AMATEUR RADIO

73

March 1962
40¢

6M VFO

Car Radar Rec.

500 W Linear

High Level Mixer

Modulation

REPLACEMENT TYPE TRANSFORMERS & REACTORS

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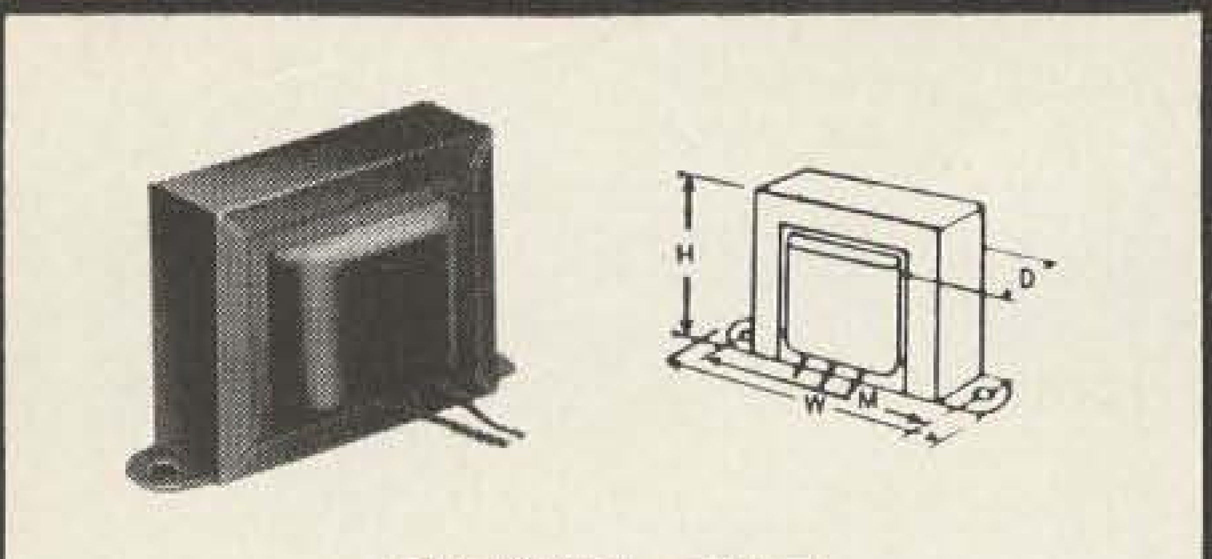
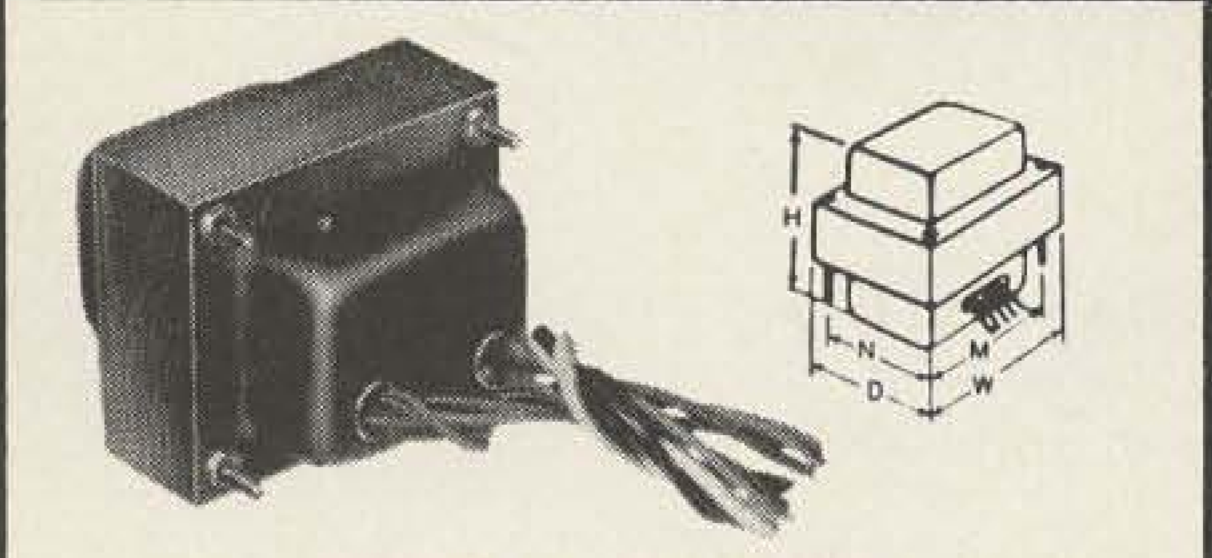
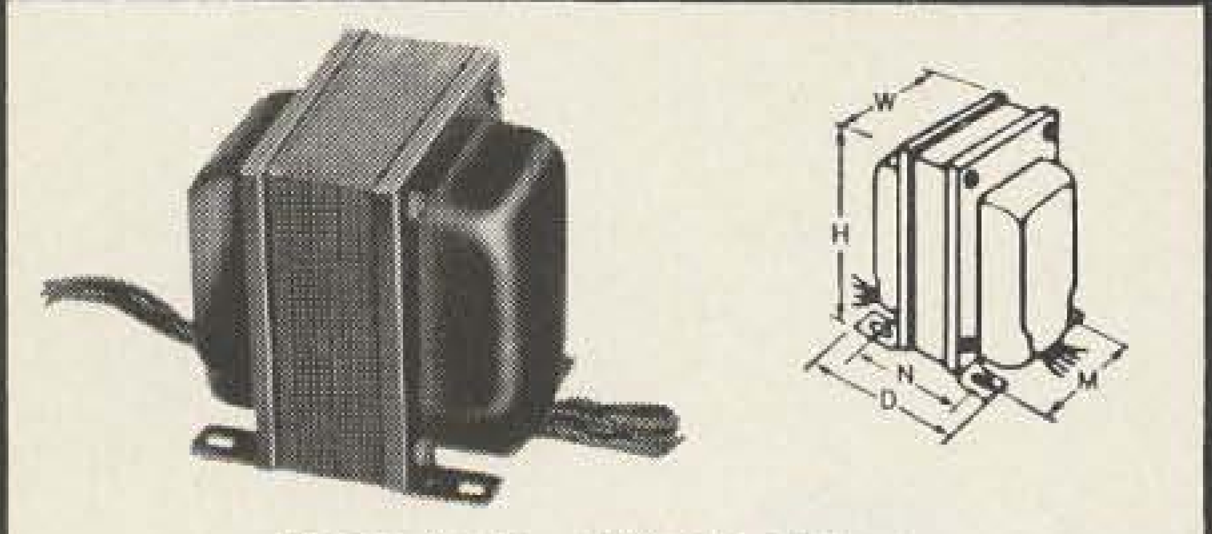


CHANNEL TYPE



DOUBLE SHELL TYPE



VERTICAL SHELL TYPE

CHANNEL FRAME FILAMENT/TRANSISTOR TRANSFS.

Pri. 115 V 50/60 Cycles—Test Volts RMS: 1500

Type No.	Secondary	W	D	H	M	Lbs.
FT-1	2.5 VCT-3A	2 7/8	1 1/2	1 11/16	2 3/8	3/4
FT-2	6.3 VCT-1.2A	2 7/8	1 1/2	1 11/16	2 3/8	3/4
FT-3	2.5 VCT-6A	3 5/16	1 7/8	2	2 13/16	1
FT-4	6.3 VCT-3A	3 5/16	1 7/8	2	2 13/16	1
FT-5	2.5 VCT-10A	3 3/4	2 1/8	2 5/16	3 1/8	1 1/2
FT-6	5 VCT-3A	3 3/4	2 1/8	2 5/16	3 1/8	1 1/2
FT-7	7.5 VCT-3A	3 3/4	2 1/8	2 5/16	3 1/8	1 1/2
FT-8	6.3 VCT-8A	4	2 1/2	2 5/8	3 9/16	2 1/2
FT-10	24 VCT-2A or 12V-4A	4	2 5/8	2 5/8	3 9/16	2 1/2
FT-11	24 VCT-1A or 12V-2A	3 3/4	2 1/8	2 5/16	3 1/8	1 1/2
FT-12	36 VCT-1.3A or 18V-2.6A	4	2 5/8	2 5/8	3 9/16	2 1/2

Taps on pri. of FT-13 & FT-14 to modify sec. nominal V, −6% +6%, +12%

Type No.	Secondary	W	D	H	M	Lbs.
FT-13	26 VCT-.04A	2 1/8	1 3/8	1 1/4	1 3/4	1/4
FT-14	26 VCT-.25A	2 7/8	1 5/8	1 11/16	2 3/8	3/4

DOUBLE SHELL POWER TRANSFORMERS

Type No.	High V.	DC ma	5V. Fil.	6.3 VCT Fil.	W	D	H	M	N	Wt. Lbs.
R-101	275-0-275	50	2A	2.7A	3	2 1/2	3	2 1/2	2	2 1/2
R-102	350-0-350	70	3A	3A	3	2 1/2	3 5/8	2 1/2	2	3 1/2
R-103	350-0-350	90	3A	3.5A	3 3/8	2 7/8	3 15/16	2 13/16	2 1/4	4 1/2
R-104	350-0-350	120	3A	5A	3 3/4	3 1/8	3 7/8	3 1/8	2 1/2	5 1/2
R-105	385-0-385	160	3A	5A	3 3/4	3 1/8	4 5/16	3 1/8	2 1/2	7

VERTICAL SHELL POWER TRANSFORMERS

Type No.	High V.	DC ma	5V. Fil.	6.3 VCT Fil.	W	D	H	M	N	Wt. Lbs.
R-110	300-0-300	50	2A	2.7A	2 5/8	2 13/15	3 1/4	2	1 3/4	2 1/2
R-111	350-0-350	70	3A	3A	2 5/8	3 7/16	3 1/4	2	2 3/8	3 1/2
R-112	350-0-350	120	3A	5A	3 5/16	3 11/16	4	2 1/2	2 5/16	5 1/2
R-113	400-0-400	200	3A	6A	3 7/8	4 5/16	4 5/8	3	3 1/8	8

CHANNEL FRAME FILTER REACTORS

Inductance Shown is at Rated DC ma—Test Volts RMS: 1500

Type No.	Induct. Hys.	Current	Resistance Ohms	Dimensions, in. W	D	H	M	Wt. Lbs.
R-55	6	40ma	300	2 3/8	1 3/8	1 3/8	2	1/2
R-14	8	40ma	250	2 7/8	1 1/2	1 11/16	2 3/8	3/4
R-15	12	30ma	450	2 7/8	1 1/2	1 11/16	2 3/8	3/4
R-16	15	30ma	630	2 7/8	1 1/2	1 11/16	2 3/8	3/4
R-17	20	40ma	850	3 5/16	1 5/8	2	2 13/16	1
R-18	8	80ma	250	3 5/16	1 5/8	2	2 13/16	1
R-19	14	100ma	450	3 3/4	1 7/8	2 5/16	3 1/8	1 1/2
R-20	5	200ma	90	4 1/8	2 1/4	2 5/8	3 9/16	2 1/2
R-21	15/3	200ma	90	4 1/8	2 1/4	2 5/8	3 9/16	2 1/2
R-220	100/8 Mhy 25/2 Mhy	2.5A 5A	.6 .16	3 3/4	2	2 5/16	3 1/8	1 1/2

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. . . de W2NSD

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Undependable

The annual boating show hit New York at about the same time as the last issue of 73 and all of the papers ran special boating sections. My estimate of 400,000 boaters turned out to be a rememberance of the attendance at this show, not the number of boating enthusiasts. It seems that there are now over 8,000,000 registered boats in these here United States. My estimate of their average expenditure was a little closer, being closer to $1500 per year than the $800 estimated.

How many hams do you know that put that kind of money into ham radio? Darned few!

Like any other interest, the more you put into ham radio the more fun you get out of it. The more I'm referring to isn't necessarily money, though cash is an important ingredient. When I look back at what I consider the high points of ham radio operating I can see that each of them took a lot of extra effort, plus some capital.

Though I've always enjoyed operating on the VHF's, the real fun didn't start until I went to the effort to cook up an amplifier for my Gonset. Once I had 500 watts perking and a 24 element beam I found that I could work anything I could hear and usually I got 'em on the first call. The number of answers to my CQ's was enough to keep any hungry ego well inflated. When aurora was in full bloom I could get on there and work anything coming through. What a difference this was from low power operation with a small whip where I was lucky to contact anyone outside of Brooklyn!

Two meters from a small plane is something I won't ever forget either. You have that DX feeling with the whole band coming back to you every time you stand by. Neglecting the effort involved in getting the plane and learning to fly it, there were the miseries of beating the ignition noise down to where I could hear anything through it, battery problems, antenna impossibilities, and so forth. But it sure was a ball.

Then there was the time I set up my two meter station on top of the News Building in New York, complete with sixteen and five element rotary beams. Even with a 522 rig I found that I was working from Delaware to Rhode Island with amazing regularity. The fun I had operating from there was worth many times the difficulties I had to surmount to get the permission and set up everything. It was even worth the permanent case of wobbly knees that I developed putting up my rotary beams thirty feet out on that ten inch wide ledge, with a 70 foot drop on one side and a 500 foot chasm on the other.

This was on a par with the idiocy that drove me onto the roof of the New York City Municipal Building one night during a blinding rainstorm. The roof was slick slate and slanted at about 30°. It took everything I had to hold on and put up that ground plane for two meters. I won the VHF contest that year, so maybe it was worth it.

My trips to Mt. Greylock, Mt. Mansfield and Mt. Washington have been told before. There is not one of those trips that I'll ever forget. These were sort of junior DXpeditions and I'd recommend your giving something like that a try. It even makes a great club activity. The Windblowers Club over in New Jersey puts on a big "Blow" every year with several mountain top stations operating simultaneously for a day and a certificate to every station that manages to contact all of their outposts.

The last word in this kind of activity is the full fledged DXpedition. This sort of thing is worth many times the dollars it costs and the months of preparation. Not one of us that went on the Navassa Island Expedition (KC4AF) will ever forget one minute of that trip. I note that most of the fellows have since gone on more trips like that. I sure wish I could manage to get away again some time. You can bet that I'm doing everything I can to make it so that eventually 73 Magazine will be sponsoring some DXpeditions. Heh! Heh!

Which brings me back to my original idea that the more you put into ham radio the more fun you will have. When I visit a chap with 100 watts and a dipole and operate his station (as I have done a couple hundred times or so) and compare this with operating a kilowatt station with a good beam, there just is no question about who is having the most fun. It is like comparing the fun of a row-boat to

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March 4—Tunnel diodes: what they are and what they can do.

March 11—Tunnel diode circuitry.

March 18—Applications of drift transistors to radio receivers.

March 25—Transistorized voltage regulators.

April 1—Advantages of compactron multi-function tubes in electronic equipment.

April 8—What computers can do.

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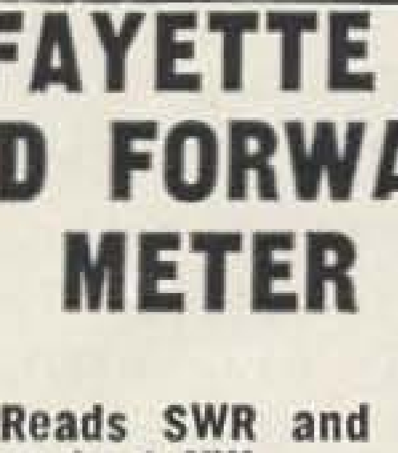

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that of a speed-boat. I've done a lot of low power dipole operating with my own station and I find that somehow there is no substitute for an antenna and an amplifier.

For all our grumbling about "those high power stations," there are relatively few hams that take the time and effort necessary to put out a first rate signal. Sam Harris W1FZJ always comes to mind in this respect. Sam has a peculiar emotional difficulty: he cannot be happy on any band unless he has the loudest signal in the world on that band. I haven't visited him recently, but I believe he operates on 75M, 50-144-420-1296 mc. This entails quite a forest of towers and beams.

Hmmm, now lets' see, where is that catalog? I've got to order a tower for that twenty meter beam and I might just as well get right at it.

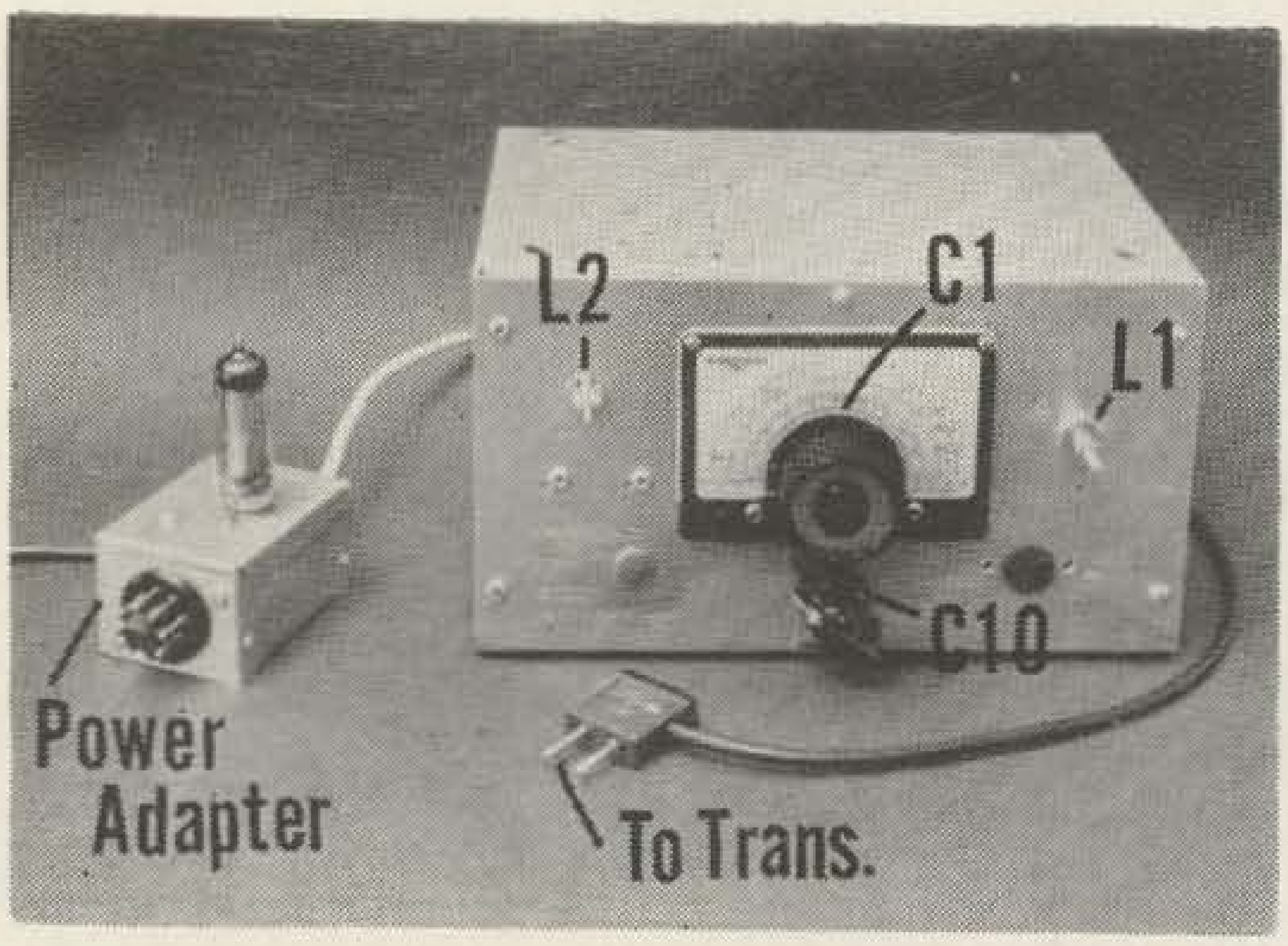
Clubs

Radio clubs are an integral part of our ham radio hobby and it behooves us to spend some time and energy in keeping them going the best way we can. Unfortunately it is far easier to kill off a club than make it flourish. While there are a few clubs that go on year after year in good health, we find sickly clubs more the rule than the exception. It would be nice if I could present you with a neat little list of things you should do to keep a club in good operating order, but I'm afraid that this has not yet been reduced to a science.

Though I have slept through the greater part of many club meetings, I have stayed awake enough times to arrive at some conclusions of my own as to what makes a club meeting interesting and what defeats it. The one big factor in the success of a club, I feel, is the smoothness of operation of the executive committee. If this committee is running smoothly they will second-guess the club members on almost every item which might ordinarily come before the club during a meeting and hash out all pro's and con's, sort of predigesting problems for the club. Then, during the meeting the results of the committee's thinking can be presented, together with all of the factors that went into their decision. This should cut down tremendously on the amount of time that the entire club has to spend in discussions.

Many clubs get all wrapped up in endless business meetings which seem to keep everyone engrossed at the time, but which don't seem to keep members coming back for more. Whenever there is an argument there must be at least two sides. This means that every time you have an argument you are going to have losers and these chaps may have been voted down, but they haven't changed their minds about the argument. They are still convinced they are right and they'll never be

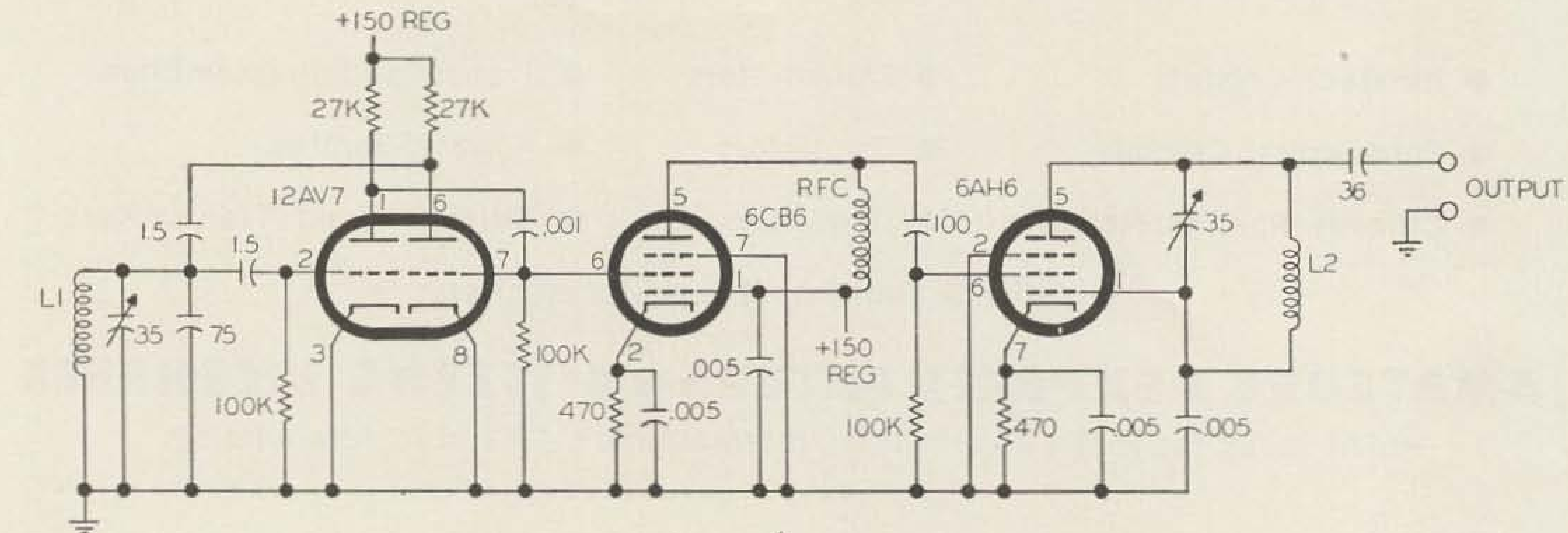
(Turn to page 45)

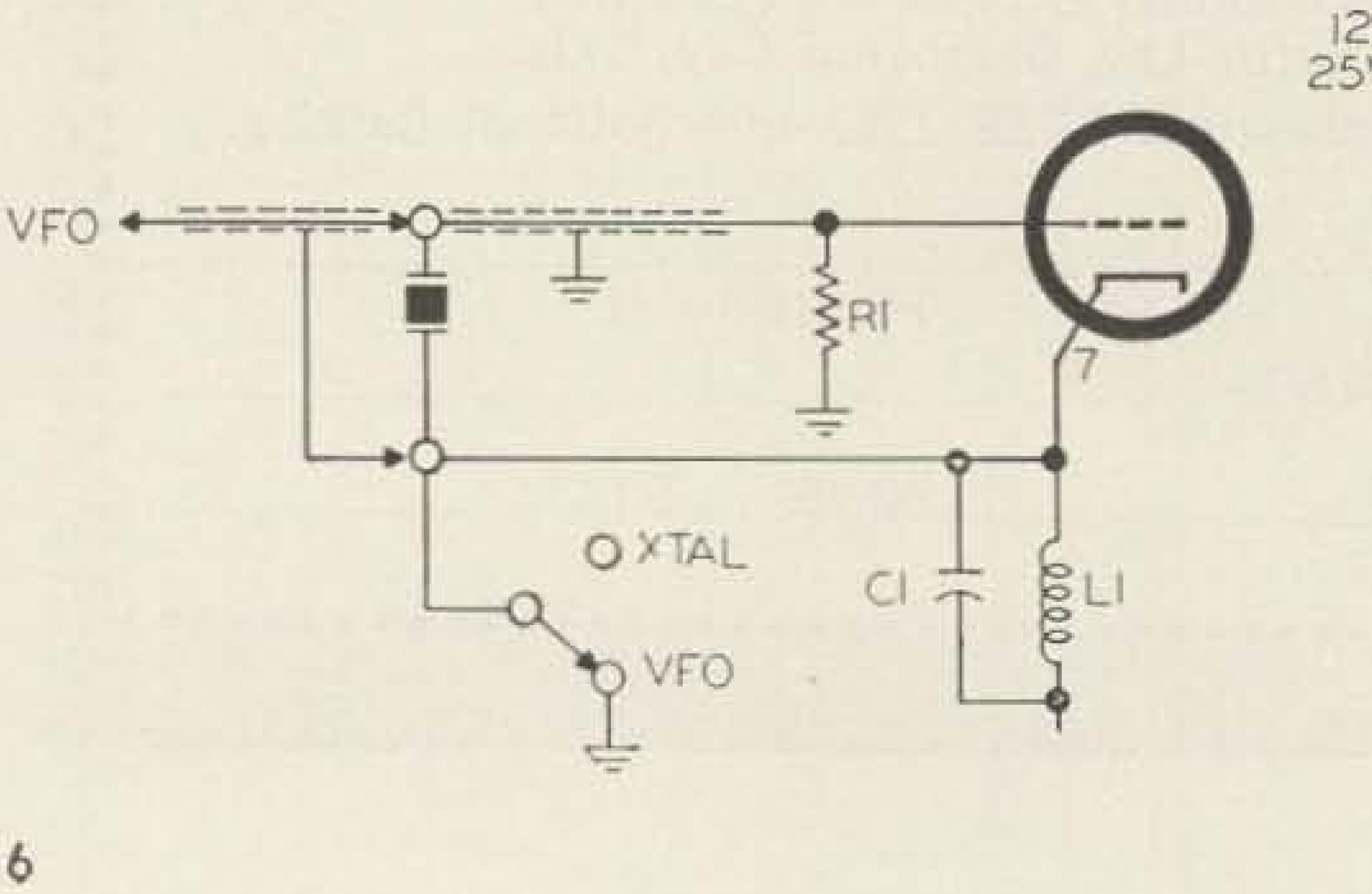


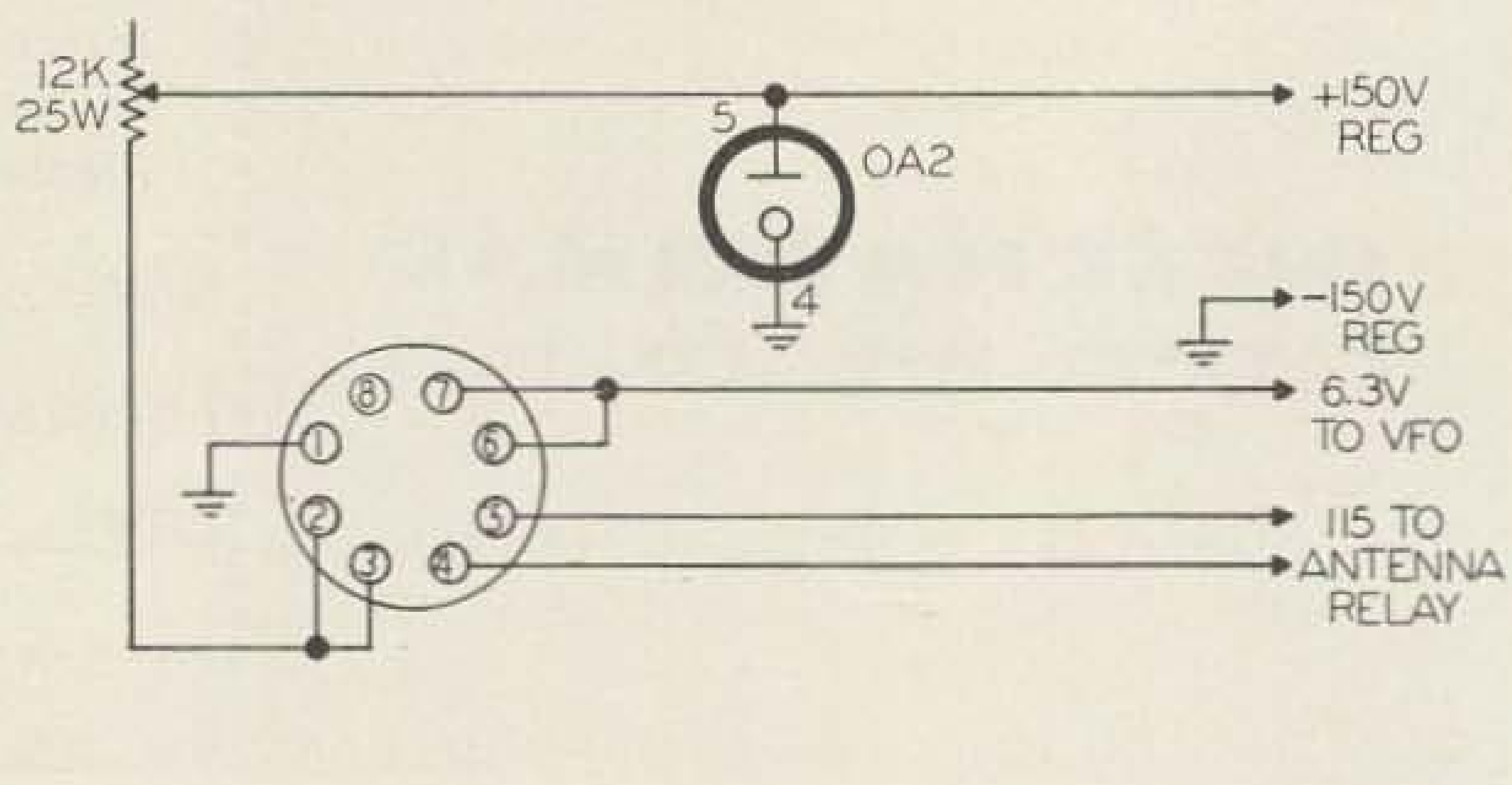
Printed Circuit VFO for 50 mc Transmitters

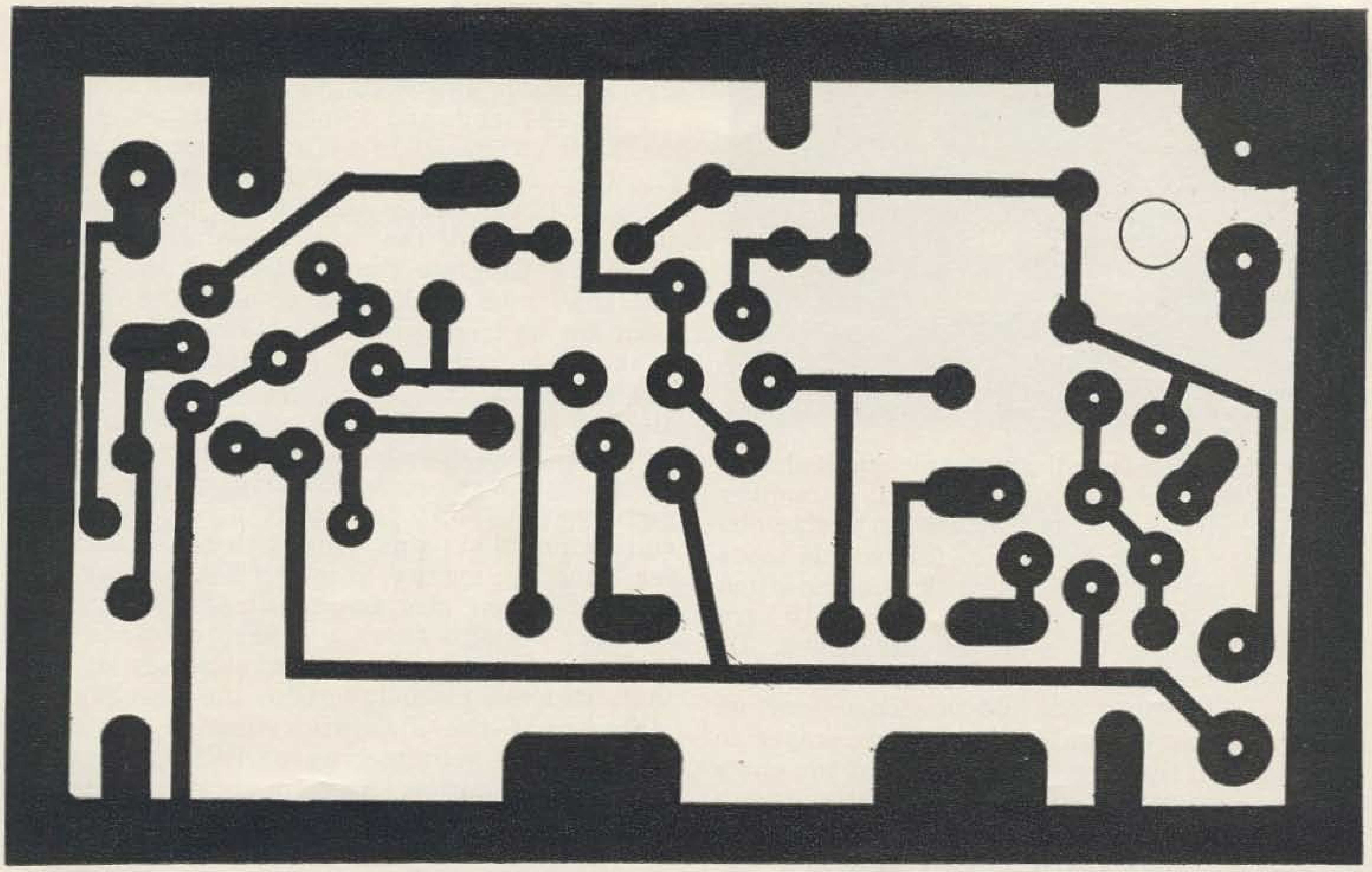
Irving Seligman W5UB
402 McNeel Rd.
San Antonio 28, Texas

THE control of the frequency of HF transmitters for many years has been accomplished by variable frequency oscillators, commonly called VFOs. They have been called many other things when their use has resulted in undesirable frequency stability, chirps and etc. that have been attributed to the nature of the beast rather than to the shortcomings of a particular unit. The one to be described here has been used successfully in conjunction with SSB rigs on the HF Bands and, in this particular instance, to control the









Printed Circuit Board—Actual Size

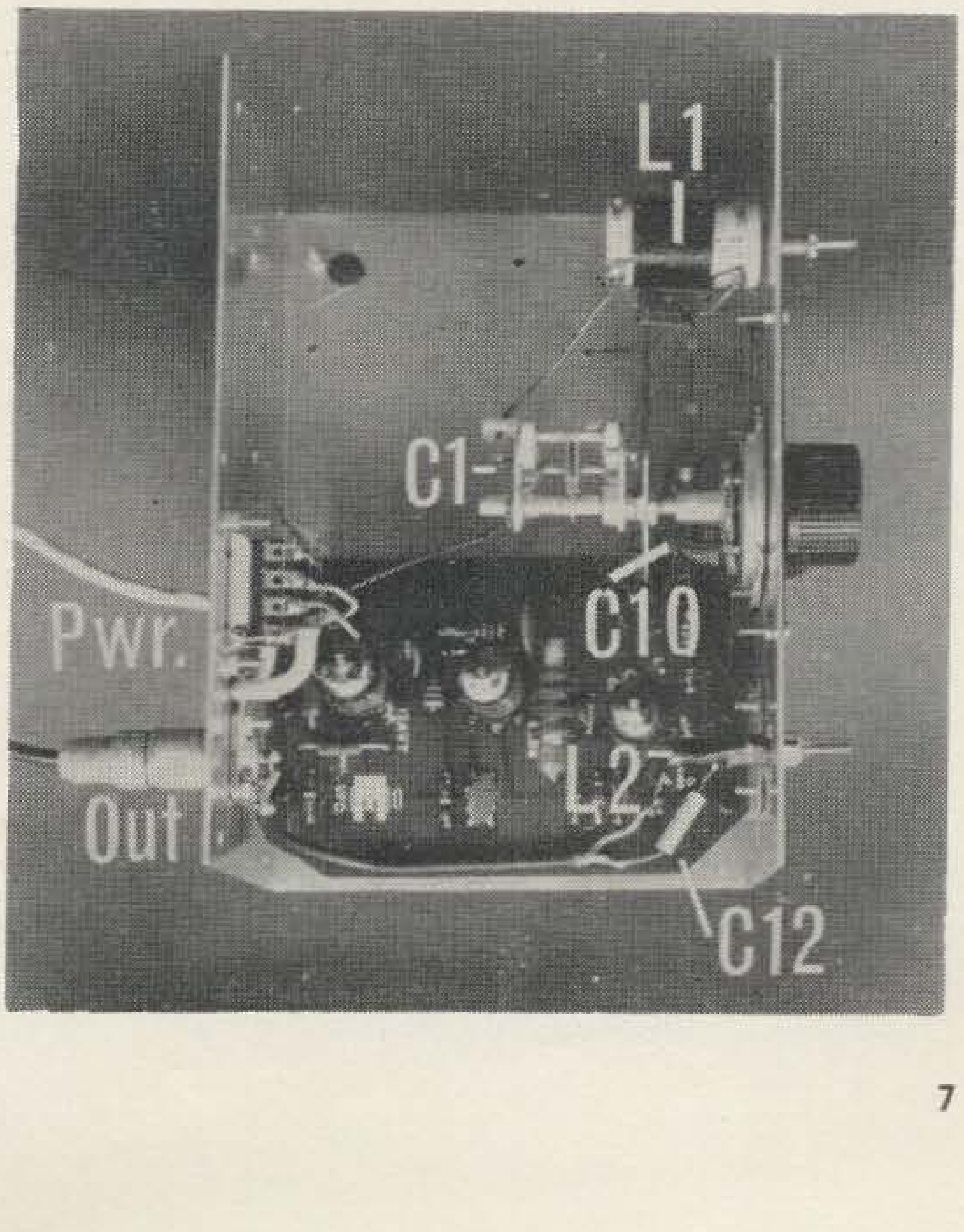
frequency of the author's "Globe Hi-Bander" on 50 mc without too much gnashing of teeth and tearing of hair either by the operator or the recipients of its results.

The circuit used in this unit is the product of Don Stoner, inappropriately termed the "Driftless VFO." There just "aint no such animal." But be that as it may, and with due respects to my author colleague, it is a fine circuit; and while not "driftless" in the strict sense of the word, it performs admirably. The VFO consists of a 12AV7 oscillator (Franklin type), a 6CB6 buffer and a 6AH6 doubler. The oscillator operates from 4.165 to 4.5 mc, with doubler output from 8.33 to 9.00 mc, which is satisfactory for rigs requiring xtals frequencies in this range, as does the "High-Bander." It obtains its power from the octal Accessory socket at the rear of the transmitter. The power requirements are 25 ma at 150v regulated (plate) and 1.20 amps. at 6.3v (Fil.) This can readily be secured from the transmitter without overloading its supply. The rated load of the final (120-125 ma) can be slightly reduced without too much loss of output if you are worried about the transmitter transformer 'going west.'

The only changes from the published circuit in the Sideband handbook are:

1. The grid resistors of the 12 AV7 are reduced to 100 K from 1 meg. (I bet that was a misprint.)
2. The coupling capacitor from the buffer to the doubler is reduced from .001 mfd to 100 mmfd (Ditto)
3. The doubler is a 6AH6 instead of a 6CB6 to secure an increase in output.

A cabinet, 9" x 6" x 5", of heavy guage aluminum was available in the junk box. It did not have too many extraneous (?) holes and quite a few in the right places which resulted in its being used to house the contraption. The photograph shows the placement of the various parts. Special care was taken to isolate Coil L-1 from the heat producing elements of the unit (tubes) in an effort to minimize instability due to heating. Variable Capacitor, C-1 was mounted on a heavy aluminum bracket, securely fastened to the



cabinet in order to eliminate mechanical frequency 'shakes.' Having on hand a number of etched circuit boards for this particular circuit (adv.) it was decided to follow this mode of construction. All parts with the exception of Coils L-1, L-2, C-1, C-2 and C-10 are mounted on the 6" x 4" circuit board. Of course if you want to be strictly square you can build the unit the old-fashioned way on a metal chassis (ugh). It's so easy simply to drill holes in the circuit board, mount the parts in the designated spaces and solder (more adv.). The power cable enters the cabinet thru a rubber grommet and is fastened to a terminal strip from which leads are run to the P. C. board. The output is connected to a coax chassis connector. The coax lead to the transmitter is terminated in a crystal holder which plugs into the xtal socket of the transmitter.

The power plug for connection to the Accessory socket is mounted on a 2¾" x 1¾" x 2" Minibox. This box also contains the parts and circuitry shown in Fig. 3. The photograph shows the mounting arrangement. Leads are also provided to obtain 115 v ac to operate the Antenna relay. Plate voltage is automatically applied to the unit when the Transmitter Function switch is in the Tune, AM and CW position. Filament current is applied to the unit when the Transmitter AC switch on the gain control is turned to the "On" position. A separate filament transformer may be desired by some users in order to keep the unit "warm." If such is the case, it may be outboarded anywhere but on the VFO case. The voltage output from the transmitter measured 470 v. on 'Tune' and 400 v. on AM. It is necessary to adjust the slide on R-8 to cause the OA-2 regulator, to glow in either position of the Transmitter Function switch.

The oscillator of the Hi-Bander has a tendency to oscillate when the VFO is connected in the manner recommended by the manufacturer. This is putting it rather mildly. The blank thing takes off like a jet airliner. It can be restrained by replacing the grid lead from the 5763 to the crystal socket with a piece of coax as shown in Fig. 2. It is also necessary to ground pin 7 of the same tube when using the VFO. This was accomplished by mounting a single pole double throw rotary switch in the space just above the transmitter crystal socket and wiring as shown in Fig. 2.

With the coil and capacitor values given the VFO covers 50 to 54 mc in the full 180° rotation of C-1. As a result 50.0 to 51.0 mc is about 45 degrees of the dial. If more spread on this portion of the band is desired by those who only populate that section of the band, C-1 should be made smaller and C-2 larger until the desired spread is obtained. However, it should be remembered that lots of DX was worked when the band was from 56-60 mc and the high end of the present band is open more often than most people realize it.

The unit was connected to the power socket and "warmed up" for about an hour before calibration. This was done with the transmitter function switch in the "Tune" position. The VFO can also be stabilized by running filament voltage from a separate source for a similar period. The re-set accuracy of the unit depends largely upon the mechanical stability of the dial. However, do not rely entirely upon your receiver or VFO calibration for good accuracy. A good frequency meter is indispensable if you must operate close to the band edges on any band. The following frequencies are given as an aid to calibration and hold only where the final frequency is the 16th multiple of the starting frequency:

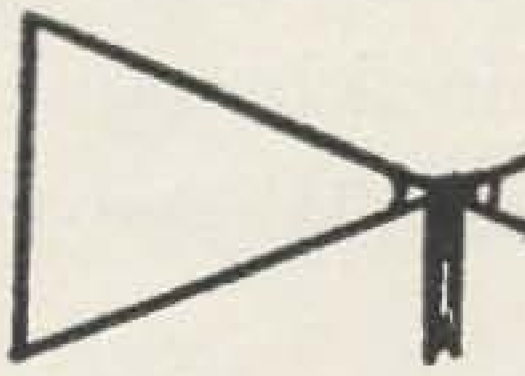
VFO Frequency	Operation Frequency
8.333 mc	50.0 mc (Band edge)
8.416 mc	50.5 mc
8.500 mc	51.0 mc
8.583 mc	51.5 mc
8.667 mc	52.0 mc
8.750 mc	52.5 mc
8.834 mc	53.0 mc
8.917 mc	53.5 mc
9.000 mc	54.0 mc (Band Edge) *

No checks were made to determine how many cycles the frequency changed per degree or temperature rise. It has given satisfactory results as judged by the lack of squawks begotten by excessive dial twisting to keep track of its signal. The only one received was when the electric fan in the shack was too close to it and wobbled the frequency at a 60 cycle rate. So beware of fans in the Ides of August but have fun in busting in on your rivals choice DX.

P. C. Board including tube sockets available from Irving Electronics, P.O. Box 9222, San Antonio 4, Tex. for $2.25 postpaid.

Fig. 1—All resistors ½-W carbon except as noted.
C1—Hammarlund MC-35S (remove all but one rotor and 2 stator plates).
C2—75 mmfd silver mica.
C10—35 mmfd variable (Hammarlund HF 35).
C12—36 mmfd ceramic.
S1—SPDT rotary switch (CRL no. 1460).
L1—27 Turns #24 enamel close wound on National XR60 slug tuned form—1" dia. x 1¾" long.
L2—9/16" length of #28 close wound on ¼ slug tuned form.

BULLSEYE BUYS at ARROW!



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A true ham station, ideal for both fixed station and mobile operation.
Double conversion superhet gives you extreme selectivity and freedom from images and cross modulation.
Transmitter section has an ultra-stable crystal oscillator which also may be controlled by external VFO.
Efficient, fully modulated 8 watt final works into flexible Pi network tank circuit. Large S meter serves for transmitter tune-up procedure.

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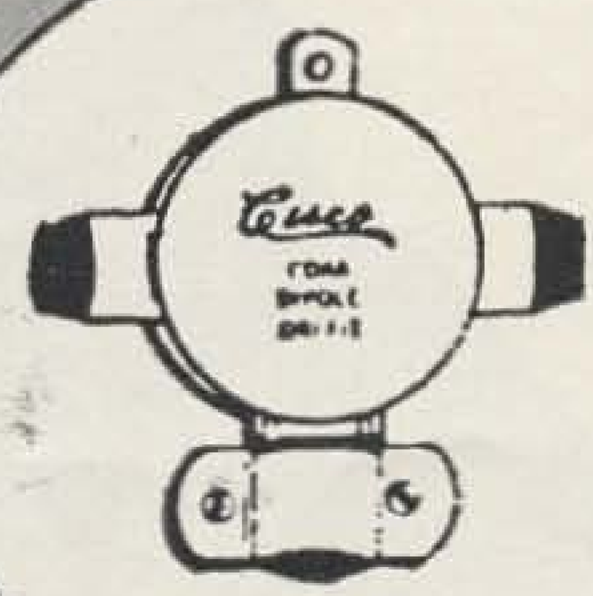

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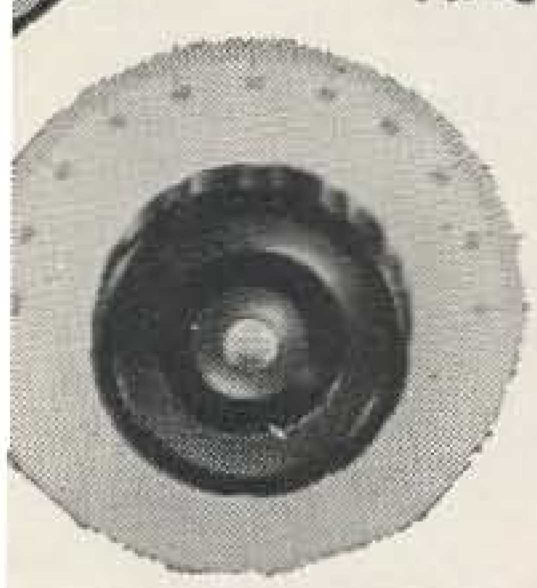

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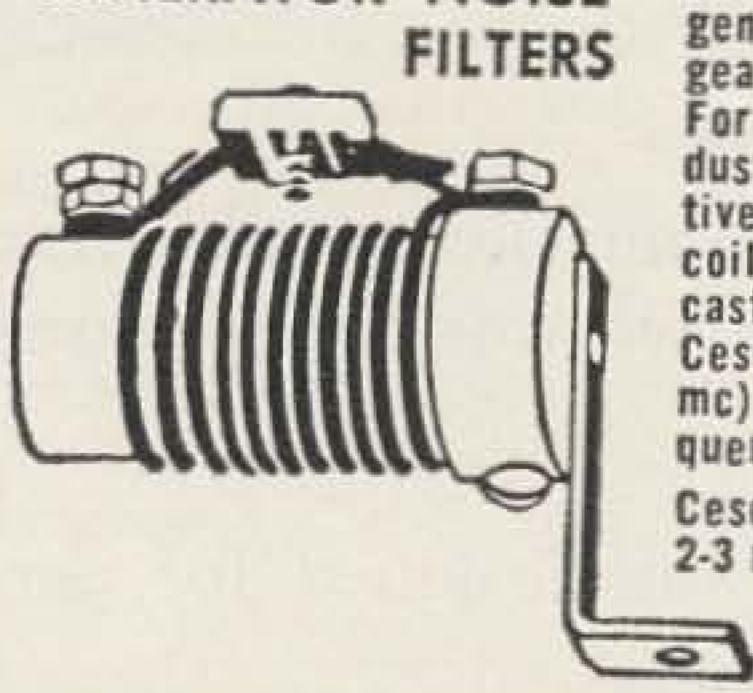

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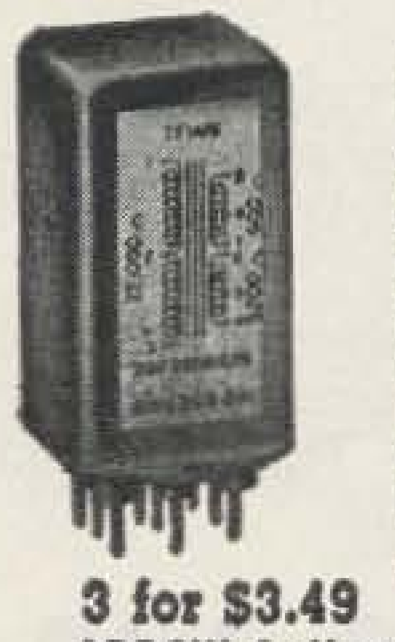

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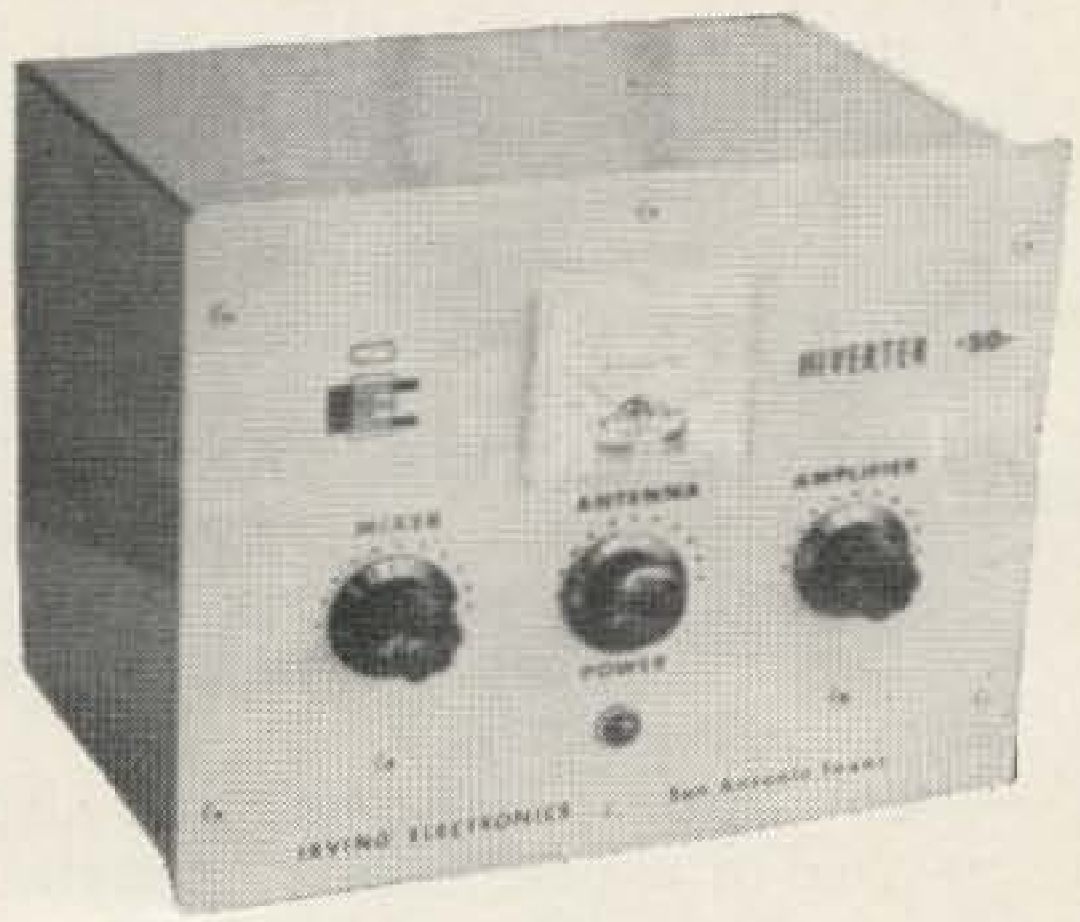

HIVERTER 50

PREVERTER 50 & 144

CHECK THESE FEATURES

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- ✓ Tubes: 6CL6 Oscillator, 5763 Mixer, and 6146 Linear Amp., with 2-OB-2 Regulators.
- ✓ Pi-Net Output to match 50-100 ohm Antenna Load
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  6.3 V. AC-2.7 Amps (Filaments)
  300 V. DC-60 Ma. (Osc.-Mixer)
  600 V. DC-120 Ma. (Amplifier)
  -130 V. DC-(Amp. Bias)

- ✓ Uses Low noise Philco Transistor - Less than 3 Db on 6M, 3.5 Db on 2M
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IRVING ELECTRONICS CO

P.O. Box 9222 San Antonio 4 Texas

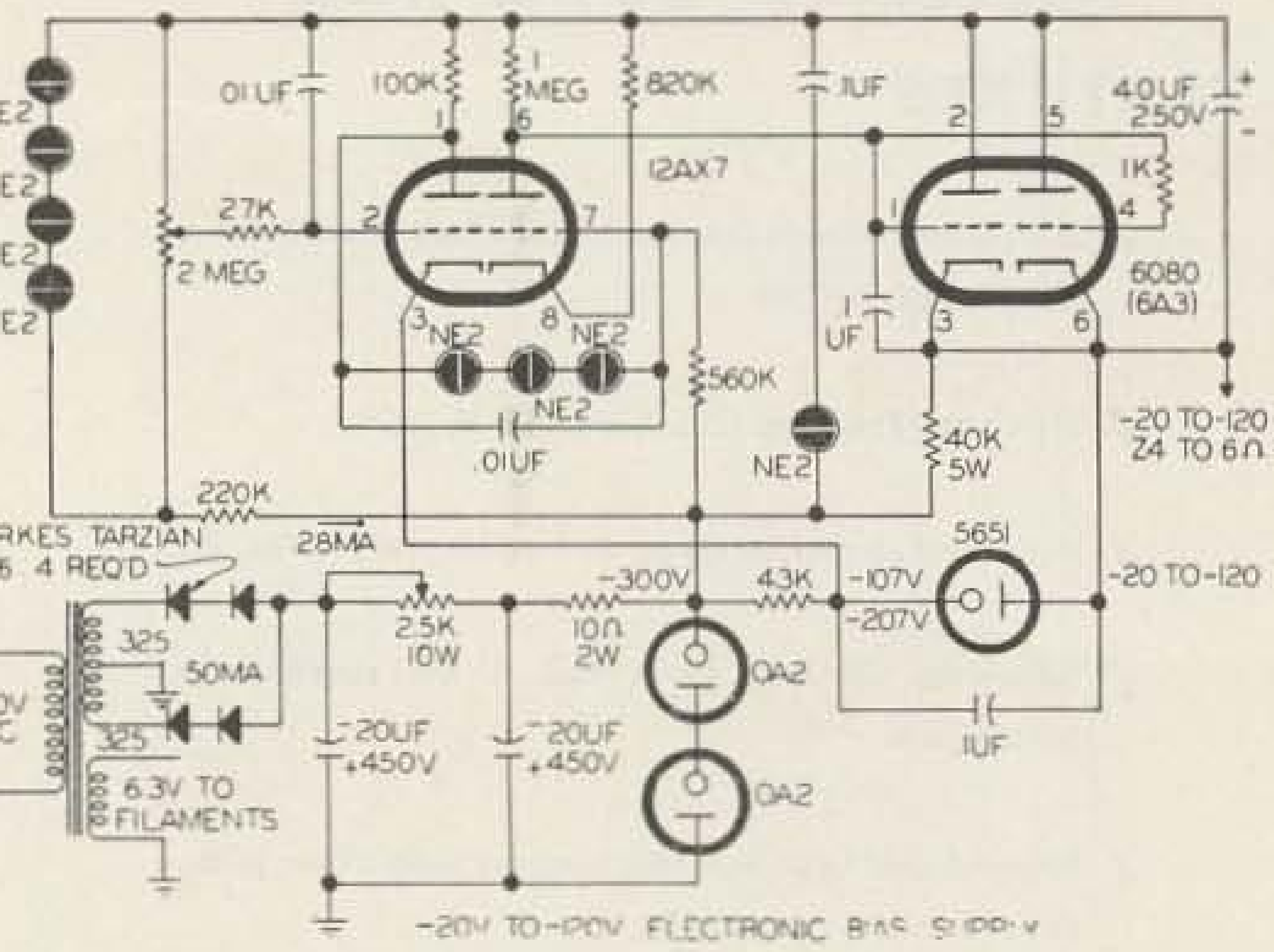
Regulated Bias Supply

Vernon Trexler W5IUR
2459-A 45th
Los Alamos, New Mexico

A stable bias is needed if you run your linear amplifier class AB2. As the tubes draw grid current the bias supply voltage must not change, the bias supply must present a low impedance to this grid current, otherwise distortion will result. The regulated bias supply is very convenient when you need to set the plate idling current at some specific value in linear operation.

A battery could be used for this service, however if you need to change the voltage for different operating parameters or run your amplifier Class A through C as the need arises, you will need a variable bias supply. Batteries also have a tendency to change in time when used as a bias supply.

Some electronic bias supplies do not have a great enough voltage change to meet the different operating classes when using large tubes such as the 4-250A, etc.



-20V TO-120V ELECTRONIC BIAS SUPPLY

With these requirements in mind, a variable voltage bias supply was developed for a grid current range of 0 to 70 ma and a voltage range of -20 to -120 volts, and an impedance of 4 to 6 ohms presented to the amplifier grid circuit.

The circuit is unique in that it uses small NE-2 neon bulbs to hold various critical voltages constant. A 5651 voltage regulator tube is used because of its higher current rating as compared to a NE-2 in one location in the circuit. The circuit gives the various voltages and currents to expect at different points, and should be self-explanatory.

The 12AX7 is used as a sensing unit to vary the resistance of the 6AS7 so that as the grid current changes the impedance presented by the 6AS7 does not vary, thereby presenting a constant impedance to the grid circuit for varying currents.

The author has used this circuit for almost a year in a pair of 810 modulator tubes and a final rf amplifier using a pair of 4-250A running class A, AB_1 and AB_2 and Class C and has been very pleased with the results.

Other Hams have built the supply and only one problem has presented itself, the four NE-2 in series sometimes do not light properly. If this occurs, substitution of other NE-2's will cure the problem.

Be sure to follow the polarity marking on the schematic for the electrolytics. It is very convenient to bring the potentiometer to set the bias out the front panel of your amplifier. Be sure to shield the leads to this pot.

The power supply for the bias supply is voltage regulated and the current through the two VR tubes is set for 15 ma with the bias supply operating but not in use.

The author is indebted to Dr. Ralph Partridge for assistance on this project.

. . . W5IUR

Calls of the Past

Most radio amateurs are familiar with the present system by which the FCC issues radio call letters. For any given district in the 48 contiguous states, the "W" calls are issued from (numeral) AA through (numeral) ZZZ, skipping the letter X, to holders of Extra, Advanced, General, Conditional, and Technician Class licensees. "WN" calls are given to Novice Class licensees. When this series is used up, the FCC shifts to "K" and "KN" and repeats the process. The next step is the "WA" and "WV" series.

It has not always been so simple, though. In past years distinctive calls were issued for now-forgotten special purposes. Did you know that for many years the "Y" block of calls (like W5YJ) was not issued to stations owned by individuals but was reserved for colleges, universities, and other institutions of learning? The "X" block has always been reserved for non-amateur, experimental stations. Until the mid-thirties, "Z" calls were issued only to holders of a "Special Class" station license which authorized additional privileges, usually as to operational frequencies.

Portable and mobile operation required additional station licenses and call letters. "W10" (W ten) calls were issued for aircraft mobile operation in all call districts. Call letters for portable operation outside of your own call area began with the letters "ZZ". This meant that some calls had four letters after the numeral (like W6ZZAJ).

. . . W5EHC

How to Check Transistors with an Ohmmeter

or: Let's Cheat

Don Grayson W9QKC
2144 East 12th Street
Indianapolis 1, Indiana

WHAT the ham needs is a good go-no-go way of checking transistors with a piece of gear that he already has. Most transistor testers give you all sorts of exotic numbers and are expensive. What we want is a method to cheat and get a good idea of the quality of the transistor for the least fuss and cost.

First let's examine the transistor to see what is available to measure. Fig. 1 shows the equivalent configuration of a PNP transistor. You will note that it is shown as two diodes, the emitter and collector with a common cathode, the base This is actually how the transistor is made. It operates by injecting a little current into the base which controls the number of electrons that flow from the collector to emitter. This, basically, is all there is to transistor action.

At first glance it would appear that, since the transistor is just really two diodes, we could just take an ohmmeter and measure the forward and backward resistances of the two diodes. We would set it up as in Fig. 2 and if the transistor were good we could expect results like those shown. This test will give us some information about the operation of the emitter-base and collector-base diodes but leaves us in the dark whether it has even any gain or not. In other words it does not test the basic operation of the transistor. In fact the transistor can have a collector to emitter short and still have good diode action on both the emitter and collector. Well, you say, "Why not measure between the emitter and collector, that will surely detect a short." Sure it will, but define a short. Remember that now we are not measuring the ratio of forward to backward resistance, but the backward leakage resistance of one diode in series with the forward resistance of another diode. What will be a good number for one transistor will be a dead short for another. There would be a tremendous variation in this resistance from a small signal silicon rf amplifier to a germanium audio power amplifier. And we still know nothing about whether the thing will amplify or not. Besides, the manufacturer does not normally give such data anyway. What we want is a foolproof method of deciding if the thing is "transistoring" even though it was invented in Russia in 1933.

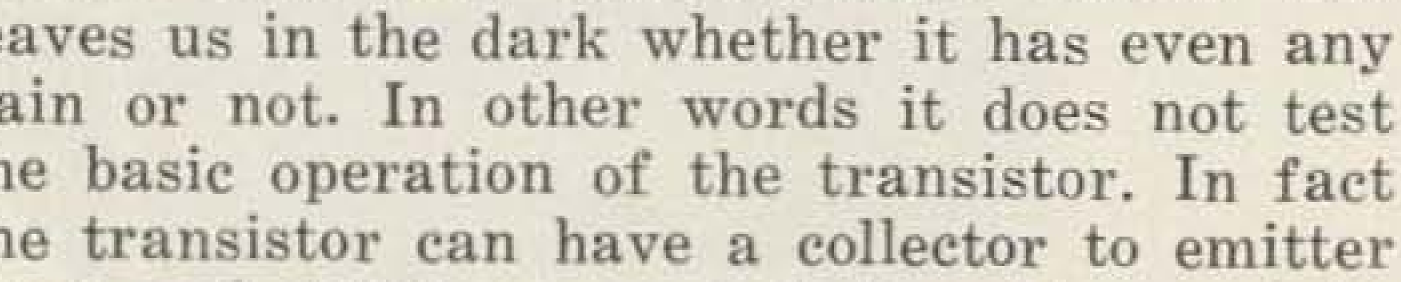
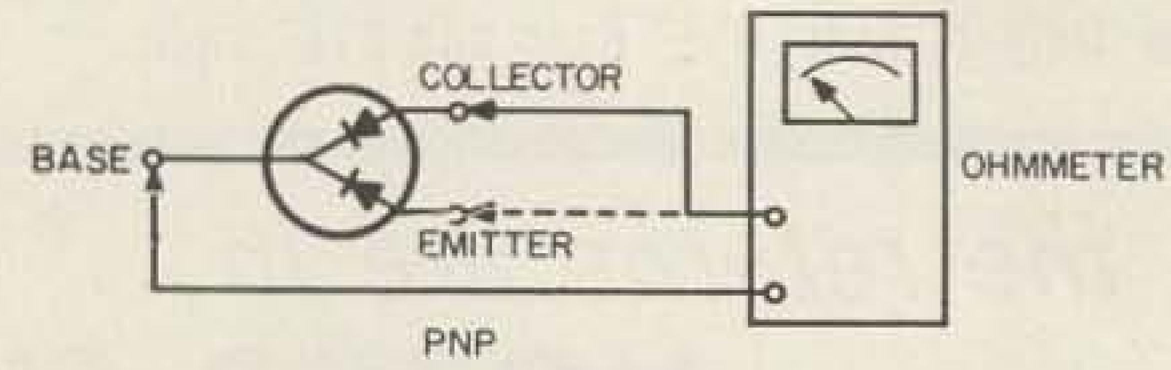


Fig. 1. At the left is the symbol of a standard PNP transistor. At the right is the equivalent physical configuration of this transistor. Note that it is actually two diodes tied to a common point, the base.



