages of true Class B operation, and does so to a great degree—although the disadvantages do remain as the major ones of Class AB operation as well.

In a Class AB amplifier, bias is not so great as in Class B. Thus some plate current flows even with no signal. When signal is applied, the positive-going portions permit additional plate current flow just as in Class B operation, while the negative-going portions tend to cut plate current off completely. However in a push-pull Class AB amplifier (and almost ass AB amplifiers *are* operated in push-pull arrangements) the other tube supplies the missing half cycle.

The cross-over from one tube's operation to the other occurs at the resting value of plate current, though, which means that both tubes are in operation for very small signals and the first-one-then-the-other action applies only to the larger input signals. Because the transition from cut-off to the linear region of the tubes' transfer characteristic is gradual rather than abrupt, moving the crossover point to a higher plate-current value tends to reduce crossover distortion.

In the Class A amplifier, the main objective was to accomplish "linear" amplification without distortion. In both the Class B and the AB amplifiers, the idea was still to amplify without distortion, but circuit tricks were necessary in order to get rid of the distortion introduced by AB or B operation.

The Class C amplifier, on the other hand, is intended to distort its input signal. That is, its purpose is to put out the largest practical amount of power while washing off all variations of signal level which may be present in its input.

To do this, the tube's operating point must be changed rather radically. Instead of operating at the center of the linear region, as in Class A; at cutoff, as in Class

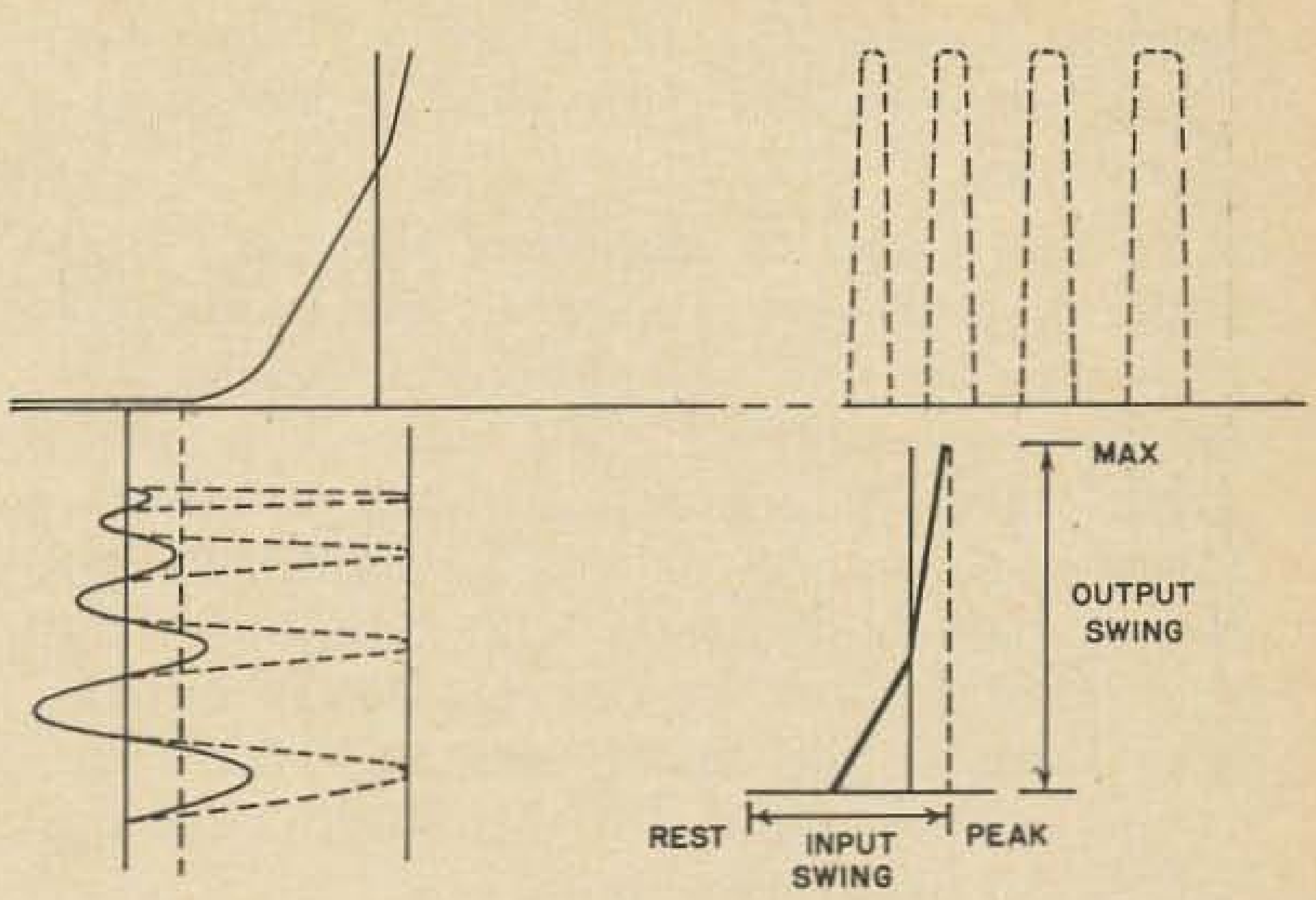

Fig. 4—Class C amplifier is biassed far beyond cutoff, so that tube acts more like a switch than a resistance. Only extreme positive peaks of input signal permit current to flow through tube. Signal is totally distorted; this type of amplifier is used only when amplitude distortion is unimportant. Since tube is resting most of the time, this class of circuit permits maximum power from the tube. Efficiency up to 80 percent is not uncommon. Idealized curve, inset, shows how circuit's characteristic resembles switch more than normal amplifier.

