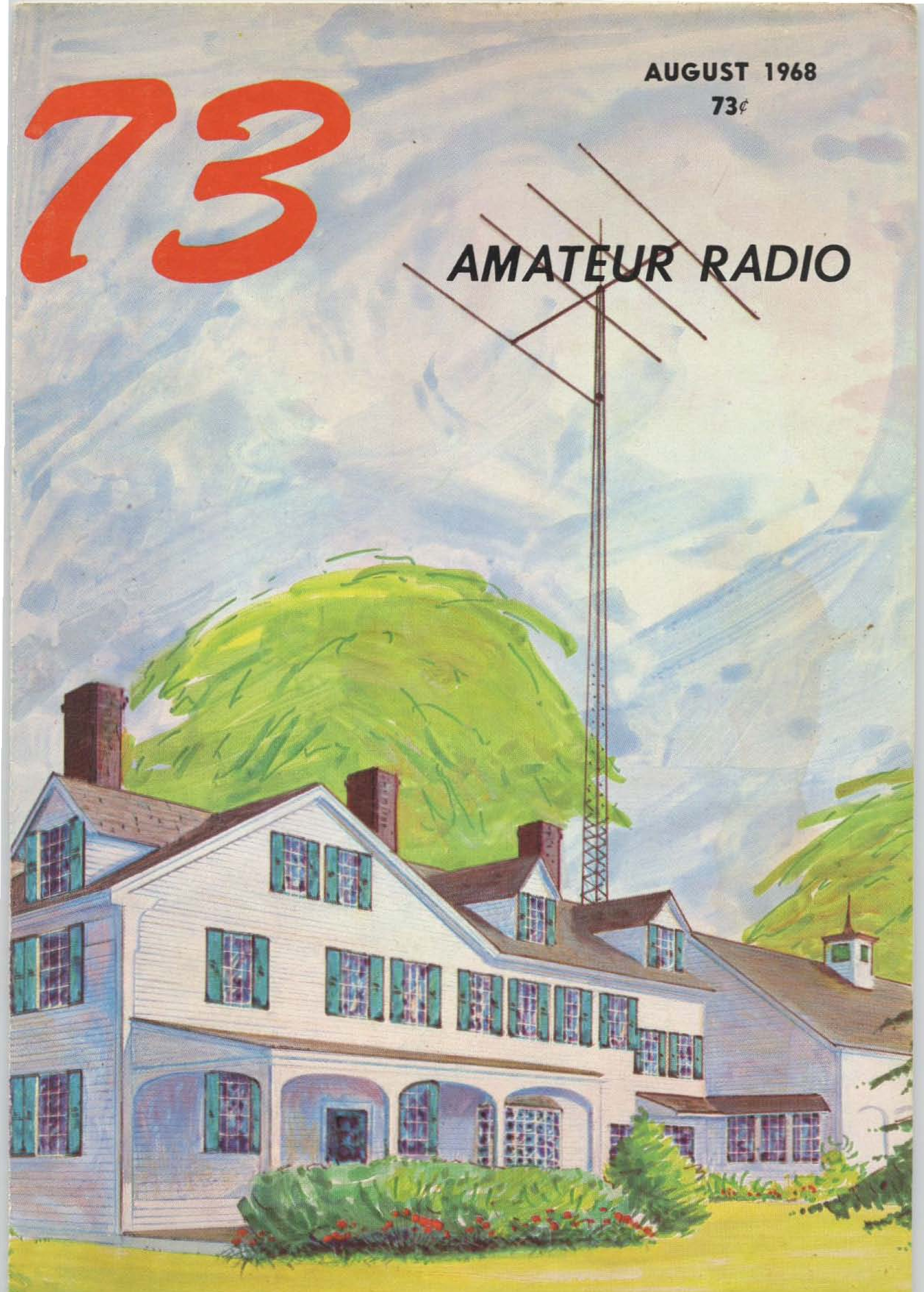
73

AUGUST 1968

73¢

AMATEUR RADIO



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73 MAGAZINE

August 1968
Vol. XLVII No. 8

Departments

Cover: An original painting by Sydney Willis. This is the house where 73 Magazine is produced. The house is over 200 years old and contains some 37 rooms.

Wayne Green W2NSD/1
Publisher

Kayla Bloom W1EMV
Editor

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

Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.
Stop reading this fine print. Look at page 66 and go out and sell subscriptions.

Editorial Liberties

There are some days in the life of this editor when she wonders where she can obtain a good cyanide pill to end the agony. There is a goof on page 101 of the June issue. A close look at the diagram will show that this circuit can't possibly work. The coil is shorted out. Our draftsman is usually on the ball and doesn't draw errors into a diagram, so I sent it off to have an engraving made. When the proof of the engraving was returned, the error was obvious, so I very carefully took the original drafting and used white correction fluid to block out the line which shorted the coil. I returned the proof of the cut with the error and told the printer to kill it and insert the new one. The new proof came back all ok, and I heaved a sigh of relief that I had caught the error. Then the magazine came out in print . . . How can you win?

The first few months of my editor's job were pretty hectic. I didn't have much experience in production and was thrown into the work to sink or swim. The files were full of articles, but no drafting was done. It is hard to print a construction article unless you have diagrams to illustrate it. The time lag was severe! Our draftsman was involved in moving and his equipment was packed up. A search for someone to do the work proved futile. So . . . we had three months of having to fill the pages with articles which didn't require much artwork.

There were many complaints from irate readers who impolitely told me to get back to the kitchen where I belonged. But, cooking for one isn't terribly rewarding, so I answered the letters as politely as I could and muddled onward. I kept muttering to myself, "keep the faith, baby" and sure enough, things began to work smoothly again. The flow of material between the magazine and the draftsman began to move, and a few letters of apology came in.

To those who encouraged me, my thanks. To those who were disgruntled and angry, I hope the last couple of issues have improved their state of mind.

We hams frequently handle emergency traffic and usually come through with flying colors. It is a natural thing to wish to give credit by notifying the news media so there will be a write-up in the newspapers or perhaps radio and TV coverage. In some instances, in order to properly impress the public with our good work, the facts get distorted and the emergency becomes exaggerated.

Quite recently, Alan Biggs W3ZP was sailing his new 46 foot Catamaran from Yucatan, Mexico, to Key West, Florida enroute to Chesapeake Bay. On the second night out, one compartment flooded due to a back up of the sea cocks leading to the shower. This flooded the 32V batteries, so there were no lights. Alan hooked up the 40 meter rig to the starting batteries and made contact with Bob Fenimore W4TY in St. Petersburg. Bob notified the Coast Guard and aid was sent. They were taken under tow by a shrimp boat which began towing at a fast clip. This caused further damage to Alan's boat. Both rudders snapped off before he could contact the shrimp boat to slow down. Other than being exhausted from bailing, at no time was the boat or it's four crew members in any serious trouble.

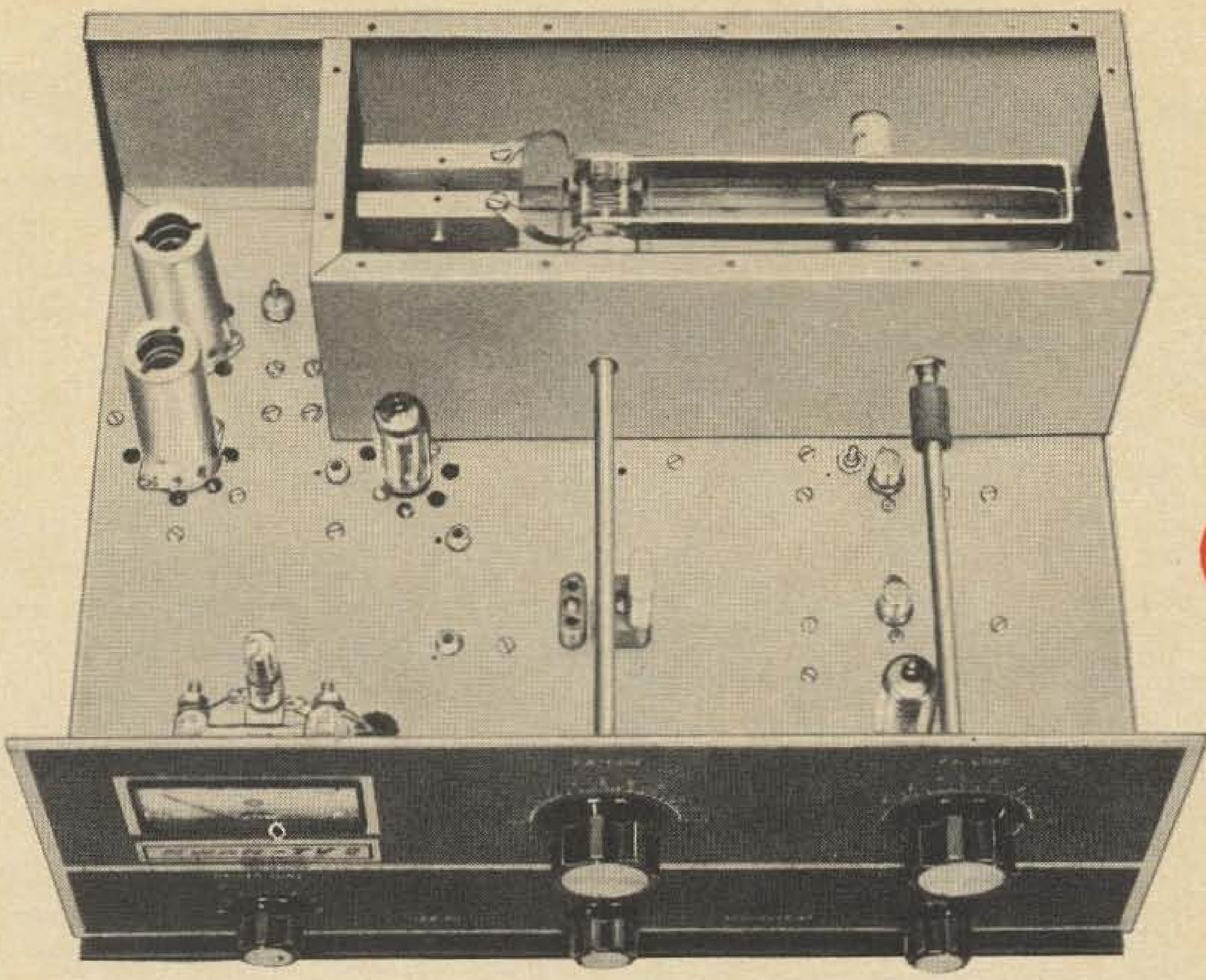
The stories which reached the newspapers from hams told a very different tale. They told of the boat in danger of sinking, that both engines were flooded out, that they were in high seas and had no power. In fact, at no time did the engines quit as they were in watertight compartments. While one compartment of one hull was flooded, they were able to keep up with the bailing and the second hull had no water at all. Most of the damage was caused after they were safely under tow and headed for Key West.

It seems to me that accurate reporting of facts without embellishment will do ham radio more good than blowing up a minor incident into an "emergency" situation. Most of the stories which were on the ham bands involved second and third hand information. I am reminded of a game we used to play when I was a kid. It was called "telephone" and a whole group of kids would form a

Turn to page 90

Henry Radio has this in stock... naturally!

THE NEW SWAN TV-2 TRANSVERTER



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MODEL TV-2
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UFO Net Report

More and more UFO investigative groups have been getting the word about the amateur radio UFO net and have been writing to find out about amateur radio activity in their vicinity which might tie in with their work. We certainly have struck a spark at the right time with this activity.

The first announcement of an actual net frequency and time was made last month and even before the June issue was out there were seven stations calling in for the first net meeting. By the second week there were over 50 checking in. We will continue to meet on Wednesday nights for net check in on 14,300 kHz at 0200 GMT. If the interest in the net continues the way it has we will soon be able to have a check in every evening of the week at that time . . . and may eventually work toward our goal of getting upward of a thousand stations tuned to the alerting frequency with a simple automatic alarm.

If you are interested in joining this net all you have to do is check in on Wednesday nights and start getting ready for handling emergency traffic. Contact your local newspaper and radio station and tell them the story of the purpose of the network and get them to release information to your area so that you will be immediately informed if anything is sighted that should be reported. Contact your local police and CD officials too. If there is an active CB group contact them. Contact any other users of mobile radio in your area. Contact the highway department, doctors, taxis, any users of mobile radio and offer to alert them if they will in turn alert you when something is sighted. Point out that this effort is not restricted to UFO reports . . . that once an emergency reporting network is established that it is of great value for any type of emergency.

As your local organization grows keep reports coming into your local papers and radio stations. Both your organization and amateur radio can well use the publicity.

If we go about this diligently we can end up with the most complete radio communications organization ever conceived. Even in the smallest of towns there is an amazing number of mobile radio units. In our little town of Peterborough we have police radio, State Police radio, highway department, Forestry Department, fire department, ambulance service, the local vet, any number of CB units, CD communications, CAP, taxis, a construction company, public service, and the phone company. I'll be very interested in plans that are worked out for the coordination of all these services into our net by ops around the country.

If your club is interested in learning more about the UFO problem then I would suggest that your activities chairman write to NICAP, 1536 Connecticut Ave., N.W., Washington, D.C. 20036, and ask if they have anyone in your area who might be able to put on a slide program for the club.

Most of you probably read the Look article on the disgraceful University of Colorado UFO whitewash brought on by our Air Force. NICAP is stepping up its investigation system to fill the breech. I recommend that every amateur interested in the UFO Net join NICAP and coordinate with their local sub-committee. The dues are $5 a year and you get their very interesting UFO Investigator magazine. The current issue, by the way, gives a lot of the inside information on the Colorado debacle. Write NICAP, 1536 Connecticut Ave., Washington, D.C. 20036 and send the $5.

Auto-Call

One basic need we will have for alerting net members will be some simple auto-call system. With the present low cost of IC's we should be able to come up with something reasonably sophisticated and yet relatively inexpensive. How about it you builders out there? Let's see some articles on auto-call systems.

UFO NET SCHEDULE

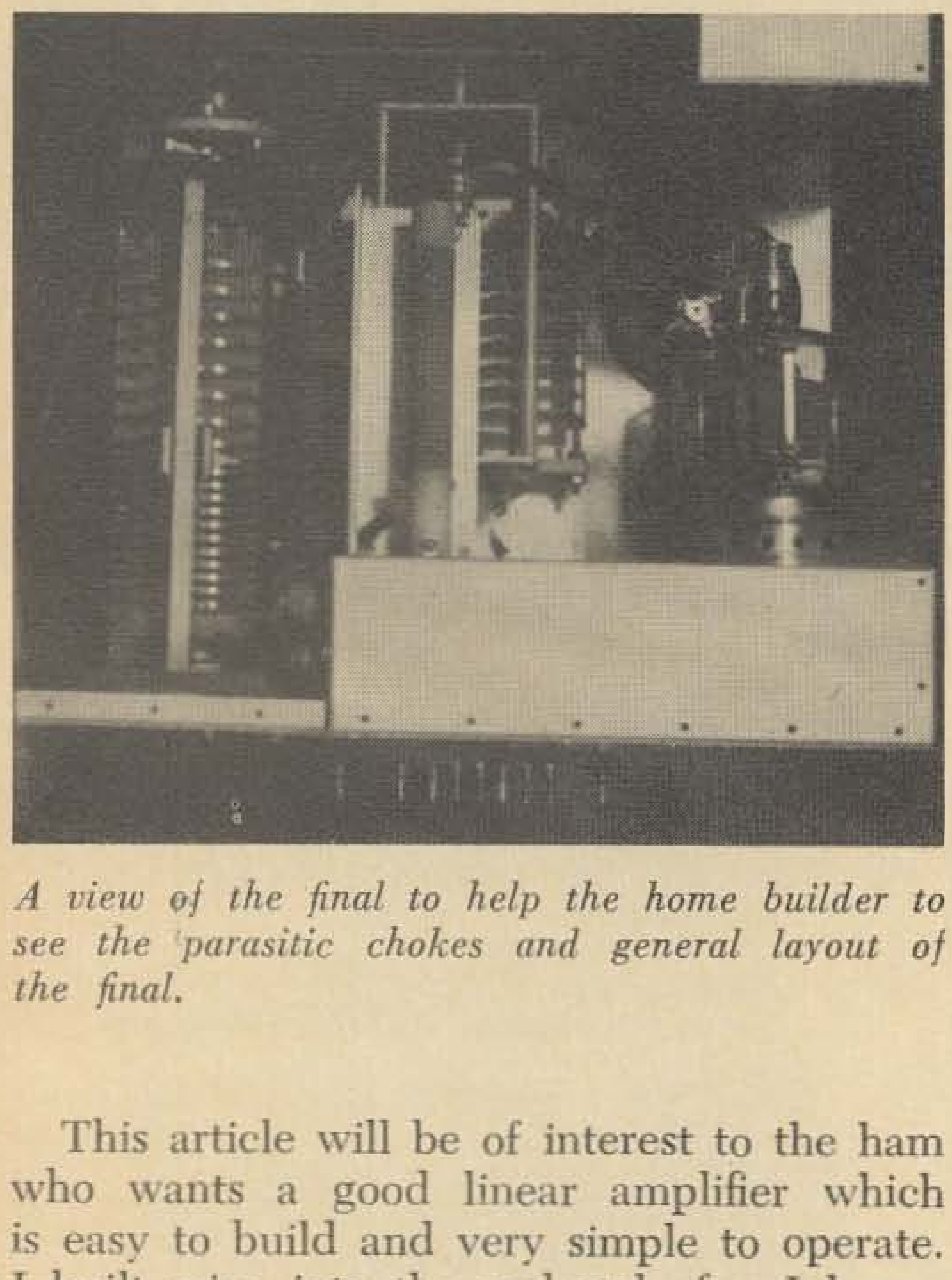
Wednesdays 0200 GMT 14,300
Thursdays 0200 GMT 3950

Turn to page 86

A Terminated Grid Linear Amplifier

James F. Hartley W1DIS
Route 302
Raymond, Maine 04071

An Extremely Stable Configuration



A view of the final to help the home builder to see the parasitic chokes and general layout of the final.

This article will be of interest to the ham who wants a good linear amplifier which is easy to build and very simple to operate. I built mine into the pedestal of a Johnson Viking Kilowatt which will be of interest to owners of this piece of equipment. The type of tetrodes and the amount of power can be almost limitless with this type of circuit. The pair of parallel 4-400 tubes I used gives me a full 2000 P.E.P., with no problems, 80 through 10 meters.

What are the reasons for building a low-impedance, or terminated grid type of amplifier?

1. The input impedance has a resistance of low value. A non-inductive (Globar) resistor of 50 to 100 ohms resistance provides an exciter load suitable for use up to 30 MHz—probably higher. It is non-reactive, except for stray capacity.

2. It requires no input tuning.

3. With proper shielding of the input circuit components, this low input impedance materially reduces problems of feedback from output to input. Neutralization is seldom, if ever, required.

4. Good designs are almost invariably basically simple, and this certainly is simple.

5. Bias may be brought up through an *rf* grid choke, the bias being isolated from the input terminal and the 50 ohm resistor by a low voltage mica condenser of .001 to .01.

Alternatively, the 50 ohm resistor may serve as an input resistor, bias being brought up through it, in which case the low side of the resistor should be adequately by-passed.

6. An additional refinement is that a 100 K pot. (approx) could be connected into the bias lead to provide alc voltage for the exciter. This value of resistance would provide about 10 volts peak when grid current reached 1/10 of 1 mA. The exact values would have to be determined for the amount of alc voltage desired. Moreover, the moving arm of this pot. would have to go to a silicon rectifier diode connected to provide a negative alc voltage. Since any grid current flowing would already represent one rectification, the voltage taken from the pot would be audio; the second rectifier thus would provide an envelope voltage for application to an appropriate stage in the exciter.

Fig. 1 shows the linear amplifier using a pair of Eimac 4-400s in parallel class AB-1 as it is now installed in the pedestal of my Viking Kilowatt. In my rig the grid circuit reflects a 52 ohm load to the exciter at all times. This makes my Drake T-4X operate as if it were working into a 52 ohm dummy

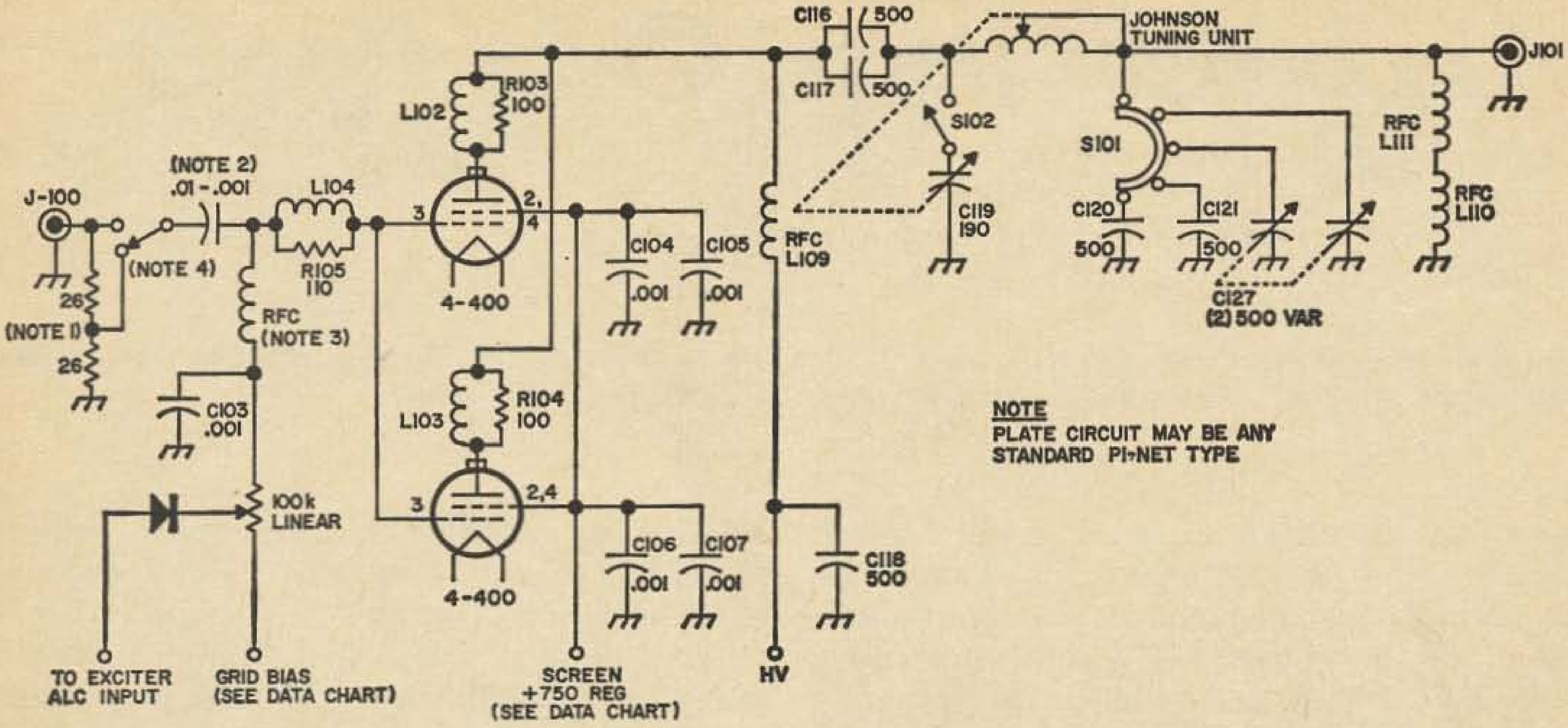


Fig. 1. The basic circuit of the amplifier, Note 1. Grid resistor load. Note 2. Mica condenser any size. 01 *to* .002 *voltage is low. Note 3. National R-*100 *or equal* 2.5 *mH. Note* 4. *Switch for adjusting power output of exciter to proper power input to amplifier. See text for details.*

load. Most exciters are made to operate into 52 ohms, and I feel it is only sensible to follow along with the designers plan. Terminating resistance as high as 100 ohms can be used without the linear becoming unstable. There is only one reason I can see to use 100 ohms for termination, and that would be if you were using an exciter that had under 100 watts P.E.P. output and it could not drive the linear on the higher frequency bands. I would suggest trying the 52 ohms first and if more drive is required, put in a larger terminating resistor.

My terminating resistors are made up of two 26 ohm resistors, in series, with a switch in the grid circuit so I can tap down from full power input to place just half the rf into the grid. If I see my alc circuit operating when I am on full input with the exciter gain reduced, I switch to the 26 ohm position and increase the exciter gain. I find that some exciters drop off in output on 15 and 10 meters. I suggest using the 52 ohms on these bands and then using 26 ohms on 20-40 and 80 if this is your problem. I plan very soon to use parallel resistors to make 13 ohms. I will use four of these packages in series for a total of 52 ohms. I will then have a four position switch so I can tap the grid down every 13 ohms. The circuit diagram only shows two positions as I am now operating the rig.

Refer to the Typical Operation Data for the 4-400 tubes (**Fig. 2.**) You should obtain this information for the particular type of tetrode you plan to use, and compare the voltages you can get from the power supplies at hand with what the manufacturer recommends. In my case the Viking Kilowatt power supply gave 2750 volts under load. This was not the 3000 volts shown on the chart but it was "make do".

My screen supply was giving me 600 volts into 4-VR 150 regulator tubes, and was

Typical Operation Eimac 4-400 Tubes
Class-AB1 R-F Linear Amplifier
Frequencies to 110 MHz *per tube*

dc plate voltage	3000	3500	4000 Volts
dc screen voltage	810	750	705 Volts
dc grid voltage**	—140	—135	—130 Volts
Zero-signal dc plate current	90	75	65 per tube
Single tone rf (peak) grid volts	140	135	130 Volts
Single tone dc plate current	300	280	250 mA
Single tone dc screen current	18	15	11 mA
Single tone dc grid current	0	0	0 mA
Single tone plate power input	900	980	1000 Watts
Single tone plate power output	500	600	650 Watts
Two tone average dc plate current	215	200	175 mA
Two tone average dc screen current	4.0	3.0	2.0 mA

NOTE **Adjust grid voltage to give stated zero-signal dc plate current

Fig. 2. *Typical operation data for the* 4-400 *tubes.*

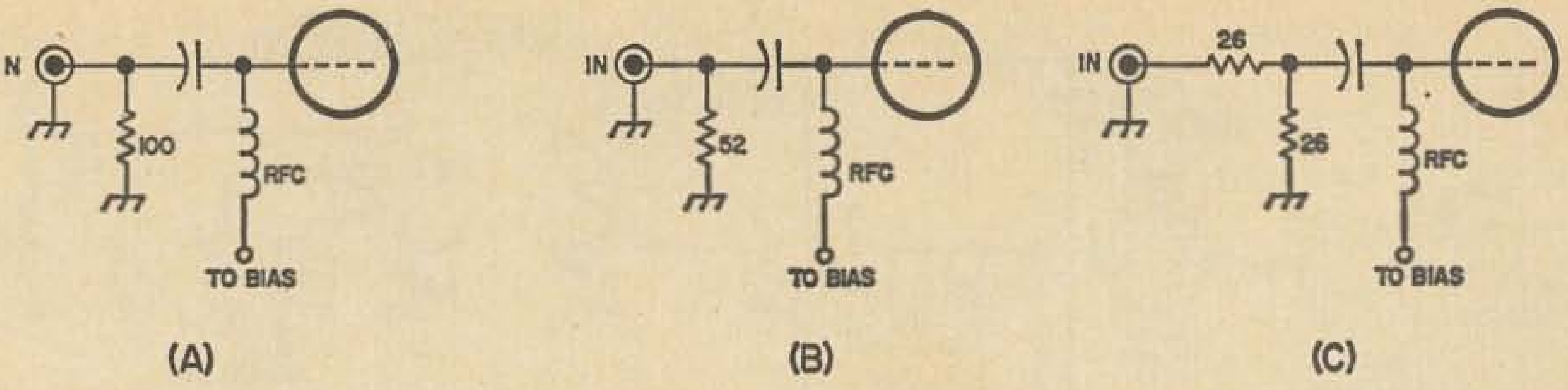


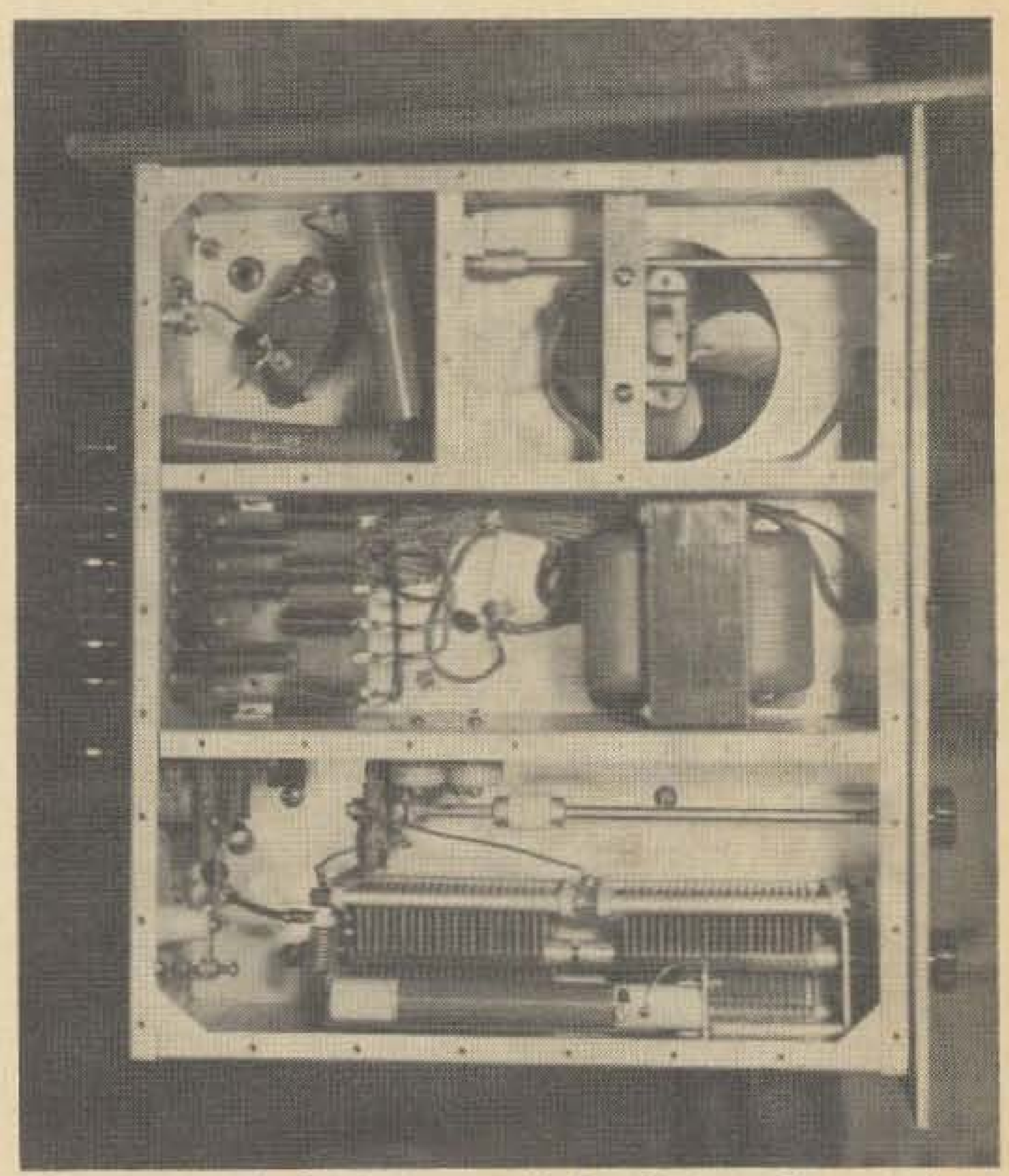
Fig. 3. Terminating resistors for A. Exciters under 100 *watts using* 100 *ohms, B. Exciters in the* 200 *watt range using* 52 *ohms, and C. Exciters over* 200 *watts using* 26 *ohms.*

wired up as choke input. I needed more voltage so a 2 mfd 2000 volt filter condenser was placed from B plus to ground ahead of the choke. With condenser input I got 840 volts to get my required 810 volts as per the data sheet. However when I tried to get regulators totaling 810 volts (4-VR 150 and 2-VR 105 in series), I found the supply would not keep the regulators fired up under modulation peaks, so I had to settle for 5 VR 150 in series for 750 regulated volts; and the output of the rig is not at all impaired. I have adjusted my Zero signal dc plate current to 95 mA per tube, or 190 mA total, because I am running less than 3000 volts on the plates. I merely interpolated the typical data to fit the voltages available to me.

There are two points I want to make. First, if you use a grid meter an 0-1 mA will do the job. If you are operating properly, it should never read anyhow. My rig had a 50 mA unit in it but by removing R-108, a 2.2 ohm shunt resistor, it now reads 5 mA full scale and serves as a check on overdrive. Second, be sure to use a screen current meter as it will tell you more about how the linear is operating than any other meter you can use. The unit I had in the rig was a 50 mA but I should say anything from 25 to 100 mA would do.

I have found from watching my linear on a scope as I operate, that if it shows over 10 mA screen current, the final is not fully loaded. I load mine to about 2 mA and the data sheet says 4 mA. I also note that if I load to the point where the screen current goes negative I am overloading the linear. Keep the screen current positive and in the area of a very few mA at most and you won't have much trouble with complaints. The meter should not fluctuate greatly under load and the screen voltage must be regulated. Be sure that the VR tubes keep conducting (stay blue inside) under all speech conditions. These precautions will not preclude the use of a scope if you can afford one. I feel all high powered amplifiers should have the closest control of operating conditions that can be had. After all big power, not properly controlled, can make big trouble for a lot of hams operating on the band many kilohertz away from your frequency. The more power you use, the more responsibility you have to keep your signal clean. This is one good reason for considering building this simple linear.

For a plate meter, I used the 750 mA meter that was in the rig. All it is good



This view of the bottom of the linear shows where the coils were located and now contains the four resistors obtained from John Meshna Jr. A pair in parallel for 26 ohms and two sets in series to make 52 ohms at about 200 watts. The blocking condenser is a bigger one than needed but was handy in the junk box.

for, along with a voltmeter in the plate supply, is to indicate the power input to the final, as required by FCC on 2000 PEP linears. I never use it to indicate the function of the plate loading on the tubes. I feel the screen meter does a far better job.