BASE	COLLECTOR	RESISTANCE	BASE	EMITTER	RESISTANCE
+	−	HIGH	+	−	HIGH
−	+	LOW	−	+	LOW

Well then, let's set the thing up in a circuit like it is supposed to work and squirt some current into the base to see if the current going through the collector-emitter leads does increase. If we are careful about polarity we can use our trusty ohmmeter to do this. An ohmmeter is nothing but a battery in series with a resistance and a meter. Assuming that we want to test an NPN transistor we merely place the positive test lead on the collector and the negative lead on the emitter. A small amount of leakage current will flow which will be indicated as a resistance on the ohmmeter. The theory says that if we apply a positive voltage to the base the current in the collector-emitter circuit should increase. Well that's easy enough to do, just push the base lead over until it touches the positive collector lead. If the transistor has any gain the collector-emitter current should increase. Of course since we are using an ohmmeter our indication will be a decrease in resistance. As a further check push the base lead over and touch the emitter lead. This effectively grounds the base and the current in the collector-emitter circuit should decrease from the value of current with the base left floating. This,

of course will be indicated as an increase in resistance on our ohmmeter.

Notice that all of these measurements are relative to each other, we don't have to have any data or "reference." Actually in each configuration you are measuring a basic parameter of the transistor, and, if you happened to have the curves for that transistor, you could check them. In the first configuration with the base open the measured parameter is I_{ceo}, current through the collector-emitter with the base open. The second configuration with the base tied to the collector is actually a measurement of the transistor's beta. (The manufacturer usually calls this h_{fe}). The third configuration is a measurement of I_{ces}, current through the collector-emitter with the base shorted to ground.

It is a bit hard to obtain exact numbers on these parameters as we are looking at a linear representation of basically a logarithmic device. If the collector-emitter current does go up when we apply the proper bias to the base we know that the device has a beta and it is "transistoring." This information is augmented by the action of the current when the base is grounded. On a dc basis we can now select a "hot" transistor from several of a similar type by picking the one that shows the greatest resistance change.

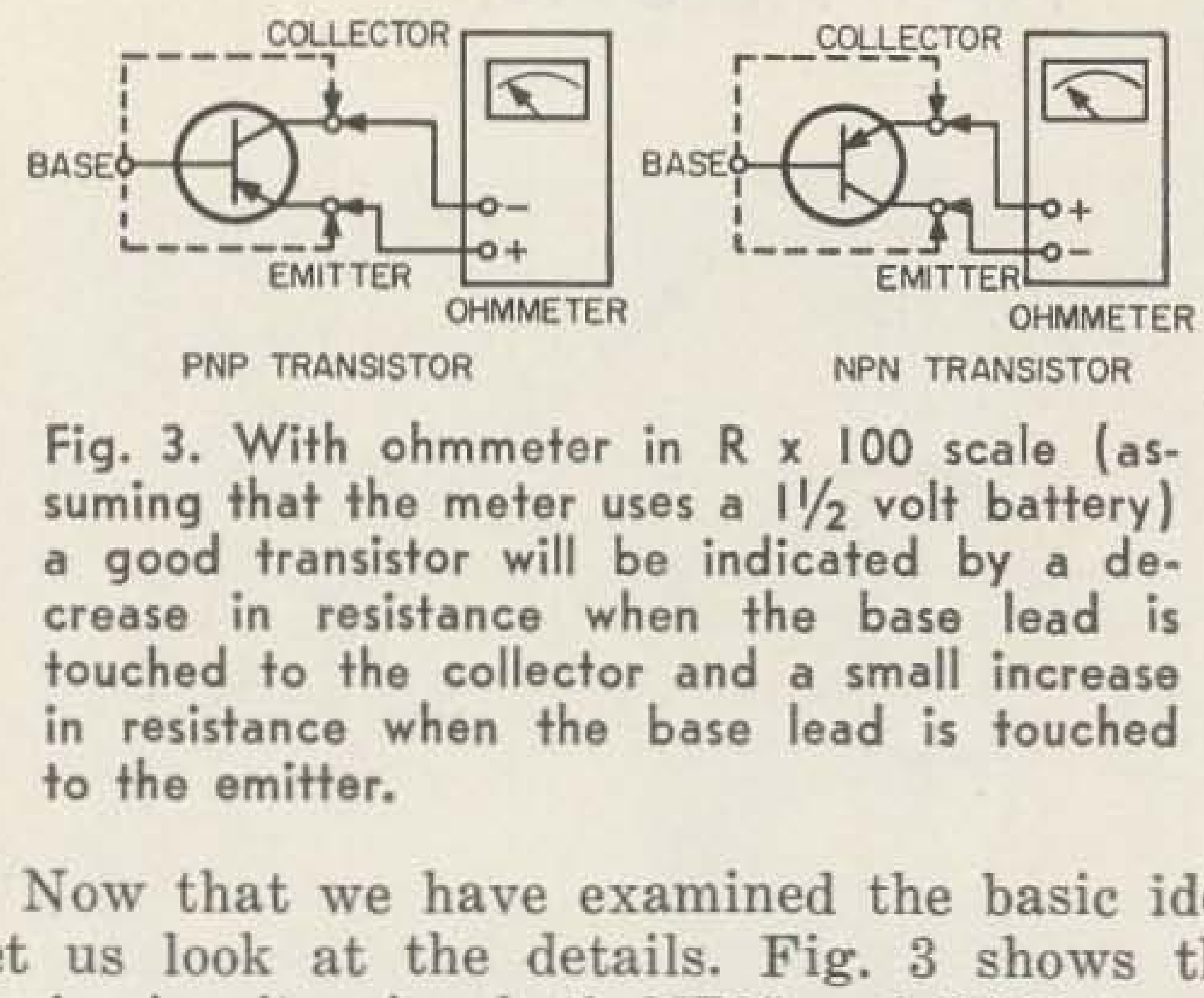


Fig. 3. With ohmmeter in R x 100 scale (assuming that the meter uses a $1\frac{1}{2}$ volt battery) a good transistor will be indicated by a decrease in resistance when the base lead is touched to the collector and a small increase in resistance when the base lead is touched to the emitter.

Now that we have examined the basic idea let us look at the details. Fig. 3 shows the basic circuit using both NPN and PNP transistors. In each case proper transistor action is indicated by the resistance going down when the base is connected to the collector and up when the base is connected to the emitter. Normally the resistance change when the base is connected to the collector will be several times greater than the resistance change when the base is connected to the emitter.

One important question that must be answered is which resistance scale should be used. This depends entirely upon the voltage used by the ohmmeter and the internal resistance of the ohmmeter. The mid-scale resistance reading on the ohmmeter dial is the internal resistance of the ohmmeter circuit on that range. The maximum current will therefore be the battery voltage divided by this resistance. On most ohmmeters this is 1500 ohms on the times one hundred scale. This coupled with the almost standard 1½ volt battery means that no more than one milliampere of current can flow. Since even the lowest powered transistors are almost always rated at one milliampere at least, this means that R X 100 is the logical scale on which to start. It will be impossible to injure most transistors with one milliampere no matter how it is connected.

On germanium transistors, especially power transistors, it will probably be necessary to switch to a lower resistance scale to get a useable reading. Usually you need not worry about burning the transistor up with excessive current as power transistors are designed to stand far more than the 100 milliamperes or so of the normal ohmmeter on the R X 1 scale. On the other hand these new, small signal silicon transistors have such small leakage currents that it is often impossible to get any reading with the base open and using the R X 100 scale. This need not be a deterrent however, just go right ahead and touch the base lead to the collector, the ohmmeter should now read something downscale from the infinity mark indicating a good transistor. You can switch to a higher resistance scale, but care must be taken that the voltage ratings of the transistor will not be exceeded as normally a higher battery voltage is used on the higher resistance ranges.

Incidently almost all ohmmeters with the exception of the Simpson model 260 have their polarities reversed on ohms. That is, the black or common lead is tied to the positive side of the battery and the red lead is tied to the negative side of the battery. If you are in doubt as to your particular meter and do not have a separate meter to check, don't despair, just find an old diode that is marked and measure it's resistance. In one position the resistance will be low and in the other position the resistance will be high. The negative lead on your ohmmeter will be the one that is on the cathode of the diode when it is in the low-resistance position. The cathode end of a diode is usually marked with a black band. In any case it is the lead opposite the arrow in the diode symbol.

Fig. 4 shows the standardized lead configurations for most transistors. Unfortunately some transistors, especially the high power ones, do not follow a standard lead pattern.

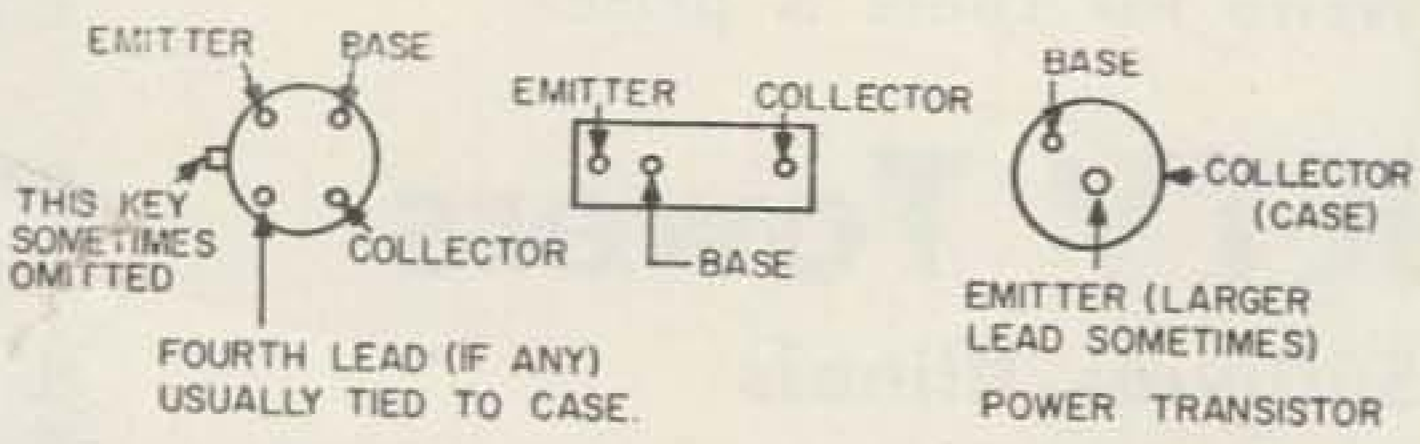


Fig. 4. Standard transistor lead configuration—all views of transistors from bottom.

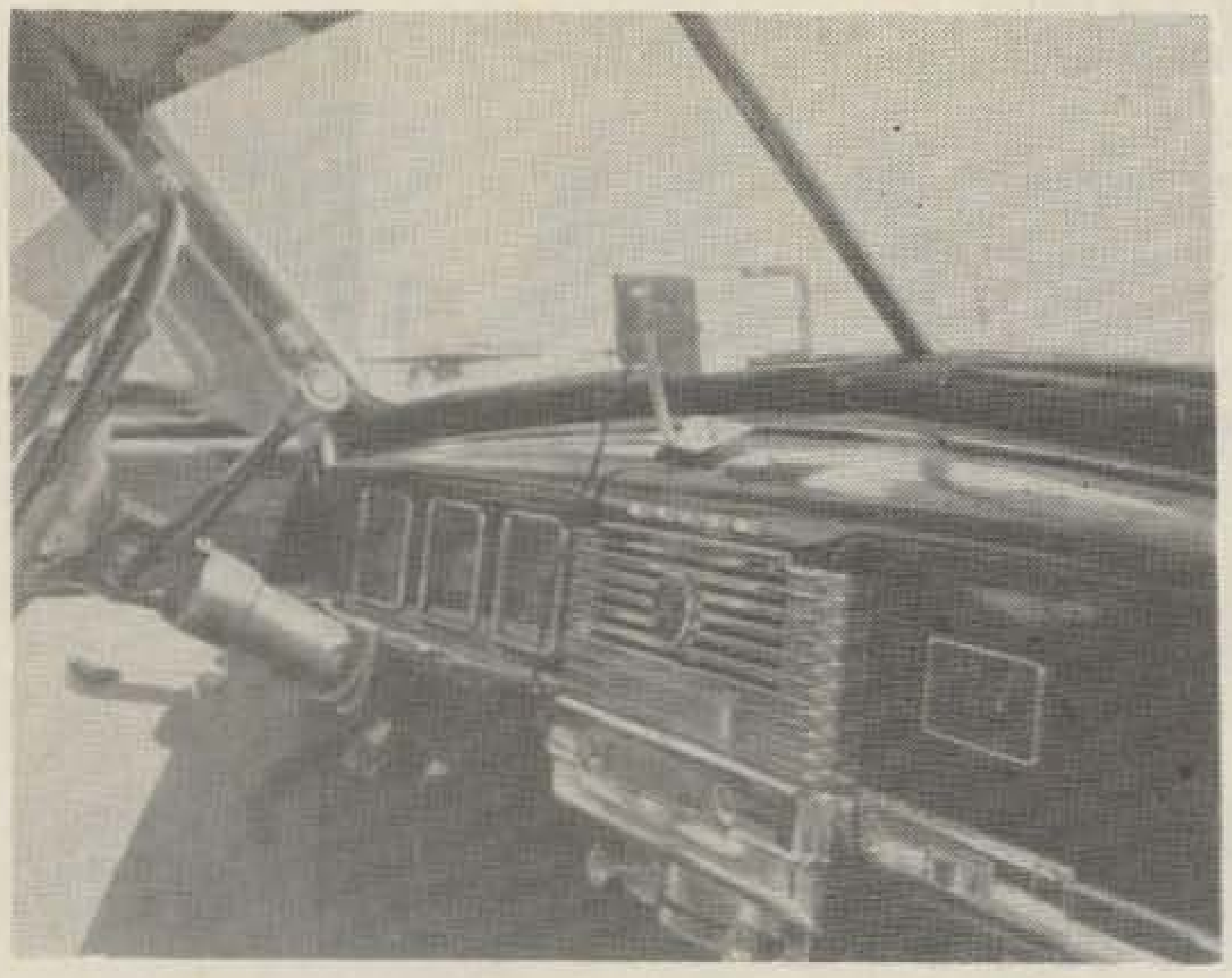
Normally in these the collector is tied to the case and the larger of the two leads is the emitter. In case you cannot decide which lead is which, try the original ohmmeter test on the diodes. Measure the resistance between any two leads, reverse the leads and measure again. If there is a large difference in the readings, one of your transistor leads is the base. The lead that shows a difference in forward to backward resistance to both of the other leads is the base. The two leads that show no or the least difference are the collector and emitter.

By knowing which lead is the base you can try the other two leads both ways to see which polarity gives a resistance decrease when the base is connected to the negative terminal. Assuming that you are dealing with a PNP device (which will be true 99 and 44/100% of the time for commercial transistors) the collector is the lead tied to the negative terminal.

This method, while not the world's best, is probably the world's cheapest, especially if you already own an ohmmeter! It certainly is as good as these cheap transistor testers one sees flooding the market, and a good deal handier. You just have to know how to cheat.

I would like to thank Mr. Jerrold Ford for the original idea and Mr. Robert Atherton for his help.

. . . W9QKC



Paul Barton W6JAT
P. O. Box 1278
San José, California

Mobile 2.455 KMC Radar Receiver

IN JANUARY 1958 issue of CQ, Don Stoner W6TNS, described a radar trap receiver. The receiver described here, is the same principle, but higher gain.

A slot antenna picks up the signal and transmits it into a piece of waveguide where it is detected to audio by a simple diode detector. The audio output of the detector is then amplified through a six stage high gain transistor audio amplifier, perhaps as much as one hundred DB, and fed into a one and one half inch PM speaker.

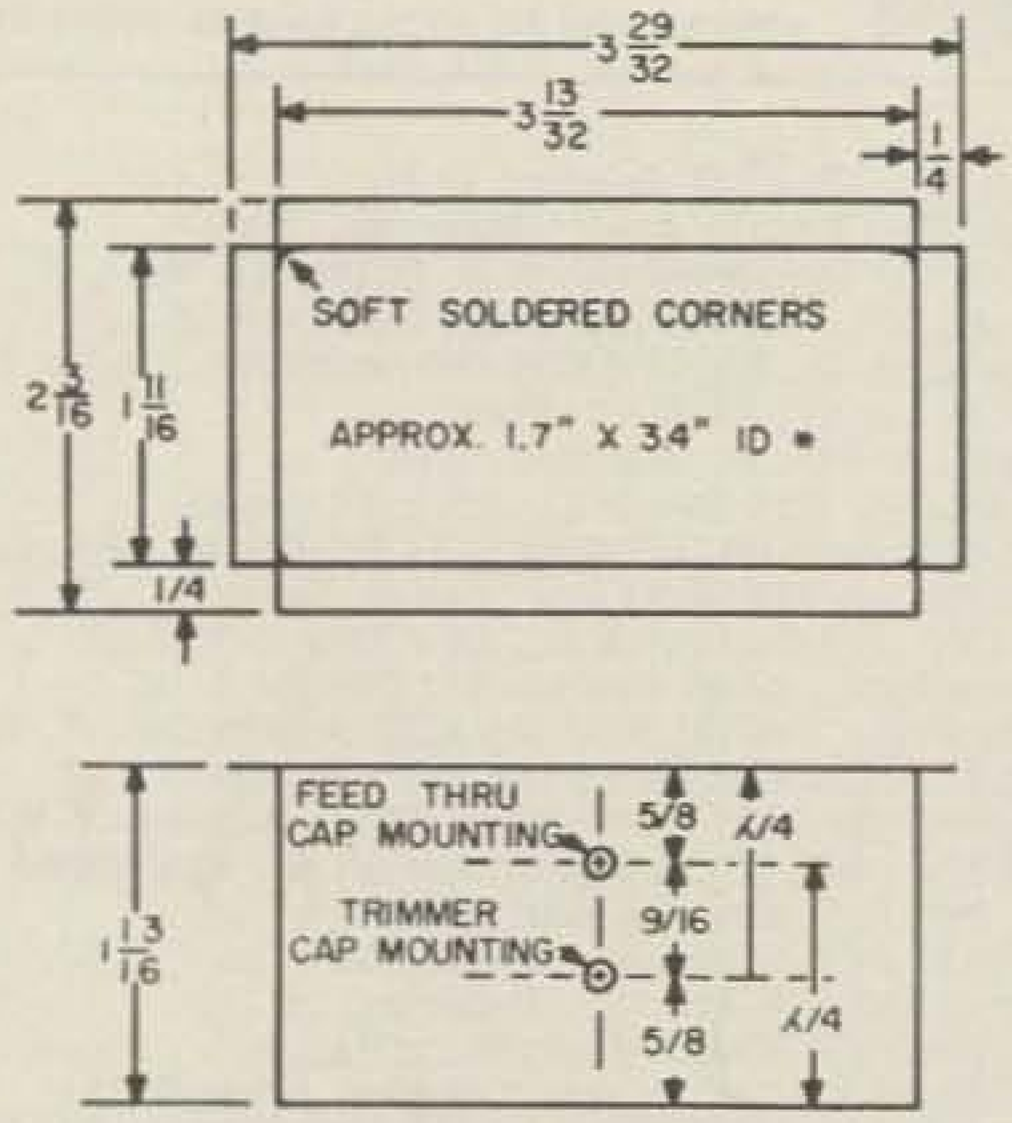
Only a modulated signal can be heard in the speaker, as no BFO or equal was put in this unit.

Military radars are normally modulated by their pulse repetition rate, and can be heard very well by this receiver. However, police radar is normally unmodulated. They depend on the doppler effect to give a tone proportional to the speed.

This tone will be equal to 86.4 times the speed in miles per hour, divided by the wavelength in centimeters. ($f_d = 86.4$ V)

At 2.455 kmc and 60 mph the tone will be 440 cycles. So, if you hear a high tone in your radar trap receiver you are in the beam of a police radar and *going fast.*

The wave guide arrangement was designed by Ted Tillman K6AZU, Jennings Radio's VHF engineer. A small screw type trimmer capacitor is located down the waveguide a quarter wavelength from the slot (antenna). This trimmer then acts like an inductance in parallel with the slot, making it electrically shorter. So, the slot is made slightly longer than a half wave length and tuned in with the trimmer capacity. The diode detector is located in the waveguide a quarter wave from the back of the waveguide. The slot antenna is a half wavelength long, plus about 5%. These three dimensions, the spacing of the trimmer and the diode and the length of the slot, are the only critical dimensions in the waveguide. The cross section is not at all critical. If you

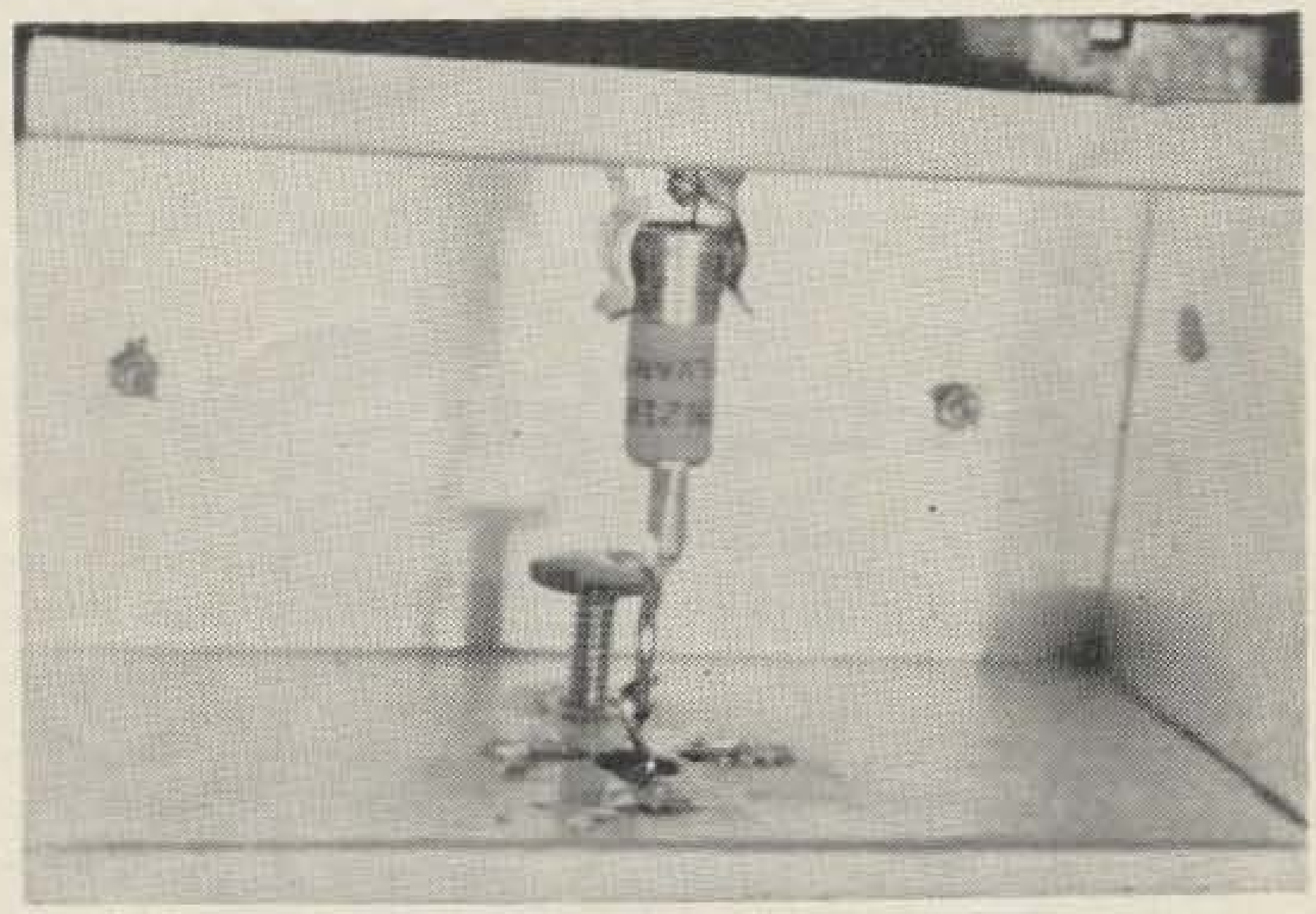


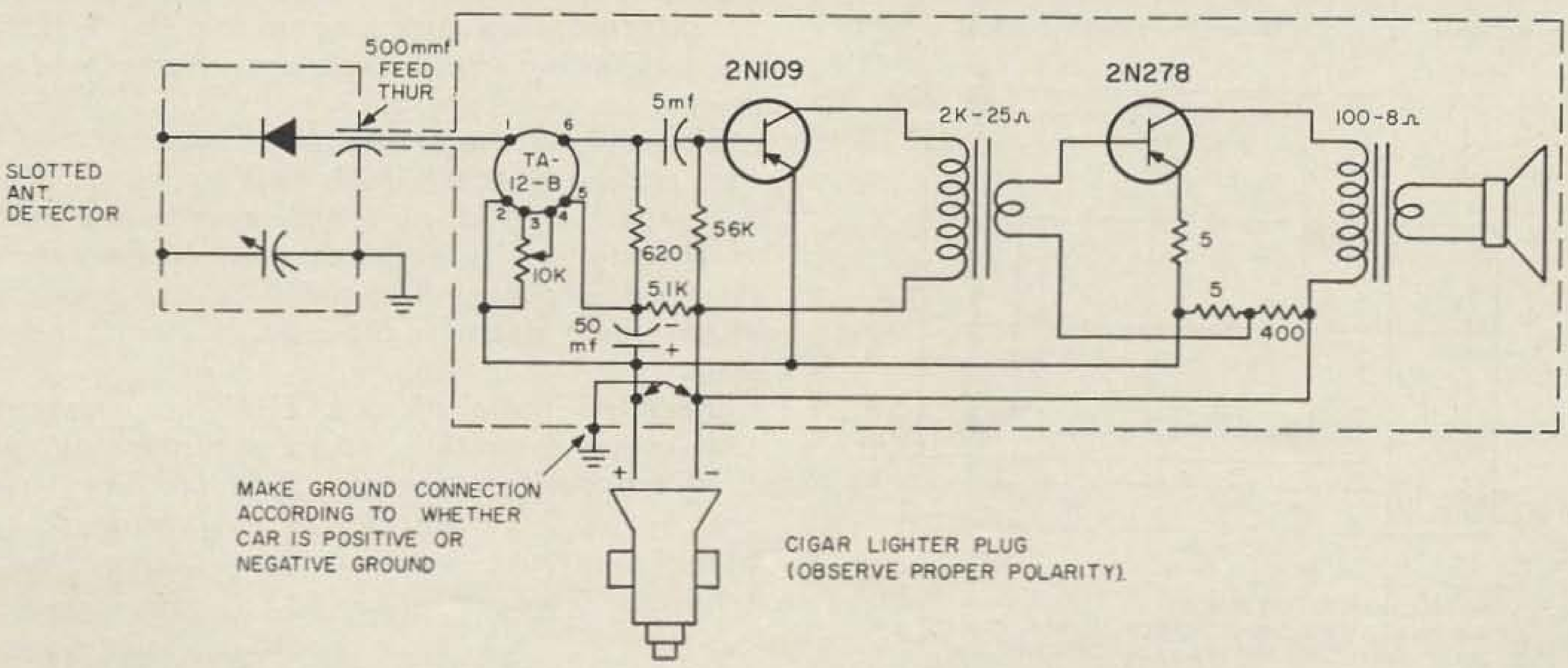
* RETMA STANDARD DIMENSIONS FOR 2.2-3.3 KMC = 1.7" X 3.4"

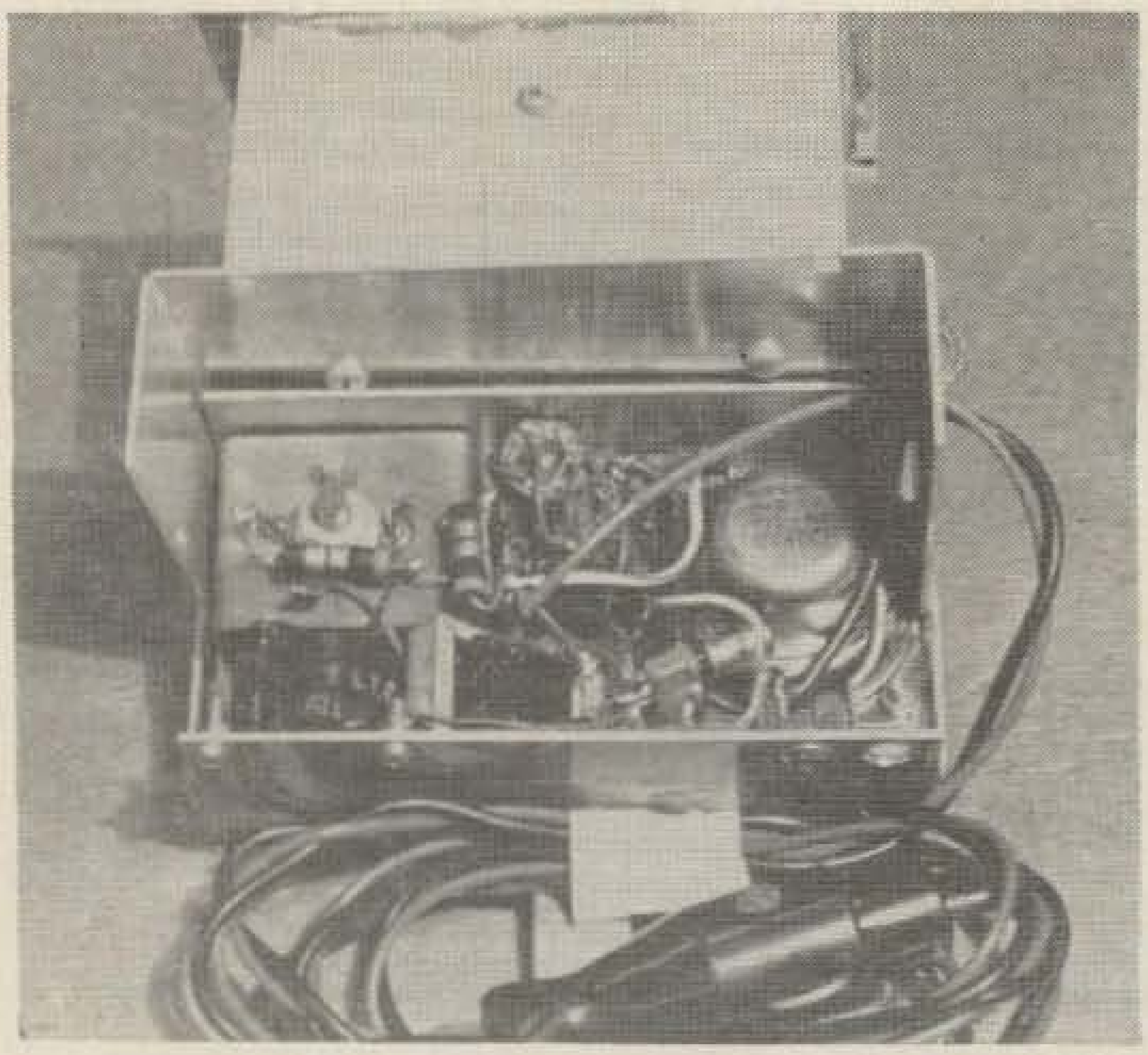
lay out a piece of .022 copper as shown in the stretchout, fold it and solder it, the dimensions will be close enough to work O.K.

The 1N21B detector mounting is a strictly off the cuff arrangement—quick, easy, and practical. A fancier arrangement could be made, but probably would work little better. The large end of the diode is gripped by a small fuse clip. The other end is gripped by a pin taken from an octal tube socket and soldered to the terminal of the feed through capacitor (see picture).

Police radar assignments are 2.455 kmc and 10.55 kmc. This unit is tuned to 2.455 kmc,







however the slide rule indicates that on 10.55 kmc, the slot is approximately four half wavelengths long, and the location of the diode and trimmer is approximately five quarter wavelengths. Thus this box can be expected to respond after a fashion on 10.55 kmc too. The size of the waveguide is not correct and the mechanical mounting of the diode is poor for this frequency though.

The police radar units send out (usually) a horizontally polarized signal. To receive horizontally polarized signals on a slot antenna, the slot should be vertical. In this case the unit is mounted on an arm so it can be turned either horizontal or vertical but is usually kept at 45 degrees to pick up either polarization, but with less sensitivity. The suction cups hold the unit in place on the dash, looking through the windshield.

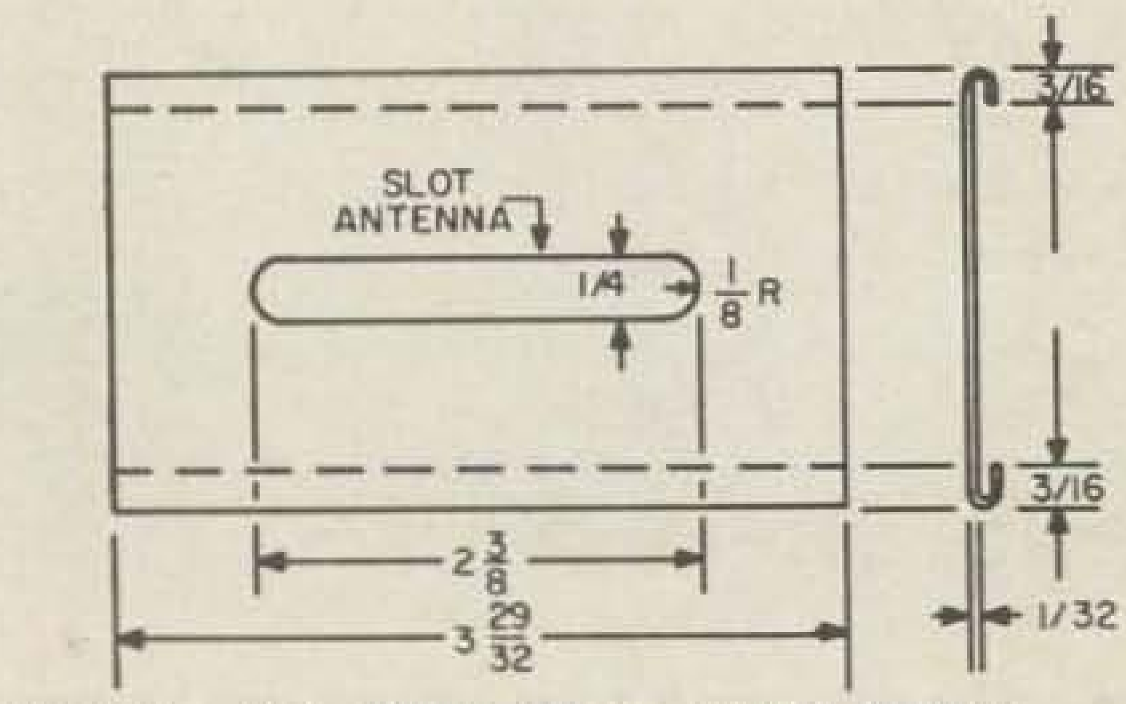
After the detector, the rest of the unit is a sensitive high gain transistor audio amplifier. In this case a centralab TA-12-B four stage pre amp was used, followed by a 2N109 transistor amplifier and a 2N278 power transistor output stage.

The amplifiers and speaker were "jammed" into a small California Chassis Company utility box 2-¼" x 1-¼" x 4-¼". The construction is non-critical. A pair of wires to a cigar lighter plug makes for quick installation. Polarity must be observed.

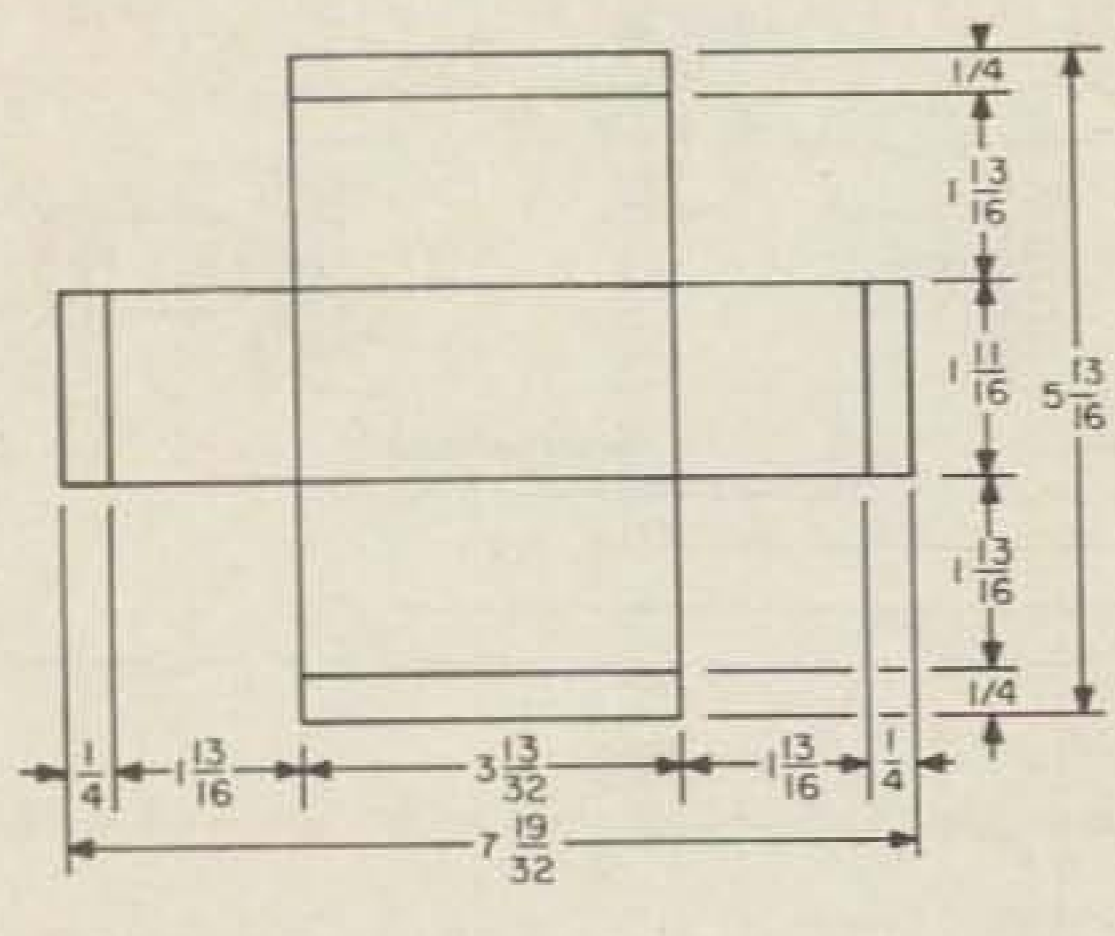
Provision was made to ground the case to either the positive or negative input lead to allow for either positive or negative ground in the car. This unit will operate on either 7.6 volts (6 volt system) or 15.2 volts (12 volt system). It works OK at reduced volume on 6 volts.

The 2N109 transistor stage is heavily biased causing severe harmonic distortion. This results in output in the speaker from lower audio frequencies than would normally be audible.

This speed trap receiver was built as a matter of interest. There is no real need for one in this area as speed traps are uncommon here. In fact, in six months time I still haven't found one to test the unit on so cannot report on the sensitivity of the unit. However, it should be quite sensitive as it receives military radar from Moffett field 20 miles away with ease. I wonder how many megawatts of power they run? . . . W6JAT



MATERIAL: .022 COPPER SHEET (SILVER PLATED).



1) NO ALLOWANCE FOR BENDS.
2) MATERIAL; .022 SHEET COPPER, SILVER PLATED
3) FOLD, THEN SOFT SOLDER BOX CORNERS

Editor's Note

My great interest in the UHF's naturally caused me to invest in one of the "Radar Sentry" receivers when they first came out. Being interested in DX I now have one of their new improved models. I find it very fascinating to drive along and listen for radar signals from airports, planes, ships and OTHER sources. On the off chance that you, as amateurs, may be interested in listening in on the UHF's I am publishing this article on a home made receiver.

You may occasionally hear some of the police radar systems with this receiver. These are used for checking traffic speeds and will be of little or no interest to you. If you are interested in the equipment they are using you might slow down a bit just to see it as you pass.

Perhaps some of you UHF experimenters will come up with a small portable low powered transmitter for our 2500 mc band which can be used in the car to communicate with other amateurs who are monitoring this intriguing band.

. . . wayne

Melvin H. Shadbolt WØKYQ

Ham TV Survey 1962

Status of TV established in recent poll! Interesting facts revealed!

SHOULD there be ONE MC TV on the upper portions of 6 and 2 meters? Do you want a TV organization? Are you presently on television? Shall we have more articles on this subject?

Answers to questions like these have been coming in from all parts of the country as the result of our aJnuary nationwide Ham TV survey. Did you vote? (What about your local ham friend, did he vote?) There's still time! We want this to be as complete a survey as possible, including not only those fellows who are presently on television, but also those who are still in the planning stages.

This information will help us in several ways: (1) to reinforce present evidence that a majority of TV enthusiasts are in favor of petitioning the FCC for ONE MC TV in the upper portions of 6 and 2 meters. (2) To complete our listing of TV operators . . . a very important forerunner to the forming of a television organization. (3) To aid in determining the number of 73 readers interested in seeing more articles concerning this phase of ham radio.

So if you don't have your January issue handy, or simply don't care to cut it up, just jot down the answers to the above questions and send them to: 73 Magazine, 1379 East 15th St., Brooklyn 30, New York.

In the meantime however, we've received more than enough surveys to indicate very definite trends on the major issues. So in order to further analyze the results, as shown in the illustrations, let's take a close look at each issue separately and see what conclusions can be drawn.

One MC T Von 6 and 12 Meters

This undoubtedly was the most important issue and quite likely the one which created the most enthusiasm among amateurs who have been questioning the future of ham television. As you can see by the results shown, the "yes" votes were way out front with an 88.7% majority with only 5.6% against the issue and another 5.7% undecided pending further details.

QUESTION	YES	NO	UN-DECIDED
ONE MC TV ON 6 & 2	88.7%	5.6%	5.7%
ORGANIZATION	81%	5.5%	13.5%
MORE TV ARTICLES	94.4%	.8%	4.8%

The major question raised by those who voted against the ONE MC TV system, seemed to be: "What happens when the band opens, or when too many stations from any one particular area try to use the band at the same time . . . since at most, only a couple channels could be allowed on either 6 or 2 meters?"

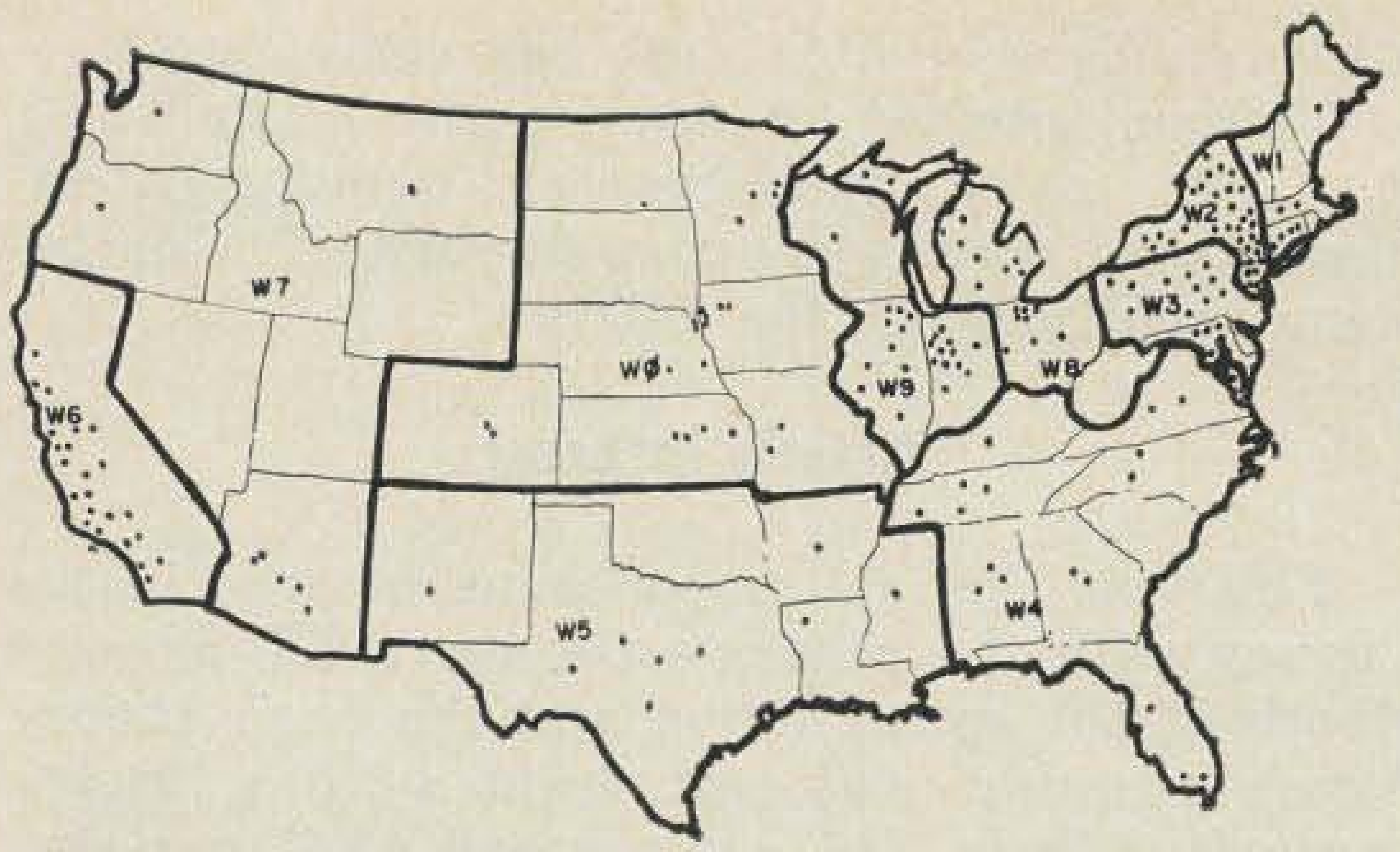
Actually, this is not as serious as it might first appear. After all, don't we presently have similar difficulties on our all ready well established AM and CW bands? Look at 75 meters in the evenings. Often it is so crowded as to be almost useless. Or take 15 meters for instance, during some skip conditions the band is so cluttered that it is nothing more than a mass heterodynes with only an occasional opening. Does this present a major crisis? Of course not, it simply means that if we can't successfully work out on one band we move to another.

As still a better example, take our present TV band, 420-450 mc, of which, by mutual agreement we are confined to the 436-450 mc portion . . . a mere 14 mc . . . which, although it may seem like a lot, often cannot accomodate as many stations in any one area as 2 one mc channels on 6 or 2 meters. The reasoning behind this is due to the fact that only vague bandpass limitations have been placed on TV operations in this band. Consequently, if an operator desires to transmit the somewhat normal wideband 4.5 mc signal, he has actually taken up a total of 9 mc . . . assuming the use of standard amplitude modulation techniques.

At present however, this band is of little value to a large portion of amateurs, since the distances which they must span are well beyond the normal capabilities of equipment operating on such high frequencies. (Observe Fig. 2.) Therefore, these fellows either loose interest or confine their operations to closed-circuit experimental work.

A 6 and 2 meter restricted bandpass system, on the other hand, could aid in closing this gap! Fellows in relatively inactive areas could begin transmitting over greater distances. As the activity increases (in any one area) or during skip conditions (when the lower bands become too crowded for satisfactory operation) it would be a simple matter of moving up to the next higher band. This would not only reduce the confusion of a congested band, but also promote the use of all our allotted frequencies as conditions permitted.

Besides, why shouldn't we be allowed the upper portions of these bands . . . they are presently being almost entirely rejected by the AM and CW fellows, and after all, look what happened to 11 meters through lack of activity! If we don't use 'em . . . we're sure to lose 'em!



It's a sure cinch that such a system, in addition to providing an operational band for many widely scattered enthusiasts, would also stimulate experimentations far beyond anything we have seen so far in this phase of amateur radio. New ideas and circuits, which are now being confined to basement experimenters, could finally be "air-tested"! A few of the possibilities quite likely to be at the top of the list might include such band-conserving projects as: (1) SSB-TV Vestigial sideband TV (the system used by broadcasters in which the bandpass is reduced by suppressing a portion of one sideband) (3) Different combinations of horizontal and vertical scanning rates (4) Various scanning processes such as interlaced scan, controlled random scan, spiral scan, etc.

Recently some very interesting and promising results have been obtained by various groups in such specialized scanning experiments. The goal, of course, is to develop a truly practical and economical system which would eventually require even less bandpass than the presently suggested system. What's really needed at this time however, is for us to get into the race with a ONE MC 6 and 2 meter system and show others that amateurs still have that old traditional pioneering and experimental spirit!

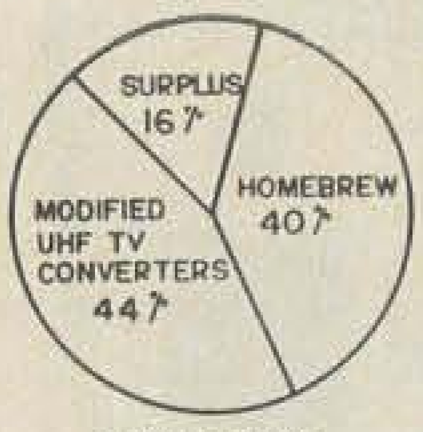
Some Sort of Organization Needed

This was also accepted with flying colors . . . with 81% voting "yes," and only 5.5% voting a definite "no". . . the remaining 13.5% remaining uncommitted pending furither details.

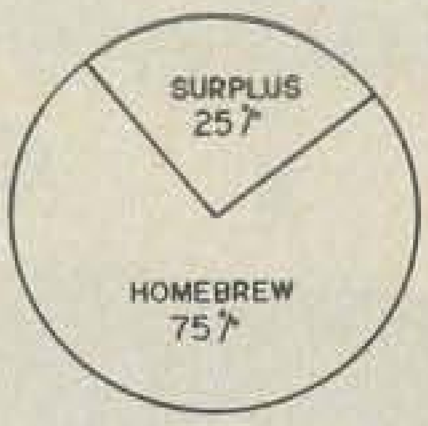
Now the question seems to be: How far shall we go for a start? It would appear to us after studying all of the surveys that we are not quite ready to form a full-fledged organization at this moment, however, we could be wrong.

Our decision lies in the fact that although some 81% voted "yes," only about 15% of these were presently on TV . . . the remainder still in either construction or planning stages. However, late voters may alter this figure considerably.

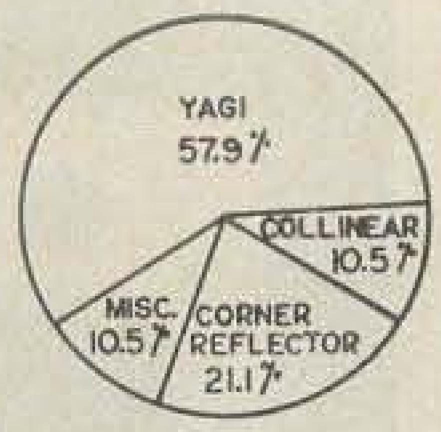
The desire for an organization seems to stem from the need to:



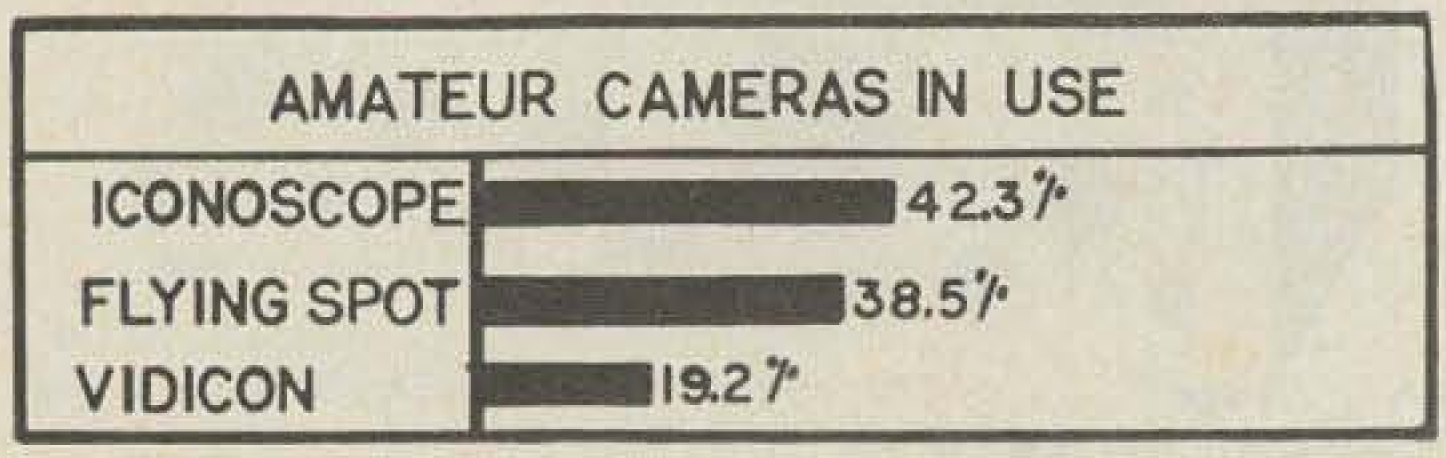
CONVERTERS



TRANSMITTERS



ANTENNAS



(1) keep in contact with fellow TV enthusiasts.
(2) establish a periodical bulletin which would include such things as a swap column, hints and kinks section, technical developments among members and specialized articles.
(3) join our efforts for more effective voicing of our opinions with regards to promotion of this phase of hamming, changes in allocations, etc.

Several fellows have offered their services in any manner in which they can be put to use. Any other volunteers . . . especially those with qualifications needed to form such an organization . . . it's a job for someone with a fair amount of time. How about some of you fellows who are partially retired??

In the meantime, until something more definite can be formulated, we are in the process of making up a small directory including the present status of all available amateurs who participated in the survey. Keep watching 73 for details on how to get your copy . . . these will be offered strictly for cost of printing and handling.

Cameras in Use

As can be seen from the diagram, it looks as though the flying spot scanner cameras and the old surplus converted iconoscopes are running nearly neck and neck in popularity; with the vidicon taking third place. No reports of anyone using image orthicon tubes as yet . . . probably due to their unattractive feature of "image burn-in," a problem that results when the camers is left focused on a subject for any length of time without being moved. Vidicons, fortunately do not inherit this bad feature and consequently are close contesters to the flying spot and iconoscope cameras. These tubes are evidently, for the most part, those discarded by local TV stations.

Taking all factors into consideration, the FSS seems to be the top favorite, especially among those first starting out in TV. This is probably largely due to its straightforward construction, ease of operation, and the requirement of almost nothing other than standard, readily available junk box components.

Vidicon interest should, on the other hand, continue to enjoy increasing popularity, especially as more and more discarded tubes become available to the fellows.

Article Interest

This was the last major issue covered in the survey with the requests for more TV articles (both of the construction and the basic theory type) running way out front with a 94.4% majority! Only .8% against and 4.8% not caring! Looks like we won this issue also . . . now all that is needed is some writers. According to the survey letters, at least one or two articles are in the developmental stages already.

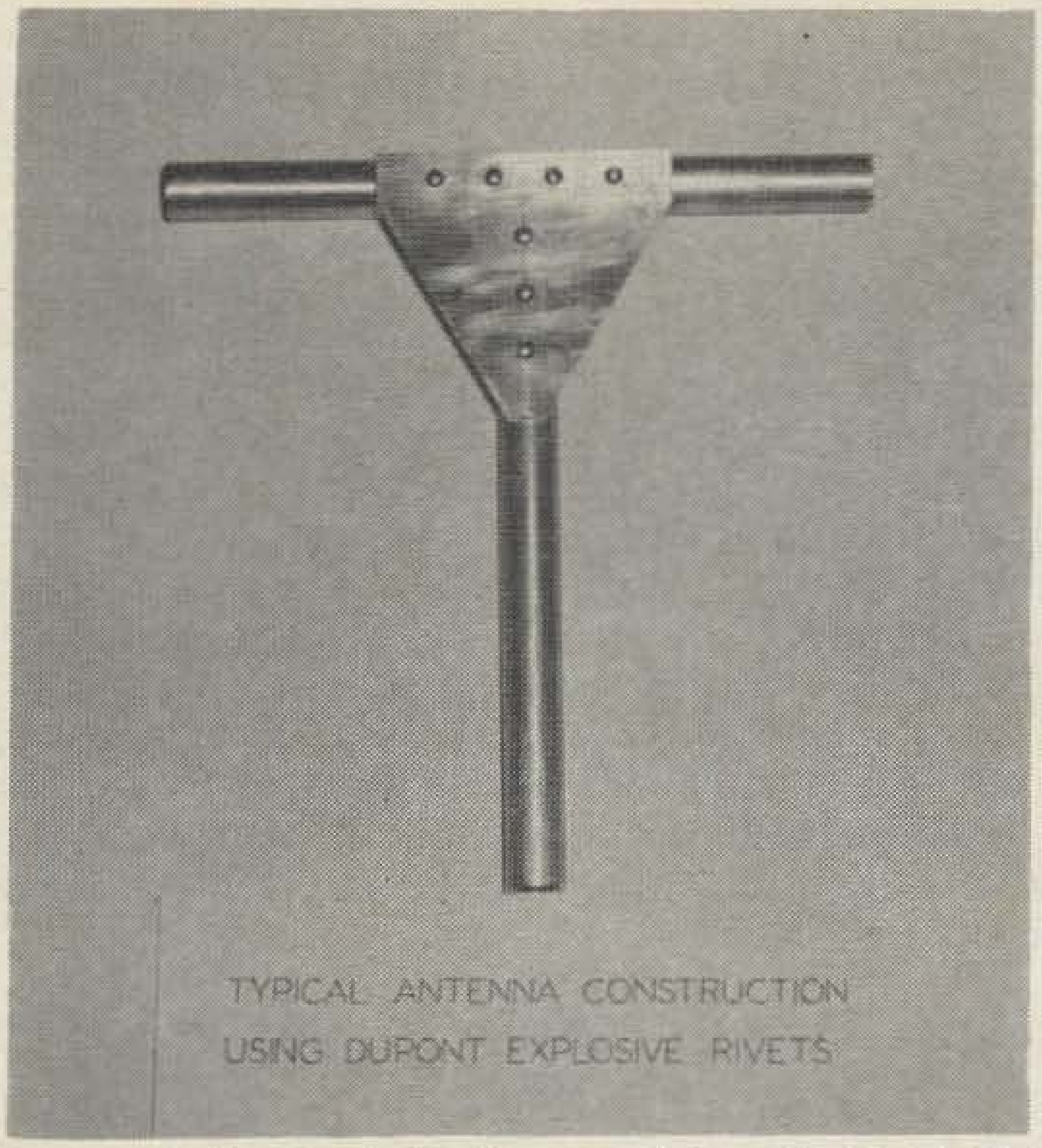
One thing we should keep in mind when submitting these articles is that over 80% of the individuals participating in the survey indicated they were still in the planning or early construction stages. A large majority of these fellows indicated a need for more basic understanding of the fundamental principles involved. So when submitting your articles, don't think entirely in terms of construction, alignment, and operation, but also include brief, but thorough explanations on how the equipment functions. This will often give a reader just the added confidence he needs to actually begin construction. Let's not promote "Black box" mystery projects!!

Blind Fasteners Aid Construction

Roy E. Pafenberg W4WKM

THE writer has a particular genius for maneuvering himself into an inextricable position in just about any field of endeavor. In the area of equipment construction, it is more a matter of wishful thinking than an ignorance of the electronic facts of life. In project after project, the attempt is made to construct equipment equal to or smaller in size than the cube of the component parts. Not the least of the problems encountered in this approach is the installation of nuts and washers on screws extending into inaccessible portions of the equipment.

It was, therefore, with a degree of elation that samples of the Du Pont expansion rivets were obtained. These one-piece fasteners appear to be conventional brazier or flat head aluminum rivets. The only distinguishing feature is the presence of a small chemical charge loaded in a cavity in the rivet shank. Application of the proper amount of heat to the head causes the chemical to expand the shank and to lock the rivet securely in place. No access to the back of the rivet is required at any

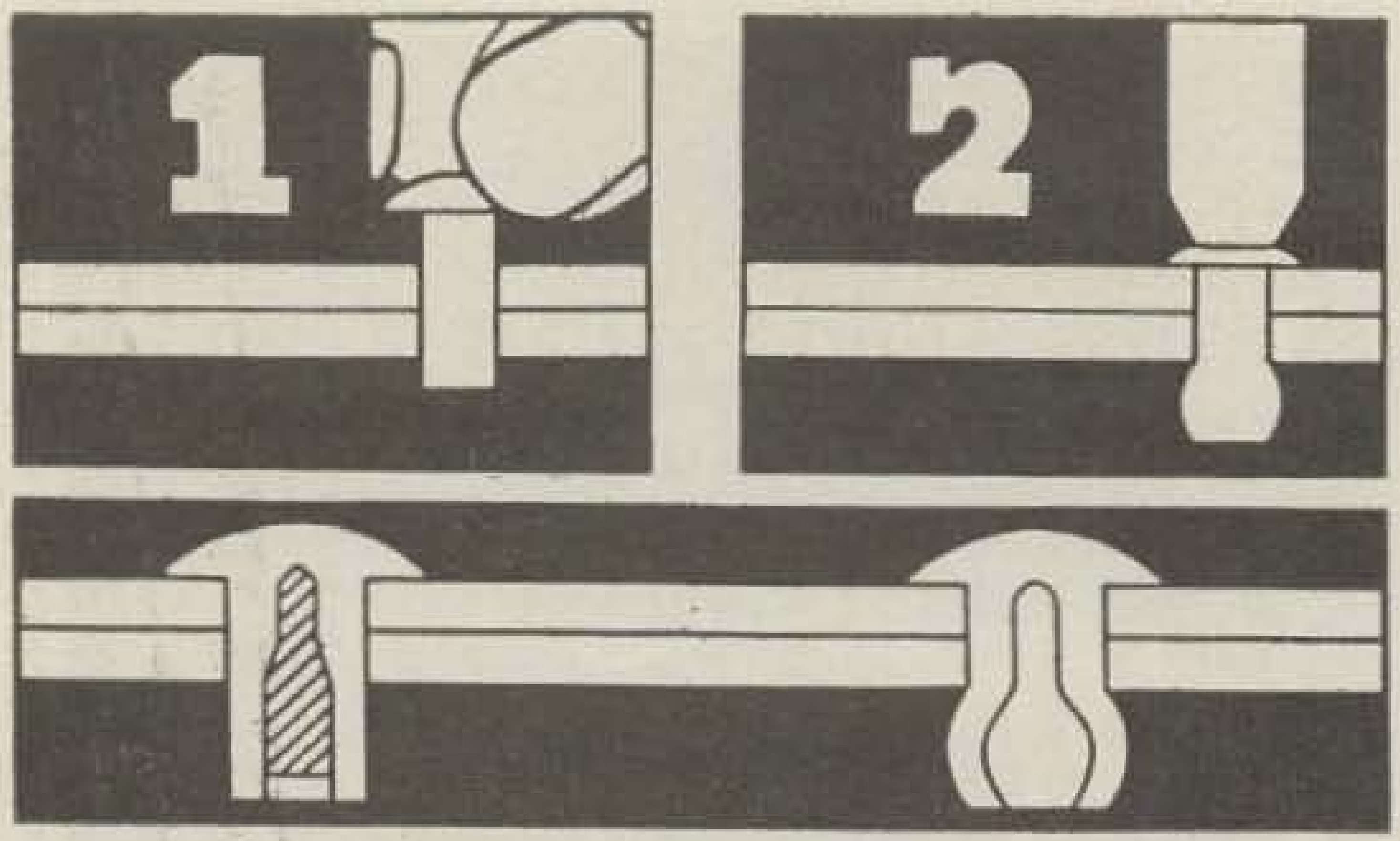


TYPICAL ANTENNA CONSTRUCTION USING DUPONT EXPLOSIVE RIVETS

stage of the installation, making it ideal for those difficult assembly jobs. A neat, finished job results and the color coded, alodized finish is attractive enough for "as is" use in exposed locations.