B; or somewhere between, as in Class AB, the Class C amplifier is adjusted to an operating point far below the cutoff region. Thus no plate current can flow in the absence of an input signal. This is true of a Class B amplifier also, but with Class C because of the much greater bias the plate current remains zero even *after* input signal is applied, until the input signal goes sufficiently positive to overcome the added bias.

Fig. 4 shows the operation. With a normal-level input signal (solid waveforms) only the extreme tips of the positive half-cycles overcome the additional bias, and the output signal consists only of brief current pulses.

But Class C amplifiers are used primarily for *power* amplification of *rf* signals, rather than as voltage amplifiers, and in this application are driven with signals so large that they would be excessively strong signals to the other classes of amplifiers. Such an input signal and its corresponding output are shown in dotted lines in **Fig. 4**.

Actually, in a Class C amplifier, the tube is being used more like an electronic *switch* than as a variable resistor. There's really no difference, if you keep in mind that an ordinary switch is actually a resistor with two values (one very high, in the billion-ohm region, and the other very low, measured in hundredths of an ohm). When you operate the switch, you choose one of the two values.

In the Class C amplifier, the very high value of grid bias establishes the extra-high-resistance or "off" condition of the switch-resistor represented by the tube. The "overdrive" level of the input signal establishes the low-resistance or "on" condition. And the transition between one condition and the other, which carries operation all the way through the linear region of the tube, is made very rapid by the sharp rise and fall of the signal waveform.

The inset illustration in **Fig. 4** brings out this characteristic of the Class C amplifier. For Class C use, the linear region of the tube's transfer characteristic is only a nuisance. Tubes designed primarily for Class C operation, as a consequence, may not behave very well if you attempt to use them as linear amplifiers.

The advantage of Class C operation is its efficiency. Theoretically, you can get as close to 100% efficiency as you like in a Class C circuit. In practice, 75 percent efficiency can be reasonably expected, and with a little care it's possible to stretch this to 85 percent or so (the remaining 15 percent of output power can be gotten, all right, but it's in the form of high-order harmonics of the input signal, and any attempt to *use* it will get you in trouble for excessive harmonic radiation!).

Because the tube is being used as a switch, virtually all the dc power taken from the power supply goes into the output signal. The only part lost in the tube is the voltage drop from plate to cathode, which usually is only 20 to 50 volts at most; the rest of the losses occur in the associated tuning circuit, and in the process of converting those switched current pulses back into a reasonably harmonic-free signal waveform.

An additional advantage is that the power output of a Class C amplifier is not affected by the input-signal level (so long as the input drive is enough to reach the maximum-output level), but *can* be controlled easily by controlling the applied plate voltage. This means that modulation can be applied to a Class C amplifier with ease.

The steady output level without regard to input level, after a certain input threshold is reached, provides still another advantage. A Class C amplifier can be used whenever a signal *limiter* is needed, so long as there's no need to retain any of the amplitude variations. FM receivers sometimes use one or two stages of Class C amplifiers in their *if* strips for just this purpose.

Disadvantages of Class C amplifiers vary depending upon the application. The most obvious is the extreme amplitude distortion of the input signal, which makes them impractical for use with signals which must be amplified linearly (such as SSB or low-level-modulated AM). The high harmonic content of the output, if too great efficiency is sought, is another potential disadvantage; it may be overcome by keeping grid bias as small as possible while retaining the desired operating conditions, and keeping "drive" (input signal level) as low as possible consistent with desired operation.

Where Can An Amplifier Be Grounded? In addition to the various "classes" of amplifier operation which we have just examined, and which depend upon adjustment rather than upon circuit changes, there are many different amplifier circuits.

Many of the differences in these various amplifier circuits have to do with the grounding of the amplifier. For instance, the "normal" amplifier arrangement—that is, the one most commonly encountered—operates with its cathode grounded.

The cathode is not always actually directly grounded (although it frequently *is*, especially in *rf* amplifiers), but it is used as the return point for both the input and output circuits.

But we also have grounded-grid amplifiers, and, strange as it may sound, a grounded-plate circuit. The grounded-plate circuit is more often called the "cathode follower".

These different types of grounding for the input and output signals lead to vastly different sets of operating characteristics for otherwise identical amplifiers. The answer to our question can be fully expressed only if we can learn *how* the different groundings make such vast changes in amplifier action.