The data on the tubes shows a two tone average plate current per tube of 215 mA or a total, with a pair of tubes, of 430 mA. This is almost 1200 watts input and over the legal limit. If I swing the tubes from the standing current of 190 mA in my rig up to 350 mA by the meter reading, I am getting 2000 watts P.E.P. from the power

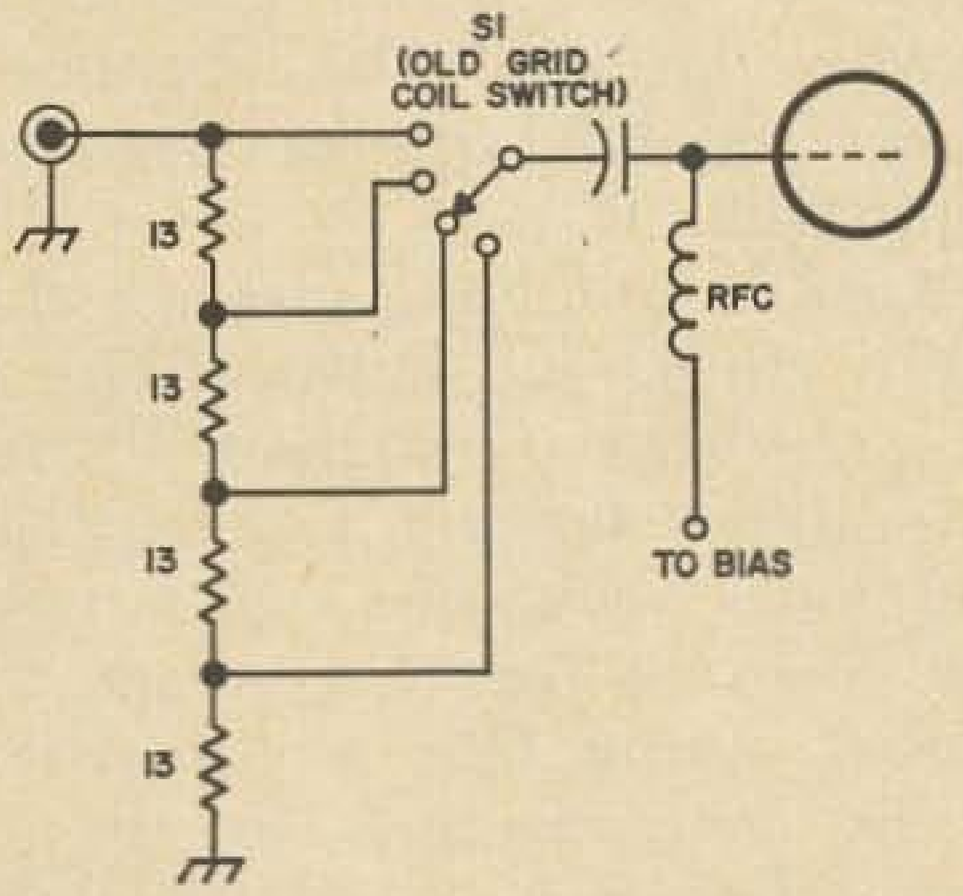


Fig. 4. The deluxe grid switch circuit.

supply into the amplifier. Going over this amount is not legal power input to your final.

I would recommend the use of the alc circuit in the grid of the linear if your exciter has the provisions for this voltage. If you use the adjustable input to the grids of the 4-400s this feature might not be so necessary. However it is so simple to add, I see no reason for not using it.

I would suggest some sort of rf output meter be used with this rig. Between watching the screen current and the rf output, you should get the rig properly tuned. The February 1967 *73 Magazine* showed how to have a combination plate current and rf output meter. See page 23 in the article by W5MPX. Since the plate meter is not too important, it seems a good idea to put it to a better use by throwing a switch.

This linear amplifier can be operated on CW in the AB-1 condition. You will key your exciter, and use it in the standard CW condition. If your exciter in CW has more than enough power to drive the linear and you want to be right on the ball, I suggest adding bias until the drive is just enough to do the job. This will tend to operate the final closer to class C, and the plate dissipation will be less during stand by periods. This is also true when using vox control. Use the contacts on the antenna change over relay to place higher cut off bias on the tubes during receive conditions, and return the bias for the standing plate current when in the transmit condition.

Now to spend just a moment on the terminating resistor. This resistor does not have to be right on the button. Your exciter will make allowances if your surplus resistors should be off a little. If you want to buy resistors, and you don't intend to pour rf into them for minutes on end as a dummy load, I might suggest some 10% 2 watt carbon jobs. For the deluxe job **Fig. 4** why not place 5 each 68 ohm 2 watt in parallel for 13 ohms and place four of these assemblies in series. This would give a 40 watt resistor, which should handle most exciters if the load is not held too long. Although I have not tried it, I should think one of the Heath Kit dummy loads or the Cantenna placed in the line from the exciter to the final with a coax T fitting would also do the trick. A recent catalogue prices the two watt resistors at 20¢ each. The terminating resistor should not be too expensive unless you want to get into a full dummy load type, then **noninductive** surplus items would be best.

For those readers who have the Viking Kilowatt and wish to change it over, I can assure you that you will double the output of the unit before you start to flat top. Also you will no longer have the loading problem with the grid tuning and there will be no need for attenuators between the

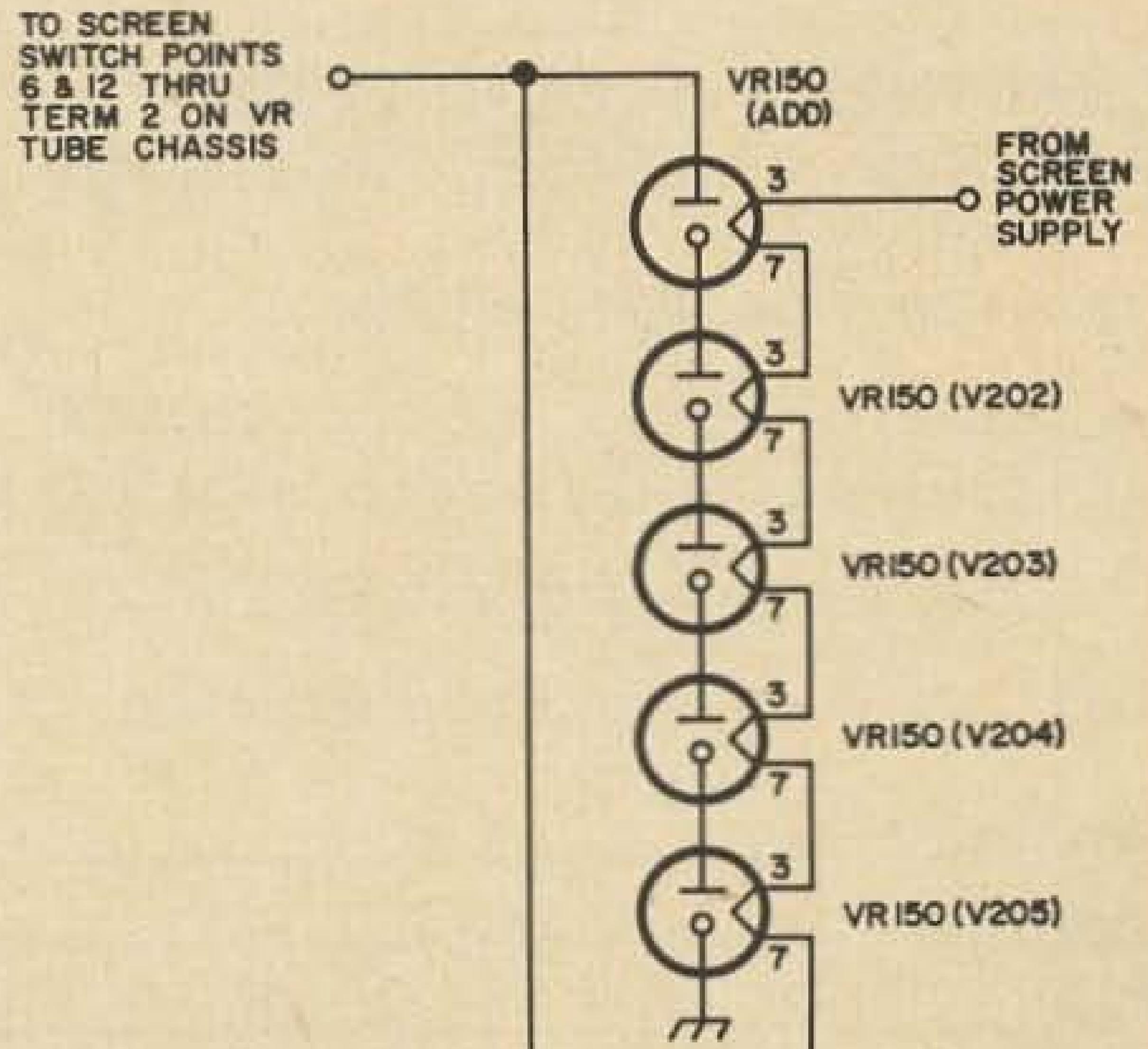
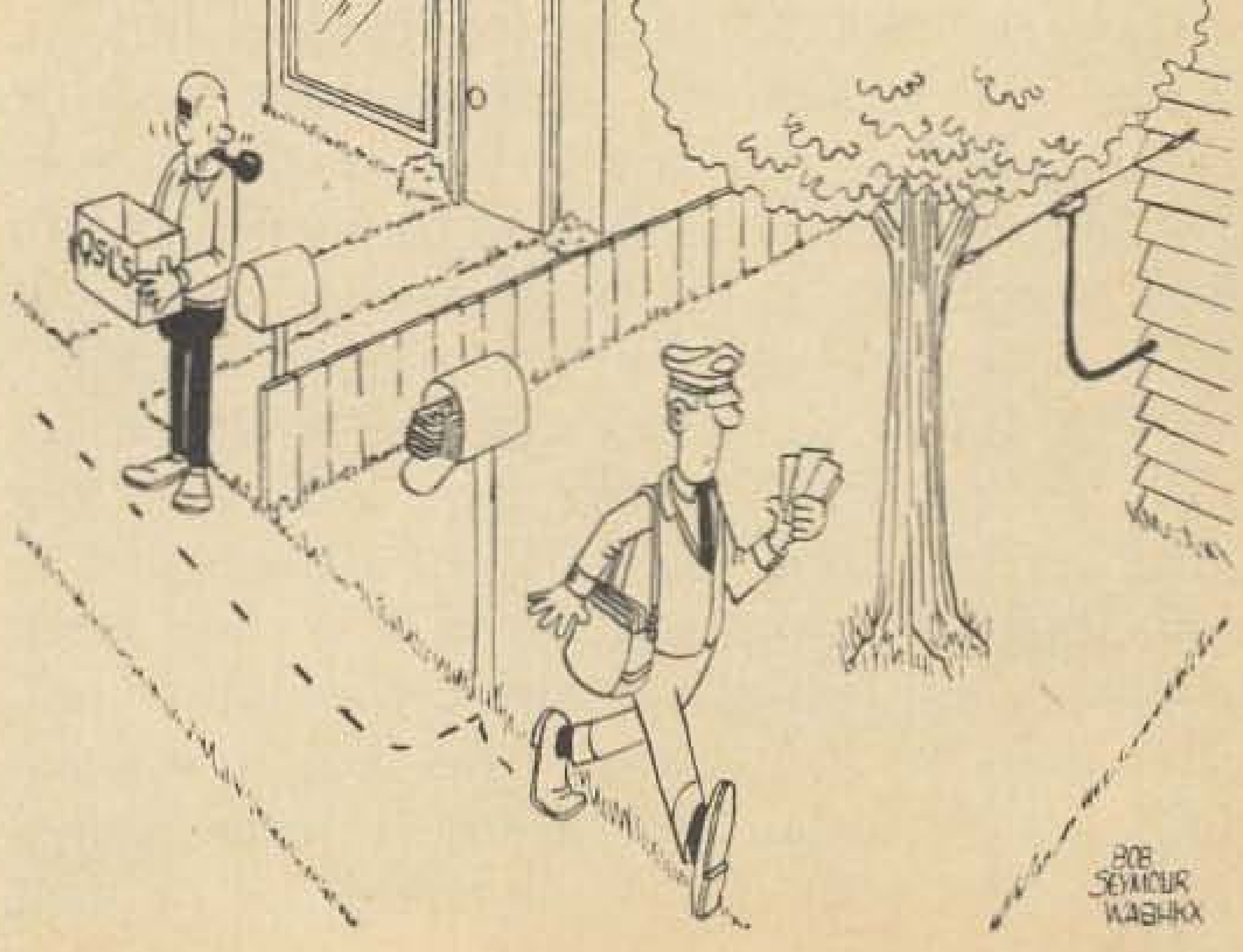


Fig. 5. Screen voltage regulation as changed in Viking Kilowatt.

exciter and linear. I suggest you leave in the 810 modulators as a bleeder. They will help regulate the plate voltage and improve the signal. When my 810s give out I doubt if I will replace them as they make a costly bleeder. The change in the screen supply has been covered. I added one outboard socket on the VR tube chassis so that I could have a string of 5-VR 150 tubes. Actually you could do away with the grid bias control tube (you won't need controlled bias on SSB), and use this for the fifth VR-150. Where you removed the old tuning condenser you can mount the alc potentiameter, and the drive switch now has the old band switch location. The changes do not make any outward appearance change in the equipment.

The greatest operating pleasure this linear has given me so far is this. With the old circuit, no matter how hard I tried (and with my scope showing a perfect picture), I would have about one call a week from a fellow ham complaining about by borad signal and asking that I cut the gain. I might not have changed the gain control for weeks and all seemed normal. However by adjusting the drive and the grid tuning or the neutralization my problem would disappear. With the present rig, I think I have been called perhaps three times in a year for wide signal complaints, and I have found if you watch the screen meter instead of the plate meter you shouldn't get any calls at all.

. . . W1DIS



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2224 Winterberry Drive
Lexington, Kentucky 40504

Recently, when confronted with the problem of operating a surplus vacuum tube receiver from the automobile supply, it was decided to use a transistorized inverter circuit to supply approximately 300 vdc at 50 or 60 mA. After a search through a reasonable amount of literature, I discovered a serious drawback to transistor inverter circuits. The most usual case is one in which an elaborate transformer (usually having five windings) is used in a push-pull class B arrangement with the extra windings usually for feedback. If this transformer can be purchased after three months of letter writing it is usually expensive. The other alternative is to wind your own transformer by "bopping" down to your local distributor and purchasing so much Z-PTR-XLP-21 transformer core, assorted enameled wire, and various insulating materials. If one is lucky enough to finally get his transformer wound, it is a feat to be proud of.

If only a standard "off-the-shelf" transformer could be used it would be a tremendous help. The circuit shown is such a device. A standard 12.6 vct filament transformer is used in reverse, driven push-pull with a pair of large power transistors, which in turn are driven by a conventional astable multivibrator. PNP transistors are used for the multi, so that base current in the power transistors can be accurately controlled. The

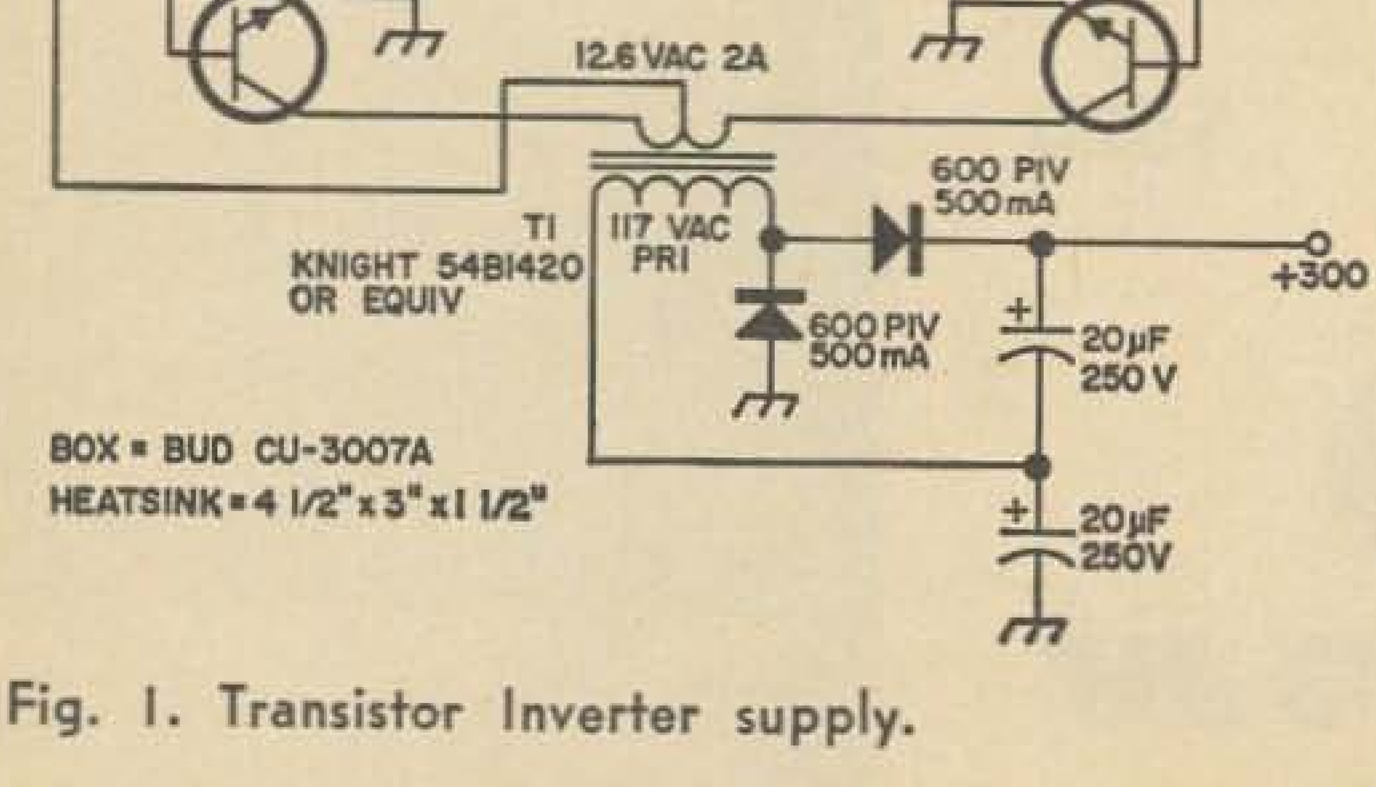

Fig. 1. Transistor Inverter supply.

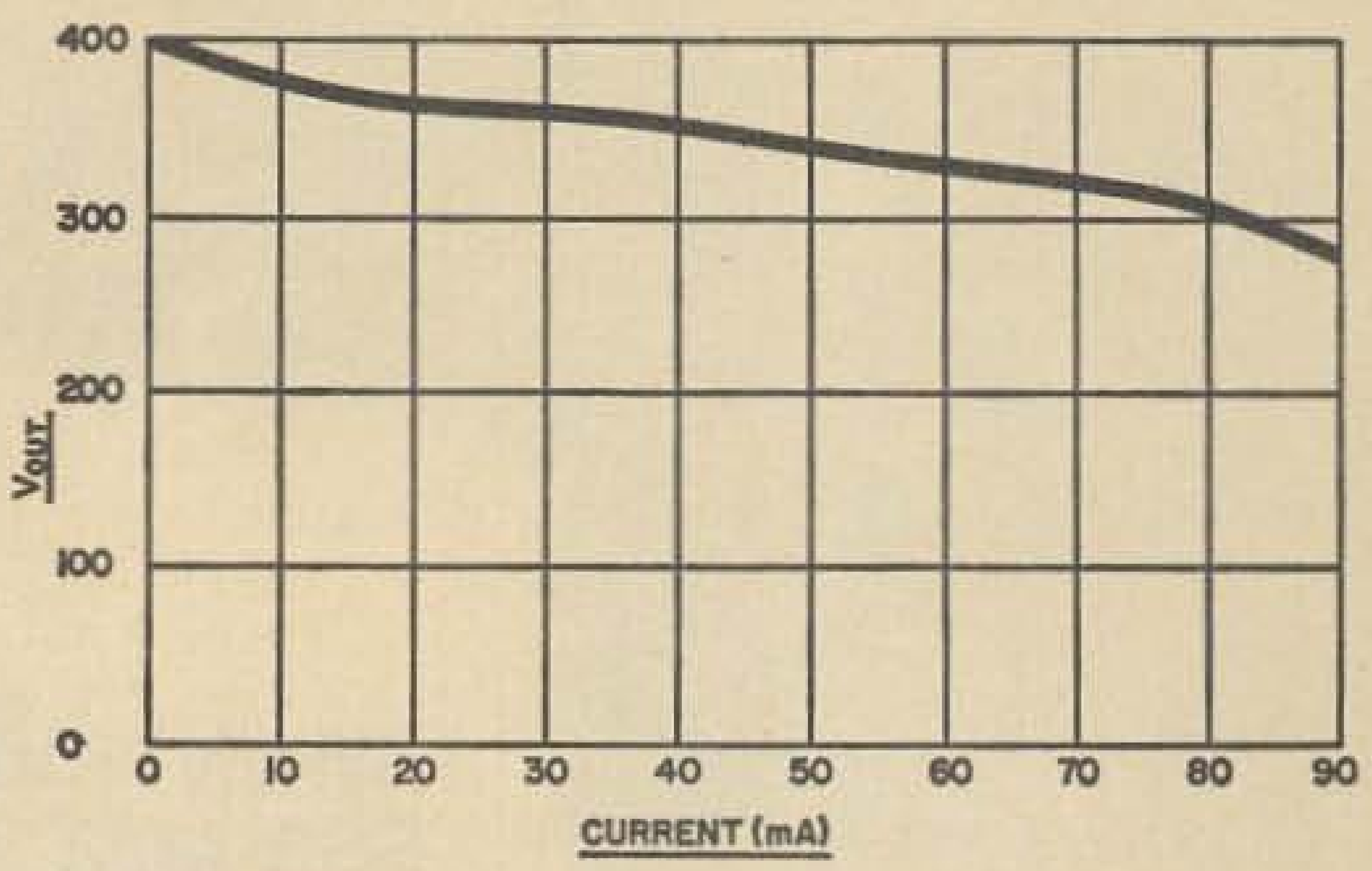

Fig. 2. DC output voltage vs. output current.

circuit configuration also provides high isolation between the oscillator and amplifier. The 2N1305's are very inexpensive switching transistors and the entire cost of the oscillator portion is approximately $1.50. Since an inexpensive transformer is used, the cost of the unit is substantially reduced, even though extra circuitry is required to supply the drive to the power transistors. The power transistors are specified as 2N3055's but the circuit is very flexible, and any of the "bargain-type" NPN power transistors should work equally well, although to guarantee operation with minimum debugging it would be best to stick to the circuit components listed.

The frequency of oscillation is approximately 1500 Hz. This frequency allows good filtering with small capacitance and yet is low enough to enable a reasonable amount of power to be transferred through the transformer. A half wave voltage doubling circuit is used, but this is entirely up to the builder, depending on his particular requirements.

Layout is not at all critical but note, care should be taken that at no time any part of the high voltage circuitry be allowed to come in contact with the transistor circuitry. This would have a devastating effect on the transistor junctions.

The two power transistors can be mounted on one heat sink. Care should be taken to insure that the power transistors are insulated. Mica washers and thermal grease should be used. Before applying power, an ohmmeter should be used to insure that the power transistors are indeed insulated.

When power is applied, a high pitched whine should be audible, which indicates that the transformer is being driven. If no whine is audible, then place a pair of conventional 2000 ohm earphones from collector to collector of Q_1 and Q_2. The earphones should sing loudly, indicating that the astable circuitry is indeed oscillating. If these tests indicate the circuitry is operating, check for high voltage output. (Note, when this unit is delivering full load it requires approximately 4 amps at 12 vdc). The load curve shown is for 12 vdc input, using component values as listed. To decrease output voltage for a particular load, the resistors R3 and R4 can be increased, but it is not recommended that they be decreased to obtain higher voltages.

The entire cost of the unit is approximately $15.00 depending on the builder's junkbox. The inverter is ideally suited for operating small transceivers similar to the "lunch-box" series. Happy DX-ing.

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Photographic Printed Circuit Process

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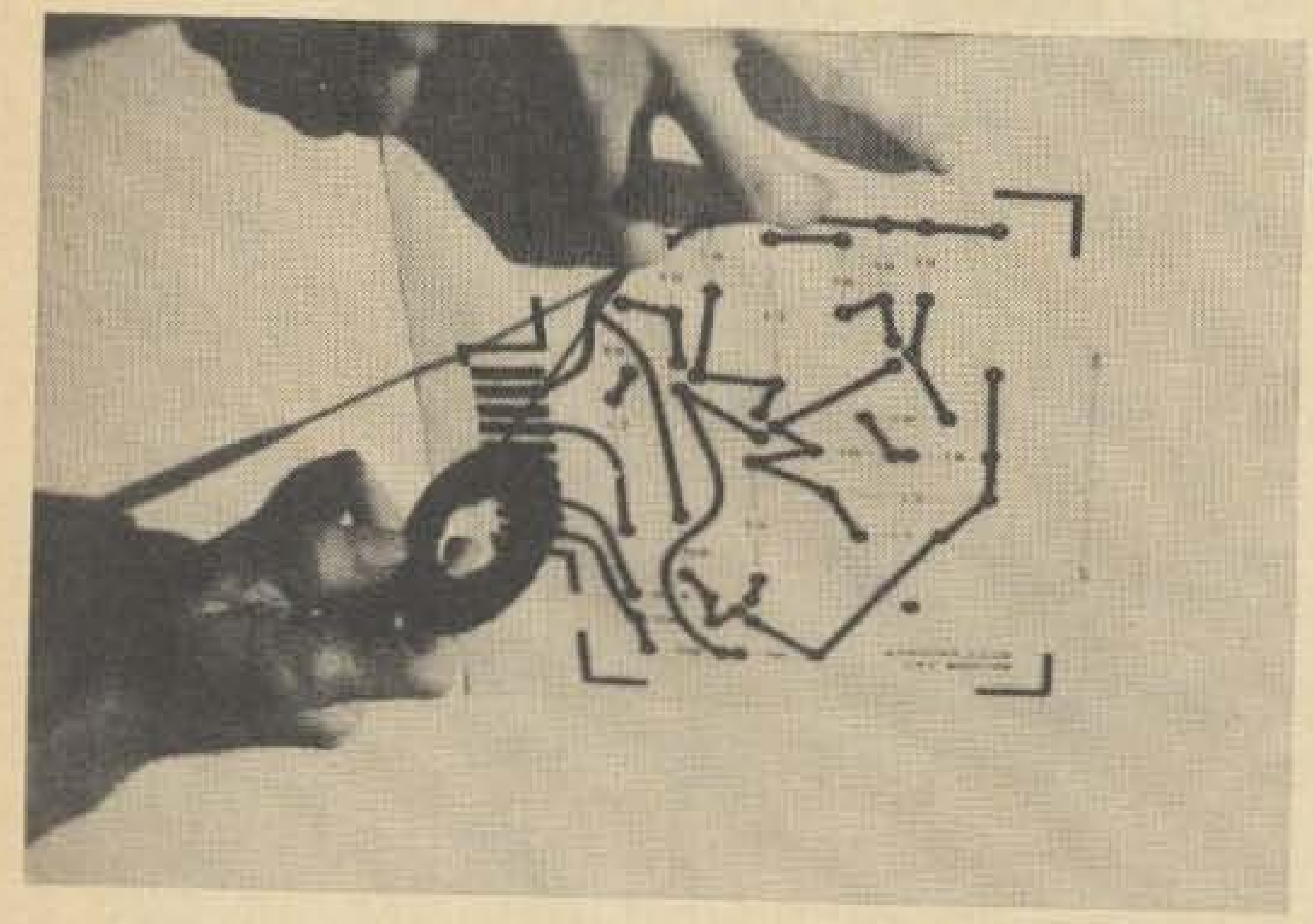


Printed circuit tape on clear plastic forms the photo master. Tilting and marking is done with dry transfer letters and a felt pen.

Although printed circuits have been around a long time, there are still a surprisingly small number of amateurs who use the technique to it's best advantage: Hundreds of companies manufacture materials necessary for making printed circuits, yet, in spite of this, hams continue to neglect the primary advantage of the etching process; the mass production of circuit boards.

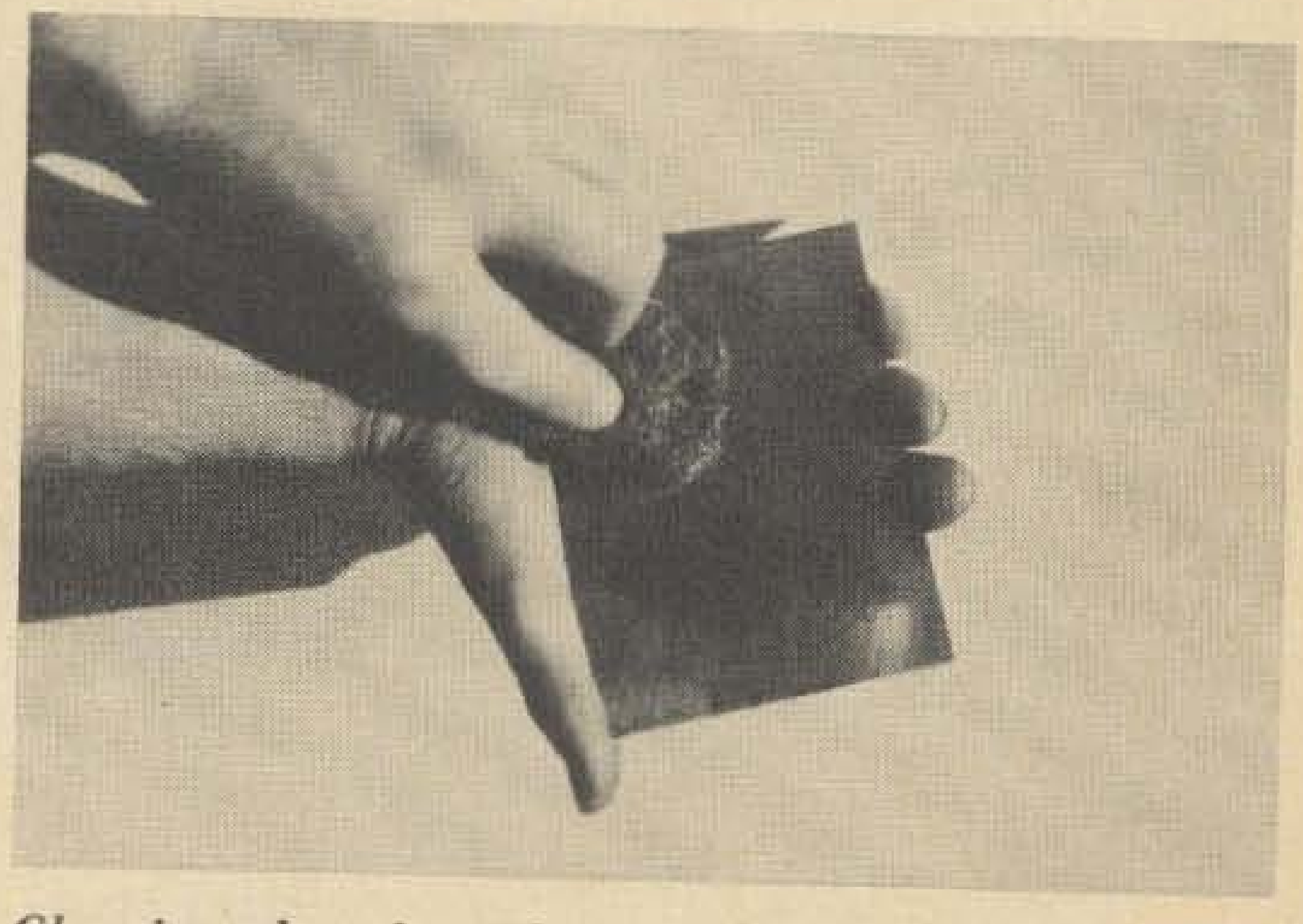
Although of greatest use on club projects, where dozens of the same item are to be made, a mass production process can be of considerable help to the amateur working alone, provided he needs more than one of any item. There are an unlimited number of projects, both private and club, which will go faster, cost less and look better on printed circuits. Besides this, you can make as many bcards as you want; each identical to the other. A photographic process is employed but it is not necessary for you to own any photography equipment; not even a camera. Once the chemicals have been purchased (cost will vary from $10 to $25 depending on quantity), each run of boards will cost about $3 not including the board stock.

The process can be divided into two major steps. The first would be the production of a film negative to photoprint the resist on the boards. Making this negative includes laying out the proposed printed circuit on paper. The second step is the printing and etching of the board itself.

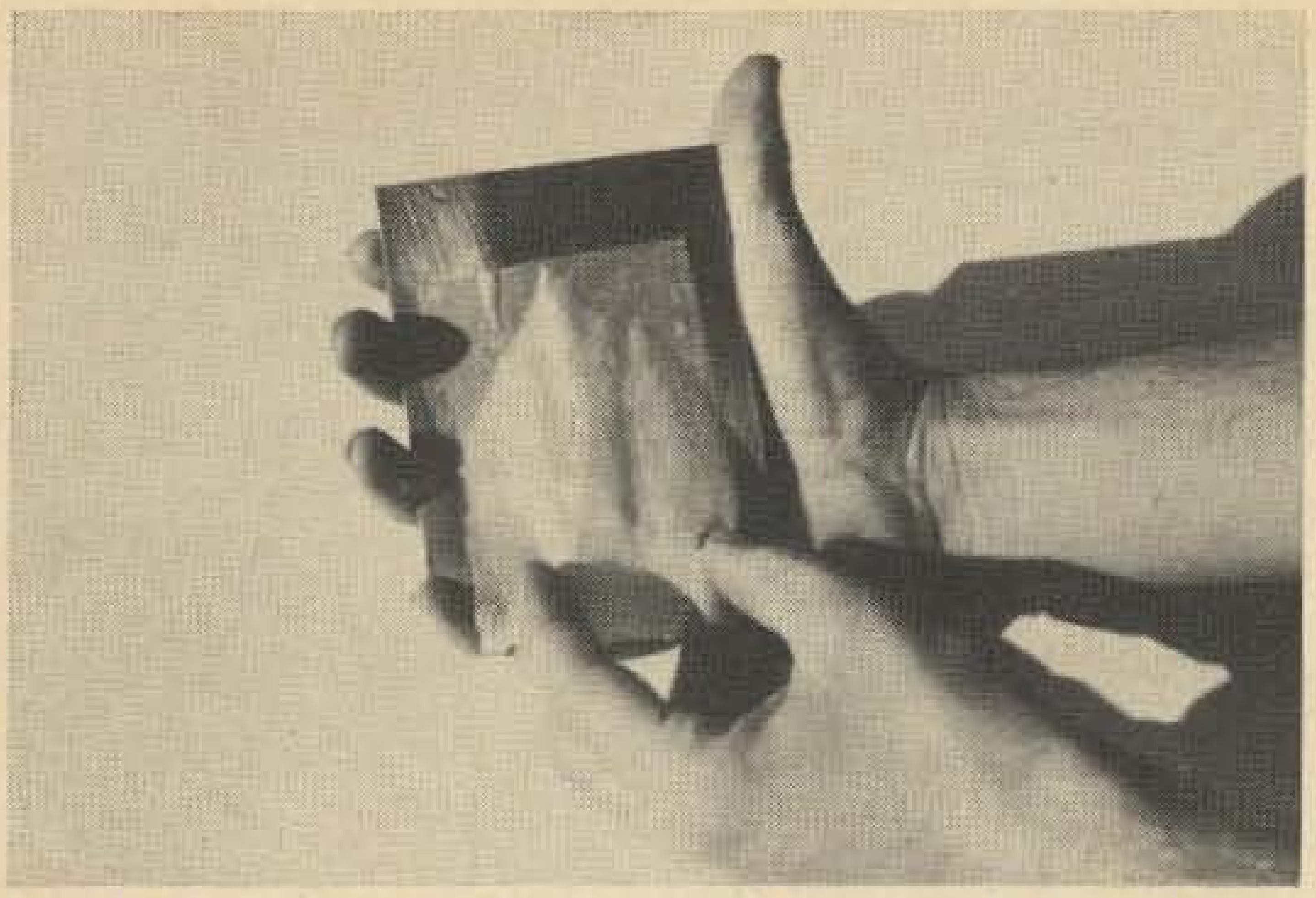
To start the process, a suitable layout of the conductors must be made on paper. Graph paper is used to maintain neat horizontal and vertical lines and the layout is done double size. When a suitable arrangement is arrived at, a piece of clear plastic or a sheet of vellum is laid over the hand drawing

Using tape pads and printed circuit tape, layout the conductor pattern by pasting the tape over the conductors and pads on the drawings. Also use the pads to mark locations for drilling mounting holes. Notice on the sample layout that the corners have been marked with tape in 'L' shapes. These are guide lines for cutting the boards square after printing and etching. The dimension along the side of the layout is necessary for the photographer to reduce the finished product. Since the board is double size the distance between marks measures an actual 4 inches but is labeled 2 inches. When the film negative is made that distance will be an actual 2 inches.