Another amateur application of these fasteners is shown in the photograph. Antenna construction requires a strong and secure

(Turn to page 26)



Cross-section of Rivet before and after expansion.

means of assembly and through bolts are ruled out by the danger of collapsing the aluminum tubing normally used. The gusset plate and one wall of the tubing are drilled as a unit, with the rivets inserted as each hole is drilled. The rivets are then expanded, the assembly turned over, and the second gusset plate installed in the same manner.

While Du Pont does not recommend this, a standard electric soldering iron, not a gun, of 100 watt or higher capacity, may be used to expand the rivets. The copper bit should be reversed in the iron and the blunt end shaped to fit the rivet head. The drawing shows the details on inserting and expanding the rivets. Bit temperature is fairly critical and a Variac is suggested. In any event, the heat should be such as to expand the rivet in ½ to 4 seconds.

These rivets are available in a variety of styles, materials and sizes. The following list shows *some* of the sizes manufactured in the 56S aluminum alloy, modified brazier head type:

DU PONT TYPE	RIVET DIAM.	SHANK LENGTH	DRILL	WORK THICKNESS MIN.	MAX.	COLOR
56S-134A-4	.134"	.150"	#29	up to	.045"	yellow
56S-134A-20	.134"	.310"	#29	.166"	.205"	blue
56S-134A-36	.134"	.470"	#29	.326"	.365"	black
56S-173A-8	.171"	.235"	#17	.025"	.085"	red
56S-173A-26	.171"	.415"	#17	.206"	.265"	black
56S-173A-38	.171"	.535"	#17	.326"	.385"	red
56S-204A-10	.202"	.290"	#6	.025"	.105"	blue
56S-204A-32	.202"	.510"	#6	.246"	.325"	brown
56S-204A-56	.202"	.750"	#6	.486"	.565"	black

The above list is by no means complete and is presented only to show the size range of these fasteners. Complete information, along with prices, may be obtained by writing Chemical Sales, Explosives Department, E. I. Du Pont de Nemours & Co., 350 Fifth Avenue, New York 1, N. Y. The biggest problem in the use of these rivets, from the amateurs point of view, is the fact that they are available only from the Du Pont outlets in minimum quantities of 100 each. Cost ranges from under $5.00 per hundred and up, depending on type and size.

These fasteners really work and their use will ease many difficult construction projects. If the cost seems high, have you recently priced high quality screws, nuts and washers?

Photograph and drawings courtesy of E. I. Du Pont de Nemours & Co.

The Half Wave Transmission Line

Mitchel Katz K2KPE

As most hams already know, a half wave line repeats the load impedance back towards the feed point at each half wave node when the line is terminated in its characteristic impedance. Using this information several ideas came to mind to facilitate antenna tuning and installation.

Before putting up a new antenna, measure the distance from the antenna site to the transmitter. Some rope, string, or scrap wire can be run over the final transmission line path to determine the length. Now calculate the transmission line length required so as to present a half wave multiple between the antenna site and the transmitter, for the lowest frequency band to be used. A half wave length of transmission line has a different length than a half wave of antenna wire in free space due to the velocity factor of the line. As coaxial cable using a Polyethylene dielectric has a velocity factor of .659 the following formula can be used to calculate the length of our half wave line. Length in feet, 492 multiplied by .66 and divided by Fmc. (324.72)

As an example, if we design a line for 7150 kc, using the formula we come up with 45.4

feet. This line then becomes 1 half wave at the design frequency. It is also 2 half waves at 14300 kc, 3 half waves at 21450 kc, and 4 half waves at 28600 kc. From the above it can be seen that if you cut a transmission line for the lowest band to be used it can also serve for other harmonically related bands. If we are primarily interested in 20 meter operation we could have designed the line for perhaps 14300 kc. This line would then figure out to 27.7 feet. Any multiple of the 27.7 could then be used between the transmitter and antenna.

Now for the actual installation. Measure the coaxial line so that you will have some full multiple of the half wave line between the antenna and the transmitter. Connect a suitable connector at one end of the line. Next cut off 10 feet of cable at the other end, and terminate these two ends with Amphenol type 83-1P male coax connectors. The other end of the 10 foot section can now be conveniently attached directly to the antenna proper. Both the main transmission line and the short sections, going to the antenna, can be joined by means of an 83-1J straight connector (female at both ends) and then taped over. If aluminum foil is wrapped around the fittings before taping they will stay bright and clean and will be well protected against the weather. In the future when you want to change the antenna, instead of removing the complete transmission line it is only necessary to replace the small 10 foot section, still maintaining our original half wave line length. If the transmission line you are using is much longer than the distance originally measured from the antenna to the transmitter, the coax may be coiled up at any convenient place, and tucked away out of sight.

Getting back to the half wave line, it is now possible to insert an SWR meter at the transmitter and know exactly what type of match we have between the transmission line and the remotely located antenna. Of course if the SWR is actually 1:1 then you would get the same meter reading on any length line. However if a mismatch does exist then by means of the half wave line you can ascertain the actual SWR of the antenna to transmission line.

If a spare line is built and kept coiled up, it can also be used for connecting a dummy antenna to the transmitter, still maintaining the proper SWR indication on a bridge. This may be important in tuning or aligning a transmitter. A 52 ohm dummy gave an SWR reading of 1:1 when connected directly to the terminals of an SWR meter. The same reading was obtained with the dummy load connected to the end of a half wave line. When intermediate line lengths were tried with the dummy, surprisingly large amounts of variation in the apparent SWR was indicated on the meter. . . . W2KPE

Robert D. Grimm K6RNQ

50 MC No Crossmodulation

2800 Monticello Avenue Oakland, California

How many times has your receiver been tied up in knots by strong local signals? If you are among the many that cringe whenever a rockcrusher comes on the air, weep no more; this converter may solve your problem.

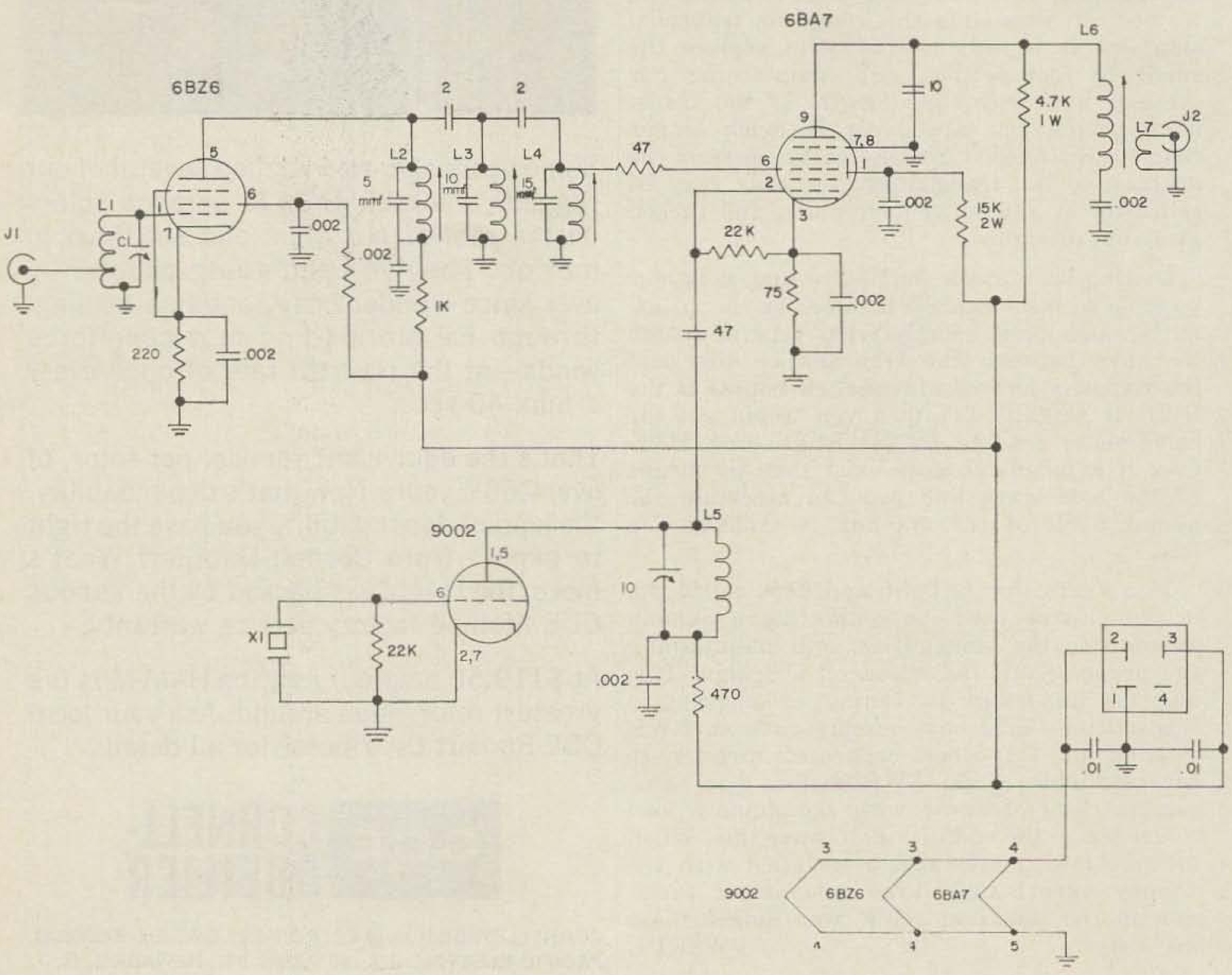
This crystal controlled converter was designed to handle extremely strong 50 mc signals without overloading. It has met that requirement quite well, while still maintaining a high degree of sensitivity along with adequate overall gain.

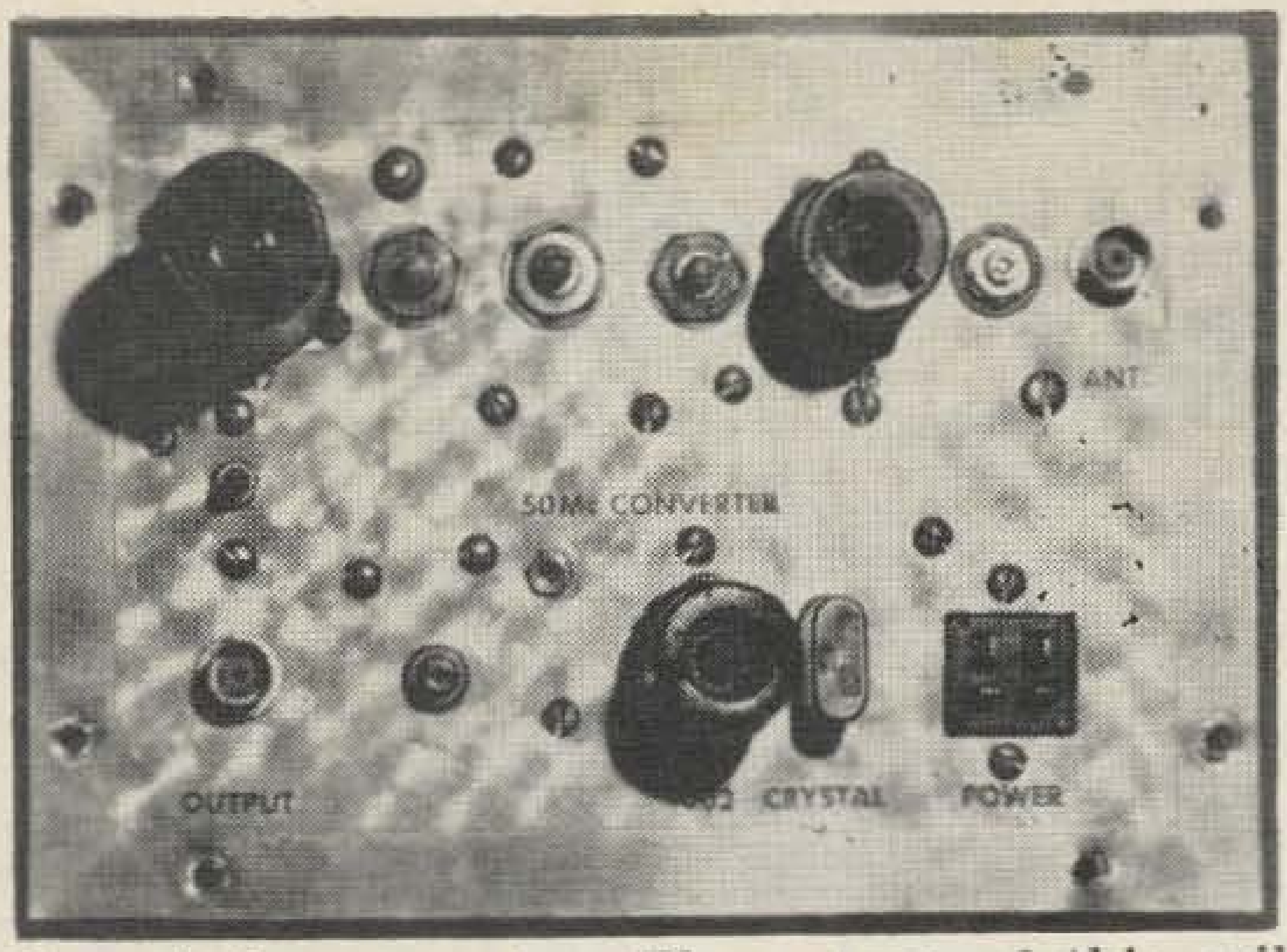
The heart of the converter is the mixer stage (this is where most cross modulation takes place), a 6BA7 pentagrid converter tube is used here. This tube was designed for converter service in the 88-108 mc fm band. It works quite well at 50 mc and its capability of handling strong signals without overloading is nothing short of phenomenal.

From the standpoint of noise one may question the use of a multigrid converter tube at vhf. While the noise level of the 6BA7 is greater than that of a triode mixer, it is still less than the atmospheric noise level at six meters. The only exception to this might be for that rare individual who lives out in the boondocks and who wouldn't have any worries about crossmodulation anyhow. While we are on the subject of multigrid converter tubes, the aforementioned statements about noise apply only to the 6BA7. They do not apply to the 6BE6 and 6SA7, which are inherently too noisy for vhf use. The determining factor in this matter is the ratio of plate current to screen current of the particular tube in question. This is the secret of the 6BA7.

Every effort was made to eliminate images and other spurious signals. To attain this end a high Q tank circuit was used in the grid of the 6BZ6 rf stage. A triple tuned bandpass circuit is used to couple the rf amplifier to the mixer. This triple tuned circuit provides excellent bandpass characteristics over the range of 50 to 54 mc and falls off steeply on either side. To assure the highest possible Q, silver plated, brass slug tuned coils were used in this circuit.

The *if* output coil is loaded by a 4.7 K swamping resistor, to make it broadly resonant over the 9 to 13 mc range. This tends to further enhance the overall bandpass characteris-

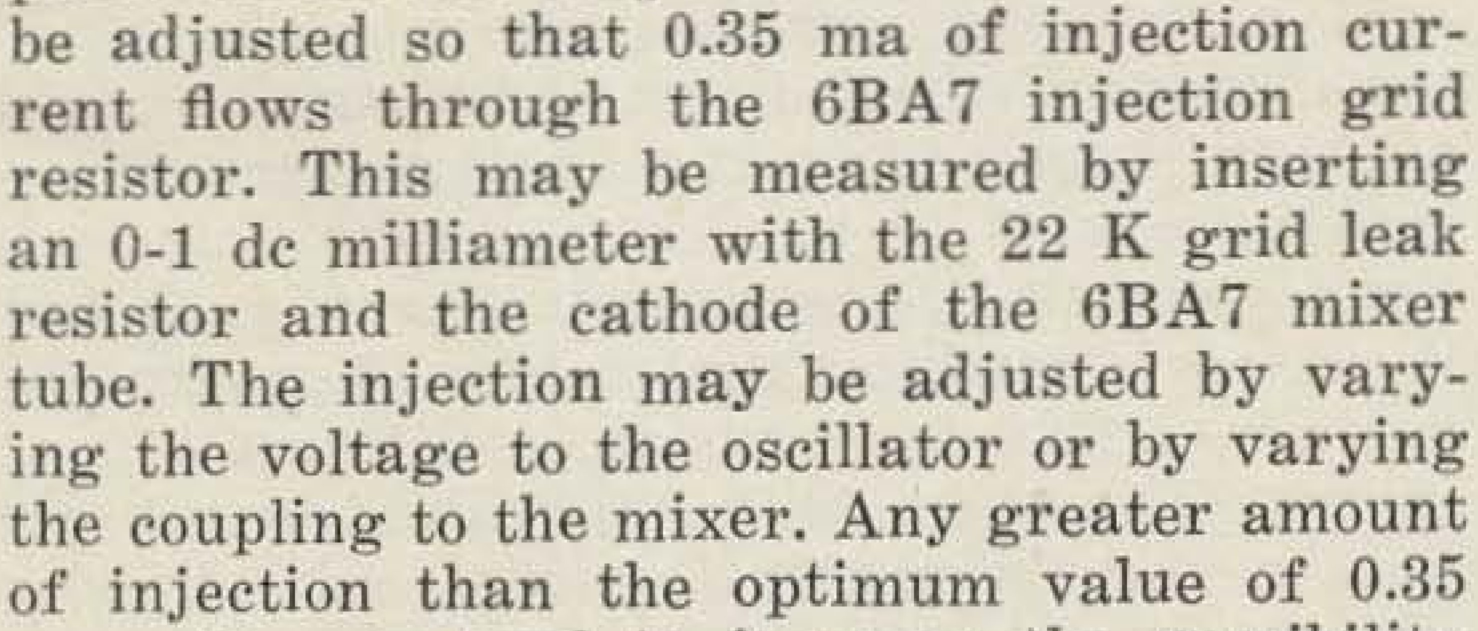




tics of the converter. The output of this coil is link coupled to the communications receiver through a length of coax to reduce the possibility of *if* pickup. If pickup of signals in the *if* range is a problem in your locale, it would be advantageous to use double shielded coax for this application.

A 9002 miniature triode is utilized in the oscillator (any triode may be used). This oscillator uses a 41 mc third overtone crystal in a conventional circuit. To obtain optimum performance the output of the oscillator should be adjusted so that 0.35 ma of injection current flows through the 6BA7 injection grid resistor. This may be measured by inserting an 0-1 dc milliameter with the 22 K grid leak resistor and the cathode of the 6BA7 mixer tube. The injection may be adjusted by varying the voltage to the oscillator or by varying the coupling to the mixer. Any greater amount of injection than the optimum value of 0.35 ma will only tend to increase the possibility of spurious responses and will not improve the performance of the converter.

The power leads are shielded and bypassed to further reduce the possibility of spurious responses and *if* feedthrough, as well as to eliminate a potential source of TVI.



All circuits are shielded from each other to prevent interaction and stray capacity coupling between stages. Copper shields are used between the individual coils in the triple tuned bandpass circuit to reduce the coupling between coils.

The converter is constructed on a 5 x 7 inch aluminum plate. This plate is mounted on an inverted 5 x 7 x 2 inch chassis which serves as a case for the unit.

From the photos it will be noted that the aluminum plate sports a jewelers finish. This may be duplicated by placing a small piece of steel wool under your thumb and twisting it on the surface of the converter plate. With a little care and patience a very professional appearance may be had.

While this converter was designed for 50 mc there is no reason why it could not be used on 21 or 28 mc (by making the proper coil and crystal changes) with excellent results. . . . K6RNQ

Parts List

L1—10 turns #16 copper ½" diam., 1½" long.
L2, L3—8 turns #26 enamelled, closewound on ½" diam., brass slug tuned form.
L4—5 turns #26 enamelled, closewound on ½" diam., brass slug tuned form.
L5—8 turns B&W 3003 Miniductor.
L6—30 turns #30 d.c.c. closewound on ⅜" diam., iron slug tuned form.
L7—10 turns #24 enamelled, closewound at cold end of L6.
C1, C2—10 mmf. midget variable capacitor.
J1, J2—BNC type coax connectors, UG-1094/U.
X1—42 mc., third overtone crystal.

Page from a Designer's Notebook

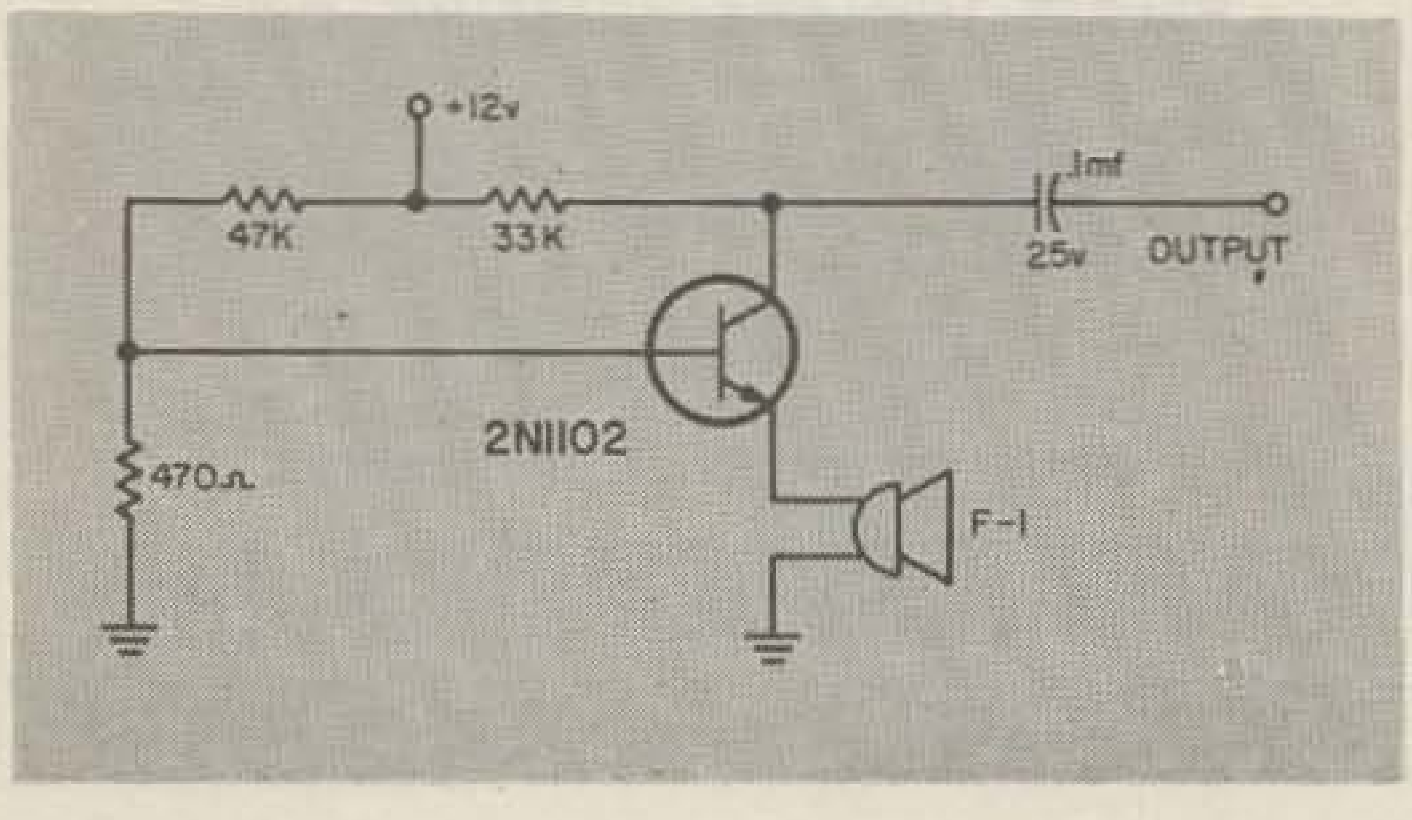
Notes concerning the design of transistorized carbon microphone preamps

James L. Tonne W5SUC

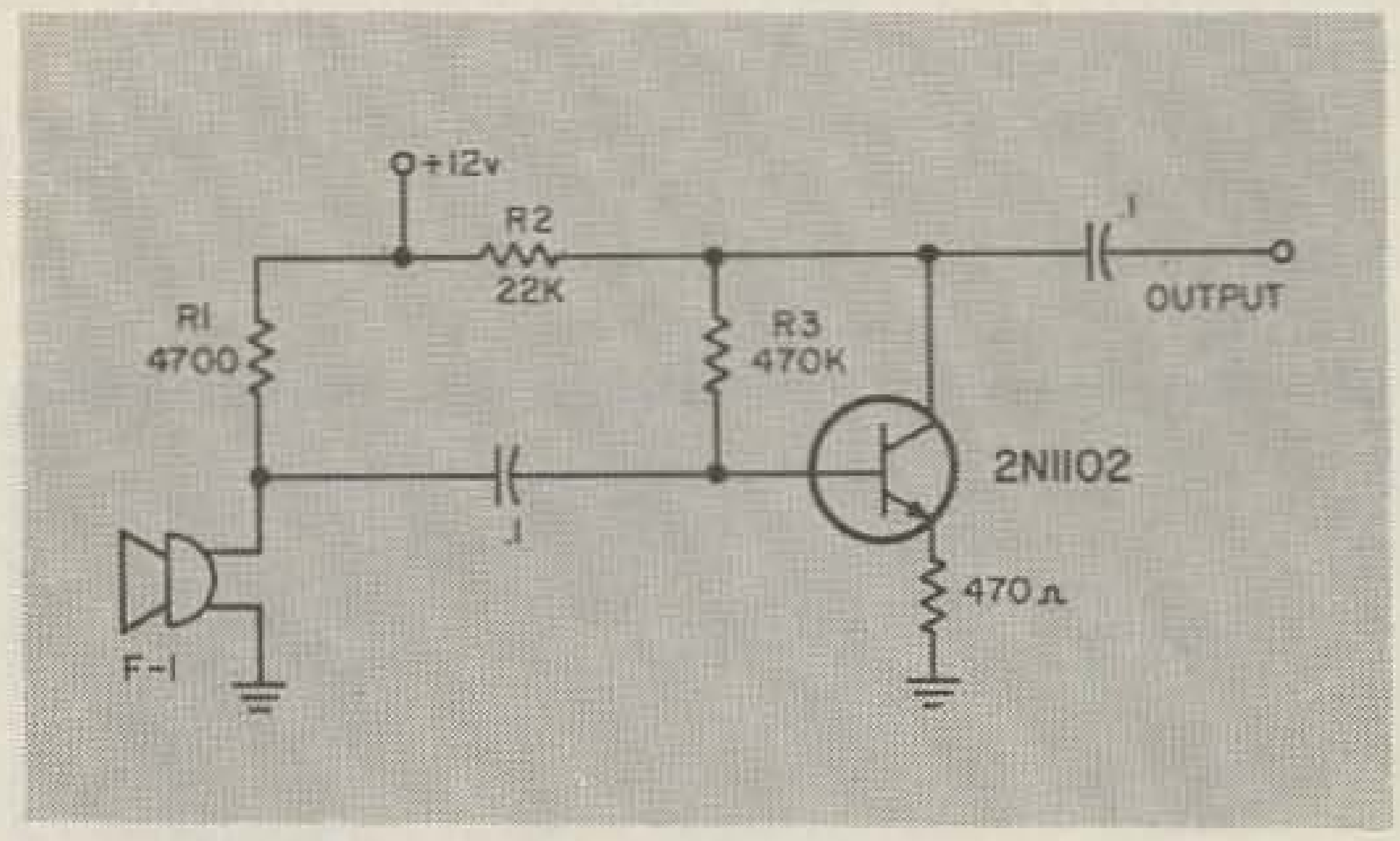
THE most logical approach to use in such an amplifier is to use a fixed bias on the base and insert the microphone in the emitter circuit. This circuit configuration corresponds to the grounded-grid tube circuit. This type of circuit (Fig. 1) is capable of good output and quality, and draws a very low value of current from the power supply.

If an additional current drain can be tolerated, a better circuit to use is a circuit wherein the microphone forms the grounded leg of a simple voltage divider from the power supply to ground, the output of the microphone then being sent on to an amplifier. It is found that this circuit (Fig. 2) has much more output and is more stable with regard to the position of the microphone than the "grounded base" arrangement. The voltage divider configuration is a bit more complex but has a much higher output. The output from the circuit can be controlled by adding an external resistance from the voltage divider to ground. The best place to add this external resistor is from the "supplying" resistor midpoint to ground. See Fig. 3. Alternatively, the output level can be controlled in steps by using a variety of resistors for the "supplying" resistor as in Fig. 4.

If the value of the load resistor is made large in the common-base configuration, in an attempt to get more voltage gain, the microphone current is reduced and the circuit output actually drops and in addition becomes highly nonlinear. But the load resistor for the separate-amplifier circuit can be of a high value to give good voltage gain, providing only that the transistor beta holds up at low values of collector current.



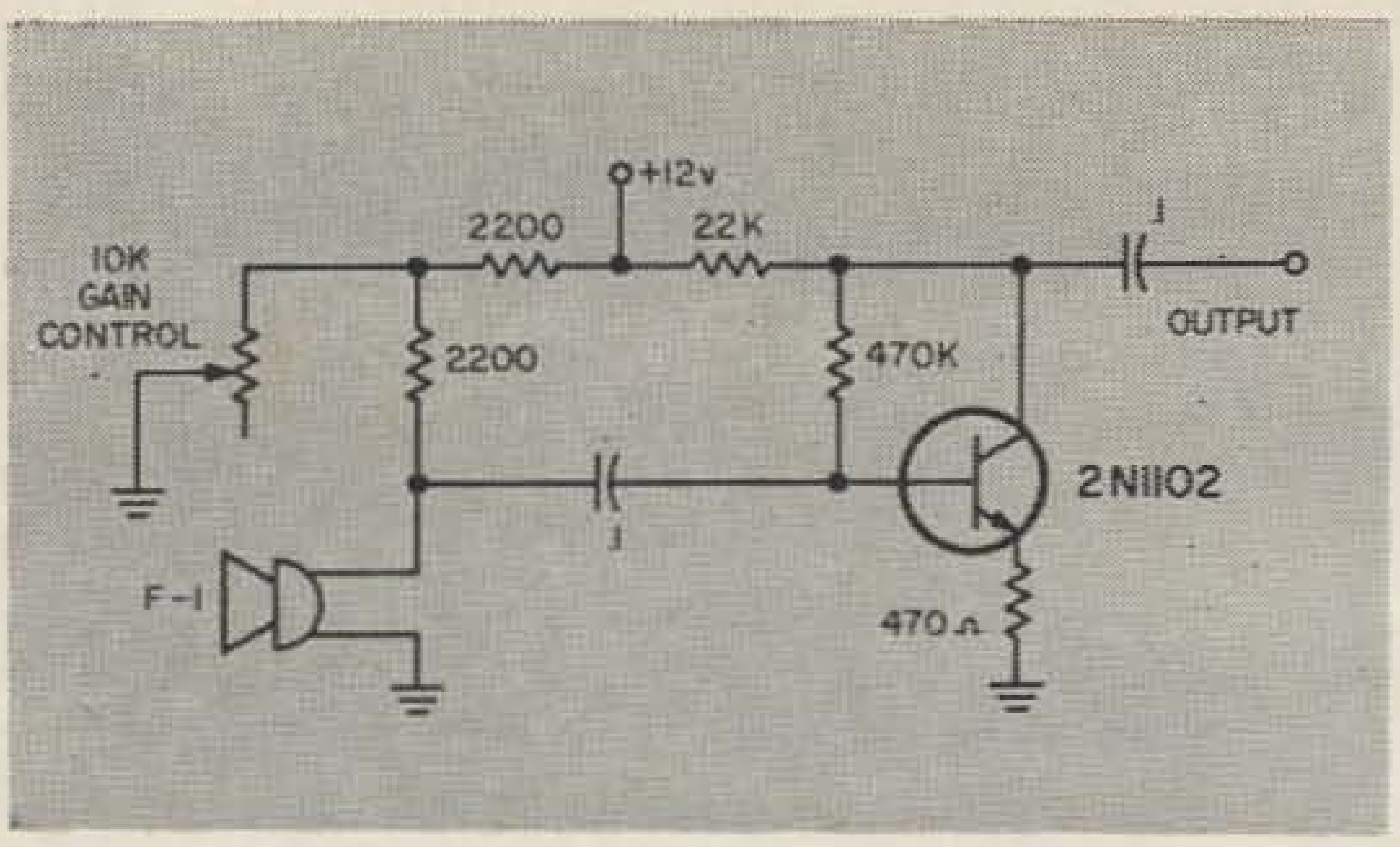
If a two-stage amplifier is used, it is not recommended that direct coupling be used between stages, since the average microphone resistance must be treated as a near-unknown. Such a circuit has been built (see Fig. 5) but it was only conditionally stable. Changing the position of the microphone sometimes caused severe distortion. This particular circuit did have a very high gain, however, and clipping was obtained even with low input levels.

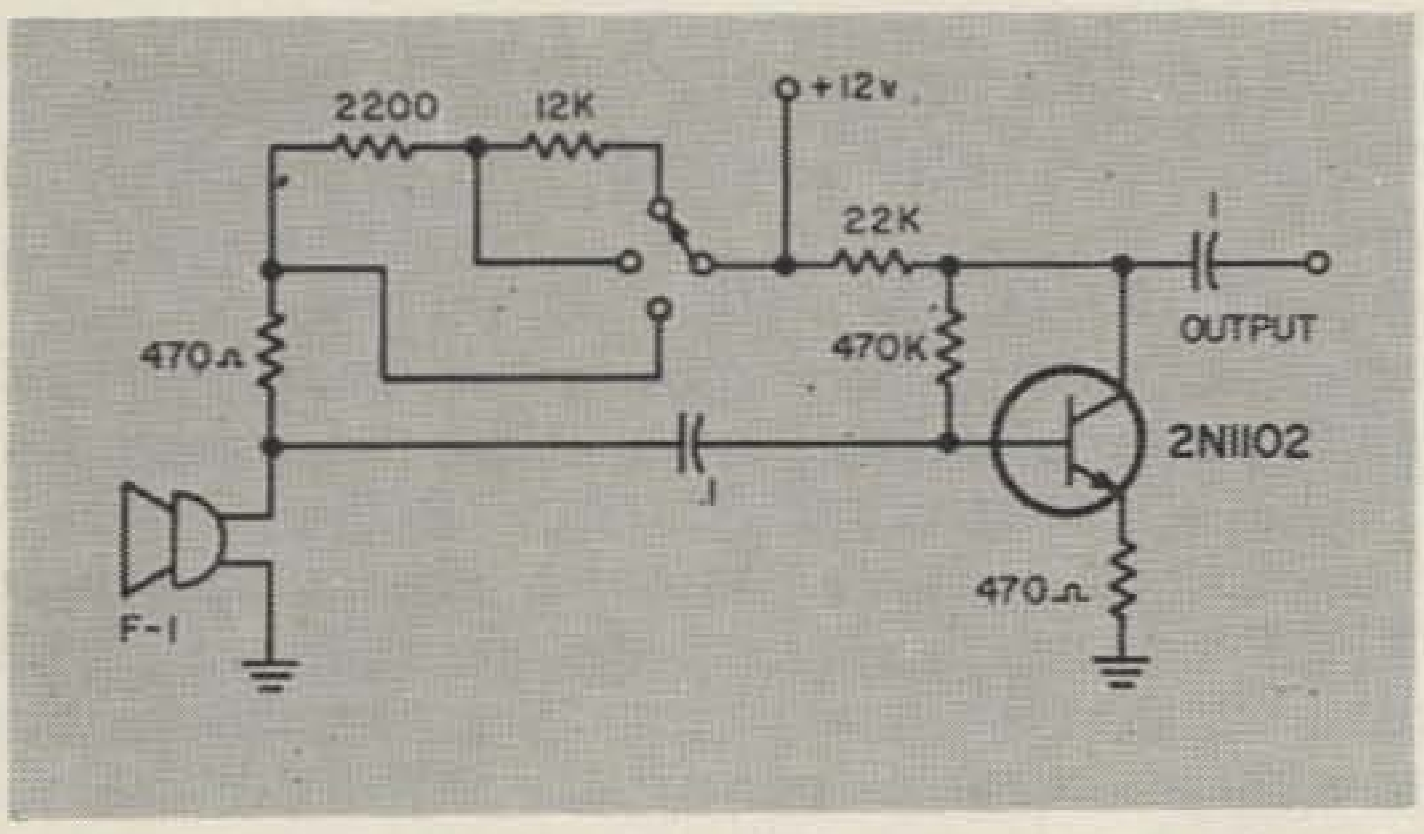


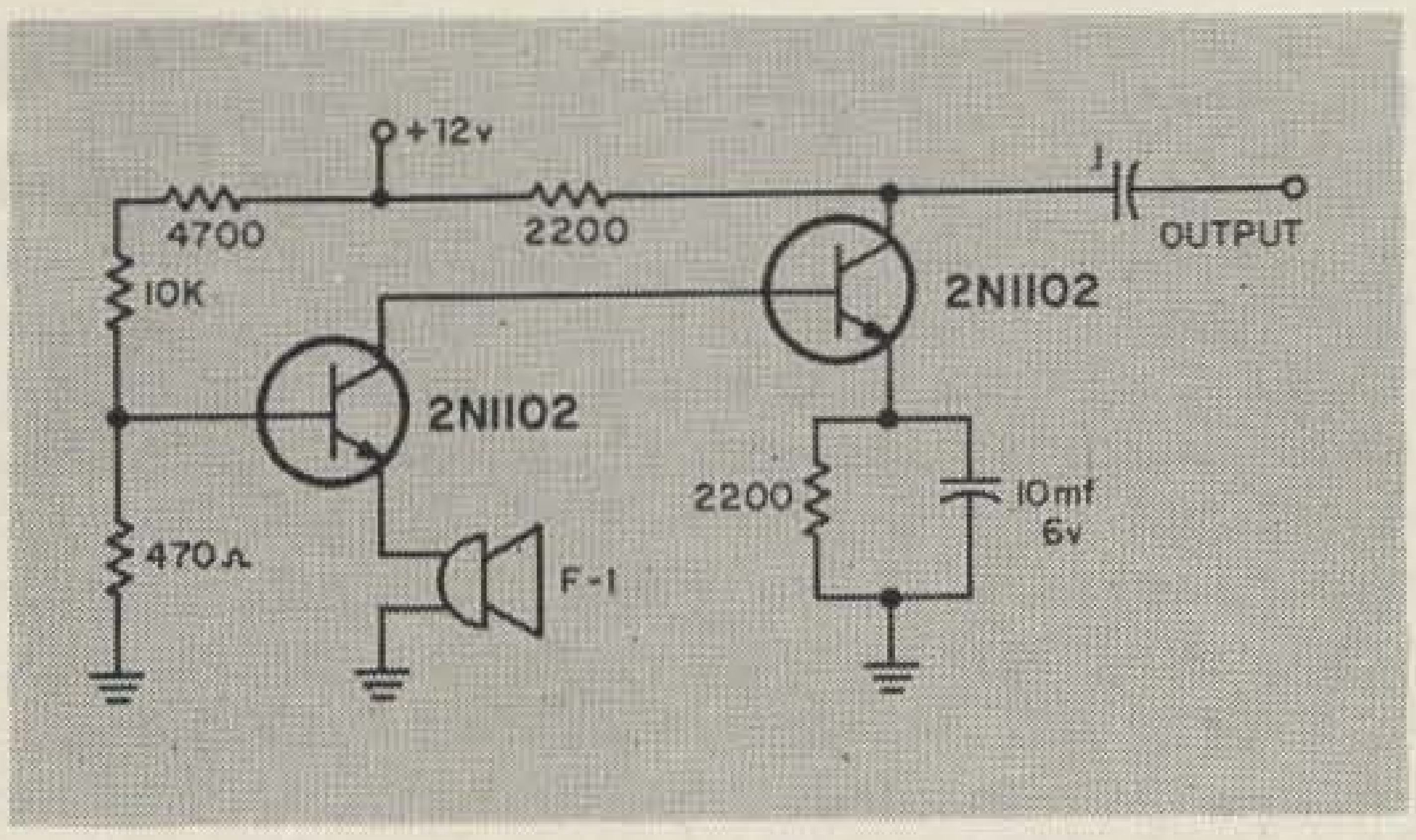
Under no conditions use a transistor as a mere current source for the microphone, and attempt to generate the output across some third element, such as a transformer. If the microphone resistance under static conditions drops to a low value, the collector current will soar. As an example of this don't, see Fig. 6.

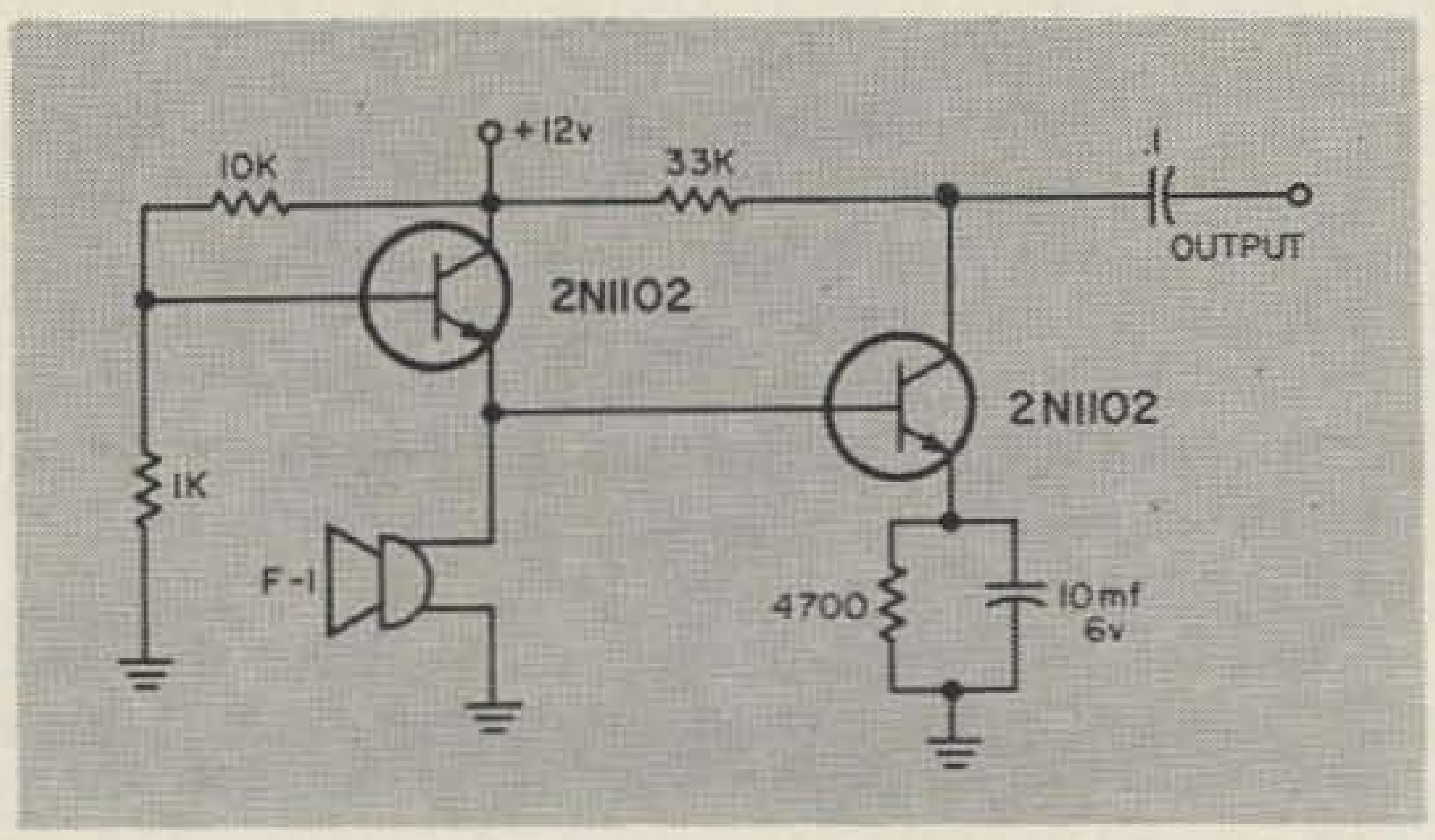
If it is possible to add the gain control at a later stage in the amplifier, then R_1 in Fig. 2 can be adjusted once and for all and forgotten. Lowering the value of this resistor will increase the output. Increasing it will decrease the output.

It should be pointed out that the high fre-









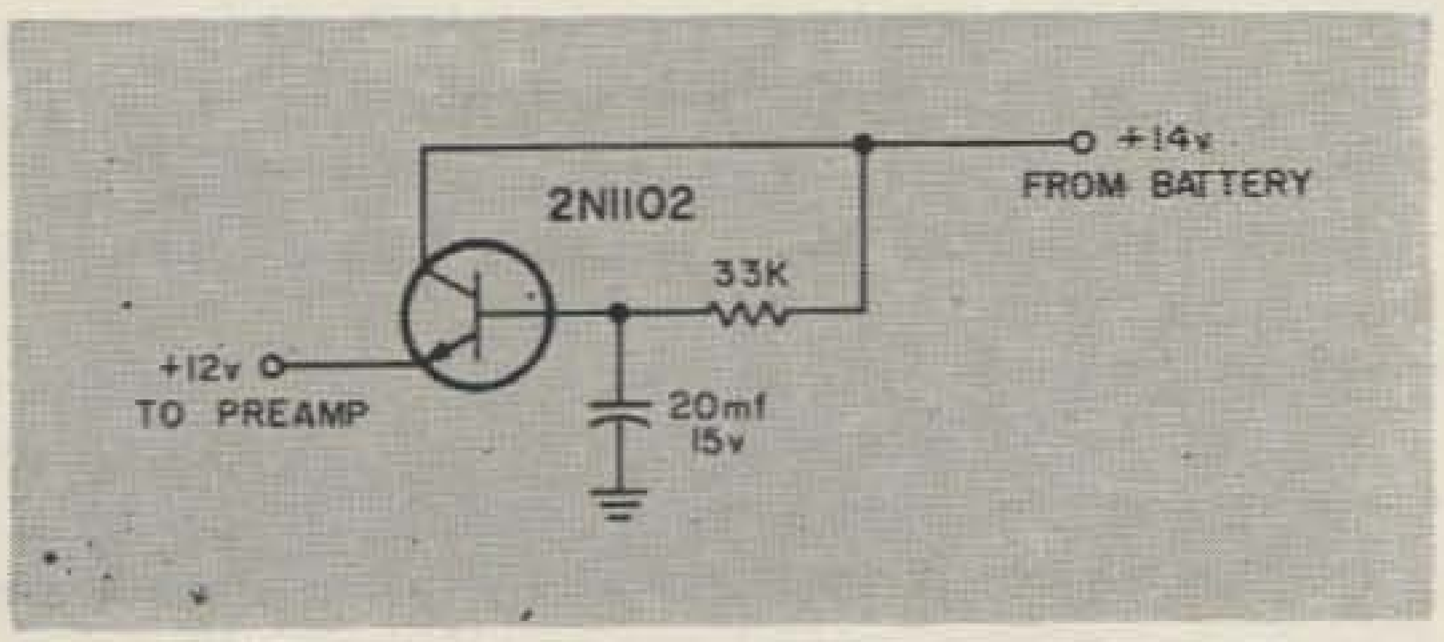


Fig. 7. A line filter to cut down on noise on the output which enters via the power source. The 33K resistor can be adjusted to adjust the output voltage.

quencies should not be filtered out by putting a condensor across the load resistor R_2 (in Fig. 2). If this is done, a severe distortion will occur at high input levels.

R_3 may need some adjustment if a transistor of unusually high beta is used. Simply adjust this resistor for symmetrical output on a scope at high signal levels.

Transistors of types 2N1059 and 2N1102 seem to work about the same. Type 2N679 seems to have a bit more gain, on the average.

The circuit of Fig. 2, then, is of reasonable simplicity, has about as much gain as most of the others, and is very stable. Output with a positive 12 volt supply is about 3 volts RMS. This circuit is to be highly recommended.

. . . W5SUC

James E. Ligon W4KOC
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2185 Hawthorne Street
Sarasota, Florida

To Brew or Buy

THE one question with which we amateurs are all faced at one time or another is whether to "home brew" or purchase a commercial rig. Now the purpose of this piece is to furnish some guidance in arriving at a satisfactory (at least to me) solution to the problem.

It is obvious that there is no simple answer —"one man's cup of tea is another man's poison" (or somewhat similar words to that general effect), but it is possible to provide some broad guide lines and perhaps recite a few personal experiences to assist in identifying and assembling the various facts which may have bearing on the problem.

In the first place, this somewhat unpleasant question was brought to me recently by my young son who spent the summer boning for his ticket. He has taken the examination and now must determine his equipment.

I explained that he must consider just what his own particular interests might be. It was pointed out that he would probably acquire a more solid theoretical basis for further pursuit of the hobby by constructing his own equipment, that he might take considerable pride in his accomplishments in putting a rig of his own construction on the air and that this would provide a valuable means of self-expression. On the other hand, most commercial equipment is expertly designed, efficient, has a low maintenance factor, is fairly priced, is immediately available and can be purchased on terms. His reply was to the effect, "Yeah, I know, but what do I do?"

It's like this. My first rig was a commercial job, but I really had no choice. You see, I was stationed overseas and in those days you just couldn't hardly get parts —. And then there was this fellow who was being rotated home—he had this equipment which he bought from his brother-in-law who is in the electronic supply business and he wanted to unload it before—.

My next rig consisted of a home brewed California KW which I bought from an impoverished W2 who was going SSB (or so he said). I never really had any trouble with it since I never got it on the air. My letters to him were returned and rumor has it that he was lost on a DXpedition.

I also tried my hand at constructing a "Sooper-Dooper Modulation Pooper," the details of which were contained in an issue of the ham publication "QRM." The article seemed to be clear and contained a list of components. Old W1 Ooble Ooble, the author, stated that he had found all the parts he needed in his junk box except for a few Fahnstock clips which he bought used from "Willy" in New York for two bits. I didn't have a junk box so I just clipped the parts list and sent it to "Willy" along with $59.95. (Just when was this you ask? You remember that your Mother was quite upset for a while after the $60 you were saving for a new bicycle disappeared? It was along about that time. And I must say that I'm proud of the way you pitched in mowing lawns, etc., to recoup the loss).—Construction of the "Pooper" was a cinch. It just didn't function. Six months later, "QRM" carried a short paragraph which indicated that resistor and capacitor values had somehow become confused with the blonde typist's telephone number. The paragraph indicated that this obvious error had, of course, been spotted and appropriate corrections made by the alert "QRM" readers. I never seemed to regain interest in construction of the "Pooper," particularly since about this time a standard transistorized production model became available for less than two dollars. The one I use now is the deluxe three dollar job which operates from 110-440 volts ac or dc, with multiplex outputs, covers the entire radio spectrum and has provisions for fuel injection.

My next project was the "Hi Q Squelch Meter." I found this a most rewarding operation. The meter works well even now. It is true that there is some question as to its actual necessity in operating the rig but you must admit that the visual red and green flashes and the intermittent high frequency buzzers which function nicely each time I receive a signal report of less than "50 db over 9" do aid in eliminating further contacts with rude and unqualified operators.

This should give you some food for thought and in conclusion, I can only say that it must be remembered that while my commercially engineered and installed equipment does operate with separate finals in all modes and at the maximum legal powers permitted in the amateur service, I am entitled to this since I have the money to pay for it and I have considerable amateur seniority.

Now, young Junior, you and your contemporaries are counselled to build your own equipment and keep your power at or below the Novice level until such time as you meet the Extra Class qualifications. This will insure not only your greater competency in the hobby but will reduce QRM for me and I like it that way. . . . W4KOC

500 Watt Linear Amplifier

Louis Hutton WØRQF
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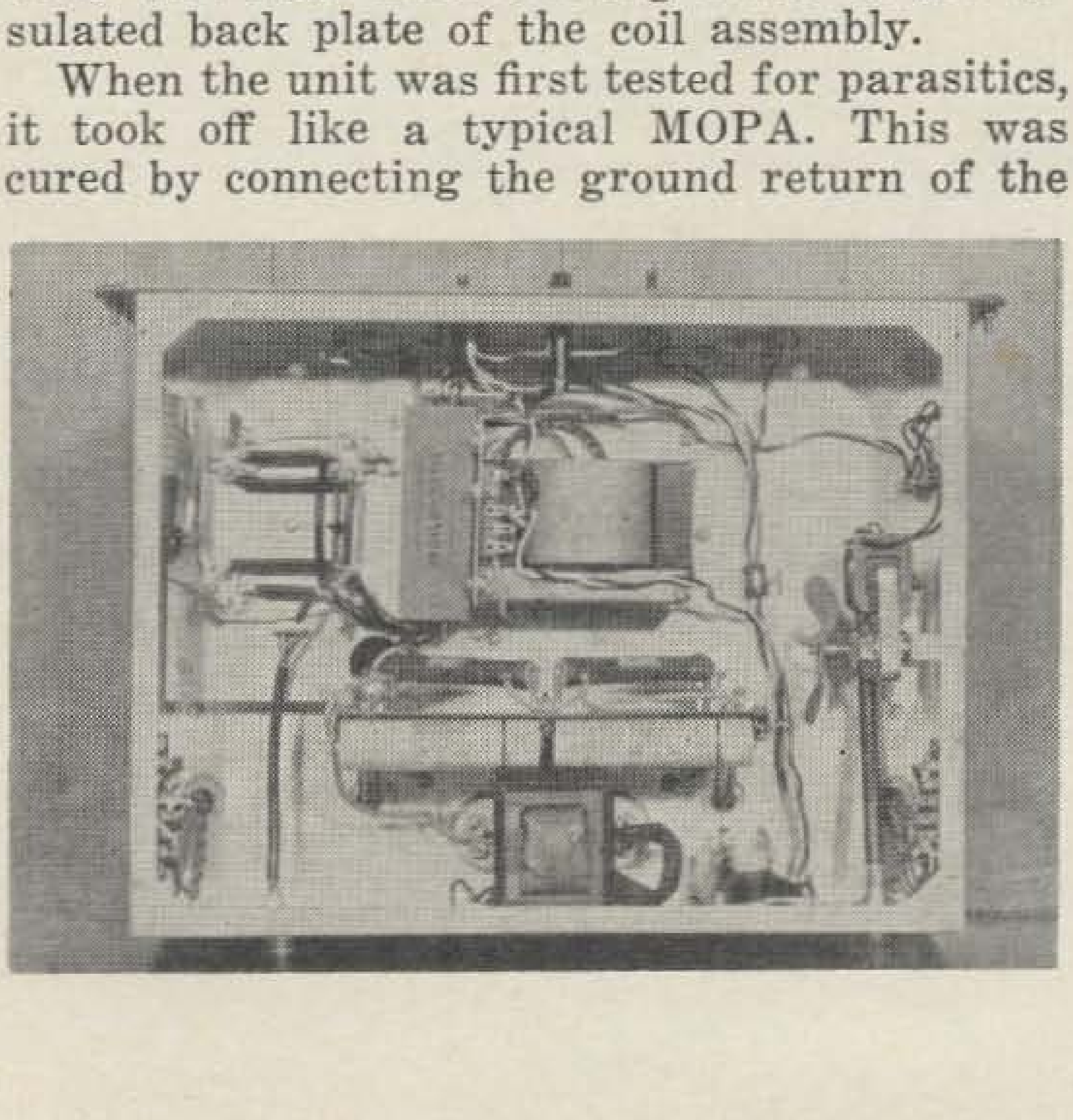
Wichita 17, Kansas

THIS unit was built as a power amplifier for my HT-37 exciter. It consists of four 811A's in grounded grid running 1400 volts at 300 ma. The external configuration was designed to match the HT-37, but still have some individuality. If the constructor does not rely on his junk box or surplus house as a source of low cost components, the amplifier will cost approximately $167. It took me about eight months to collect the major components and one month of lapsed time for construction.

Amplifier Construction

The amplifier was built on a 13 x 17 x 4 inch chassis, with a standard 19 x 10½ x ⅛ inch aluminum front panel. The four 811A's were mounted on a small sub-panel below the main chassis so that the tops of the tubes will clear the top of the cabinet by a safe margin. The 866A sockets were salvaged from the AN/APX-6 modification project. The insulating panel which mounts the four filter capacitors and two bleeder resistors was also salvaged from that project. The 10 meter coil section of the B&W coil switching assembly was rotated 180° to make for shorter lead lengths. A sixth band switch position is available on the B&W assembly and was used to provide an additional 100 mmfd of load padding capacity on the 80 meter band. Duplicates of the existing wiper contacts were made from .006 brass shimstock and are fastened by small bolts and nuts thru existing holes in the insulated back plate of the coil assembly.

When the unit was first tested for parasitics, it took off like a typical MOPA. This was cured by connecting the ground return of the plate rf choke bypass condenser to the same ground point of the plate tank tuning condenser and changing the parastic choke coil from 3 turns to 5 turns across the 100 ohm resistors. The bias battery was added after testing to provide for more linear and cooler operation. The static plate current was 55 millamperes and the amplifier is loaded to 300 millamperes under the single tone condition. Using my HT-37 as a driver, the power output is sufficient to light a 300 watt dummy light bulb load to full brilliancy with excellent linearity.

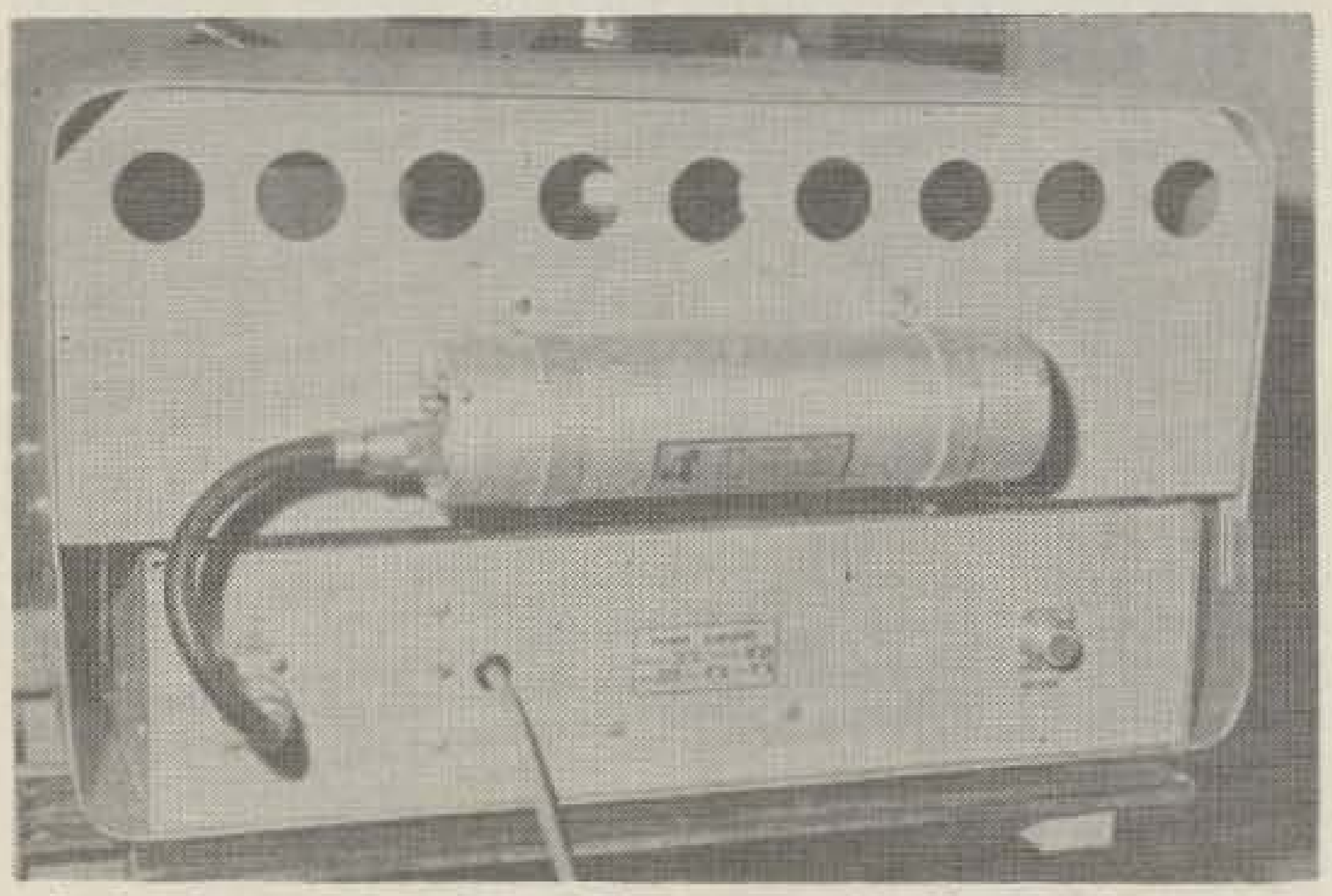


Cabinet Construction

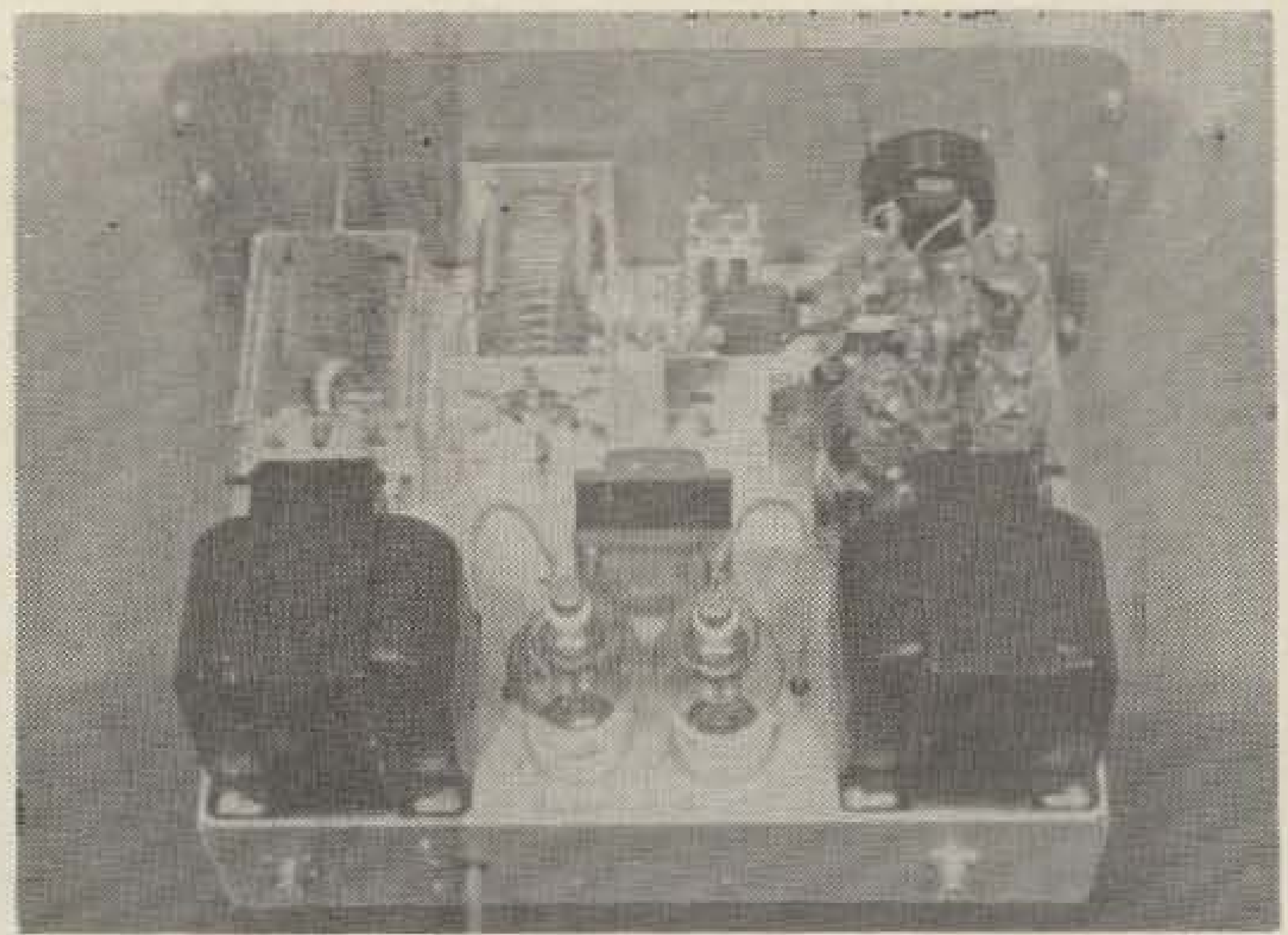
After all the holes have been located and drilled on the grey hammer tone front panel, the corners are rounded off using a jig saw. Paraffin was applied to the blade to make cutting of the thick panel easier. The panel was then sprayed with two coats of Krylon #1605 Dove Grey spray enamel. A one-eighth inch width strip of masking tape was taped to the panel, marking out the border. The panel was then given two coats of Krylon #1604 Light Grey enamel. The lower half of the panel was then masked off and the top half sprayed with Krylon #1502 Flat Black. When the paint dried, the masking was removed revealing a three toned front panel. Decals were used for dial scales and lettering. Dummy relay rack panel screws, cup washers, and nuts were used to fill up the panel notches. The brushed aluminum trim strip was made from cabinet top metal trim.

The cabinet was formed from two pieces of .040-52S0 aluminum. The rounded corners were formed by manually bending the metal around a 1½ inch diameter 3 foot length of thin wall conduit that was fastened to the edge of my work bench by "C" clamps. Two small pieces of scrap aluminum sheet were placed under the pipe before clamping to provide a slot between the pipe and the work bench.