Let's start by forgetting all about amplifiers, tubes, and the like for a moment and considering a simple "black box". This is one of the favorite phrases of modern engineers, and with good reason. Any circuit whatever can be considered as an opaque black box; all we need know about it is

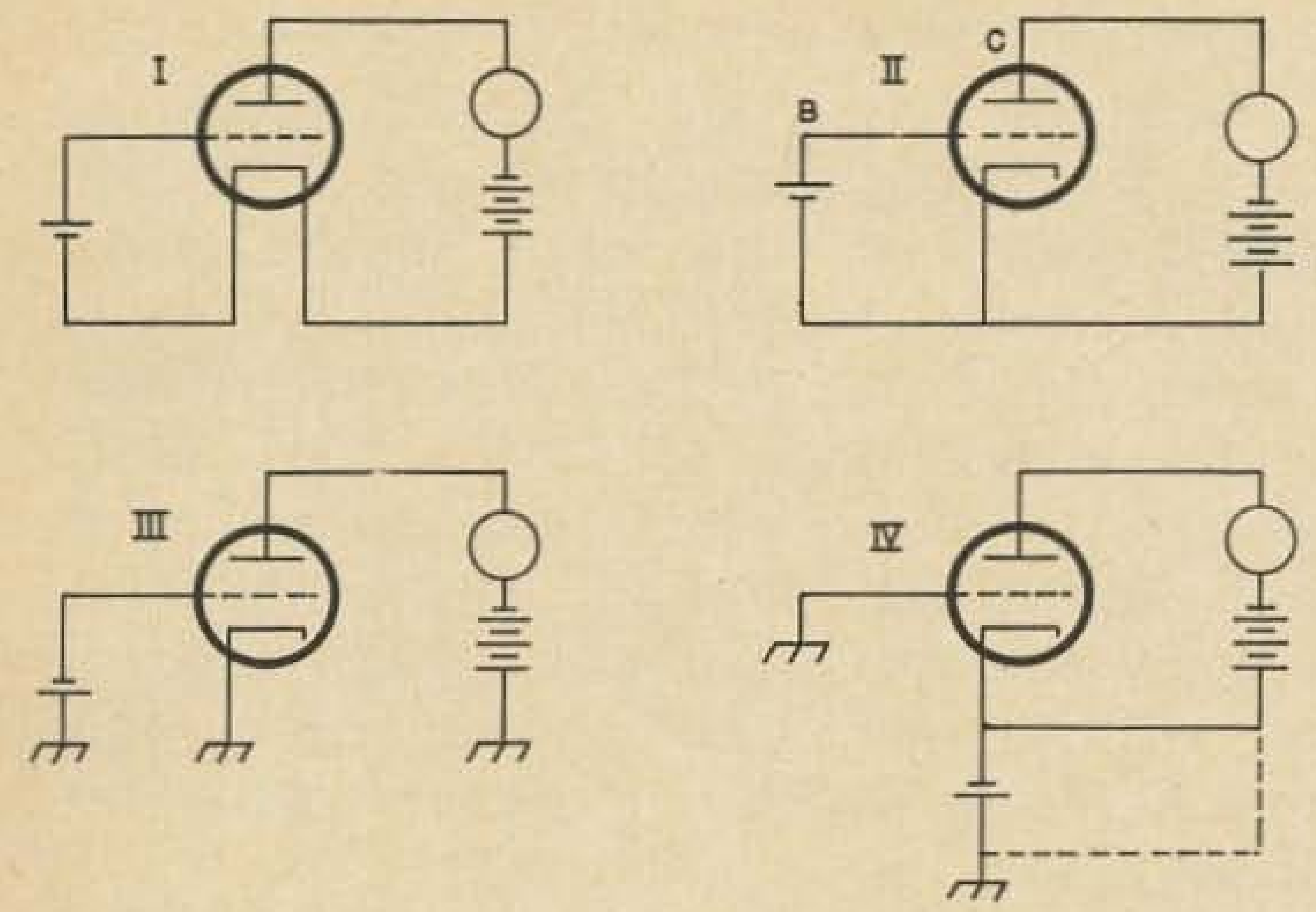

Fig. 5—Any amplifier circuit reduces to the basic arrangement shown at I; the separate input and output leads to the cathode are to emphasize the difference between input and output circuit. The version shown at II is electrically the same. It may be grounded at any of points A, B, or C, or even at other points not directly associated with a tube element. Most often, the cathode is grounded as shown at III; this permits both the input and output circuits to work "against ground". If the grid is grounded but the plate supply left ungrounded as shown by solid lines at IV, the circuit is not changed. Breaking the plate-supply return at X and connecting it as shown by the dotted lines does *change circuit action; text explains how and why.*

what its input and output terminals make it act like. What is actually inside couldn't concern us less, because in any practical application of theory, it's the results that count rather than how they got there!

The classical "black box" studied by engineers usually has four terminals; two of them are input, and the other two are for output. Any needed power supply is considered to be inside the box.

Any amplifier, you can see, can be thought of as such a box. We put a signal in at the input terminals, and we get out the amplified signal at the output.

Similarly, just a vacuum tube is also a "black box". We don't have to completely understand the electron physics involved, or the three-dimensional geometry which dictates the transfer characteristic, in order to make good use of the tube. All we need do is supply it the proper voltages, an input signal, and take off the output signal.

Right now let's ignore all the extra grids found in most modern tubes and think only of the classic triode with cathode, grid, and plate (the multi-grid tubes operate on the same general principles as the triode, anyway).

The electrons boil off the heated cathode and are drawn to the plate by the positive plate voltage. On the way, they must pass the grid; the voltage between grid and cathode controls the number of electrons which negotiate the path from cathode to plate.