To get the photo work done take your tape master to a blue print supply store that is equipped to do photo work. Ask for a high contrast, film negative of your layout reduced



Cleaning board with steel wool removes oxide which would otherwise hamper etching.



Apply an even coating of photo resist by pulling paper towels across board. Be sure to cover board completely.

to ½ size. A 5 x 7 inch negative will cost about $2.50. If you know an amateur photographer consult him about getting the job done. When you receive the film negative, inspect it for line definition and contrast. Sometimes the clear areas of the film will appear slightly gray. If the grayness is extreme it will cause trouble in printing and the operator can bleach it out of the film for you. Upon reception of the film, protect it at all times from smudges, fingerprints and scratches.

Making circuit boards is a process which has been developed to a fine art by industry and there is no reason why amateurs should not take advantage of their effort. Here is how you do it. First cut your stock to an approximate size allowing about ½ inch extra on all edges. Clean the copper thoroughly with steel wool until it shines brightly, rinse in water and dry with a paper towel (lint free). Now the photosensitive chemical is applied to the board. It is called *Kodak Photo Resist* and is sold in varying sizes by Kodak. Although sold in aerosol cans it is recommended that you stick to hand applications. Don't let the price of the bottle scare you as that little dab goes a long, long way. Apply a thin coat with a small piece of paper towel spreading it evenly all over the board. This work need not be done in complete darkness since the chemical is rather insensitive to low light levels. Just pull the drapes and go to work. Allow the board to dry completely before continuing. Drying can be accelerated by placing the board in the oven at lowest temperature for about 15 minutes.

When the board is dry and cool place it copper side up on a flat, thick piece of plywood. Place the negative on the copper and

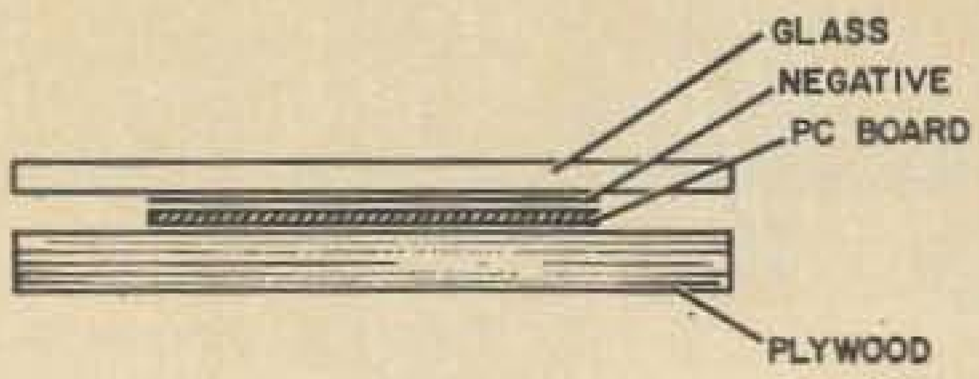


Fig. 1. The 'sandwich' as seen from the side.

center it. Over this, place a piece of clean glass which will keep the negative pressed against the surface of the copper. You now must pick up this 'sandwich' and walk outside with it. Aim the glass side at the sun and hold steady for one minute. The sun should not be obscurred by clouds or be low in the sky when this is done. After exposing, return indoors and immediately place the copper clad board in a shallow, glass dish of Trichloroethylene (sold in electronics parts stores as a cleaning solvent) being sure the entire board is covered with solution. Gently agitate the dish for one minute then remove the board and rinse it under running water for about 30 seconds. Allowing the light to reflect off the board should reveal the impressions of the resist still left on the board. Check for any imperfections at this time. If some exist, the board must be cleaned and the printing process repeated.

The board is now ready for etching. Ferric Chloride is the etchant used and is obtainable from chemical supply houses in crystalline form. Varying size tubes can be bought and the size will be determined by the project. This is by far the cheapest way to purchase the ferric chloride although it can be had in solution from the local drug

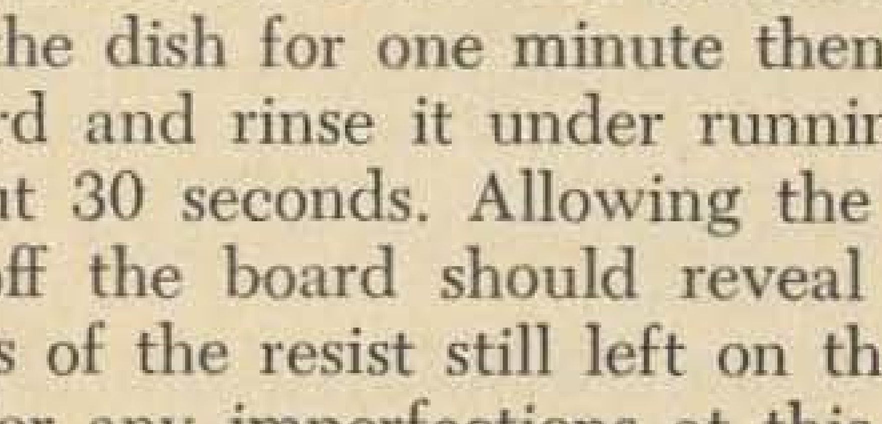
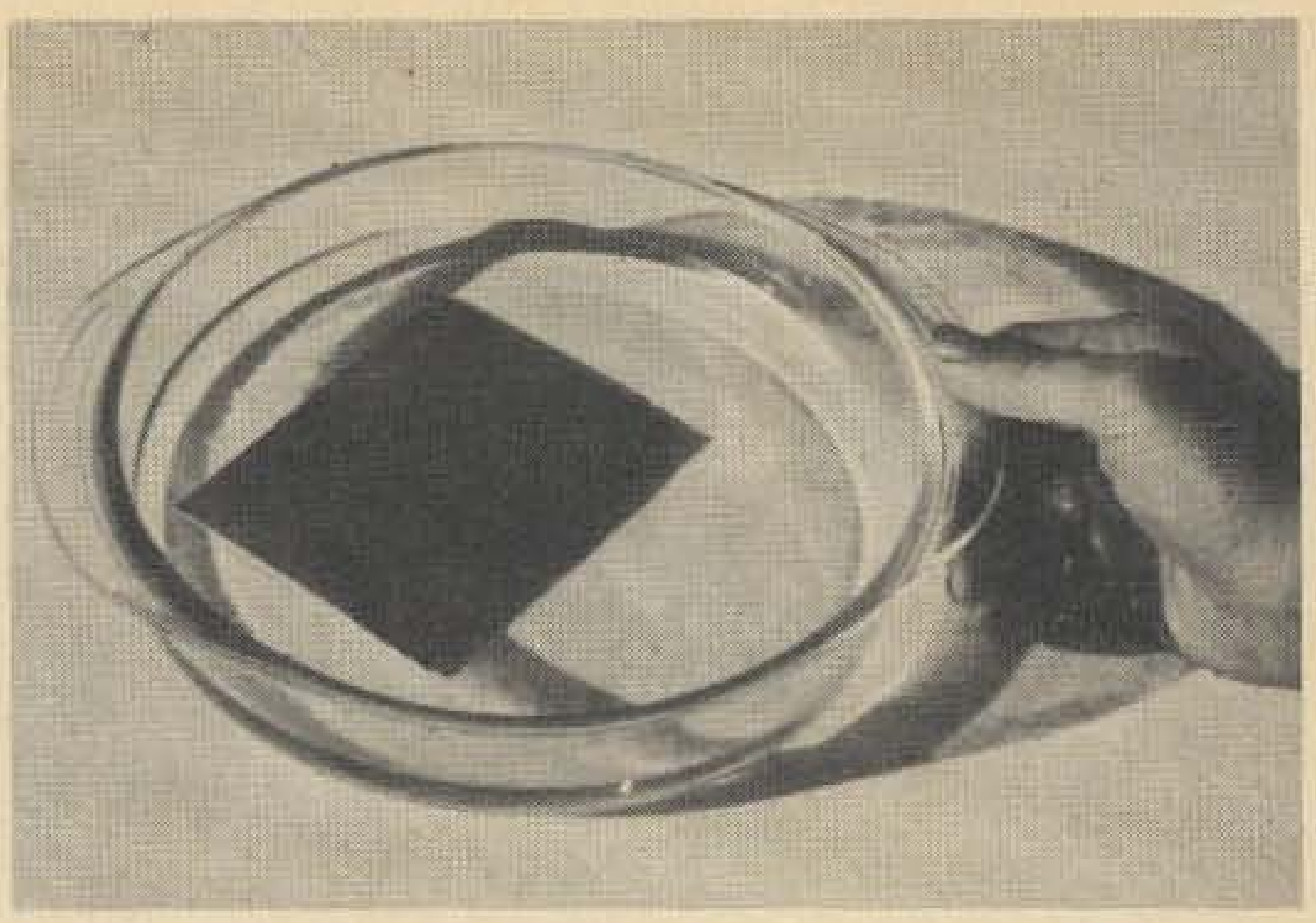


Fig. 2. After etching, a cross section of the printed circuit board will look like this. Copper will remain where there is a coating of photo resist.

store. The crystals which you get are to be mixed in water. The ratio is 8 pounds per gallon of water. Mix until all the crystals are dissolved in the water. Do not use metal containers or utensils with the etchant. You will now find that by dunking a prepared board into the solution it will etch in a couple of hours. There are two methods which will aid in reducing this time to 15 minutes. First of

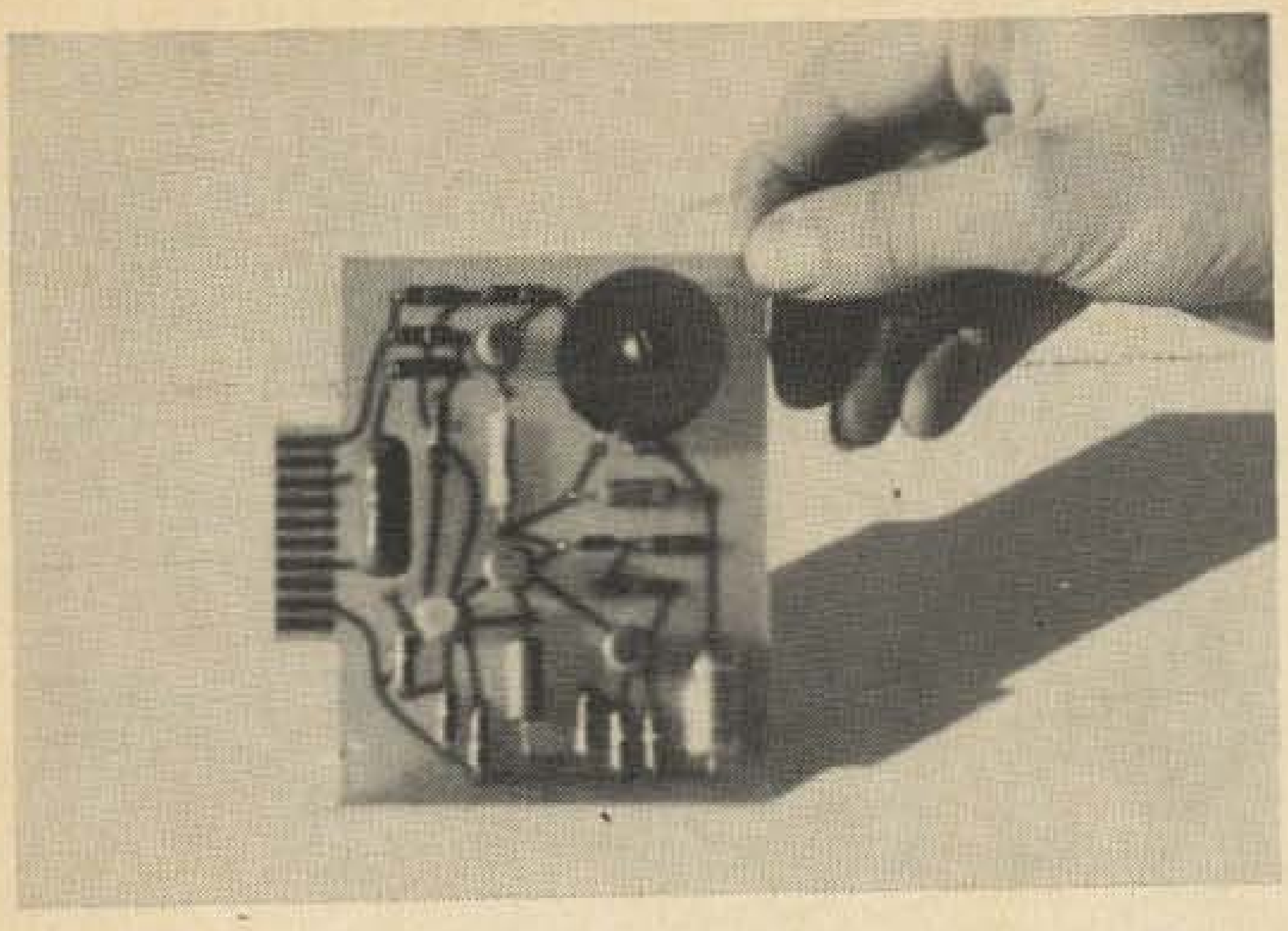


Submerge board in trichlorethalene developer and agitate for one minute. Immediately rinse in water.

all the chemical reaction which is taking place is enhanced by heat. By elevating the temperature of the mixture to 120° Fahrenheit, a great reduction in time will be noted. I would recommend doing this by setting the container of etchant inside a container of water placed on a small hotplate. This allows better control, adds a small bit of safety and allows you to monitor the water temperature instead of the etchant.

Oxygen is also an aid to a faster reaction. A small bubbler with a hose going to the etching tank will speed things up considerably. By suspending the board upside down at the surface of the solution an excellent cutting action is produced as the liquid splashes against the copper. An aquarium type bubbler might be ideal for this and would cost very little.

A few additional hints at this time might prevent some unpleasant experiences. From the time the Kodak Photo Resist is put on the board until the etching is completed it would be wise not to touch the surface of the board. If the layer of resist is scratched it will allow the copper to etch where it is removed. Keep your working areas clean, especially the steel wool section. Those nasty little fibers polute chemicals very easily. Avoid inhaling the fumes from the developer (Trichloroethylene) and the etchant (Ferric Chloride). Both are toxic. Keep the developer covered when not in use as it evaporates quickly. While drying the photo resist coating after application store the board in a warm, dark, dust-free place. The dust particles will print as hairlines on the board. Change developer periodically by observing particles of contamination floating in it. Change etchant solution when the etch time



The finished product with components mounted.

has increased to twice its original value. Never mix new and used chemicals together. Attempts to restore contaminated chemicals result only in greater quantities of poluted chemicals than you started with.

This is the whole printed circuit process in a nutshell. I have used this system with great success on many different projects and am happy to report that it is much easier to do than to say. Below is a list of possible problems which might be encountered in the various stages of production along with their solutions. Also you will find a list of materials for the layout and printing of boards.

Problems	Causes
All the photo resist comes off in the developer. No print left on board after washing in water.	Probably caused by under exposure to the light. Also can be caused by improper drying of resist before exposure.
None of the photo resist comes off the board in developer. No print left on board after washing.	Too much light in room during preparation of board for exposing. Never leave cap off photo resist bottle. Developer bad. Increase developing time.
Resist turns gummy in developer and peels off board.	Coating of resist too thick or not sufficiently dried before continuing.
Print on board after washing appears and disappears in various places. When held to light print is difficult to see.	Coating of resist is too thin. Exposure to light too short. Left in developer too long. Washed board too strenuously or used hot water. Water should be cool.
Board will not etch at all or just in places leaving big splotches of copper.	Unexposed resist was not removed by developer (see above). Board not steel wooled enough.
Print fuzzy on edges of conductors before etching.	Film negative not held tight against the board during exposure.
Print fuzzy on edges after etching.	Left board in etchant too long. Not left in long enough.
Entire board etches leaving no copper.	Coating of resist was applied too thin. Too much light allowed to strike board prior to exposure.

List of materials for layout

Quantity	Item	Source
——	graph paper 1/10 inch squares	stationery store
one	sheet of clear plastic or vellum	stationery store
one	felt tip marker pen—black	stationery store
——	printed circuit pads	electronic supply house
——	printed circuit tape	electronic supply house

List of materials for printing and etching

Quantity	Item	Source
one	bottle of Kodak Photo Resist	photographic-supply store, electronic supply store, direct from Kodak
one	bottle of Trichloroethylene	electronic supply store, druggist
——	Ferric Chloride etchant	druggist, chemical supply house
one	large, glass tray similar to small tropical fish tank (No metal however)	variety or dime store, chemical supply house
two	large, shallow glass trays	
——	paper towels	
one	piece of glass, clean	
one	piece of plywood	
	Optional	
one	small aquarium type bubbler	
one	hot plate, preferably one with thermostat	

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REFERENCE

Ritchie, George L., *Electronic Construction Techniques*, 1st ed. New York, Holt, Rinehart and Winston (1966).

A Simple Method of DSB Conversion

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Dallas, Texas 75228

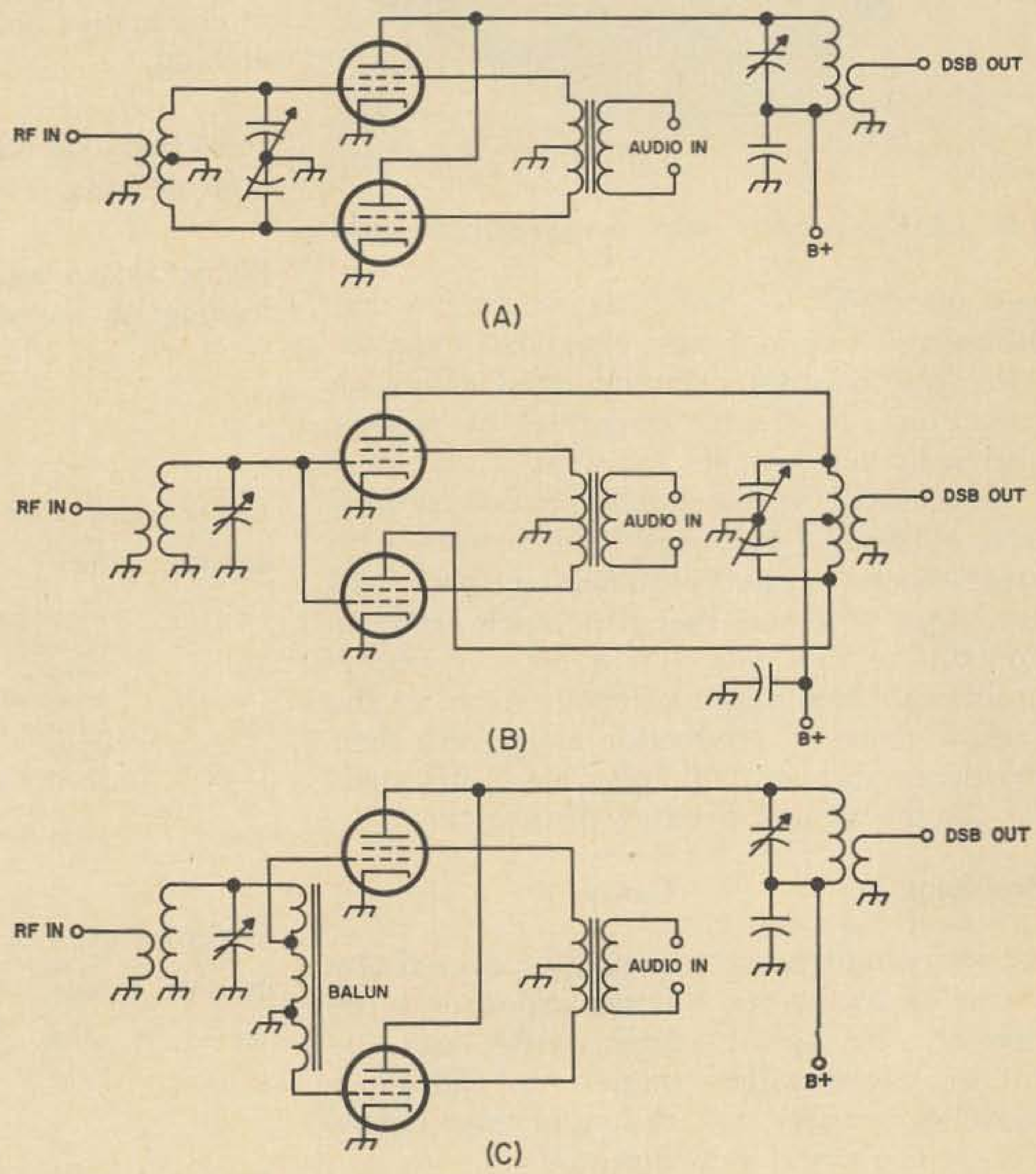


Fig. 1. Basic high-level DSB circuits. Grid biasing arrangements are not not shown.

Here is a simple way to convert any AM transmitter using two tubes in parallel in the output stage to double-sideband suppressed-carrier operation. This conversion is simpler than others I have seen in that the original single-ended grid and plate tuning circuits are used, with only minor changes to be made in the grid circuit.

Theory of operation

Basically what is required for double-sideband suppressed-carrier operation is a push-pull rf grid circuit with a parallel rf plate circuit, **Fig. 1(a)** or a parallel rf grid circuit with a push-pull rf plate circuit, **Fig. 1(b)**, either combination to be modulated by push-pull audio.

The transmitter I converted is home-brew, using a pair of 1625's driven by a 5763, with a pi-network output circuit. I left the output circuit alone and changed the grid circuit to push-pull by adding a broad-band balun between the original single-ended grid tuning circuit and the two grids, **Fig. 1(c)**. The balun provides a balanced input to the grids. Each grid is isolated from ground and supplied with a signal 180 degrees out of phase with the other grid. The balun is not tuned; all tuning is done with the original tuned circuit.

Construction

The balun is wound on a .68 inch outside diameter powdered iron toroid form (Ami-

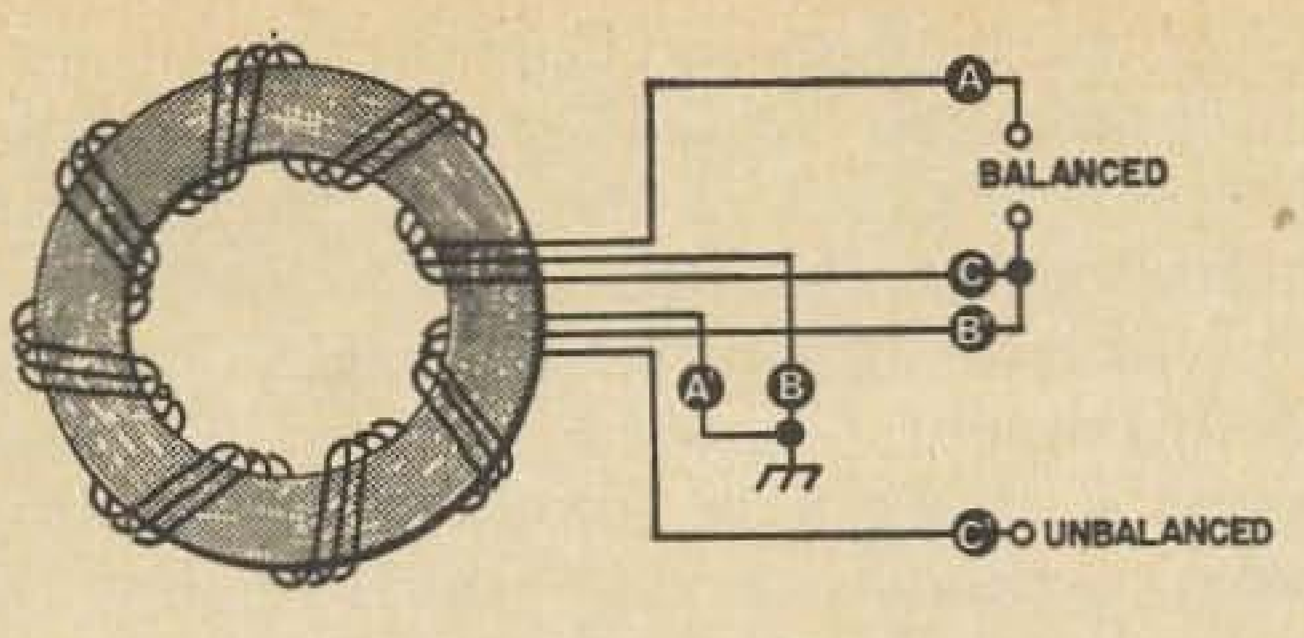


Fig. 2. Balun wiring diagram.

Tron type "E", number T-68-2). This is one of the two cores contained in the Ami-Tron Experimenters Toroid Kit which was purchased locally for $1.50. I had no information on using a balun in a high impedance circuit so I proceeded experimentally and wound three different baluns. See **Fig. 2** for balun wiring diagram.

The first balun was wound with 14 trifilar turns of No. 24 enameled wire (the wire that come in the toroid kit). This worked well on the 40 through 10 meter bands but the 80 meter tuning was shifted several megahertz too high. The second balun was wound with 23 trifilar turns of No 28 enameled wire. With this one the 80 meter band was about one megahertz too high, while the higher bands were still all right.

The third balun, which is the one I used, was wound with 28 trifilar turns of No. 30 enameled wire. This one allowed tuning the 80, 40, and 20 meter bands, but added enough capacitance to put the 15 and 10 meter bands slightly out of the tuning range. This was cured by moving the 15 and 10 meter taps on the grid coil up one turn each. There is no noticeable loss in grid current with the balun on any band.

To wind the balun, cut three 25-inch lengths of No. 30 enameled wire and twist or tape the ends together. Start at the center and wind both ways to make it easier. Feed the wire carefully through the core to avoid kinking and don't allow the wires to cross each other, as this may cut through the insulation. The wires must be close together at the center of the core to allow space for the 28 turns. Tape each end of the winding to the core. I covered the core with thin plastic tape before winding, but this may not be necessary.

I mounted the balun by its leads. This is not very rigid and a stronger mounting should be used for mobile operation or if the rig is moved around much. The balun may be taped or glued to a stand-off insulator of some sort. Just keep it away from the chassis and don't put any metal screws through the center.

Separate grid-leak resistors are required for each tube. Each one should be about twice the value used for parallel operation of the grids. I have measured each grid current separately, and have found them to be very nearly equal. Keep all grid leads as nearly symmetrical as possible and you should have no trouble.

Several methods of modulation are possible. The easiest way to do this with tetrode tubes is to apply push-pull audio to the screen grids. Not much power is needed, but fairly high audio voltages are required. About 300 volts peak is required for a 1625 or 807. No dc screen voltage is needed for tubes in this size class, but with some higher-power tubes a negative screen bias may be needed to keep plate dissipation within the ratings.

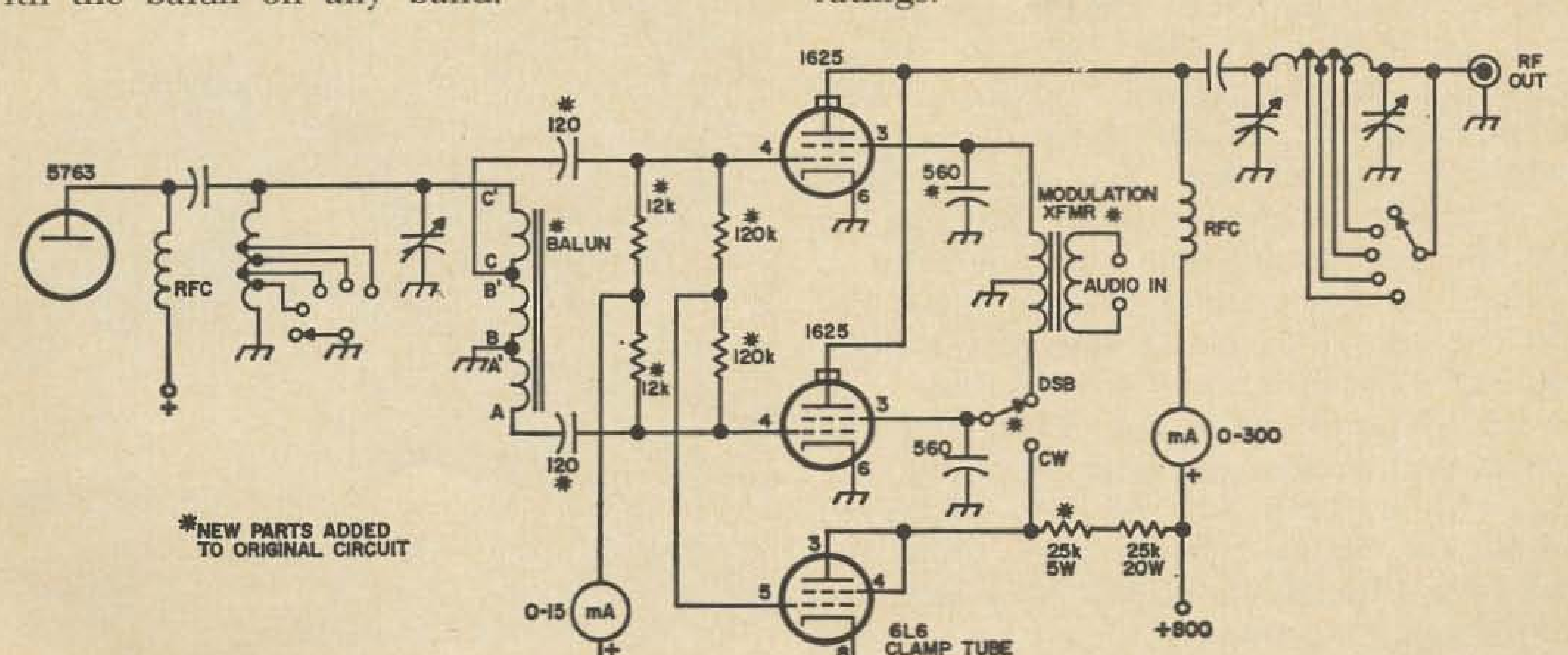


Fig. 3. Circuit diagram of the simple DSB conversion.

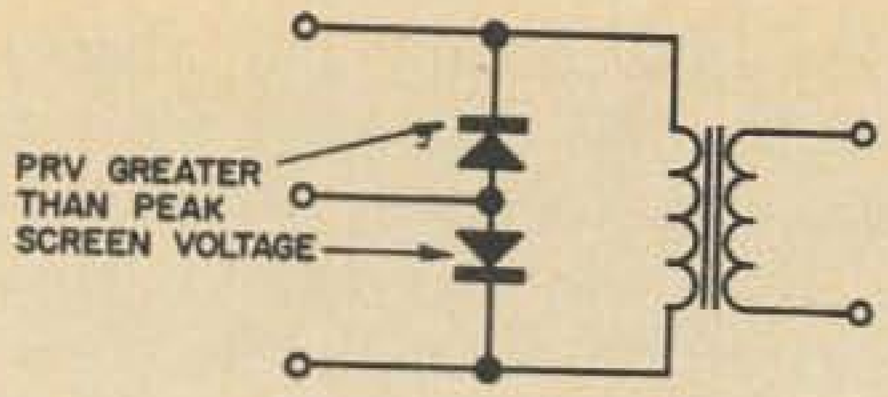


Fig. 4. Diode center tap, for use with modulation transformers that have no center tap.

For a modulation transformer I use a push-pull output transformer from an old auto radio, with the high-impedance windings going to the screens, and the center tap grounded. The low-impedance winding goes to the 16 ohm output of an old Heathkit 6 watt radio amplifier, which is used as a modulator. Anything with a few watts output can be used as long as you choose a transformer with a turns ratio that will give sufficient output voltage, If your modulation transformer has no center tap, a diode center tap, as shown in **Fig.** 4, may be used. The screens must be by-passed for rf but not for audio, so use a maximum of about 1000 pF on each screen.

To get the carrier back for CW operation or tune-up purposes requires only the addition of a single-pole double-throw switch. One screen is switched from the modulation transformer to the screen voltage-dropping resistor. The dropping resistor will need to be twice the resistance value of the original resistor that supplied two tubes. The easiest way is to add another resistor of the same value as the original, in series with the original resistor. This resistor need be only one-quarter of the original wattage value.

The above method uses only one tube for CW operation. To get full power from both tubes on CW, you must add another switch as shown in **Fig.** 5. The grids are simply switched back into parallel, and the screens are supplied through the center tap of the modulation transformer. The original voltage-dropping resistor is used. Be sure to keep the grid leads short and symmetrical. I didn't use this method because I had insufficient room to mount the grid switch. I did try it, however, and it works fine.

I key the cathode of the driver stage in my rig, and protect the final when the key is up with a clamp tube. The dc voltage to operate the clamp tube is taken from the final grids through the 120 k ohm resistors.