The aluminum sheet was then slipped through this slot on to the bench of the proper depth, and the protruding part was bent upward, thus forming the rounded corners. The top half of the cabinet was attached to the bottom half by sheet metal screws. The screws pass through holes drilled in the upper section into a metal strip that is riveted to the inside



of the lower section. Two ventilation holes were cut in the top of the cabinet, one over the 811A's and the other over the 866A's. The ventilation holes were covered with grills made from Reynolds do-it-yourself perforated alu-

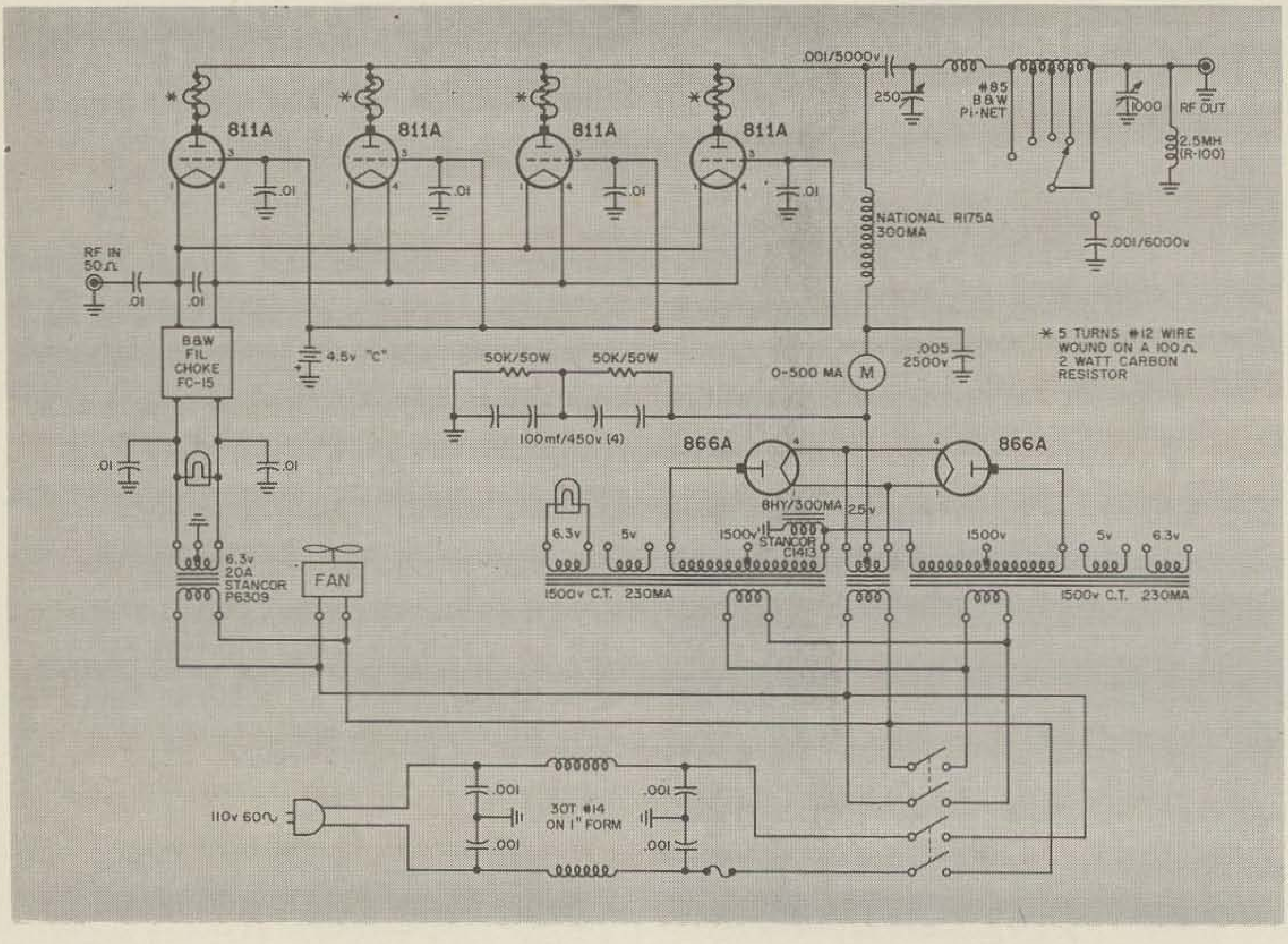


minum stock (cane bottom perforations). They are hand formed so as to fit flush with the top surface of the cabinet. When the sheet metal work was finished, I steel wooled the cabinet, then washed it in hot sudsy detergent soap to clean off all the grease and oil. This helps the paint adhere to the metal. It was then sprayed with 3 coats of Krylon #1605 Dove Gray paint.

This linear amplifier has received excellent reports from on the air operation, and from those who have visually examined the equipment. . . .WφRQF

Parts

Power Transformers:: McGee Radio Company, 1901 McGee Street, Kansas City 8, Mo. part number 949231.
Fan: 4" blade. Olson Electronics,, 260 S. Forge St., Akron 8, Ohio. Part number MO-48.



Bob Baird W7CSD
3740 Summers Lane
Klammath Falls, Oregon

How to Build a Ham Shack

or

The String's the Thing

THE average ham or audiophile, or any other kind of hobbyist for that matter, has a limited amount of money to spend on his hobby. The thought of spending any vast outlay to house this hobby is something we instinctively avoid. At W7CSD there was a nine foot square space under a gable in the roof which was unfinished. A quick estimate of materials to finish and insulate this area ran into three figures. This was prohibitive if we expected to spend anything on ham radio. So a cheaper yet respectable looking job had to be devised. This article describes one method which is not 100 percent beautiful, but it doesn't look too bad and it is cheap.

Original Condition

The space had a sub floor and wall studs on all sides and there was a hinged door at the entrance. The gabled end had a window in it. Electrical power was easily available.

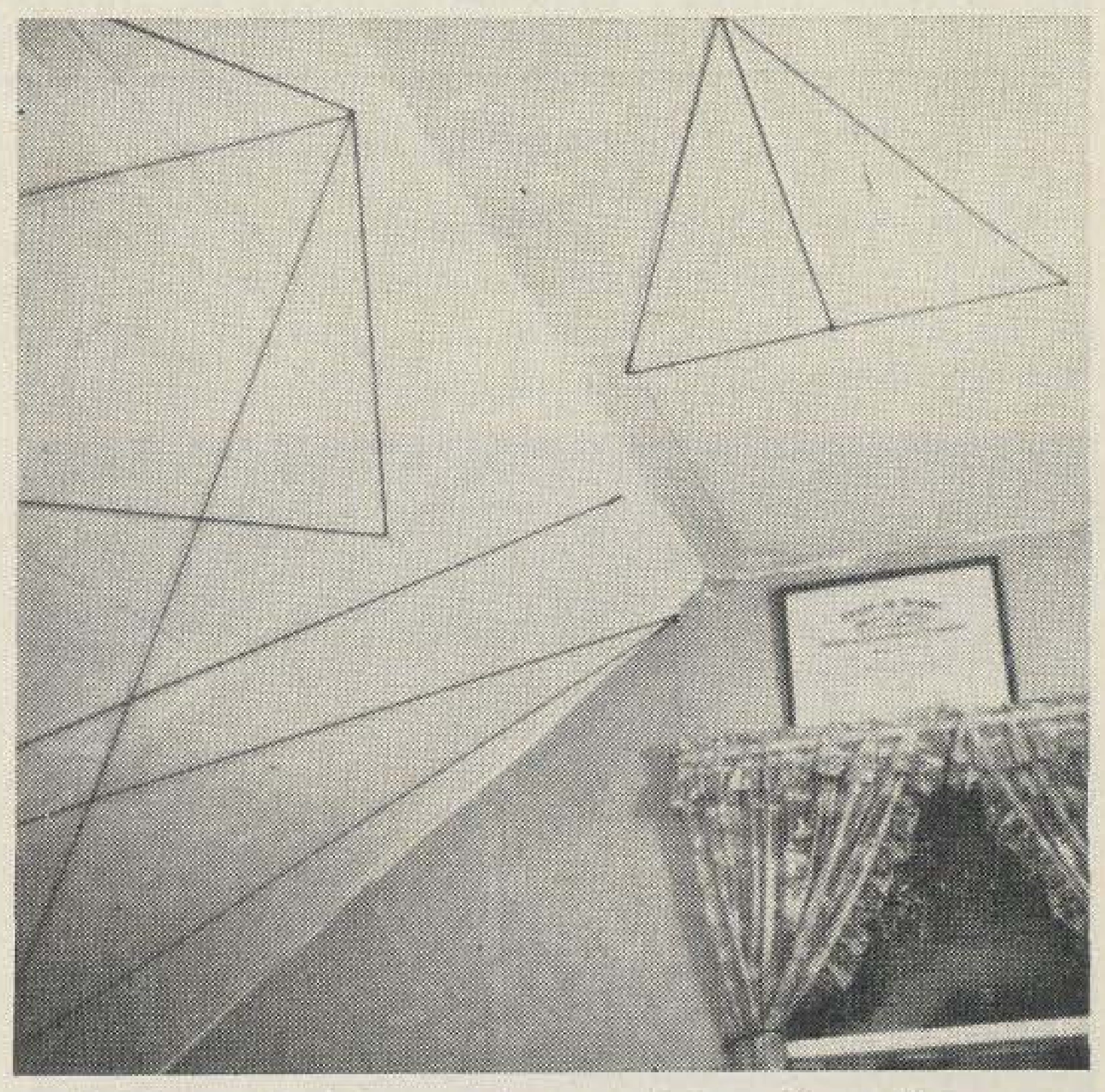
Walls and Ceiling

The first problem was insulation. Obviously a rock wool blanket neatly stapled between the studs would be ideal, but not for free. With a little reflection one will recognize that dead air is the all important part of insulation. So we merely nailed some heavy cardboard over the back sides of the studs and broke up the vertical circulation with cross pieces placed horizontally between the studs at frequent intervals.

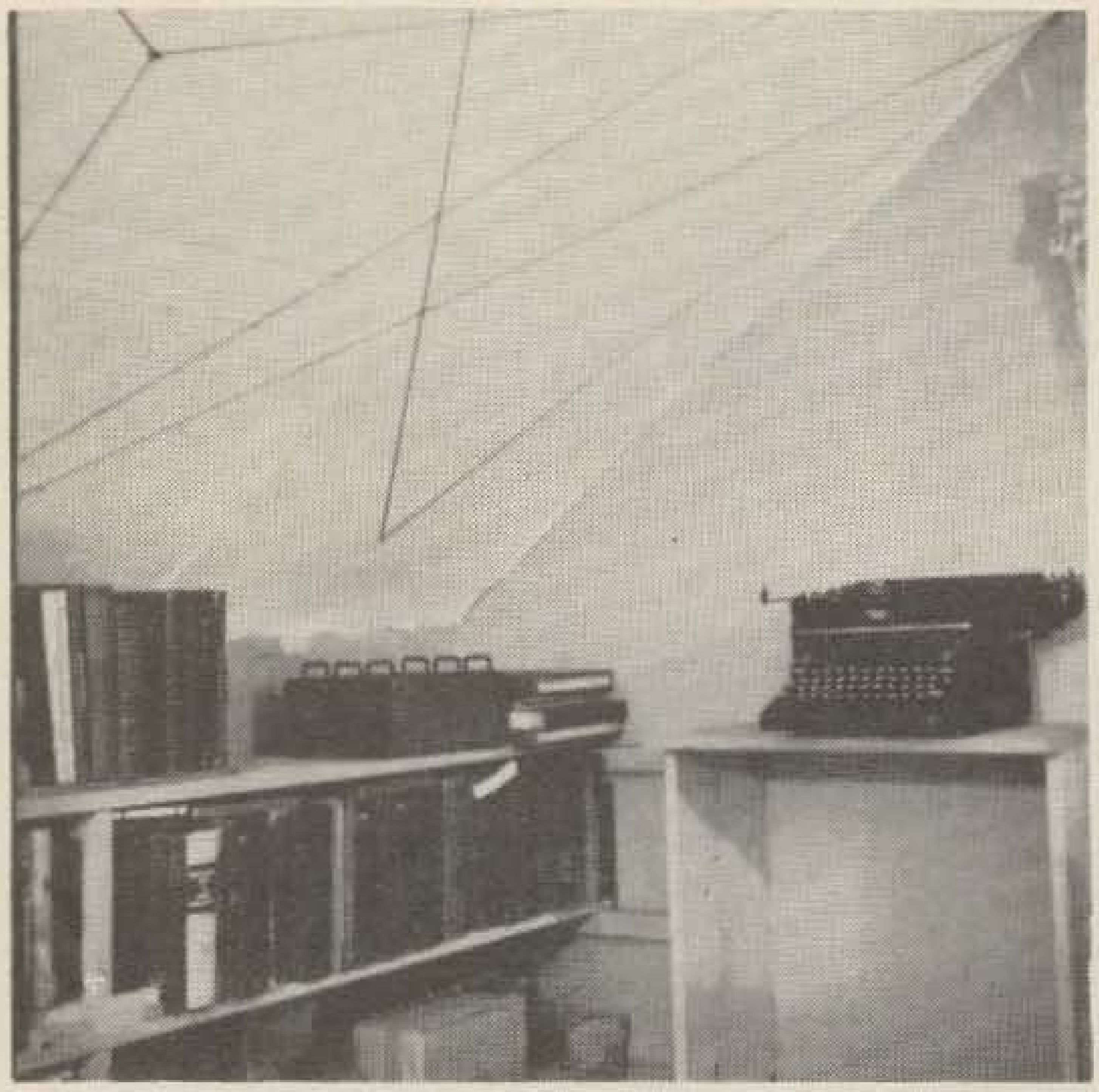
The internal walls and ceiling are likewise made of cardboard nailed on the inside of the studs and rafters. Our source of cardboard in large pieces was an appliance store that sold refrigerators. Three or four of these giant cartons will do the whole job.

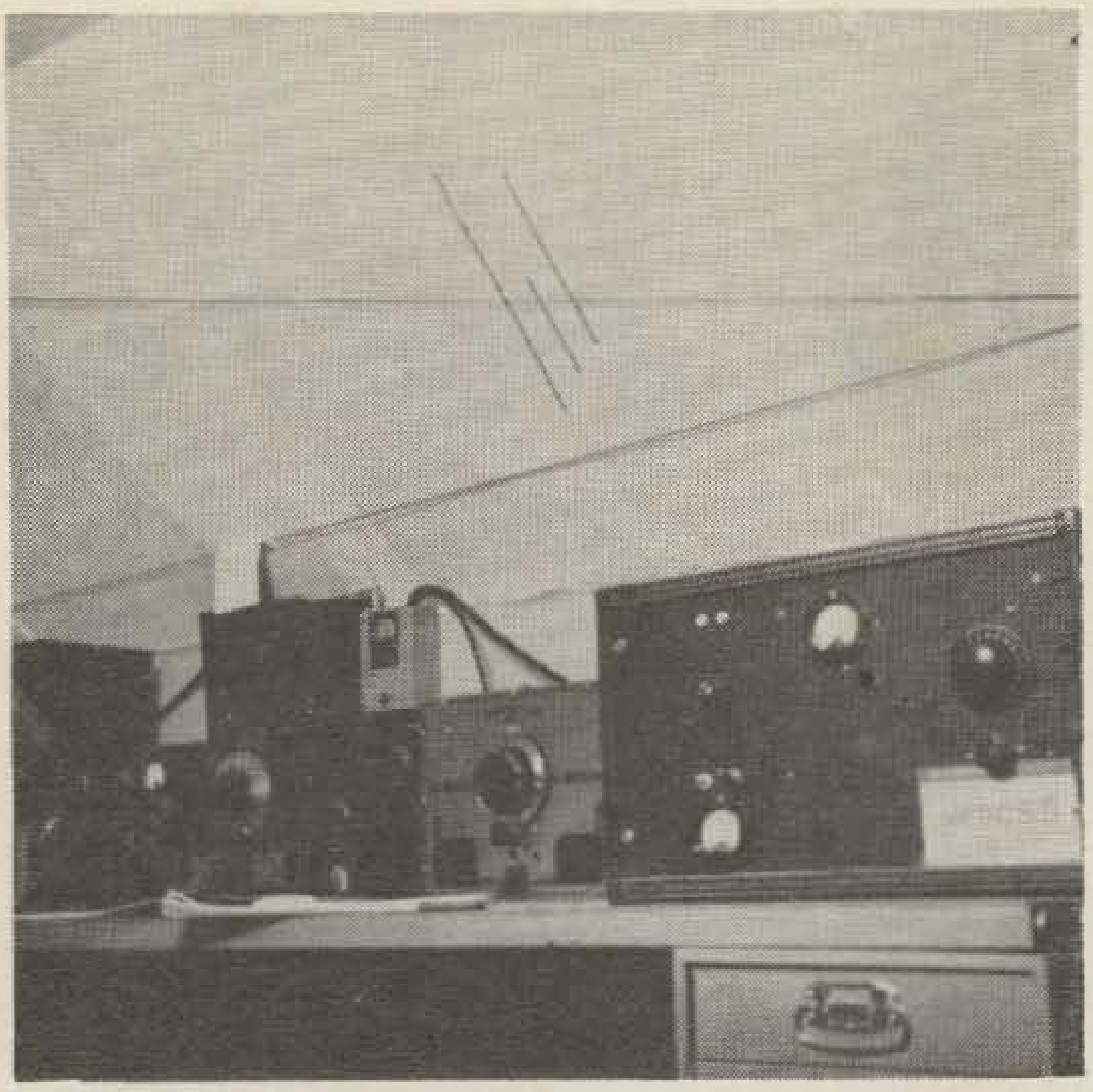
At this point in construction, your room will not be a thing of beauty and a joy forever. Cardboard does not lend itself to making clean neat perfect fitting joints. We fairly well solved this problem with wall paper paste and strips of muslin. Wall paper or wheat paste is readily available from any hardware or building supply store for a few cents. We mixed this with water and applied it to the seams with an old paint brush and then applied the muslin strips, painting on another layer of paste on the outside. The muslin was procured from an old bed sheet. The results at this point are shown in Fig. 1. A couple of coats of Kem-Tone or other water base paint on top of all of

Figure 1. Walls after cardboard and muslin have been applied.



Bright red string makes an interesting distraction from the cardboard walls and ceiling.





A door makes a fine operating desk.

this makes things begin to look respectable.

There seems to be no way to get a good floor for free. We paid real money for enough quarter inch masonite to cover the floor satisfactorily. Some mop board was scrounged from a bargain basement scrap pile and our room, as such, was about finished.

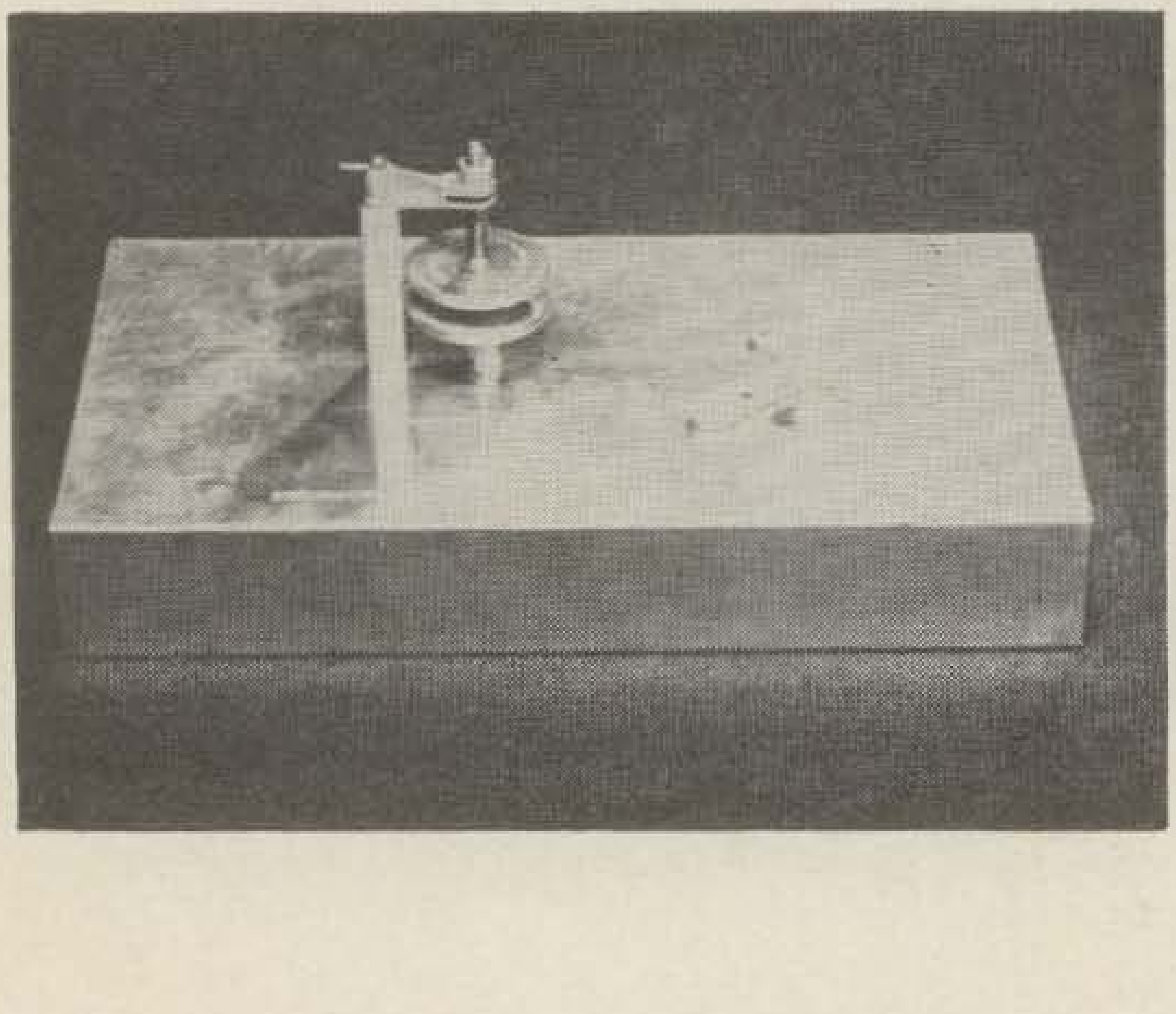
It was necessary to buy some good lumber for book shelves and a typewriter table. The table holding the ham equipment was made from a blank Philippine mahogany door. If you can find one of these damaged on one side you can usually get it for about half price. The steel drawers were also purchased and serve as one leg to the table. The rest is wall supported.

You can't get everything for nothing. And although the room at this point was fairly presentable the material used and many seams were quite obvious. It was decided that we would devise some kind of scheme to divert the attention of any visitor from some of the shortcomings of our construction. So we bought a hundred feet of hard wrapped twine, chalk line is very good, and a package of red dye. We unwound the twine and dunked it in the bright red dye and came out with some nice bright red twine. This we arranged in abstract designs over the walls and ceiling. Some of these are illustrated in the accompanying photos. It should be pointed out that taking pictures of the inside of a nine foot room from the inside of a nine foot room is somewhat of a problem for the casual shutterbug. We hope the general idea is conveyed. In any event brightly colored twine can be arranged in the abstract, in geometric designs, or in parts of a schematic diagram. Any or all of these give a novel setting to the cheaply constructed room and tend to camouflage the imperfections.

. . . **W7CSD**

Component Mounting Technique

Many electronic components are supplied with a mounting base to which the various parts are secured. While this design permits factory assembly and packaging as a single item, it often does not provide optimum performance. This is particularly true of RF components used at the higher frequencies.



It is sometimes possible to discard the mounting base and achieve better layout. An example is shown in the photograph. The neutralizing capacitor, as supplied, requires three holes to mount the base and a fourth hole to provide clearance for the grid lead. Discarding the base and mounting the bottom plate on a feed-through insulator permits installation using only two holes. A neater job results and better circuit isolation is provided.

Consider each component mounting problem carefully with the objectives of conserving space and improving efficiency. Many other components, such as rf chokes, lend themselves to this treatment and the same advantages accrue. . . . **W4WKM**

Photo Credit: Morgan S. Gassman, Jr.

A Nostalgic V-Beam

Frederick Haines W2RWJ

BACK in the old days (just after the war), the beginning young op just couldn't afford to run out and purchase a "ready-made" rotating beam. For one thing there was only one make on the market, and for another it was just too much money! Some folks just up and built their own too, but aluminum tubing was practically unheard of yet, and the favorite method of construction was to use a 200 pound painter's ladder as the boom. These light-weight marvels worked out fine, but most of the boys didn't have the required 50 foot rigging crane to lift them up on the roof. As a result most everyone was content to use a half-wave dipole on the twenty meter band. I wasn't.

Slowly it took shape and after a long time bubbling beneath the surface, it broke through! Surely the only kind of antenna capable of excellent results isn't the rotating Yagi beam. Well, what was it to be then? 8JK's were in use, lazy H's weren't unheard of, and some of the more ambitious actually had erected Sterba Curtains and Bruce arrays. Somehow none of these appealed to me, I think because they all exhibit too much directivity, and would therefore not be much good unless rotatable, Heaven forbid! The die was cast, and a V-BEAM hit the drawing board.

As I reminisce, it's hard to keep from chuckling over the elaborate construction methods and over-design that were employed, and it's always a source of amazement to consider the perseverance and unlimited energy of the young.

The overall dimensions of the monster were staggering to behold. Each leg of the V was 272 feet long, the included angle between them 37°. Average height above terrain was the minimum recommended for good results, approximately ½ wavelength at 14.250 mc, which came out in the neighborhood of 34 feet. The theoretical gain over a half-wave dipole in the favored directions was about 10 db.

The feed system employed was a conversation piece for area residents and other hams for years, not because of technical oddity, but because of its length and appearance. The main portion of the array was mounted upon three 34 foot towers of wood. Each of these edifices was made of two 16 foot 4x4's, connected together by screwing four pieces of ½" thick hardwood about 2 feet long so they lapped halfway onto each 4x4, and on all four sides. Of course only non-rust brass screws were used throughout! At this point the three behemoth towers were lying side by side on nine specially constructed sawhorses receiving their three coats of aluminum paint. The area residents were only dimly suspecting that a change in the landscape was imminent; their interest was mild.

Holes were drilled to pass eyebolts arranged to attach wires and insulators, guys and pulleys. Simultaneously, three 3 foot deep holes were surveyed (a good trick in itself) and dug. Concrete and gravel were ordered and dumped near each tower location. Two 2x4's were set in each hole and bonded in concrete, spaced apart to allow the 4x4 towers to be bolted between them. Three iron stakes were also set in concrete around each tower location to hold the guys.

Then came the day of days! With the help of three friendly neighbors, the towers were bolted into their mountings and pulled skyward by the guy wires. One fellow manned the level, two others steadied, while I scurried about attaching guys and adjusting the turnbuckles for the exact tension deemed necessary. Then we stood back about ¼ mile and surveyed our handiwork. Without question it was the most remarkable sight we had seen in years!

After the ladder work was over and the wires were hung with care on those nice big fat ceramic insulators, the two acre plot looked suspiciously like a transatlantic broadcast installation on Long Island. Then came the feedline into the shack. . . .

Open wire 600-ohm feedline was used, and all 150 feet of it carefully hand fabricated using ceramic insulators and wire ties. A quarter wave shorted matching stub was run down the apex tower and the feedline attached. From there it ran over a series of 15 foot "telephone poles" to support its weight to the house roof. Over the roof and through feedthrough insulators, it went. In the shack it terminated in an antenna tuner, fed by the 100 watt 20 meter phone rig.

To insure proper adjustment of the feedline on the quarter wave stub, a 600-ohm open line "twin lamp" was made and the stub adjusted until the outgoing light was brightest and the reflected power light went out. This, incidentally works very well, although I don't think I've ever seen the "twin lamp" written up for open wire lines.

With 80 to 100 watts input on the crowded 20 meter phone band 25 countries were worked in Europe, Africa, and the Pacific in less than 24 hours continuous time, spread out over a 6 month period. Some real juicy ones too. It was found that stations could be worked in any direction due to the many minor radiation lobes characteristic of the V, but of course extraordinary signal reports were only received in the favorable directions. In fact, many times, when working rare DX, I was reportedly "the only W on the band today."

All good things come to an end and so it was with my monster. For three years I enjoyed that notoriety which is afforded only those hams with antenna farms. None in the entire Central New York State Region had the slightest difficulty finding my house. Once in the neighborhood, one had only to ask about a large antenna and directions were immediately forthcoming. Then came the day I took a job in a far away city, and my long suffering mother, who is the real martyr of my story, suggested that perhaps I could take down the array? With heavy heart and almost reconsidering that new job, I agreed. Down it would have to come.

Ah, what a fate, to end up as a wooden border for a new flower garden, but that's what happened. The four by fours to this day keep the grass from encroaching on the flowers in the back yard. The concrete bases were just too much to consider moving and still are known to break cutter bar knives of unwary farmers cutting hay on the old antenna farm.

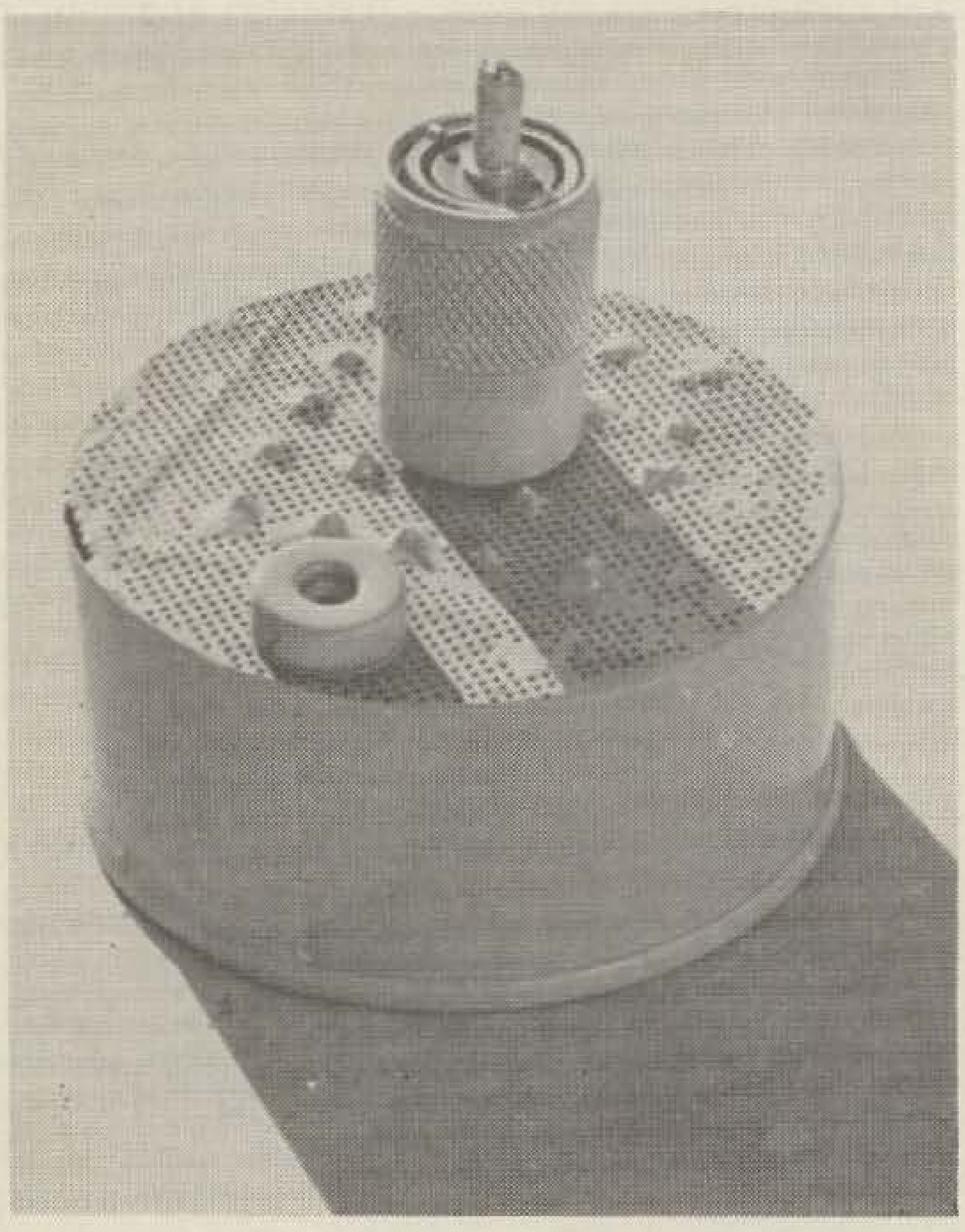
With the demise of that great old antenna, it was as if an era had ended for Ham Radio, and indeed it had, for it was just about that time that the trend toward store bought gear and ready made beams was established. Today if an antenna is much larger than a bread box, it's no good. I'd like to see a trend toward more of the large old wire antennas such as this one. Think it over, they really work out fine!

. . . W2RWJ

The Tiny Terminator

Jim Kyle K5JKX/6
1851 Stanford Ave.
Santa Susana, Calif.

HAVE you ever felt the need for a dummy load which would also indicate accurately the actual rf output power of a transmitter?



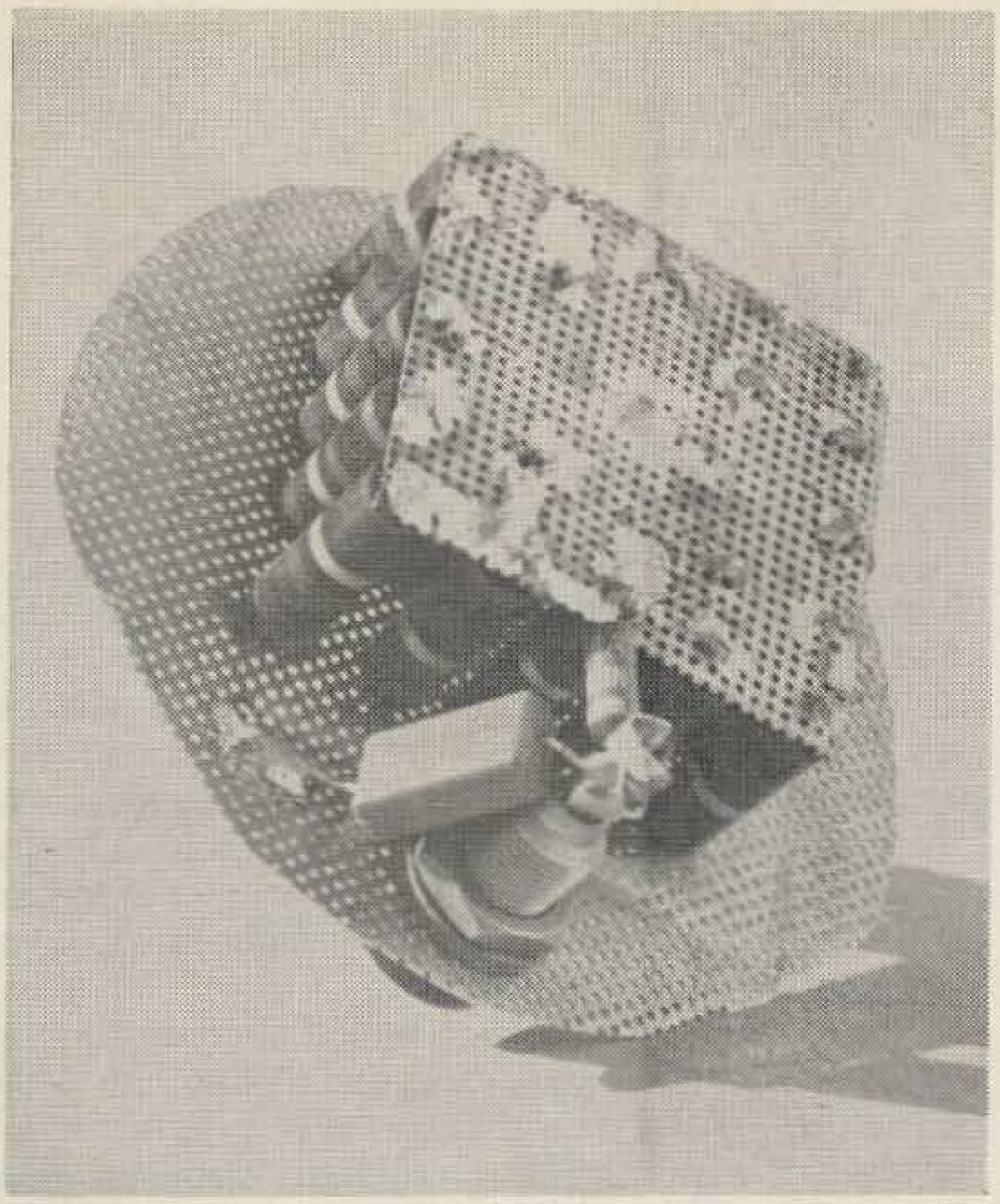
You can buy such a beastie, you know. The Bird *Termaline*, standard of the two-way communication industry, shouldn't set you back much more than a C-note . . .

But you can also build one at considerable less outlay, and that's what this article is all about.

As the photographs show, there's almost nothing to the "Tiny Terminator"—nothing, that is, but a 50-ohm load for any transmitter, which will absorb 20 watts for days on end and will handle 40 watts for brief periods (a minor modification can double these ratings), will *not* radiate rf into the ether after the fashion of the "standard" light bulb load, will allow accurate measurement of output power up past 225 mc, and can be built in less than two hours for less than $5.

You can see by the schematic that there's nothing to the device electrically; the tricks are all mechanical. Electrically, the Tiny Terminator consists of 20 (that's what we said) 1000-ohm 1-watt resistors connected in parallel, with a crystal diode running from the hot end of the composite resistor to the meter jack and a 27 mmfd capacitor bypassing the meter.

Mechanically, the big problem with a unit



such as this is the problem of keeping the load resistive regardless of frequency. Resistor leads have inductance (about 25 millimicrohenries per inch) so we get rid of the leads as completely as possible. This is done by punching holes in a flat plate, passing the lead through the hole until the resistor is flush with the plate, and soldering rapidly with a hot iron (an Ungar 47-watt 1100-degree tip was used in building the model shown) so that the resistor body won't cook before the leads and plate are joined.

The flat plate has capacitance. This is avoided by keeping the plate shielded from outside influences, and separated as far as possible from its shield.

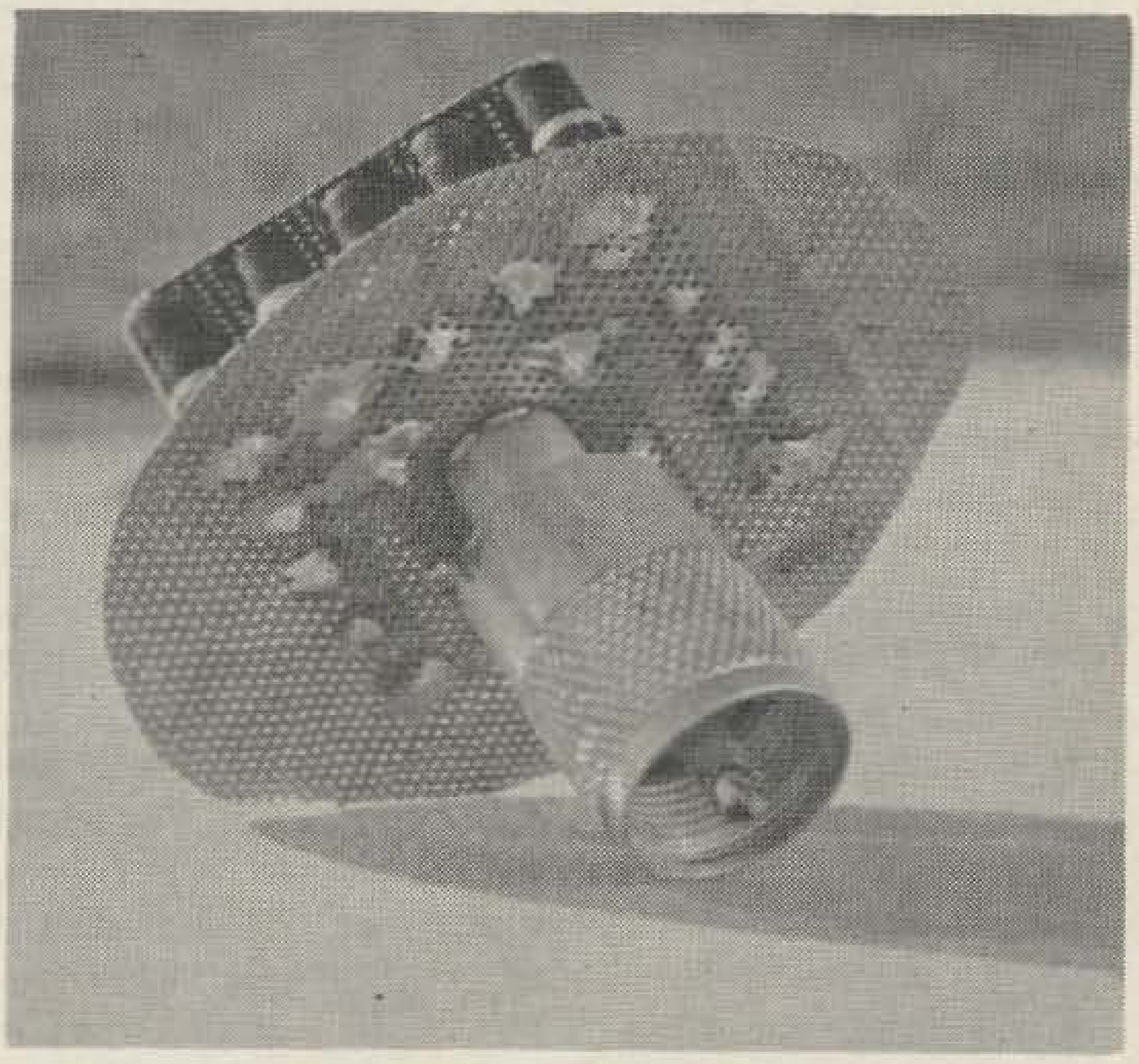
The shield, incidentally, is the bottom of 1½ inches of a Canada Dry cola, soldered all around the edge to the front resistor plate. This confines all rf inside the terminator.

Addition of the crystal diode (a 1N34 was used, but a higher-voltage unit is recommended if you ever expect to measure power higher than 8 watts) and the bypass capacitor provide the power-measuring feature. These two components, in conjunction with an external voltmeter of at least 1000 ohms per volt sensitivity, provide you a peak-reading ac voltmeter. The voltage indicated on the meter will be equal to the peak value of rf voltage present across the load. Squaring the voltage and dividing by 50 (the resistance) will give you the *peak* power. Most power ratings are in rms values rather than peak; multiplying the indicated voltage by 0.707 before squaring will give you the rms power output.

The unit shown in the photos used perforated brass stock for the resistor plates; this happened only because a length of the brass was on hand in the junkbox at the time. A cut-out tin can lid will work equally well and will be much less expensive.

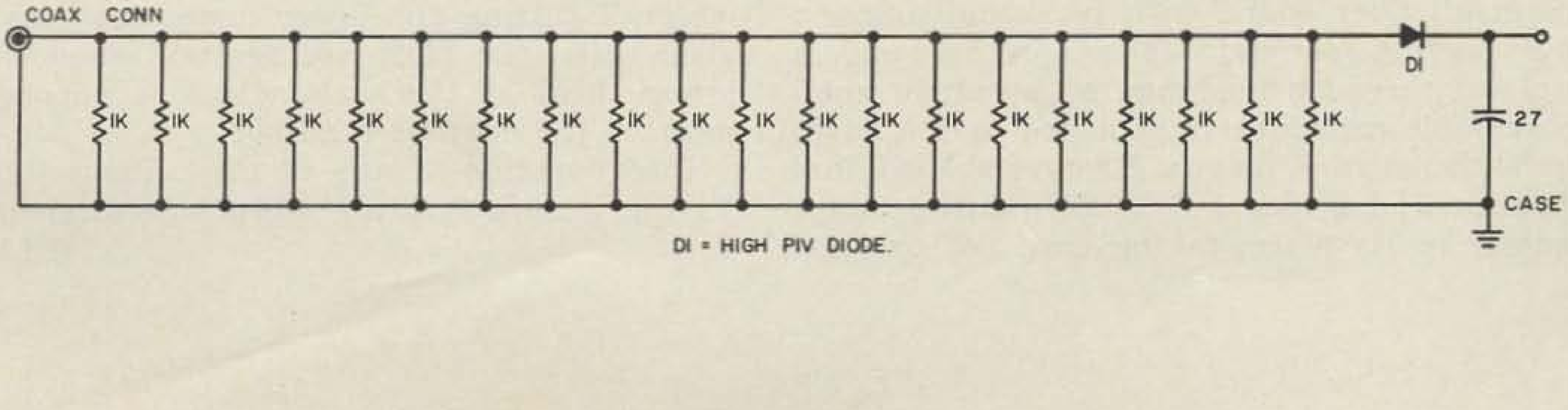
Not visible in the photos is the means of connecting the hot end of the resistor plate. A hole was punched in the middle of the hot plate and a length of No. 14 bare wire was soldered in, then filed off flush on the rear side. The bare wire was threaded through the coax connector and soldered to the center contact after checking for possible shorts.

The coax connector itself is held in place by a solder joint all around the rim of the cable-end aperture (see photo). This joint, if well made, provides plenty of strength.



Earlier, we mentioned that a minor modification would double the power rating. That modification is this: instead of 1-watt resistors, use the 2-watt variety. If you really want to go high-power, use 50 2700-ohm 2-watt resistors and have a terminator which will absorb 100 watts continuously and 200 watts ICAS. However, one that big will cost more—and you'll probably have to use a coffee can for the shield instead of the cola can used here.

. . . K5JKX/6



Old Vikings Never Die

John H. Bauer W4AWM
87 Marlborough Road
Asheville, North Carolina

WHILE making a recent tour of used equipment counters in amateur supply houses, I discovered that one piece of gear was conspicuous by its absence. This was the Viking II.

The one here at W4AWM is over seven years old, has had a life of faithful service, with few exceptions. One of these is a loss of gain in the speech amplifier. A cure for this problem has meant a modified speech amplifier for some Vikings or a distortion producing pre-amplifier for others. I tried a trick suggested by W4OXZ and it restored the gain to what it was when the transmitter was new, even with a dynamic mike. Simply replace C1 and C54, the 10 mfd 25 volt electrolytic capacitors used as cathode bypasses on V1 and V2, the 6AU6 speech amplifier tubes. You can increase the overall gain of the stage slightly by using 20 or 25 mfd electrolytics in place of the tens. Be sure to observe polarity when making the replacement.

If you find it necessary to replace an 807 in the modulator, it is advantageous to replace the other also. This is to facilitate the use of a pair of balanced tubes. You can check balance by removing one tube and noting the resting current of the other on the modulation position of the meter. Now swap tubes and again note the current. The tubes are balanced when you find a pair that draw equal current. Resting current, with both tubes in their sockets, should be within 5 percent of 75 milliamperes. Be sure the empty plate cap does not touch ground, and remove *all* voltages when changing tubes.

While the bottom is off, take a look at the pilot lamps. If they seem a bit black around the gills, it might be worth your time and a few cents to replace them now. There are several screws holding that bottom plate.

Operation on MARS or CAP frequencies can bring a note from the FCC if you have ignored reports of slightly off frequency operation. This next little item can save you the toil of crystal grinding and the embarrassment of a "pink" ticket. The first step is to obtain a surplus tuning unit type CO-985, which consists of a small fiber board with two small banana plugs having one-half inch spacing, and a couple of threaded bushings attached. A small air variable capacitor is attached to the bushings with machine screws. Remove the original capacitor and solder a 5 to 25 mmfd ceramic trimmer in its place, taking care not to overheat the solder tabs. Install the trimmer assembly in one of the crystal sockets and insert the net crystal in the succeeding one. Finally, jumper the corresponding terminals on the crystal switch SW8, thus placing the trimmer in parallel with the crystal. Turn on the oscillator and "zero beat" the net control station or an accurate crystal by turning the trimmer with an insulated tuning tool. I found that the 5 to 25 mmfd trimmer would move my 4595 kc Air Force MARS crystal several hundred cycles in each direction.

Many amateurs enjoy modifying equipment but hesitate doing so for fear that the holes left from these "improvements" will ruin the trade-in value, which is all too true in most cases. The Viking, however, lends itself quite well to modifications. Since few operators use 160 meters, the 160 meter IN-OUT switch SW6, may be partially removed to permit utilization of the front panel hole for another switch, such as an SSB-AM switch. All that is necessary in this operation is to remove the dial cord from the shaft and drive wheel assembly under the chassis, tie the cord so it will not slip through the chassis and off the switch drive wheel, and remove the shaft and wheel from the bracket. This leaves the bracket free to receive a switch, and eliminates drilling a hole in the panel.

If you plan to use an SB-10 with the Viking, drill a small hole in the chassis bottom plate and pass the coax leads to and from the SB-10 through the hole. You may now attach the coax directly to the driver and final, thus saving two connectors and a few more price reducing holes in the cabinet. A feature of this system is that it eliminates the added capacity of the connectors in the grid circuit. For electrical connections, there are four unused pins on the accessory socket, and drilling out the end of the aligning pin on the VFO plug will provide for additional leads if you are driving a modulator for a high power final in addition to the use of the sideband adapter.

Using the proper multiplier and the OFF position contacts on the meter switch, the transmitter plate voltage may be read on the meter. Utilizing the lower meter scale as 0 to 2500 volts, the plate voltage will read on the lower third of the scale which is normal for most of the current readings.

Incorporation of any of these items in your Viking is sure to bring added operating pleasure.

. . . W4AWM

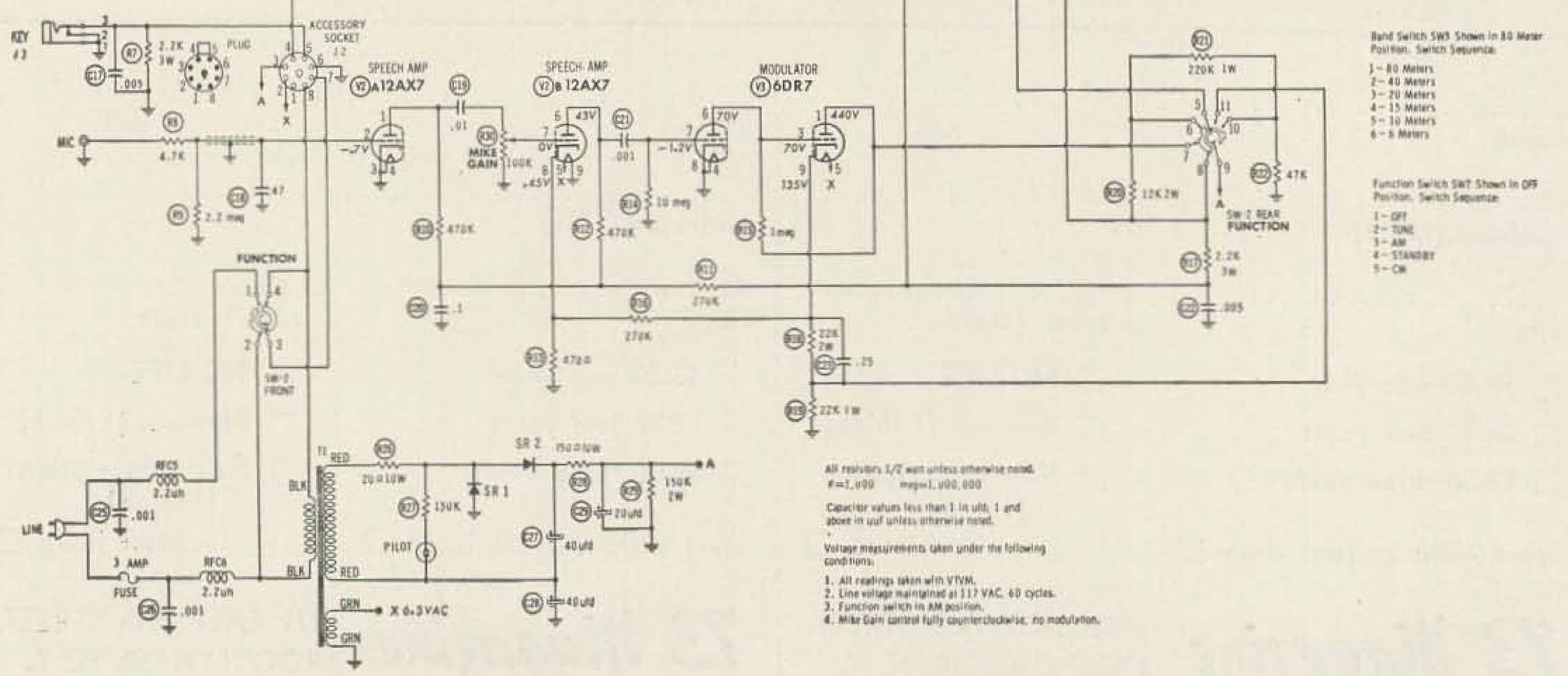
Roy E. Pafenberg W4WKM
316 Stratford Avenue
Fairfax, Virginia

73 Tests

The Knight T-60 Xmitter

A 60 watt AM and CW transmitter with full 80 through 6 meter amateur band coverage for less than $50.00? It's hard to believe but this is what Allied Radio Corporation has accomplished in their new transmitter kit. The Knight T-60 is a completely self-contained, neat little package that puts out an amazing signal for its size.

A quick check of the specifications will verify that this easy to assemble kit is a real bargain on today's amateur equipment market. How does this Knight-Kit provide so many features at the price of $49.95? Part of the reason is, of course, that it is a kit; you supply the majority of the labor. That is, if you call the interesting, easy assembly of the transmitter labor. The design concepts that provide high performance at low cost include a silicon rectifier power supply, use of a mass produced, high efficiency TV sweep tube in the output stage and a highly effective, controlled carrier screen modulation system that provides good quality speech with plenty of punch. This audio system allows the final to loaf along at about ¼ normal power input and still approach the CW input of 60 watts on voice peaks.



These same features make compact construction possible and this little transmitter is no larger than a man-size shoe box. The gray wrinkle finished, rugged steel cabinet and the two-tone panel provide a very attractive and practical housing. Despite the compact construction, assembly is easy.

The 218 separate assembly steps are arranged in easy to understand, check-off order in the large 8½" x 11", well printed instruction manual. This 32 page booklet contains 19 clear illustrations in addition to the schematic diagram and complete illustrated parts breakdown. As a further construction aid, 6 of the major assembly illustrations are duplicated in 15" x 20" wall chart form. With all of this assistance, it is indeed difficult to goof.

Good quality parts are used throughout the transmitter and packaging of the parts is geared to convenient assembly. Resistors are card mounted and are marked for ready selection. Other small parts are supplied in transparent plastic bags for easy identification. These features, along with the illustrated parts breakdown, detailed drawings and self-checking instructions make for rapid assembly by even the most inexperienced individual.

The schematic diagram of the T-60 transmitter is shown in Figure 1. The circuit consists of a 6HF8 triode section (V1A) operating as a Pierce crystal oscillator os as a VFO amplifier. The pentode section of the 6HF8 (V1B) is used as a buffer amplifier or frequency multiplier, depending on the band in use. An adjustable pi network tuned circuit is used to couple the buffer-multiplier stage to the grid of the 6DQ6B (V4) power amplifier stage. The plate of the 6DQ6B is shunt fed and a pi network used to provide the proper match between the high impedance plate circuit and the antenna. Antennas with impedances ranging between 40 and 600 ohms can be matched with this network. Figure 2 charts the frequency coverage of the transmitter along with the recommended crystal or external VFO frequencies for each band.

The metering circuit of the T-60 follows the trend established in several recent transmitters. A crystal diode, CR1, is used to rectify a portion of the RF present at the output of the antenna network. The filtered output of the diode is applied to the meter and a shunt resistor may be switched in to avoid off-scale deflection of the meter when feeding high impedance loads. The DRIVE TUNE, PLATE TUNE and LOAD controls are all adjusted for maximum meter deflection with the FUNCTION switch in the tune position. The switch is then thrown to the CW position and the controls peaked for maximum output. While this may appear to be a quick and dirty method of metering a 3 stage transmitter, it really works well and permits easy, accurate tuning by inexperienced operators.

Band (Meters)	Frequency of Crystal or VFO (MC)	Transmitter Freq. Range (MC)
80	3.5 to 4.0	3.5 to 4.0
40	7.0 to 7.3	7.0 to 7.3
20	7.0 to 7.175	14.0 to 14.35
15	7.0 to 7.150	21.0 to 21.45
10	7.0 to 7.425	28.0 to 29.7
6	8.334 to 9.0	50.0 to 54.0

The cathode circuits of the oscillator, buffer-multiplier and power amplifier stages are connected to the key jack. When the key is closed, these points are at ground potential. In the key-up condition, a 2.2K ohm resistor is inserted in the circuit. The cathode current of the 6DQ6B develops a bias voltage across the resistor which is sufficient to reduce the 6DQ6 plate and screen currents to a safe value and completely cut off the oscillator and buffer stages. This design feature reduces the voltage across the open key to a safe value and provides excellent keying characteristics. There is one disadvantage to this keying circuit. If an external VFO is used, it must run continuously and keying must be accomplished in the transmitter.

In the AM mode, a cascaded 12AX7 (V2) is used as a speech amplifier which drives the first section of the 6DR7 (V3) modulator stage. This section of the modulator is operated at zero bias and grid rectification of the applied audio signal occurs. This increase in bias causes the plate voltage to rise, varying with the modulating signal. The grid of the second section is connected to the plate of the input section and this positive voltage rise increases the cathode current, and thus the voltage, of the output stage. A portion of this voltage is applied to the 6DQ6B screen. This voltage rises with modulation and varies at an audio rate, modulating the screen of the rf output amplifier and increasing the average dc potential of the screen. In the TUNE position of the FUNCTION switch, reduced screen voltage is applied to the 6DQ6B and out of resonance plate current is reduced to a safe value.

The power supply is conventional and consists of a power transformer with plate and filament windings. A full wave voltage doubler circuit, using silicon rectifiers and an RC filter develops 440 volts dc for the plate and screen circuits.

The completed transmitter was bench tested, using an M. C. Jones Type 625 wattmeter as a 50 ohm load with the internal indicator used to measure power output on 6 meters. Since the directional coupler used in this instrument is frequency sensitive, a Hewlett-Packard 41 OB VTVM was used to measure the voltage across the load and power output computed for the other bands. PA stage input power was metered and, with the transmitter tuned for maximum output in accordance with the instructions, found to range between 63 watts on 80 meters and 76 watts on 10 meters. Using *active* crystals, CW power output ranged between 40 watts on 80 meters and 26 watts on 10 meters. Efficiency on 6 meters is of course greatly reduced since the PA is operating as a doubler. Measured power output on 6 meters was 13 watts with 80 watts input. It must be emphasized that these measurements were made by tuning in accordance with the instructions, letting the operating conditions fall as they would.

A 1000 cycle tone was applied to the microphone input and a scope connected to monitor the rf envelope. The gain control was advanced to the point where distortion was apparent. This occurred at between 90 and 100% modulation, depending on tuning and loading. Measured *peak* power output was roughly equal to the CW output for identical tuning and loading conditions.

On the air tests produced good results. No attempts were made to establish any DX records, the objective being to obtain critical reports on signal quality. Comments on the controlled carrier modulation system were typical. "Your audio quality is good, OM, but your carrier seems to be going up and down." Those operators familiar with controlled carrier AM signals gave good reports. Constructive, "on the air" help in finding the proper setting of the audio gain control was difficult to obtain. The proper point, verified by the scope, is just below the setting where audio distortion becomes noticeable.

There are very few complaints with the transmitter. The comments on the metering system can not be taken too seriously since the system works and works well. The reduced output on 6 meters is more serious. However, since 6 meter coverage is a bonus anyway, we can afford to be philosophical and not look a gift horse in the mouth. The writer has personal objection to the RCA phono jack used as the mike connector and it is suspected that many will change it to a type to fit their microphones.

All in all, the Knight T-60 is a very good buy. For the Novice, it is an ideal first transmitter and it is very attractive to the more experienced amateur as an emergency or standby unit. The rugged construction and simplicity of the unit make it probable that this little rig will be in service long after more sophisticated equipment is "down for maintenance."

. . . W4WKM

(W2NSD from page 4)

quite the same again toward the club. How many defeats will they take before they drop out? Not many. You say, "Good riddance." Maybe so, but if the executive committee had pre-solved the problems then these chaps might never have become needlers.

One lousy president can undo years of club building. It does the executive committee no good if the president is not on his toes and does not see what is coming when discussion starts to heat up. He should then refer the matter to the executive committee for presentation at the next meeting and quickly get on to other business. It is up to the president to maintain order during the meeting. He should have a sergeant-at-arms to separate youngsters who sit together and are occasionally more interested in each other than the meeting. He should stop the meeting entirely when attention wanders from the matters at hand and call for courtesy to the speaker. This also acts to push a dull speaker into the closing part of his speech.

While parliamentary procedure can sometimes slow things down, it is also a useful weapon in the hands of the president to beat down disturbances. The president should know the Rules-Of-Order cold and be able to flatten anyone with them.

From all of the preceeding it should be obvious that I view the business part of a club meeting as the most hazardous to the longevity of the club. Unfortunately, even if the business is done away with quickly and efficiently, this does not guarantee that a club is going to survive. I do feel that it is important enough so that no matter what else the club does it cannot be a really successful club with poorly run business meetings.

What else can you do? Well, while this has nothing to do with ham radio, you should consider the possibility of serving some food during the middle of the meeting or at the end. I prefer the middle for this keeps everyone around with nothing to do but munch and talk to each other. One of the important benefits of a club is in getting people together. When you remove the chow session you cut out most of the socializing of a club. Best food? Coffee and doughnuts or cider and doughnuts. A coffee urn is a good club investment A little cup by the urn for donations should pay for the upkeep on this ritual.