Note that since we have only three elements in this tube, we cannot have four separate terminals on the black box model of it. Two of the four terminals *must* connect to the same element.

And the mechanics of tube action dictate that the cathode must be the doubled-up element, common to both input and output circuits. The controlling voltage is that between grid and cathode. The current controlled is that between cathode and plate. The control terminals, or input, then must be the grid and the cathode, while the controlled terminals, or output, must be the cathode and the plate.

So the tube is a three-terminal black box, rather than four. **Fig. 5** shows this schematically; part I shows the input and output circuits separately, using two leads to the cathode, while part II uses a common cathode lead.

Now so far as the tube is concerned—but only under some rather strict restrictions—it makes no difference at all which of these three terminals is connected to an external ground. In fact, all three could be kept ungrounded, and the tube would still do the same job.

But this is true only if both the input signal and the output signal are isolated from ground, both on the supply and the return sides of the circuit, and the power supplies also.

In any practical amplifier circuit, "ground" means much more than just a connection to chassis. "Ground" is the reference point for all circuits, and is used to shield from each other circuits which must be kept isolated.

And when "ground" is used in this way, then it does make a major difference whether the tube is grounded at point A or at point B.

When the cathode (point A) is grounded, as in part III of **Fig. 5**, then the input signal is applied between grid and cathode and the output signal is taken between plate and cathode. This corresponds to "normal" action within the tube and so is the "normal" connection for an amplifier.

When we ground the grid instead (point B), as in part IV of the illustration, the first effect is that the phase of the input signal is effectively reversed because it is grounded on the opposite side of the circuit from "normal" connection.

If the isolated-output situation exists the circuit would be as shown by solid lines in part IV, and except for the phase reversal the circuit would behave exactly the same as that of part III. But the normal connection of output components and power supplies is as shown by dotted lines—and this puts the input and output circuits in series with each other.

This, in turn, means that all of the *output* amplified current must flow through the input circuit. Polarities are such that the input and output signals are in the same phase, so our grounded-grid circuit has 100 percent positive feedback. It's kept from oscillating by the fact that the feedback is *current* feedback while the tube amplified *voltage*. Still, the feedback results in much lower input impedance, and much higher output impedance, than we would find in a grounded-cathode circuit using the same tube in the same application.

The grid being connected directly to ground makes it an effective shield between plate and cathode, and this in turn permits operation of the tube at frequencies which otherwise would be too high to be practical for a given type of construction. It was this characteristic for which the grounded-grid amplifier was first developed, and is still one of the major uses of this type of circuit.

Since the input and output circuits are in series when the grid is grounded, any excess power in the input signal (above that necessary to drive the amplifier) passes on through to the output. This characteristic is taken advantage of in the SSB linear-amplifier circuits which employ grounded-grid stages; the low input impedance makes a good match to low-power transmitters used as exciters, and the power feed-through makes it unnecessary to swamp out excess input signal.

If the plate, rather than the grid, is grounded, then the input and output signals are effectively in parallel rather than in series. This prevents the output voltage from ever rising above the input voltage level, but allows current amplification.

In this case, the feedback is of voltage rather than current, but is negative rather than positive. The 100-percent feedback reduces distortion, and produces very low output impedance and high input impedance.

Cathode followers find wide use in preamplifiers and test instruments, to present a very high input impedance and reduce loading upon the circuits under test. They are also employed in conjunction with other amplifier circuits for special uses which we'll examine a little later.

While we've only examined tubes, transistor amplifiers follow the same general rules. **Fig. 6** tabulates the characteristics of the various types of grounding for both tube and transistor amplifiers.

Common ("Grounded") Element	Input/Output Ratios Voltage	Current	Impedances Out	In	E	—Gain— I	PWR
Vacuum Tubes							
Cathode (Normal)	>1	>1	Med	Med	Good	Good	High
Grid	>1	$\leqq 1$	Low	High	Good	None	Med
Plate (Cath. Foll)	$\leqq 1$	>1	High	Low	None	Good	Med
Transistors							
Emitter (Normal)	>1	>1	Med	Med	Good	Good	High
Base (Early CKTS)	>1	$\leqq 1$	Low	High	Good	None	Med
Collector (Emitter Follower)	$\leqq 1$	>1	High	Low	None	Good	Med

Fig. 6—General characteristics of the three different types of amplifier circuits are listed above for both tubes and transistors. Notice that circuit characteristics are determined by in/out ratios of voltage and current, more than by choice of tube or transistor. All comparisons assume that the same tube type or transistor type is used in the various circuits, of course. A low-gain tube with grounded cathode may have less gain than a high-gain tube in grounded-grid arrangement, still.