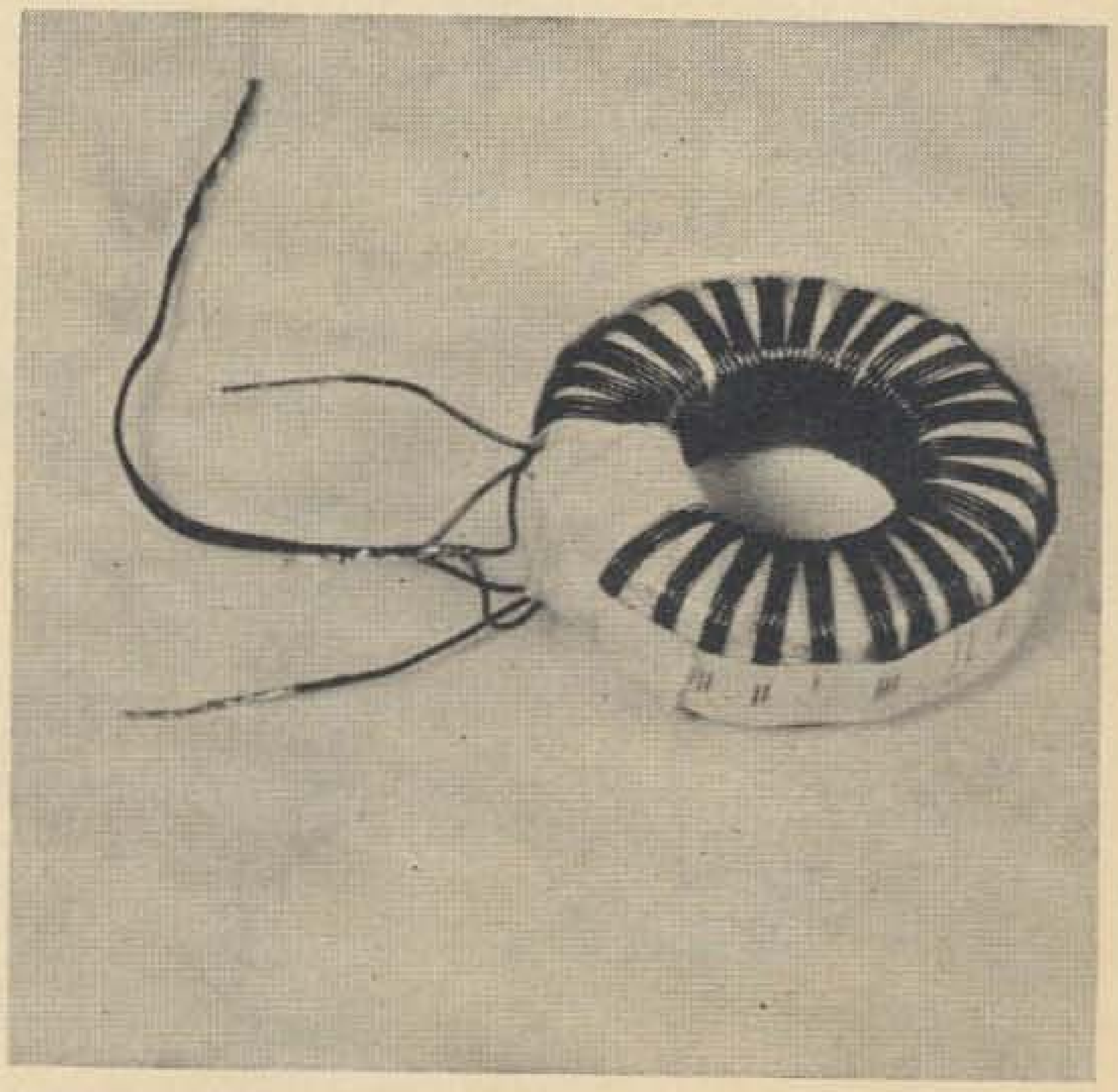
Testing and adjustment

The initial adjustment of any double-sideband transmitter must be done with the aid of an oscilloscope. Connect the output of the transmitter to a dummy load. Couple the vertical plates of the scope to the transmitter. Switch the transmitter to CW, set the grid current at the normal value, and tune for maximum output. Switch to DSB and apply a single-tone audio signal with an audio oscillator or by whistling into the microphone. Increase the audio gain until the peaks begin to flatten, and note the maximum height of the oscilloscope pattern when this occurs. Then speak normally into the microphone and adjust the audio gain until the peaks approach the previously noted level. This is the maximum input which can be applied without causing distortion and the resultant splattering.

An audio compressor or clipper will help to keep the average level high while preventing accidental overdriving. There should be no output noticeable on the scope when no modulation is applied.

The transmitter should always be loaded as heavily as possible. Light loading will cause flat-topping to occur much too soon.

The peak double-sideband power output with a given plate voltage will be about the same as the CW power output from one tube. A considerable increase in power can be obtained by using higher than normal plate voltage. Up to double the AM rating can be used without exceeding the dissipation ratings of the tubes. I use a plate voltage of 800 volts on my pair of 1625's. The



The grid-circuit balun. The over-all size is only ¾ inch diameter by ¼ inch thick.

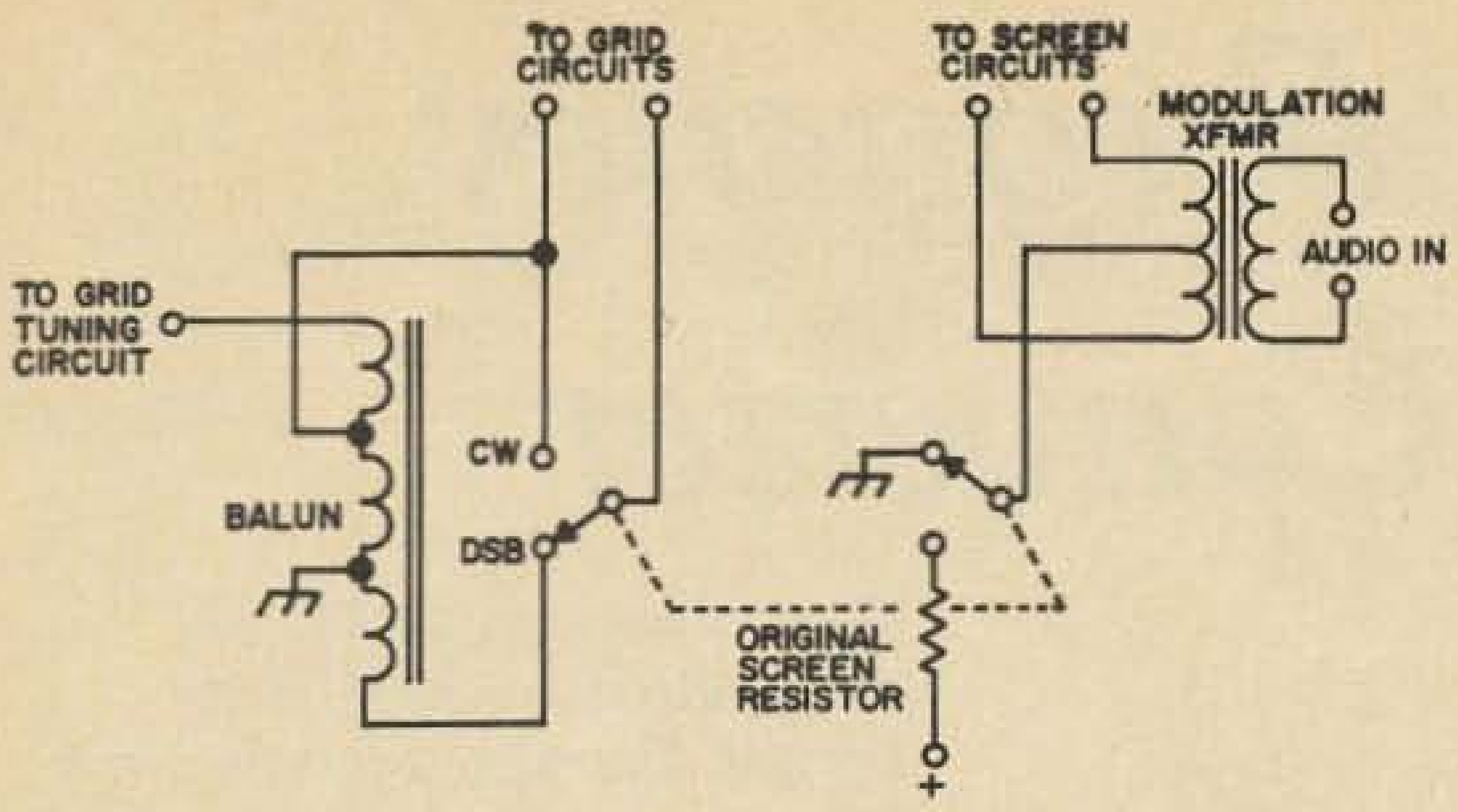


Fig. 5. Modifications necessary to get full power on CW from the circuit of Fig. 3.

dc plate current is 80 mA, with maximum sine-wave audio input before flat-topping occurs. The resting plate current, with no modulation, is about 25 mA. I estimate the peak power output to be about 50 watts.

Results

The on-the-air performance of my low-power DSB rig is hardly spectacular, but I find it easy to make contacts on 20 meters with a dipole antenna. I can now operate in the SSB portion of the band with a clear conscience, knowing that I am causing no heterodyne interference. I believe that DSB is an excellent mode of operation, especially for someone with a good AM or CW rig who wishes to try sideband operation without making a large investment in new equipment.

For more information on baluns, see the "Coaxial Accessory Handbook", 73 Magazine, September 1966. For details on using an oscilloscope for transmitter testing, read "Monitoring an Oscilloscope," 73 Magazine, July 1967, or any handbook.

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Navy RTTY Book Published

RTTY enthusiasts will want to keep their library complete by ordering this new book from the Superintendant of Documents, Washington, D.C., 20402, for $1.50. It is called Principles of Telegraphy (Teletypewriter) and has the designation "Navships 0967-255-0010."

P of T starts in with the basics of the TT system, covers the history and development of the field and goes into just about all phases of modern TT operation. It is about 200 pages and is well worth while for every RTTY'er. Newcomers to RTTY will find the explanation of the TT systems and codes of particular value.

Basic High Frequency Receiving Converter

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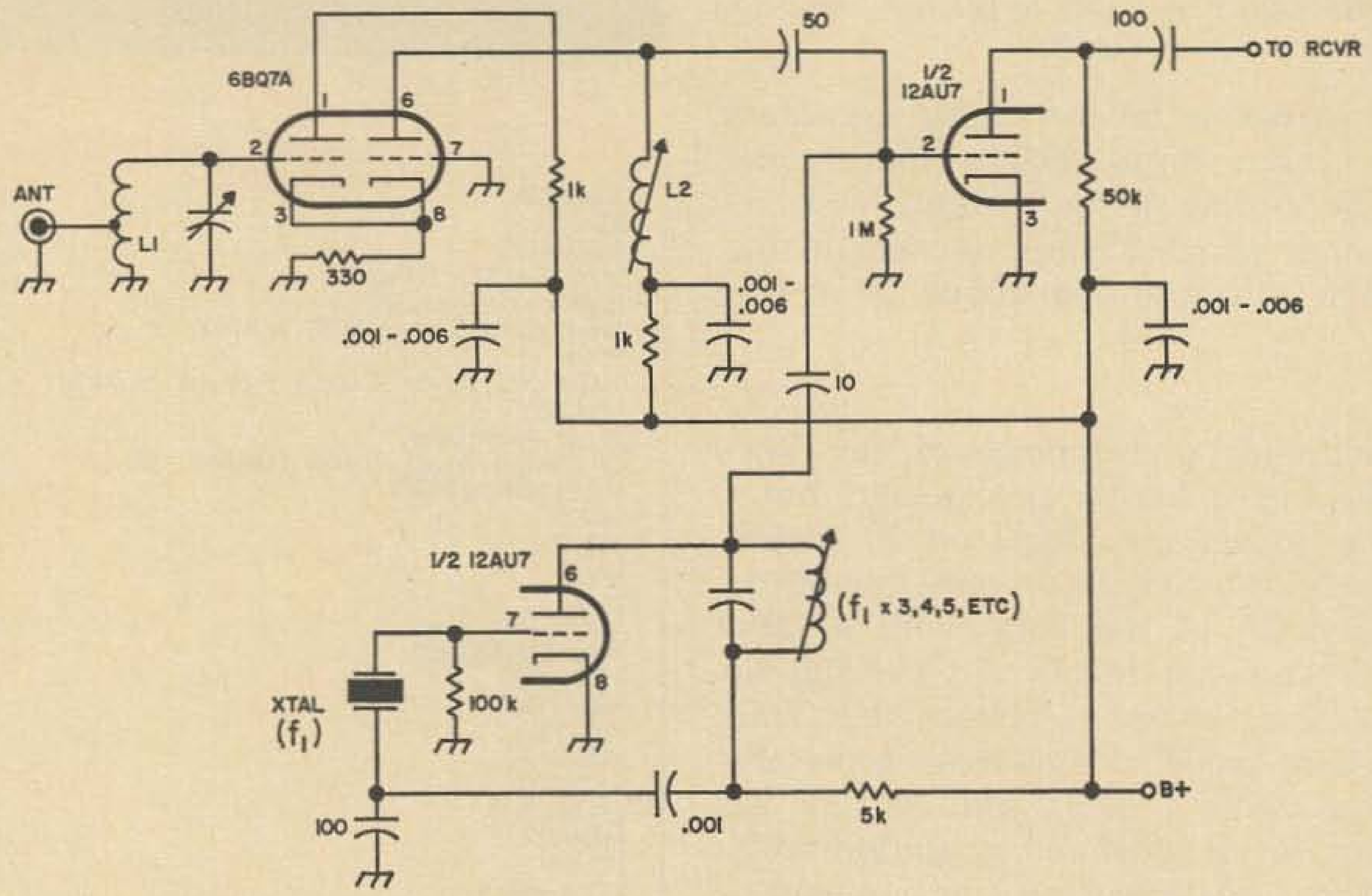

There have been many articles published over the years describing converters to extend the range of otherwise satisfactory low frequency receivers. This article does not present a unique design, but rather a successful combination of previously published circuits which, taken together, have the advantage of simplicity, dependability, and easy adaptation to a wide range of frequencies and a variety of applications.

If we consider the requirements for a good rf amplifier, it should provide efficient energy transfer from the antenna to the mixer; enough amplification to overcome internal mixer noise; a low degree of noise introduced by the amplifier itself; a low degree of cross modulation in the presence of strong adjacent signals; and a moderate amount of selectivity (a requirement which will vary from one application to another). In practical design compromises are required.

We may fairly assume that most receivers to which we will want to attach converters use tubes rather than transistors; consequently, we may as well use tubes in the converter as well. Pentodes provide high amplification and good selectivity but often with poor intermodulation characteristics and fairly high amounts of noise. Triodes, in contrast, have good noise figure, less selectivity, lower amplification, and fair intermodulation characteristics.

The rf amplifier shown utilizes two similar triodes, cathode-coupled. This has several advantages. Cathode coupling provides good energy transfer between the two stages and the circuit is not prone to oscillation so long as the antenna loading is adequate. With a typical amateur antenna system fed by a transmission line of fifty to three hundred ohms, it is easy to get good signal coupling to the first grid by adjusting the tap on the coil L1. Raising the tap will increase the coupling and by loading the circuit it will broaden the tuning, which is desirable in many applications. Try one-third up from the bottom as a first approximation. Note that this coil is resonated with a variable capacitor, which allows for the easiest adjustment at the front panel when changing antennas or moving to different parts of the band.

The plate coil L2 is shown as slug-tuned. It may be necessary to shunt this coil with capacity to reach the proper frequency, and if the response is too critical it may be necessary to shunt it also with a resistance of ten thousand ohms or less to reduce the Q and thereby broaden the frequency response. Generally, it is a good plan to resonate L2 near the high frequency portions of the band to be covered and resonate L1 near the low end. Some published versions of the circuit show an rf choke between the junction of the two cathodes and the resistor which goes to ground. This increases the efficiency, but I usually omit it. It is also possible to make the cathode resistor variable and adjust it for optimum gain. The 330 ohm value shown is generally adequate.

The resistors in the B+ lines to the rf amplifier (here shown as one thousand ohms) are not critical as to value and can be omitted entirely if the power supply is located close to the rest of the components on the converter chassis. However, they do provide additional decoupling, if needed, and as they are hardly larger than a piece of wire and not very expensive it may be a good plan to include them.

This option does not apply to the 5000 ohm resistor feeding the oscillator, which is an essential part of the rf voltage dividing network. (It could, however, be replaced with a suitable rf choke). The oscillator shown here is a particularly good one for developing output at some harmonic of the fundamental frequency of the crystal. I have used this with common surplus FT243 crystals to produce 3rd, 4th, 5th, and 6th harmonics. Output decreases as you go higher. Where the converter oscillator operates on a relatively low frequency, and a crystal for the fundamental frequency is available, a simpler Pierce-type oscillator can be used, thereby eliminating a few components.

Note that the output of the mixer stage is not tuned. This means that images will be present in this output and we depend entirely upon the front end selectivity of the tunable receiver which follows the converter to eliminate them. Image rejection can be improved by adding a tuned mixer plate circuit, although this will restrict the bandpass characteristics beyond what is desirable for some applications. In many situations, the amateur may find it convenient merely to change the crystal if some one strong local image falls in a portion of the band which he wants to use.

Fixed capacitors shown should be either mica or high quality ceramic. Coils can be wound on any suitable material, including forms salvaged from old TV sets. The easiest way to make them is "cut-and-try," checking as you go with a grid-dip oscillator. The circuit in general is sufficiently uncritical that layout imposes no great problem and any convenient arrangement of parts should serve. It is well to separate the coils so that they do not directly interact.

Tubes also are not critical. The 6BQ7A connected as shown provides a satisfactory noise figure up through the six-meter band, although at this point, and on higher frequencies, improvement would be found by substituting nuvisters. There is nothing magical about a 12AU7 as an oscillator-mixer, but they are plentiful and work well on this circuit. Other triodes can be used if available. Power supply requirements are slight, and 150 volts B+ is entirely adequate.

In some units where I needed a converter of this description to be separately powered, I have salvaged the power supply from an old TV preselector, and found it entirely adequate. An alternative output circuit might be to put a resistor in the cathode of the mixer and take the output signal from the cathode. In such a case, the mixer plate load resistance would be reduced to zero or merely to a 1000 ohm decoupling resistor as in the rf stages.

Since this circuit is so simple, inexpensive, and dependable, it is a good one to pass on to the novice who is just getting started building equipment and needs the encouragement of success in each project. However, it is also good enough that I have several of these in operation in various kinds of gear and have virtually given up experimenting with any other circuit, after having tried nearly all that I have seen published over the years. In short, it is not the best, but it will do a very good job.

. . . WA4UZM

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3 on 20 for 15

Steve Rock WA4YVQ/4
4474 Lauderdale Ave.
Virginia Beach, Va. 23455

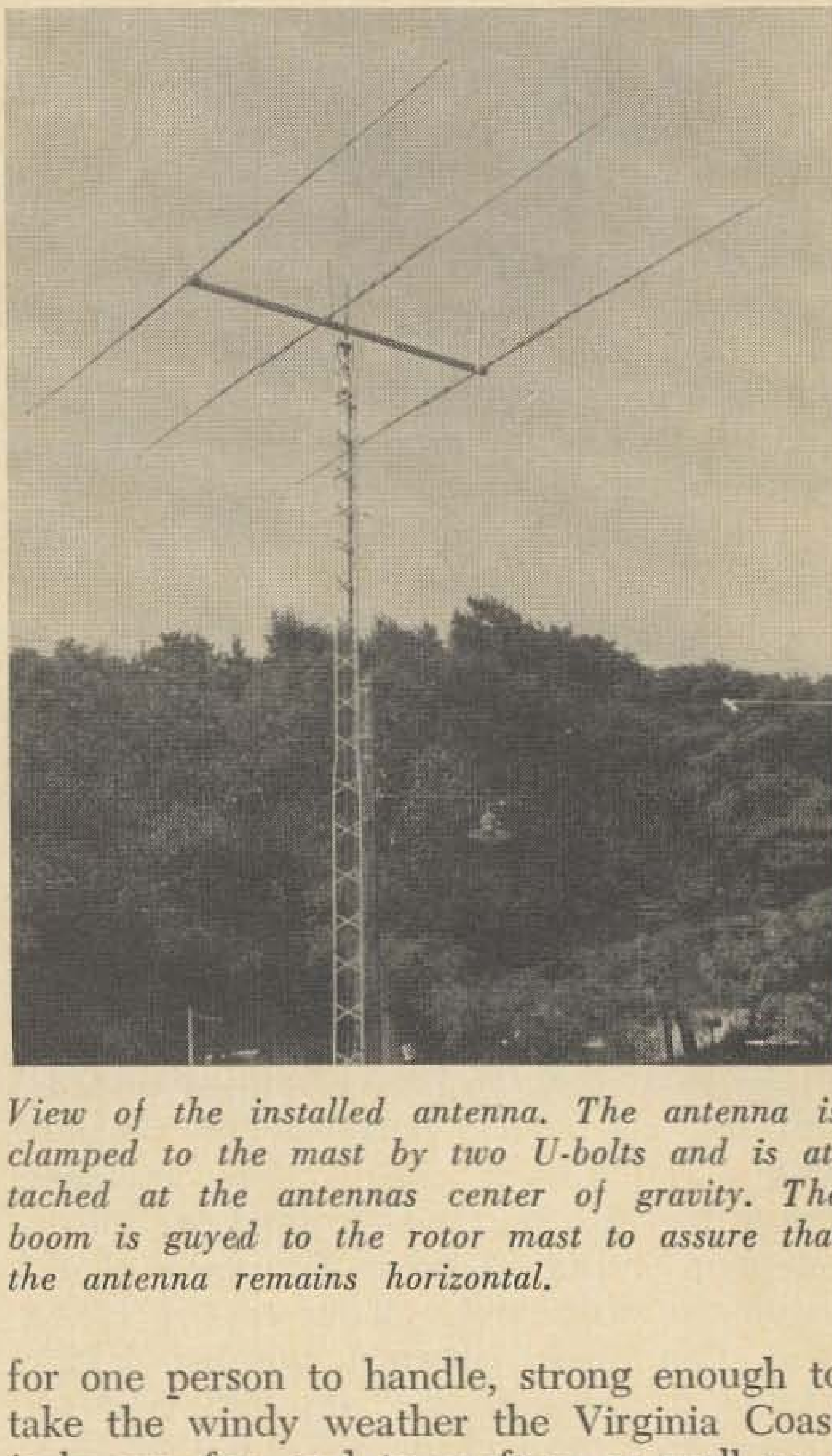
Dollars that is!

About a year and a half ago I felt a great desire to operate on 20 meters. Verticals and dipoles were tried with disappointing results. Several types of homemade beams were tried, but they either didn't work as advertised, or fell prey to the weather.

After much frustration I tried a "ZL Special". Not only was this antenna a fine performer, but it was also very inexpensive to build, and it withstood the weather very well.

Using information attained from the ARRL Antenna Handbook and the Dec. 1965 issue of *QST*, I constructed a three element "ZL Special". My results indicated that the idea was good, but the antenna needed to be refined. Electrically it was good, but as is the case with any beam, the mechanical construction was where most of the problems arose. Since that first beam was constructed several more have been built, utilizing new ideas that occured to me.

My goal was to build an antenna that would be inexpensive to build, light enough for one person to handle, strong enough to take the windy weather the Virginia Coast is known for, and to perform as well as a commercial beam.



View of the installed antenna. The antenna is clamped to the mast by two U-bolts and is attached at the antennas center of gravity. The boom is guyed to the rotor mast to assure that the antenna remains horizontal.

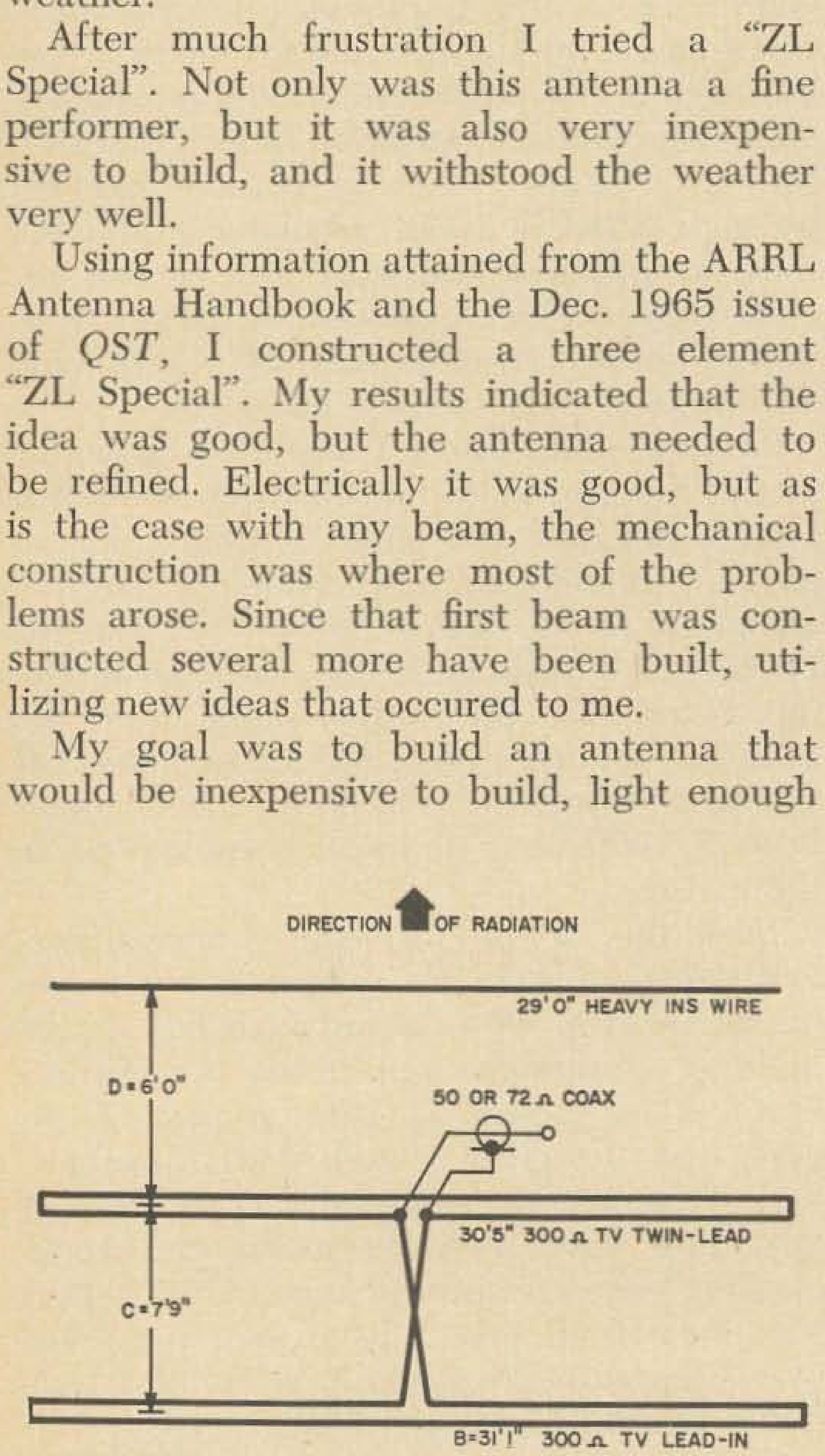


Fig. 1. The 300 ohm twinlead is shorted on each end. The above assembly is taped to the beam framework. Measurements are shown for 20 meters (14.2). For the other bands use these formulas.

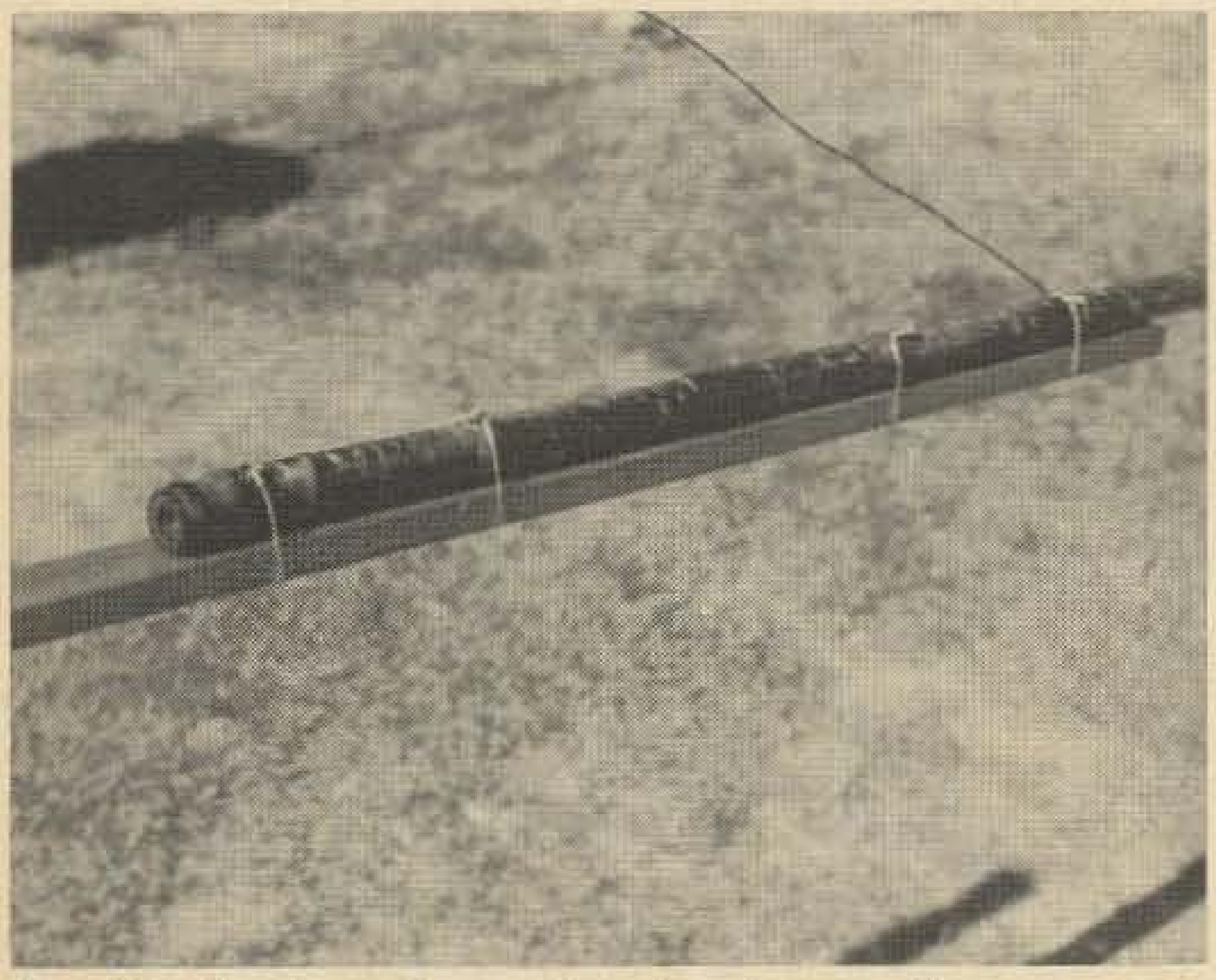
$A = 430/$*frequency MHz*
$B = 447/$*frequency MHz*
$C = 101/$*frequency MHz*
$D = 0.1$ *wavelength*
$E = 10\%$ *less than A*

The following article is designed as a guideline in the construction of this fine antenna. The cost, will to a large extent, depend upon the contents of your junkbox. My cost was $15.00 and I have a very limited junkbox.

The following material will be needed

- 75 feet good quality 300 ohm flat TV lead-in wire
- 29 feet #12 plastic covered wire (any heavy covered wire)
- 1–14 foot 2 x 4 (I used fir as it is light and strong)
- 3–10 foot lengths of 1 x 2

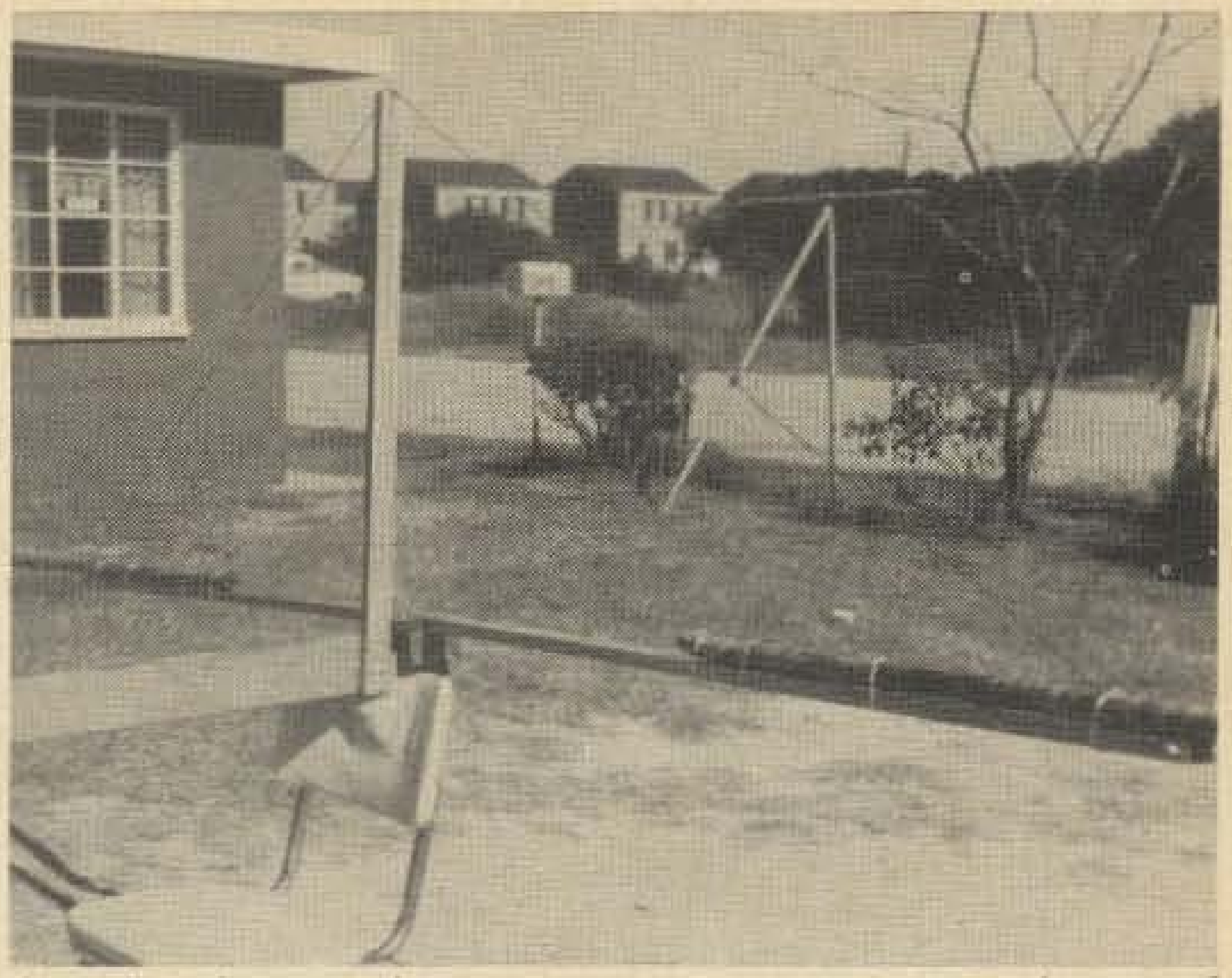
3– 3 foot lengths of 1 x 2
6–15 foot bamboo poles (It pays to select these very carefully as they will determine, for the most part, the appearance of the finished antenna.)
6–3½ x ¼ inch stove bolts with nuts and washers
Tape, nails, varnish, 50 feet guy wire, U-bolts, small screweyes etc.



Detail showing how the bamboo poles are connected to the 1x2 boards. The wire used is regular 6 strand guy wire. The wire wraps are taped over with electricians tape after the final coat of varnish has been applied.

Before actual construction begins, several coats of a high grade exterior varnish should be applied to all wooden parts.