After coffee, call the club back to order and introduce the speaker for the night. The president should let the speaker know what time the club usually adjourns so he can plan his talk accordingly. The president should also make sure that the speaker has plenty of time to give his talk. It is certainly not fair to ask a chap to come and talk to the club and then turn the meeting over to him at 10:30 p.m. I

(Turn to page 89)

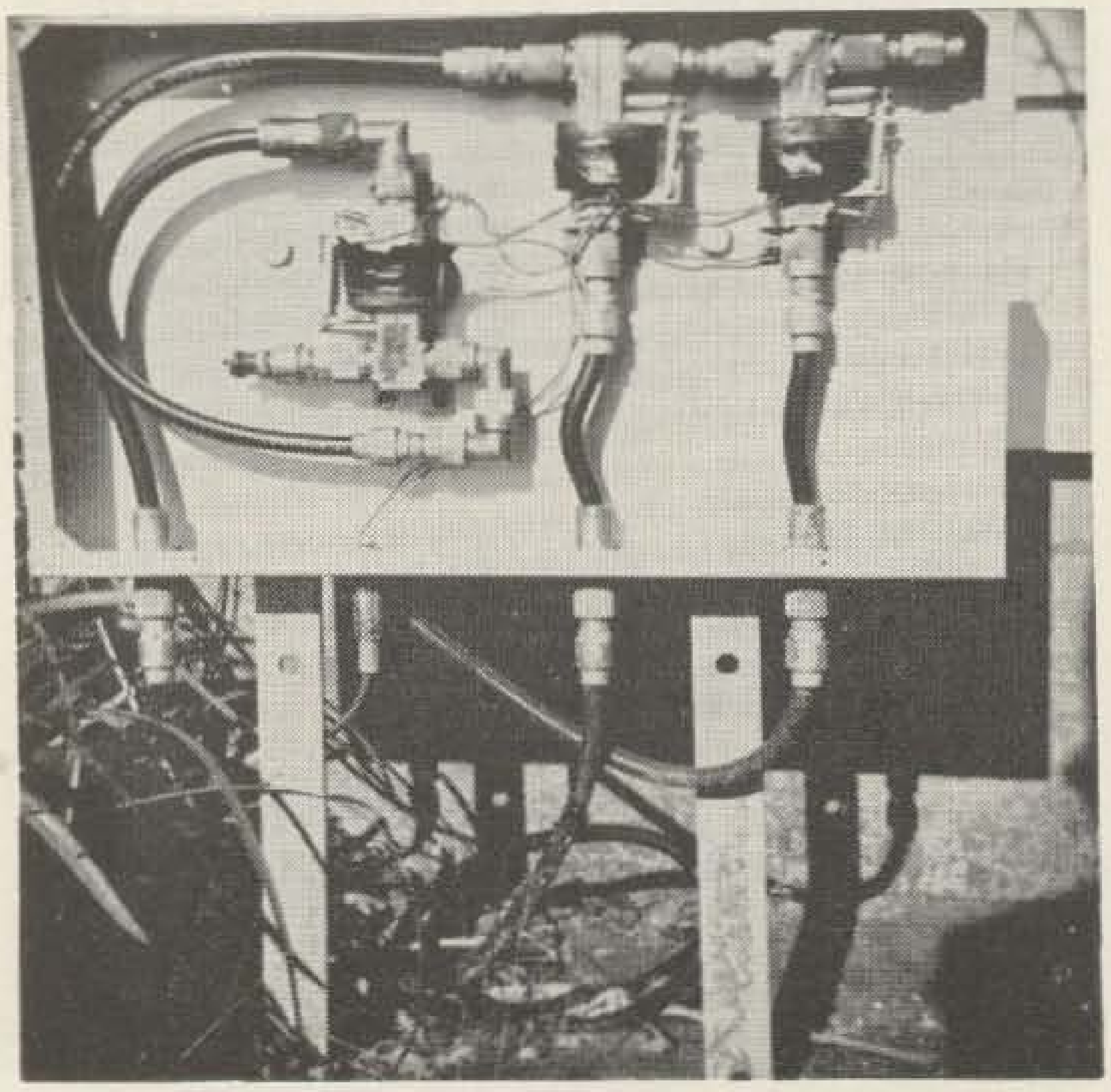
Antenna Protection and Switching Unit

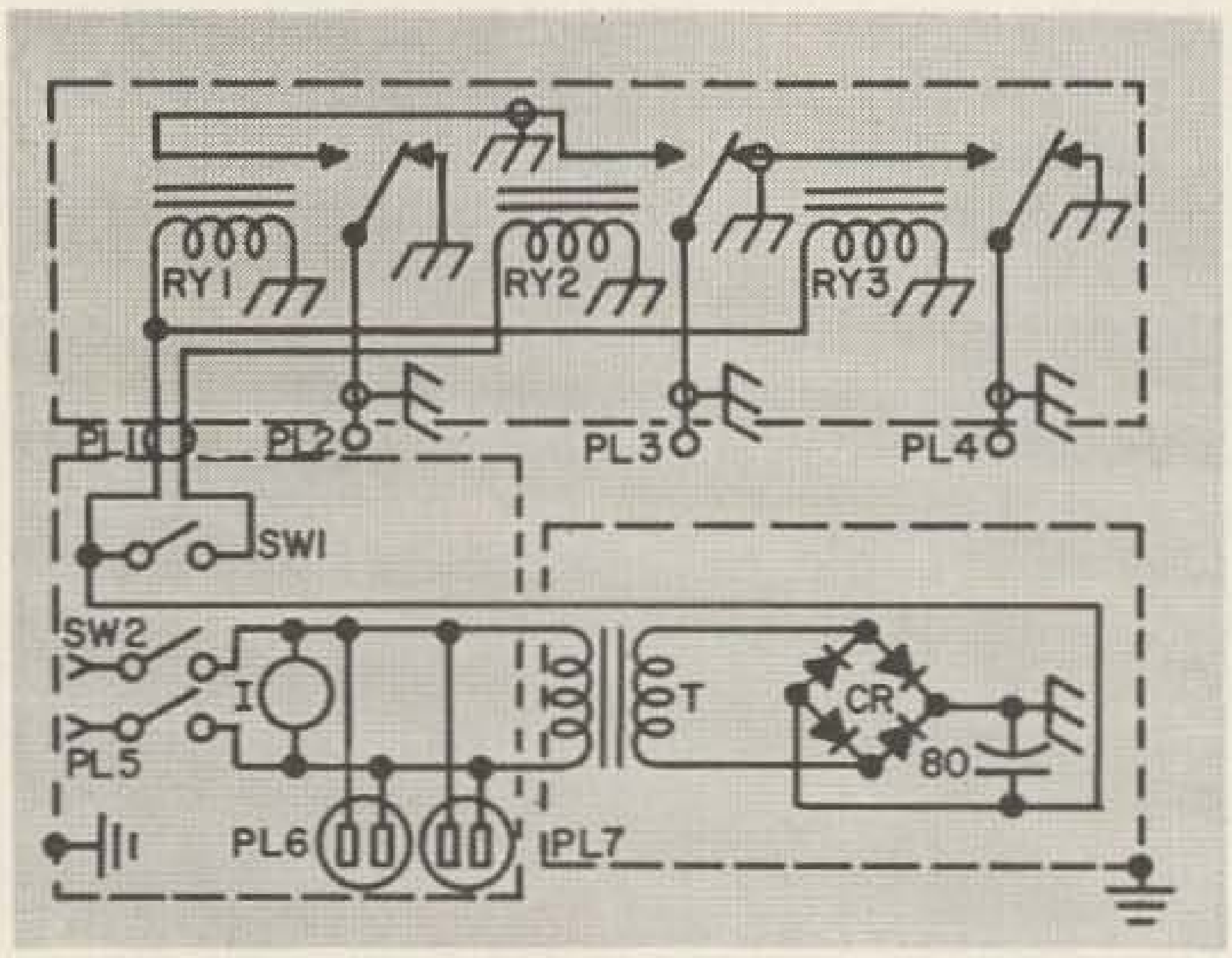
Carl Drumeller W5EHC
5824 N.W. 58th Street
Oklahoma City 12, Oklahoma

LIGHTNING protection for amateur radio antennas is nothing to be lightly regarded. Common sense dictates that no antenna installation should be without a fail-safe, neglect-proof system of ensuring that each and every antenna at the station is grounded whenever the station is closed. If such a protective system can be combined with an antenna selection system, so much the better.

This article describes just such a dual system. It provides toggle-switch selection between a trapped-doublet all-band flat-top and a tri-band rotary beam. At the same time, it provides automatic grounding of both antennas when the station receiver is turned off by a line-control switch. As a bonus item, it also ensures that one can never inadvertently leave the transmitter energized.

The heart of this system is a little box mounted outside the house. The box is grounded by its mounting legs, which are metal stakes driven into ever-moist earth. Three co-ax relays are mounted in this weather-proof box. Two of these relays are connected to the antennas and "normal" to ground. When energized, they lift the two antennas off ground and transfer them to the third relay. This third relay "normals" on the flat-top antenna, the most-used at this station, and selects the beam antenna when energized.





A heart is useless without a brain (a control center) to order its actions. The control center of this system is a 2" x 3" x 5¼" Mini-box containing two toggle switches, an over-size pilot light, and a terminal strip. One toggle switch controls the main 117-vac line serving the station; power for the relays, the station receiver, and the station transmitter all are taken from this 117-vac line. The other toggle switch merely controls the antenna-selector relay. The king-size pilot light, with a 117-volt, six-watt bulb, being across the station master power buss, provides an attention-demanding indication of a "live" position of the main-line toggle switch.

"Muscles" for the heart may come directly from the 117-vac line or, as in this case, from a 24-vdc power supply. The selection of 24-vdc for operation of relays was based solely upon the highly-important item of having three 24-volt relays available.

Construction is simple. The relays are mounted in a 10" x 2" x 17" chassis pan. A standard chassis bottom-plate provides an adequate cover, held on by self-tapping screws. As shown in the photograph, the relays are mounted in a rather unorthodox fashion dictated by the availability of connectors. It will be noted that two relays are joined by a male-to-male co-ax connector; therefore they are mounted closely together. The third relay sits off to itself; two right-angle connectors make possible its attachment to the center relay without a short-radius bend in the co-axial cable.

Along the bottom edge of the box are mounted three co-ax feed-through connectors and a two-prong chassis connector for the control lines.

Shorts for grounding the "normal" positions of two relays are made from male connectors with a very short piece of co-ax cable attached; the inner and outer conductors of the cable are soldered together.

As indicated in the schematic diagram, wiring is simple and needs no special explanations or precautions.

Operation of this system has proved satisfactory in all respects. About the only refinement that could be desired would be an interlock circuit that would inhibit the selection of the 10-15-20 meter beam when the transmitter was tuned to 40 or 80 . . . but that would be asking for egg in one's beer! . . . W5EHC

Rl_1, Rl_2, and Rl_3: 28-vdc SPDT coax relay
Pl_1: Female 2-prong chassis receptacle for control circuits, with plug
Pl_2: Female coax chassis receptacle for beam antenna
Pl_3: Female coax chassis receptacle for coax to Send-Receive relay
Pl_4: Female coax chassis receptacle for trapped doublet antenna
Pl_5: Male chassis plug for 117-vac input
Pl_6: Female chassis receptacle for 117-vac to receiver
Pl_7: Female chassis receptacle for 117-vac to transmitter
CR: Full-wave bridge rectifier for 28 v, 2 A
T: Transformer, 117 v to 28 v
I: Dial light, 117 v, 6 w
Sw_1: SPST switch for antenna selection
Sw_2: DPST switch for ungrounding antennas and powering receiver and transmitter

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Kit HX-10 . . . no money down, as low as $22 mo.... **$334.95**

SPECIFICATIONS—Emission: SSB (upper or lower sideband), CW, AM and FSK. **Power input:** 180 watts PEP—SSB and CW, 75 watts AM. **Output impedance:** 50 to 75 ohms with not more than approximately 2:1 SWR. **Frequency range: (MC:)** 3.5 to 4.1; 6.9 to 7.5; 13.9 to 14.5; 20.9 to 21.5; 27.9 to 28.5; 28.5 to 29.1; 29.1 to 29.7. **Frequency stability:** within 100 cps, overall. **Carrier suppression:** 50 db below peak output. **Unwanted sideband suppression:** 55 db below peak output. **Keying characteristics:** Break-in CW provided by operating VOX from a keyed tone using grid-block keying. **Audio output:** High impedance microphone. **Audio frequency response:** 400 to 3000 cps at ±3 db. **Power requirements:** OFF 4 watts; STANDBY—200 watts; KEY DOWN—400 watts at 117 volts, 50/60 cycles AC. **Cabinet size:** 19" W x 11⅝" H x 16" D.

A FEW OF THE 32 FEATURES THAT MAKE THE MARAUDER AN AMAZING BUY!

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- 165 to 1 gear drive tuning assembly
- Air-cooled, shielded final amplifier

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Kit HX-20, 19 lbs., no money down, $19 mo. . . **$199.95**

GH-12: Microphone illustrated **$6.95**

SPECIFICATIONS—Types of emission: SSB (Upper or lower) and CW. **Power input:** 90 watts PEP, SSB and CW. **Output impedance:** 50 to 75 ohms with not more than approx. 2:1 SWR. **Frequency range** (MC): 3.5 to 4; 7.0 to 7.5; 14.0 to 14.5; 21.0 to 21.5; 28.0 to 29.5 (using crystals furnished; extra crystal required for 29.5 to 29.7 MC). **Frequency stability:** Overall frequency stability within 100 CPS after warmup. **Carrier suppression:** 50 DB below peak output. **Unwanted sideband suppression:** 55 DB below peak output. **Keying characteristics:** Grid block keying throughout. **Audio input:** High impedance microphone. **Power requirements:** 6.3 V at 8 amps. or 12.6 V at 4 amps.;—125 volts 20 milliamps; 300 volts 100 milliamps; 600 volts 130 milliamps (uses Heath HP-20 or HP-10 power supplies). **Cabinet size:** 12¼" W x 6¼" H x 9¾" D.

Heathkit HR-20 SSB MOBILE RECEIVER

• Modern 8-tube superhet circuit • Tunes SSB, AM & CW signals—80 through 10 meters • Crystal I. F. bandpass filter • Crystal controlled BFO's for selectable sideband reception • Built-in calibrated "S" meter • 30-1 gear drive tuning • Fast or slow AVC selection • Series noise limiter

Kit HR-20 . . . 17 lbs.
no money down, $13 mo. **$134.50**

SPECIFICATIONS—Frequency range: 80 thru 10 meters in 5 bands-3.5 to 4.0; 7.0 to 7.3; 14.0 to 14.35; 21.0 to 21.5; 28.0 to 29.7 MC. **Intermediate frequency filter:** Center frequency, 3.0 MC; Bandwidth at −6 db, 3.0 KC; Bandwidth at −60 db, 10.0 KC Max.; Hermetically sealed. **Panel controls:** Sideband Select; R.F. gain; A.F. gain—Off—On; Noise Limiter; AVC select; main tuning; band switch; antenna trimmer; SSB, CW-AM switch. **Signal-to-noise ratio:** 10 db at 1 microvolt or less. **Output impedance:** 500 ohms and 8 ohms. **Power requirements:** 6.3 V at 8 amps. or 12.6 V at 4 amps. AC or DC. 300 volts DC at 120 MA. (Uses Heathkit HP-10 or HP-20 power supplies). **Cabinet size:** 6¼" H x 12¼" W x 19¾" D.

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"Is Marconi Like Spaghetti, Daddy?"

Mrs. Sylvia Margolis (XL-G3NMR)
95 Collinwood Gardens
Tilford, Essex, England

"HONEY," asked the dreamboat DL on leave in London, "did he use the potentiometer system of bias stabilization?"

"Honey," I replied, wondering why Englishmen could never make a question like that sound sexy, "maybe he did, maybe he didn't—I wouldn't know. But I do know how to make perfect coffee!" And in a British house that's saying something.

This is no ordinary amateur radio establishment. Our motto is "If you can't work the DX, then invite them!" And with the h.f. bands in the condition they have been for the past year or so, our DX score is mounting fast. When Loverboy works a remote station he isn't satisfied just to talk to them. "Any time you're in London," he burbles, "drop in."

And they do. From France and British Guiana, from America and Australia, from Switzerland and Kenya, they come with their wives, children, girl-friends. Only our blessed quarantine laws prevent their bringing their dogs too. Operation DX Guest has now become routine in our house. My younger son is so tired of giving up his room to visitors that he can't wait to take his own license and spring a nice surprise on some unsuspecting XYL in Paraguay. True the household has become geared to these little incidents. One night we were out at a theatre and I phoned home to make sure that the babysitter had put the kids to bed—and not vice versa—and she said a Chinese gentleman had called. She had given him a meal and should she put him to bed too. Another freezing, pouring night—in July—an SM5 knocked at our door at 11:30 to say he had been told by his local radio club that this was a hotel. Period.

The first thing I do in these cases is to find out whether the client has any food preferences. Embarrassing situations arise, like the day I served roast beef to find that the visitor was a practicing Hindu. I once asked a VP8 whether he ate everything and he replied that he was allergic to eggs. He could only eat penguin eggs. A maratime mobile K2 used to call my husband from mid-Channel to tell him to put the beer on ice. He knew his Britain. A wandering K6, who claimed to be on vacation in London doing an overseas Kinsey report, taught me to cook paella. He had perfected this recipe whilst on top of an 11,000 ft. mountain, with a YA1 call. My electric range was hotter than the dried dung fire on which he had experimented—or perhaps the essential part of the recipe was the chunks of dried yak—but it appears the resultant goo wasn't quite up to Afghan standards.

A knowledge of languages is a great help with these customers. We can cope with French, German, Italian, Polish, Russian and American. We speak no Spanish. Came a YV1, all eager to "make a nice QSO with Caracas." How to explain to him, with his four words of English, that British regulations forbid any other than a licensed G to speak over the rig? He made a polite show of understanding, but I know he left convinced that George Washington knew what he was doing in 1776.

We throw a party at the drop of a hat. One night a man phoned to say we were breaking through on his TV. I went cautiously into the TVI-coping spiel with expressions of guarded regret, then thought to enquire where he was located. Bronx. Within an hour we had rounded up the local radio population and had us a party which lasted until 2 a.m. and confirmed the neighbours' opinion that we are all nuts.

Naturally visiting amateurs evince great interest in the rig. I don't know a dishwasher from an 813, but I look after the clerical side of the station. For this purpose I have evolved an index system which I can say, with true British understatement, is the finest I know. I was trained to keep records in the best school in the world—the British Foreign Office, where we had to produce documents thirty years old on seconds of demand. Certainly our index doesn't carry such weighty information as what Clemenceau said in 1917 to Wilson, but we love it just the same. Certain items appear which could not be said to be strictly technical. One K4 is known as "Old Rumleguts." A DXCC (twice over) with whom we had personal, perhaps too personal, contact is described as "Wandering Hands." An XYL in California is listed as "Swell Dish" —well surely Loverboy is entitled to get *some* pleasure out of amateur radio!

The visiting amateur, bemused with all this efficiency, often turns to his wife and says "Why can't you do something like this, Doll-Baby?" Doll-Baby is non-commital — merely turns her strontium-loaded glare on my inno-

The coffee business demonstrates just how amateur radio can change your life. I now know three different ways to make coffee—French, American and Turkish. That, in itself, shows the miserable depths to which we have plunged, for there is something frightfully un-

British, almost caddish, about coffee. But a Canadian guest, with that charming frankness which permits the VE's to insult you and yet leave you smiling, suggested that my coffee, which I had offered him only as an international compliment anyway, might possibly be the cause of another Boston Teaparty. He had a can of coffee sent from Montreal, told me where to buy it in London, stood over me whilst I concocted the brew to his liking and now appears regularly to do spot checks.

There was the WI whom we were taking to London Airport with his wife after they had spent some days with us. I stopped the car and bought a bunch of roses for Alice, thinking how wonderful it was that these same flowers would decorate their table that night back in Boston, Mass. Next week he told us that they had the devil of a job getting the roses through the Boston Customs because the Officer had found a louse on one of the blooms. That was one louse less in London.

One weekend we had two VK's staying with us. My elder son had been miserable for the previous week and blossomed forth that morning covered with little red spots. I phoned the doctor, who came straight round. I opened the door, said "Sh-h-h," and sent him up to the patient. Ten minutes later he came down, announcing triumphantly that it was measles. He was sh-h-h-d once more by an unimpressed mother, a pair of large and ecstatic Australians and a most disinterested father who had just got a 5-9 report from a VR1 and was utterly detached from trivia such as anti-biotic and linctuses. The doctor left the house suitably abashed, having learnt things that never appeared in any Materia Medica.

All our visitors teach us how to live. We patiently bear the criticisms of our small cars, expensive gasoline, our plumbing, damp climate, terrible coffee, ubiquitous tea, socialized medicine, privileged aristocracy, narrow roads and 150 watt maximum power allowance. Then we carry on blithely, until the next batch of DX arrives.

Faithful, Long Lasting Signal Booster

Joe Smith W9ZDN
719 Jordan Street
Jacksonville, Illinois

ARE your finances just now limiting you to small communications receiver which has no rf amplifier stage and, as a consequence, no rf signal amplification? Are you a relative newcomer on todays Novice bands with the usual beginner's S-38, NC 54, Heathkit AR-3, or similar small amateur band receiver? Would you like to boost those incoming signals quite considerably for "Q-5" copy even during many periods of normally weak signal periods? Well, my friend, then this little signal booster will do the job.

This booster is the latest version now in use at the W9ZDN ham shack. It is used, in conjunction with an antenna tuner, ahead of a rather gray haired model S-38 Hallicrafters receiver, together with a "Poor Man's Q-Multiplier" (QST March 1960—p. 46). With this combination, I can hear stations my little 40 watt fone rig can reach! The signal gain and improvement of the signal-to-noise ratio when used with a small receiver must be heard to be believed!

The original model of this signal booster came into being ten years ago. Almost daily use has required only the replacement of the 6AK5 rf tube itself!

The Booster is simplicity in itself, consisting of a tuned grid circuit utilizing plug-in type coils, a high gain pentode rf amplifier tube, and a choke—capacitance type coupling into the antenna terminals of the receiver. The built-in power supply is a conventional half-wave selenium rectifier type supply that is well filtered and isolated from the 117 volt line via an inexpensive power transformer.

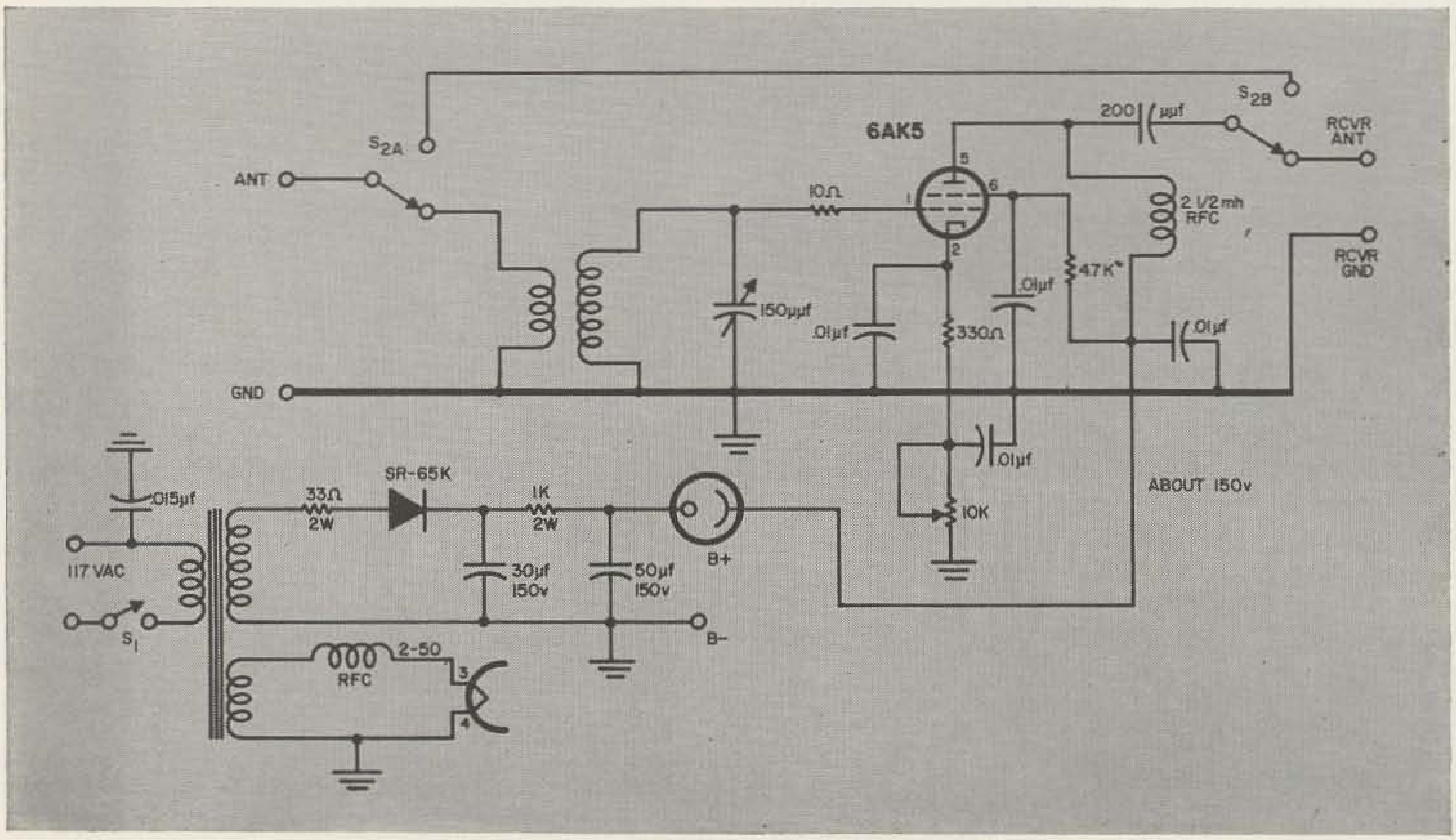
Construction

How do we build it you ask? Well, first off, make a PARTS LIST copy. Check through your spare parts of TESTED GOOD NEW AND USED PARTS. Don't use any questionable parts here if you want good results! Check off parts on hand, and order or purchase the remainder. The fellow with a flat-looking budget can save money via armed forces surplus new parts or through some of the "Bargain" sections of several wholesale catalogues.

I used a 3" x 4" x 5" L.M.B. aluminum box for the chassis.

Mount all major parts as shown. Wire the simple half-wave power supply and check it over carefully, when you test it, the no load voltage should measure around 170 volts dc.

Now wire the rf amplifier section, keeping all leads as short as possible for best results on the higher bands. Be careful not to let



solder run down inside the 7-pin miniature tube socket!

When all is completed, connect the feedline from the antenna to the booster input terminals, and connect a suitable length of similar line from the output of the booster to the receiver antenna terminals. Then, with SW2 (bypass switch) in the bypass position, turn on receiver and tune in a signal in the normal manner. Our incoming signal at his time is bypassing the booster and going directly into the receiver. Now turn SW2 to the operate position and tune the booster for maximum signal strength. The cathode pot (10,000 ohms linear taper) is our rf gain control. That's all there is to it! Once the booster is tuned for maximum for say the middle of the band, it seldom will need be returned over that one band as such a booster's grid tank is rather broad tuning.

Parts List

Quantity	Item	Approx. Cost
1	10 ohm ½W resistor	.12
1	330 ohm ½W resistor	.12
1	4.7K ohm ½W resistor	.12
1	10K linier taper pot	.91
1	33 ohm 2W resistor	.24
1	1K 2W resistor	.24
3	.01 mfd 600V disc cap	.54
1	200 mfd 600V S.M. cap	.12
1	150 mfd APC variable cap	1.19
1	dual-section 30-50 mfd 150V filter cap	.49
1	.015 mfd tubular cap. 400V	.10
1	Selenium Rectifier SR-65	.47
1	2½Mh—50 ma Radio Freq. Choke	.30
2	Z-50 rf choke	.90
1	4-pin tube socket	.13
1	7-pin miniature tube socket	.23
1	S.P.S.T. toggle switch	.39
2	Two-Terminal strips—screw type	.12
1	D.P.D.T. toggle switch	.78
1	Power XFMR—Pri-117v ac. Sec-125v ac & 6.3v ac @ 3 amp	1.45
1	AC line cord with plug 6AK5 radio tube	.99
2	Knobs	.22
1	Aluminum 5" x 4" x 5" L.B.M. Box	1.41
	Total approx. cost	$11.48

Coil Data

A set of ready-wound I.C.A. coils cost $2.49 and cover from 160M through 10M. If you prefer to wind your own, four prong 1½" diameter ribbed coil forms cost about 51¢ each. Leave about ¼" between the primary and secondary windings.

Frequency Range	Grid Turns	Primary Turns	Winding Length
1800-2300 kc	82T—#28	16T—#30	1⅞"
2000-4500 kc	38T—#26	11T—#30	1⅝"
4000-9000 kc	18T—#24	6T—#30	1½"
7.3 -17 mc	9T—#16	5T—#30	1½"
15 -33 mc	3½T—#14	3T—#30	1"

Evolution of the Bug

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CONTRARY to present belief, the semi-automatic key is not a Twentieth Century invention, nor was it primarily intended as a speed key. The instrument was one of the many that were designed to either ease or prevent "telegraphers paralysis," or "glass arm," the occupational disease of the profession. This became a very real and serious threat to the operators almost as soon as the Telegraph industry was formed. As the work of the telegrapher increased into the tremendous output of anywhere from ten to eighteen thousand words in a single trick, it became apparent that something had to be done to ease the strain on the muscles of the wrist and arm. Quite often continuous operation with the hand keys could and did produce permanent disability.

All sorts of gadgets were tried and used by those who were afflicted, the so-called "sideswiper" being among the most popular forms since the horizontal action of this key produced less strain, and the effects were lessened.

By the 1880's, the first semi-automatic-type keys, or those that produced a series of self-made dots, appeared under the general name "Vibrating Keys." These were bulky, cumbersome instruments equipped with magnets to hold the vibrating portion, and each one required a pair of dry cell batteries to activate the magnets. Actually these batteries and magnets served still another purpose, they not only created the multiple dot action of the key, but were also used to overcome the line-lag that was present during the days of iron wire on the telegraph lines. They were inefficient, since there was either a very primitive damping action, or none at all.

Most of the operators, who took great pride in their daily output of many thousands of words, would have nothing to do with these instruments, and ranked them with the anathema of the wire fraternity, the "Plug," or poor operator, whom they referred to in the slang of the day as a "Bug." These keys were called "Bug's Keys" or fit only for a "Bug" to use; and "Bug" in the 80's meant much the same as the term "Lid" does now in the wire game, hinting at dubious ancestry.

The original meaning died out, as slang terms do, so that, by the turn of the century, "Bug" had become generic, designating any key that sent a string of dots, while the dashes were made manually.

In 1903, Horace Martin patented his first form of this key. Martin was concerned not only with producing an instrument that would make operating easier, but would also increase the sending speed. He was encouraged in this by the publisher, Walter Phillips, who was always looking for faster sending methods, and as many short-cuts as possible to increase output. Phillips held one half of the first Martin Patent Number 732,648.

While the 1903 Martin Patent is mainly an improvement of the earlier Vibrating keys, and still employed the battery-magnet action, it is interesting in that Martin saw the possibilities of utilizing many different forms of the vibrating action, and, included in his description every possible method. When the United Electric Company manufactured and sold the first of the "Martin Telegraphic Transmitters" they were making the only "legal bug." Legal, because Patent No. 732,468 completely closed

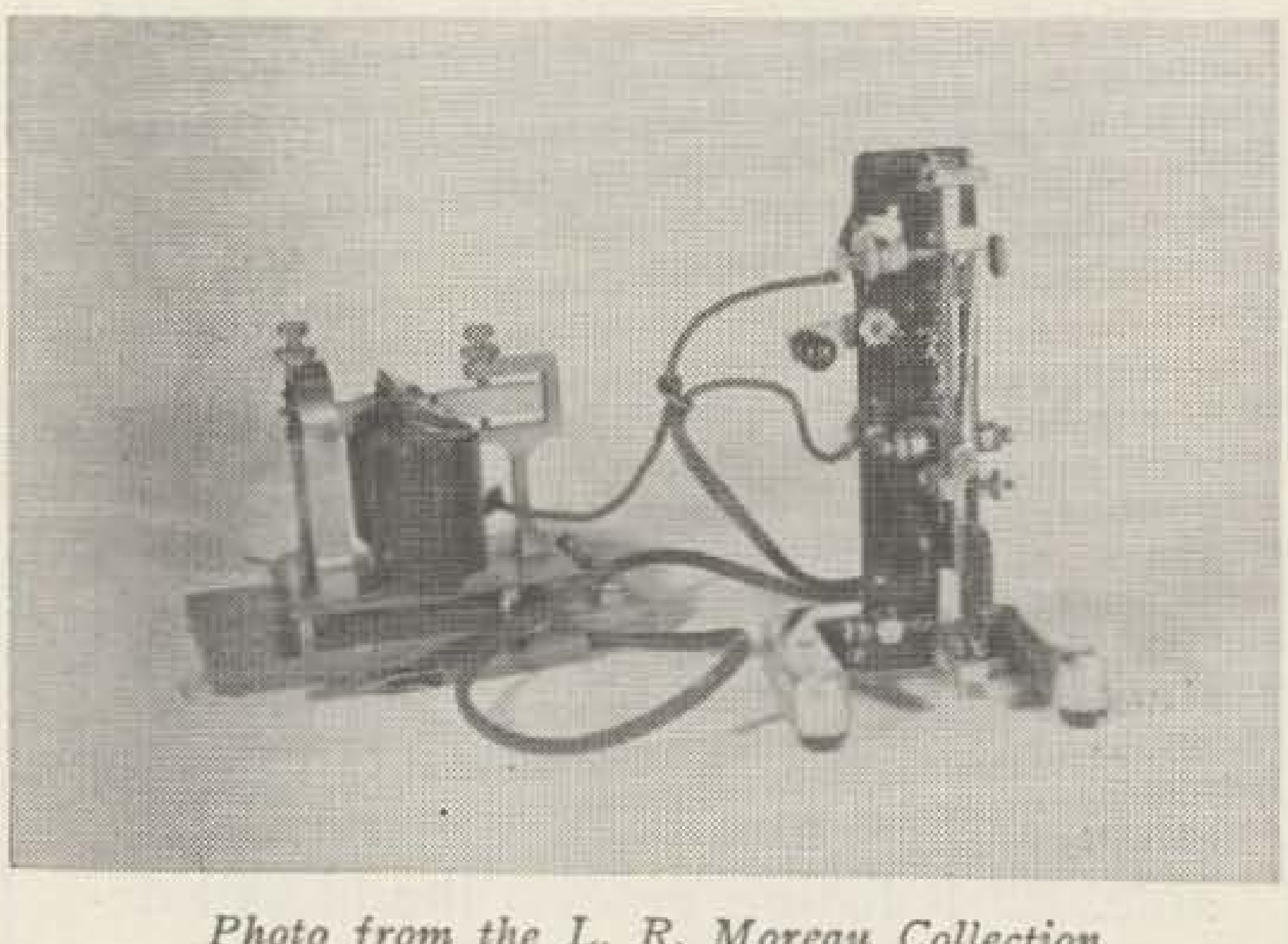
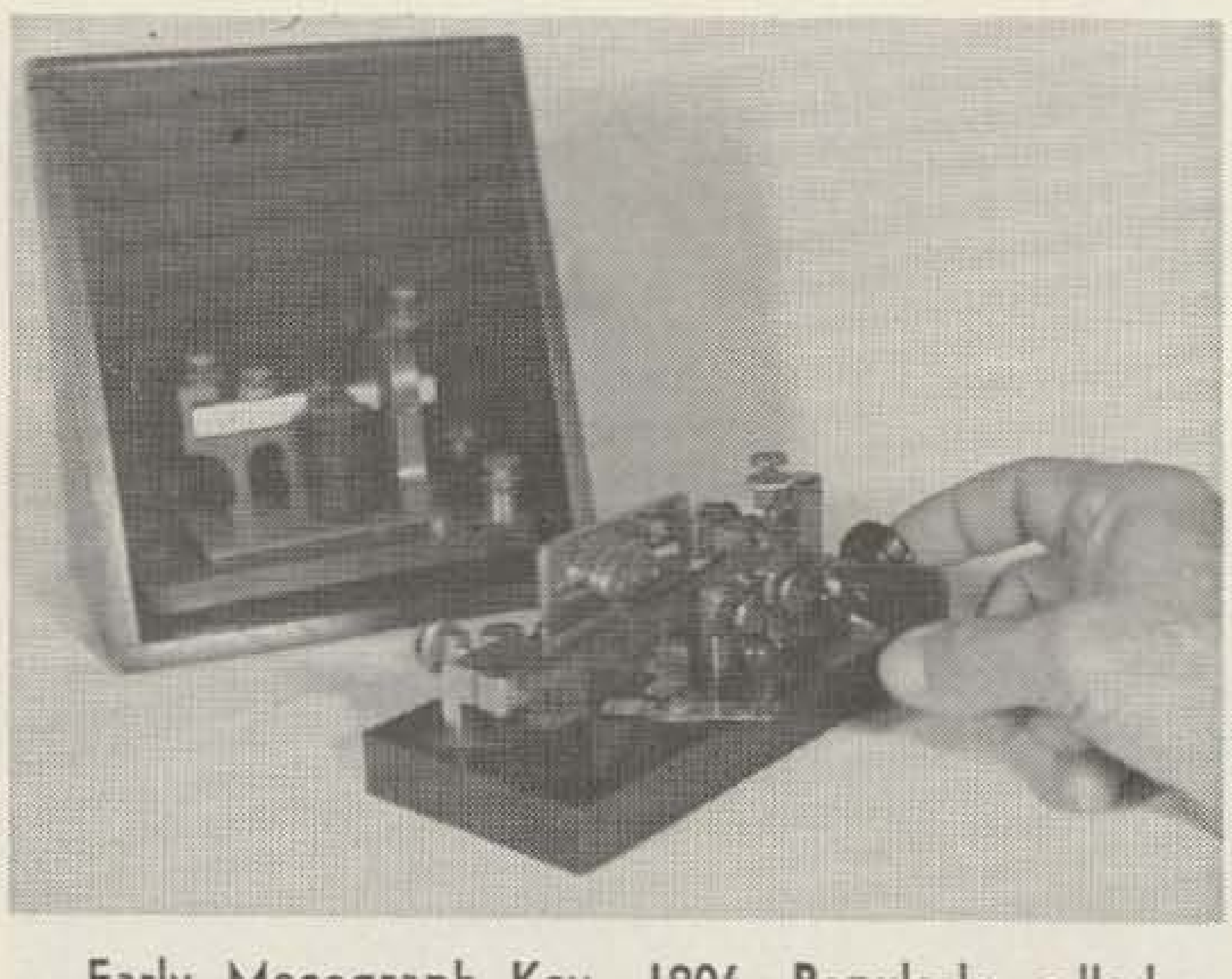
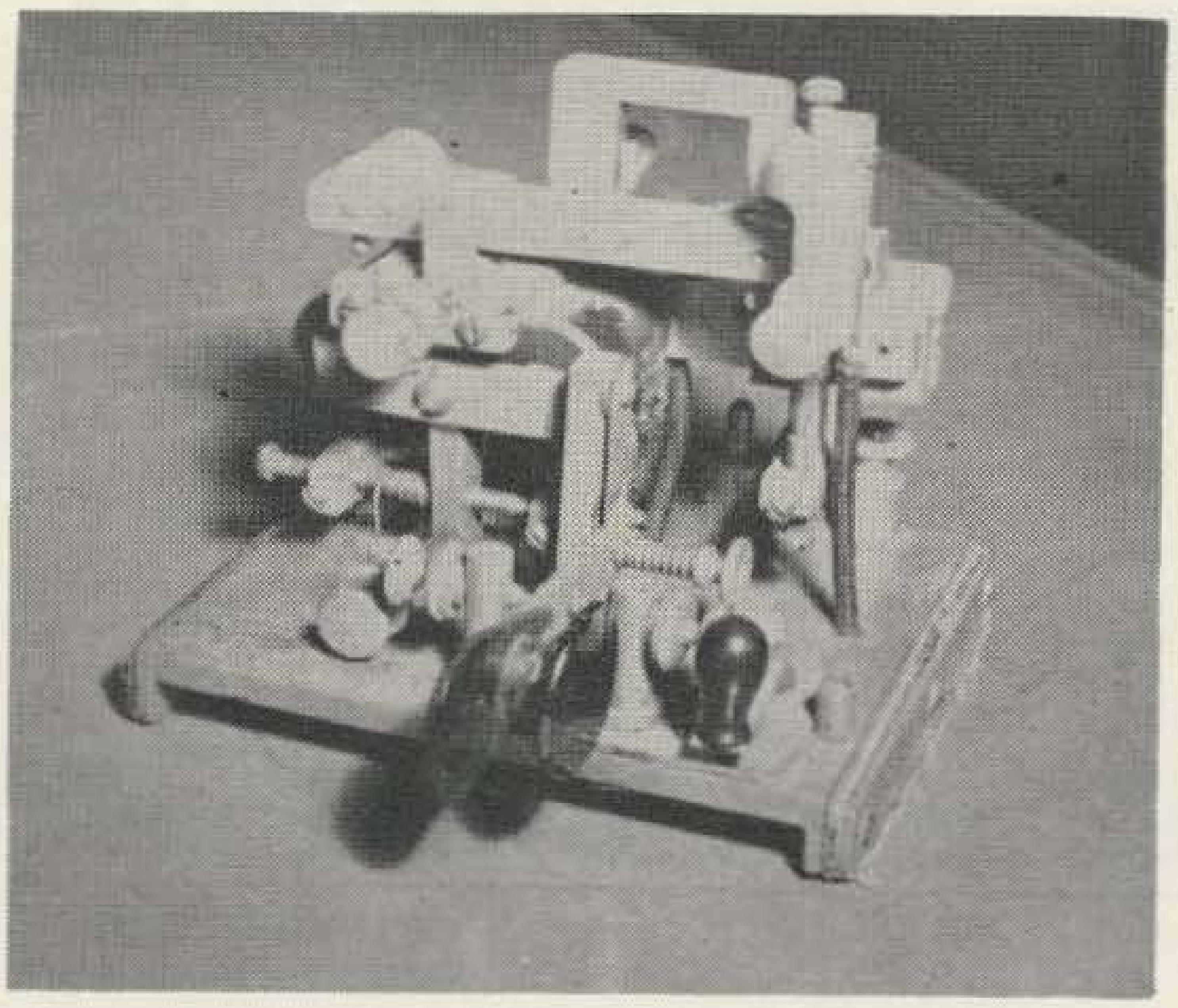


Photo from the L. R. Moreau Collection
Upright model Vibroplex, 1918. Known also as the "Wire Chief's Key," it was designed by H. G. Martin for use in crowded operating space.



Early Mecograph Key—1906. Popularly called "The Right Angle Bug" by telegraphers. This is the first of three models made by the Mecograph Company.



Martin Telegraphic Transmitter. This is the first of the Martin semi-automatic keys, produced in 1903, using a magnet and battery action. This is the ancestor of todays semi-automatic keys.

the field to anyone else. No matter what design the key took, or how it operated, it ran headlong into the Martin Key. William Albright, another telegrapher, joined Martin and the Vibroplex Keys, as we now know them, began to appear with a name plate reading:

The Vibroplex
Horace G. Martin's
Patent No. 732,648
Patent No. 767,303
Others Pending

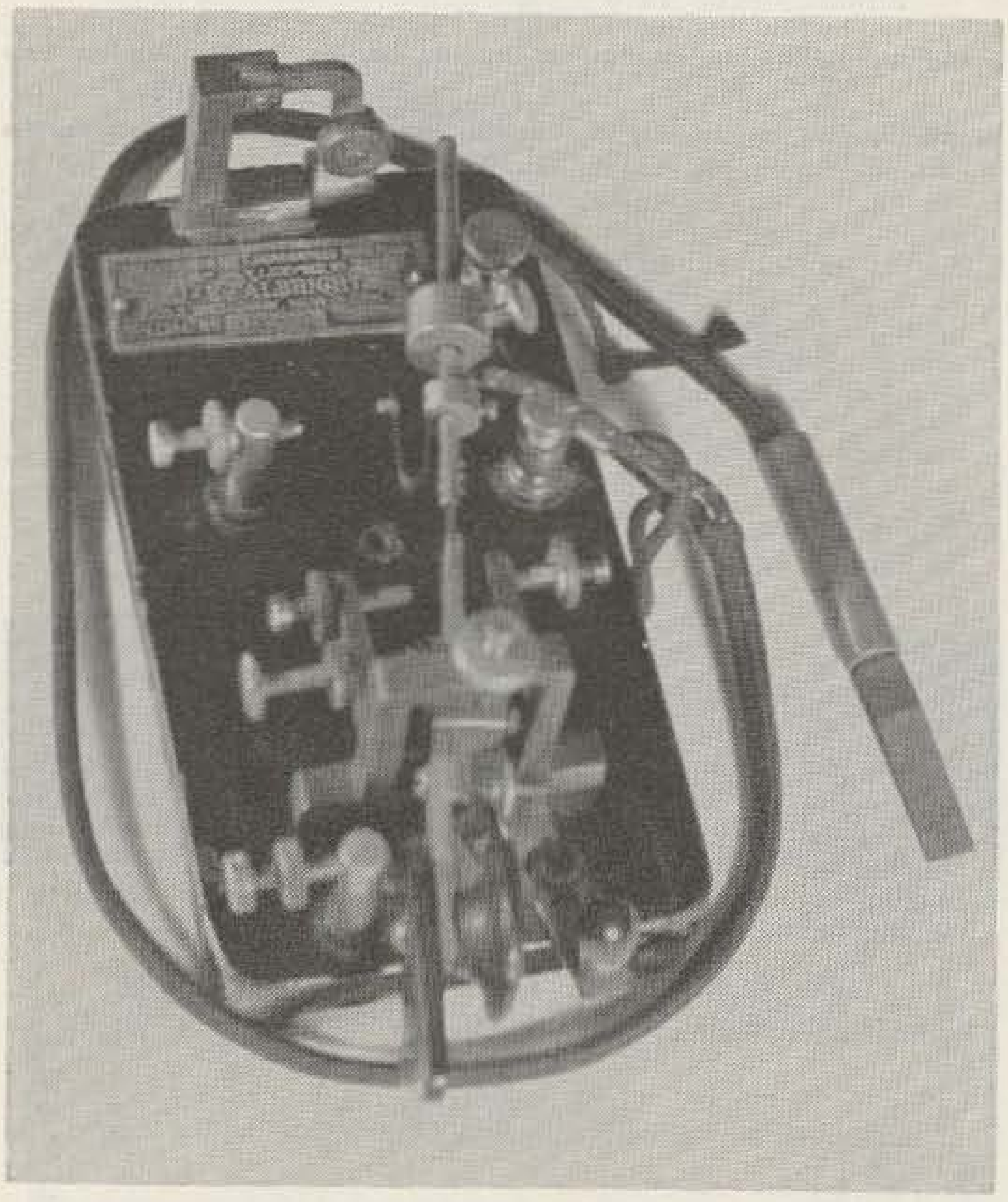
The batteries and magnets had been eliminated, and the famous Martin damping action had been added, and, in 1907, it was Martin who coined the phrase "Semi-Automatic" as a description of the action of the key.

When anything new, with plenty of sales appeal appears on the market, there is a rush to cash in on the golden shower of profits. Many independent companies appeared with what they hoped would be ways to get around Vibroplex. The Mecograph Company, of Cleveland, Ohio, produced three different kinds of "Right-Angle Bug," or the "Mecograph Key" that had the vibrating reed at right angles to the lever, and used a "release" rather than a pressure on the spring to make the dots. There were also key-wound, spring-driven instruments, and those with a pendulum action. There were even those with a dual-key arrangement, much like a Cable key whereby they were operated with a drumming, vertical movement of the fingers. But they all fell before the legal might of the Vibroplex Company and were forced to close.

At first the telegraph companies would not permit these keys to be used at all. Many operators objected to receiving on a wire where the sender was using a "bug" and refused to copy. But Albright was busy selling the companies on the efficiency and speed of the instrument. Now that the typewriter was being used more and more in the telegraph offices, the increased facility in receiving made it almost imperative to have a faster transmitting instrument.

Western Union, and Postal Telegraph finally agreed in the use of this key by the operators, but only if the instrument were set for a maximum of eleven dots per second. Some of the office managers insisted that the weight be soldered at this setting. This, of course, achieved a universal rate over all the wires.

With the acceptance of this instrument by the telegraph companies, the demand for it became even greater, and many independent manufacturers made a comfortable profit from the operators who wanted their own personal keys. However, these "Bootleg Bugs," or "Illegitimate Bugs" were not accepted for use by



"Albright License." This brass plate, attached to base of keys not accepted by the telegraph companies, authorized the use of the key by the operators.

either Western Union or the Postal Telegraph, who had an agreement with the Albright Company to use the Vibroplex, only. The operators protested, when they found that their favorite sending instrument could not be used just because it had been declared illegal by the Courts, when the keys they were using had proved to be efficient. So, a compromise was reached in the form of the so-called "Albright License," a metal plate attached to the base of their keys that read:

> This machine not guaranteed nor made
> but only licensed by
> J. E. ALBRIGHT
> 233 Broadway, New York
> Special No. ————

These plates were sold to the operators for two dollars, and once they were attached, the key was legally usable.

The semi-automatic key remained exclusively with the telegraph industry until CW appeared in the wireless field. The earlier wireless could not follow the fast dots, nor was the key itself designed to break the heavy primary current of "spark" transformers. A Bug, however, was used in 1909 on Wireless as an experiment by E. N. Pickerill, from the De Forest Wireless Station at Colorado Springs, by operating it through a Relay Key. This is the first recorded use of one of these keys for wireless telegraphy.

The name "Bug" is a copyright of the Vibroplex Company as is the little insect depicting a "lightening bug" on the name plate of the modern keys. The insect is contemporary, as is the copyright. However, the idea is as old as the keys themselves, for, in the early issues of the "Operator," the newspaper of the profession in the 1870's and 1880's, cartoons of the "Plugs" (those "lids" of the wire who broke with intent to interfere; used a busy wire to practice, or as one wit of the day described it "6ASTISE"; and generally made life miserable for the busy operators), quite often had a carefully sketched insect, much like a mosquito, inserted in the drawing. It does not appear in any other type of cartoon.

. . . W3WRE

Jim E. Thompson, Jr. W4THU
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Cure that Angry Band

Audio Selectivity: Your key to improved CW reception

Do you own one of the less expensive short wave receivers that makes an excellent showing in all respects—except selectivity? Do you always have trouble copying the other fellow because of QRM, and in many instances lose his signal altogether? This annoyance takes away from the enjoyment and pleasure of amateur radio. If this is your problem, the government has already solved your problem for you—both simply and cheaply. The cure for your selectivity problems is a filter which wears the tag: FL-8 Audio Filter.

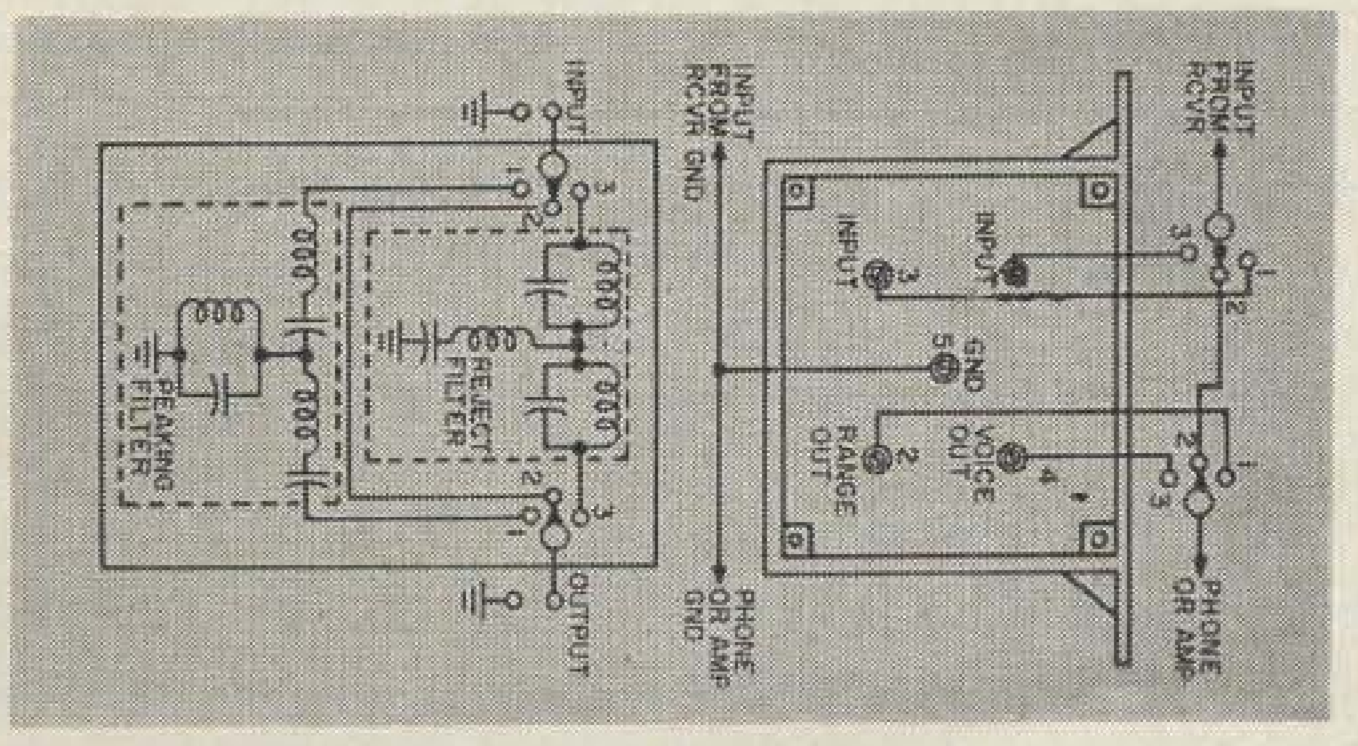
Audio filters, like all other types of external filters, have their disadvantages, but contribute many outstanding features. A list would include: no external power requirements, good selectivity, low cost and absolutely no internal connection to the receiver.

The filter unit is available from most large surplus stores. By the way, when ordering from any of the larger surplus stores, specify both the FL-8 and the FL-5F Audio Filters, and let them send the one which they have on hand at the time. Try to secure a FL-8 filter because it has built in "peak-null" switching. The price should be under five dollars for the FL-8 and under four dollars for the FL-5F.

Circuit wise, the filter consists of six L-C tuned circuits, tuned to a frequency of 1020 cycles. Three of the tuned circuits are devoted to the peaking function and the remaining three are used in the nulling circuits. The different functions are switch selected by a three position switch, marked: Range (peak), Null, and Both (filter off).

In operation the filter passes only those signals that beat with the BFO to produce a beat tone of 1020 cycles. As a result the filter "washes" out most of the QRM and QRN that are not audible at 1020 cycles. Thus the spectrum is relatively clear of all signals except for the 1020 cycle beat tone.

It might be well to say, here, that the filter



cannot be used on "fone" as a peaking filter because it is far too selective to pass voice intelligence, but can be useful in eliminating heterodynes.

There are many different uses for the filter, but the most simple is to use it just as a series fed filter and connect it to the output of the receiver via the headphone jack. Two methods of operation are listed here; both are equally effective.

The easiest way of producing high selectivity at the least possible cost is to insert the filter in series with the headphone line. Make sure that the wire from the receiver ground (chassis) goes to the filter ground and not to the filter input.

Insertion of the filter into the headphone line produces good results, but with one draw back: the filter presents attenuation to the filtered signal. During severe fading, the signal may become entirely inaudible because of the attenuation. This can be easily corrected with the use of an audio amplifier. This audio amplifier follows the filter so that it boosts the filter's output, resulting in gain instead of a loss. Any audio amplifier that you may have around the shack will do. I used a tape recorder. Be sure to use shielded cable to avoid hum. Speaker output can now be enjoyed, but if you like "cans" just hook them up to the output of your amplifier. You will probably need a .05 mfd condenser in series with the amplifier input to give dc isolation.

Modification of the FL-5F Filter

The function switch of the FL-8 filter can be easily added to the FL-5F. Obtain a three position double pole switch and wire it as shown in the diagram. This will allow you to select either: peak, null, or bypass.

To put the filter in operation, just plug the filter into the receiver headphone jack. Turn the filter's function switch to "Both" and turn on the receiver. The receiver should perform as usual. Now turn the filter's function switch to "Null" and tune across a strong CW signal. You will notice that there is one spot that seems to attenuate the signal to a very low level. This is the nulling and peaking frequency of the filter. Now that you have used the filter for nulling a signal, set the function

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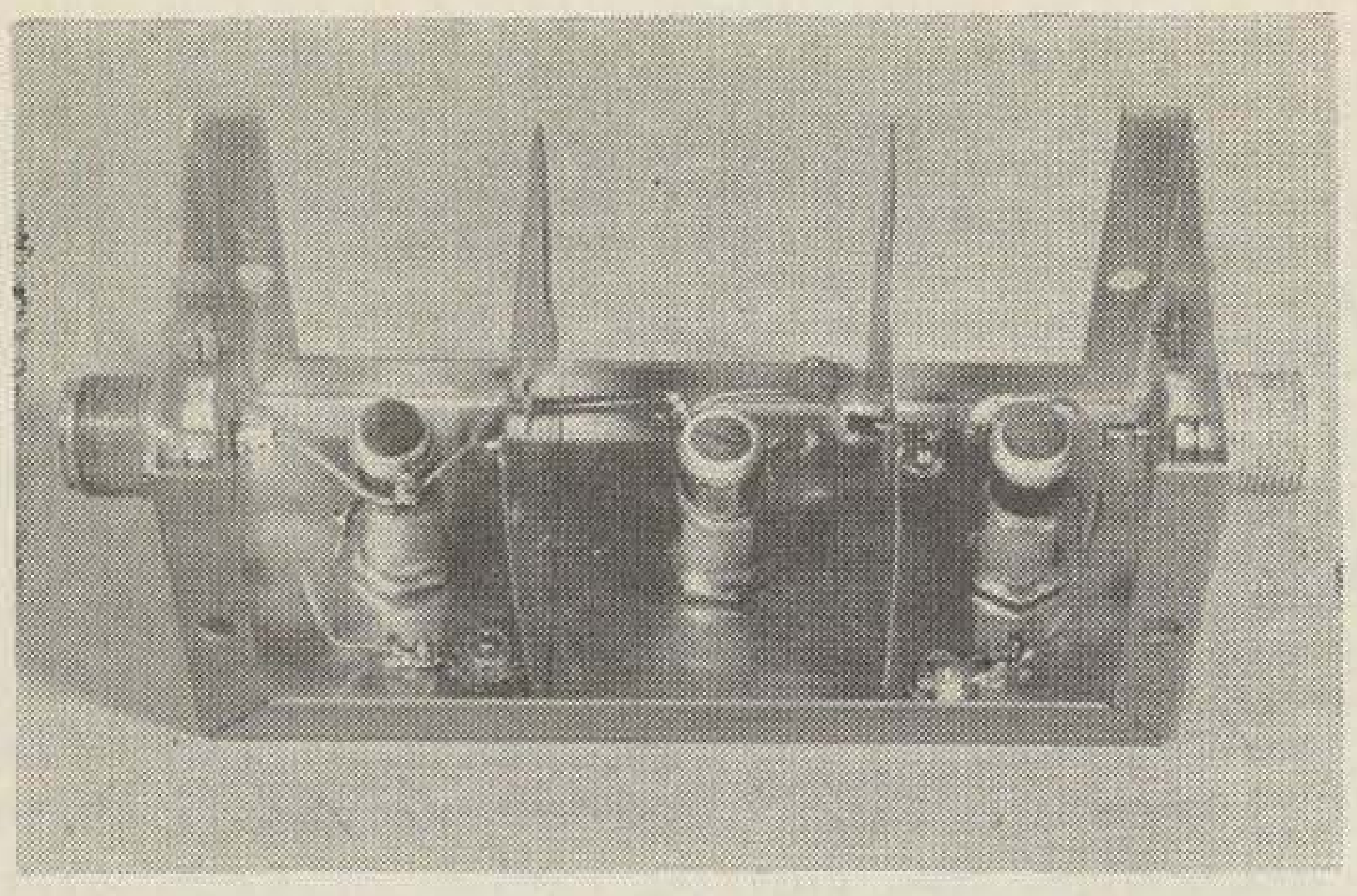

BCI in your QSO?

Allie C. Peed, Jr. K2DHA
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Rochester 20, N. Y.

Did you ever notice that most of the books and articles which treat with broadcast interference deal with the subject from the standpoint of interference by amateur transmitters to receivers operating in the broadcast band? But, the reverse situation can be a problem to urban hams who live fairly close to broadcast stations.

Take it from one who knows, this can be a problem of some magnitude too. I live within sight of the antennas of five local broadcast stations—not to mention two TV stations and a couple of FM stations. All of these are within a two mile radius of my QTH. From the initiation of operations from this location there were multiple appearances of broadcast signals of poor quality but good strength in the lower ham bands. The 160-meter band was blanketed and for all practical purposes totally unusable, 80-meters had about fifteen distinct places where strong BC "garbage" could be heard, and the 40-meter band had about six S-9 spots. However, I accepted these as my cross to bear and went about fitting my operating into those frequencies which were clear of the interference.

Then, recently, I installed a new antenna twice as long as my previous one and the ripe banana hit the fan! The BC interference became so strong that operating on 80-meters was impossible at any point, and better than half of the 40-meter fone band was occupied by a mushy omelette of several broadly tunable BC signals. Obviously something had to be done.

There is no need to recount at great length all of the empirical things that were tried in attempts to locate the source of the trouble. None of these did much more than give clues to areas of possible difficulty. In fact, the solution to the problem was greatly complicated by the fact that no single thing completely and clearly was the total source of the trouble!

First, it was noted that BCI was experienced in every audio amplifier in the shack (an intercom, a tape recorder, and a phono amp) when the lead-in from the new antenna was brought in through the wall and connected to the receiver (a Hallicrafters SX-101). This was first thought to be due to the fact that the RG-8U coax came through the wall and passed right by the Romax bringing the 110-volt ac power into the shack. Since Romax is unshielded, having as it does only the two power leads and a ground wire surrounded by insulation, it was decided to lessen the coupling between the power distribution system and the antenna. This was done by replacing all of the Romax with BX cable which is enclosed in a grounded metal sheath. This made some improvement in the strength of the BCI in the audio amplifiers, but had little effect on the strength of the interference in the ham bands.

Next, the grounding of the station equipment was investigated. It was the usual hurriedly installed temporary type which we had never gotten around to re-doing properly. It consisted of a ground clamp on a convenient cold water pipe. Then, as additional pieces of gear were added on the operating desk, they had been merely allowed to ground through their interconnecting leads or pieces of hook-up wire had been run from one chassis to another—a real mess.

(Continued from preceeding page)

switch to "Peak" and listen to the same signal. You should hear nothing but this one signal. Now tune up and down the band. There is quite a difference, isn't there.

The best method for tuning the desired signal is to tune the receiver in the "Both" position. When the desired signal is found, switch to "Null." Now very carefully tune the receiver until the signal is nulled out. Turn the filter to peak and you will have the signal tuned perfectly.

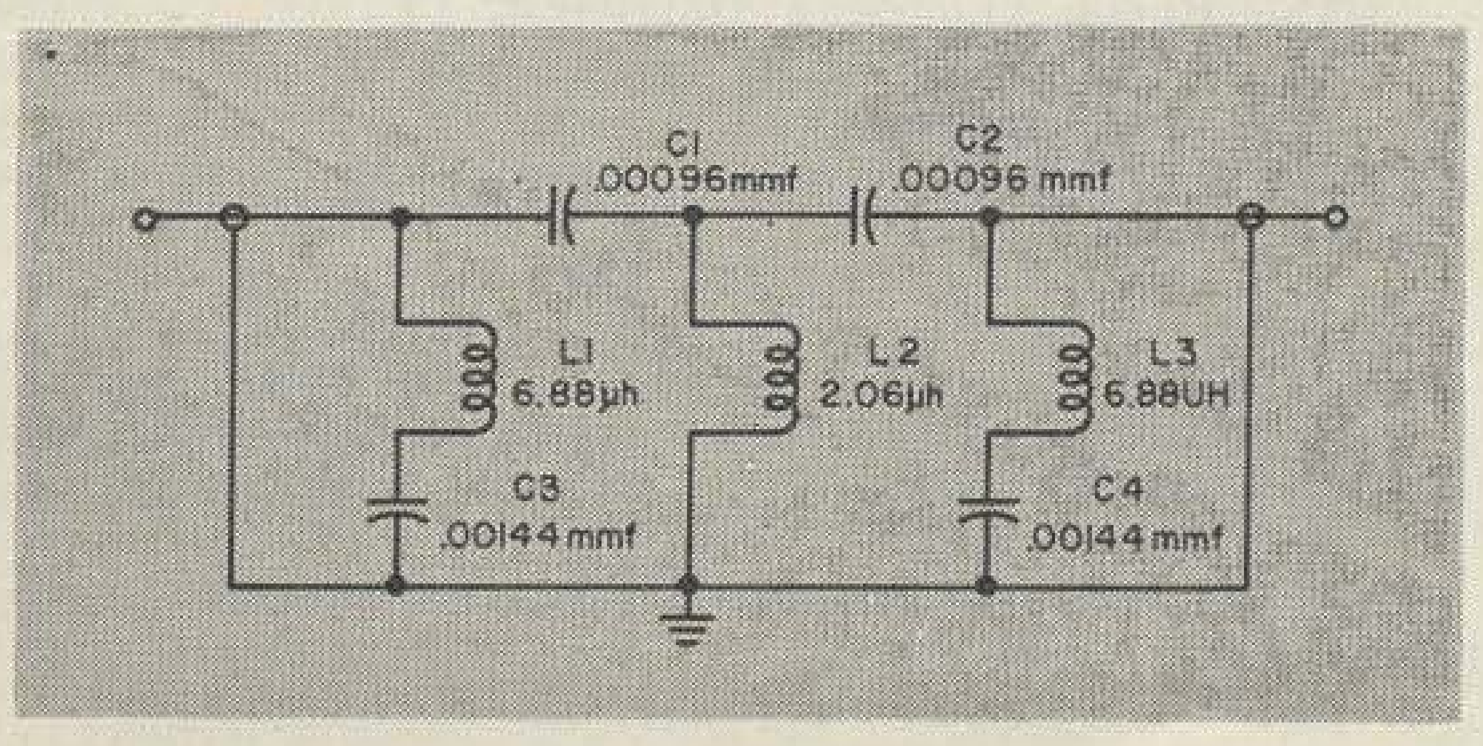
Well, there you have it. Five dollars and half an hour's work will surely be rewarded with improved reception. . . . W4THU

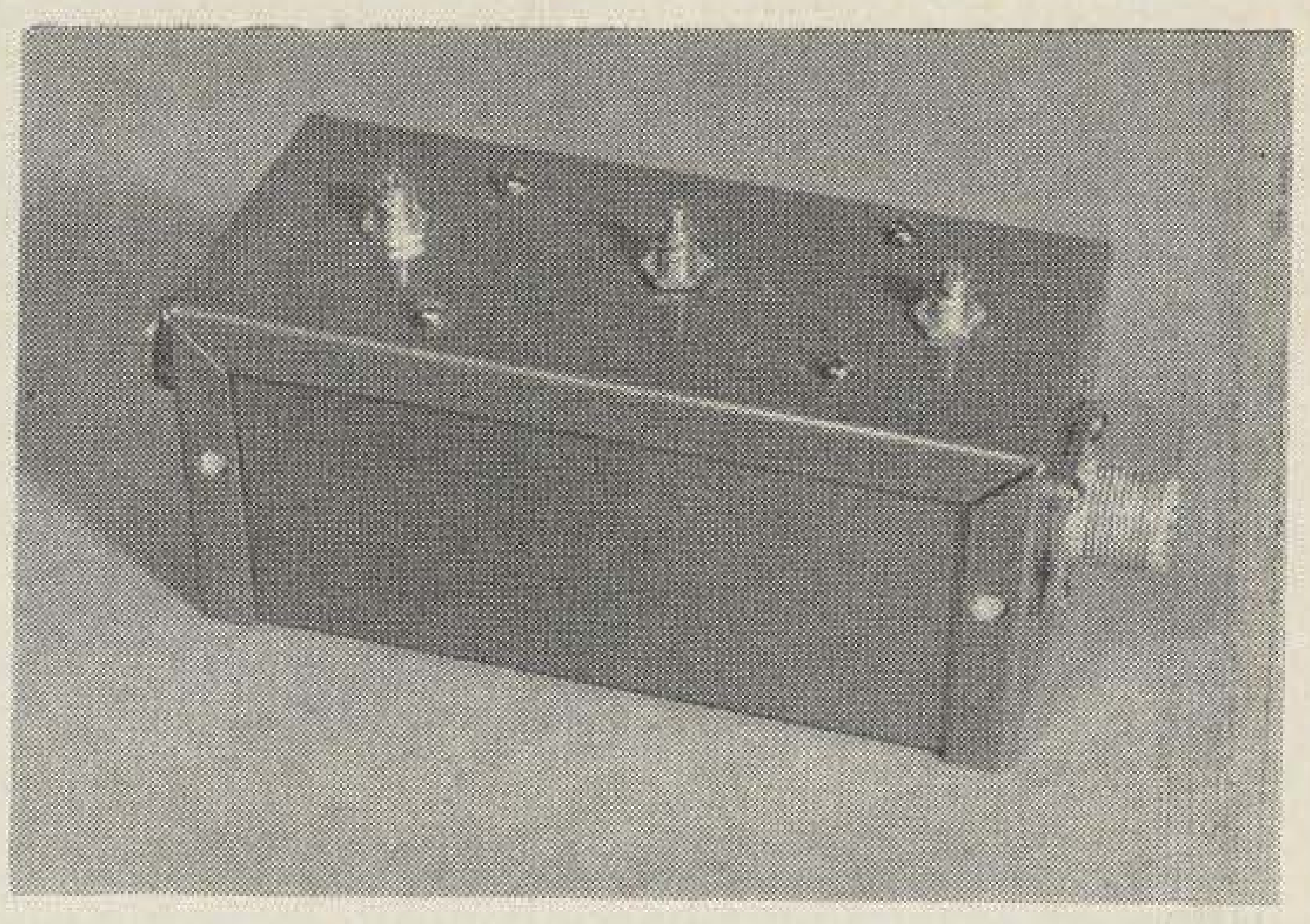
All of the old grounding was removed. Three of the copper plated steel ground rods sold for rf grounding purposes were obtained. These were driven down into the ground at three locations alongside the house about ten feet apart. They were all bonded together with #6 aluminum grounding wire and a flexible lead of #12 stranded copper was brought from this into the shack through the wall. This was run from grounding point to grounding point among the gear on the operating desk. Each point of connection was fitted with a copper plated lug of proper size crimped onto the wire and soldered thoroughly. This made some improvement in the BCI situation and also served to clear up some of the chassis which had previously had a tendency to "tickle" just a bit when they were touched with sweaty hands.