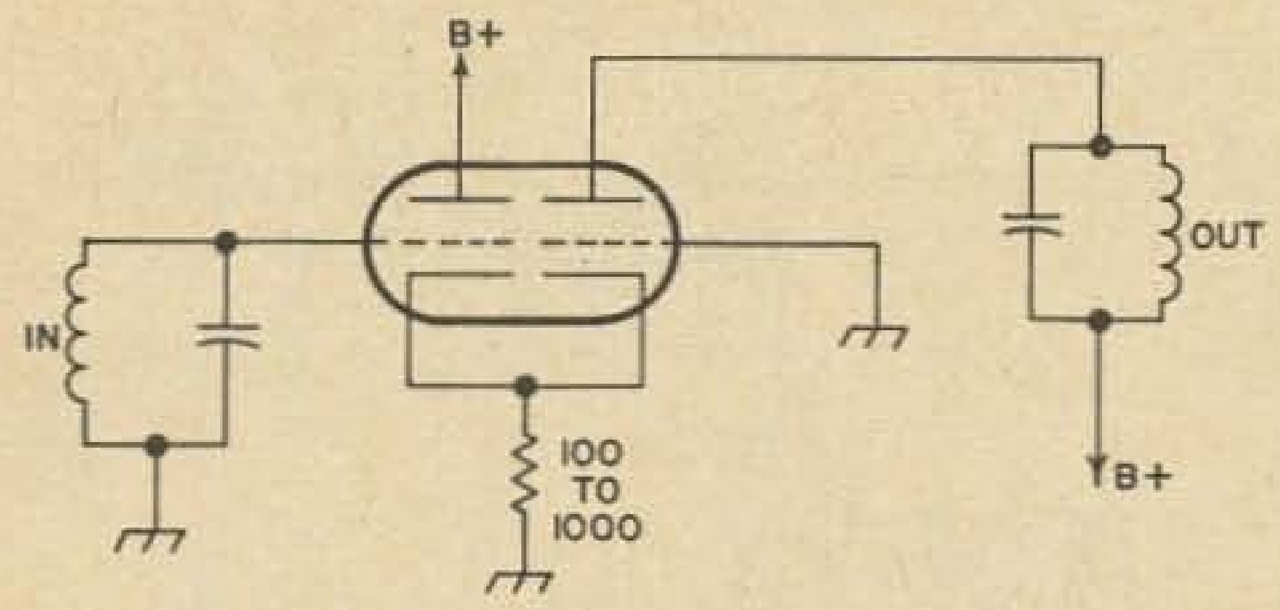

Fig. 7—Cathode-coupled amplifier consists of cathode follower stage (at left) direct-coupled to grounded-grid stage (right) with common cathode resistor. Almost any twin triode can be used; for RF use the TV-tuner types are recommended. Circuit can also be used for audio by using resistor-capacitor input and output coupling rather than the tuned circuits shown here. Circuit provides low noise of triode, gain equal to a single stage, and does not require neutralization.

What Limits An Amplifiers Usefulness? Amplifiers can be "cascaded", one after another, with the output signal of each furnishing the input signal to the next stage.

It might appear that any number of amplifier stages could be cascaded, to get any amount of gain we might want. This isn't the case, however. There are definite practical limits to the number of stages which we may cascade, and some good reasons for those limits.

The extreme limiting factor is "noise". Any substance at a temperature greater than absolute zero—which means anything at all that exists in the real world—has at least a few electrons in motion in it. They're jittering about because of the energy of heat, which is present in everything.

The exact number of electrons in motion at any instant, and their direction of motion, is totally unpredictable; it's something like trying to predict which kernel of corn is going to pop next in a corn-popper. Since we cannot predict it, the electrical energy which results from this random motion of electrons is called "noise"—and as we have seen, everything has at least some electrical noise present in it.

If we have several amplifiers, each with very high gain, and connect them in cascade with each other, we will quite rapidly reach a point at which the noise present in the input circuit of the first stage will provide all the output signal which the final stage can accept. Any input signal at all, under these conditions, would overdrive the cascaded amplifiers. Obviously, such an arrangement would not be usable.

In practice, we reach the limit much sooner. As soon as the amplified noise reaches an objectionable level in the output, we have all the amplification we can make use of. This condition is usually reached by the time we stack three or four stages in cascade with each other, if each stage has "normal" gain.

The noise also sets another limit—it determines the weakest input signal which we can locate. Any signal weaker than the noise cannot ever be made stronger than the noise, because any amplification which we apply to this signal will be applied to the noise as well.

This is the reason that we find so much emphasis on "low-noise" amplifiers for VHF reception and for high-quality audio work; they permit weaker signals to be used.

Any practical amplifier also has a limitation in the bandwidth it will handle. While we can build amplifiers to operate with dc signals, they're tricky; most amplifiers work only on ac, and use coupling capacitors to isolate the stages from each other so far as dc is concerned.

These coupling capacitors establish a lower limit on the amplifier's frequency range. When the reactance of the coupling capacitor is equal to the input impedance of the next stage, half the signal will be lost in voltage drop across the capacitor, and as a result the signal will get only half the amplification which a higher-frequency signal would get.

In addition, all practical amplifiers have stray capacitance in parallel with the input and output circuits. This stray capacitance shunts off some of the output signal. So long as the reactance of the stray C is much higher than the impedances designed into the circuit, this has little effect—but as the signal frequency goes up the reactance of the stray C goes down, while the designed-in impedances tend to remain constant. This means that more of the signal is shunted off to ground, and again less output is obtained than we would expect.

The result is that any practical amplifier has a closely defined operating bandwidth. The low limit is set by the interstage coupling capacitors, and the upper limit by the impedances in the circuit and the amount of stray capacitance.