Most of the details of construction can be seen in the photographs and diagrams, however, several things should be pointed out. If wire is to be used for the element guys, it should be insulated from the TV wire elements by several layers of tape. The reason being that sometimes, when using high power, the TV lead broke down around the bare element guy wire and arcing occurred. The 180° twist in the 7'9" phasing line is most important and the antenna will not work properly if it is omitted. The length of the parasitic director is figured to be 10% less than that of the forward driven element. The spacing between the parasitic director and the forward driven element is figured to be .1 wavelength. The height and location of the antenna will have quite an effect on the SWR. Most of these antennas require some trimming. Remove an equal amount of wire from both ends of each element when trimming. The ends of the driven elements are shorted together and all the elements are taped to the top of the beam's frame-

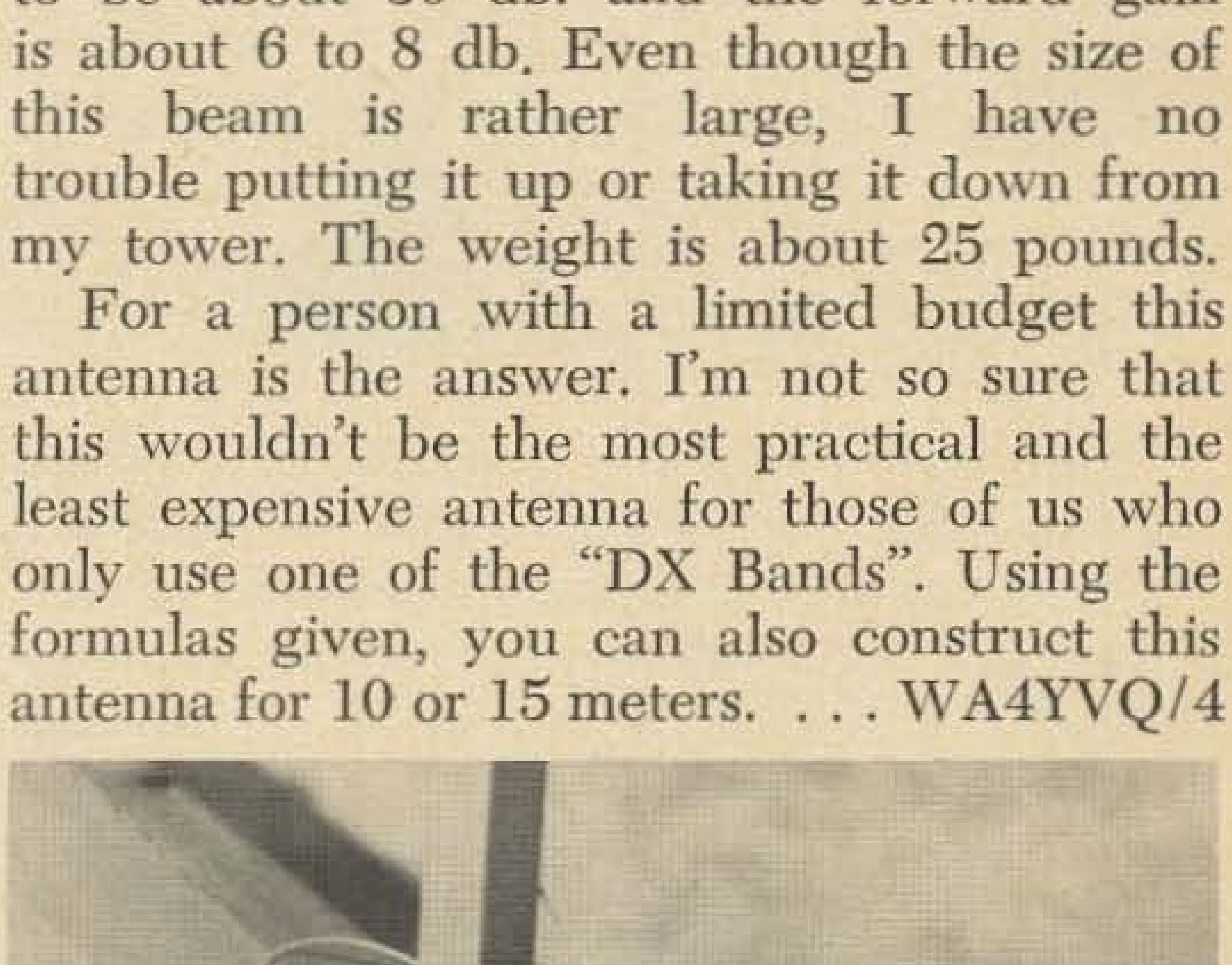


Detail of the element guy mast construction and use. Another set of guys is installed to a point about halfway down the length of each bamboo pole. See text for details.

work. Either 72 or 52 ohm co-ax may be used. 72 ohm seems to give the better match.

The performance of this antenna has been most gratifying. Front to back ratio seems to be about 30 db. and the forward gain is about 6 to 8 db. Even though the size of this beam is rather large, I have no trouble putting it up or taking it down from my tower. The weight is about 25 pounds.

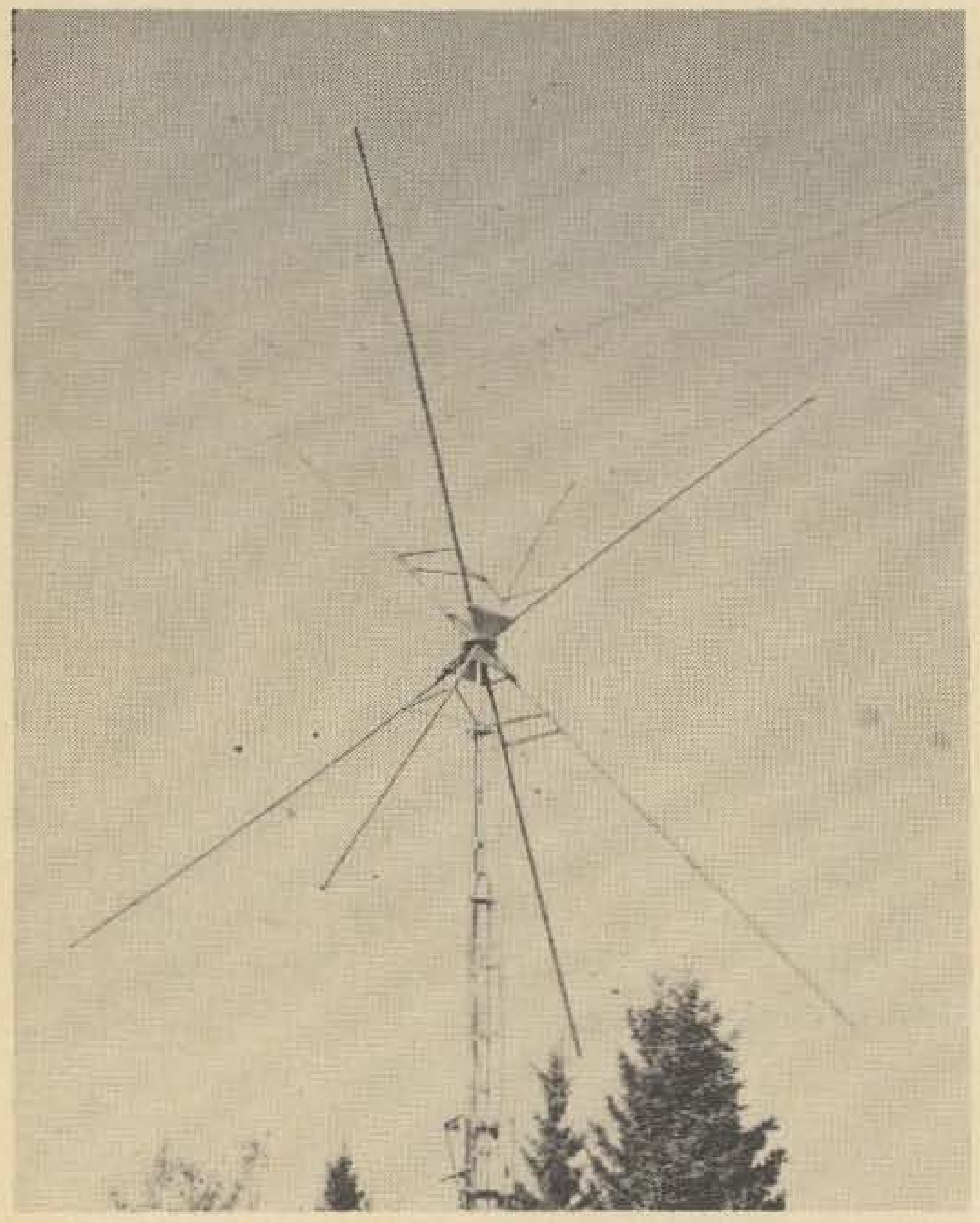
For a person with a limited budget this antenna is the answer. I'm not so sure that this wouldn't be the most practical and the least expensive antenna for those of us who only use one of the "DX Bands". Using the formulas given, you can also construct this antenna for 10 or 15 meters. . . . WA4YVQ/4



Detail of the element to boom connection. Small blocks on either side of the boom are for added strength. The small piece of 1x2 between the element guy mast and the element, is used to make sure the element stays square with the boom. This type of assembly is used on all 3 elements. Note the small screw eye in the end of the boom used for the boom guy.

Mini Boom Quad

Walter C. Jordan VE6FS
443 19 St. North
Lethbridge, Alberta, Canada



The Author's interest has been directed for some time to various types of antennas. Wishing to build a Quad for ten and twenty I found it necessary to sum up what I considered the weaker points of such antennas in this area.

First of all this area is subject at times to winds ranging from a mere breeze to 100 mile per hour and let's be honest fellows, any antenna regardless of construction takes a beating under these conditions.

So with this in mind and after much experimenting with different boom lengths the antenna I wanted would have to meet the following requirements.

1) It would have to be as light as possible so that it could be raised or lowered in a few minutes by one man.

(2) It must be of rigid construction and full electrical size.

(3) It must be economical to build.

The Mini Boom Quad I am about to describe is the result of experiments at this QTH, This antenna which weighs a mere 37 pounds is easily raised or lowered with the aid of a home brew tilt over tower.

You will note that Bamboo Poles converge to a more or less central point, in effect the poles are the boom. This makes for rigid construction as the poles brace themselves in each plane when wires are drawn taut and turnbuckles tightened.

I have made the angles in the two parasitics section rigid whereas the angles in the 9 foot spacing is adjustable to facilitate assembly and final adjustment.

As you will note in close up photo I used a piece of 1¼ inch pipe 30 inches long on top of which I welded a twelve inch phono turn table (any light metal would do here and eight inch diameter would suffice) I then reamed the center of turntable and pipe to allow a piece of wood dowel one inch by forty two inches to be driven into pipe leaving thirty inches above turntable.

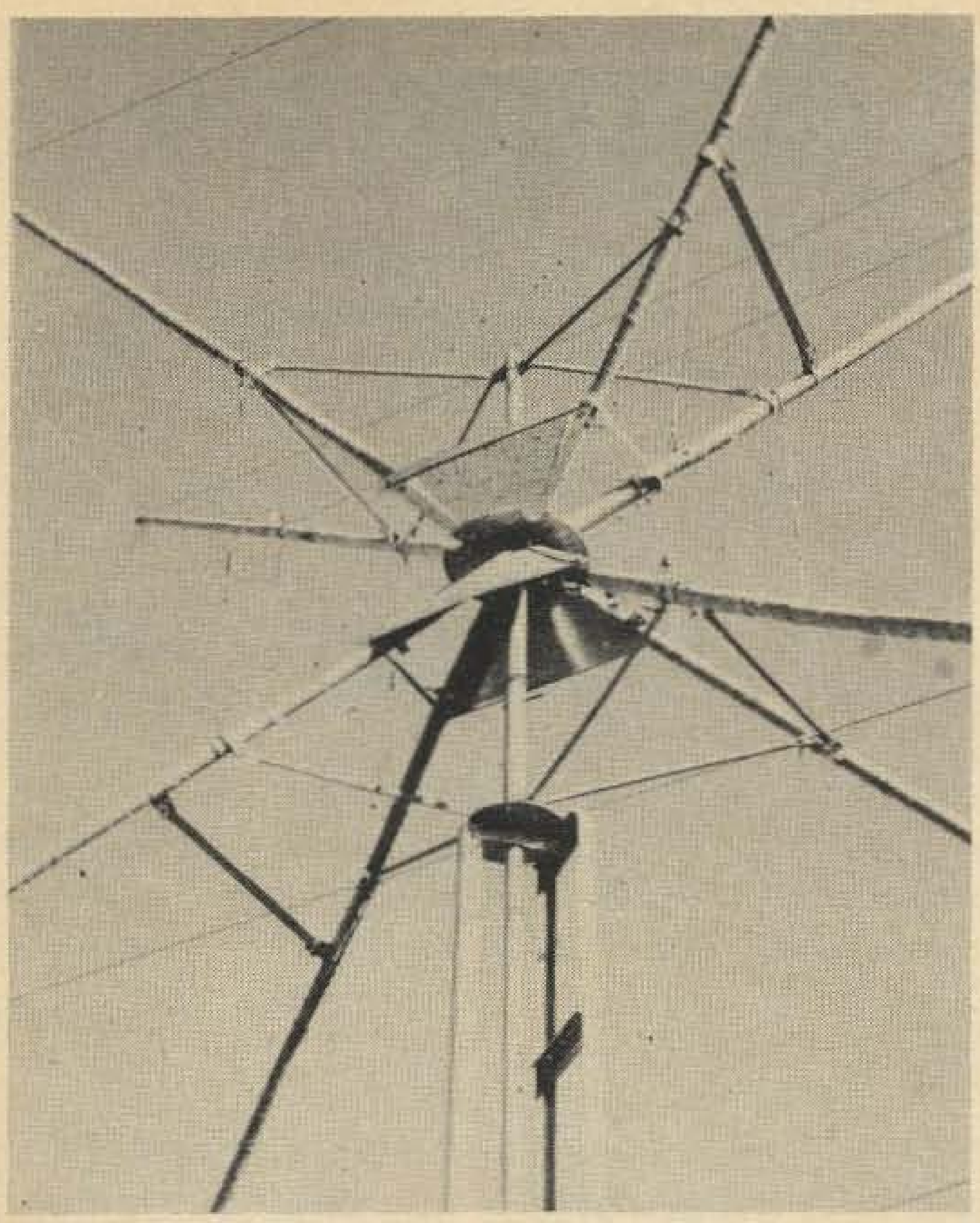
I then centered the four small hinges on the top and bottom of the turntable, using the short side of the hinge nearest the mast. These in turn are bolted or welded in position, the four pieces of sheet metal are then centered on the hinges and bolted.

With my mast lowered to its horizontal position, and with the aid of a small scaffold, I slid this assembly over my rotator drive shaft which is one inch pipe. This was then drilled and bolted.

I then oriented this assembly so that the rigid angle was facing down, the four bamboo poles were clamped in position, the assembly rolled over, and the remaining poles clamped in position.

The nine foot spacing sections were measured and spacers clamped to the poles. Space these at least 9'8" to allow for any slight wow you may find in the poles and make a tighter job.

The parasitic sections are then measured, clamped and spaced between pole and mast. When squaring these sections in position, it will help to string the wire and temporarily tie them in position. The final position of the twenty meter wire will be close to the thirteen foot spot as measured from the center of the mast, and it is better when making these spacers to install clamps to the poles first and measure to get the length of the spacer. Light aluminum pipe or conduit, cut to size, flattened on the ends and drilled to



fit will make good spacers. The turnbuckles and guy wire were then installed and tightened and the remaining wires were strung in position, Small weatherproof nylon cord was then installed between the ends of the nine foot spaced poles and drawn taut into final position.

With this nylon cord and small turnbuckles it is possible to come up with a real zinging tight job.

Fifteen foot bamboo poles were used and the ends cut to approximately thirteen foot when the final positioning and tightening were done.

Twenty four gauge galvanized sheet metal was used for the pole angle mounts, and I intend to punch a number of one inch holes in these mounts and will clip all bolts short, this will further lighten the antenna.

Measurements for the square loops can be obtained in most handbooks and will depend on which portion of the band you wish to operate. I find the resonant point quite sharp and intend to further experiment with different size wires to broaden response.

All bolts used were three sixteenths galvanized, the clamps are made from aluminum sheet.

Finally, I might add that this project is merely a new approach to mounting an otherwise good antenna.

During the last three months this antenna has withstood winds of sixty mile an hour without any noticeable effects, when the nine foot side is headed into wind it shows very little wind resistance.

In conclusion my thanks to Joe Parsons VE6PD for the very fine job of photography.

. . . VE6FS

D. E. Hausman VE3BUE

Ventilation by Elevation

An important consideration in the operation of radio equipment is proper ventilation. When high heat is present, electrolytic capacitors dry out and lose capacity, VFO's drift, vacuum tubes burn out, and overall performance becomes unreliable. The best way to overcome high heat is the installation of a cooling fan; but this is quite expensive for the average ham. A simpler, although not as good a solution, is to separate each piece of gear from the other. When gear is stacked, this means the use of spacers. Two aluminum or steel square tubes about 1½ inches sq. will do the job nicely. The length of each tube is the same as the depth of the gear it supports. As an added bonus, the inside of the tubes can be used to hold pencils; indeed a useful feature.

The Collinear Resurrected

David P. Babcock WA1DVB
200 Washington Street
Middletown, Connecticut 06457

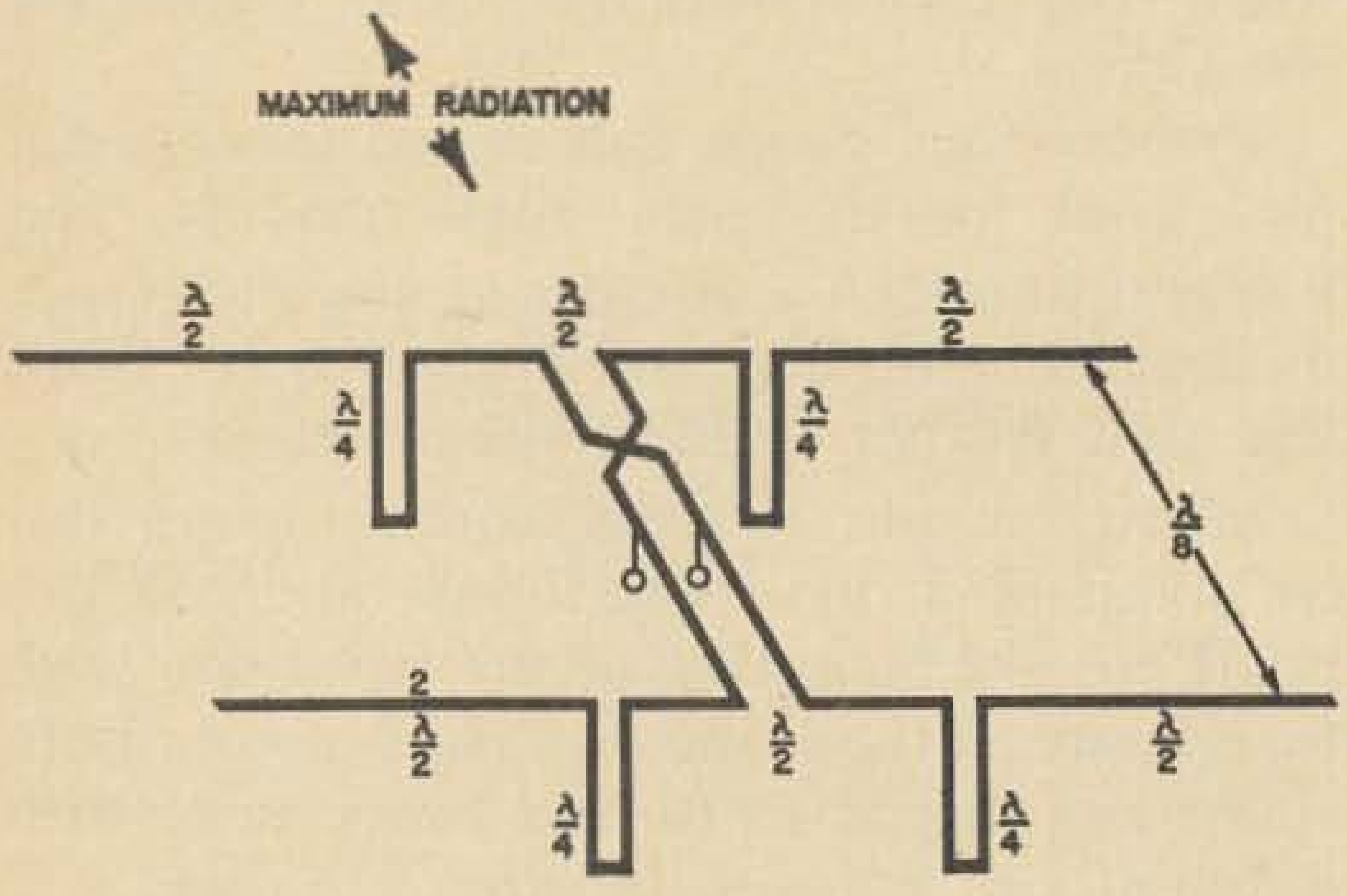


Fig. 1. The spacing is distorted to make clear how the two collinears are fed. The half-turn in the connecting line is vital! But make sure it is in one side only.

There are undoubtedly many hams who would like the gain of a beam or a quad in their shacks, but cannot convince XYL, landlord, or neighbors of the wisdom of their desires. For such unfortunate souls it is necessary to construct wire arrays if any significant signal gain is to be achieved along with continuing diplomatic relations.

There are many problems to be solved in the construction of a three- or four-element wire beam. Even assuming that proper element lengths and spacings can be found and a decent match achieved, there remains the problem of supporting the thing. For a three-element beam it is necessary to have six trees or other objects in convenient places, or else a mile of rope is required to keep everything properly positioned.

For the ham who experiences QRM from unsympathetic people but does not wish to fight with a wire beam, there is a solution. The solution is the construction of an end-fire driven array of elements.

The big advantages of end-fire arrays are that they are not critical of tuning, and they can be constructed with very close element spacing without sacrificing performance. This in turn means that two supports are sufficient to hold up this type of antenna. This is readily seen from **Fig. 1.**

So why aren't such arrays in more common use? The reasons seem to be, first, that few hams know how well they work, and, second, that no one knows how to use anything but coax to feed antennas. This is quite understandable as a partial result of the rise of transceivers. It is more convenient for the manufacturer and for the mobile operator, and it happens to work with whips and other mobile antennas, to equip transceivers with output circuits that will feed fifty ohms and melt with anything else. Unfortunately a driven array will usually exhibit an impedance of hundreds or thousands of ohms. It cannot be driven well through coax (let alone fixed-tuned output circuits) unless baluns are used at the antenna. Hence the unpopularity of driven arrays. However, satisfactory feed to a high impedance array is not nearly so difficult as one might think, and later on the problem of feed will be discussed.

The six-element array at WA1DVB (cut for 20 meter CW) is shown in **Fig. 1.** It has a theoretical gain of 7.7 db., a bi-directional radiation pattern with half-power points only 25° away from the line of maximum radiation (perpendicular to the elements), and, for anyone already curious, a driving impedance of 150-200 ohms, depending on height and proximity to conductive objects.

In practice, the QTH required that one pair of elements pass eight feet over a copper roof, and that the feedline be brought away from the antenna feed point almost parallel with the elements (ideally it should drop straight down for at least a quarter

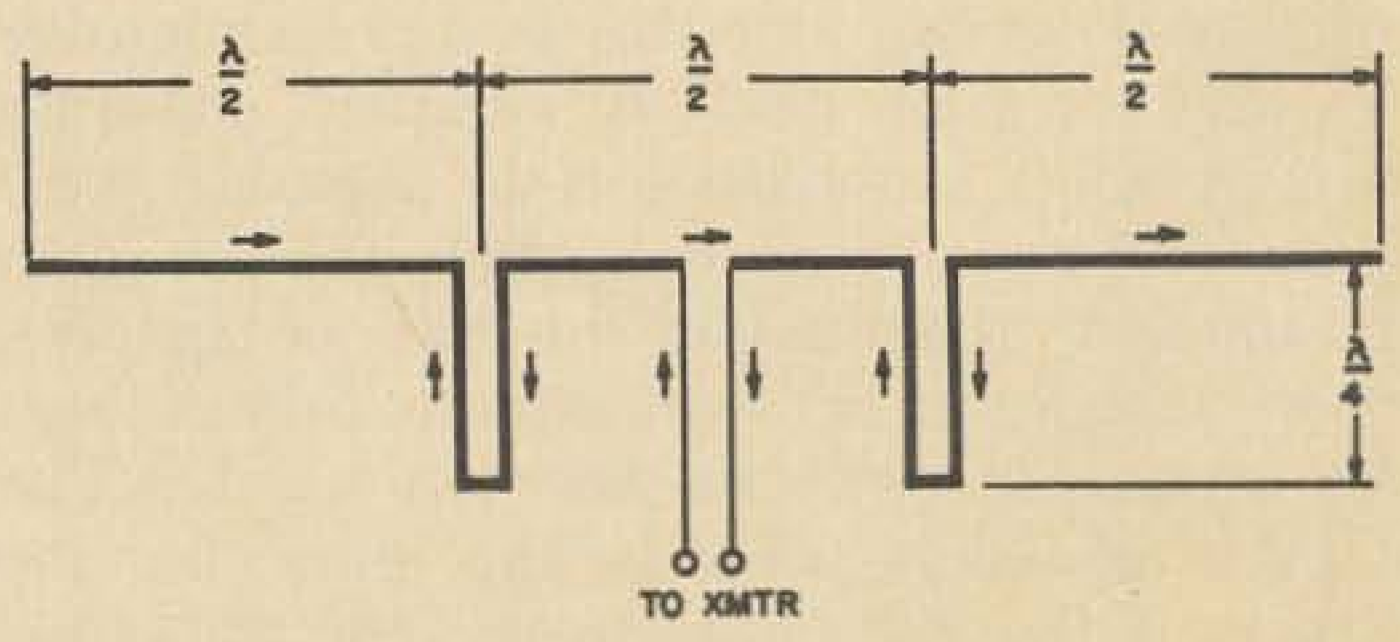


Fig. 2. Pattern of current distribution along a collinear antenna.

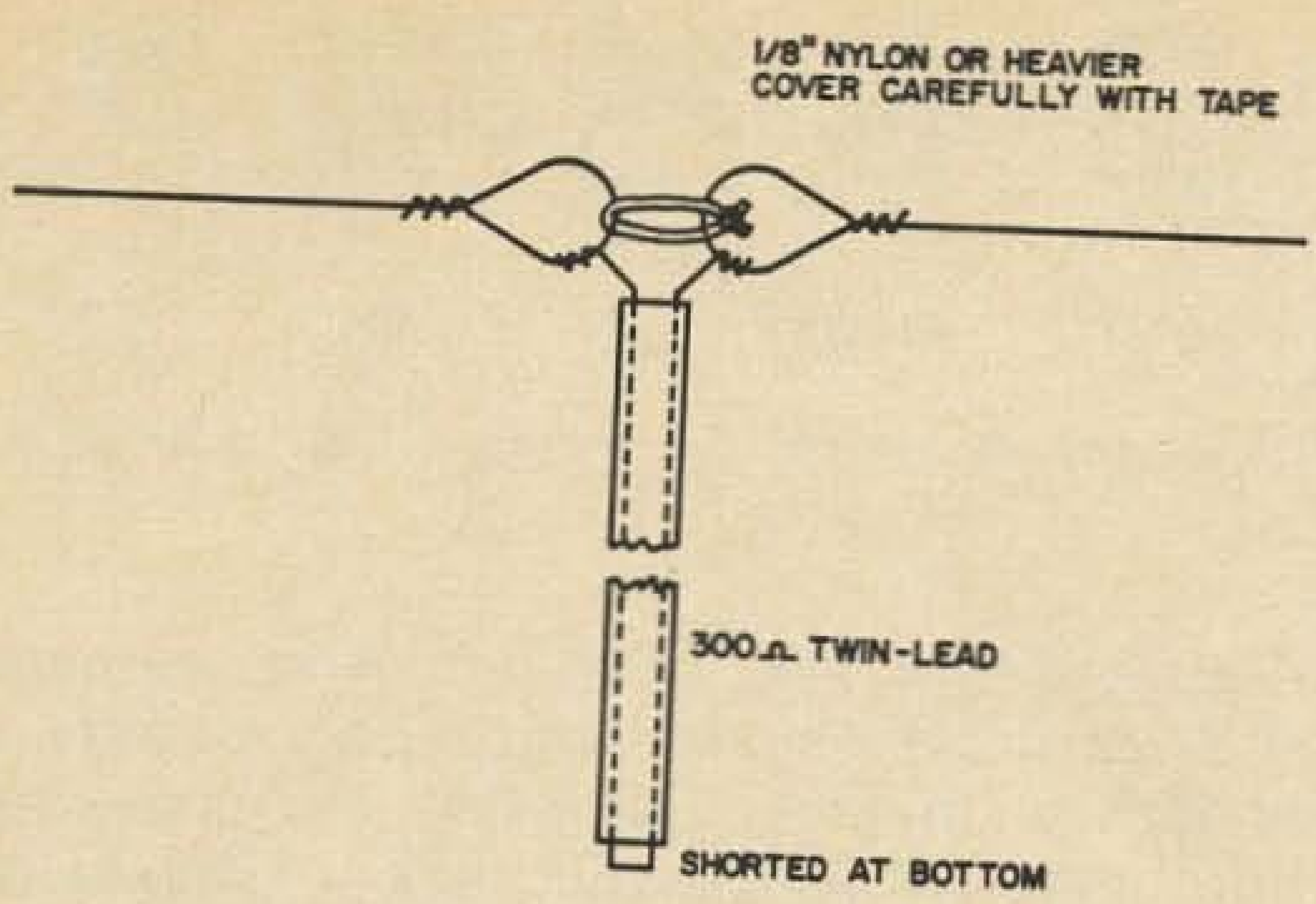


Fig. 3. The "It ain't beautiful, but it works" method of connecting the collinear elements.

wavelength). Nevertheless, in comparison with a dipole that was parallel to the array, six feet higher and clear of obstructions, signal reports along the array's major line of radiation were consistently two or three S-units better than they were on the dipole (this was due as much to the low angle of radiation as to the gain). Running 150 watts input with the array one-half wavelength off the ground, reports of S7 and S8 are typical from VK land, even though that area is more than 45 degrees off the line of major radiation. (The half-power points, by the way, were determined by comparing received signal strengths on the array with received signal strengths on the dipole, assuming a figure-8 radiation pattern for the dipole.)

The array is simple in theory. The phasing sections in each collinear are intended to keep "wrong-way" currents off the horizontal elements. The current distribution in either of the collinears is shown in **Fig. 2.** It can be seen that the collinear is nothing more than an improved long wire. An end-fire array results when two or more collinears are positioned in such a way that out-of phase feeding produces significant gain in the plane of the elements, and perpendicular to the elements.

It should be mentioned that any number of elements can be hooked together in collinear fashion as long as phasing sections are used between half-wave sections of the wire. It is not necessary that there be an equal number of elements on each side of the center-fed element, though symmetry does help to distribute approximately equal currents to each element. In any case, for anyone wishing to try a collinear of any size, the driving impedance will be under 500 ohms for any reasonable number of elements, because the array is fed at a current loop. The gain of a single collinear is theoretically 1.9 db for two elements, 3.2 db for three elements, 4.3 db for four elements, 5.3 db for five elements, and 6.3 db for six elements. Use of a pair of out-of phase collinears adds about 4.5 db to these figures. Thus the gain of the WA1DVB array is estimated at 3.2 db + 4.5 db, or 7.7 db.

A collinear array can also be fed between elements, but this configuration generally presents an extremely high impedance to the transmission line. Center feed of one element is to be preferred for simplicity of matching.

It has been determined in practice that optimum spacing between collinears of an end-fire array is about one-eighth wavelength. Spacing can be between one-fifteenth and one-quarter wavelength without significant sacrifice of gain. Discussion of this point is impractical here. However, it should be considered that extremely close spacings may result in serious impedance changes being caused by winds during operation.

The dimensions of the 20-meter CW array are:

elements (#14-#18 copper)..................33'4"
phasing sections (300 ohm twinlead)....14'3"
spacing between collinears...................... 8'9"

The elements were connected in accordance with the if-it-works-it's-good-practice theory. **Fig. 3** shows how each pair of collinear elements was connected.

There is considerable tension on the rope as the antenna is raised to the horizontal, so it seems best to use nothing less than one-eighth inch nylon (or the equivalent) rope. The tension can be even greater if either end is connected to a tree that is subject to whipping by the wind. If the connections are properly made, there should be no strain on the twinlead phasing sections.

Fig. 4 gives dimensions for collinear arrays for each end of 40, 20, 15, and 10 meters.

If a pair of collinears with its 4.5 db additional gain is decided upon, it is essential that the collinears be fed out of phase (feeding in phase will send your signal straight up!). This is accomplished most easily by connecting the two collinears at their feed points with open-wire line or 300-ohm twin-

frequency	7000	7300	14000	14350	21000	21450	28000	29700
element length	66'9"	64'0"	33'4"	32'7"	22'3"	21'9"	16'8"	15'9"
phasing sections	28'10"	27'8"	14'3"	14'1"	9'7"	9'5"	7'2"	6'10"
spacing between collinears	17'7"	16'10"	8'9"	8'7"	5'10"	5'9"	4'5"	4'2"

Fig. 4. The spacing given is one-eighth wavelength; it may be varied by as much as +100% or −50% without significant loss of gain.

lead (being sure to twist it one-half turn) and feeding the connecting line at its center.

And now to touch briefly on the subject of matching. Low SWR is not nearly as important as many amateurs think in achieving effective matching—*as long as low-loss transmission line is used.* As a *conservative* rule of thumb, the total loss in open-wire line may be considered to be insignificant if the SWR is below 20:1 and the line is less than 200 feet long, or if the SWR is below 10:1 and the line is less than 600 feet long. With an SWR of 4:1, the line may run over a quarter mile with negligible loss! These figures are conservative for 10 meters and below. The requirements for coax or twinlead are much stricter, of course, which accounts for the common dread of high SWR. Clearly the best way to feed any antenna and avoid matching headaches is to use open-wire line. As long as the transmitter can feed the transmission line, you may be confident that the power will find its way to the antenna. Admittedly, a very low impedance antenna such as a close-spaced beam may require a Matchbox to keep the SWR on open-wire line below 20:1. But such a low impedance would do no better with coax feed over any distance than with the open-wire line, because the inherent losses of the coax would easily equal the SWR losses of the open-wire line. So clearly open-wire line is the safest way to feed *any* antenna. If the transmitter contains an unbalanced output network such as the pi-network, it may be advisable to use balun coils, but even these may not be necessary in many cases. If the impedance of the line is above the range of the pi-network, 4:1 balun coils will probably solve the problem.

As a final note, in case you should have trouble finding copper wire for your antenna, look around for a motor repair shop. They will probably sell you wire for less than it would cost from a mail-order house.