But, I still had BCI in the station receiver. It was improved noticeably over when I started, but was by no means reduced to a level which I could live with.

Next, I carefully measured and logged the frequency of each place where I had a recognizable BC signal. Then some trial additions of mathematical combinations of the local BC frequencies was tried and it was found that at every possible combination of sums of the local frequencies I could identify a mixture product. It became something of a game to add up combinations of local BC frequencies (including second harmonics) to predict the location of a phantom mixture product. I would then tune the receiver to this calculated frequency and invariably find my predicted phantom signal. Of course, this meant that I was getting mixing of the strong local signals in some non-linear element. The mixture products were being either re-radiated to the receiving system or being generated in the system itself.

The possibility of rectification and re-radiation external to the system was first investigated. I borrowed a portable battery operated communications receiver and tuned it to one of the stronger BC signals in the 80-meter band. In the shack it was as easy to find on this receiver as on the station receiver. But, when I went outside and started walking around, the signal became weaker. It could be found easily when the portable receiver was brought under the station antenna, or near the powerlines. This pointed the finger in the direction of the mixing taking place in the





station antenna or equipment. So, the investigation was pursued along these lines.

First, the antenna itself was inspected. Every solder joint was sweated. Every screw connection was "strapped" with braid and soldered. This was done just to be sure that no non-linear joints were present in the antenna system to allow mixing to take place. One particularly bad joint was found and cleaned up and this made a gratifying improvement in the BCI situation. While I was up on the roof the connections on the TV antenna were cleaned, tightened and given a coating of protective spray just to be sure that they weren't contributing to the trouble.

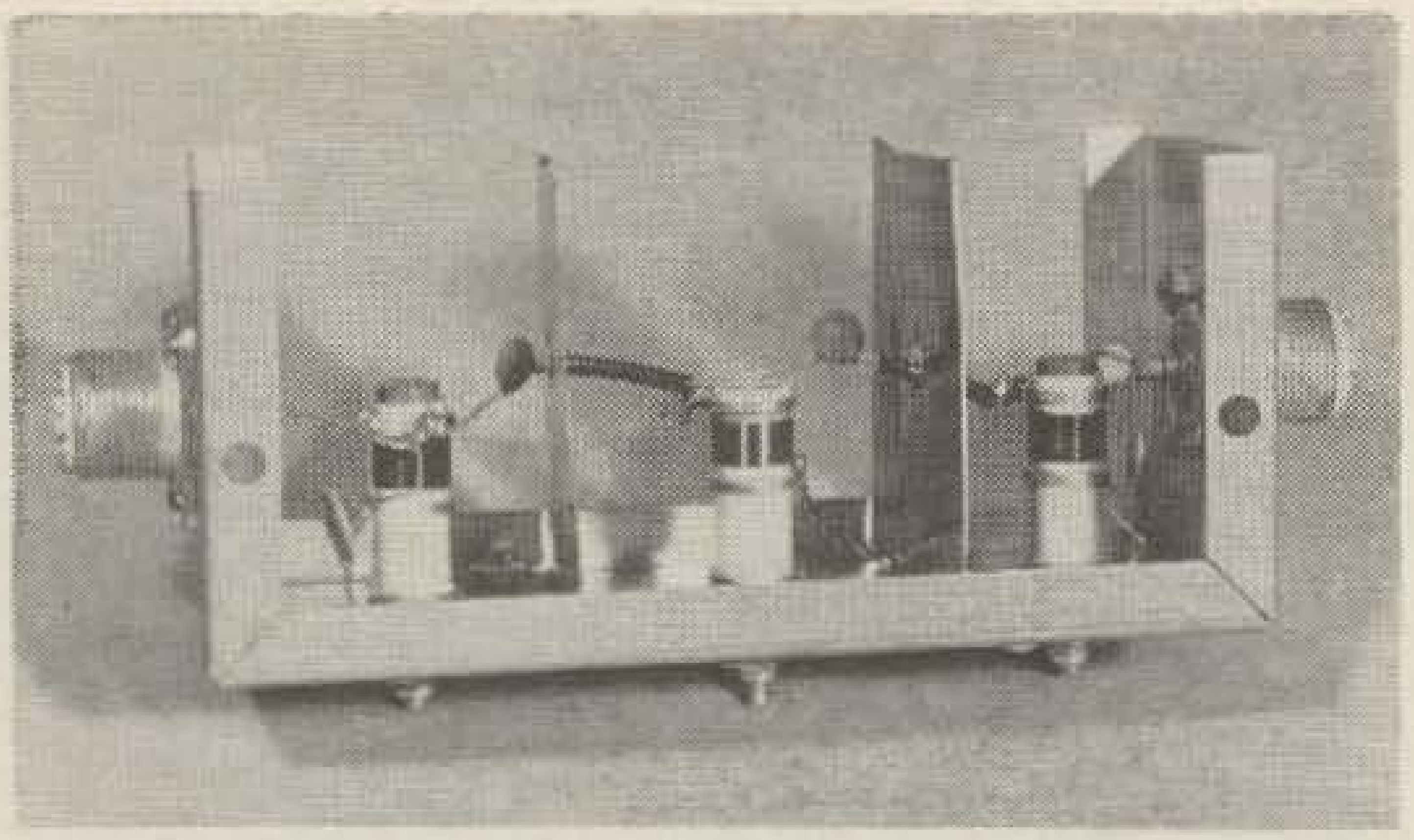
Next, the TR switch was suspected since these have a bad reputation when they are subjected to strong local signals. So, this was removed and replaced with a coax relay. Again some improvement was noted, but it was still possible to find a few of the stronger BC signals on both 80- and 40-meters.

The next assumption was that the mixing must be taking place in the rf amplifier and mixer stages of the station receiver as a result of their being overdriven by the strong BC signals. The best way to check this seemed to be to keep the BC signals out of the receiver front-end. So, for this purpose, a high-pass filter was indicated.

So, back to the textbooks. No need to go through the tedium of the calculations. End-sections, M-derived, T-configuration were chosen with a constant-K, T-configuration center-section. It was decided to have the filter cut-off at 2-megacycles which was well above the highest broadcast frequency. (If 160-meters had been a consideration, the cut-off frequency would have to have been moved down below 1.8-megacycles.)

Knowing that the filter was to work into a nominal 52-ohm coax line, and using the usual value of $m = 0.6$, a filter was designed by plugging these values into the bandbook formulas and turning the mathematical crank. These reduced to the values shown in the schematic accompanying this article.

Since the inductances required are rather small, it would be possible to wind them yourself or cut appropriate lengths from commer-



cially available coils such as the B&W Miniductors or the equivalent. However, in the interest of having some variation in inductance available for experimentation purposes, commercially available variable (slug-tuned) inductors were chosen (Miller 4400 series). The calculated capacity values were rounded slightly to those available in the standard disc ceramic type capacitors.

A Bud CU-2104-A aluminum Minibox (5 x 2¼ x 2¼") was chosen to house the filter, but any other convenient size would do as well. Two chassis-mounting coax fittings were obtained from the junk box, and the metal shields between sections of the filter were cut from a tin can.

Construction took about an hour and consisted of drilling holes to mount the coax connectors in the ends of the box, cutting the interstage shields to fit inside the box and bending a foot on them which was drilled for mounting inside the box. Then three holes for the three coils, and holes in each of the two shields for the series capacitor leads and the job was done except for mounting the components and soldering the connections.

The slugs in the coils were set at about the position in their travel which should give the desired inductance within the specified range of the particular coil. For example, where 6.9-microhenries was called for in the end-section coils, and the coil chosen had a range of 6.7- to 15-microhenries, the slug was adjusted almost to the end of its travel out of the coil for nearly minimum inductance. The center coil had its slug adjusted about a third of the way in by a similar reasoning process.

The filter was checked quickly after it was completed by using a signal generator and rf voltmeter. (It was terminated with 56-ohm carbon resistors for the check.) This revealed a rather nice roll-off in the vicinity of 2-megacycles and this dropped below the sensitivity of the meter by 1.6 mc. Some adjustment of the coil slugs was tried, but without much notable improvement in the filter performance. So, it was assumed that the original settings were good enough.

Of course, "proof of the pudding is in the eating." The antenna was unscrewed from the back of the receiver and the filter was connected into the coax line using a male-to-male coax fitting on the receiver side. The receiver had been tuned to the strongest of the BC signals before the antenna was removed. This signal measured 10-db over S-9. As soon as the filter was installed, this same signal had dropped to an S-3 on the meter—hardly noticeable above the noise level. The insertion loss on the amateur signals wasn't significant. Further checking of the 80- and 40-meter bands revealed that the last vestiges of the BC signals were hardly noticeable at any point. I now had the full band back in operation for ham purposes.

The conclusion was that there were several contributing factors to the BCI in the ham bands. Strong local BC signals were given an opportunity to mix due to conditions in the equipment lashup. By proper attention to all of these, the problem was effectively eliminated. It was a long hard process, but the results were worth it.

If the investigation with the portable receiver had revealed that the spurious BC signals were coming from some external rectification and re-radiation phenomenon in the locality, the problem would have been even more complex and its solution would probably have necessitated calling in the local utility company interference expert. Poor joints in the wires of the power system can act as rectifiers, and the attached power lines act as both antenna for reception and for re-radiation of the mixture products. The power company is as interested in elimination of these lossy joints as you are, and if you can demonstrate that you have reason to believe that you have one in your vicinity, they will usually offer considerable expert help in its location and elimination.

But, utility lines are not the only offenders. Troubles of this sort have been found in corroded joints in metal guttering and down spouts on buildings, corroded connection in TV antennas, in heating ductwork inside houses, and even in fuseboxes with dirty or corroded connections. To locate these is often difficult and time-consuming. Pity the poor OM who has such a rectifying joint right in his own antenna tower!

The references which proved most helpful in work on this problem were:

1—**How to Locate and Eliminate Radio and TV Interference**, Robert D. Rowe, Second Edition, John F. Rider, Publisher.

2—**Television Interference, Its Causes and Cures**, Phil Rand, W1DBM, First Edition, Nelson Publishing Company.

3—**The Radio Amateur's Handbook**, Chapter on Eliminating Broadcast Interference, ARRL.

4—**The Radio Handbook**, Fifteenth Edition, Chapter on Television and Broadcast Interference, Editors and Engineers, Ltd.

Parts List

1—Minibox, 5 x 2¼ x 2¼", Bud CU-2104-A or similar.
2 ea. disc ceramic capacitor, 0.001 microfarad (C_1, C_2).
2 ea. disc ceramic capacitor, 0.0015 microfarad (C_3, C_4).
2 ea. Miller 4406 adjustable rf coils (6.7 to 15 microhy.) (L_1, L_3).
1 ea. Miller 4404 adjustable rf coil (1.5 to 3.2 microhy.) (L_2).
2 ea. SO-239 chassis mounting coax connectors.

Charles E. Spitz W4API
Associate Editor

73 Tests The Viking Ranger II

THE Viking Ranger probably needs less introduction to the amateur fraternity than most any other piece of gear. It was the creator of the trend towards making a small and complete transmitter package by the incorporation of an integral VFO. No outboard gadgets other than your mike, key, (crystal if you desire), or antenna relay is required to put you on the air on any band from 160 to 6 meters. The Ranger II incorporates all of the modifications and improvements brought out for the basic Ranger to date, wrapped up within a new two tone grey ventilated steel cabinet.

The Ranger II is designed to meet the needs of the greatest possible number of amateurs; General, Technician or Novice, CW or AM phone, the 6 meter enthusiast or the 160 meter specialist—and all of the bands in between, all as a fixed station or portable. In addition, the rf section may be used as an rf exciter to drive anything in the kilowatt class, and the audio section will drive any high power modulator. Physically it is small, being 15½ inches wide by 9⅝ inches high, and 14 inches deep, weighing in at 43 lbs. The input of 65 watts on AM phone and 75 watts for CW will work anything in the world.

Oscillator Circuitry

It would be well to follow the block diagram of Fig. 1 to clearly picture the whole of the transmitter system and its component parts. The oscillator is the heart of the Ranger II. Separate calibrated bandspread dial scales are provided for each of the seven bands and 6 to 1 ratio planetary drive mechanism results in excellent tuning accuracy and smooth control. The plexiglass dial is edgelighted. Ten kilocycle calibration increments on each band provide uniform and accurate dial interpolation. Although frankly not designed for frequency meter accuracy, checks with a 100 kc crystal oscillator will excite your admiration. The VFO employs a series tuned Colpitts circuit with a 6AU6, using two separate tanks. One covers the 1.75 mc to 2.0 mc frequency range and the other the 7.000 mc to 7.425 mc range. The VFO tank circuits and the output circuits are controlled by the front panel switch indicating the band of transmitter output. Temperature compensation, optimum circuit design, rigid construction and voltage regulation result in a high order of stability. There is freedom from "wobbulation" under modulation, or "yooping" when keyed. On the 160 meter and 80 meter bands, the VFO output remains on the 160 meter tank. On the 40, 20, 15 and 10 meter bands the VFO changes to the 40 meter oscillator tank. On the 6 meter band, additional capacitors are switched across this tank to lower the VFO frequency to a harmonic relation to the 6 meter band and add additional "C" to the oscillator to enhance stability.

A 6CL6 acts as an isolation stage and broad tuned frequency multiplier when the VFO is used. During crystal oscillator operation, however, it functions as a hot cathode oscillator. Grid-block keying is employed for the oscillator, the 6CL6 isolation stage and an additional 6CL6 buffer-multiplier, utilizing a 12AU7 as the keying tube. This system is called "Timed Sequence Keying." To avoid adjacent channel interference, a wave-shaping filter is used in the 6CL6 circuits. To avoid chirp when the VFO is keyed, the 12AU7 permits the VFO to start before the 6CL6s conduct and continues oscillation until after the 6CL6s stop conducting. There is a VFO keyer adjust control which permits adjustment of the "hold" time in order to permit rapid CW break-in operation to suit the operator.

When operating break-in, a slight arcing at the key may be noticed in your receiver. This is not transmitted over the air, and may be eliminated by installing a 2½ millihenry rf choke in each key lead right at the key. On the lower frequency bands, the rf stages are sufficiently broad as to permit a change of frequency within a CW or Phone portion of a band by means of the VFO alone. Obviously this would be more difficult on 10 and 6 due to the size of the bands. For greater excursions, the dial marked "exciter," final dip and loading will of course have to be touched up. Practice will quickly indicate the degree of latitude in this respect that you will have for the bands you use the most. A "spotting" switch position permits you to observe your transmitting frequency without unnecessary radiation on the air and to "zero" in on a transmitting station.

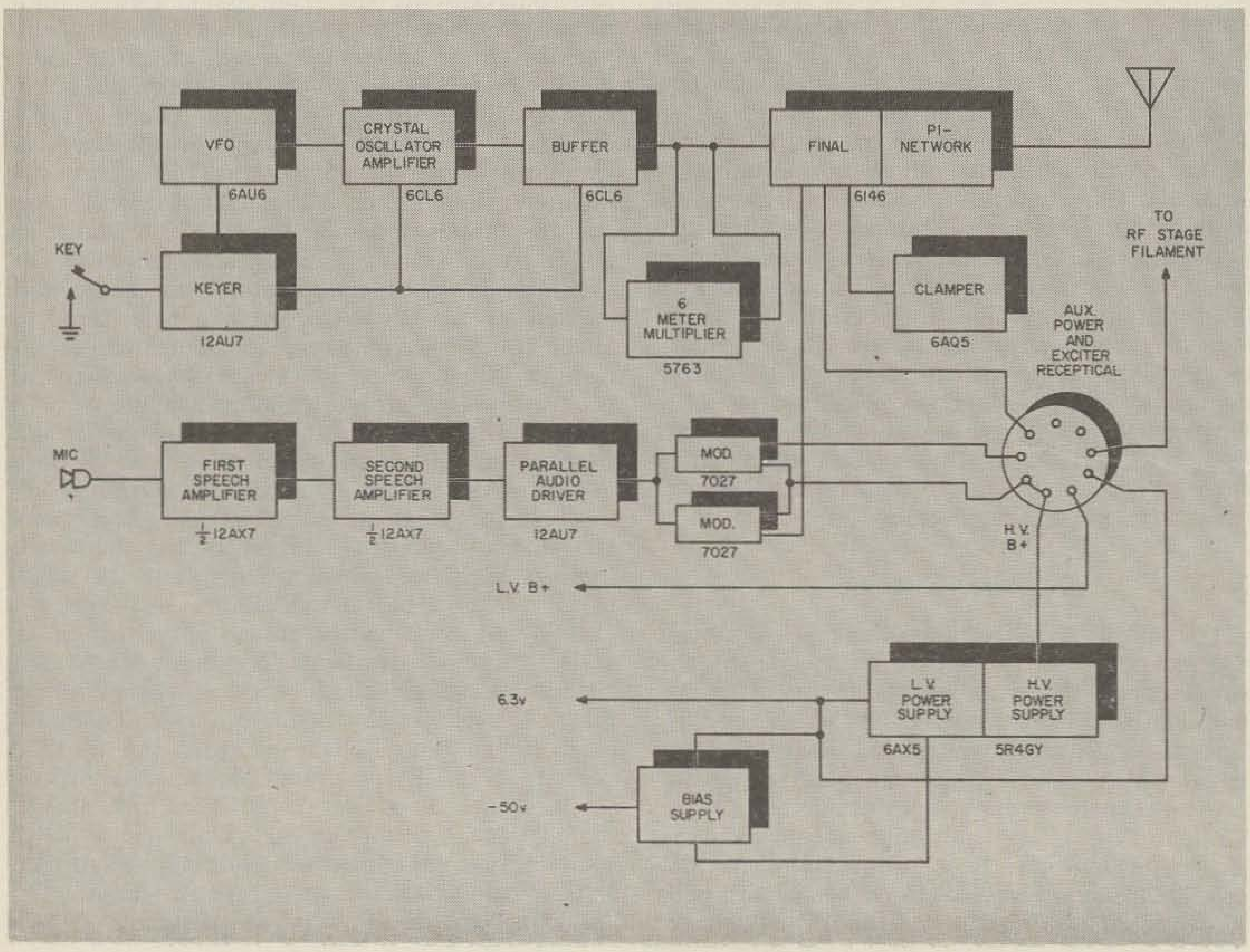
RF Circuit Operation

The 6CL6 stage used as a buffer-multiplier, mentioned earlier when the keying action was described, uses a tuned high Q plate circuit which is tuned to the same frequency as the final on all bands. Protection against excitation failure is derived from a cathode resistor. The band switch and coils are fully shielded to avoid any possible interaction, insuring clean circuit isolation and preventing instability. The output of this stage is controlled by a potentiometer which controls its screen voltage. This permits precision in adjusting final grid drive. An additional multiplier stage, not present in the original Ranger, uses a type 5763 tube. It is switched in to drive the 6CL6 buffer-multiplier when operation is to be on 6 meters.

The final stage uses a 6146 with a completely band switch pi-network of Hi Q design. The range of antenna impedances which may be matched on all bands is 50 to 500 ohms, plus the tuning out of a wide range of inductive or capacitive reactance. The range of antenna impedance which may be matched at frequencies above 7 mc extends, roughly, from 25 to 2000 ohms. The 6146 is protected from excitation failure by a 6AQ5 which is connected in shunt with it's screen dropping resistor. When excitation failure is encountered from any cause, the 6AQ5 conducts and lowers the 6146 screen potential to approximately plate current cutoff. The screen of the 6AQ5 clamper is connected to a voltage divider making the stage continue to conduct even at extremely low plate potential values. Under this cutoff condition the 35 to 40 ma current is indicated on the transmitter multimeter. It is not the plate current of the 6146 but is the plate current drawn by the clamper tube.

The Audio System

All triodes are employed in the speech and driver stages. The first and second amplifier is



the high gain 12AX7, ample for any crystal or high impedance dynamic microphone. A three circuit microphone jack is provided to accommodate the addition of a push-to-talk relay if PTT operation is desired. A 12AU7, parallel connected to a driver transformer is the source of low impedance drive for the modulator. The modulator, employing a pair of 7027 tubes in push-pull class AB can deliver more than enough audio for 100% amplitude modulation. Plate saturation limiting prevents large swings beyond full modulation thereby providing some limiting to reduce distortion and spurious output. The modulation transformer has a tertiary feed-back winding coupled to the grid of the audio power driver. This provides damping for improved regulation, stability and a flattened frequency response. This method also enhances the direct driving of external modulators when the Ranger II is used as an exciter.

The secondary of the modulation transformer is center tapped, to fill the requirements of an audio driver permitting it to work directly into the grids of external high power Class B modulators. The leads are filtered and by-passed, and made available at the exciter-auxiliary plug at the rear of the chassis. By using one half of the secondary winding, a nominal 500-600 ohm output can be obtained for driving large speakers used in paging or public address work. Thirty-three watts of audio are available at the output of the modulators for any application required. The frequency response range of the modulator section is flat within 3 db from 250 to 3000 CPS with a very pronounced roll off above and below these frequencies. The passed range is sufficient for pleasing quality yet confines the audio power within these frequency limits for a noticeable audio punch.

The Power Supply

This is a conventional dual plate voltage supply, employing a 5R4GY high voltage rectifier tube and a 6AX5GT low voltage rectifier. Choke input filtering is used in both supplies. The high voltage is 525 volts dc for the final and modulators, and the low voltage 320 for the rf exciter and low level speech stages. A 6AL5 rectifier for bias for the keying circuits and the modulator is fed from a third set of terminals on the power transformer secondary. If you want to power other equipment in the shack, you can use the rig as a power supply, from the exciter-auxiliary plug. In addition to the audio at this terminal, there is available 6.3 volts at 5.5 amperes for filaments, 300 VDC at 50 ma and 500DC at 210 ma. When the auxiliary plug is wired to tap off for external power, the complete rf section of the Ranger, including filaments, is de-energized, as the power supplies cannot provide the normal Ranger full power requirements and external power use simultaneously.

Specifications of the Viking Ranger II

Frequency Range: 160, 80, 40, 20, 15, 10 and 6 meter bands.

Power Input: 65 Watts AM Phone, 75 Watts CW.

Power Requirements: 105-120 VAC, 50/60 cycles, 260 watts.

Frequency Control: Integral VFO, or two switched crystal positions.

Utilization: All-round portable or fixed transmitter, RF Exciter, Speech or power amplifier, or power supply source.

Form and Price: Kit No. 240-162-1 ....$249.50
Wired No. 240-162-2....$359.50

Maker: E. F. Johnson Company, Waseca, Minnesota.

Operation

The E.F. Johnson Company did extensive research when amateur radio first faced the threats of TVI. This is reflected in minute detail throughout the Ranger II. The cabinet is electrically sealed with flexible monel braid on the inside of the front panel and large cabinet overlap. A cup type shield seals the meter, and spring type contract washers on the front panel shafts prevent possible radiation from shaft clearance openings. The power line and relay jack circuits have double L type filters; all auxiliary socket, meter, dial lamp, key, and meter lamp leads are equipped with L filter networks. To minimize harmonics, interior harness leads and filaments are by-passed to the chassis. Careful by-passing of the final and design of the output circuit were aimed at reducing harmonics. This deep interest in TVI led to the investigation of causes beyond the well engineered transmitter. Improper grounding in the shack, as well as improper impedance matching, turned out to be another major source of trouble. This affliction troubles many an installation, regardless of the equipment, so if you are one who is being so deviled, beg, borrow, steal or buy a Viking Ranger II Operating Manual. There is a great deal of common sense procedures within it which could be applied to your shack, both on the subject of TVI prevention and proper loading and matching of your antenna system.

One panel meter serves as a multimeter, providing ample indictation of tuned circuit operation, switching between oscillator, buffer, grid, final plate and modulator. The manual tuneup instructions are a little confusing in that when told to tune the "buffer" your control is marked "exciter" on the panel. I would have preferred a slightly different turn-on, turn-off sequence in mode switching, but I guess you can't please everyone ın every detail.

Putting the equipment on the air was revealing. I had a warmed up BC-221 and a 75A4 ready to check calibration, but had little to do since the VFO dial markings fell right into the slots they were supposed to. The first firing up was late in the afternoon on 75 meters, with the initial CQ answered by a chap two states away who said his xtmr had been on 15 meters, but I sounded so good on 75 that he bust his buttons changing bands to call. Equally flattering remarks were produced on six and then the other bands. With scope and panadaptor on, the bug contacts were polished up, but no fault had shown up there either. The design and bugs on this equipment had been worked out so long ago that it might have been presumptious to hope to dig up flaws thousands had been unable to find. The unsolicited flattering remarks were in themselves outstanding. I even tried to QRM my color TV receiver on 3.579545 mc with no luck!

There is the Ranger II for you. It covers a whale of a lot of amateur bands in a day when many people specialize in just one of them. It gives you long or short range communications to fit any geographic requirement or environment or skip, and is a good basic piece of equipment to use as a standard for the measurement of other gear which you can be sure will be hard put to meet it. . . . W4API

Zerobeatnick

Gus Gercke K6BIJ

THE main difference between an expensive modern receiver and a cheap old one is:

1. Stability of its oscillators.
2. Price.

If, while listening to a *good* SSB station (be sure it is not just someone talking thru a garbage disposal unit), you have to retune every few minutes to take the "Donald Duck" out—you better meet Zerobeatnick.

Z-B is just a transistor oscillator used to zero-beat the incoming signal at its frequency (or a CW signal a little off its frequency), and mix with it *in the front end* of your receiver with your BFO off.

Z-B does not drift, as it does not generate any of its own heat (it operates on 1 ma 3v), it does not pick up heat generated in the receiver (separate box), and it works into a constant "load"; you can leave it for hours on a SSB group and watch *them* drift in all directions. The drift of your mixer oscillator is still there (BFO is OFF), but all it can do now—is cause the signal to get weaker; you cannot change the voice pitch, using your receiver controls, even if you want to do so (remember the BFO is off).

There is only one trick in using Z.B.: to be effective it must supply a signal of about the same strength* (at the point of mixing) as the signal you are listening to.

The mixing point can be the antenna terminal, or some point on your rf or mixer stage, and will differ from receiver to a receiver. It must be found experimentally, as too much input will result in a blocking action (only very strong signals will get thru); too little input will cause only weak SSB signals to sound normal, strong ones will sound as SSB sounds with BFO off.

There are dozens of transistor oscillator circuits, I used just one of them, you may find a better one.

With the 2N169A use fundamentals on 80 & 40 and harmonics higher, you may raise the voltage to 6 or 9 volts if you need higher output.

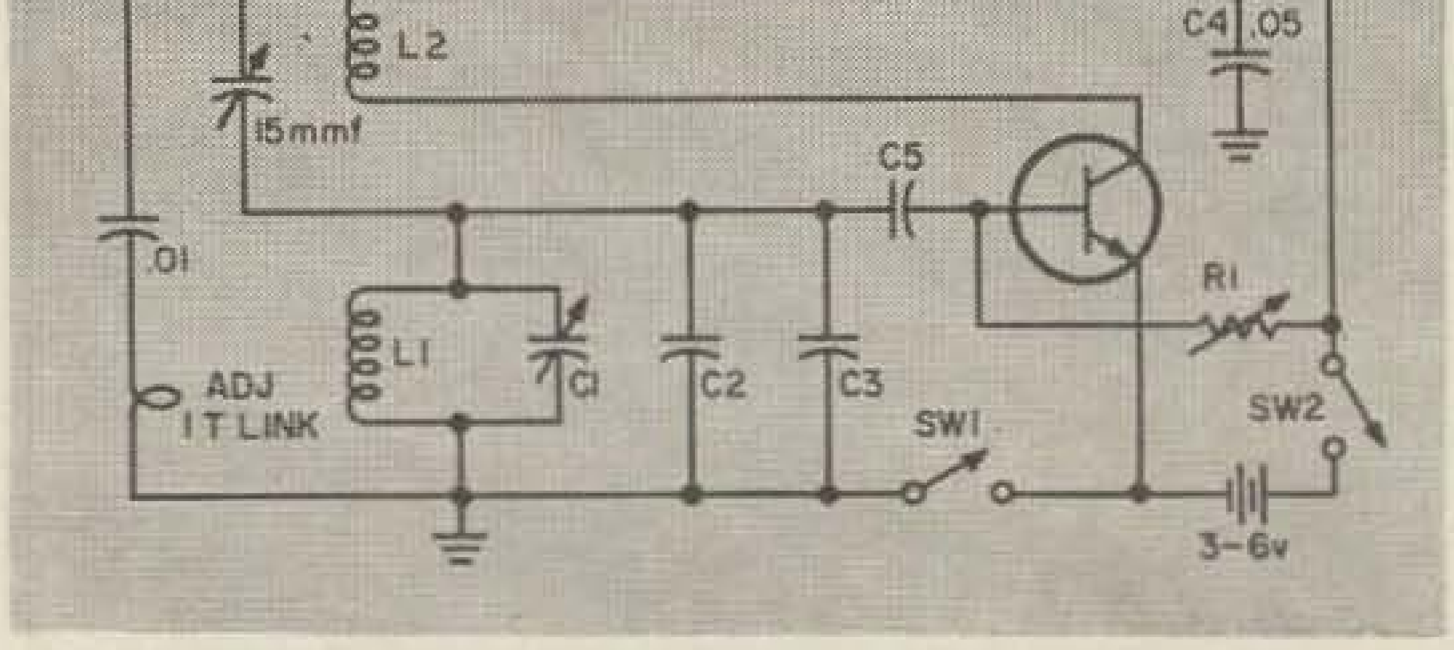
In some cases you will be able to use your VFO as a Z-B, this will give you an additional advantage of staying on another guy's frequency (or drifting with him) during a long listening period.

. . . K6BIJ

*Ratio of about 1:5 is acceptable.

Parts List

SW1—OFF: for 40M (C1 covers the band).
Om: for 80M (use iron slug to cover band).
Set R1 for smooth regeneration over both bands. This can be a screwdriver adjustment.
L1—3 turns #18, ½" long on a slug tunes coil form.
L2—5 turns #24 over L1.
C1—365 mmfd variable.
C2—Bunch of silver micas totalling about 2000 mmfd.
C3—Same, about 8000 mmfd.
C4—.05 mfd disc ceramic.
C5—100 mmfd mica. or ceramic.
R1—½ meg pot.



A High-Level Frequency Converter

Carl C. Drumeller W5EHC
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Oklahoma City 22, Oklahoma

ONE OF THE problems confronting the user of SSB equipment is how to get it on another frequency. Of course if it is a factory built job, probably the manufacturer took care of that little task. If it's a homebuilt exciter, the constructor has a job on his hands.

It's not that there is no literature available on frequency converters. Far from it. But all these frequency converters have one thing in common: They require first that the signal to be converted be reduced to the milliwatt range. If the exciter has a milliwatt output, this is no problem. But what of the exciter unit that you so proudly built to put out 20, 30, 50 watts? Are you going to tear out the amplifier section and start all over again? Or are you going to soak up all those hard-fought-for watts in a swamping resistor? Dry your tears, son; there's a way to make those watts earn their keep.

Let's see how we can put watts to work in a frequency converter. First, though, we need to establish a line of reasoning. Unless one has done a bit of thoughtful study of the subject, not many of us are prepared to equate a converter to a modulator. This being a construction article and not a treatise on theory, it would not be in order to take up the proof of that statement. If you're one of those hard-to-convince souls who must have proof, read Chapter 10 of Carson's Principles of Applied Electronics, published by McGraw-Hill. Now that we've convinced the skeptics, let's get into the job of planning the construction of a modulator . . . ah, that is, a frequency converter.

First, let's review the types of modulators

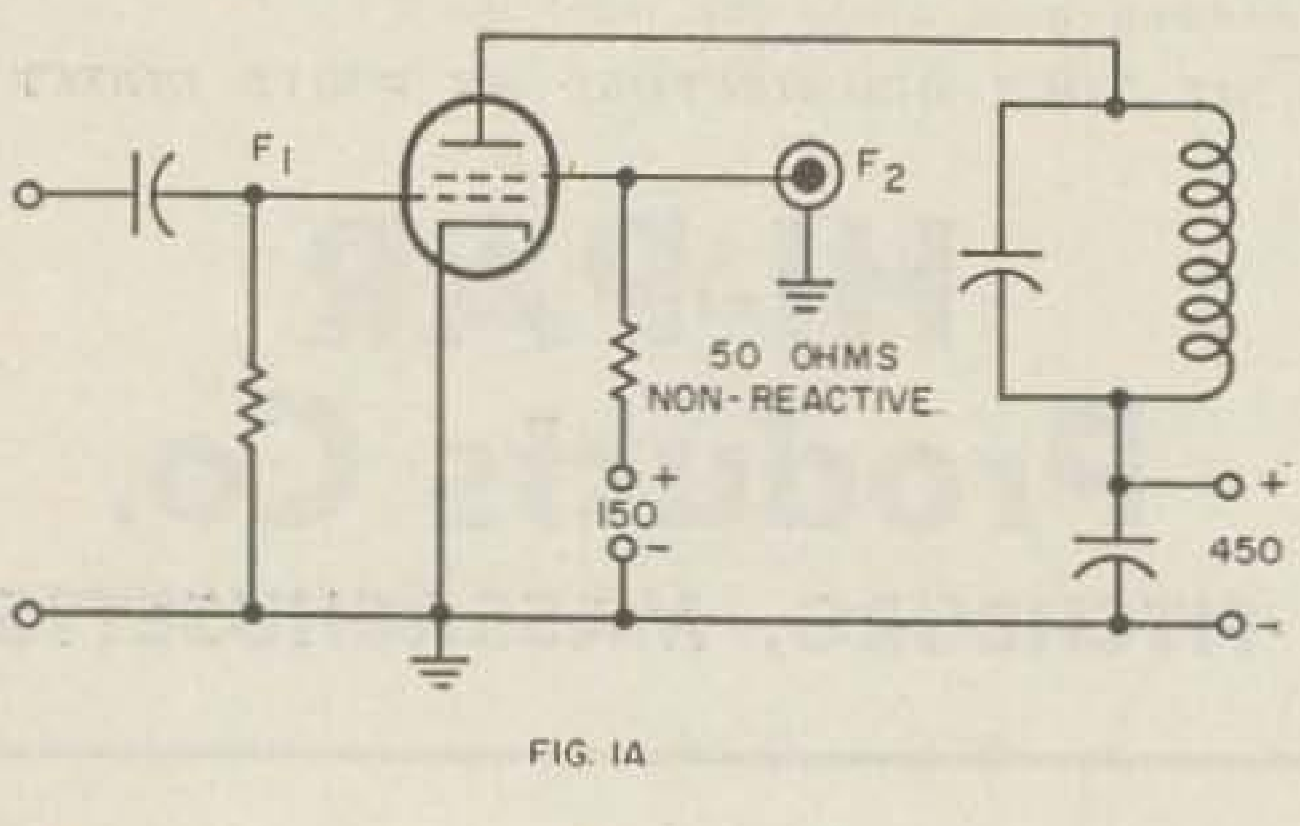


FIG. 1A

available for use. There's the plate modulator. It requires the modulating frequency to be inserted in the plate circuit, effectively in series with the dc power supply and also in series with the rf output tank. We note these items and consider the next in line, control grid modulation. This has the modulating frequency in series with the dc grid bias and with the rf input tank. Again we make mental notation and progress to a third type, the suppressor grid modulator. This is more simple, requiring only that the modulating frequency be in series with the dc suppressor grid bias supply. It has just one nasty aspect: tubes with suppressor grids brought out to external connections and with suitable suppressor control characteristics are not in bountiful supply in the average amateur's junk box. Let's regretfully pass this system by and consider another, cathode modulation. This is a beast, partaking of all the disadvantages of both control grid and plate modulation while possessing none of the advantages of either. With a wry face, we bury this in File 13 and go on to consider screen grid modulation. Ah, this has promise! It asks only that we insert the modulating frequency in series with the dc screen grid supply. Better still, many common tubes have very excellent screen grid control characteristics.

Having picked out what appears to be the most promising form of modulator, we next take up the problem of how to squirt that modulating frequency into the screen grid. There are many ways it can be done, but we're looking for the lazy man's way. The problem is somewhat complicated by the fact that we're going to be modulating with rf and not af.

We could do it with a tank circuit, tuning the tank to the modulating frequency. This has disadvantages. It requires an extra control, one that must be precisely adjusted to exact resonance if it is to offer a non-reactive load to the exciter (and we very much want just such a load). Then, too, if such a tank is used with either control grid, cathode, or plate modulation, we have the very nasty situation of two tanks in series, which can engender lovely headaches springing from interaction

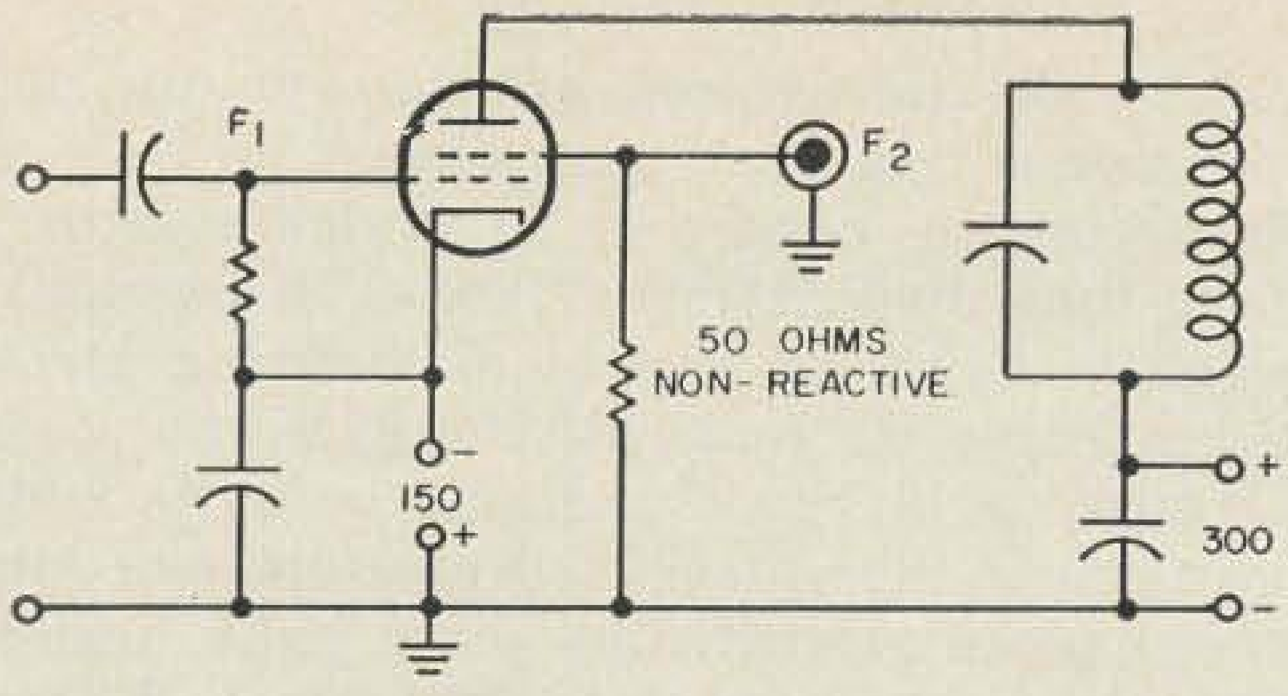


FIG. 1B

effects. That's why we skitter away from these three types of modulation.

Having ruled out tank circuits, what remains? There is our old friend, the resistor. Ah, but that consumes power, you cay. True, but maybe we can put a byproduct of that power, voltage, to work. Let's get into a very minimum of theory to see how this can be done.

There's an old, familiar formula that says W equals E square divided by R. With a bit of juggling, we rewrite that as saying E equals the square root of W times R. Now lets' drop in some figures in place of letters and grind out an answer For R, let's use 50 ohms, that being the load that 99% of the exciters like to "look into." For W, let's take 50 watts, that being the power output of most of the 100 PEP watt exciters commonly used. Also, to be real sneaky about it, it simplifies our solution, for the square root of 50 times 50 is 50. This fifty, of course, is the RMS value of E. We'd like, however, to deal in terms of peak voltage, not RMS; so we multiply the 50 by 1.414 and come up with 70.7 volts. At the same time we make a mental note that this means a 141.4 peak-to-peak voltage.

Now let's see what we can do with this voltage. We can use it to vary the control function of the screen grid, and that's what we're intending to do. A quick review of the screen grid control characteristics of tubes likely to be found in one's junk box (807's 6L6's, 1625's, etc.) reveals that this control function is quite linear over a restricted range above and below the operating point of 150 volts. We'll select, then, 150 volts as our operating point.

This is the point to take time out for a small lecture. Screen grid modulators used in most homebuilt and all factory built amateur transmitters can give acceptable audio quality . . . if one is very charitable about what he classifies as "acceptable." Let's have no rosy illusions, however, about the absolute excellence of this modulation. The sad facts are that it is far, far from being linear when it goes beyond 50% or 60%. This generates several forms of distortion, of course, but we poor mortals, conditioned by years of listening to squeaky broadcast receivers, think nothing of 30% distortion. In fact, we call it good. A spectrum analyzer, however, is not as charitable as our "conditioned" ears. And a spectrum analyzer is the thing that'll tell whether a frequency converter for a SSB signal is good or just plain junk. The point of this little lecture is that we can't get by with just so-so linearity in this modulator; it must be good.

Now back to our construction. Figure 1a illustrates a possible means of getting the output of the SSB exciter into our modulator. There is one glaring fault. If we fed the rf into it with a coax cable (as we'd like to), we'd short-circuit the 150-volt screen supply. Rather than have fireworks, let's slip that 150-volt power supply over into the cathode circuit, as shown in Figure 1b. This not only enables us to feed the screen with a grounded coax but places the 150 volts in series with the plate supply voltage. We now can use a lower voltage power supply for the plate.

Now that we've got our modulating frequency into our modulator, let's consider some other aspects of the circuits. In an af modulator we'd have rf going into the control grid and a composite signal present in the plate circuit. What makes up that composite signal? The original rf signal fed into the grid, the af modulating signal fed into the screen grid, the sum of these two frequencies, and the difference between these two frequencies. As there is a tank circuit tuned to a radio frequency as the sole load circuit for the stage, there is no load into which the af components can develop power. We'll forget them, then. The original radio frequency fed into the grid appears in the plate tank circuit as the "carrier." The sum of the audio frequency and the radio frequency appears in the plate tank circuit at the "upper sideband." The difference between the audio frequency and the radio frequency appears in the plate tank circuit as the "lower sideband."

The same conditions apply to our modulator in which the modulating frequency is a radio-frequency signal, not an audio-frequency signal! There is one small difference, however. That difference lies in the fact that, because of the high frequency of the modulating signal, the "sidebands" will lie far from the "carrier."

This might bear a bit of explanation, for it has an important bearing on both our plate tank circuit tuning and on the amount of rf power present in that tank circuit.

Consider the condition in which a pure rf (single-tone modulation of the SSB exciter) is present in the screen grid modulating circuit. Let's call this F2 and call the rf signal fed to the control grid F1. These may be quite widely separated in frequency. Now, in the plate circuit (plate circuit, not plate tank circuit), there will be present F1, F2, F1 + F2, and F1—F2. All four of these are radio frequencies, capable of producing rf power when fed into a suitable load. The load, of course, would be a tank circuit tuned to the desired frequency. Therefore we tune the plate tank circuit to the frequency (F1 + F2 or F1 — F2) that we desire and hope feverently that we have rejected the other three! Don't delude yourself, though; you'll never get that desired rejection with just one tuned circuit. You may well resign yourself to the stark necessity of having a multiplicity of tuned circuits in order to come up with the signal you want and no extra frequencies tossed in "for free."

Now you've got a signal on the desired frequency. Your first reaction, probably, will be one of disappointment as to its amplitude. After all, you've observed the magnitude of the rf coming out of a similar modulator fed with an af modulating frequency. Ah, but there's a difference! When you modulated with af, the "sidebands" lay so close to the "carrier" that the plate tank circuit tuned all three of them at once! Now, you may recall, you are rejecting the "carrier" (that hulking brute in which a very large percentage of the rf power lies) and one "sideband." The remaining "sideband," the one you've selected with your plate tank circuit, has a right to appear "puny" when compared with all three lumped into one. Relax, pal, you've got all the rf power that's rightfully yours. It's enough to tickle the grid of a very man-sized Class AB_1 rf linear power amplifier, too!

If you're ready and eager to reach for a soldering iron, Figure 2 will show you a few pointers. The box labelled 11.1 mc exciter contains very conventional circuits; no need to take up space with them. Its sole purpose is to

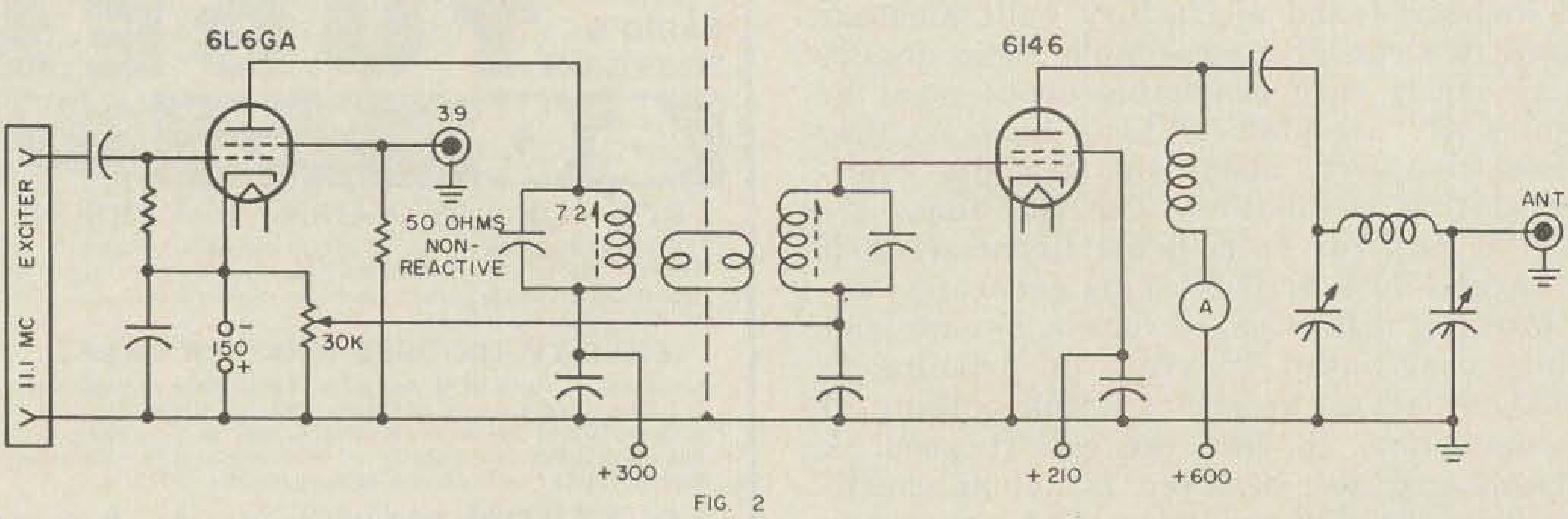


FIG. 2

produce F1. Note that F1 feeds into the grid of a 6L6GA. Into the screen grid of the 6L6GA comes the 3.9 mc output of your SSB exciter. Assuming it to be 50 watts, the 70.7 (peak) volts developed across the non-reactive resistor varies the screen grid potential from 150.0 − 70.7 = 79.3 to 150.0 + 70.7 = 220.7 . . . all voltages well within the linear portion of the 6L6GA's screen grid control curve. In the plate tank circuit, we pick off F1 − F2 = 7.2 mc. Just to play safe, we link-couple to a tuned grid circuit for the next stage. By using plenty of C in each of these two tanks we arrive at a total Q (Qt = Q1 Q2) that is high enough to discriminate against F1, F2, and F1 + F2. The output stage is a conventional Class AB_1 linear amplifier. Although a tube in the 6146 class is indicated in the diagram, the rf drive available is sufficient to excite a much larger tube.

Should you wish to use a 3.8 mc exciter on 14.2 mc, you'd select 18.2 mc for F1. If you have an "all-band" (3.5 to 29.7 mc) exciter that you want to put on 50 mc, you'd select 49 mc for F1 and use the 21 mc output of your exciter for F2.

You may wonder about the lack of detail in a "construction" article. It was deliberate, being based upon the author's opinion that no radio amateur needs to be told every component value, every wire's position, every tube's location in a piece of equipment to be built. If one does, he should engage in some serious introspection to determine whether he is an amateur of radio or an amateur of talk-over-radio.

Test Lead Tip

Many vacuum tube voltmeters are equipped with banana jacks for the "OHMS-AC" and "COMMON" test leads. These leads often pull out of the jacks and are a constant source of inconvenience. This is particularly true if the disconnected lead is not noticed and time is spent attempting to reconcile inconsistent meter readings.

The answer to this problem is simple. Remove the instrument from its case and discard the banana plugs which are attached to the test leads. Thread the leads through the jacks, tie knots in the leads to serve as strain reliefs and solder the leads to their respective receptacle lugs.

Replacing the leads is not the problem it would appear to be. Good quality, live rubber test leads (you should tolerate nothing else.) will last for years. Even if you are careless enough to lay a 200 watt soldering iron across the leads, replacement only takes a few minutes and affords a good opportunity to perform a little preventive maintenance on the instrument.

. . . W4WKM

Modulation

Staff

ALL of us, as hams, know the importance of modulation. Some of us go to great lengths to avoid its problems; others go to equally great lengths to take fullest advantage of its possibilities. But none of us, at any time, escape it.

For modulation, you see, is inherent in every act of human communication — whether by radio, the printed page, or a flirtatious wink!

One of the classic scientific books on modulation theory opens with the phrases: "Boy winks. Girl smiles. That's modulation in action." And while it may seem a far cry from single sideband or RTTY, the statement is completely true.

What's more, it hammers home the point that modulation, in essence, is *any* process of communicating information by modifying existing energy which does not, in itself, carry the information. The wink, for instance, caused a modification of the reflected light rays seen by the girl, and communicated the message, "I like you" or a similar thought.

While flirtatious winks are frequently interesting, our main purpose here is to explore the subject of modulation as applied to ham radio, so let's restrict the definition of the word a little bit: "The modification of a radio-frequency signal to transmit information."

Now, if we look closely at the classic picture of a radio-frequency signal, we will discover that it has only two characteristics which may be varied: its amplitude and its frequency. These two characteristics completely define the signal, and since either of them may be varied to transmit information this immediately leads us to the two major forms of modulation: amplitude modulation (which we will *not* abbreviate in this article for reasons which will soon become clear) and frequency modulation.

If you re-read that last paragraph you'll also see that no other basic forms of modulation are possible; actually, many more types exist, but all of them are variants of the two basic forms.

A possible exception is pulse modulation, which is concerned not with a steady rf signal but with an intermittent signal. The timing of the intermittent signal provides a third characteristic which may be varied. However, from a slightly different viewpoint both amplitude- and frequency-modulation processes may be considered as pulse modulation (if you think of each half-cycle of rf as an individual pulse) so it's not so much of an exception as it might appear at first.

About here we ought to break the two basic forms down into the more commonly known types, and make the point that CW is a form of modulation also.

Amplitude modulation includes CW, known to the FCC as type A1 emission; phone (commonly called AM, an abbreviation which we'll avoid for the sake of nonconfusion) or A3; and television or A5. It also includes AFSK (type A2), MCW (also A2), and facsimile (type A4).

Frequency modulation includes FSK or type F1, phone or type F3 (which may be called FM, NBFM, PM, or NBPM also), and facsimile (type F4).

Let's look at these classifications a bit more closely.

CW transmission is familiar to all of us, but the concept of CW as a type of modulation may not be so familiar. However, consider a special kind of modulator which allows the transmitter to produce full output when the modulating signal is present and cuts off all output when the signal is absent. For the modulating signal, use a square wave which drops to zero on negative peaks. The output signal will be a string of dots—and nothing more.

Approaching CW as a special case of amplitude modulation allows an easy handling of key clicks, chirp, and other keying problems which can be most confusing in the conventional approach. We'll come back to this later when we examine circuits.

Phone transmission is what we all think of when "AM" is mentioned; however, there are many forms of A3 emission. The most conventional is DSB plus carrier. Also included are DSB without carrier, SSB with carrier, and SSB without carrier. While the circuits for producing these various types of A3 differ, the classification does not.

The difference between A3 and A5 (television) is primarily one of bandwidth. While distortion-free phone conversations can be transmitted in a 10 kc bandwidth, it requires something like 6 megacycles to handle an A5 emission with the same clarity. The bandwidth problem forces different circuits into play also.

The differences between A2, A4, and A3 are mostly a matter of degree. A2 is a cross between A1 and A3, while A4 is a cross between A3 and A5. In either case, the common circuits apply.

How about frequency modulation?

Type F1 emission, frequency-shift keyed telegraphy, is used primarily by RTTY operators. It corresponds roughly to A1 or CW transmission, except that where CW uses a coded combination of the signal's presence and absence to convey information, FSK uses a coded combination of the signal's presence on either one frequency or another to convey the information. Since the signal must always be on one or the other of the frequencies used, the system is fail-safe — if the signal disappears entirely, you know for sure that something has happened to the transmission. You don't have to wonder if the guy at the other end is trying to think of something to say.

Type F3, as mentioned earlier, has many names. Its major subdivision is into FM and PM, abbreviations for frequency- and phase-modulation, respectively. However, no essential difference between the two processes exists. In a pure FM system, the actual output frequency is controlled by the audio signal. In a pure PM system, the rate of change of the output frequency is the controlled element. In broadcasting practice, the "FM" signal ranges from pure FM at one end of the audio spectrum to pure PM at the other, with a Heinz mixture in between. The prefixes "NB" and "WB" mean, respectively, narrow-band and wide-band. For ham use, narrow-band means a bandwidth not greater than 6 kc, while wide-band means any bandwidth greater than that.

Type F4 is seldom used by hams and is included merely for the sake of completeness. It bears the same relation to type A4 that F1 does to A1.

While we're looking at modulation systems in general, let's take a swing through the field of pulse modulation.

The basic difference between pulse modulation and the other forms of modulation lies in the nature of the *unmodulated* signal. In more-conventional types of modulation, the unmodulated rf signal is a steady "carrier," constant in both frequency and amplitude. However, with pulse modulation, the unmodulated rf signal consists of a series of brief pulses of rf energy. Timing of the pulses, frequency of the rf signal emitted, and amplitude of the pulses are all constant.

Pulse modulation offers a number of advantages over the more-common modulation processes, as well as possessing a number of disadvantages.

One of the greatest advantages is that it allows much more rf power to be transmitted; this comes about because power is a quantity which exists only with respect to time. A steady rf signal such as is used in the more-common forms of modulation has a "power" which is equal to the power produced by a certain amount of direct current *in a given period of time*. This is true even though much of the time the instantaneous voltage is near zero.

To illustrate this point, let's look at a signal with a rms power of 100 watts. That means that the signal's power is equal to that produced by 100 volts of dc flowing at a current of 1 amp. But 1 ampere is defined as 1 coulomb of electric charge moving past a given point in 1 second. If 10 coulombs of charge were moved past the point in 1/10 second, and no charge moved during the other 9/10 second, the current would still be 1 ampere.

Let's go even farther. Let's allow the charge to move for only one one-millionth of a second. To get that one ampere now, we have to move a million coulombs of charge. During the millionth-of-a-second that the current flows, the instantaneous power is 100 million watts. During the rest of the time, instantaneous power is zero. But by the definition of current quoted above, the power flowing over a two-second or longer time is still just 100 watts.

We've been talking about dc. The same treatment, though, applies equally well to rf energy. By concentrating the rf output in pulses one microsecond long and sending only one pulse per second, we can shoot 100 million watts out of the antenna with a 100-watt transmitter—and be perfectly legal about it all.

While we're talking about advantages, let's also mention that some types of pulse modulation offer a signal/noise ratio of infinity; that is to say, if the signal can be detected at all, it will have a noise level of zero.

But with the advantages come disadvantages. To transmit these pulses without distorting their shape requires lots of room. To transmit the microsecond-wide pulses we talked about a few paragraphs ago will take about a megacycle of bandwidth — which means more rf spectrum space than the entire 80 and 40 meter bands put together! For this reason, the FCC limits pulse transmission to the uhf regions and above.

The increased bandwidth required also hurts the signal/noise ratio at the receiver, just about balancing out the power advantage gained. In other words, the same tube will give you about the same range with either pulse or conventional modulation when operated at the same *average* power level. The advantages gained by the signal/noise ratio = infinity types of pulse modulation are somewhat offset by the complexity of the circuits involved.

The net results is that pulse modulation still appears promising for use at uhf, because it's easier to get going at 1215 mc and above than is the equivalent amount of power with conventional modulation—but results with the two types of modulation under best conditions will be about the same.

After this general introduction to pulses, let's look at the specific types which make up pulse modulation.

As mentioned earlier, pulse modulation involves not just two but three characteristics of the rf signal which may be changed to transmit information. These characteristics are the pulse amplitudes, the pulse timing, and the pulse width.

Pulse amplitude modulation is similar to ordinary amplitude modulation, in that pulse amplitude is directly proportional to the value of the modulating signal.

Pulse timing gives rise to "pulse position modulation," abbreviated PPM, in which all pulses are the same amplitude and width but their position with respect to each other changes in accordance with the modulating signal. Since only the timing is important, noise has little effect (the pulse may be "regenerated" before detection, so that no noise reaches the detector).

Pulse width modulation (sometimes called pulse duration modulation and abbreviated PWM or PDM) is similar to PPM except that the pulses all start at the same time with relation to each other but their width is controlled by the modulating signal. Like PPM, noise may be eliminated by "regeneration."

PAM is roughly equivalent to conventional amplitude modulation, PWM is equivalent to FM, and PPM has no direct equivalent in conventional terms but is a cousin of FM. The fourth class of pulse modulation has no relative at all among conventional systems, and offers the greatest noise freedom possible (at the expense of added circuit complexity).

This fourth class is pulse code modulation, abbreviated PCM. In PCM, the modulating signal is sampled at a regular rate. The instantaneous value of each sample of modulating signal is converted to a binary-number code, and this code is transmitted. Thus, the signal actually transmitted bears no obvious relationship to the modulating signal — you must know the code to receive it.

Since pulses can be "regenerated" along the way, the code signal will not be distorted by

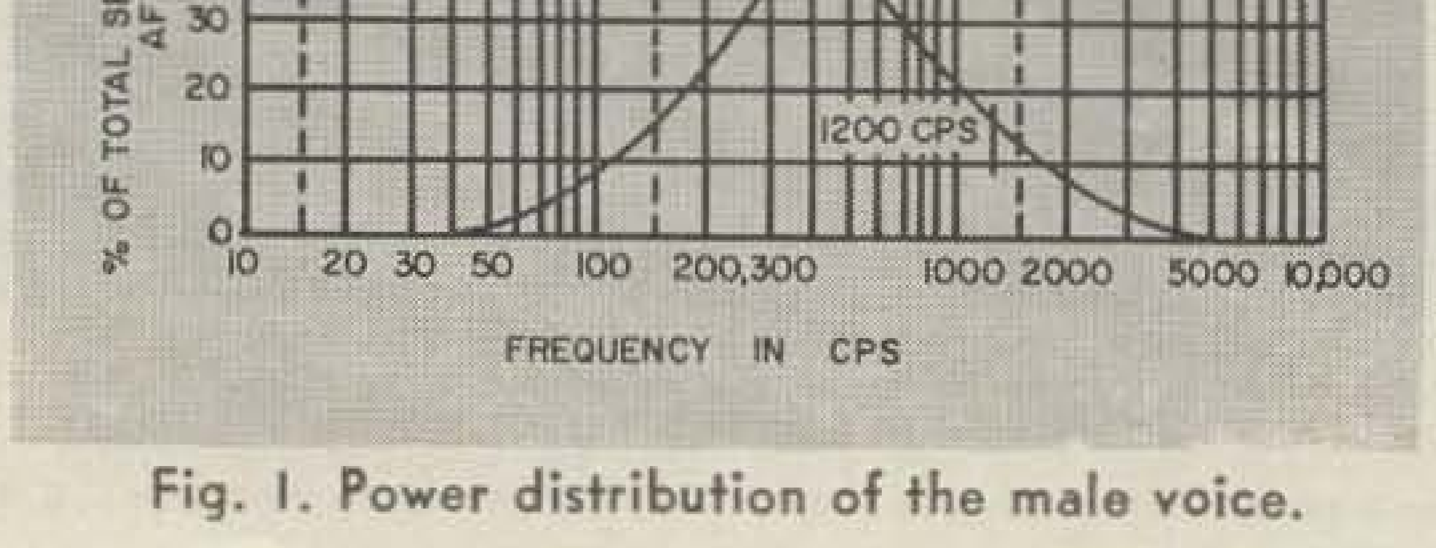


Fig. 1. Power distribution of the male voice.

any transmission conditions, and at the receiver can be used to reconstruct the modulating signal. Transmission-path noise never gets near the modulating signal at all; the only noise introduced is a type called "quanitizing noise" or "granularity," caused by the fact that the reconstructed signal is never a true replica of the original. The more characters provided in the code, the less this noise will be. Television signals can be transmitted with a 7-level code, but speech requires 256 levels of coding for "undistorted" reproduction.

So far, we've examined the entire field of modulation *processes* in general terms. Now let's look at the modulating *signal.*

In general, a modulating signal will consist of one of three forms of information: speech, visual material, or coded language. Speech needs no explanation. Visual material includes photos, typed, printed, or handwritten material, and live action such as television. Coded language includes "CW" coding, RTTY, and such lesser-used forms of coding as landline Morse.