The bandwidth effect, also, is cumulative as stages are cascaded. At the low-frequency end, if each stage is giving only half the amplification we would expect, then two stages would give ½ x ½ or ¼ the amplification we would expect, three stages would give only ⅛, and so forth. At the upper end, the same type of action occurs. The bandwidth of a multi-stage amplifier, then, is usually much less than that of any one of its stages.

This last statement is not always true. If all the stages except one are designed to cover a very wide bandwidth, while the one exception has narrow bandwidth, then the narrow-band stage will establish bandwidth for the entire amplifier. This situation is frequently encountered in hi-fi amplifiers, but seldom in radio applications.

How Can The Limits Be Stretched? The history of amplifier design is largely a history of successive, successful attempts to stretch the operating limits of existing amplifiers. Early vacuum-tube amplifiers had limited gain, narrow bandwidth, and were difficult to adjust. Today's circuits, while based on the same theoretical principles, can provide more gain than we can use, almost unlimited bandwidth, and virtual total freedom from adjustments.

The major limiting factors, as we have seen, are those of noise and of bandwidth. Another factor, which we didn't discuss previously because it is relatively unimportant with modern tubes and careful circuit layout, is that of unintentional feedback. The problem of unwanted feedback and techniques of neutralization were covered in the "feedback" installment of the Advanced Class course; they apply equally here.

The grounded-grid amplifier circuit employs the grid of the tube as a shield between input and output circuits to reduce the feedback problem—but it adds a new one of its own in the form of its abnormally low input impedance.

To counter this, the "cathode-coupled" amplifier circuit was developed. This circuit, shown schematically in **Fig. 7**, is essentially a cathode-follower to transform a high input impedance down to a low value without voltage gain, coupled directly to a grounded-grid stage. The grounded-grid stage provides voltage gain.

The cathode-coupled circuit works extremely well, and combats not only feedback but also the noise problem. Triode tubes inherently have less noise than do tetrodes

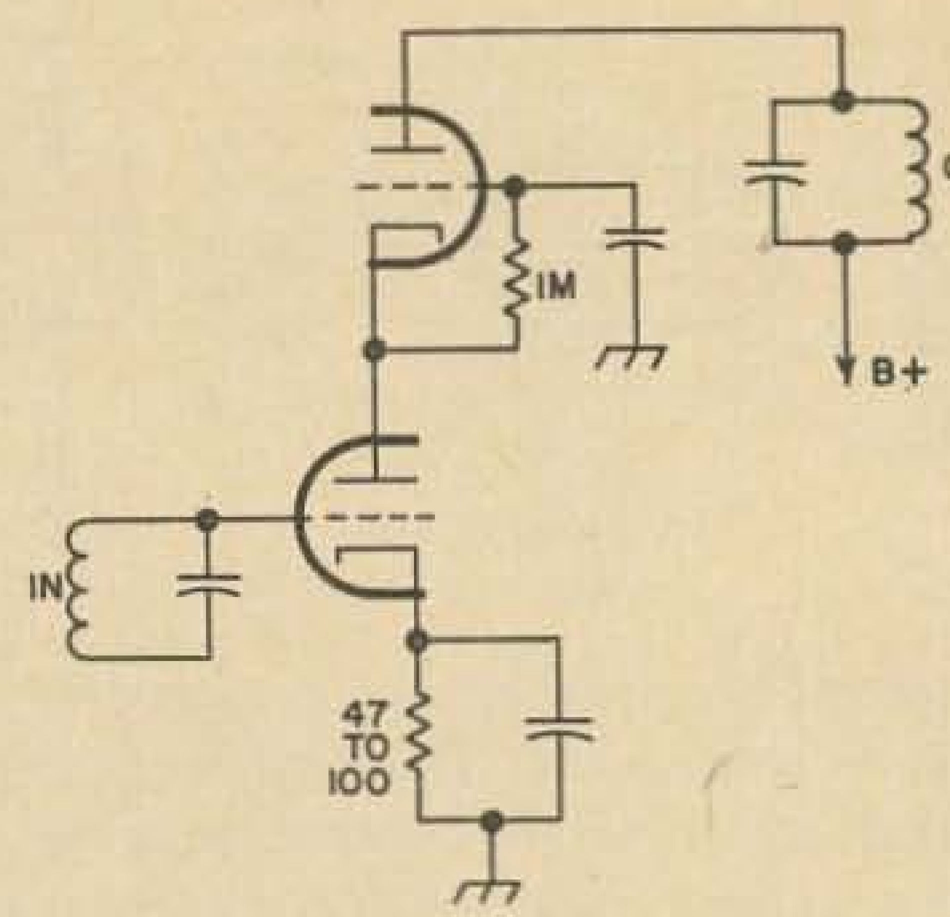

Fig. 8—Cascode circuit shown here replaced cathode-coupled arrangement in most applications, since gain is higher while noise is equally low when same tubes are used. Lowest noise is obtained if neutralization coil is added between plate of lower half and cathode of upper, but performance is usually adequate without coil as shown. While circuit is usually employed as RF amplifier, it also may be used at audio by changing input circuits accordingly.

and pentodes; each additional element introduces additional noise. The cathode-coupled circuit made it possible to use a twin triode in place of one pentode, and obtain approximately the same gain with far less noise.