. . . WA1DVB

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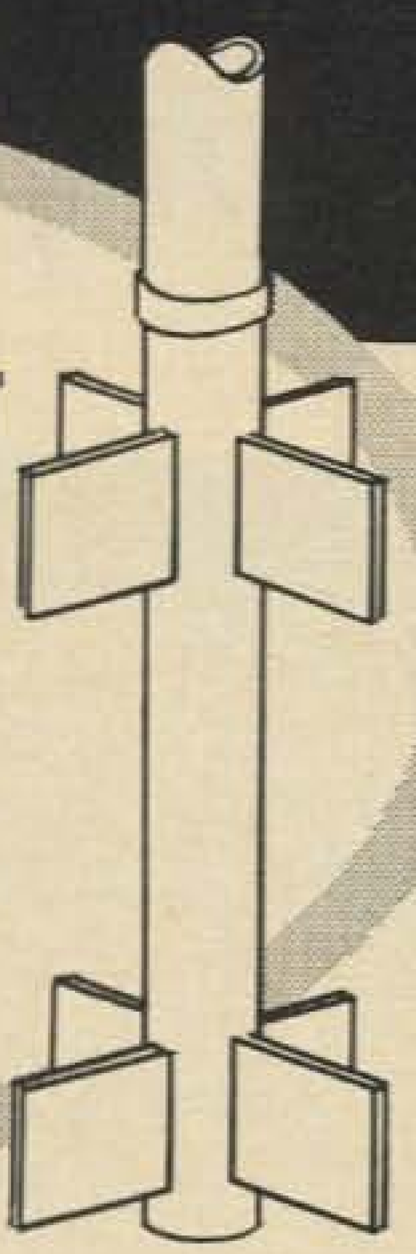

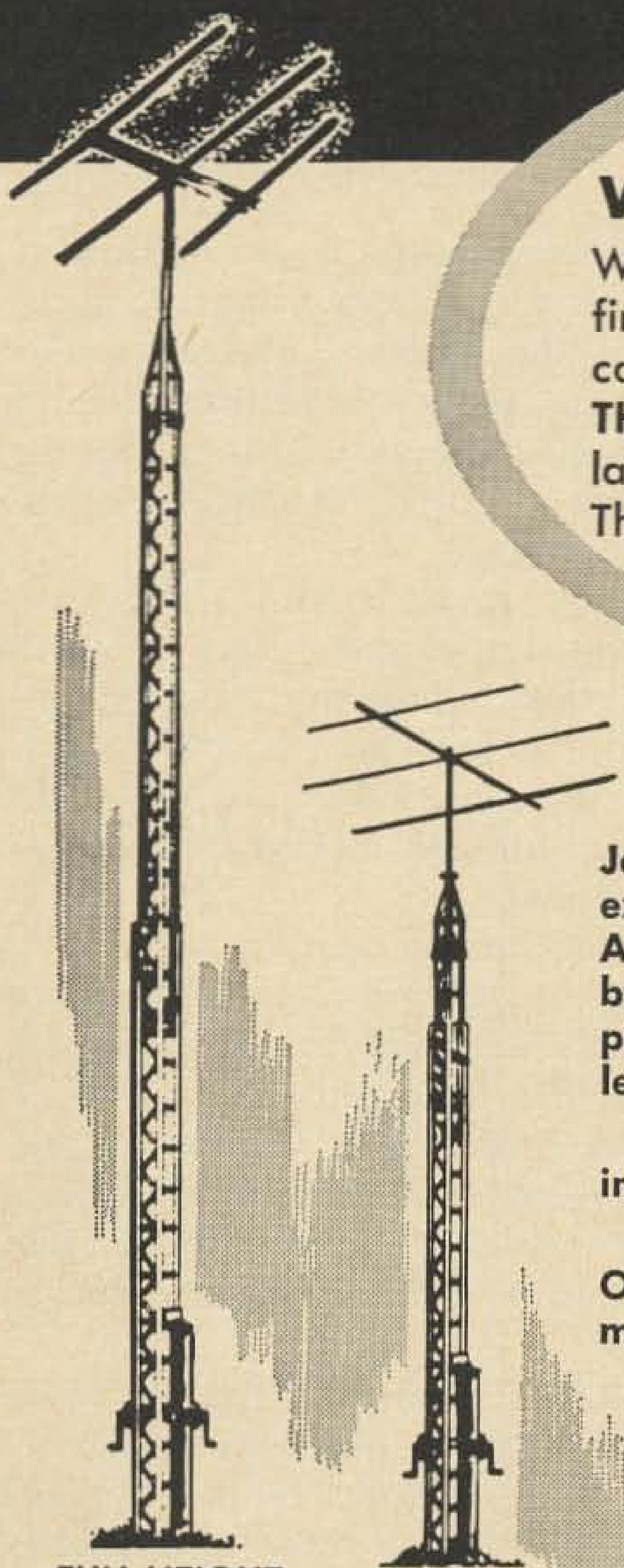

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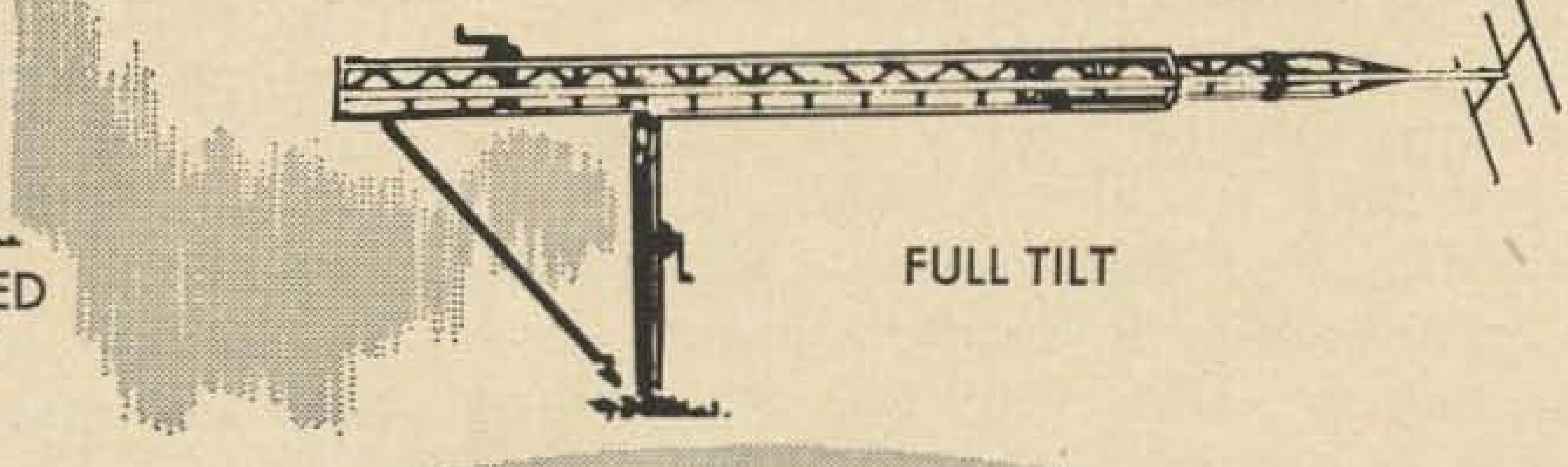

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Built-in Microphone Preamplifier Clipper

John J. Schultz W2EEY/1
40 *Rossie St.*
Mystic, Conn. 06355

Clippers, for fixed station installation, have gone out of style in recent years, being replaced by compressor amplifiers. However, for mobile installations with AM or FM transmitters, they are still very appropriate. This article presents a particularly compact and simple, but effective, clipper circuit for the mobile operator.

Clipping circuits no longer find much application in home stations because of the use of SSB. Although the amplitude of the harmonics generated by diode clippers decreases quite rapidly in amplitude (as the square of the harmonic order), they still produce undesirable modulation effects in SSB transmitters. However, for use with AM or FM transmitters in mobile installations, a simple clipper still has great value in maintaining a high average modulation percentage.

The circuit described in this article provides both a preamplication and clipping action and, because of the small components used, can be built directly into most mobile microphone cases. The circuit of the unit is shown in **Fig. 1.** It was adapted from a hearing-aid circuit which was developed to provide improved symmetrical clipping action. A speech waveform can be clipped to a great degree without destroying intelligibility, but any slight phase shift in the waveform components will destroy intelligibility very rapidly.

Since phase stability is a function of the symmetry of the clipping action, it is important that the positive and negative variations of the input waveform be limited equally to a close degree. This is accomplished by the use of a pair of carefully matched diodes in the circuit.

Almost any small signal diode can be used and the diodes can either be matched by testing their characteristics, or a pair of matched diodes can be purchased (for instance, a pair of IN541 diodes, sold as a matched pair for use in FM detectors, costs less than a dollar).

The circuit must operate from a high impedance microphone. It will not operate properly with some of the low impedance dynamic mobile microphones (300 to 1,000 ohms) because sufficient voltage is not developed to allow proper clipping action by the diodes. Aside from the diodes, the circuit is that of a simple transistorized audio amplifier.

The photograph shows the placement of the clipper stage in the housing of a typical mobile microphone. The components are simply assembled on a piece of vector board shaped to fit into an empty corner of the enclosure. A thin piece of foam plastic or rubber material is glued on the bottom of the vector board. The foam material is, in

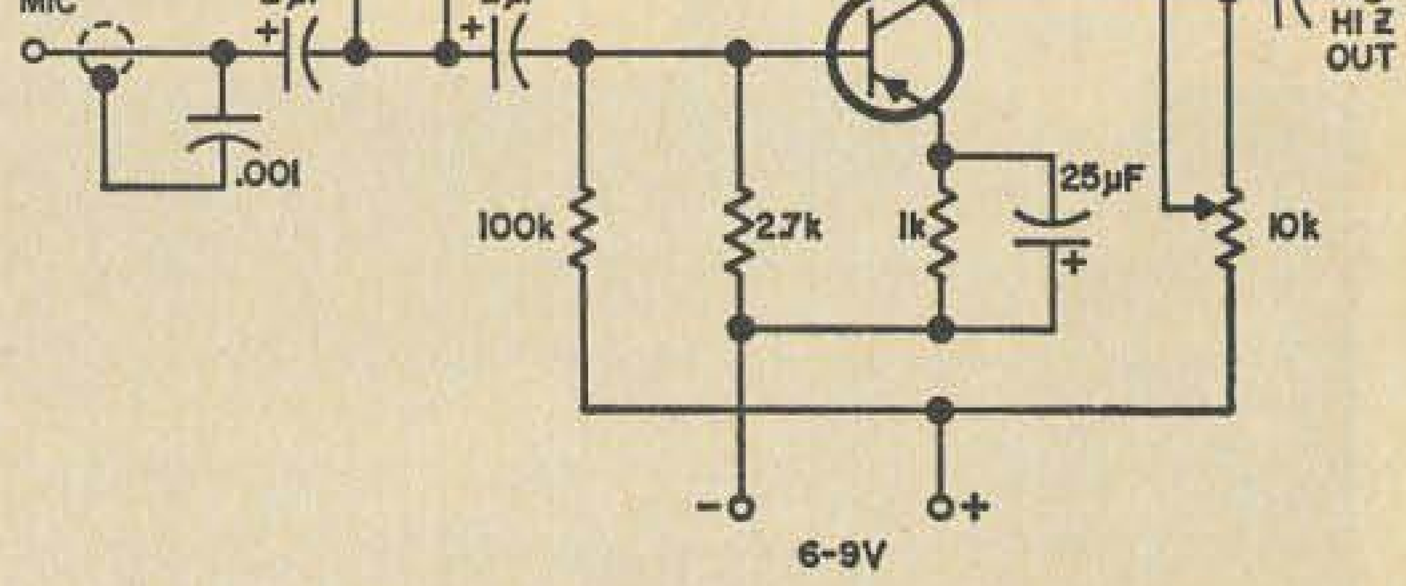

Fig. 1. Circuit of the preamplifier clipper circuit. Potentiometer adjusts clipping level and may be replaced by fixed resistors once desired level is found.

turn, glued on each corner to the microphone enclosure.

The power for the amplifier can be supplied in any one of several ways. A miniature battery might fit in the particular microphone used and could be wired to extra contacts on the push-to-talk switch, so the clipper is only energized during transmit periods.

The power can also be supplied from the transmitter via the microphone cable. Some cables have an unused conductor (normally used as a ground connection in addition to the cable shield) which can be employed. Otherwise, the only possibilities are to replace the cable with one having an extra conductor or to feed the dc voltage over the microphone lead itself using coupling capacitors and miniature audio chokes at both ends of the cable, to separate the dc and audio voltages.

The potentiometer shown in **Fig. 1** can be used to set the clipping level. Once a suitable setting is found, it can be replaced by fixed resistors. For a more versatile installation, a miniature potentiometer could also be used and brought out to the back of the microphone enclosure as a screwdriver adjustment.

The adjustment for best clipping level can be best done in conjunction with another station. The cooperating station should adjust the rf gain control on the receiver used so that the received signal is as weak as possible, while still being intelligible. The amount of clipping is then adjusted to produce the best signal readability at the minimum possible setting of the rf gain control.

. . . W2EEY/1

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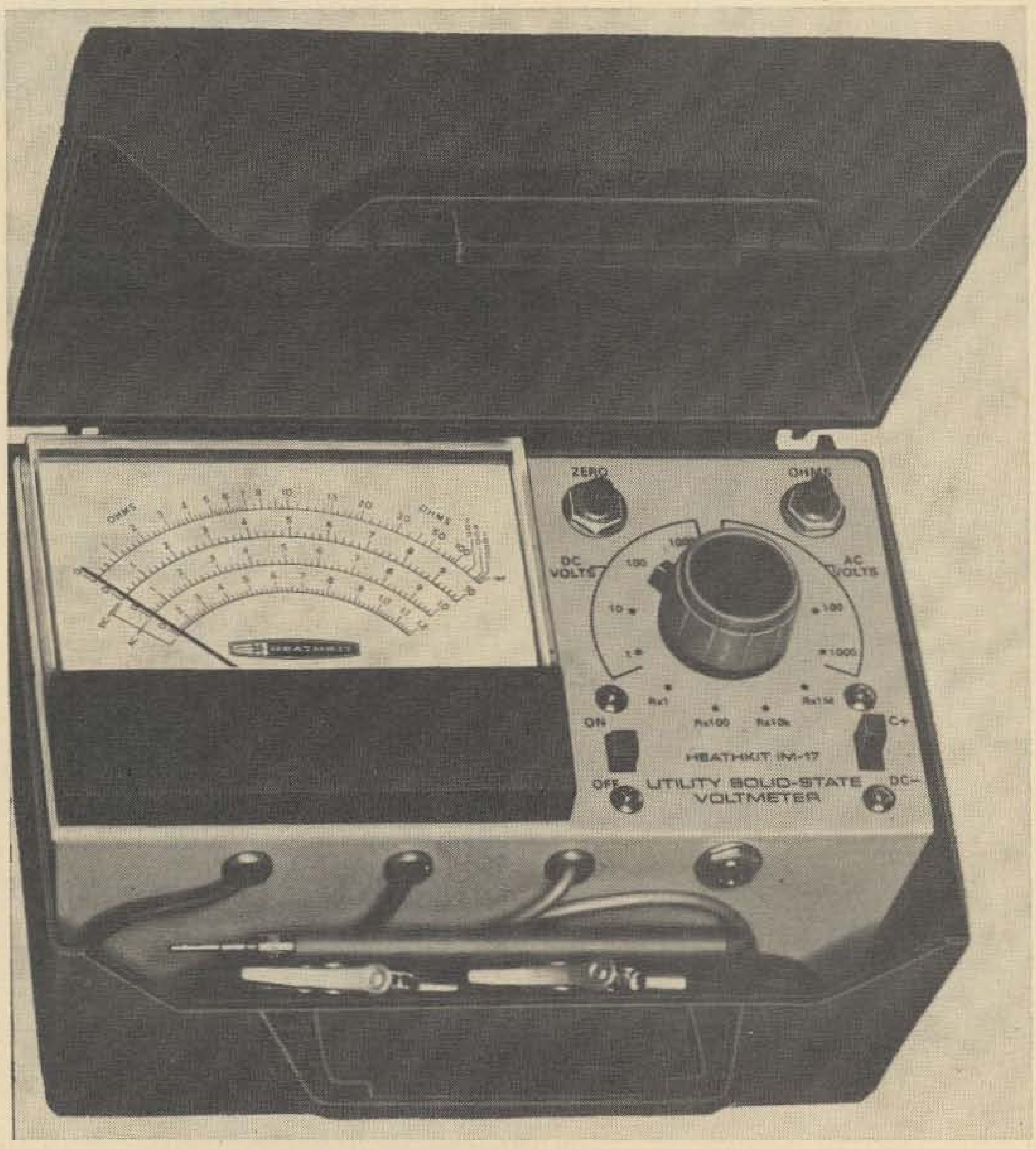
An Evaluation of the Heathkit IM-17 Solid State Voltmeter

Walter Pfiester W2TQK
Box 85
Tully, New York 13159



Still tied to the 110-volt line with a VTVM? After several hours of hunting for my test leads, pulling out an extension cord, warming up of the VTVM, I decided to invest in a good solid state voltmeter. At a price lower than most VOM's the Heath-IM-17 fills the bill for a high impedance voltmeter.

Construction

Total time, from opening the shipping carton to complete calibration, was only 5½ hours. The majority of the components are mounted on a well designed heavy printed circuit board and front panel. The selector switch is rather unusual in that it is very uncluttered, a refreshing change for an old test equipment man. As usual, Heath has a very well constructed assembly manual using pictorials and fold-out pages to their best advantage. By following the manual carefully, even the novice will experience no trouble in construction with this kit. The packaging is uniquely Heath. A hinged black polypropylene case houses the basic instrument, probes and power supply (two batteries). This case serves to protect the meter when not in use, (covering the face of the instrument). In addition, the case makes it possible to measure voltages both of which are "hot," since the case does not conduct. An accessory jack is included for other probes, such as high voltage, demodulator, rf, etc.

Circuitry

Basically, this high impedance (11 megohm) meter does not depart from its vacuum tube counterpart in either circuitry or operation. dc and ac voltages are handled in the same manner, with the exception of a half wave peak detector for ac. A string of 1% resistors make up the voltage divider chain. The output of this divider feeds both a protection circuit and the gate of a field effect transistor. The FET is source-coupled to a transistorized balanced bridge. This bridge may be considered as a differential dc amplifier whose current difference (a function of the measured voltage) is measured by a 200 A meter between the emitters of the bridge.

There is one unique circuit worthy of consideration in this instrument. The overload protection circuit which is used in the instrument. It is not immediately apparent how this circuit operates. When either zener is in a nonconducting state, the gate of the FET remains at a high impedance. If, however, the breakdown or the zeners is reached, either Q_1 or Q_2 will conduct depending upon the polarity of the offending voltage, protecting the FET. Another feature found only in higher priced instruments is meter protection (when the meter is not in use). The meter is shorted out when the power switch is placed in the "off" position.

All the components in this kit are of high quality and of a reliable grade. With normal use, this instrument should last a lifetime. The batteries used are a 1.5-volt C battery and an 8.4-volt mercury battery. The mercury battery may be difficult to obtain, however, the standard 9 volt battery (NEDA #1611) will work just as well. I have used both at home. If it is desirable to obtain an 8.4-volt battery, Mallory makes one which should be available from any large sales outlet. The Mallory number is TR 133.

Operation

Calibration of the meter was performed as set forth in the manual without any special precautions. I checked the accuracy with laboratory standard equipment and found that all specs were complied with that were set forth by Heath. The use of the instrument is very easy and will pose no problem to the VTVM user. A large portion of the assembly manual is devoted to the use of the instrument for the novice, and as a review for the advanced test equipment man. Functionally, all knobs are placed in such a way to make the instrument more versatile and impossible to knock out by accidentally hitting either the zero or ohms pot. The ohmmeter, once set on the highest range need not be reset on any other range, and the zero will hold for voltage measurements as well.

Specifications

DC Voltmeter	
Ranges	0-1, 0-10, 0-100, 0-1000 volts full scale
Input Resistance	11 megohms on all ranges
Accuracy	±3% of full scale
DC Voltmeter	
Ranges	0-1, 0-10, 0-100, 0-1000 volts full scale
Input Resistance	11 megohms on all ranges
Accuracy	±3% of full scale
AC Voltmeter	
Ranges	0-1.2, 0-10, 0-100, 0-1000 volts full scale
Input Resistance	1 megohm on all ranges
Input-Capacitance	Approximately 100 pF (38 pF on 1000 V range)
Accuracy	±5% of full scale
Frequency Response	±1 dB 10 Hz to 1 MHz (from low source impedance)
General	
Ohmmeter Ranges	Rx1, Rx100, Rx10k, Rx1M
Ohms Circuit Power Supply	1.5 volts (C-Cells, NEDA #14)
Amplifier Circuit Power Supply	8.4 volt Mercury Cell (NEDA #1611)
Meter	4¼", 200 A, 100 degree movement
Transistor-Diode Complement	1—FET (field effect transistor) 4—silicon transistors (2N3393, or equivalent) 1—silicon diode
Dimensions	8½" wide x 4¼" high x 7¼" deep
Net Weight	2½ lbs.

With the price at only $20, ease of operation, and accuracy, there is no excuse for anyone not being able to make valid measurements of dc, ac, or resistance. It's the biggest bargain in a solid state voltmeter today.

. . . W2TQK

Hamwriting

Your ideas on paper can put your hobby on a paying basis

Ken Sessions, Jr. K6MVH
4861 Ramona Place
Ontario, CA 91762

Amateur radio has a widespread reputation for being an expensive hobby; however, an increasing number of amateurs will attest to the fact that ham radio *can* pay for itself. Interest in amateur radio, for instance, can lead to technical competence —a prerequisite for a career in electronics.

There are, of course, a great many of us whose careers are already solidly established—who are satisfied with our vocations. We approach ham radio as a hobby and nothing more. But *even as a hobby, amateur radio can be a lucrative source of extra income.*

You can put your own station on a paying basis by merely reporting your own personal ideas to fellow amateurs! How? By the simple expedient of writing these original ideas and observations and submitting them to this very amateur journal in the form of articles. Whether it's a new receiver or transmitter you want or merely the cash to pay for your license renewal, what better source is there than a publisher's check for material *you* created?

Completely disregarding the financial aspects of writing, there's a special kind of thrill that comes with seeing your name as a byline on a published article. It's something akin to snagging a rare DX contact when you know the band is alive with listeners. The thrill is just the same for the tenth contact as it was for the first.

How about you? Maybe you're saying, "I'd write something, but I don't have any new ideas" or "How could I write an article when I even flunked English 1A?" Perhaps you feel your technical knowhow is too limited. The plain truth is that *anyone* can write a salable article; the simple requirements are *careful thought* in planning, *organization* of thought in preparation, and *thoughtful care* in presentation. There is no rule stating that a published author must be a graduate engineer. Nor is there a requirement that he be particularly proficient in English. Perhaps the most important single requirement is *originality*. This simply means that you must report your ideas in your own individual way.

Ideas for Articles

Somebody famous once said, "There's nothing new under the sun." The statement bears a lot of truth. Yet original material is published month after month after month. Here's why: The material itself is not necessarily new or novel, but the author's *approach* to it is. This is where *careful thought* comes in. Think about it. Do you know a tried-and-true shortcut for performing a normally time-consuming chore? Have you a better or simpler circuit than the one the rest of us are using? Has your junkbox been particularly productive? Do you have *any* ideas that would benefit other amateurs? Of course you do.

And how about your friends? Have any of them come up with something of general interest to amateurs? The article you write must be your own work, but *what you write about* need not be. Here's an example: During 1964, a group of us local amateurs became very active in six-meter AM transmitter-hunting. We were plagued constantly with high ignition noise and low signal levels—a problem characteristic of six-meter mobile operation. One of the fellows experimented with noise-clipper design, and came up with an extremely efficient and tiny solid-state module that could be easily incorporated into any tube-type AM receiver. His device worked so well that the rest of us built up duplicates for our own receivers. It occurred to me that there were perhaps hundreds or even thousands of six-meter mobile operators across the country who were encountering ignition problems too severe for their built-in limiters. So I wrote an article about it, crediting the design to its originator (Dick Hughes, W6CCD). It was his idea, his design; I just reported it. And 73 bought it for its January 1965 issue.

The secret of *careful thought* in article writing is this: If the idea would be of general interest or usefulness, report it. The article need not be technically oriented, either; this one isn't. It must appeal to the amateur radio operator. It can be humerous or informative. Or it can be just plain helpful, as in this case: My six-meter AM days brought TV interference problems that all six-meter operators in crowded communities face. I learned rapidly that amateurs often find it difficult to communicate with televiewing neighbors during times of interference. So I drafted a blanket letter to my neighbors explaining the TV's weaknesses with respect to the problem of adjacent-channel operation. After distributing it, my complaints virtually disappeared and I found myself furnishing other local amateurs with multiple copies of the letter. If it worked locally, why not nationally? With a few introductory paragraphs, the "letter" became an article, and 73 Magazine published it in February 1966.

If any real talent is required in the writing of articles for amateur radio publications, that talent is nothing more than the capacity for recognizing information that will be of specific interest to readers. And this is what is meant by *careful thought.*

Planning Your Article

The most important thing to remember when you're preparing an article is to be *accurate.* What could be more damaging to an editor than publishing a description of a circuit that is technically unsound? The reputation of the magazine goes on the line with every issue. It doesn't take many "bum dope" articles to mar the image of a solid publication. The embarrassment of unsound circuitry extends to the author, too. Once your manuscript has been committed to print, it is there for the eyes of the world to see. If you ever want an editor to read your second manuscript, you'd better make sure the information in your first one is correct and accurate in every detail.

Mistakes in transcription are another problem. These are serious, all right, but they are by no means catastrophic. No editor will "blackball" you for misspelled words or reversed leads in a schematic. But the mistakes had better be few.

I overlooked the absence of a short vertical line on a schematic in "VHF Operation By Remote Control" (73 Magazine, April 1968), and received letters from all parts of the country asking about it. You can be assured those readers are going to be particularly cautious when they refer to future published circuits of mine. When I think of what it cost me to send out individual letters of explanation to all those readers, I get even more convinced that *next* time I'll be a lot more careful. Don't just check your schematics; double-check them, triple-check them, and have one of your friends check them. And when you *know* it's right, check it again!

When your article is in the planning stages, don't hesitate to write. Jot down notes, ideas, facts, sketches—anything that will help you in the final preparation. Don't rush it. No one will steal your idea. Let your article "brew" in your mind for a few days or a week. Keep a file folder on hand during this percolating period for accumulating your facts, figures, and sketches.

If the article is to involve a theoretical discussion, don't make the mistake of relying solely on your own knowledge. Don't be afraid to do some research. Read articles—and books, if it will help—on your subject. Make notes during your research that you can refer to later. But don't plagiarize; your work MUST be your own. When you're finally ready to write, you'll very likely be armed with all the facts you'll need to present your ideas with competence, self-confidence, and accuracy.

Organizing Your Manuscript

There are no universal rules for preparing technical articles, but there are a number of ways by which you can increase their chances of ultimate sale. Most of them are

- Don't write without (1) research to back you and (2) an outline to guide you.
- Don't use cliches.
- Don't use unnecessary words and phrases.
- Don't use anyone's material but your own.

Few are those who can sit down and knock out a well organized article without first preparing an outline. Fewer still are those who can sell what they've written without an outline. The outline gives the final manuscript the basis for its organization. Once it has been prepared, the outline will help immeasurably to give continuity to your text. The outline is as indispensable to most writers as a roadmap is to the tourist.

Just a word about cliches: There is probably nothing as boring to the reader as the frequent appearance of highly overworked words and phrases. "State-of-the-art," for example, is a very, very tired substitute for "technologically advanced." Steer clear of words like *saltmine*, *snore shelf*, and *feedbag;* these once-colorful expressions deserve a rest, and shouldn't be used except in satire.

Your manuscript should have a definite beginning, middle, and end. The beginning is the correct place to say something to catch the reader's interest or state an existing problem. The middle is the solution of the problem or suggested approaches to it. The end is the concluding thought of the author or his recommendation. The beginning may be a sentence, a paragraph, or —in some instances—a page. The conclusion is rarely more than a few lines. The body of the text, the meat, is the middle. It might help to prepare the middle in its entirety before writing the beginning and end. This may help to give you the necessary overview of the complete article, but it is a matter of individual preference.

When your article is complete, read through it as objectively as possible. Remove *everything* that is not essential to your text. Look for sentences opening with "It can be stated that . . . " and "Thus, it is safe to assume . . . " Phrases like these say little and carry the implication that you are unsure of your ground; they can usually be deleted without degrading the final manuscript.

When you've done all you can to improve the text's readability, put your article away for no less than two days (preferably a week or more), and push it from your mind. When you finally read it again, you'll be in a much better position to judge its real merit and make any corrections that might be indicated.

Presentation

I don't know of any publisher who will read a manuscript that has been handwritten on a brown paper sack. The old saw about not being able to judge a book by its cover may be a verisimilitude, but there are a lot of admen who would prefer to believe that the package sells the goods. And while a nicely "packaged" manuscript may not sell your work for you, it will almost certainly assure that you get a reading.

Here are some of the requirements for creating an attractive "package," as applicable to *all* publishers:

Type your text double-spaced on white typewriter paper (20# bond), leaving 1½ inches of margin space on the left and no less than an inch on the right. Avoid typographical errors, typeovers, and messy corrections as much as possible so your work will have a professional appearance. In the upper corner of your first sheet, put your full name and address. Approximately centered on the sheet, and about a third of the distance from the top, place the title of your article. Directly below that, double-spaced, place your byline (name and call letters) as you want them to appear in the publication. Then triple-space and start your article (it should begin just above the halfway point on the sheet).

Number each page consecutively and place your last name or call letters on each sheet. This helps identify the author in case the pages get separated. Use a paperclip to hold the leaves together, but don't use staples. For some reason editors don't like to be bothered with removing them.

Mailing

Unless you are an established writer working regularly with one magazine, don't mail your manuscripts without including sufficient postage and a self-addressed envelope for its return in case of a rejection. But don't put the stamps on the self-addressed envelope; place them securely under the paperclip that binds your pages. If your article is retained for publication, the editor can keep the stamps and use them for some other purpose. The self-addressed envelope should be folded once and placed with your manuscript inside a heavy 9 x 12-inch manila mailing envelope. You may include a brief introductory letter to the editor along with your manuscript, although this is not necessary.

Editors are busy people. They write, rewrite, proof, and correct copy. They must read material from hundreds of sources. They must adhere to the rigid schedules associated with their work. Consequently, the time that elapses between your submittal and the editor's decision may be lengthy. The period may be as short as ten days or as long as a few months. But don't be discouraged; a long wait is usually a healthy sign. It could mean the editor likes your article but hasn't decided where or how best to exploit it. If the editor is totally disinterested in your submittal, you'll likely get it back in less than two weeks.

Payment

The pay rates are pretty well standardized, although there are variations according to individual circumstances. A beginning writer can expect from $12 to $15 per published page, depending on how much editing and rewriting is necessary, the extent of art preparation required, and other related factors. As a writer becomes better known, his rates will increase proportionately.

There are two types of payment policies in standard use; these are (1) on acceptance, and (2) on publication. 73 Magazine pays on acceptance; CQ pays on publication. (QST does not pay at all.) "On acceptance" means that when the editor has made a definite decision to use your manuscript, he (or she) will mail you a check. "On publication" means that your check will arrive after your article is in print. From the author's viewpoint, the 73 policy is better. I was spending money in August 1967 for an article that didn't get printed in 73 until January 1968. Suppose something had happened so that my article was not suitable for publication by January? The "payment on acceptance" policy protects the writer from that eventuality.

Ethics

Writing—even as a once-in-a-lifetime occurrence—carries a burden of ethical conduct. And a writer who expects to be successful to any degree must never for any reason step out of these ethical boundaries.

The first rule is one that has been touched upon before: Use your words and no one else's. Never copy a paragraph or even a line without identifying the matter with quotation marks and citing the source.

Rule two is to forget a manuscript once it has been mailed. If you mailed it to 73 Magazine, you must consider that manuscript as the *property of* 73 until you hear from the editor. You must *not ever* send a similar manuscript to another publisher unless you have the *express written permission* of both editors involved. If you're submitting material that has been published elsewhere, you are obligated to tell the editor where and when. In this way, the editor can seek a clearance from the first publisher if necessary, thereby avoiding the legal problems of a breached copyright.

The last rule is one of etiquette. Don't bug the editor once you've submitted a manuscript. Relax and wait it out. Remember, the longer the editor keeps your article, the better its chances for sale.

Now! Why not put some thought into the articles you're going to write? Turn your pet circuits and cute construction ideas into cash; it will take a great deal of the sting out of what could otherwise be a pretty expensive hobby!

. . . K6MVH

(Ed. Note) Ken has covered the subject very nicely in this article. I would like to add a couple of items. If you plan to write for 73, you would do well to read some of his past articles, as he is one of a few authors who needs little editing. Read articles and see the format, the abbreviations, and the type of material we use most. Type your photo captions and diagrams captions on a separate sheet at the end of the article. Don't label photos as figures. We may not use all photos. If you have relied on outside material for any of your article, list references for the benefit of the readers who want to build your project.

W1EMV

A 4E27 Grounded Grid Linear RF Amplifier

Howard M. Krawetz WA6WUI
654 Barnsley Way
Sunnyvale, Calif. 94087

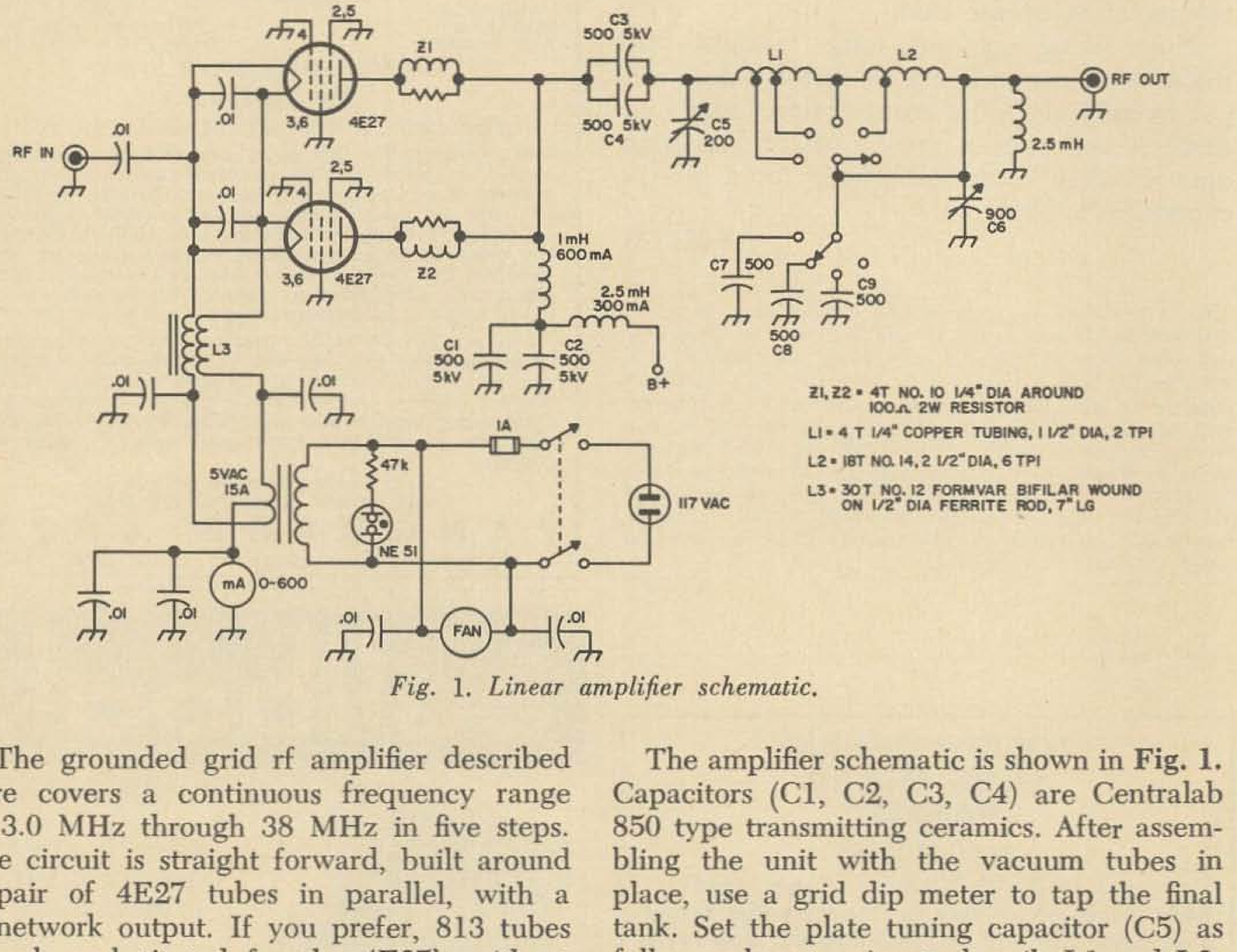


Fig. 1. Linear amplifier schematic.