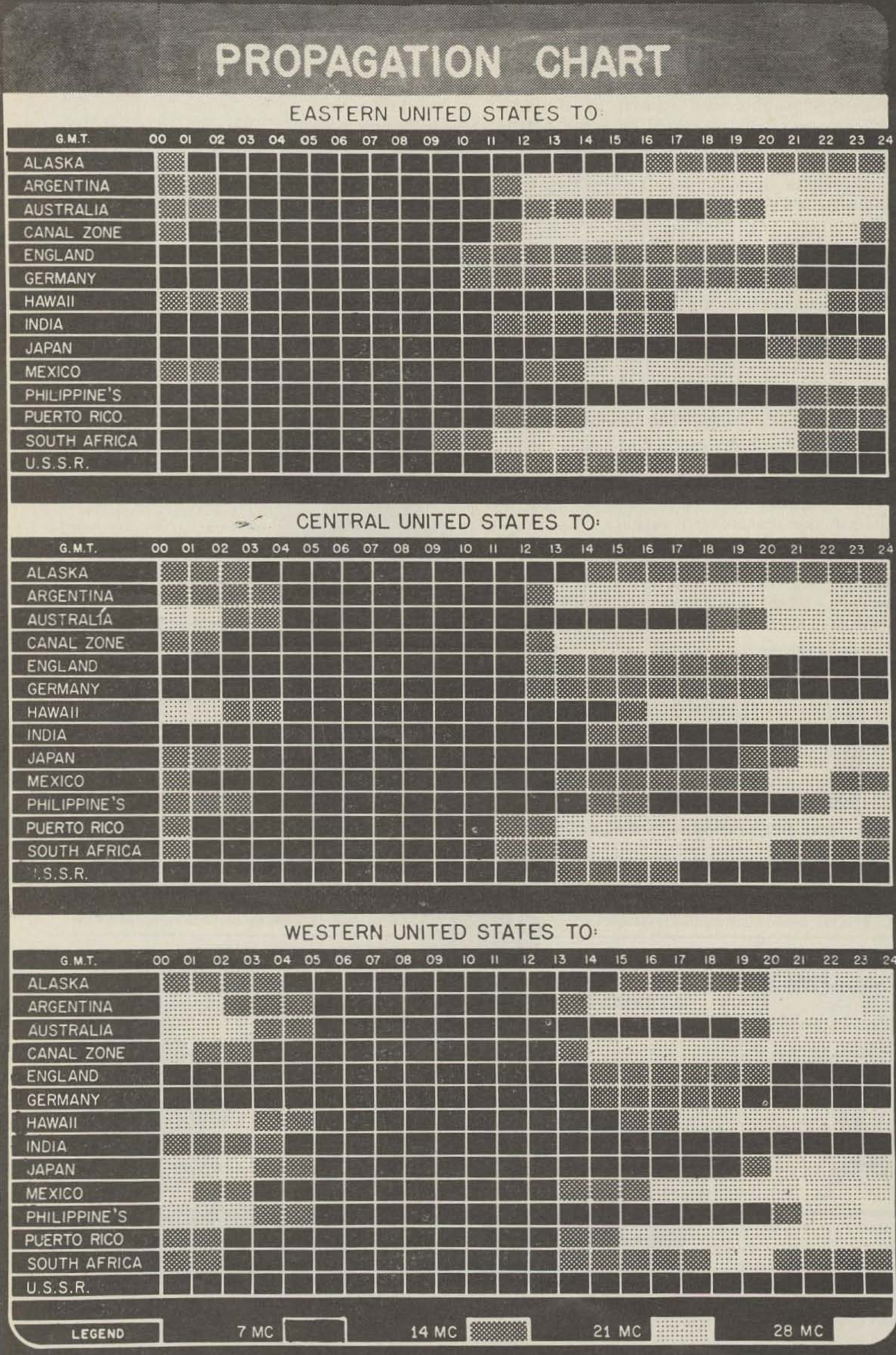
In any event, the modulating signal requires certain treatment before it can be used to modulate the transmitted output.

Speech exists as wavefronts in air. At the very least, these wavefronts must be converted to electrical signals by a microphone. However, telephone company studies have shown that a restricted bandwidth is sufficient to carry speech, and good practice requires that the bandwidth be restricted as far as possible to conserve space in the bands.

For many years, the magic figures of 300 and 3000 cycles per second have been taught as the lower- and upper-frequency limits for adequate intelligibility. We ourselves fell into this trap in an earlier technical article ("How Low the Fi," June, 1961). However, study of the actual curves published by Fletcher and republished by many others shows that the audio bandwidth can be restricted much more without hurting the transmission of information.

Figure 1 shows the average power content of human speech. Figure 2 shows the loss which results when the bandwidth is narrowed. Note that intelligibility suffers comparatively little when the frequency range is restricted to the band from 1200 to 1900 cps, but power content is reduced drastically. This means that modulator power may be increased

(Turn to page 78)


PROPAGATION CHART
EASTERN UNITED STATES TO:
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WESTERN UNITED STATES TO:
G.M.T.
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
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PHILIPPINE'S
PUERTO RICO
SOUTH AFRICA
U.S.S.R.
LEGEND
7 MC
14 MC
21 MC
28 MC

Propagation Charts

David A. Brown K2IGY
30 Lambert Avenue
Farmingdale, N. Y.

For the DX propagation chart, I have listed the HBF which is the best Ham Band Frequency to be used for the time periods given. A higher HFB will not work and a lower HFB sometimes will work, but not nearly as well. The time is in GMT, not local time.

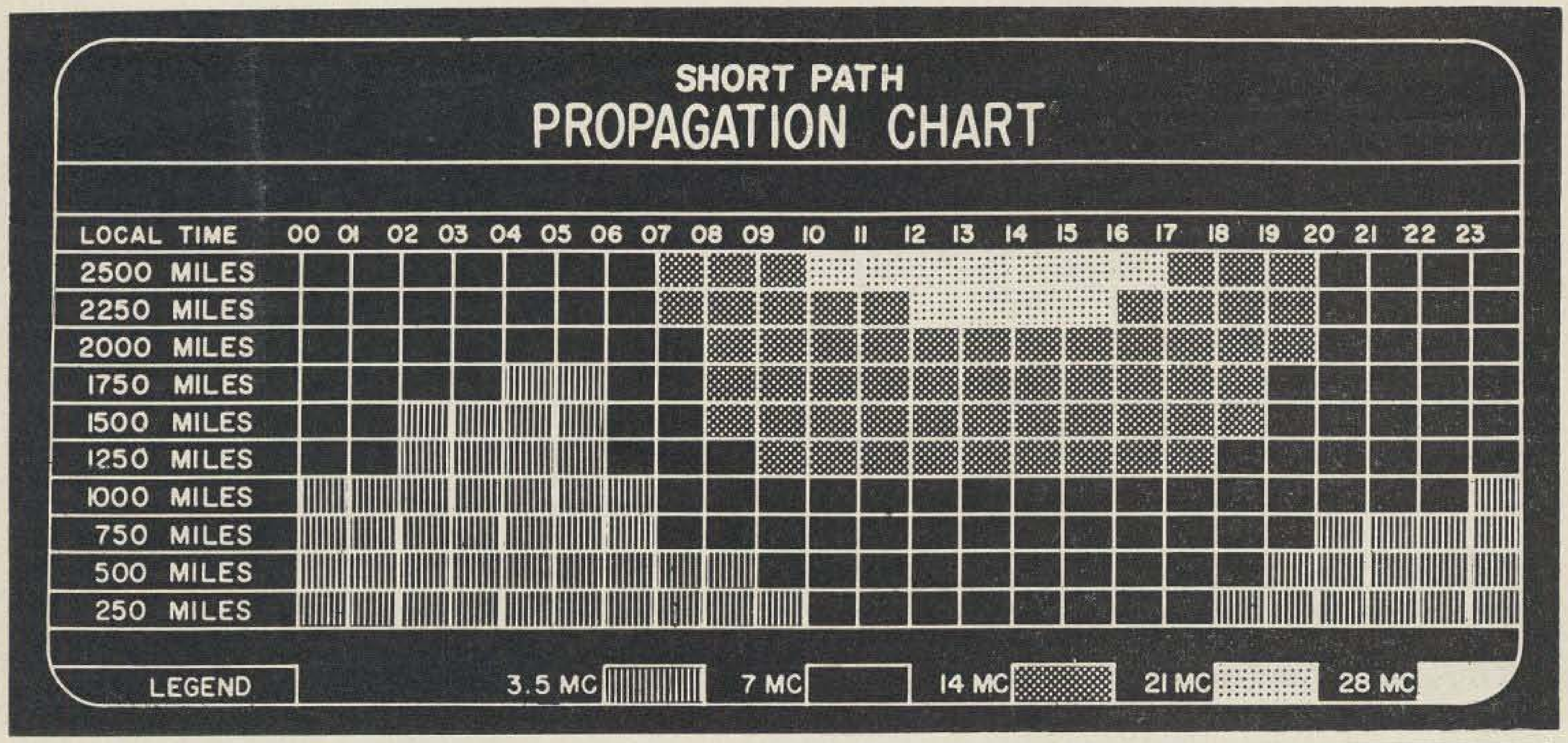
Advance Forecast: March 1962

Good: 1-23

Fair: 24-27, 29-31

Bad: 28

The Short Path propagation chart has been set up to show what HFB to use for coverage between the 48 states. Alaska and Hawaii are covered in the DX chart. The use of this chart is somewhat different than the DX chart. First, the time is the local time centered on the mid-point of the path. Second, the distance given in miles is the Great Circle path distance because of the Earth's curvature. Here are a couple of examples of how to use the chart. A.) To work the path Boston to Miami (1250 miles), the local time centered on the mid-point of the path is the same in Boston as in Miami. Looking up the HBF's next to the 1250 mile listings will give the HFB to use and the time periods given will be the same at each end of the circuit. B.) To work the miles), the local time centered on the mid-point of the path will be 1½ hours later than at San Francisco and 1½ hours earlier than in New York (the time difference between New York and San Francisco is 3 hours). Looking up the HBF's next to the 2,500 mile listings will give the HFB to use. In San Francisco subtract 1½ hours from the time periods listed for local time and in New York add 1½ hours to the time periods listed for local time.



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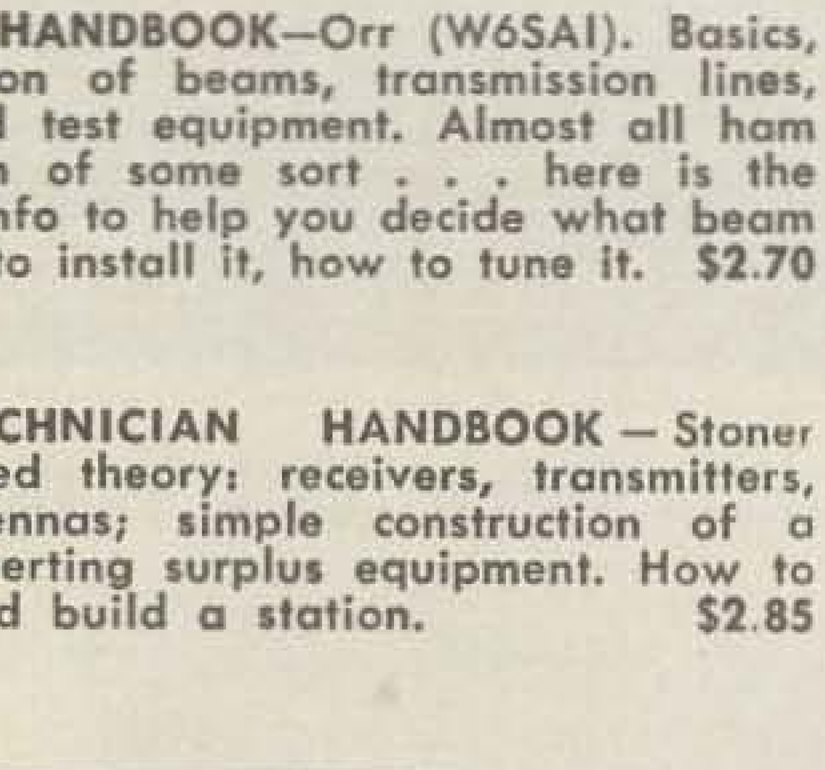

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(Modulation from page 73)

many times, giving more punch at the other end while maintaining bandwidth narrow.

In field tests, we at 73 determined that the 700-cycle bandwidth had no detectable effect on information transmission, except that it made formerly-muddy signals *easier* to copy and reduced hetrodyne interference (our filter was in the receiver). Of course, nobody sounded natural—but the loss of naturalness is a small price to pay for the increased power at the far end.

If you prefer to stay with the accepted frequency response limits, means of shaping the response of any speech modulator are shown in Figures 3 and 4. A narrow-band filter for cutting to the 1200-1900 cps range is shown in Fig. 5.

Transmission of visual material requires that the changes in light-wave intensity which make up the visual image be converted to electrical signals. For still-picture material, the flying-spot scanner is excellent. A circuit is shown in Fig. 6. This device operates by sweeping a spot of light across the picture in a predetermined pattern, and picking up the light with a photocell. Where the picture is dark, little light will reach the photocell and the electrical output will be small. If the picture is light, much light reaches the photocell and electrical output is large.

Transmission of moving visual material requires television techniques, easily an entire book in themselves. Several are listed in the bibliography.

Finally, we come to coded language. In practice, this boils down to "CW" and RTTY.

Most of us consider CW as a form of modulation all by itself. However, in a strict sense it is amplitude modulation with a two-valued

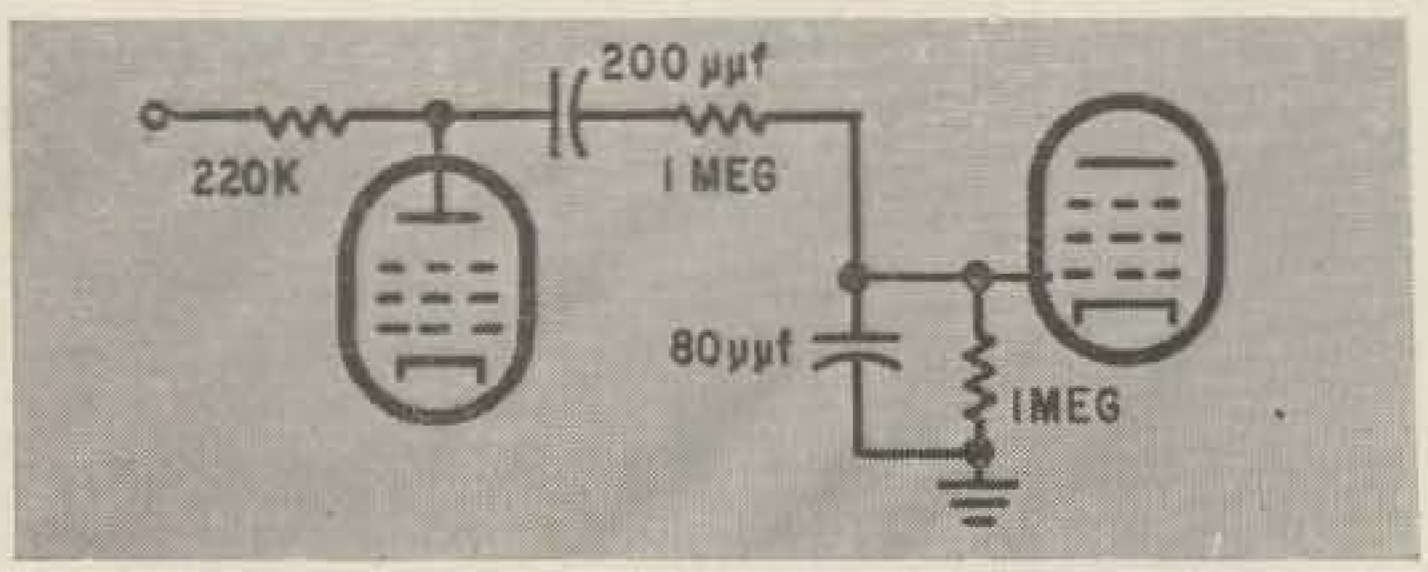

Fig. 3. Low level frequency shaping. Added or changed parts shown in heavy lines; change every R-C stage as shown.

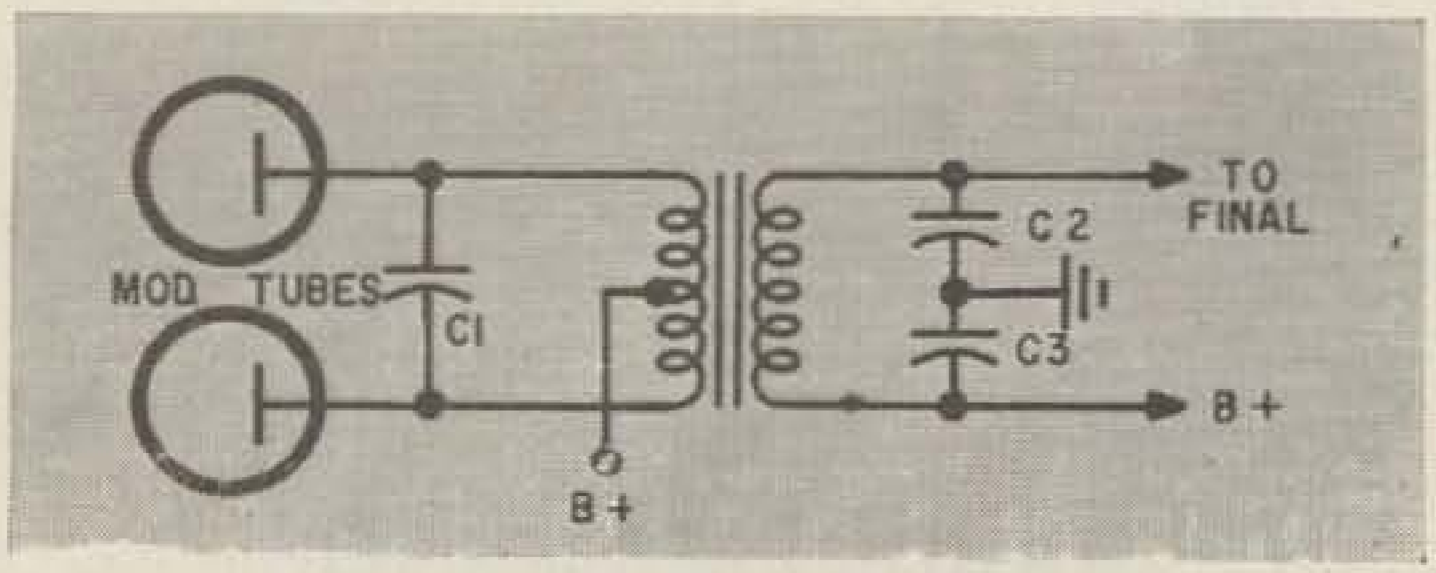

Fig. 4. High level frequency shaping. C1—.01 to .0001 mfd. choose by experiment. C2—existing bypass. C3—power supply output capacity. Note similarity to tuned if transformer.

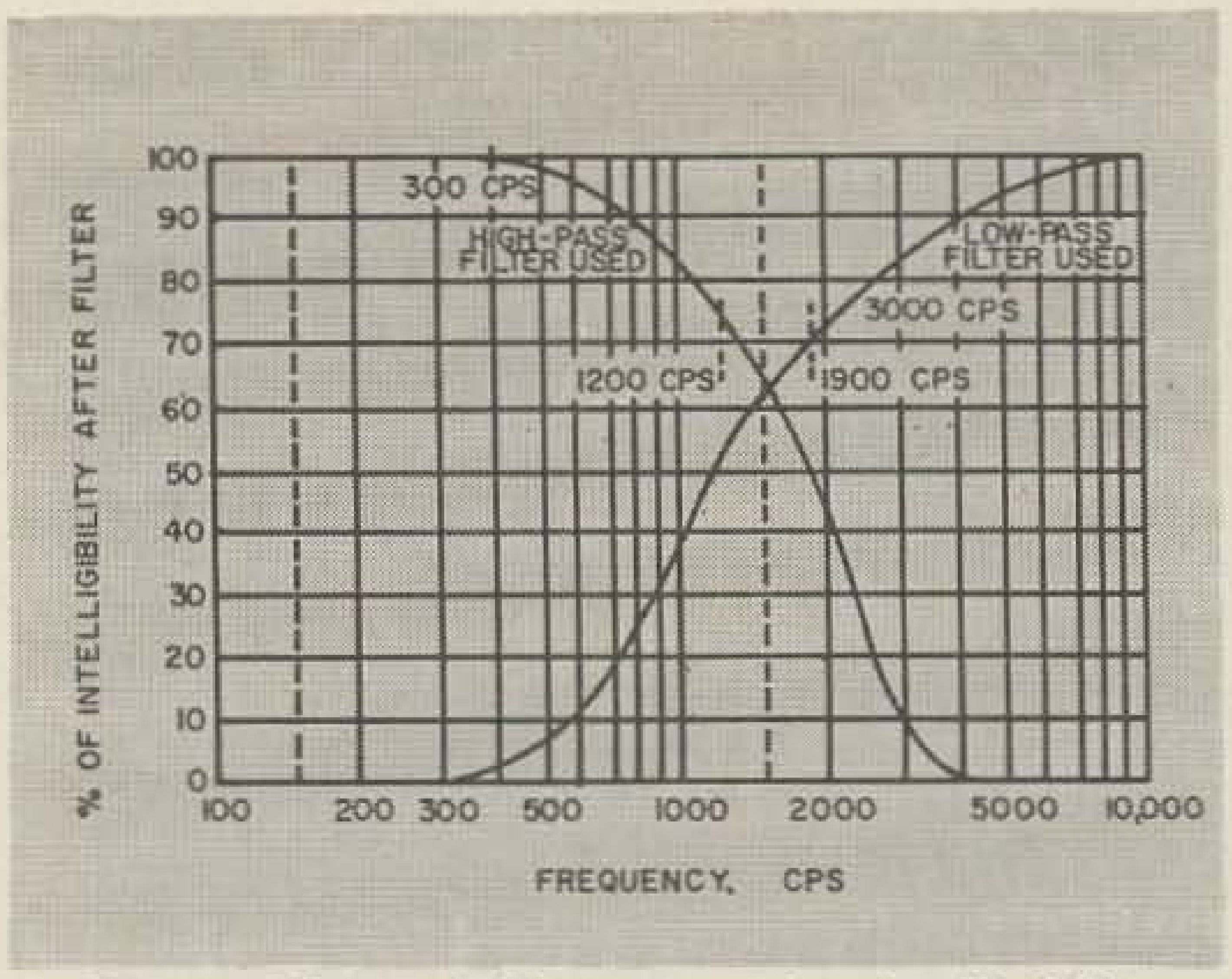

Fig. 2. Effect of filters on voice intelligibility.

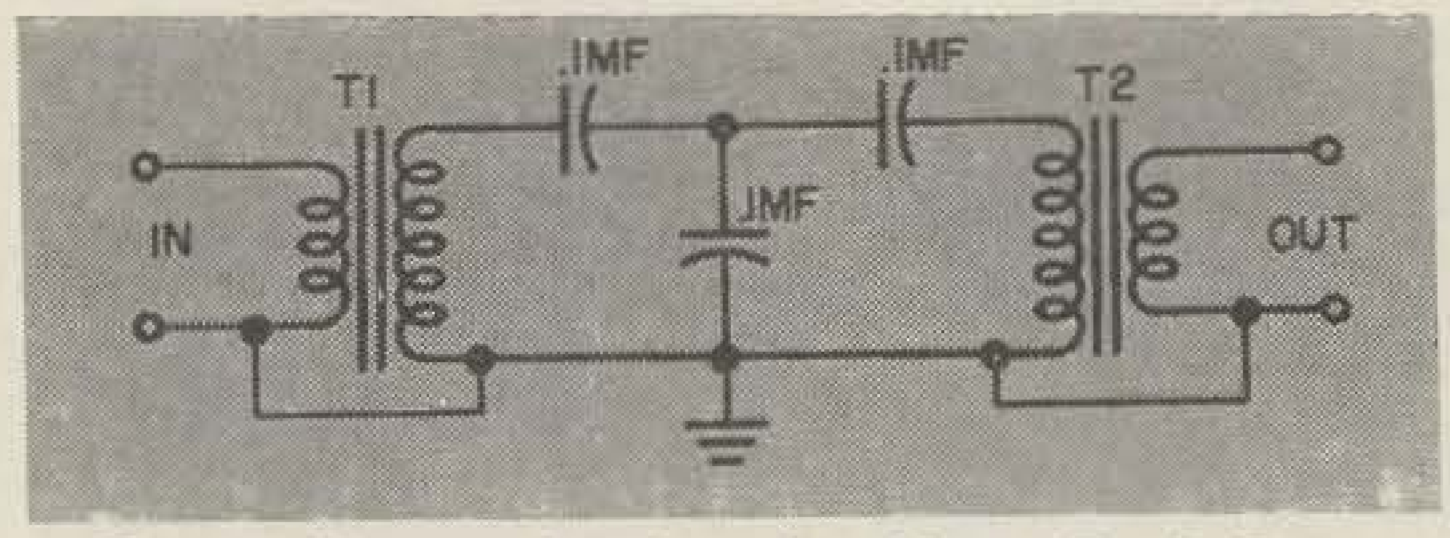

Fig. 5. Narrow band audio filter. T1 & T2—Stancor WC-17 width coils. Disconnect T1 & tune T2 for 1600 cps peak; disconnect T2 and tune T1 for 1600 cps peak; reconnect T2. Use low-Z drive and high-Z loading.

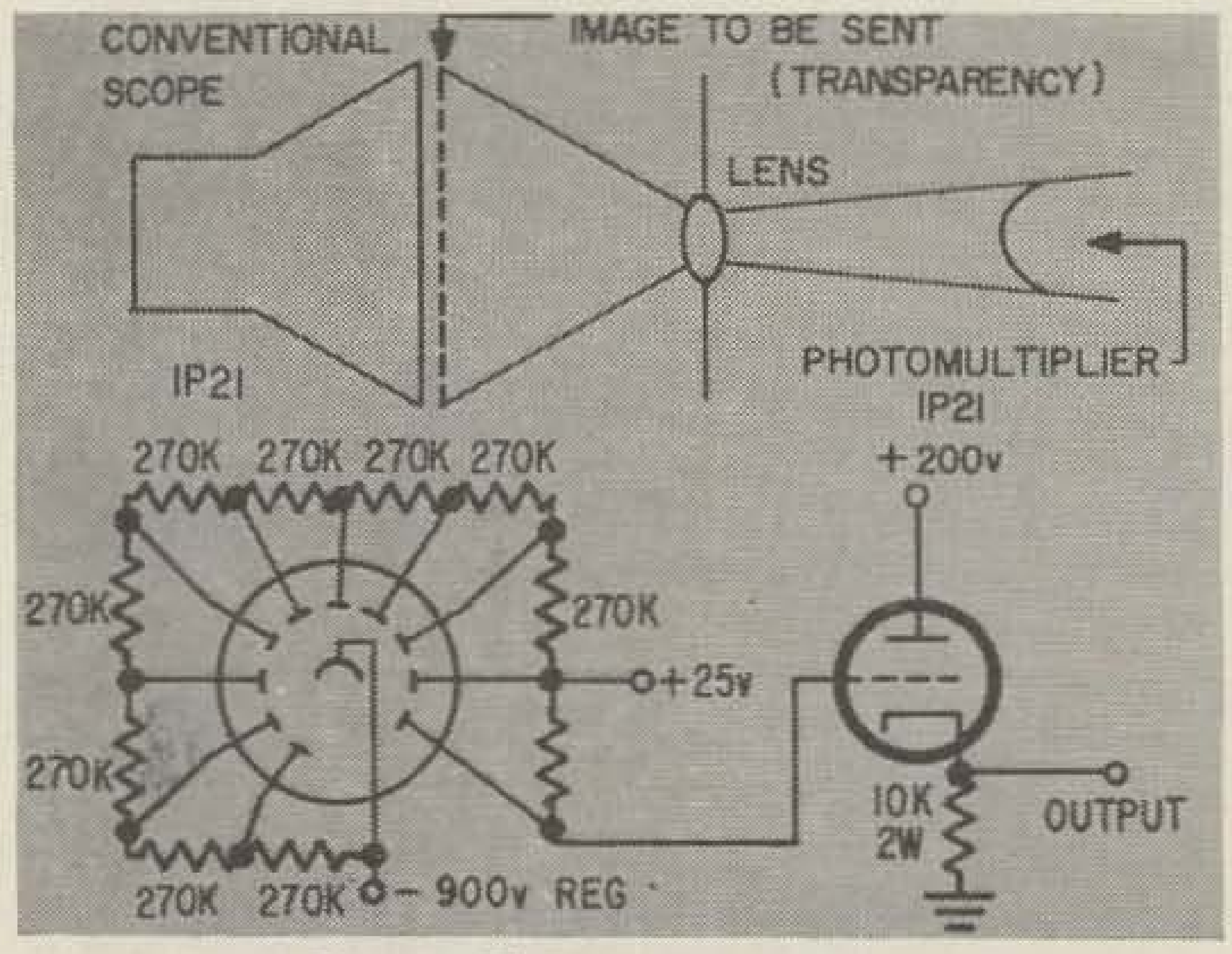

Fig. 6. Flying-spot scanner.

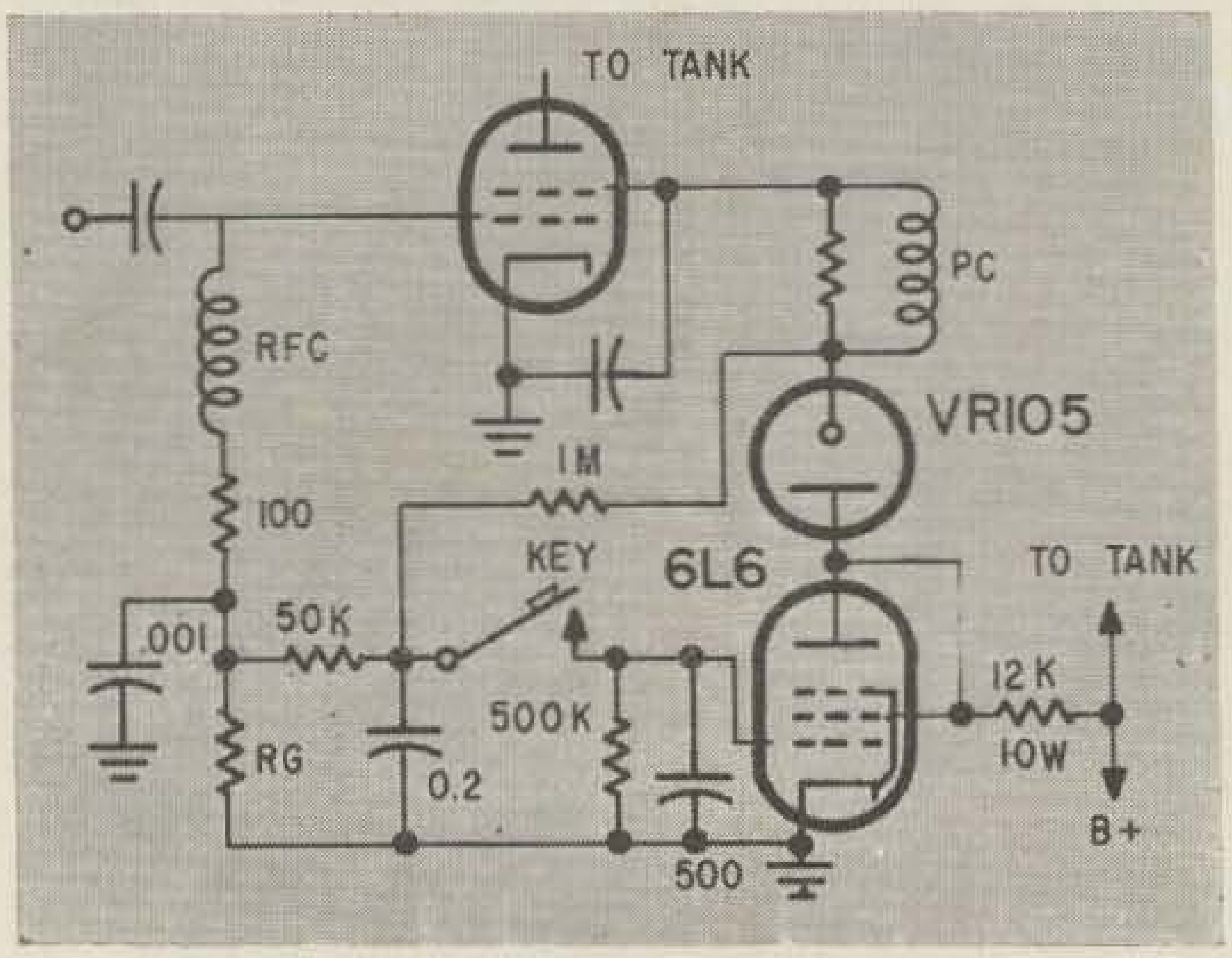

Fig. 7. Clamp-tube keyer.

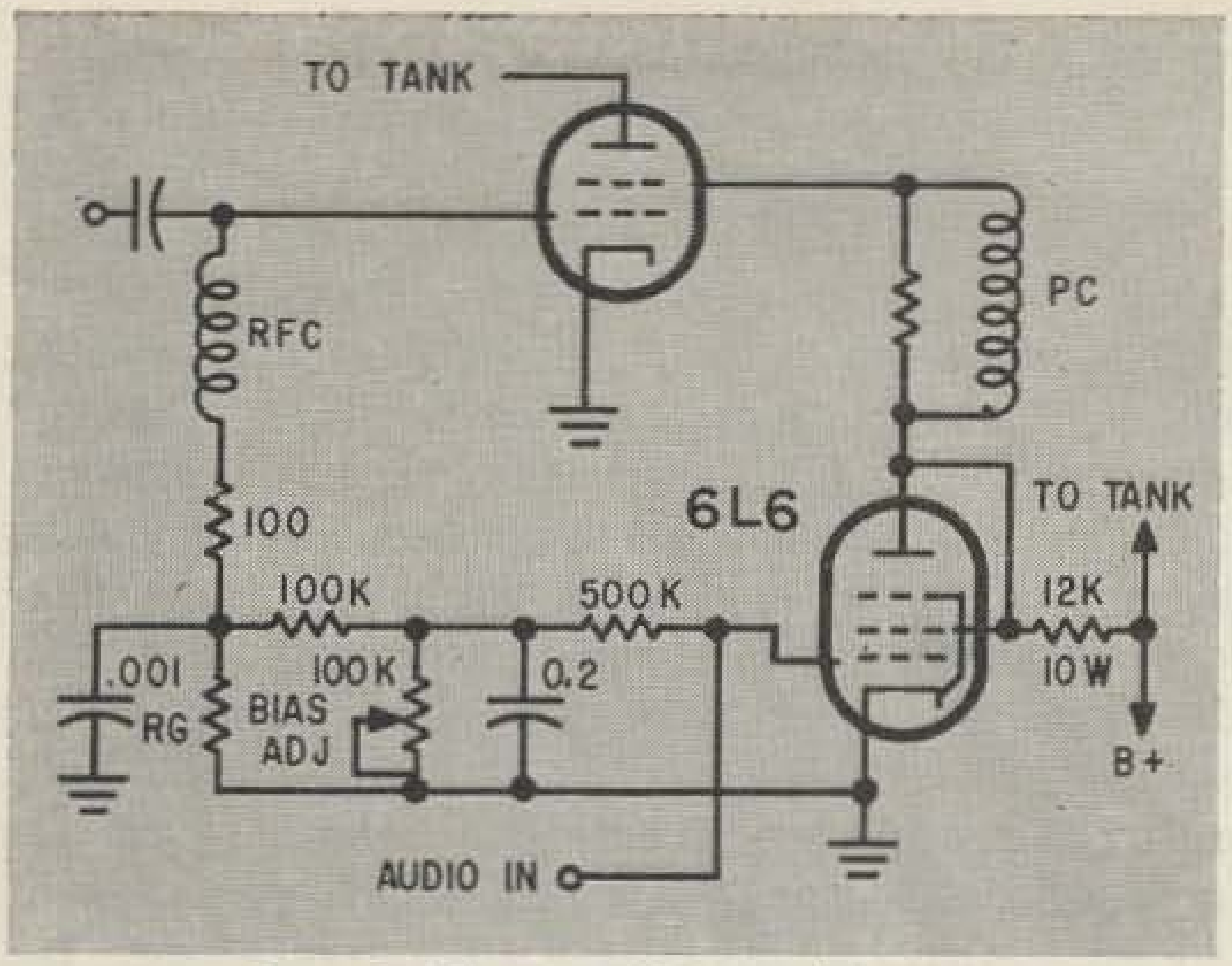

Fig. 8. Clamp-tube modulator.

signal. The major difference is that the signal is apparently electrical from the start. We say "apparently" because actually, it is not.

The signal starts in the mind of the originator. Using CW with a hand key, as an example, he decides to give his old buddy W2NSD a call. The signal begins as his determination to send the characters W, 2, N, S, and D in sequence. He consults his memory (most frequently at the subconscious level) for the code equivalents, and then converts the letters into electrical signals by pressing the key in the proper pattern to obtain didahdah dididadadah dadit dididt dadidit as an output from his monitor.

CW is amplitude modulation because the amplitude of the output signal is the characteristic that is changed. This amplitude is either maximum, or it is zero. The essential similarty of CW and A3 modulation may be seen by comparing the clamp-tube keyer, Fig. 7, and the clamp-tube modulator, Fig. 8. The only difference is that the keyer includes provision for reducing the output amplitude to zero when the input modulating signal is zero.

The major reason for bringing this discussion up is to describe a method for eliminating key clicks and other nuisances of CW operation, which may be visualized easily once the CW signal is seen as a type of amplitude modulation.

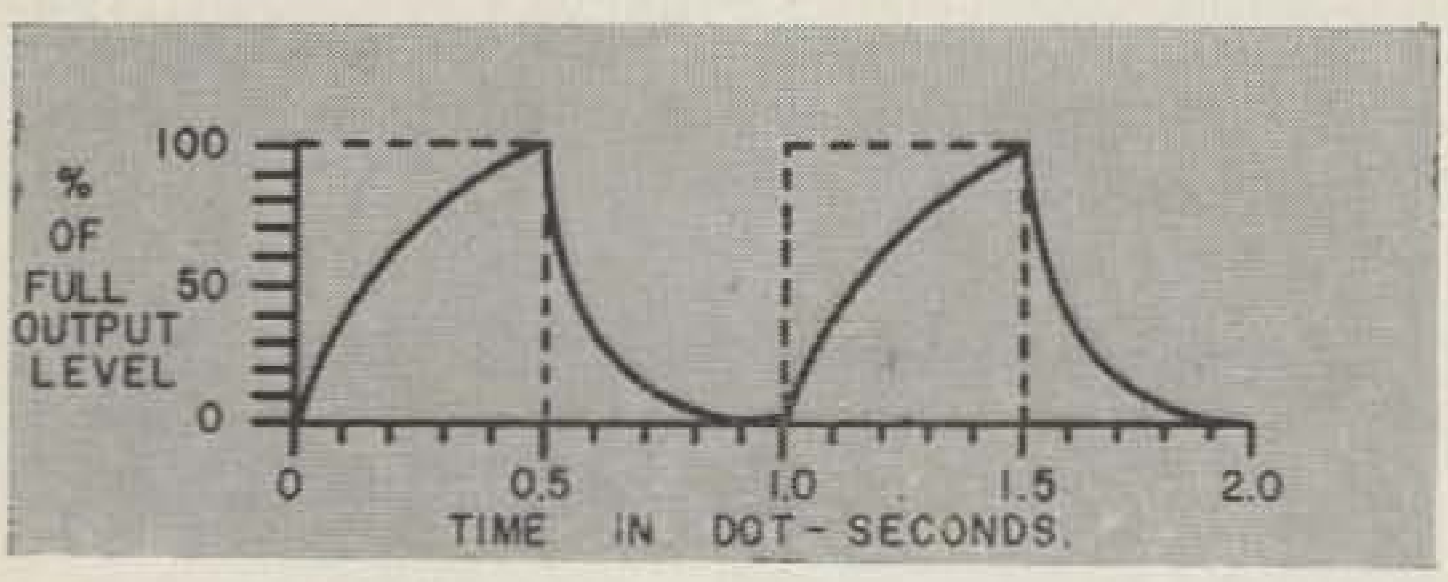

Fig. 9. Clickless keying waveform.

Since the CW modulating signal is binary—either on or off, with no in-between—it is essentially a square wave. By definition, a square wave is made up of a sine wave at the fundamental frequency, plus *all* the odd harmonics of this sine wave. Modulation

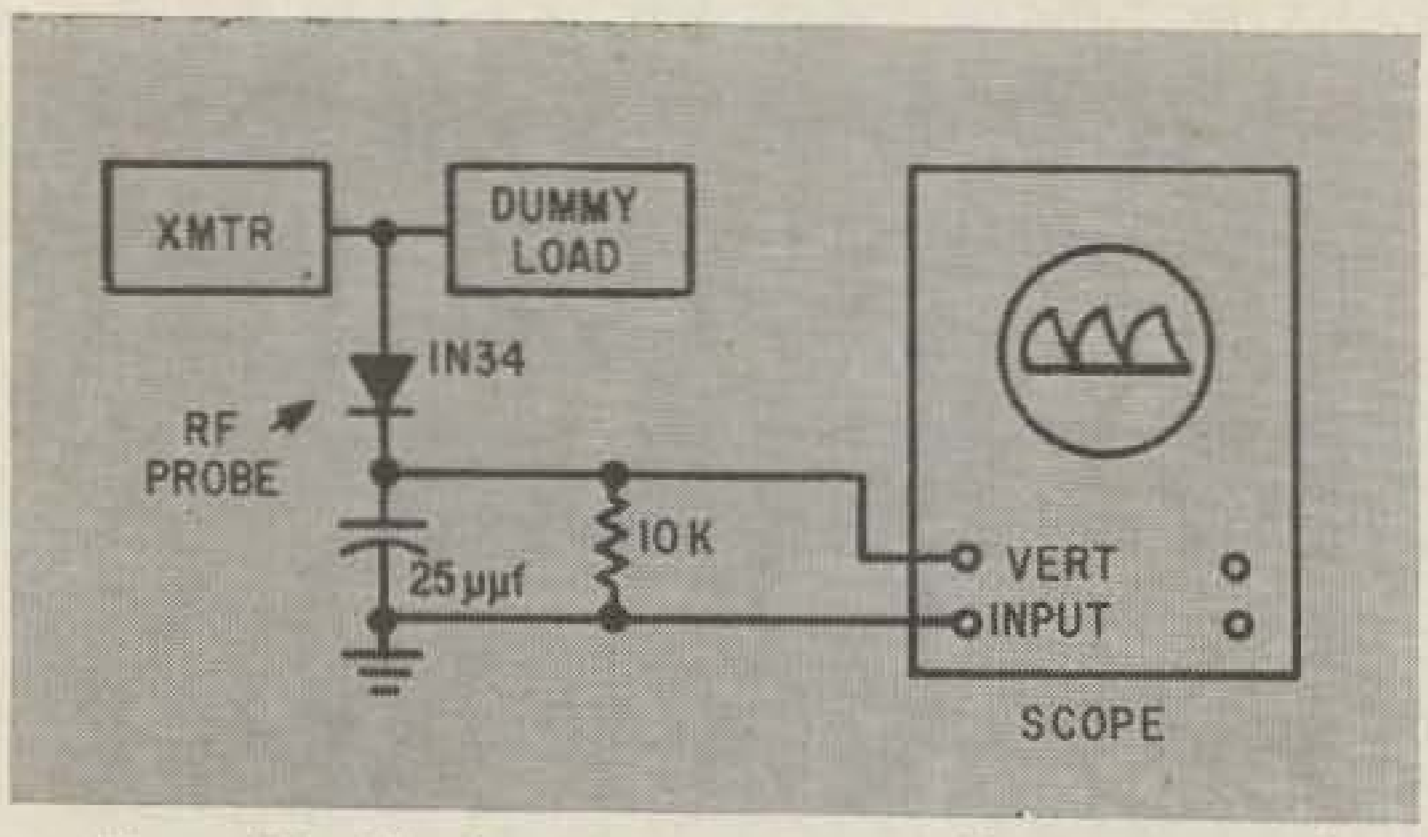

Fig. 10. Keying test set-up. Sync—internal; sweep—internal, 15 cps; key rig at 50-60 wpm.

theory tells us that a modulated signal must contain sidebands which extend as far from the carrier as the uppermost frequency of the modulating signal—and the "infinityth" harmonic of anything is infinity. This means that our square-wave keying will produce side frequencies which go out to infinity; these are the radiations usually called key clicks.

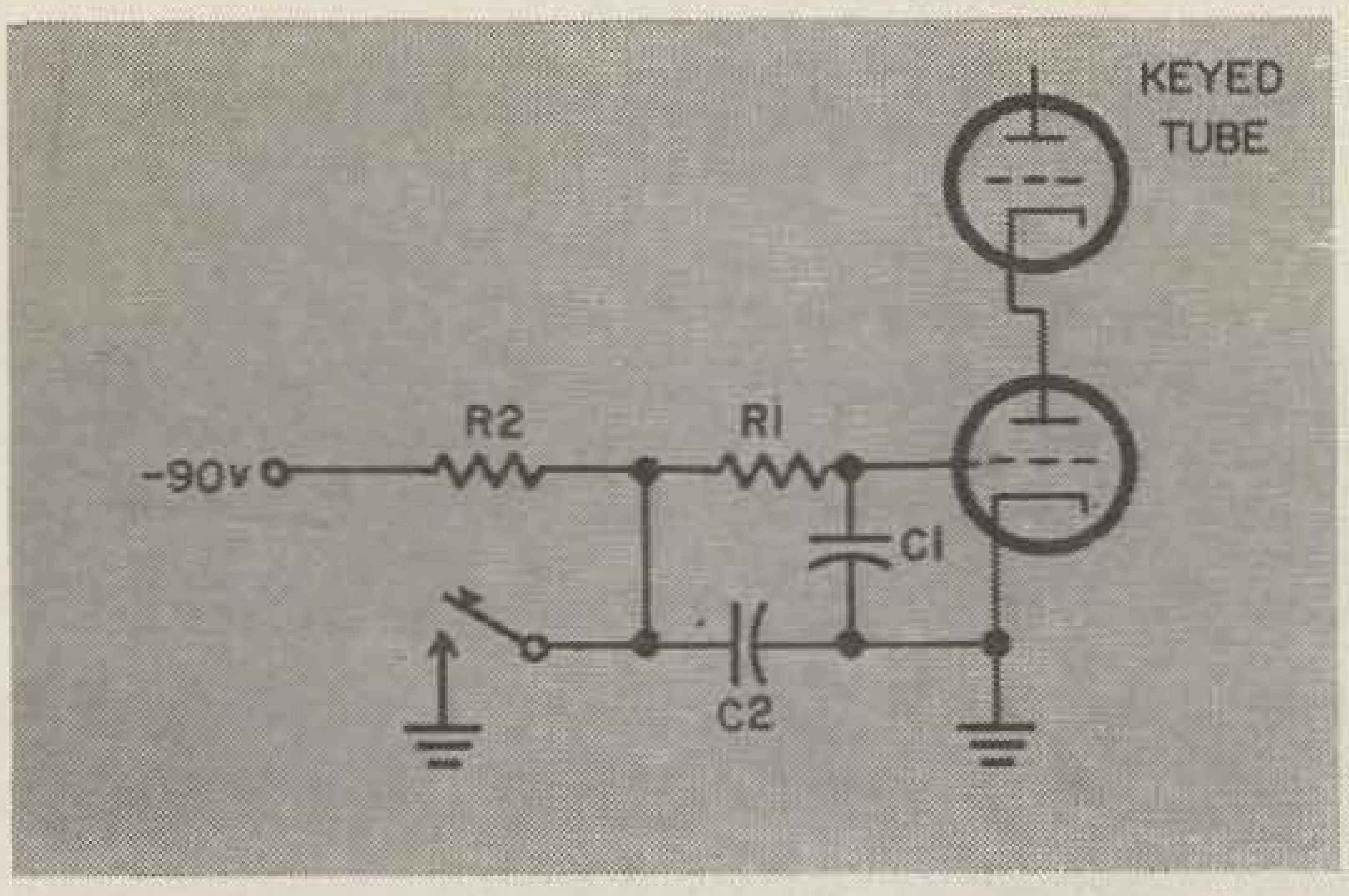

Fig. 11. Keying waveform shaping circuit. C1 and R1 control leading edge. C2 and R2 control trailing edge. Typical values: C1—.003 mfd. R1—1 meg., C2—.001 mfd, R2—1 meg.

Studies by W. A. Edson have shown that readability of a CW signal just begins to suffer when the square-wave modulating signal has been distorted to the point shown in Fig. 9. This waveform contains only the fundamental frequency, its third harmonic, and a trace of fifth harmonic. Thus, by adjusting the "modulator" (if you want to be conventional, that's the keyer stage) to produce this wave shape at the transmitter output from a string of dits, key clicks have been completely eliminated while readability hasn't been hurt.

If you have a scope handy, you can set up the shaping circuits without ever going on the air. Rig up the rf probe shown in Fig. 10, hook the transmitter to a dummy load, and send a string of dits while adjusting the keyer for a scope waveform like that shown in Fig. 9. A frequency-shaping circuit which may be used to get the proper waveform is shown in Fig. 11.

We've been talking about CW only for the last few paragraphs, but RTTY is also a coded-language form of modulation. Like television, it's a book all to itself. See the bibliography for references.

With the types of modulation and the modulating signal both well in hand, the only thing left to look at is the modulating process itself. This is where the circuitry comes in, since many ways have been developed to achieve each type of modulation and each way has its advantages and disadvantages. Let's look at them in order, with the advance warning that the collection is far from complete. The field is so wide and includes so many circuits that all circuits which are fully described in the two standard ham handbooks have been omitted from our listing, to leave room for some of the lesser-known arrangements.

Let's start with type A3 modulation, the conventional voice variety which ends up with two sidebands and a carrier. This output signal may be achieved through plate modulation, screen modulation, or cathode modulation. Plate, cathode, and several types of screen modulation are covered elsewhere, but the circuit of Fig. 12 seems to have been largely overlooked by the compilers of handbooks.

This circuit is similar to Heising or constant-current plate modulation (see handbooks for details of these) in that the dc current flow through the choke remains relatively constant. With no modulating signal, part of the current flows to the screen of the final and the rest flows through the modulating tube. When the modulating signal swings positive, the resistance of the modulating tube drops and more current flows through it. The choke opposes sudden change in total current, so the current flow to the final screen becomes less; since the dynamic screen resistance is unchanged, the drop in current causes a drop in voltage. The decreased screen voltage causes a decrease in power output. When the modulating signal swings negative, the opposite happens. More current flows to the screen, the voltage rises, and power output increases. If no-signal voltage levels are properly set, modulation will be linear. In practice, the

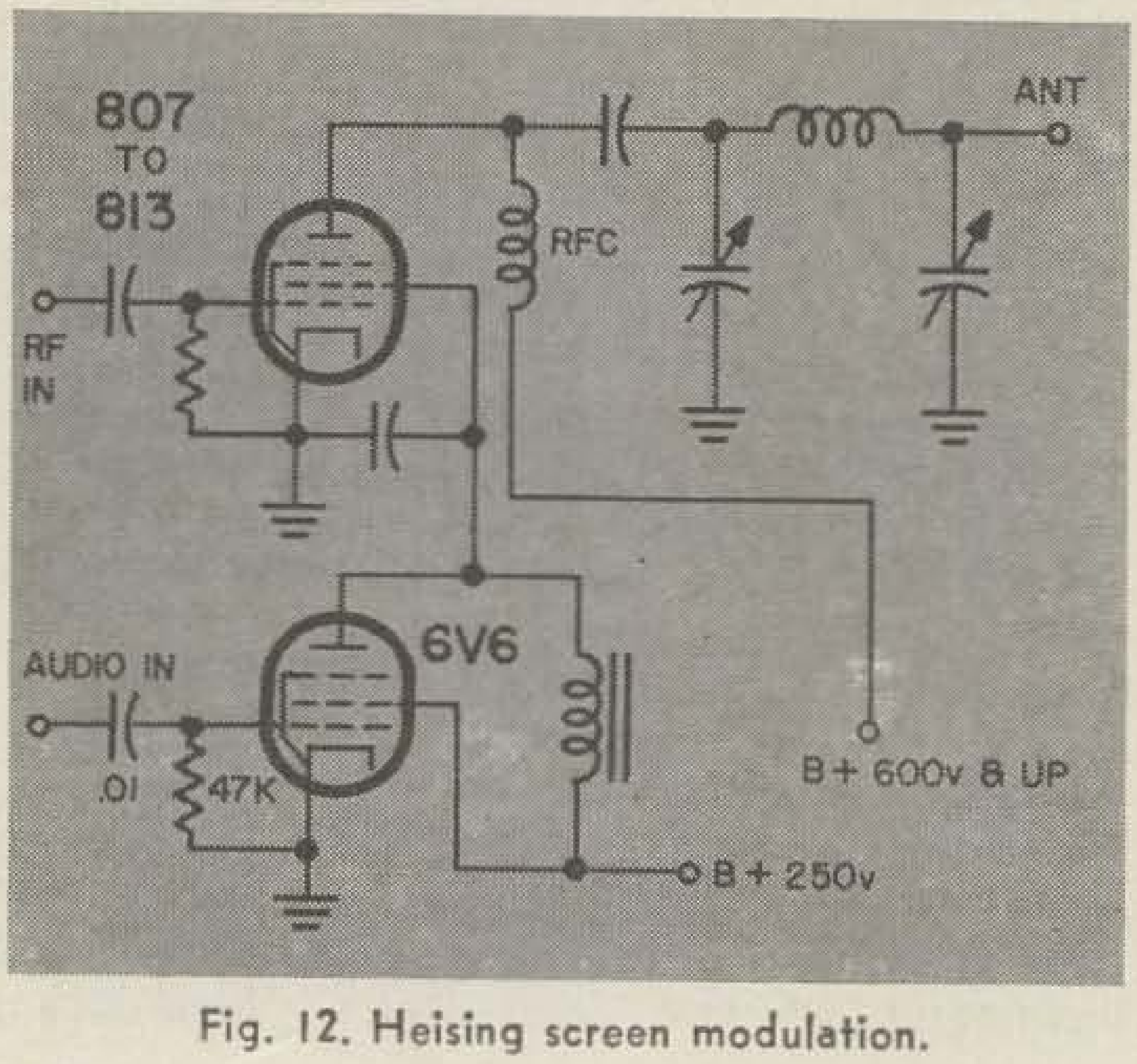

Fig. 12. Heising screen modulation.

system tends to adjust itself. Overmodulation is impossible since *some* screen current always flows. Like all screen modulation circuits, however, this arrangement is critical in drive and loading requirements, and gives only about 35 percent efficiency.

Another screen-modulation circuit not widely used is the one shown in Fig. 8, which differs from conventional clamp-tube modulators in that grid bias for the modulating tube is obtained from the final grid. Thus, the clamp-tube serves the same purpose for A3 that it does for CW in protecting the final tube in case drive is lost. Bias is adjusted for the most linear modulation, as determined by on-the-air or by scope tests.

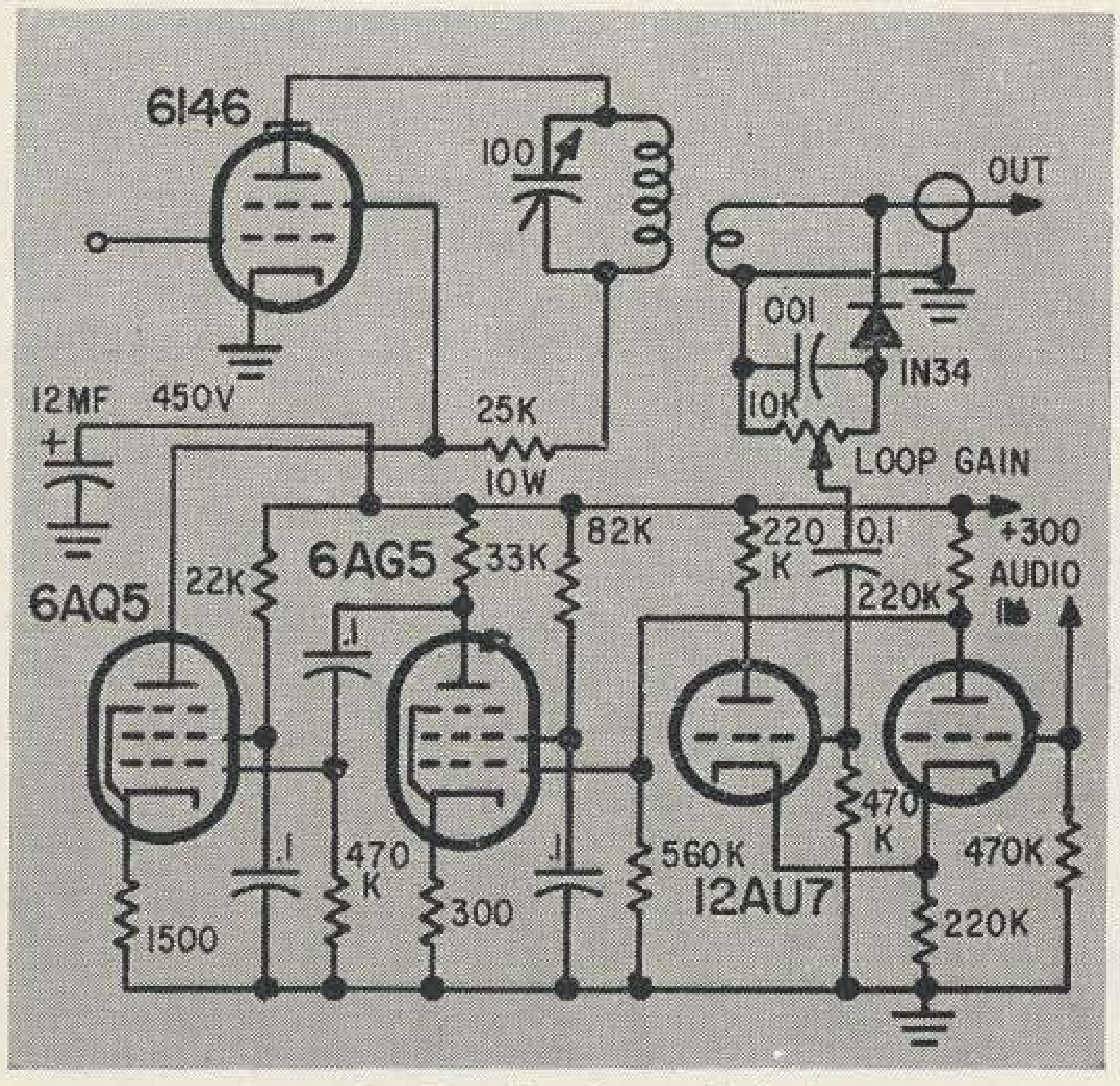

Fig. 13. Feedback modulation.

One of the great problems with screen, suppressor, and cathode modulation systems is lack of linearity. This can be overcome easily if we swipe a stunt from the hi-fi crowd and apply negative feedback to the modulator. The overall feedback connection is shown in Fig. 13. This uses a detector to pick off some of the radiated signal, then feeds the detected signal back in the proper phase to the modulator to eliminate any distortion. Linearity of such a modulator is inversely proportional to the gain within the feedback loop; if the total gain within the loop is 100, for example, modulation linearity will be approximately 1/100 or 1 percent. The circuit shown has a gain of 50, giving 2 percent linearity.

Another use of feedback is around the high-level modulator stage alone as shown in Fig. 14. This does nothing for the modulation linearity, but compensates greatly for the poor low-frequency response of most inexpensive modulation transformers and reduces distortion when heavy clipping and compression is used.

Single- and double-sideband circuits have been covered widely elsewhere, and at any rate deserve an article all to themselves, so we'll merely take notice of their existence at this point before swinging over to the field of FM.

FM may be obtained in a number of ways. The most common among us hams is by use of a reactance tube to vary the frequency of a VFO, and this approach is covered in all the handbooks. However, at least four other practical methods are almost unknown in the literature.

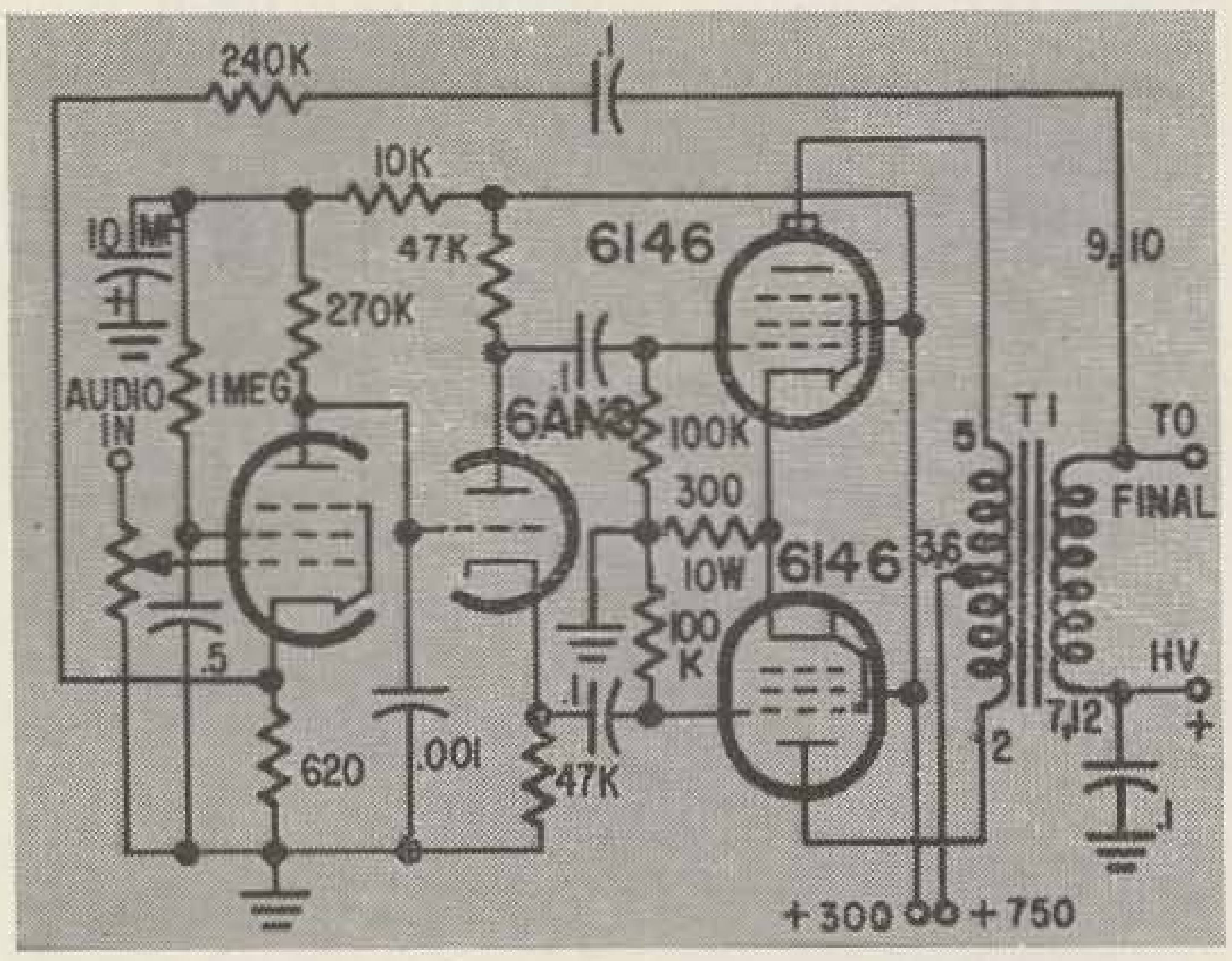

Fig. 14. Feedback plate modulator. T1—Stancor A-3893.

Most recent of these methods is that described in our October issue—the use of a voltage-variable capacitor across part of the tank circuit. The circuit is shown in Fig. 14. Hint—a Sarkes-Tarzian M500 rectifier hooked up in reverse (positive to cathode, negative to anode) does a fine job as a voltage-variable capacitor.

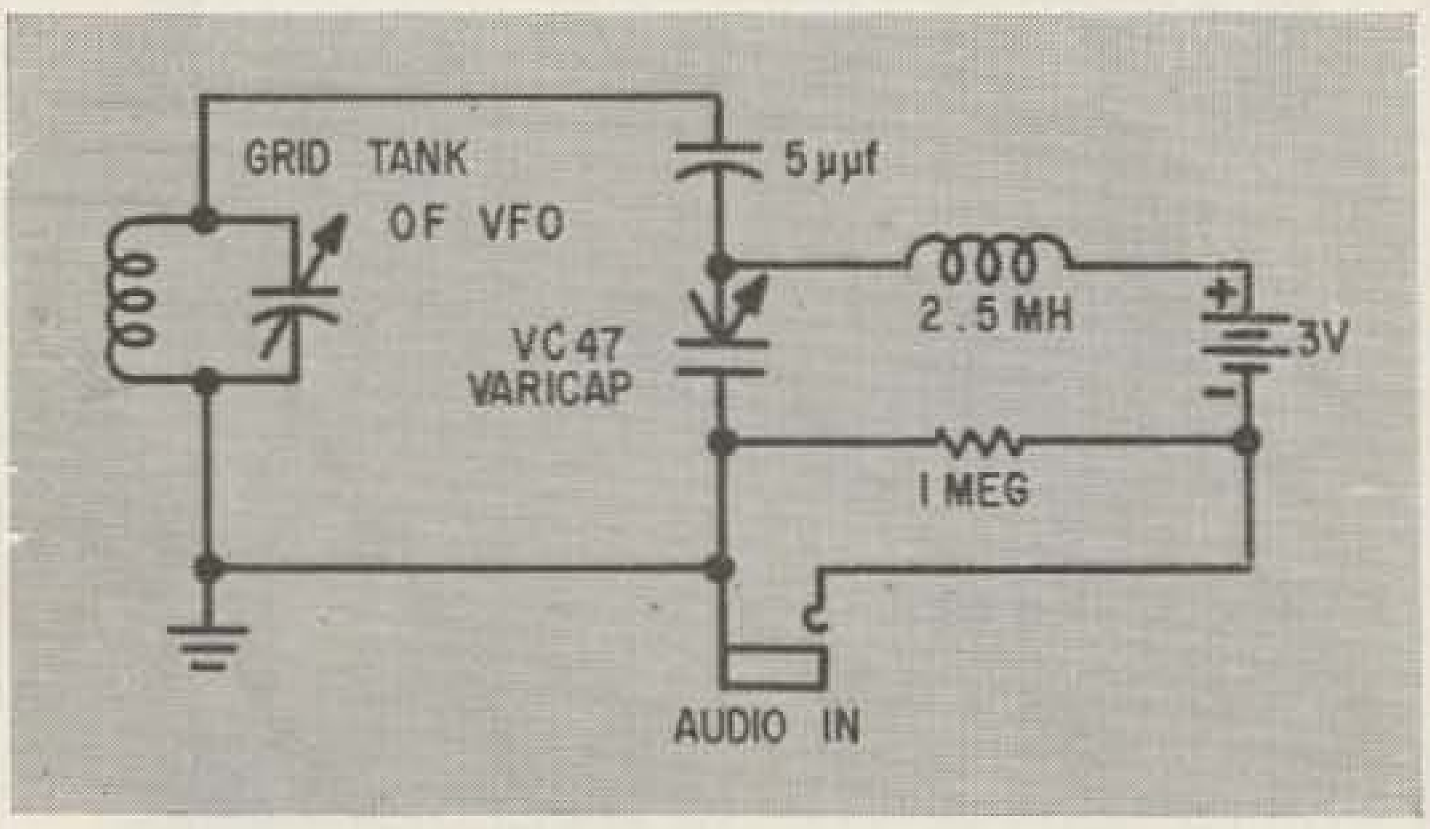

Fig. 15. Varicap FM modulator (from page 10, October '60, 73).