A somewhat similar circuit, developed during World War II at the Radiation Laboratory of M.I.T. for radar use, surpassed the cathode-coupled amplifier in performance and rather rapidly supplanted it.

This circuit, shown in **Fig. 8**, is again a pair of direct-coupled amplifier stages with a grounded-grid output stage, but the input stage is a conventional grounded-cathode arrangement rather than a cathode follower.

The first stage is prevented from oscillating or being affected by feedback because its load is the low impedance of the grounded-grid circuit; the gain is too low for oscillation. However, even so the gain is greater than that of the cathode follower, and so the gain of the two tubes amounts to that which the two tubes would provide were both used as grounded-grid (or four used as cathode-coupled) stages.

The series circuit of **Fig. 8** is the final development stage; originally, shunt feed was used and the circuit was considerably more complicated.

This circuit, consisting of two tubes *cascaded* to produce the performance of a pent*ode*, was dubbed the "cascode" circuit by its inventors, and is still widely used under that name.

While its main application is as a VHF *rf* amplifier, the cascode circuit is also sometimes used as an audio amplifier. Gain depends primarily upon the load seen by the second stage, and if the variant shown in **Fig. 9** is used as much as 2000-time voltage amplification may be obtained in a single cascode circuit. In this version, the added parallel resistor permits additional current flow through the "lower" tube section, keeping its gain high, while the extra-high valued load resistor of the "upper" section produces a wide voltage swing.

The problem of adequate bandwidth is attacked by many approaches. One of the most common is to use lower-than-normal load impedances; this reduces the effect of the unavoidable shunting stray capacitance and so extends the frequency limit of the amplifier upwards. As the load impedance is reduced, however, the gain per stage goes down accordingly and so more stages are required to get the same gain. Fortunately, the resulting narrowing of bandwidth because of added stages does not quite cancel out the improvement gained in the first place. It's not uncommon, though, to find eight to ten stages in a wide-band amplifier, providing about the same gain you would get from two or three narrow-band stages.

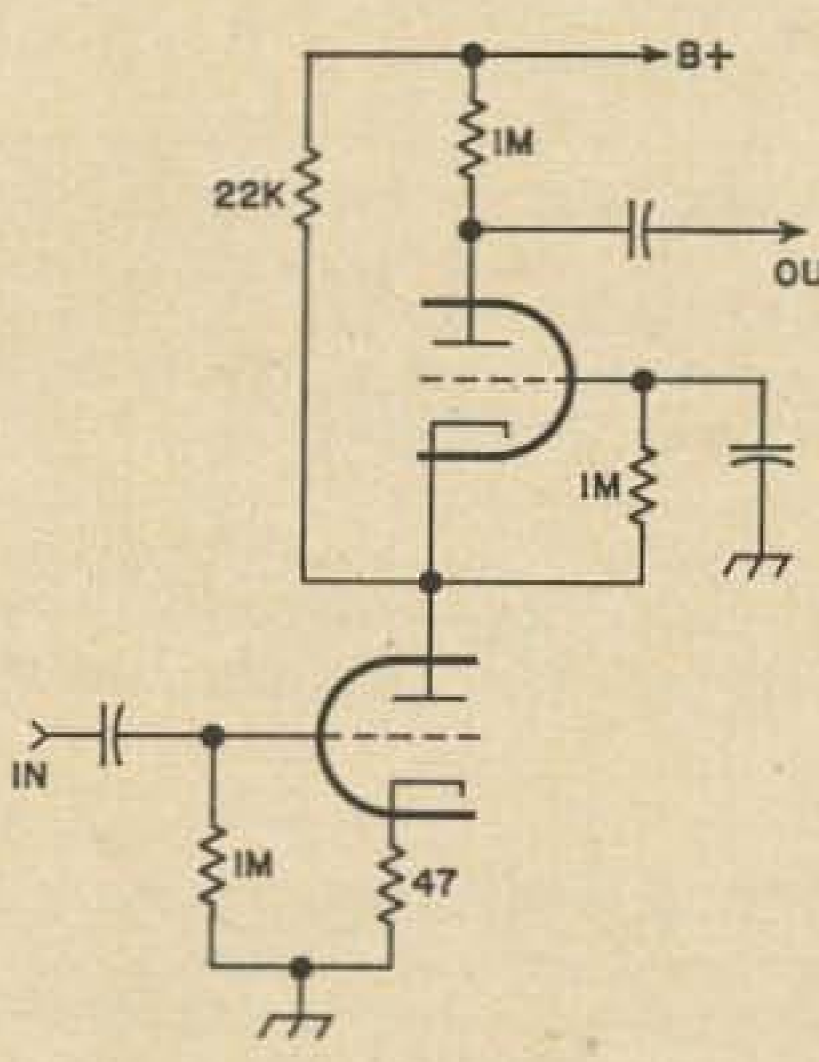

Fig. 9—This variant of the cascode circuit provides ultra-high gain, surpassing that normally obtained with pentodes. Extra-high load resistor in output circuit is responsible for high gain; 22K resistor shunting entire upper stage is necessary to provide adequate current for lower stage. Output impedance of this circuit is also very high and as a result high-frequency cutoff is usually rather low (below 3 kc). Third triode may be added as cathode follower to overcome part of this problem.