The grounded grid rf amplifier described here covers a continuous frequency range of 3.0 MHz through 38 MHz in five steps. The circuit is straight forward, built around a pair of 4E27 tubes in parallel, with a pi-network output. If you prefer, 813 tubes may be substituted for the 4E27's without any electrical change in the circuitry. Mechanically you will have to change the plate caps for the 813's, the rest of the hardware remains the same.

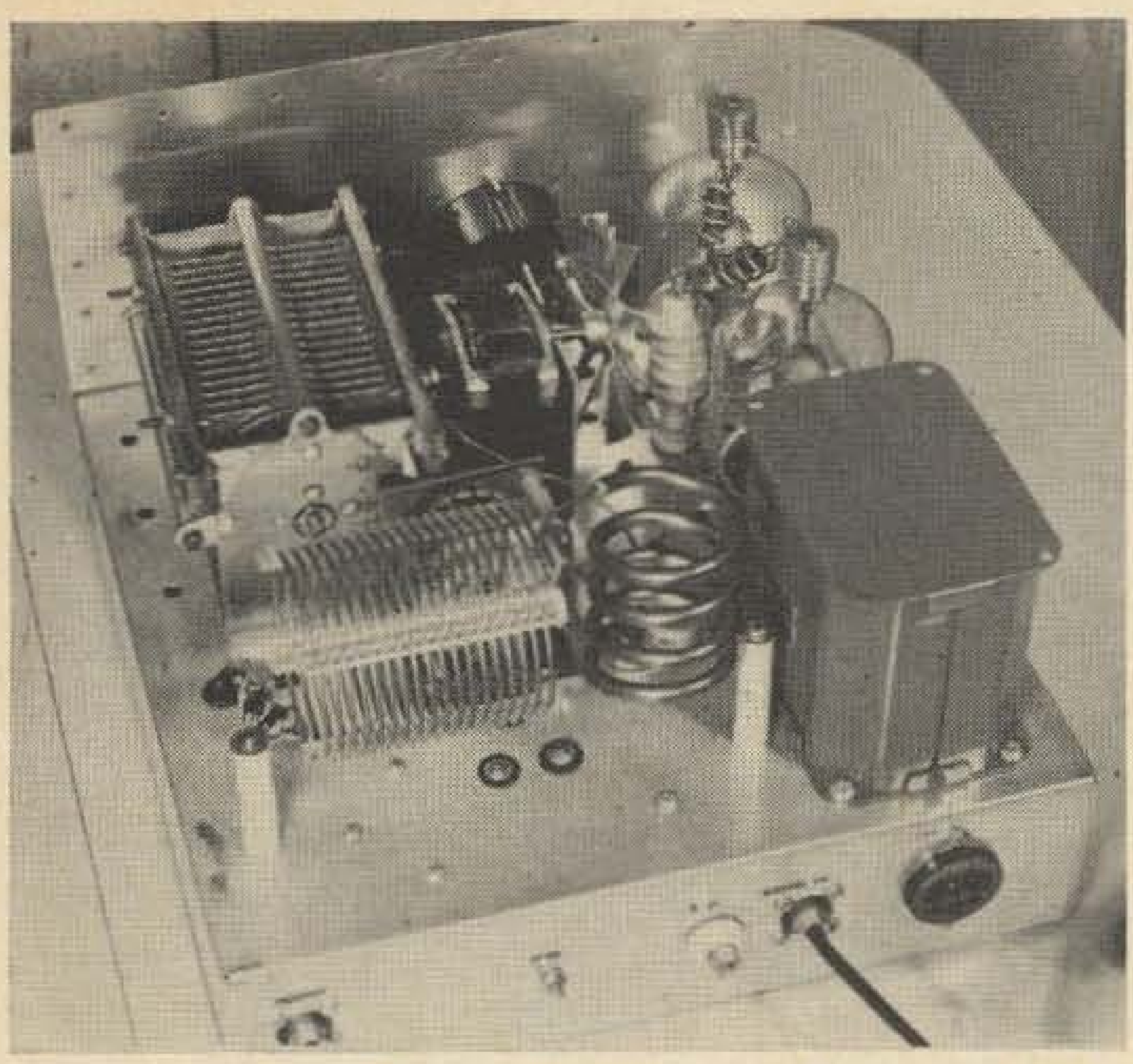
The amplifier is built on a 12 x 12 x 3 inch aluminum chassis. The total height of 8 inches is achieved by recessing the tubes 1 inch below the chassis. Drill plenty of ¼ inch vent holes in the chassis around the tube bases for proper heat dissipation. To conserve additional room, the coaxial connectors in the rear are recessed 1½ inch into the chassis.

Parts for this unit are available from surplus houses, wholesale or retail outlets, junk boxes or friends.

The amplifier schematic is shown in **Fig. 1.** Capacitors (C1, C2, C3, C4) are Centralab 850 type transmitting ceramics. After assembling the unit with the vacuum tubes in place, use a grid dip meter to tap the final tank. Set the plate tuning capacitor (C5) as follows when tapping tank coils L1 and L2:

Freq.	C5 setting	Turns in our circuit
3.5 MHz	90% of full mesh	18 turns on L2
7.0 MHz	50% of full mesh	8 turns on L2
14.0 MHz	20% of full mesh	1 turn on L2
21.0 MHz	20% of full mesh	4 turns on L1
28.0 MHz	15% of full mesh	1 turn on L1

The pi-network output capacitor (C6) is a three gang capacitor out of an old broadcast band radio. The three sections of capacitor (C6) are tied together in parallel. Three additional capacitors (C7, C8, C9), transmitting micas rated at 5000 volts test –2500 volts working, may be necessary for loading on the lower bands. The output



Notice short leads on suppressors. Keep the tank coils and variable capacitor close together. The filament transformer is shielded from rf by its case.

loading section is located below the chassis and shielded from the input circuits.

An ideal bifilar wound isolating choke (L3) is noted in **Fig. 1.** However, we could not obtain the recommended ferrite rod in the local stores so we substituted a ⅜ inch diameter ferrite rod 6 inches long. In fact we made three bifilar wound chokes with 30 turns each and tied them together in parallel to get the proper isolation and current carrying capacity.

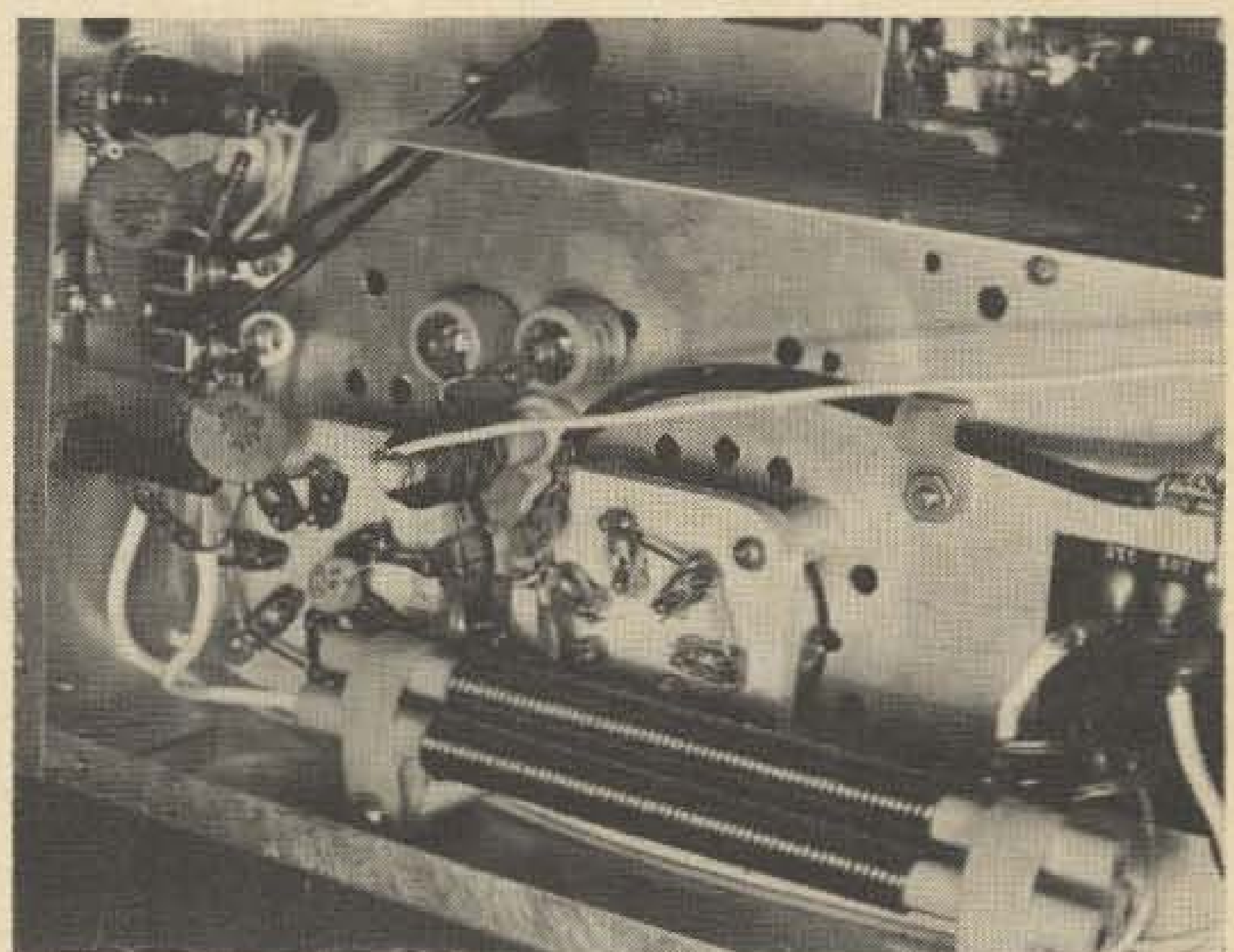
The meter is placed in the cathode circuit to keep the high B+ voltage off it. A good indication of how much total current is going through the tubes may be obtained from this meter.

It is suggested that the output power of the 4E27's in this circuit be limited as shown, although these ratings are considered to be conservative.

AM	200 watts per tube
CW-SSB	400 watts per tube

To check for parasitics (there shouldn't be any in this amplifier, but just in case) load the amplifier on 10 meters. After loading (into a dummy load of course) remove the excitation, then rotate the plate tuning capacitor (C5) 180°. There should be no variation in the cathode current without excitation. By now you may have noticed a residual current of 20 to 30 milliamperes in the cathode circuit. Don't worry about it, that's natural for this circuit. If, however, you do get a variation in current when rotating capacitor (C5) you will have to add a turn or two to the parasitic suppressor traps (Z1 and Z2).

There are several methods of tuning and loading this amplifier. You may tune by the



Note recessed tube sockets and three bifilar wound coils in parallel as close to the tube sockets and filament transformer as practical.

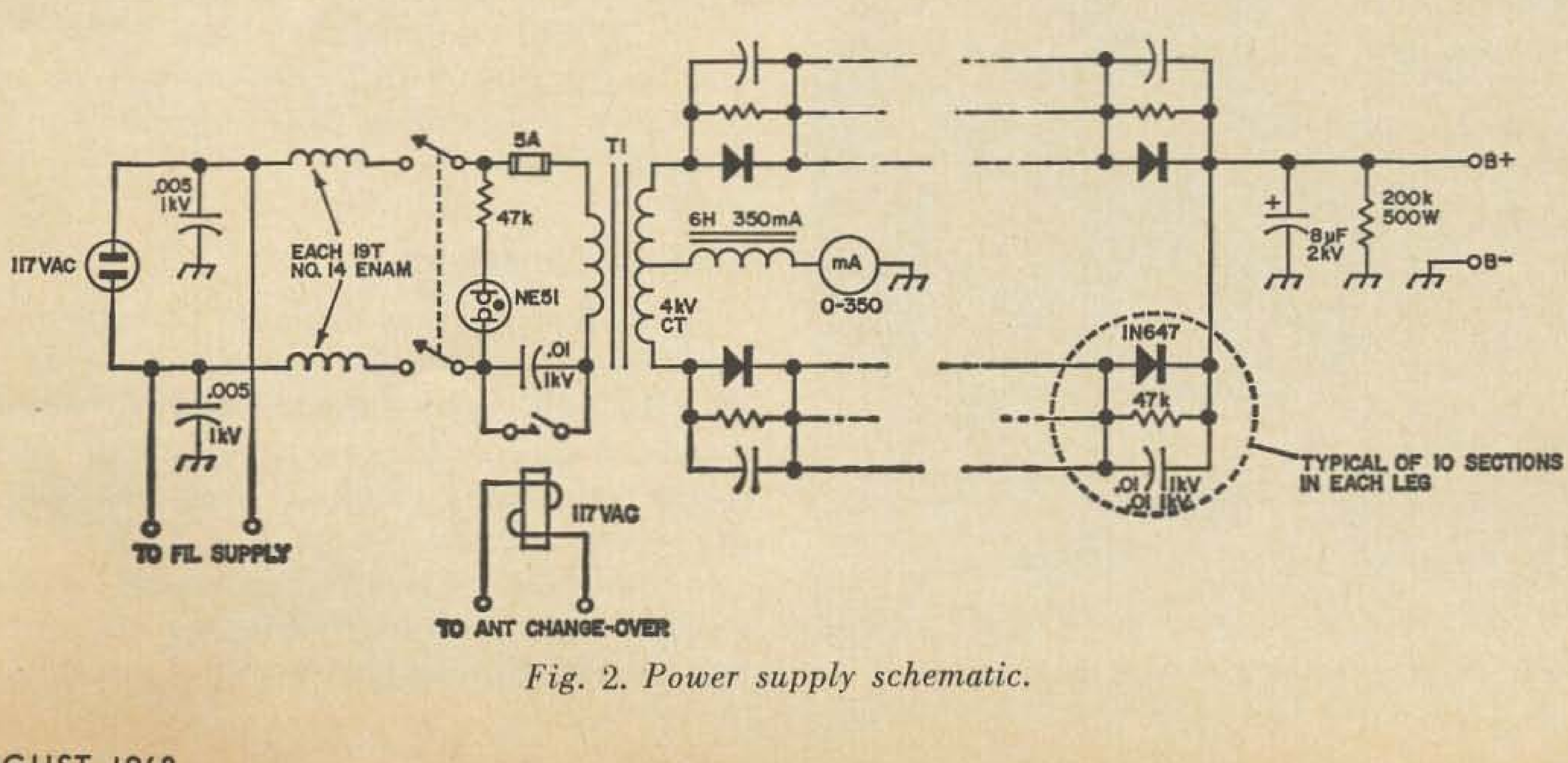
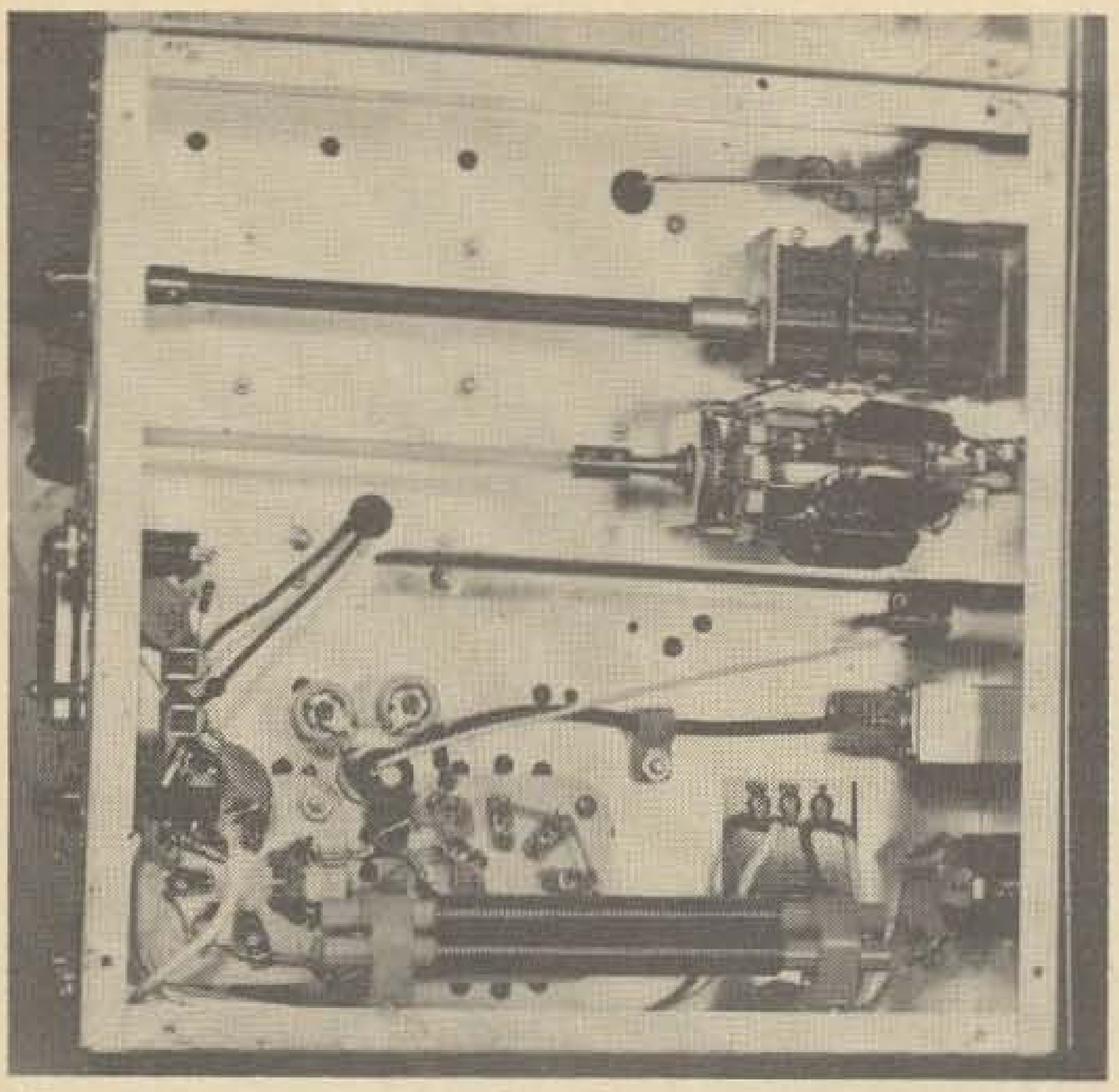


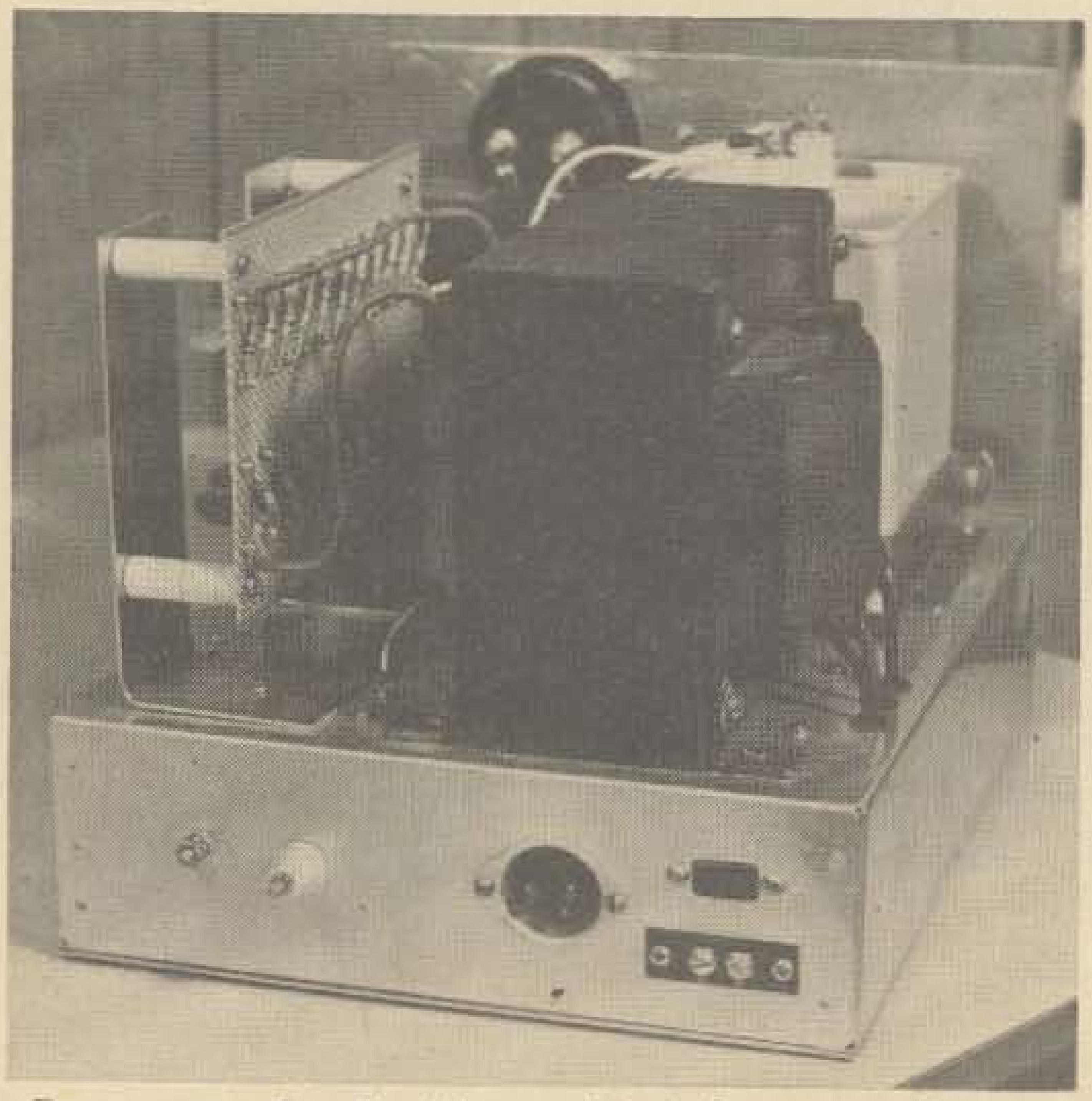
Fig. 2. Power supply schematic.



Bottom view. Notice the shield which isolates the output section from the rest of the circuit.

glow of the plates. However, I prefer to use an output indicator such as an SWR bridge or a monitor scope. Adjust the plate tuning capacitor (C5) until the output indicator reads maximum, then adjust the loading capacitor (C6) until the output indicator again reads maximum. Switch in additional capacity (C7, C8, C9) as required and retune (C6). The last step is then to readjust (C5) for maximum.

The 4E27's in this circuit amplify about 10 to 1 on 10 meters. So 100 watts driving power could get you 1000 watts to the plates, therefore, be careful not to burn up the tubes. Always tune up with reduced power.



Power supply. Nothing critical here at all.

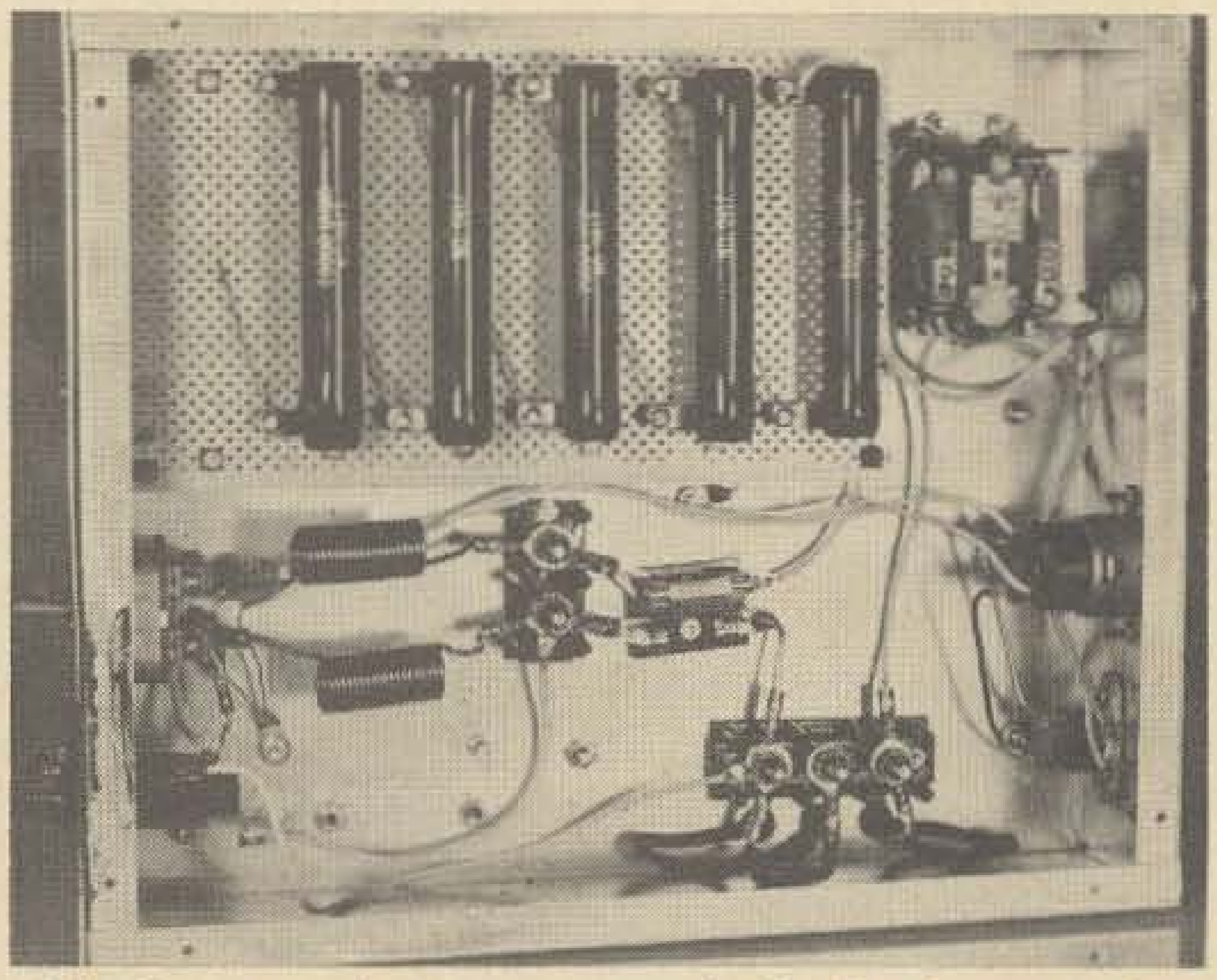
Power Supply

The power supply circuit for this 4E27 amplifier is illustrated in **Fig. 2.** A 10 x 12 x 3 inch chassis allows you plenty of room for all the power supply components.

The diode strings are mounted on terminals on a perforated epoxy glass board. The terminal mounting tools were a tack hammer and an almost blunt center punch.

The bleeder resistor is composed of ten 20 k resistors in series. Five watt resistors are adequate, but all I had was 50 watt resistors, so that's what I used. However, the larger resistors may be used in the future as a voltage divider for screen and suppressor grid voltages if you decide to change over to type AB_2 operation.

Operating the power supply is very simple, all you have is an on-off switch. The



The bottom of a power supply is the bottom of a power supply.

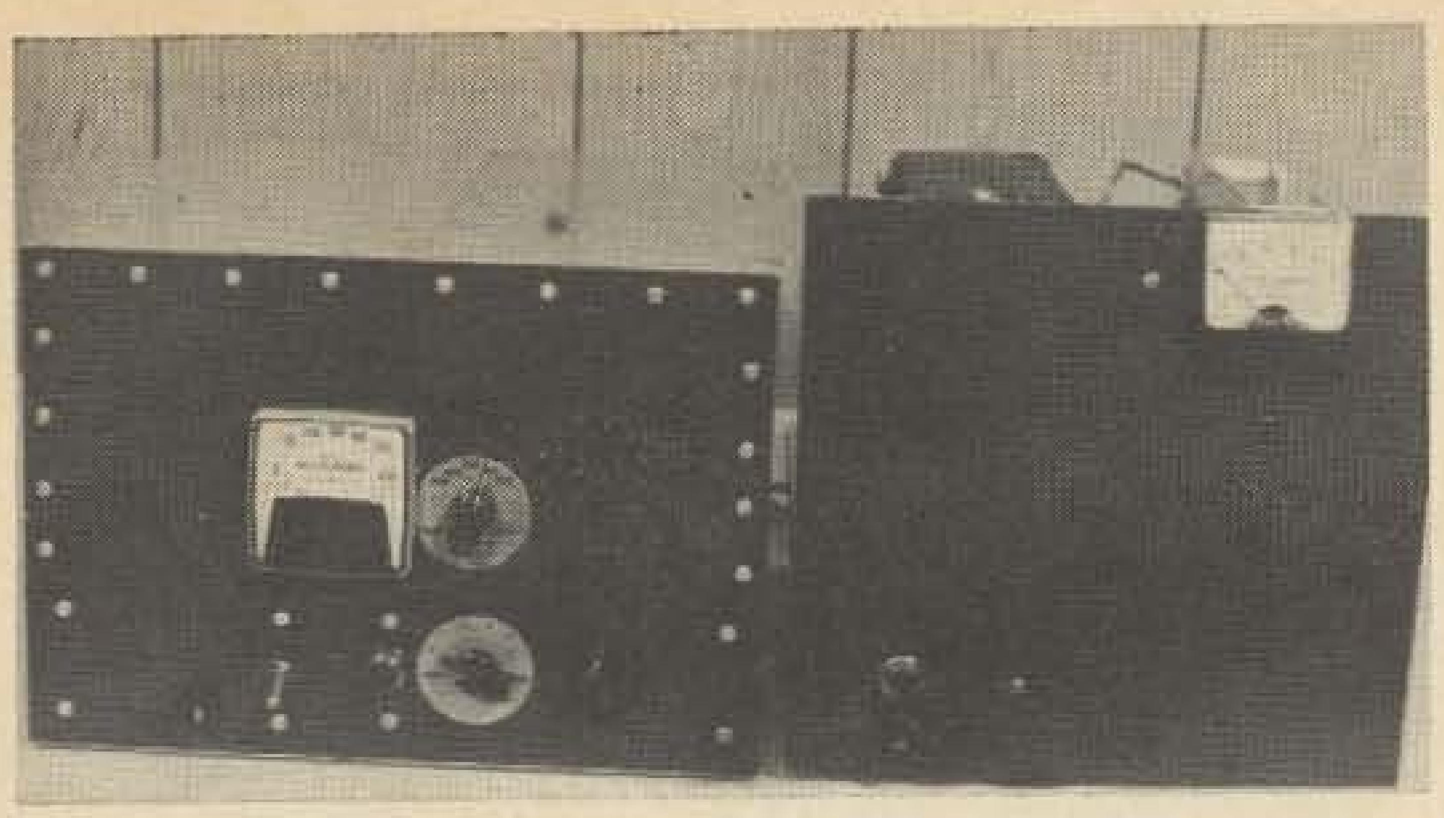
117 V ac relay makes and breaks the primary side of the power transformer. This eliminates any possibility of hash from the power supply while it's on stand-by.

A 300 mill dc ammeter in the cathode circuit of the power supply gives you an indication of how much B+ current you are drawing.

General Comments

If VOX operation is used, be sure to set the change over relay for a long delay so the unit will not change over on pauses in words. Rapid continuous keying of the power supply relay may cause an excessive load on the power supply.

I would like to thank Don Bristol, W6ZUI, for his assistance in developing this amplifier and for furnishing the major components



Amplifier and power supply

such as tubes, transformers, chokes and capacitors. One capacitor, the plate tuning capacitor (C5), was in a Bendix Frequency Standard aboard the Squalus submarine when it went down May 23, 1939 off the coast of Portsmouth, N.H. in 240 feet of salt water. Three months later when the submarine was pulled to the surface, much of the electronic gear was reclaimed including capacitor (C5).

Many thanks also to my good neighbor Marty Jacobson for the fine photos.

. . . WA6WUI

Split Frequency with the S-line

For a long while I've been plagued with having to manipulate my band switch on the 75S-3 whenever I wanted to work DX which was transmitting in the foreign phone band while I transmitted in the US phone band. A time was to come when the band switch was to give up the ghost, and it is a really difficult job to replace one.

I ordered a 8627.500 kHz crystal from International Crystal Company and inserted it into the holder for the crystal which is labeled 14.8. I now can tune 14.300 through to 14.100 with no trouble and no change of dial calibration. You can readily see what a labor-saving device this idea can be. Of course, the 32S-1 and 75S-3 are always operated transceive connected. I also find that it makes no difference if the 32S-1 is set on the 14.2 position or on the blank position which follows it. This is because when connected for transceive only the crystal in the receiver is used, despite the fact that you can split the equipment for independent operation when necessary.

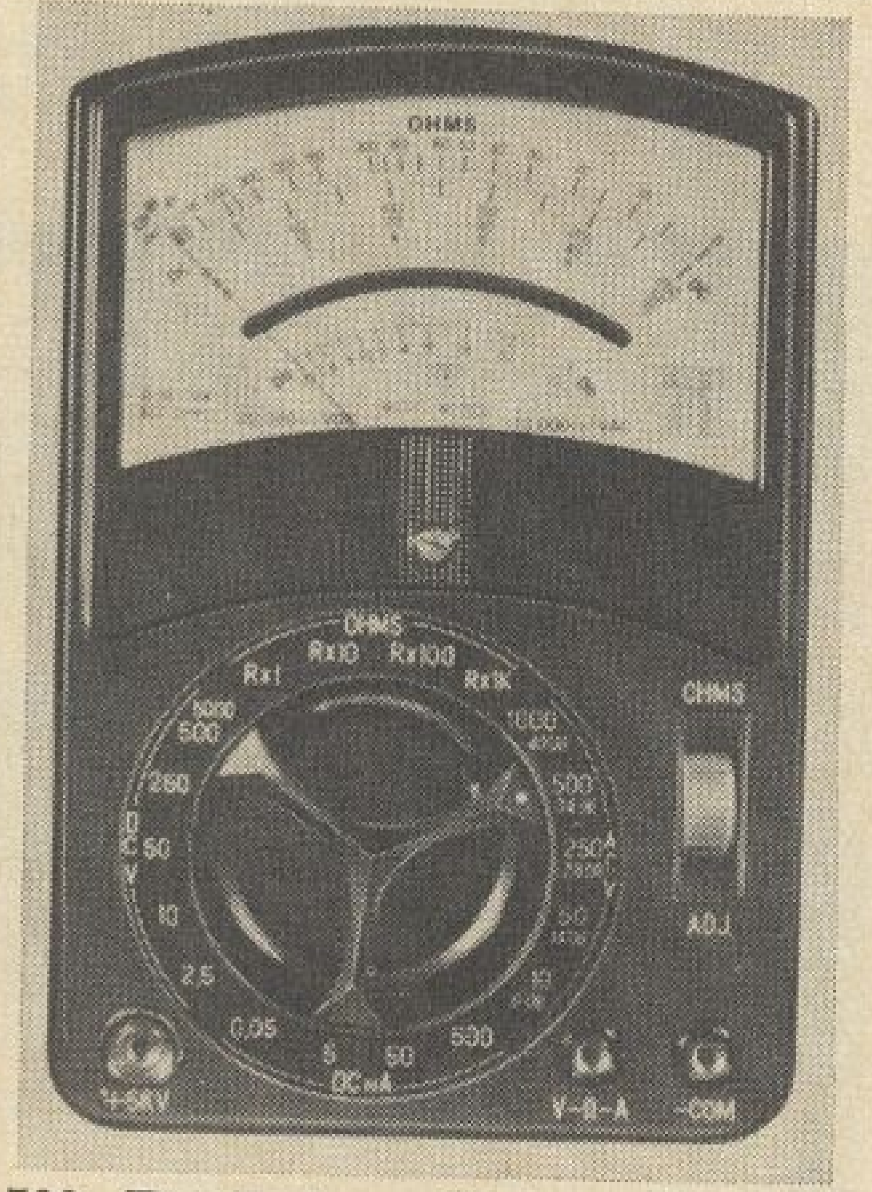
. . . Gay Milius W4NJF

TEN-IN-ONE MINI-LAB

Here is a complete test laboratory all in one package! A modern miracle of electronics. This one unit contains an AC-DC Voltmeter: 50, 150, 500 volts; 0-500 mA; 10K, 100K, 1M ohms; resistance and capacitance substitution; 9 vdc battery supply; RF Signal generator 455 kHz (and up to 700 kHz); plus an audio generator at 400 Hz. You can service just about anything with this lab. You can signal trace and align receivers and trace audio systems, speech equipment, hi-fi and tape recorders. This is probably the single most useful piece of test equipment ever to come along.