Similar, but much older, is the use of a ceramic capacitor for the same result. Certain ceramic dielectric materials change their properties according to the voltage across them, and the material used in the "Hi-K" series is one of these. By putting one of these capacitors into the VFO tank circuit as shown in Fig. 15 and applying high-voltage audio to it as shown, highly acceptable FM is produced.

Major Armstrong's FM system used still another approach, which is coming into ham use via several SSB exciters which include FM provision. His system used parallel chains of DSB and phase-shifted carrier signals, combined in such a manner that essentially pure

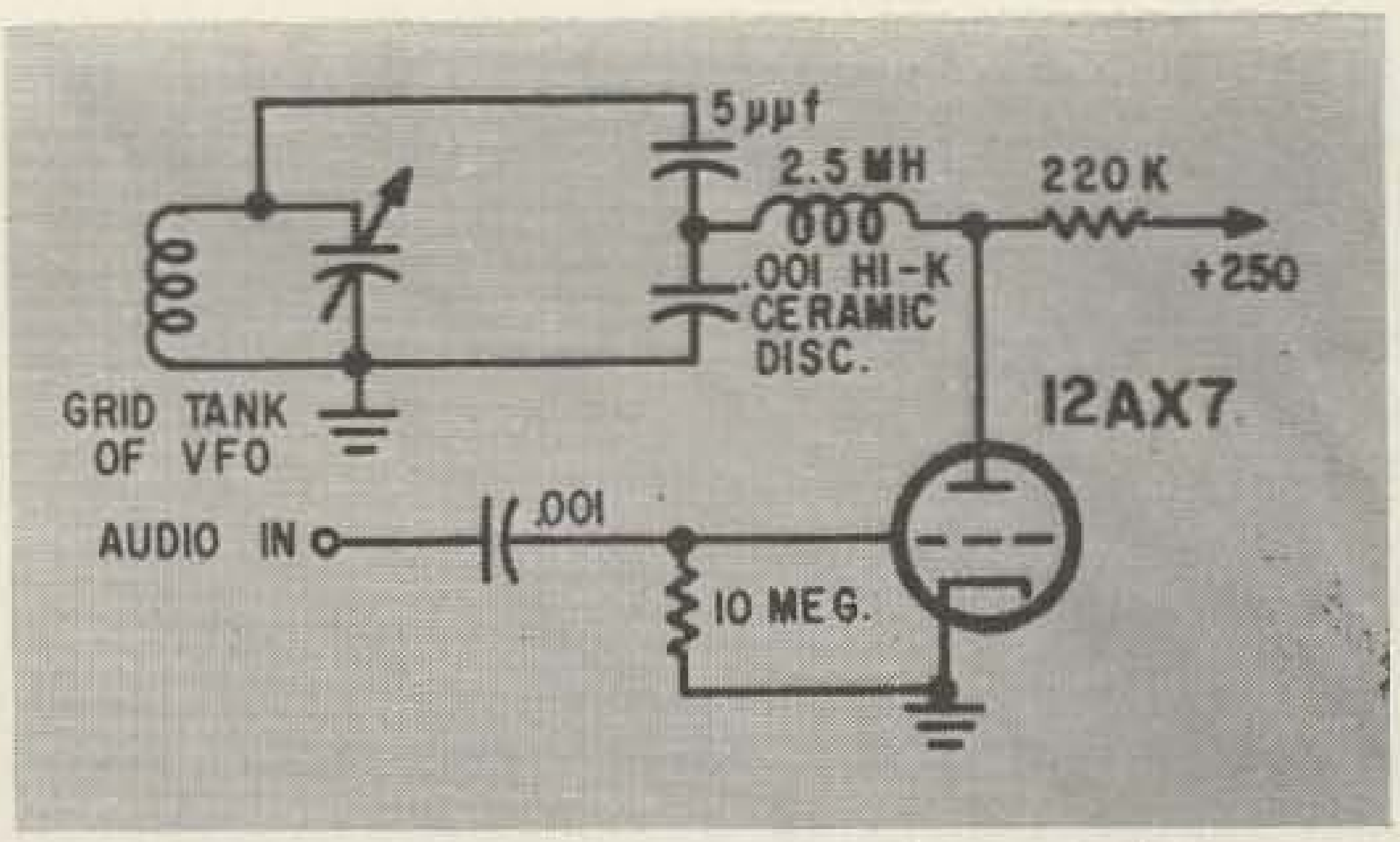

Fig. 16. Ceramic capacitor FM modulator.

phase modulation resulted. A block diagram is shown as Fig. 16. Since the schematics for such a system are highly detailed, they are left in the original references if you're interested.

The fourth aproach gives wider deviation than any other, but is limited to rather low carrier frequencies. It makes use of a multivibrator circuit rather than a conventional VFO, and varies the "on" time of one of the multivibrator tubes to vary the frequency. Since the multivibrator output consists of a fundamental sine wave and *all* its odd harmonics, this variation in "on" time corresponds to a variation of not only the fundamental but all the harmonics. The desired harmonic is then taken out through a bandpass filter, and amplified.

A schematic for such an FM modulation system is shown in Fig. 16. This operates at a basic frequency of 400 kc, taking off the fifth harmonic for an output frequency of 2 mc. This 2 mc output may then be multiplied up to the desired final output frequency.

In addition to the modulation changes, the basic frequency may be changed by varying the setting of resistor R1, thus allowing remote tuning without capacitors.

Enough for type F3; let's look briefly at type F1 before going on to the less-familiar pulse-modulation circuits.

With F1 modulation, we're concerned with only two frequencies, shifting from one to the other in accordance with the modulating signal. If you're using crystal control, the simplest way to do this is to add capacity in series with the crystal through a diode switch

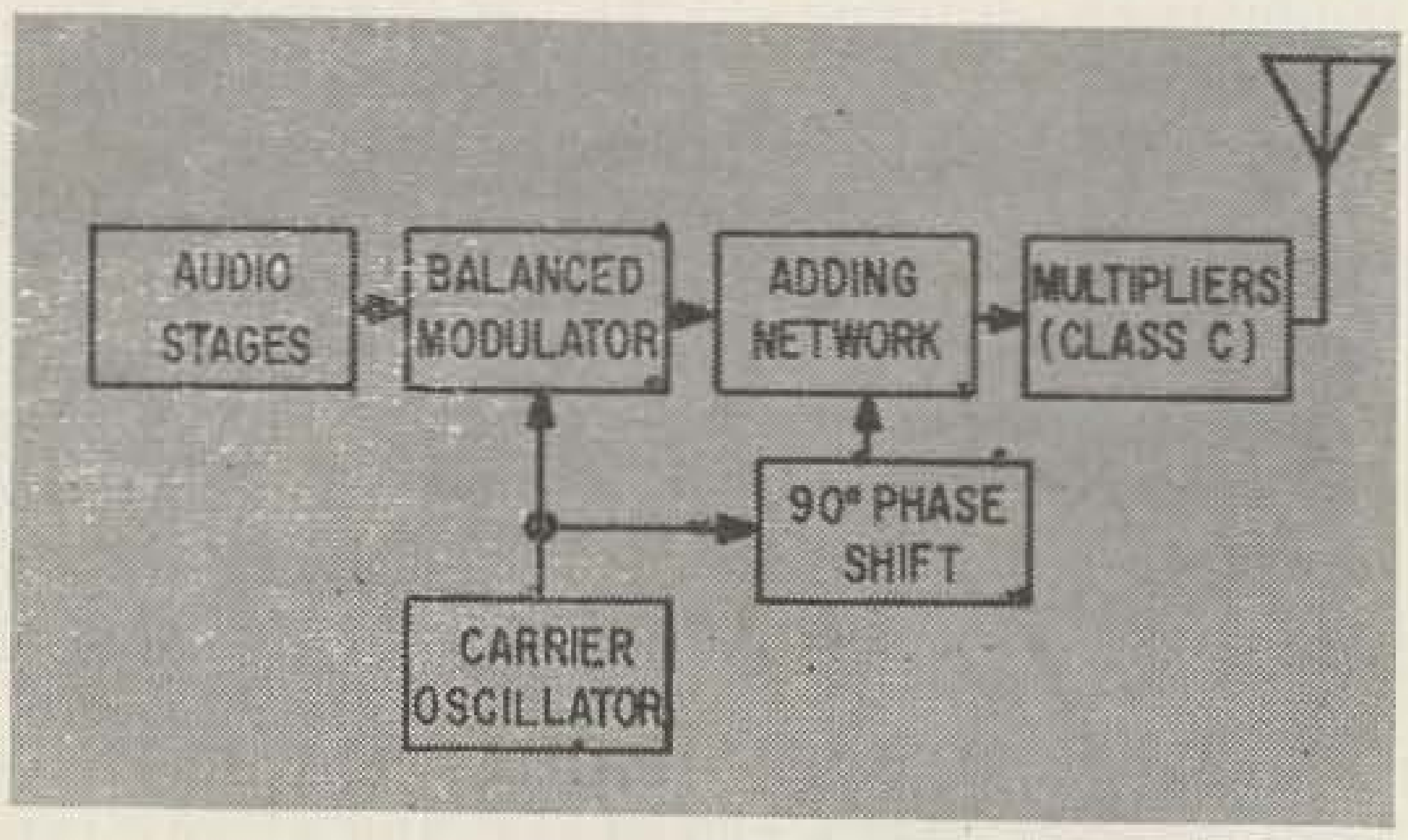

Fig. 17. Armstrong FM system.

as shown in Fig. 17. In normal operation, the diode and capacitor are effectively out of the circuit because the diode is back-biased. However, with modulating signal present the diode is forward-biased and conducts, connecting the capacitor into the circuit and changing the frequency by a pre-set amount.

F1 can also be obtained from a SSB exciter by the use of an audio oscillator keyed to change frequency, as shown in Fig. 18. The rf output frequency will change by the same amount as the original audio frequency; no changes to the SSB rig are required.

Now for the little-known field of pulse modulation.

As mentioned earlier, pulse modulation divides into four categories: PAM, PWM, PPM, and PCM. Let's look at them in order.

Pulse amplitude modulation bears a great

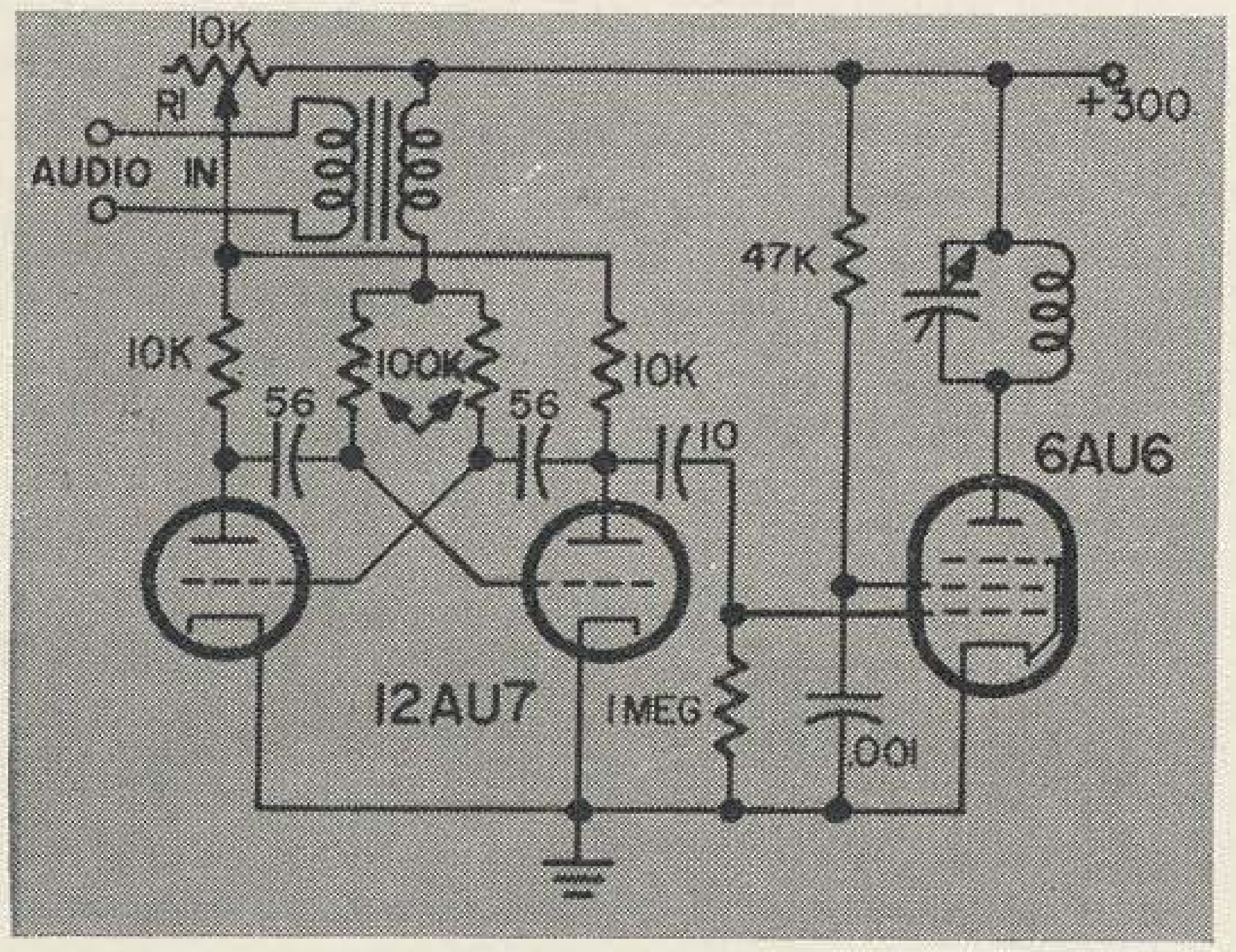

Fig. 18. Multivibrator FM modulator.

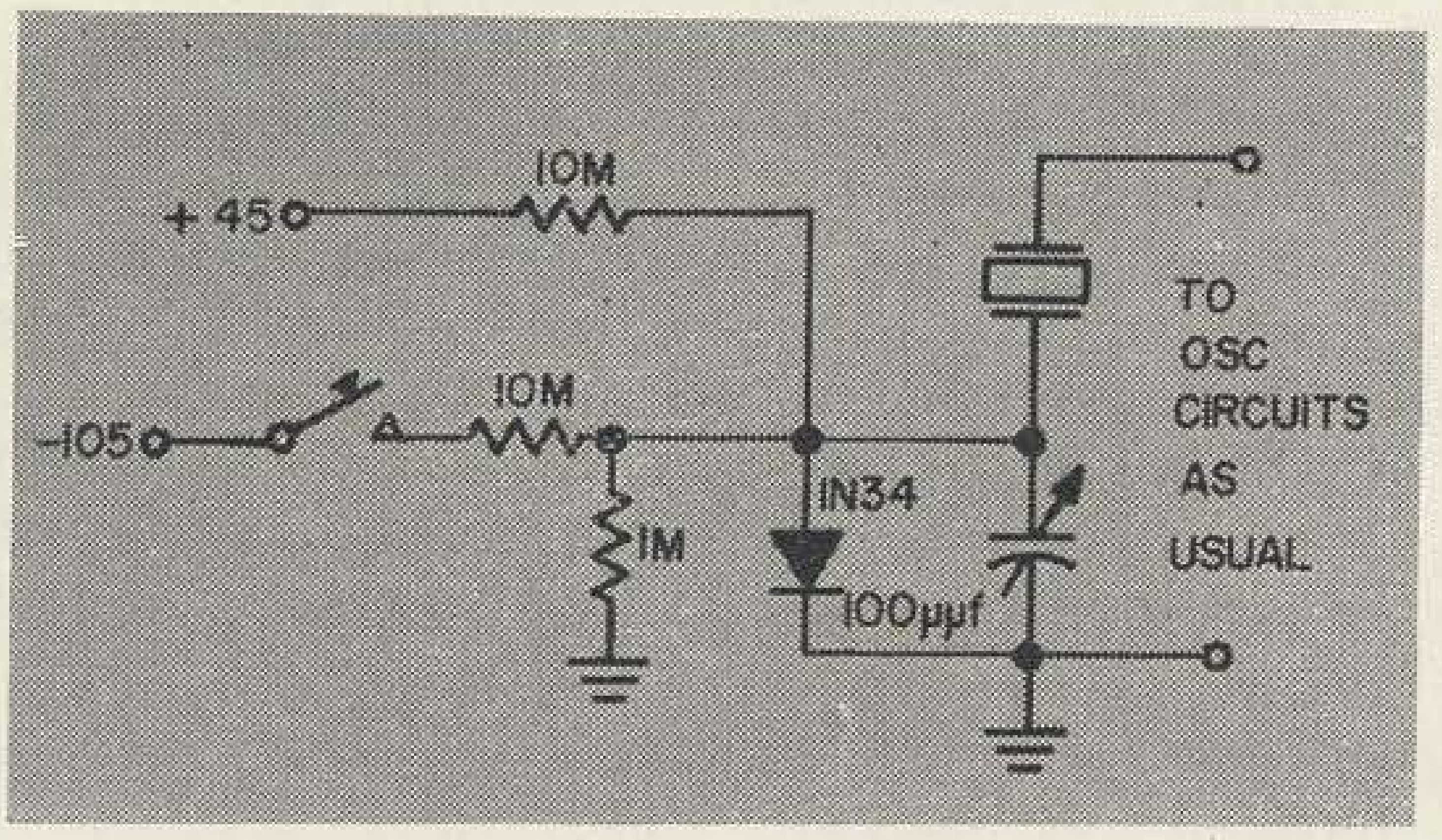

Fig. 19. FSK modulator.

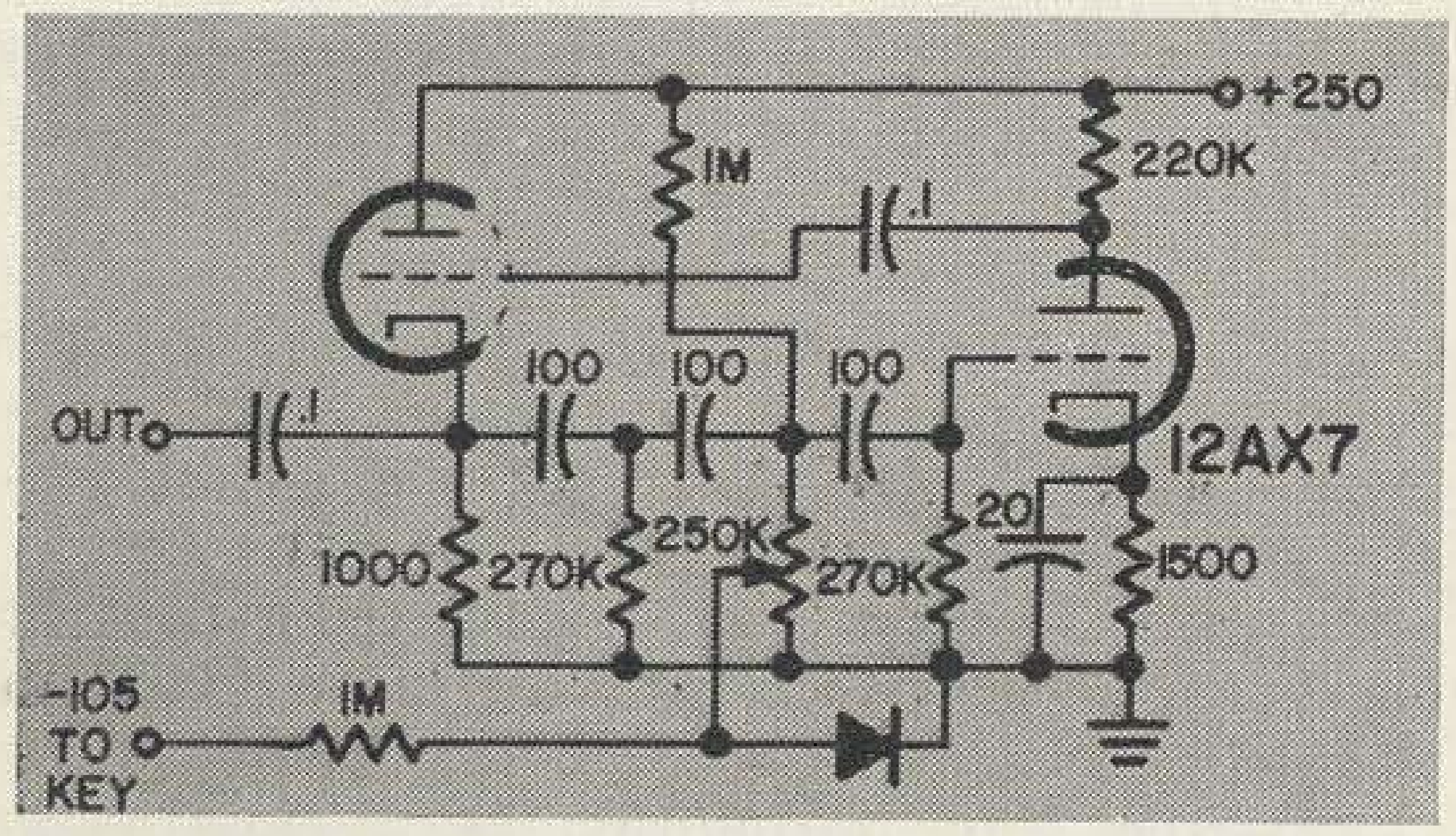

Fig. 20. FSK adapter for SSB exciter.

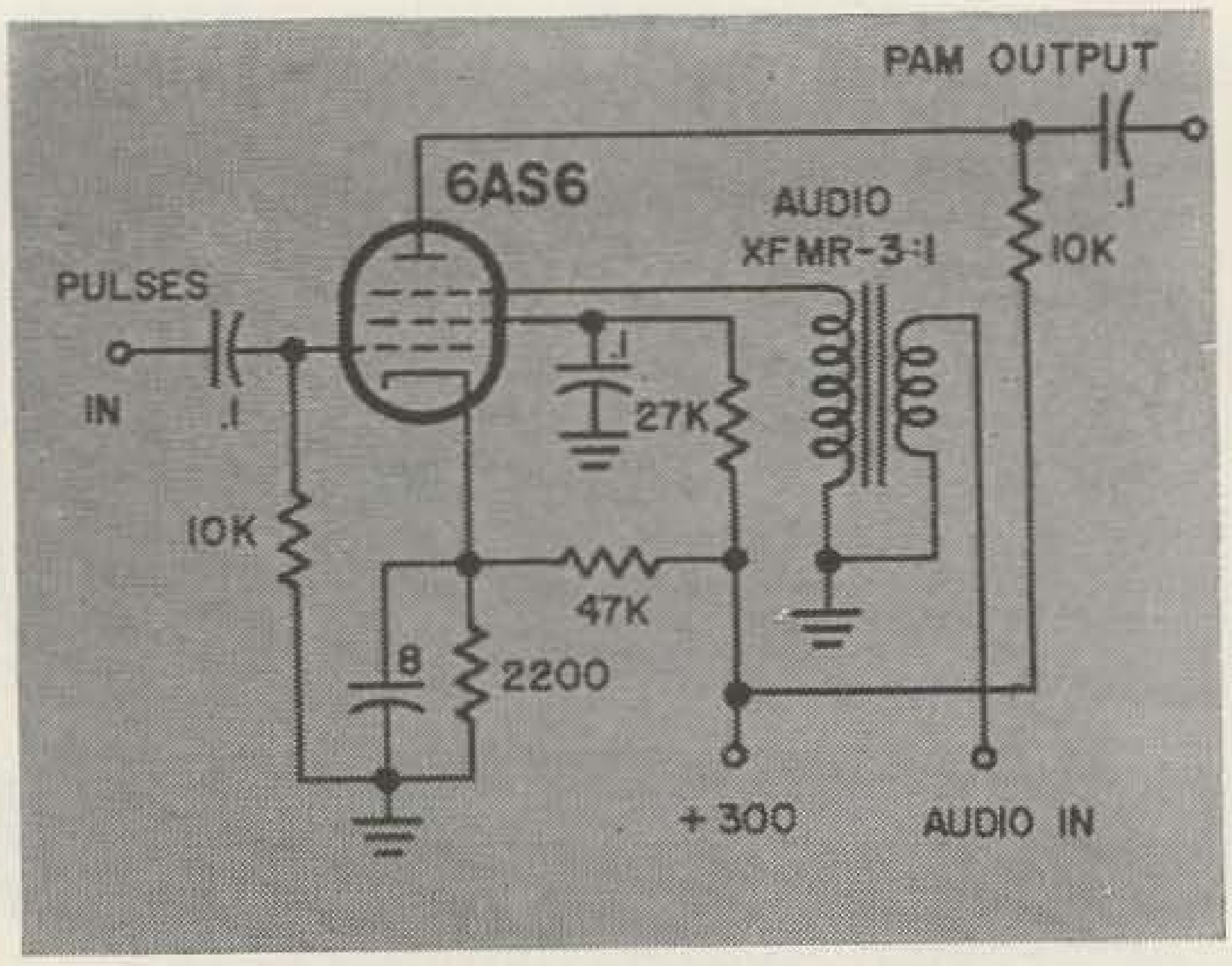

Fig. 21. Unidirectional PAM modulator.

similarity to conventional AM modulation. The pulse width and spacing remain unchanged, and the pulse height is varied to convey information. The transmitted pulses can be all positive-going, all negative-going, or can go in both directions. This gives rise to the subclasses called *unidirectional* and *bidirectional* PAM.

A circuit for a unidirectional PAM modulator is shown in Fig. 21. Here's how it works: The tube is essentially an amplifier whose gain is controlled by the voltage applied to grid No. 3; this voltage is the audio modulating signal. When the modulating signal is at its positive peak, the amplifier's gain will be greatest. Pulses from a separate pulse generator (which we'll examine later) are applied to grid No. 1. The amplified pulses appear at the plate and are coupled to the output. Since the modulating signal determines the amplification of the tube, the height of the output pulse will be determined by the instantaneous level of the modulating signal—and presto, PAM.

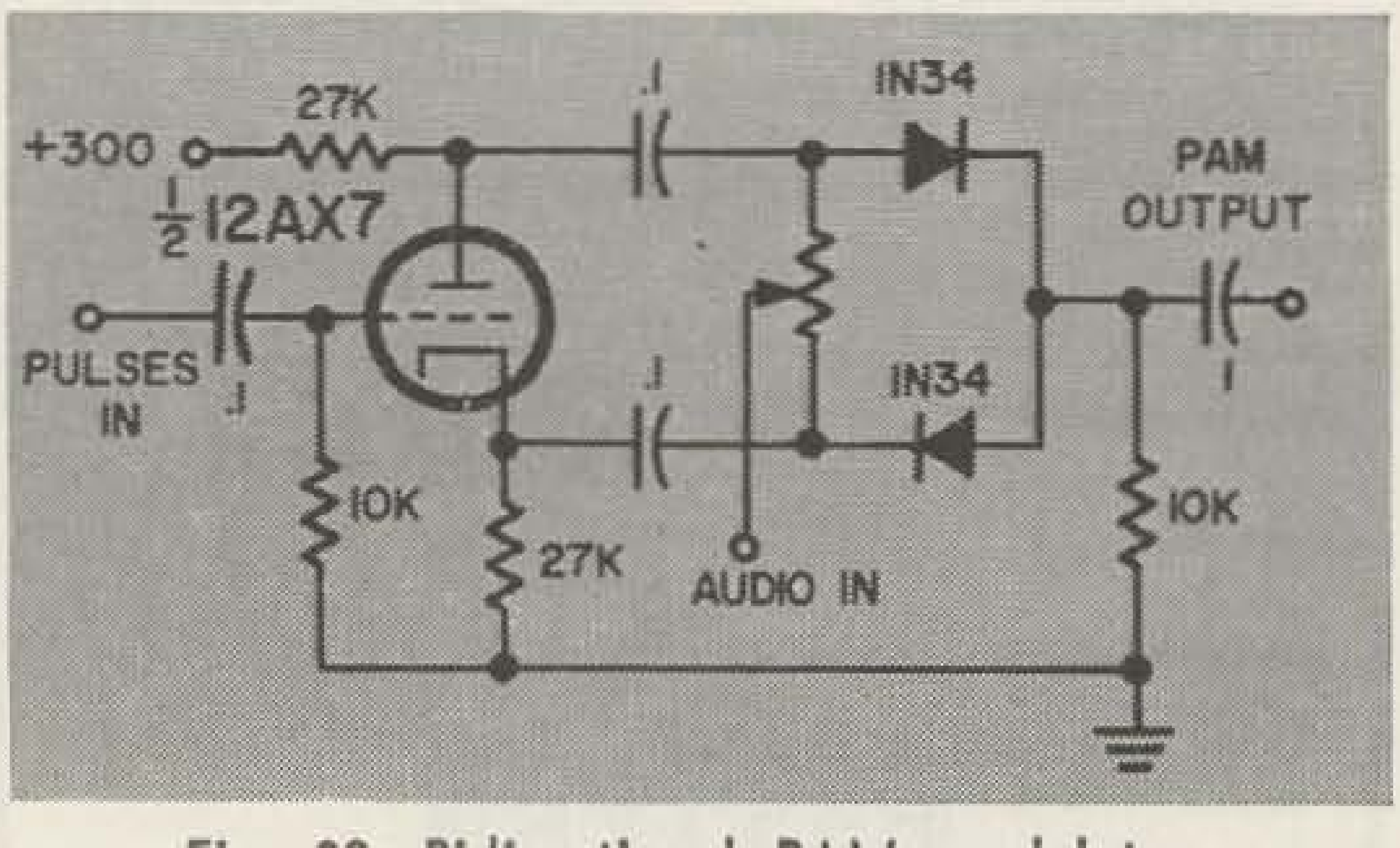

Fig. 22. Bidirectional PAM modulator.

The bidirectional PAM modulator of Fig. 22 is rather different; instead of being a variant amplifier, it's a stray balanced modulator. The diodes act as switches, which are turned on and off by the incoming pulses (the tube acts merely as a phase splitter to develop antiphased pulse channels). When a diode is "on", the audio voltage can appear across the output resistor. Polarity of the output pulse is determined by the polarity of the audio voltage.

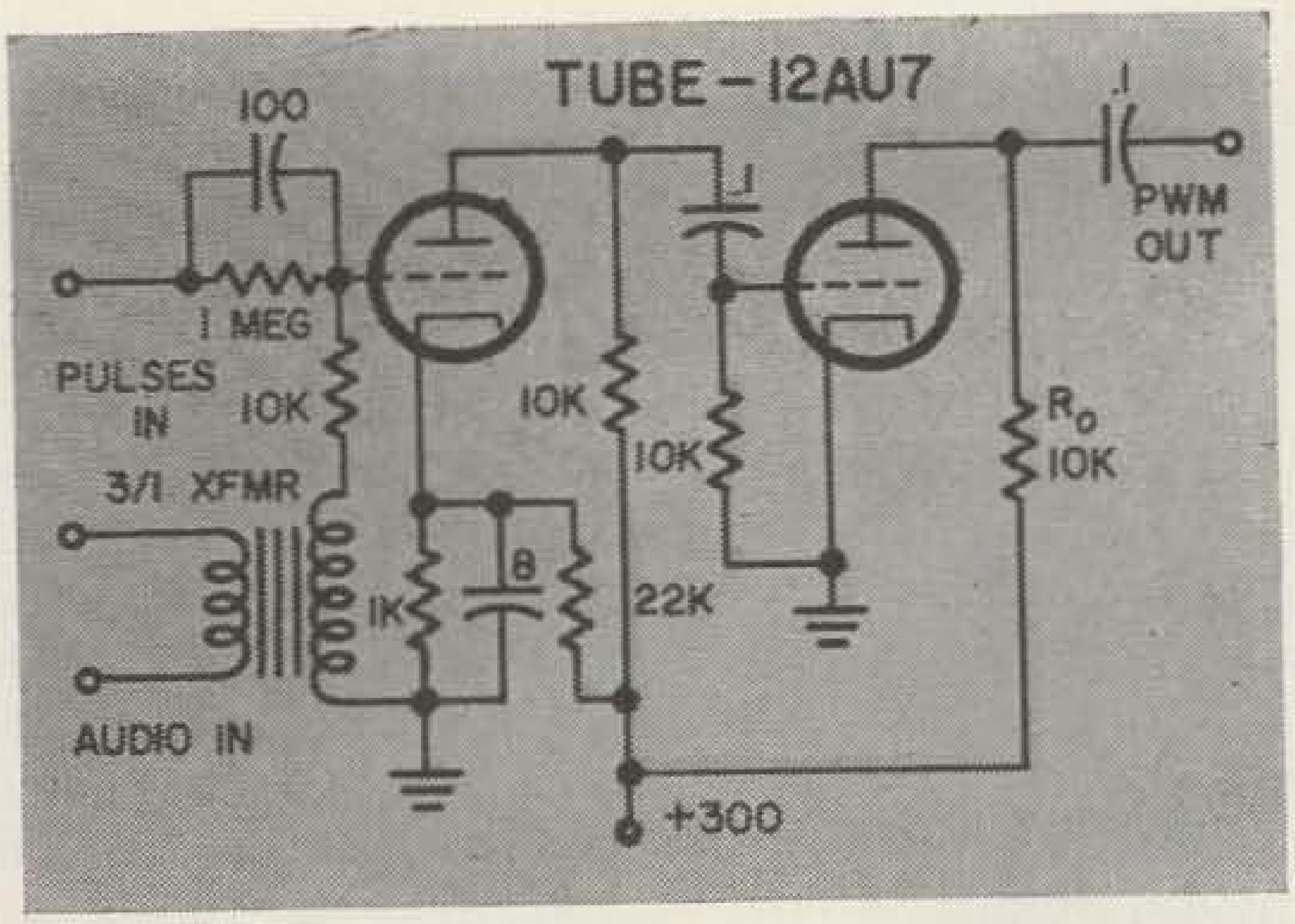

Fig. 23. PWM modulator circuit.

While the circuits are among the simplest of all pulse-type arrangements, PAM has more disadvantages than advantages in ham use. The only real advantage of PAM is that it allows high peak transmitter power; many of the noise-reducing tricks usable with other pulse circuitry are inapplicable to PAM, since the pulse height carries the information and cannot be disturbed. Unidirectional PAM can be received by conventional AM receivers; bidirectional PAM requires special receiver techniques, similar to its distant cousin, DSB.

Almost as simple to generate is pulse-width modulation, which offers all the advantages of PAM (including simplicity of reception) while picking up a noise-reducing benefit as well.

To generate PWM, we make a sawtooth out of our basic pulse from the master generator, then add this sawtooth to the audio signal. The combined signal is then fed to a slicer circuit which will not trigger on the audio signal component alone; the slicer triggers only when hit by the sawtooth riding the top of the audio. The sawtooth differs in width all the way up; since it's riding on top of the audio, the width of the sawtooth at the slicing level is determined directly by the instantaneous value of the audio, thus varying the width of the output pulse in proportion to the audio signal.

A circuit which achieves this is that of Fig. 23. Incoming sawtooth pulses from the master generator are added to the audio in the grid circuit of the left-hand stage; the plate-cathode circuit of this stage is biased to clip at such a level that only the peaks of the combined signal (the width-modulated sawteeth, in other words) get through. The second tube clips the tops off these sawteeth by saturation, leaving width-modulated pulses at the output. Other circuits are to be found in the references, but none are this simple.

Pulse-position modulation is a close relative of PWM; it is generated in much the same manner but requires special circuitry in the receiver. To build a PPM modulator, simply substitute a 2.5 mh rf choke for the 10K resistor marked Ro in Fig. 23. This inductance will differentiate the output pulse into two spike pulses, one marking the leading edge and the other the trailing edge of the original width-modulated pulse.

For the past several paragraphs, we've been talking blithely about a "pulse generator" as if it were something which existed in every ham's junkbox. Actually, almost any circuit can be made to act as a pulse generator and the pulse references are filled with good, practical circuits. The requirements are that the pulse output be a symmetrical (one polarity of pulse narrow, the other wide), that the pulse repetition rate (frequency of the pulses, counting each pair of one positive-going and one negative-going pulse as a cycle) be greater than 8 kc, and that the output pulse shape be approximately rectangular.

The circuit of Fig. 24 is a cathode-coupled multivibrator, whose pulse repetition rate is adjustable from about 8 kc up. As shown, the circuit is free-running and can also be used as a square-wave generator for amplifier testing by proper adjustment of the "duty cycle" pot. In use, the output of this circuit is connected directly to the input of the pulse modulator, omitting any duplicated coupling capacitors.

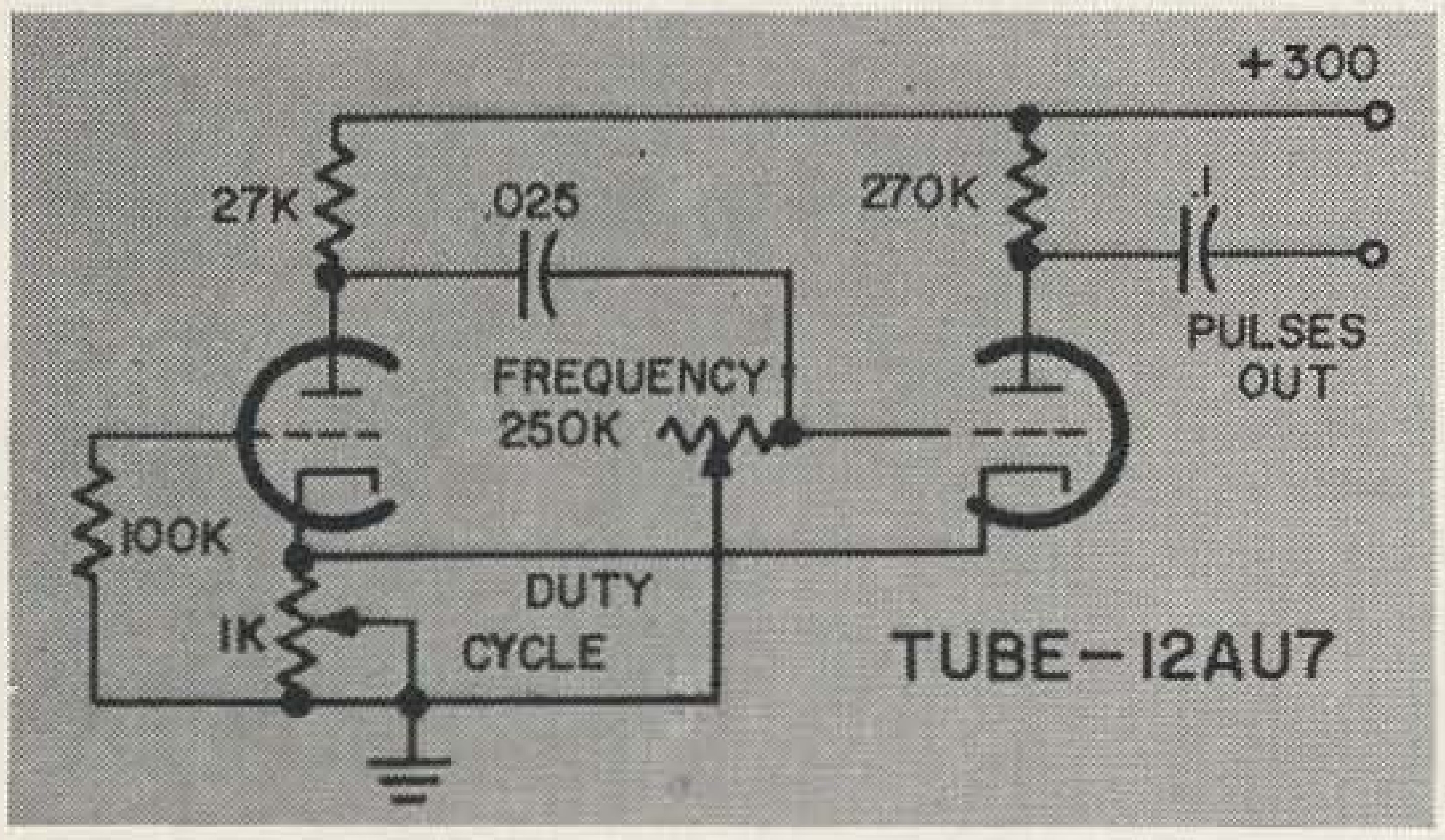

Fig. 24. Universal pulse generator.

In talking about PWM a bit earlier, we mentioned a noise-reducing benefit. With pulse modulation systems which do not depend on pulse height to carry information, noise can be almost completely eliminated by "regenerating" the pulses in the receiver before detection.

This "regeneration" has nothing to do with the more common use of the word as a synonym for feedback. "Regeneration" of pulses is more akin to the biological meaning of the word—replacing a damaged organ with new tissue, as a lizard's tail. To regenerate a pulse, you apply the incoming noise-contaminated pulse to a trigger circuit which is set to fire only at the peak of the pulse. Noise bursts will not be great enough to trigger the circuit if the pulse *peak* (not average level)

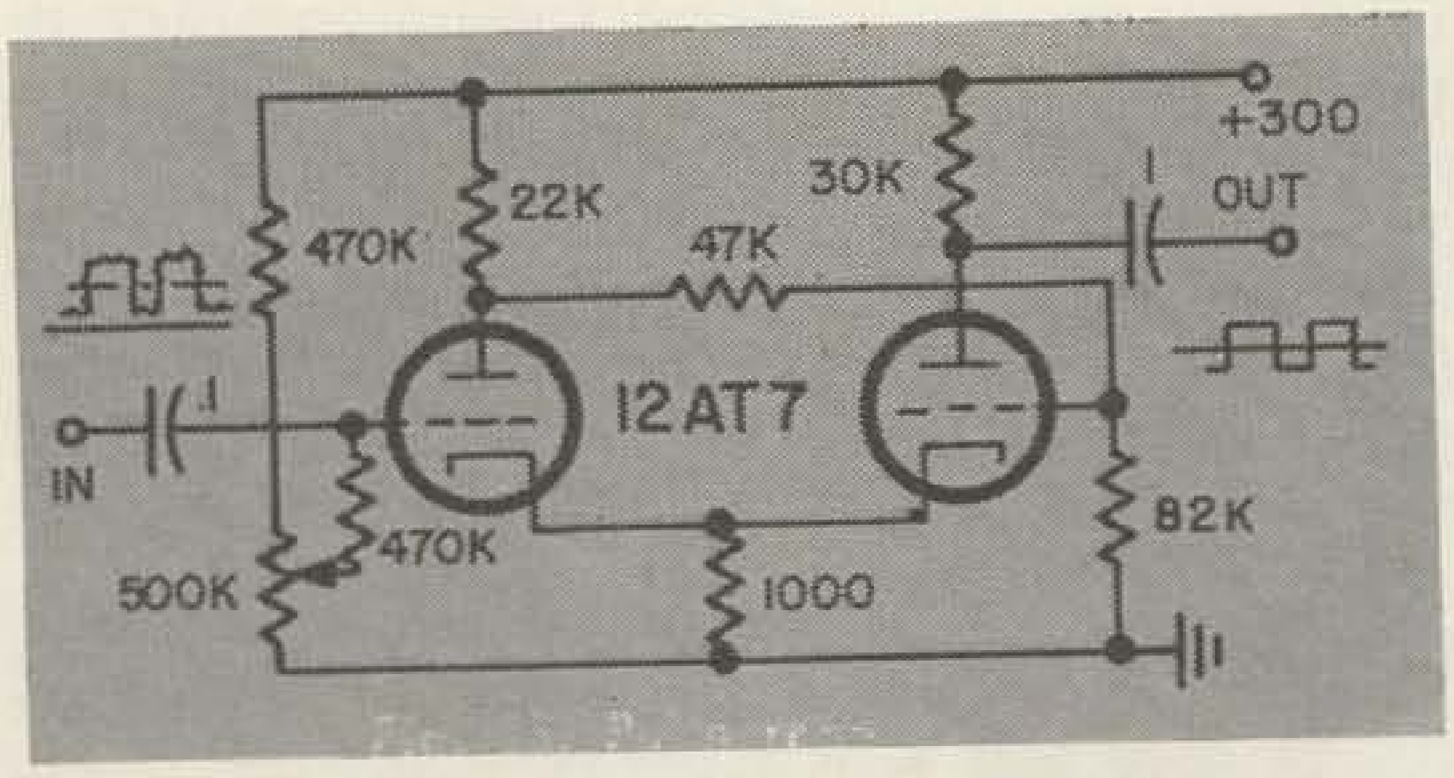

Fig. 25. Pulse regenerator.

is as much as 3 db above the noise level. The trigger circuit's output is a new pulse, minus all noise. Fig. 25 shows one such regenerator (a Schmitt trigger) together with input and output waveform sketches illustrating its action. The 500K pot is set for accurate duplication of the input pulse at the output, and usually requires an oscilloscope for adjustment. However, it need be touched only when the tube is replaced.

PCM, we're omitting. This comes about because PCM requires highly elaborate circuits at both the transmitter and receiver, and at the present state of the art appears impractical for general ham use.

We're almost finished now, except for the transmitter pulser. This is the circuit which takes the output of the various pulse modulators we examined earlier, and uses it to control the megawatts of rf output power from the transmitter. Essentially, the pulser is an electronic switch which turns the final on and off in accordance with the incoming pulses.

A circuit, taken from radar practice, is shown in Fig. 26. V1 is the switching tube, and C1 stores the energy. Normally, V1 is biased far past cutoff and in the absence of incoming pulses, no current can flow. The capacitor charges to 15,000 volts, but nothing else happens because no circuits are complete.

When incoming pulses of great enough amplitude to overcome the cutoff bias and drive the tube into saturation are applied to the grid of V1, though, things happen. V1 looks to the capacitor like a closed switch connecting the positively charged end of the

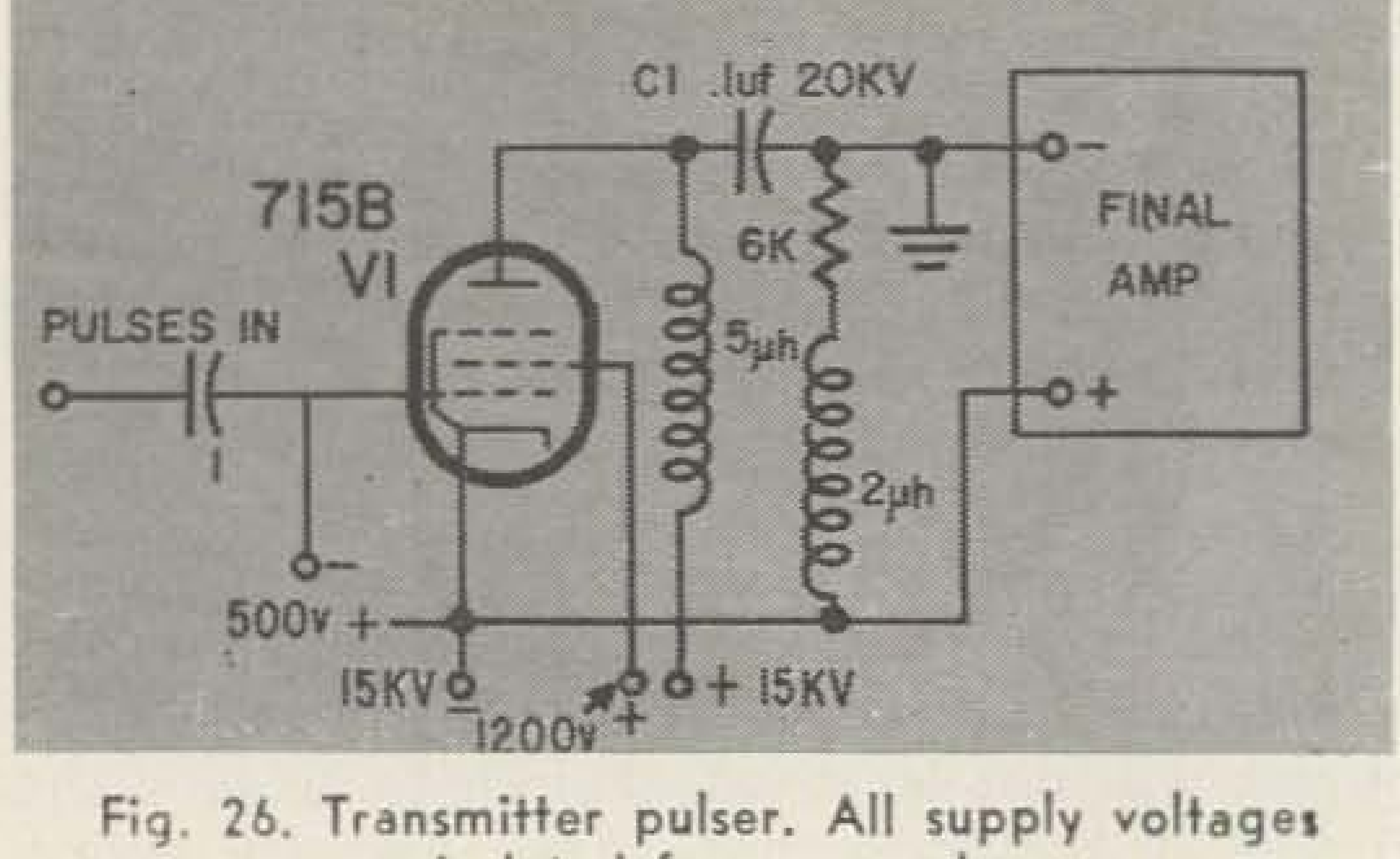

Fig. 26. Transmitter pulser. All supply voltages isolated from ground.

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capacitor to the positive terminal of the final; with power applied, the final produces rf output—great gobs of it (typical voltage and current in the circuit shown is 15,000 volts at 10 amps, which means 150 KW are going to the final. With normal PRF and duty cycle settings, the legally measured power to the final would be 150 watts!) This situation holds as long as the pulse is present at V1's grid, which is usually about a microsecond. Then everything rests for the next 99 microseconds, until the next pulse hits.

That's it—modulation from A to Z, with the more common garden-variety circuits omitted. If you're interested in more details, a number of specialized books are listed in the bibliography; these range from beginner to graduate-engineer level, and many give full design information for not only the circuits we've shown, but many others equally interesting for which we didn't have space. Happy modulation!

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NOTE: Before rushing to try out pulse modulation, check the latest issues of FCC regulations. Pulse modulation is permitted only in certain bands, all in the UHF region; it is taboo at conventional frequencies.

(W2NSD from page 45)

have been on the receiving end of unbelievable abuses as an invited speaker. I remember one small club which had invited both me and a local manufacturer to talk to them the same evening. They then proceeded to carry on a two and a half hour business meeting, a half hour for coffee, and then at 11 pm turned the meeting over to us with everyone yawning and looking at the door.

Many clubs seem at a loss for speakers. By the time you have exhausted all manufacturers of ham parts and equipment within commuting distance and had talks on special interests of your own members you will find that the manufacturers have come out with newer products that they want to show you. Unless your club is made up of particularly dead members you should have one or two live wires who are busy in their shack building something of interest. You can easily talk these chaps into bringing down their latest marvel and showing it off, complete with a short discussion.

There are many other activities which help knit a club together. Field Day is a great time for mutual effort and strengthens a club. Group construction projects are a lot of fun, particularly if you knock together a small two meter transceiver or convert a bunch of Link mobile gear to 6M for a club FM network. I wonder if any clubs have taken to mass manufacturing of KW linears yet? Mobile clinics on Saturday or Sunday morning are fine, with everyone bringing test equipment and helping each other to get their rig working. Hamfests, picnics, auctions, etc., are all good club strengtheners.

I suspect that this will result in a lot of much better ideas than I have proposed. Let's look for some good letters on the subject.

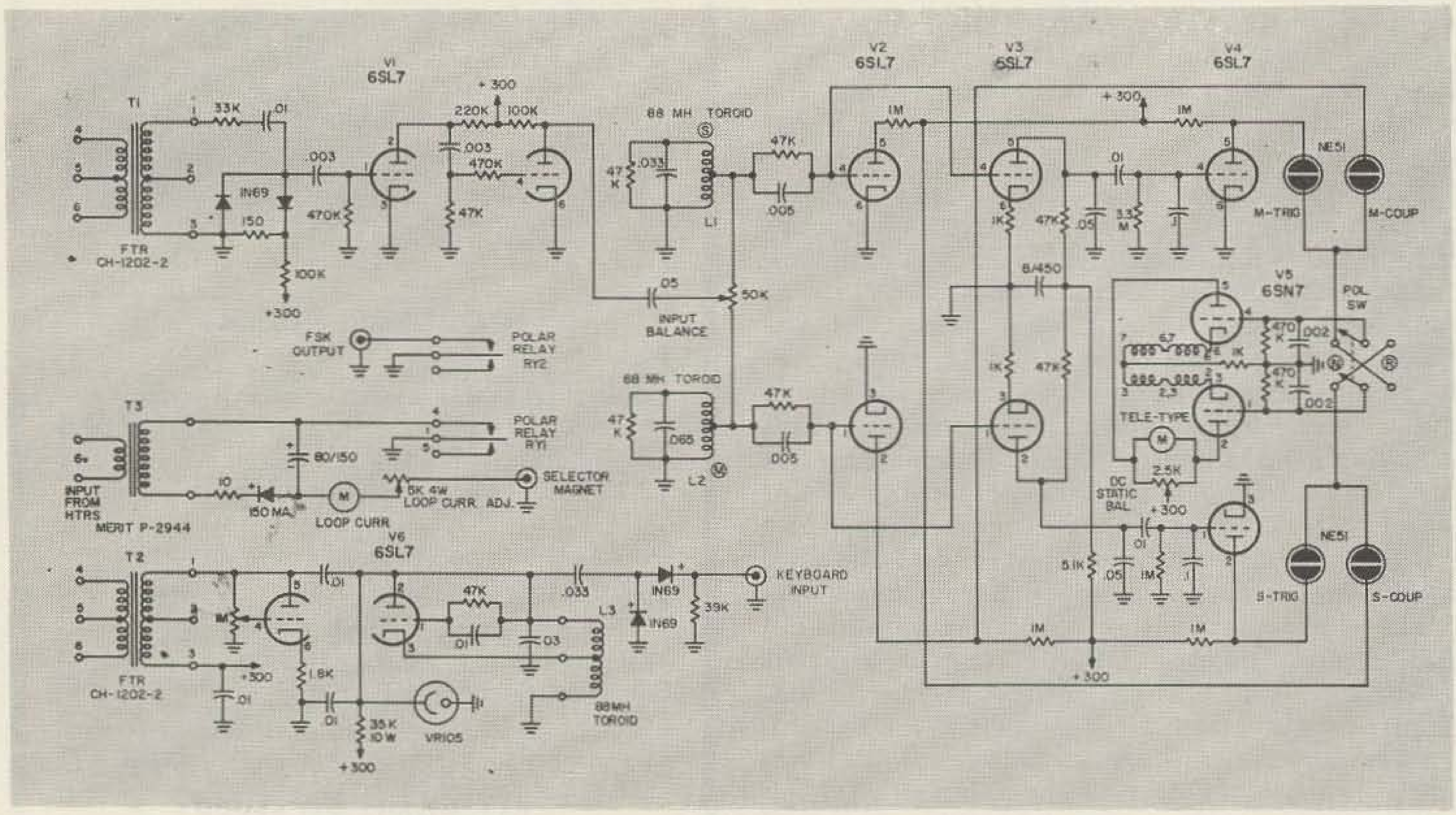
Arithmetic

A letter from Ray Frank W6JO, one of our Sharp Eyed Readers, asks, "Care to explain your arithmetic method in an editorial? Your SWORN statement in December 1961 says 15,166. In January 1962 you claim 40,000. Amazing increase." Ray goes on to compare our arithmetic to that of another ham publication. Ray, shame on you. You are hereby reduced from rank of Sharp Eyed Reader to Not Very Sharp Eyed Reader. If you read anything except the figure of 15,166 you will see that this is our *average* number of *subscriptions* over the preceding *twelve* month period.

Until our expansion into newsstand circulation in December, our circulation had been approximately half subscriptions and half sales through radio parts distributors. The three are now about running even at 20K/20K/20K. We started out at 10,000 and rose to 20,000 during the year, isn't that pretty

(Turn to page 91)

Part II WORQF RTTY Converter



CIRCUIT DIAGRAM — See page 26 — February 73 Magazine for further data.

(W2NSD from page 89)

close to 15,166 average?

You may redeem yourself if you can explain how another magazine was able to swear to an increase in their average number of subscriptions (which should not include newsstand sales or parts jobbers sales) during their 17th year of publication from the sworn 36,498 in November 1960 (p. 65) to 73,836 in November 1961 (p. 60)! They would have to have had a minimum of 111,000 subscriptions plus newsstand and parts jobbers sales to average 73K! Indeed remarkable, for that puts them well ahead of QST in circulation and they have modestly never boasted of this.

I. R. E.

Hundreds of hams will be in town for the yearly IRE Show on March 26-29. I'll probably run into many of you up at the show, or if not there then I'll see you at the Single Sideband Dinner-Hamfest at the Statler-Hilton on Tuesday March 27th. The displays open at 10 am, dinner at 7:30 pm. Bill W2SKE Leonard will master the ceremonies. Virginia will be there too selling subscriptions, back issues, bound volumes, TV Handbooks, and all sorts of things like that. Say hello.

The RTTY gang will gather on Monday night at the White Turkey Town House at 260 Madison Avenue in New York. 7 pm. Send $6 to Elston Swanson W2PEE, 101 New South Road, Hicksville, L.I., N.Y. Speakers will be W2JAV, W1BDI, W2DHE, etc. I'll be there too.

Let me know when you have something special coming up . . . hamfest, annual dinner, big picnic, etc. Let me know, that is, if a small bundle of the latest issue of 73 would help out as an added little something to give away. You'll have to give me some warning though for I am frequently so embroiled in staving off imminent disaster that it takes a few weeks before I can tend to details. You make it at least one months notice and I'll manage. You might mention whether you are expecting over 100 licensed amateurs (come on now, none of that "and their families").

March Last Year

We have a few copies of this issue available for those of you that missed it the first time around. 50¢ each. There were twenty-three feature articles in this issue, many of them of considerable lasting interest.

The lead article, undoubtedly the most hilarious we have ever run, explained how to translate technical journals. This is one you'll keep by the rig and read over the air at every opportunity. Next, in the construction department, was the W3KET transistorized GDO which you can build in minutes. W8UCG gave us detailed step-by-step instructions for elimi-

(Turn to page 92)

nating ignition interference. The Sprague Company has since reprinted this extensively.

The old superregenerative receiver was then dusted off and brought up to date with a set of rules on taming the beast. Need a parabola for 1296 mc? We show you how to generate one. Associate Editor Kyle gives some hints on getting bugs out of gear in the shortest possible time. W2IHW shows you how to wind your own top loaded whip . . . and tune it. We also give you some ideas on various free supplies of plugs for interconnections.

All RTTY'ers will want to have the article on using their TT tape gear for sending CW. It is simple to do and I notice that even some CW men are starting to use the system.

K5JKX gives us the dimensions for the first article on a practical log-periodic antenna. This one is simple to construct and works fine on all bands from 160M to 10M. W4API shows how you can double your power supply voltage by throwing in some silicon rectifiers in your present supply. W4WKM gives us a list of the impedances of all popular surplus transmitters and receivers. Handy chart. K2DHA has a good idea on making that phone patch easy to connect and disconnect without bugging Ma Bell.

Another 73 first is the W3HIX all transistorized 432 mc converter. Part I this month, part II in April. We then have a little conversion of the six meter rig in our Oct. '60 issue putting it on 2M. K5JKX shows us how to build a four transistor amplifier right into a small speaker box to give us a complete speaker and amplifier all in one unit.

One of the most interesting staff articles on receivers was in the March issue. This one discussed front ends and pointed up the pro's and con's of all popular circuits, following this with a simple and important change to improve your receiver's front end.

There is a lot of good DX on 80 meter phone if you just know where to listen for it. W1FRR gives away all the trade secrets of this obscure sect. We have a transistorized meter amplifier for measuring very small voltages or currents. A test set for tuning the converted Motorola units. One of the top voted articles for March was the "Save, Learn, Have Fun—Build" by W8VVD. If you want to know about the reasons why fellows are building their own equipment, this will explain very well.

There are a few other articles of interest to: W7OE tells how 'sines' got started; OH2YV suggests a card index log book; W2IHW has a cute little transistorized noise clipper; W7CSD shows how to build a tuning meter for the blind ops; W6NKE complains about fellows buying bugs and then using them on the air before they learn how.

All in all it was a remarkable issue. There are a few left at 50¢.

Something New

In the process of leaning on prospective advertisers each month I run into some hints of things about to be marketed. Maybe you're interested? For instance there is the new remote switching mobile antenna by Mark which will cover all bands from 10 thru 80 and can be switched from the drivers seat. The last antenna I remember like this was the Rafred which used a little motor to run a switch up and down the antenna loading coil and tap in for the different bands. I used one of those with success for a couple years back when I had a Ford station wagon. It was a bit outsized for my Porsche so was laid to rest. The Mark unit, which will be similar to their HW-3, uses the Heli-whip units instead of the older fashioned loading coil.

Mini-Products will shortly be out with a shorty 40M beam, using their clever type of end loading. I understand that this job will be about the size of a ten meter antenna and will also work out well on 20-15-10! Maybe I heard wrong, that's a lot to get out of one little beam.

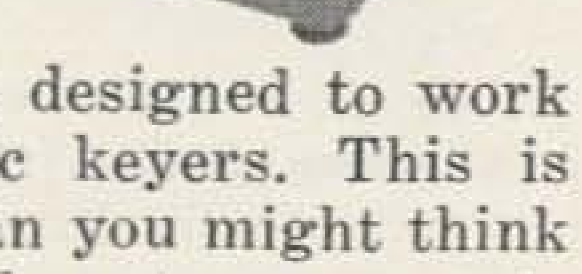
VHF-UHF has a new universal coupler in the works which will work with either 52 or 75 ohm coax. This will have a built-in field strength meter connection and a modulation monitor.

Tapetone (Telco) is trying hard to keep up with the orders on their 201 Nuvistor converter. They sent one down here for me to see. I farmed it out to WA2INM to test. Larry, who has built any number of 417A converters and Nuvistor converters and pre-amps, flipped over the 201 and bought it with the proceeds from his article on the test. We'll probably have this article for you by next month.

New Catalog

Cushcraft has just released their 1962 VHF-UHF antenna catalog. Nice. Beams for 420—220 mc, 2M, 6M, 10M, 15M, & 20M. Halos. Other stuff. You send for this catalog right now. Cushcraft, 621 Hayward Street, Manchester, N. H.

Lefor



has a cutie. The Nikey is designed to work with all types of electronic keyers. This is something quite different than you might think at first casual glance. It has two separate levers, one for dashes and the other for dots, each moving independently. Wait'll you get a feel of this one! Write Lefor Industries, New Caanan, Conn. $16.95.

Two Meter Pre-Amp

Hamboards has announced a two meter transistorized pre-amp to increase the sensitivity of transceivers. Comes complete for $12.95, though the circuit board and coils are available separately. Requires 2½ ma at 12 volts, which is fine for mobile work or can be borrowed from an audio output stage cathode. Drop a card to Hamboards, Box 13158, Pine Castle, Florida.

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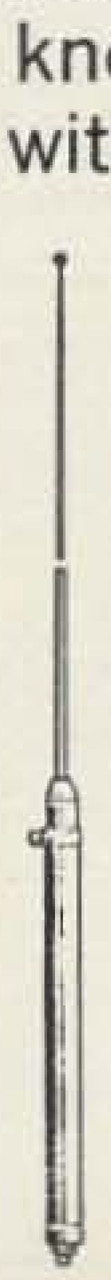

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FROM QST — JANUARY 1961

"Stability, both mechanical and electrical, is exceptional . . . The NC-270 works well enough on 50 Mc. to encourage a v.h.f. enthusiast to design his converters . . . so that they will work into the 6-meter range rather than into the lower bands. This would give him full coverage of the 144-Mc. band and a four-megacycle spread in any of the bands from 220 Mc. up . . . and he can skip the construction of a 50-Mc. job. The NC-270 should do all he'll need in that range."

FROM CQ — MAY 1961

" . . . retains all the "feel" of the more expensive receivers for which this company is known . . . It is unusual to see a front panel NOTCH DEPTH control in this price class . . . The a.n.l. circuit in the NC-270 is exceptionally good . . . Mechanical stability is impressive. It is possible to tune a s.s.b. signal on one of the high frequency bands, lift the front of the receiver up several inches and let go. Unless the main tuning knob moves, the signal will still be there . . . (The National NC-270) is an extremely stable and sensitive receiver . . . "

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