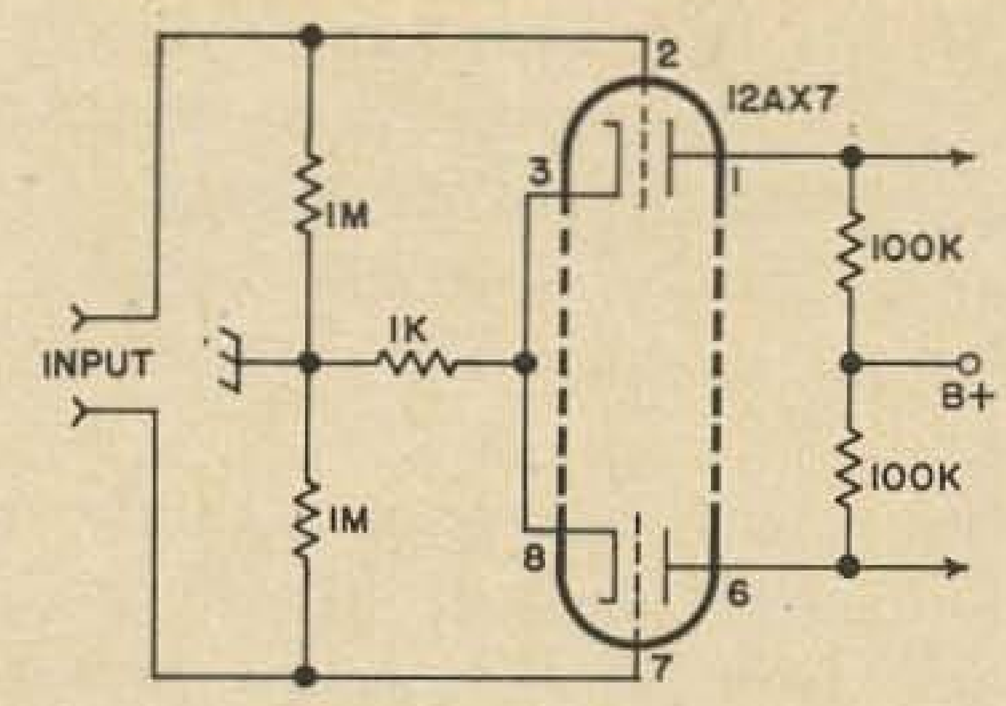

Fig. 10—Differential amplifier, often called simply "diff amp" in industry, is capable of DC amplification with relatively simple circuits. Circuit amplifies only the difference *between the input signals, and so cancels out any signal which appears on both input leads at same time in same polarity (such as hum or DC shift in power supply levels). Balance is maintained by common cathode resistor. Potentiometer may be added at junction of load resistors, with B+ applied to arm of pot, to permit static adjustment of balance as well.*

At the other end of the frequency limit the problem is somewhat different. As interstage coupling capacitors are made larger to permit improved low-frequency response, the amplifier's action in recovering from brief overloads gets progressively worse. The point is finally reached at which the amplifier requires several seconds to recover from a millisecond-long overload.

The coupling capacitors can simply be eliminated to provide response all the way down the frequency scale to, and including, dc. When this is done, though, any small change in power-supply voltages or tube characteristics is seen by all the following stages as a signal to be amplified. Because of this, a dc amplifier is much more tricky to keep operating properly.

One circuit widely used to overcome the instability problem of the dc amplifier is based on the idea that the two halves of a single tube change at about the same rate, and changes in power supply levels cannot hurt the signal if they are made to cancel themselves out. This circuit, the "differential" amplifier, is shown in **Fig. 10.**

In the differential amplifier, the signal to be amplified is applied, push-pull fashion, to the two grids. Each half of the amplifier stage operates essentially independently—but the output is not taken from plate to ground of either half. Instead, the *difference* in output levels between plates is used as the push-pull output signal.

Any change of power-supply levels affects both plates at the same time, and has little effect upon the *difference* signal. Similarly, any change of tube characteristics which affects both halves of the tube is also cancelled out.

By using the common cathode resistor, the cathode current of each half of the stage feeds back some of that half's signal to the other half. This improves the circuit's action greatly, because the feedback can occur only if *un*balance is present (if the amplifier is working as intended, the total cathode current remains constant—any increase in current in one half is offset by an equal decrease in the other half). Thus the desired difference signal is free of feedback, but any undesired components in that signal due to circuit unbalance are reduced by the feedback.

This self-balancing works so well that the circuit may be used to create the push-pull signal required, from a single-ended input. All you have to do is tie one grid to ground, and feed the desired signal to the other grid. The automatic balancing will put the proper input signal on the grounded-grid side, to produce the properly balanced push-pull output signal. Such a version is often found in hi-fi equipment, and also in sophisticated test equipment.

If the cathode resistor is returned to a negative supply of voltage approximately equal to the positive plate supply, several stages of differential amplifiers can be cascaded with all signal reference being to actual ground. This approach is almost a standard approach in lab oscilloscopes of the medium-performance class (top-grade instruments use different and much more complex amplifiers).

Next Month. VHF interest is consistently high; so are the problems of TVI. Since most TV broadcasting, and all ATV activity, is in the VHF region and above, we'll combine these subjects and explore them in our next installment. ■

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