SPECIAL $24.95 pp

20,000 OHMS per VOLT V-O-M



DC Volts: 2.5, 50, 250, 500, 5000. AC Volts: 10, 50, 250, 500, 1000. OHMS: 1K, 10K, 100K, 1M. DC mA: .05, 50, 500. Decibels —20 to +62 db. Few small VOM's read up to 5000 volts, yet this is just what you need for testing your rig. 3" meter with mirror for high accuracy of readings. This meter has both the low scales and sensitivity for checking transistor circuits as well as the high ranges for transmitters. Buy one for the shack and one for the car. Light and rugged for traveling.

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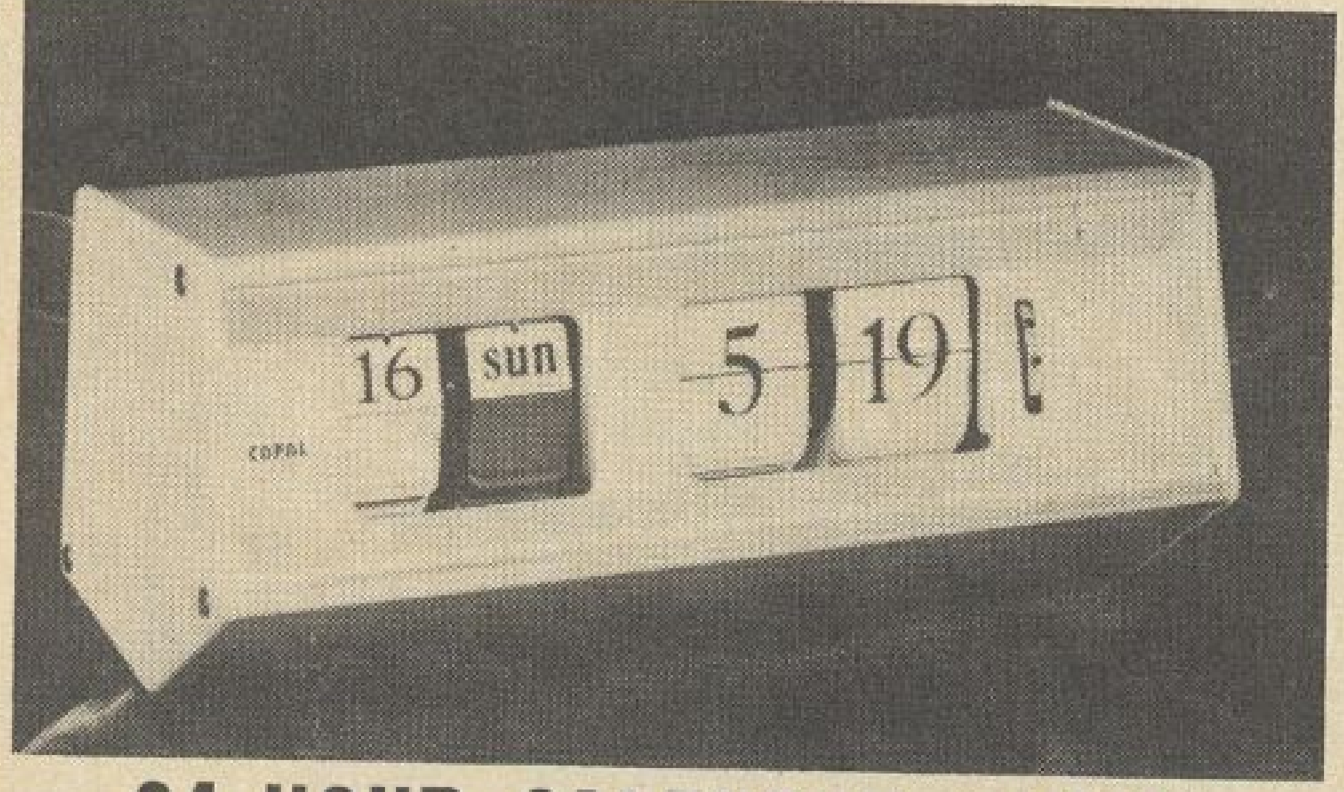

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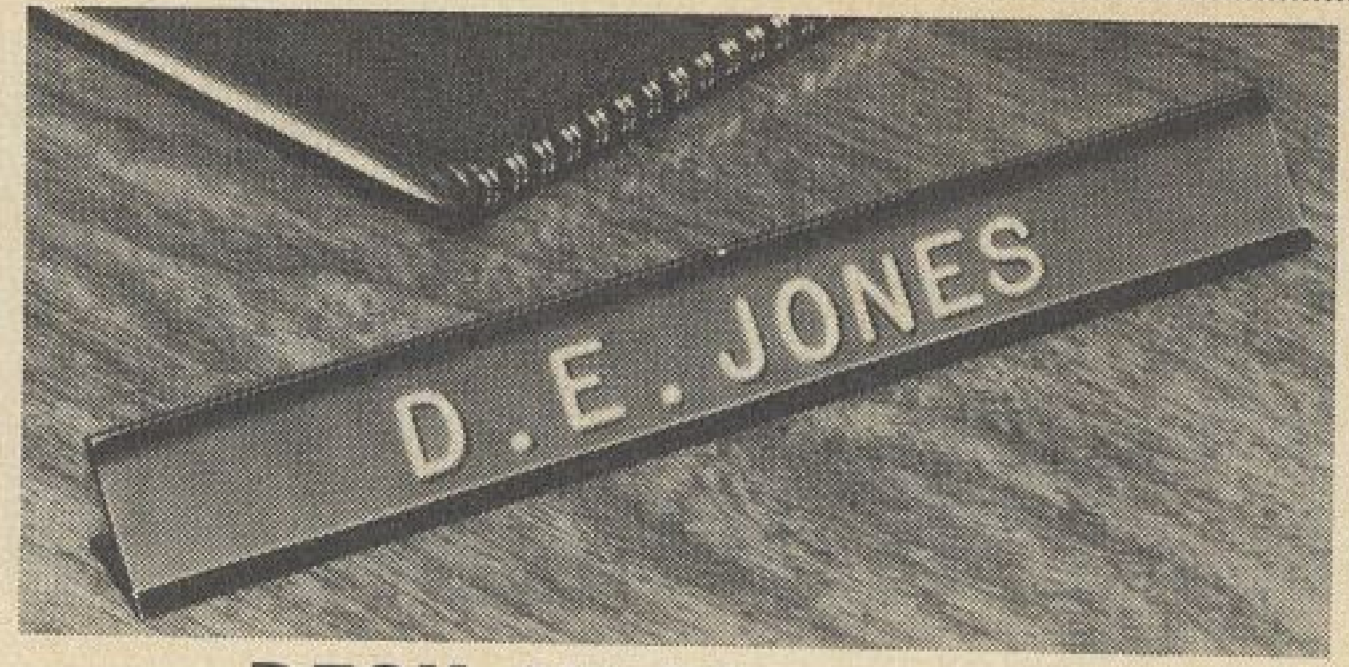

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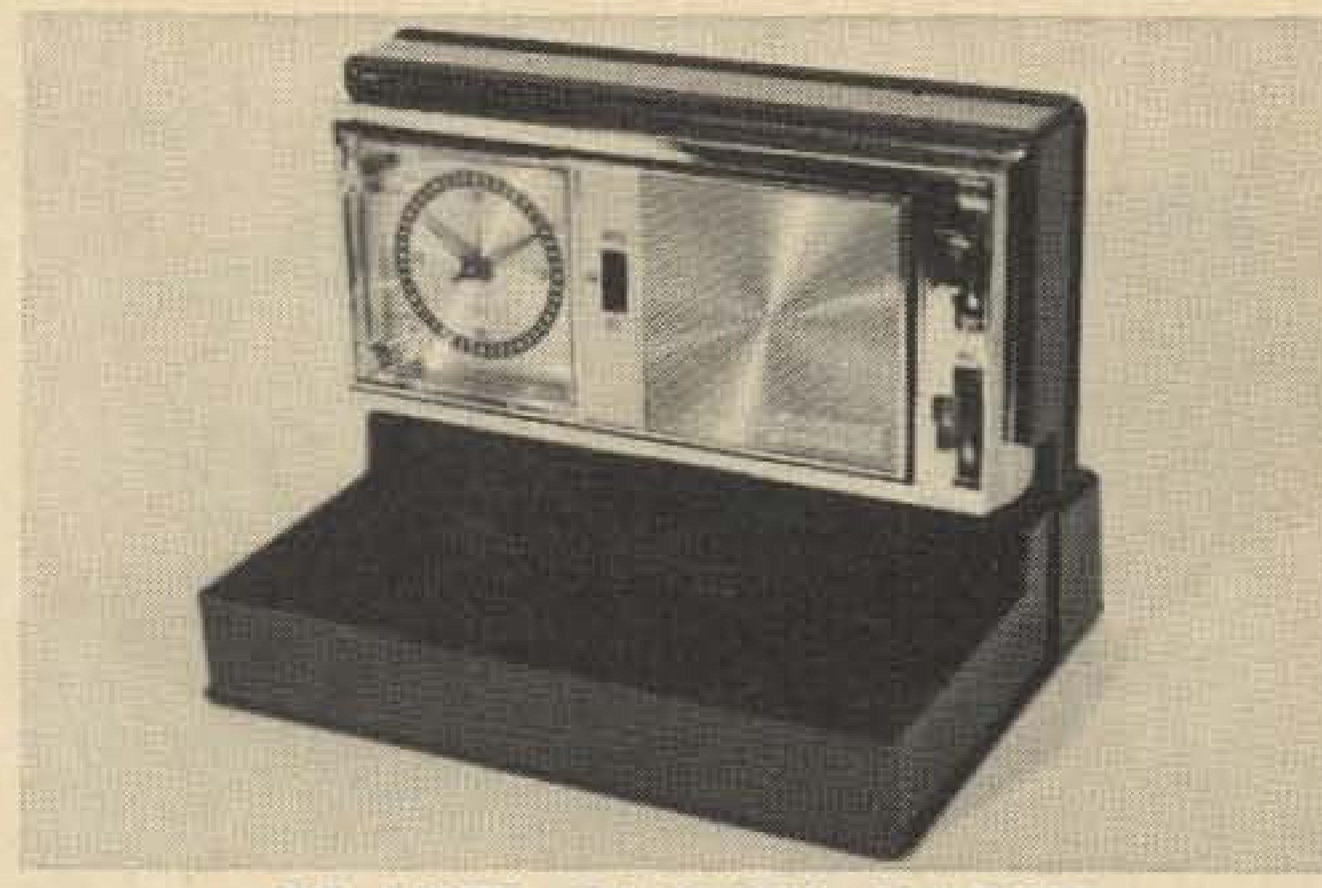

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QSL Display— The Easy Way

All hams want to wallpaper their walls with QSL cards and awards to show visitors, be they licensed or not, to show just how good an operator they are. But alas, the XYL always vetos such moves because of all the holes that will inevitably end up on the wall . . . and in most families, what the XYL says—goes! Here's an easy way to get around this problem, without spending a lot of time or money, and ending up with a really sharp QSL/certificate display.

The heart of the display is the use of *adhesive cloth picture hanging hooks and eyes*. The idea is that you *glue* your picture framed awards, etc. to the wall rather than nail them on. If at a later date you decide to remove the display, you just wet the hangers and the adhesive softens so that you can remove the frame . . . no holes, no nails! The hangers are available at any five and ten store. The ones I used are made by E. H. Tate Co. in Boston and go under the tradename of "DANDEE". They cost about 50¢ for six hooks and eyes; the instructions for both application and removal are on the back of the packages.

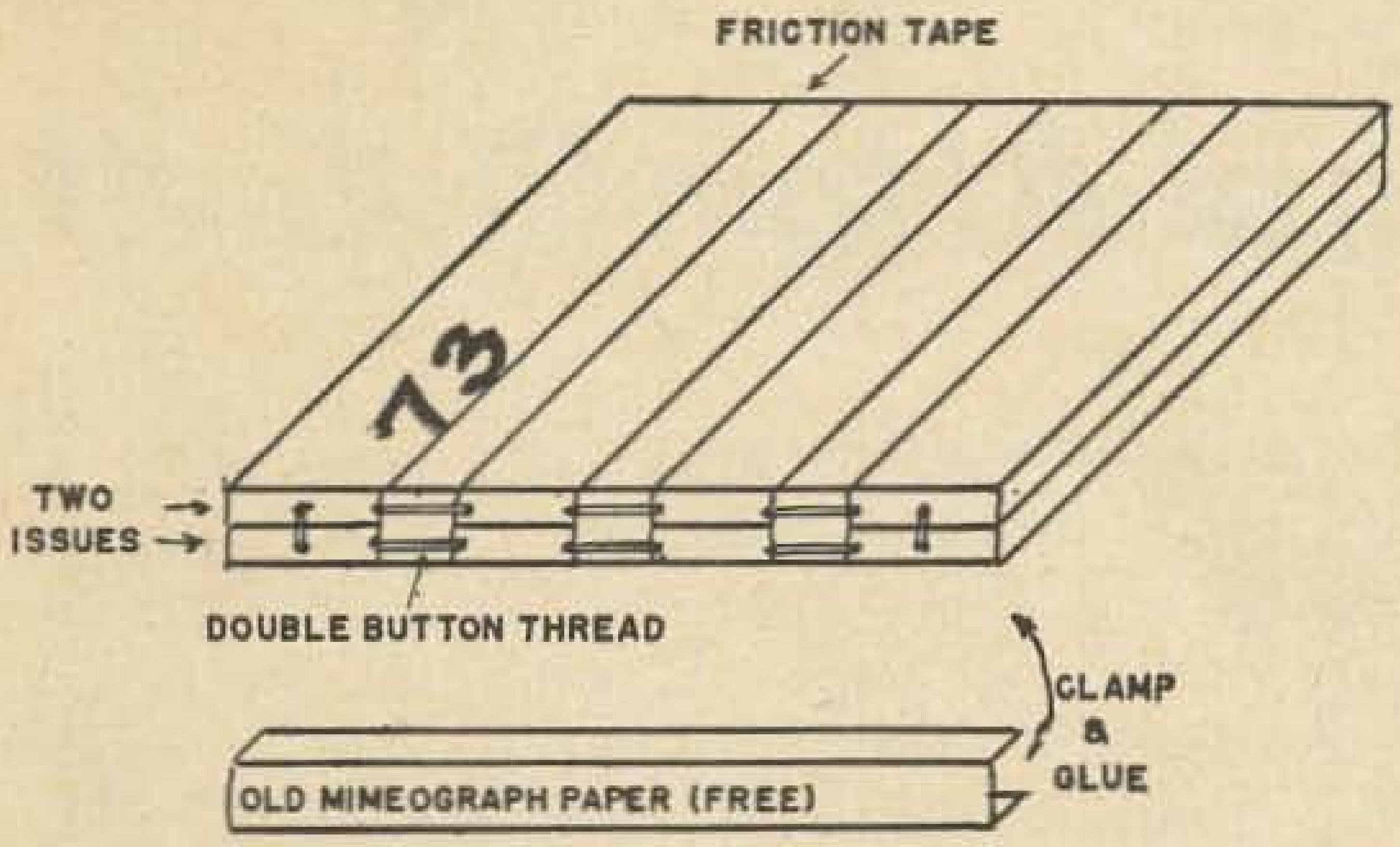
—this picture shows the materials needed for the QSL display

—the completed display really looks sharp—even if it doesn't contain a lot of DX cards!

Instead of mounting each QSL separately on the wall, I put a couple of dozen cards on a single piece of poster board or similar material, and used the hook and eyes to hang the whole board. This way a whole wall can be covered with cards with only a few sets of hangers. In order to mount the QSLs on the board, I used postage stamp hinges. These cost about two bits per thousand and are available at any hobby store. The advantage in using the hinges is that they can be removed from both the QSLs and the poster board without tearing. This is especially good for the fellow who wants to display his DX card collection but wants to be able to remove the cards easily for submission to WTW, etc.

To begin with, after you have all the hinges, hangers, etc., lay out your QSL card collection on the poster board. When you have a pleasing arrangement, you can start to fasten the cards to the board. I use four hinges, one at each corner and I find this is satisfactory. When the cards are all attached, glue on the eye as directed on the back of the hanger package and then glue on the hook. Now you can hang the board with your display. Do the same with the other boards until your display is completed. The certificates are attached in a similar fashion. Now stand back and listen to all the visitors comment on how good an operator they think you are!

. . . VE3BUE



Binding 73

Jim Kirk, W6DEG
1551 Church St.
San Francisco, Ca. 94131

In May, '68.73. I note author Tani C. Allen, WA4HRX, refers to my article on book binding in Dec. '66, 73. I have since made a great improvement that I think will prove useful to anyone following my system.

Instead of punching holes in the magazines, and mutilating them until I have a year's supply, I start the sewing process as soon as I receive the second issue. When I receive the 12th issue, I have a firm book ready to be mounted between covers. In the meantime I have a sturdy book for ready reference; one that grows with each month.

With 73's new format, it is super easy. I do not need to pull staples, or separate folios. I count the number of pages and make ice pick holes in the center of the magazine. Then I sew the two copies together. The next step is to place the "book" in a clamp, line it up, and glue a piece of absorbent (mimeograph) paper to the back. I use Le Page's mucilage in the convenient applicator bottle. I still use the re-inforcing tape, and bend the unused part over the cover.

I am now making books out of my four favorite magazines. CQ is not one of them, but 73 and QST are two of them. With QST, it is necessary to pull out the staples and separate the folios, of which there are at least 6 in each issue. This makes for more sewing, but you end up with a strong book.

Carole Allen W5NQQ
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Lafayette, La. 70501

The Care and Feeding of A Ham Club—II

Did you ever attend a meeting for the first time without even one person saying, "Nice to see you here," or "Be sure and come back next time?" Most of us have and can well remember thinking, "Well, I shouldn't have shown up in the first place." There's no percentage in being thin-skinned, but newcomers in a club should be given some kind of recognition.

Al Altomari, W8QWI, former president of the Lorain County, Ohio, Amateur Radio Association feels so strongly about this subject that he says "Treating the newcomer like an old timer" is their group's formula of success. An "Old Timer" in a club feels welcome from the time he enters the door until he leaves. Other members are quick to join him in conversation to find out what bands he's been working, etc. He may not be consciously aware of the fact that he's a member in good-standing, but he undoubtedly enjoys the friendship of the others. The same club may, without even realizing it, treat a new ham in its midst rather shabbily. If a fellow gets no greeting whatever and has to ask where to hang his coat, he couldn't be blamed for wondering if he made a mistake in showing up.

An easy way to avoid the possibility of losing a member after his first meeting is to appoint one, two, or a committee of "greeters." In fact, there may even be volunteers for this job since its usually more fun than serving on another committee—with the TVI boys, for instance. The greeters can keep their eyes peeled for a new face in the group. One or more will make a beeline for him at the first opportunity and extend the welcome of the club. If he already knows everyone, there's nothing much to do after the welcome, but if he's new in the community, introductions will be in order. This can be accomplished individually if you've got all night or done quickly if it's part of the evening program. Members of a group that isn't too large can stand one at a time giving his or her name and call letters. Hams have a definite advantage because many wear call letter badges, and new folks can use the "hamfest technique" by sneaking a look at the badge before calling someone by the wrong name.

Badges for all members of a club are a very good idea. They can be simple ones that you can get in a stationery store and just write in the name and call with a brush

A democratic club offers opportunity for members to discuss their problems and vote on important issues.

The RAMS (Radio Amateur Mobile Society) of Sacramento, California, says their formula of success is planning all activities to include the ham and his whole family. Officers who have worked for the club are (left to right—standing) K6ZFI, Bob; W6QHP, "Buck"; K6VYV, Steve; K6GUU, Bob. Kneeling left: WA6GIT, Dale and W6ZPX, Vern.

pen right on up to custom engraved club pins. Most engravers will do a nice job for you at a low bulk rate, if your secretary asks them. 73 sells club pins with the name of the club on one line and the member first name and call on the second for just $2 each in either red or black with white letters.

Since members often forget to wear their badges to meetings, thereby defeating the purpose of the badges, many clubs have the club secretary collect all badges at the end of the meeting and then hand them out at the beginning of the next meeting. Of course if the secretary is not dependable this system can fail too.

If the club has permanent badges for the regular members and makes up temporary ones for newcomers, it makes it simple for members to pay particular attention to the new hams.

Turn-about is fair play, so the new ham should also introduce himself to the club, mentioning where he lives, what kind of rig he has, etc. A bulletin editor who's on the ball will make notes and welcome the guy or gal in the next edition of the club paper.

A committee of ladies might want to drop by his QTH to say "hello" and invite his XYL to participate in club activities, too. Who knows, the ham who is the object of all the attention may turn out to be a real worker that you can't get along without. If, however, after all these expressions of good will and welcome, the prospective member doesn't darken the door again or rumors around that he had a "blah" time, write him off as a bad investment. As a member, you shouldn't feel at all guilty, for you'll know that the club did its very best to roll out the red carpet.

Getting the Show on the Road

When the president bangs the gavel and asks for attention, he takes the future of the club in his hands. The manner and speed with which he handles business directly affects attendance—the addition of new members, and the enthusiasm and loyalty of the old ones. For instance, if every session opens with a long, drawn-out business meeting that leaves little time for rag-chewing and refreshments, members may start making excuses about missing meetings. Ideally, the president should engineer a snappy opening and get the necessary business out of the way in a hurry. If the secretary can whip through the roll call, the treasurer won't need too much time unless he's handling more money than the U.S. Treasury. Although some groups like to hear the minutes of the last meeting read aloud, generally speaking, the faithful members already know what happened, and hearing the rehash is a real drag. If the club prints a newspaper or bulletin, the editor will probably welcome this material, and members who missed the last meeting can peruse developments at their own leisure.

If reports are in order from other chairmen regarding future functions, money-raising plans, TVI committee struggles, etc., these folks should also remember that they're sharing the business session with others. Since the president knows just how many reports are to be given, and what issues have to be settled, he might ask each chairman to limit his remarks to 3, 4, or as many minutes as required to cover the subject without wasting time.

A president must not only master timing but tact as well. Loaded questions and discussions may come up unexpectedly, and unless the leader knows how to handle the situation, he'll suddenly find the group squared off and feuding like the Hatfields and McCoys. For example, if someone stands up and says, "I don't think anyone under 25 should have a key to the club station," the president has to deal with the speaker, his supporters, the neutrals, and a dozen hot-tempered teen-agers. Unless touchy is-

Every club has to have a group of willing workers. Shown above are the officers of the Montgomery County (Illinois) AREC, Inc. together for a planning Pow-Wow.

sues such as this one have to be settled on the spot, it's a good idea to give answers a lot of thought. A committee can be appointed to study the question and work out a solution without insulting members on both sides.

Democratically, it's good for all important matters to come to a group vote; however, some clubs are organized by law giving final decisions to a board of trustees or directors. The latter is the case when a radio club is incorporated under state laws. Incidentally, incorporation has been recommended by legal counsel who point out that should some club activity result in a lawsuit, individual members would not be liable separately for the club's debts or troubles. A good way for a club of this type to solve a big problem is for the president's committee to report to the trustees or directors who can make their recommendations and then submit them to the club for its approval.

Established groups and their officers already know what unexpected wrinkles can arise and also how important it is to work out an acceptable solution. Newly-formed clubs will do well to copy the Boy Scouts' motto and "Be Prepared." Having a plan of action to put into effect when needed may head off real trouble.

After hearing reports and settling old and new business, the president can turn the spotlight on the program chairman and enjoy what follows. He's not completely out of the work harness, however, since adjourning the clambake is also his job. When the program is over and the discussion dies down, he closes the meeting officially. He can ask for a formal motion of adjournment, or if coffee and cookies are on the menu, he might call the host or hostesses away from the hot-plate to give serving instructions. At any rate, the session shouldn't just fade away with everyone thinking there may be something yet to come.

Technical Programs

Technical programs are to some radio clubs like salt and pepper on a fried egg—a little is a "must" but too much is tragic.

The club that is organized with the sole purpose of holding technical sessions featuring lectures and theory discussions doesn't have to worry about balancing their programs. They merely stick to the by-laws and attract hams who enjoy the same thing. But a club made up of Novices and old-timers, builders and non-builders, YLs and XYLs, has quite a chore pleasing everybody at least part of the time.

The best approach to the situation is to look the crowd over and see how many are interested in what, or even get a vote on it. If the entire membership prefers to tackle their ARRL handbooks at home with an each-for-himself spirit, you can plan accordingly. If several express a desire to see some instructional films or hear reviews of electronic trends, you'd better include some movies and speakers along these lines. It's very likely that a vote will go 50/50 and the program chairman will seem to be right where he started. Although it looks like nothing has been accomplished by a general vote, at least everyone will be aware that there's a demand for variety and will, perhaps, accept the "bitter with the sweet" without griping too much.

All right, so what do you do after some or all of the members have said "Let's have something educational." As program chairman, you may not feel like preparing a discourse on the most efficient method of demodulating a sideband signal, but who says you have to? First of all, look to the club itself for talent. If you've heard that the TV repairman on the back row is busy wiring voice booths in the high school's new foreign language training room, ask him to explain how electronics enables teachers to listen in on each student's progress. If Second-Row Joe is testing a homebrew quad on 10-15- and 20, see if he won't put his plans on the blackboard some evening.

Every club is loaded with specialists in various fields and some of them, surprisingly enough, won't require too much arm-twisting before agreeing to take a program.

When local talent has been exhausted, start scouting the community and neighboring clubs, too. Many electronic industries and businesses are happy to provide films and slides on their products that are right up a ham's frequency. They may even send an employee with screen and projector. Who cares if the company sneaks in some advertising; the club will benefit from seeing how transformers are made, receivers designed, or vacuum tubes manufactured. Representatives are usually happy to answer questions, and members like to get information from the "horse's mouth."

Don't overlook films and speakers available for the asking from the Red Cross, Civil Defense groups, and also the military. Some organizations welcome chances to appear before the public. By checking with them for program material, you're doing both your club and an outside group a big favor.

Admittedly, if you're in or near a large city and industrial area, programs may be easier to come by. Groups in the grass roots have to scratch their heads, especially if they meet more than once a month. In the midwest, several small clubs may exist within a fifty mile radius. What's wrong with the program chairmen of these clubs picking an 80 meter frequency and swapping ideas once in a while. A speaker enjoyed by the Sangamon Valley Club might agree to go to another town. College campus groups in particular could benefit by a sharing plan since student chairmen can spare little time from books to search for program material.

Another little chore for the chairman may involve the matter of money. A club with a fat pocketbook can nail down about any kind of program because they can pay the price. If your treasury hovers on the empty mark, it's even more challenging to locate people who will perform for nothing. In this day and age that may seem impossible, but, thank heavens, there are still a few folks left who will. A club member who gives a demonstration or leads a discussion probably won't expect anything in return, but an outsider should be offered the price of gasoline, if nothing else.

When a speaker has been found, the chairman still can't fold his hands and forget the job. A few days ahead he should find out what stage props or equipment the speaker will need and arrange to have them handy. Since the visitor may not know anyone in the audience, a thoughtful chairman will break the pre-program ice early in the evening and make a few introductions to put him at ease.

Just keep in mind that if your speaker enjoys himself too, he might let you schedule him for a repeat performance next year. And counting chickens before they're hatched is good business for a program chairman. . . . W5NQQ

Getting Your Higher Class License

Part V — Receivers

Operation of a ham station involves, basically, three major items of equipment—a transmitter, an antenna, and a receiver.

In previous sections of this study course for the new Advanced Class license examinations we have touched upon aspects of both the transmitter and the antenna (as reflected in the FCC study guide questions). Now it's time to turn our attention to the receiver.

The Commission's list of 51 suggested study questions contains six which deal directly with receiver operation, and they range from extremely detailed to extremely general. These questions (numbers are those assigned in the study list) are:

9. How can receiver sensitivity and selectivity be improved?
26. A superheterodyne receiver having an intermediate frequency of 455 kHz is to be adjusted to receive a signal on 3900 kHz. What frequencies can the high frequency oscillator be set to, to give a beat signal at the intermediate frequency?
33. Define the shape factor of a crystal lattice band-pass filter.
39. What functions does a variable-mu tube perform in an *rf* amplifier stage in a receiver?
41. How do noise limiters operate?
48. How does automatic gain control operate? When can it be used for SSB operation? CW operation?

Most receivers, these days, are superhets, and it's presumable that in the absence of any qualification to the contrary any question on the actual exam which deals with a receiver would assume that a superhet is involved.

However, non-superhets are still used for several special purposes. Therefore, although most of our discussion this month will concern the superhet, we must also cover non-superhet receiver types as well.

Following our usual practice of paraphrasing the FCC questions into more general questions covering (but not limited to) the same subject matter, let's re-frame the receiver portion of the study guide.

One of the first questions we ask must be, "How Does a Superhet Differ From Other Receivers" The answer to this will adequately distinguish between superhets and all others.

Any superhet, whether it be a four-transistor broadcast band squawker or an "ultimate" digital-tuning communications job, can be broken into four major portions as shown in **Fig. 1.** These offer us our remaining four questions.

Following the path any received signal must travel, we'll first ask, "How Does The Front End Operate?"

Superhet question number 2 (question number 3 of this installment) will then be, "What Does The *if* Strip Do?"

We'll follow this immediately with a look at filters in general—"Why Filter?", before our final theme, "How Does The Detector Section Work?"

Noise limiters, automatic gain control, and the like are all accomplished by the detector portions of most receivers—although AGC must also be involved with the *if* strip. Since we will be looking at the receiver as a functioning entity (except for the audio section, which we will ignore at this point), you may have a bit of difficulty relating the more detailed parts of the FCC study list to our questions.

To answer FCC question 9, you'll need to know about the front end and the *if* strip. Question 26 involves only the front end. Question 33 is handled in the discussion of filters. Question 39 involves both the front end and the *if* even though the question as stated by the Commission would involve only the front end. Question 41 involves only the detector circuits, while question 48 requires a knowledge of front end, *if*, and detector for an adequate reply.

Ready? Let's get to it.

How Does a Superhet Differ From Other Receivers? Unless you've worked your way up through a crystal set and a one-tube blooper (regenerative receiver to you young squirts) you may not have a real appreciation of the superhet. That is, of course, unless you've served your time with a Sixer or Twoer and the constant hiss of their superregen circuits.

The function of any receiver is to convert the *rf* energy transmitted upon some specific frequency into audio energy. The various types of receivers are all capable of performing this function. Some, however, perform it more capably than others.

All receivers can be compared with regard to their performance in three basic characteristics; sensitivity, selectivity, and stability. Sensitivity measures how weak a signal may be received, selectivity measures how well undesired signals are rejected, and stability measures the receiver's capability for staying on the desired signal without readjustment.

The lowly crystal set will perform the basic function of a receiver, provided that the *rf* energy carries amplitude modulation, but it ranks low in all three characteristics. Sensitivity is poor since all the audio energy produced must be supplied directly by the *rf* energy received. Selectivity is poor because only one or two tuned circuits are available to reject undesired stations. Stability is moderate, and is of little consequence since selectivity is so poor in the first place.

The next step up from the crystal set (not counting such modifications as the one-tube grid-leak detector, which is hardly ever encountered these days) is the regenerative receiver. This makes a single active element (tube or transistor) serve double duty as both an *rf* amplifier and a detector.

Sensitivity is much greater and selectivity is also improved because of positive feedback, which increases the sharpness of the tuned circuits. Stability, however, decreases; almost any movement near a regen will require retuning.

The regen has one capability lacking in the crystal set or other detector-only receivers: it can be adjusted to receive CW as well as AM by throwing the circuit into oscillation and mistuning it a kilocycle or so from the desired signal. The local oscillation and the incoming signal mix in the receiver to form an audible beat note.

The addition of *rf* amplifier stages between the antenna and the detector improved the performance of non-regen receivers and make them able to compete with regenerative circuits; this is the TRF (tuned radio frequency) receiver which was used to a surprisingly great extent as recently as the 1940's.

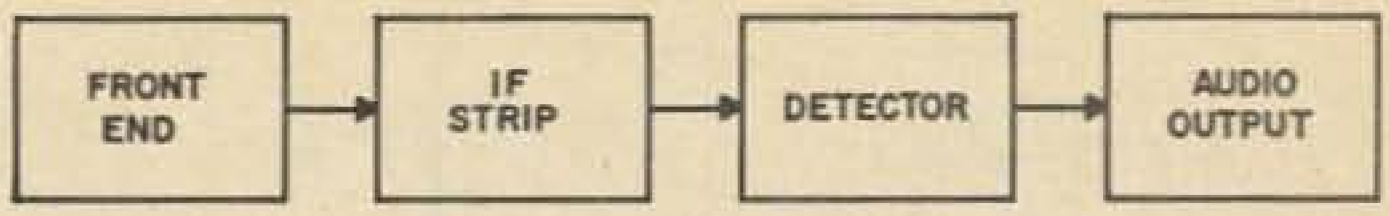

Fig. 1. Block diagram of any superhet receiver.

The regenerative receiver offered highest sensitivity per circuit element, though, and experiments aimed at increasing its sensitivity resulted in the superregenerative circuit. This circuit actually oscillates, but its oscillation is interrupted or "quenched" at a supersonic frequency. As a result, you are able to hear the actual electron noise in the antenna wire. Any more sensitivity than this would be unusable anyway.

Unfortunately, both selectivity and stability on a superregen are poor. In addition, this receiver simultaneously performs as a low-powered transmitter, interfering with all other receivers in the area tuned to the same frequency.

The superhet is a combination of the TRF, the regenerative circuit, and the crystal set. The block diagram of **Fig. 1** may be helpful here. The front end consists of any *rf* stages, plus a mixer which is similar to a regenerative receiver except that it is adjusted to produce an "intermediate frequency" output instead of an audible beat note. Some front ends use only a single tube or transistor as the mixer and call it a "converter," while other designs use separate oscillator and mixer elements. In these, the oscillator is called the "local oscillator" or "*hf* oscillator", and the mixer is known as the mixer.

The *if* strip is almost identical to a TRF receiver, except that it is permanently tuned to a single frequency and does not include a detector. The *if* frequency is usually relatively low; many circuits use a standard *if* of 455 kHz, but higher frequencies in the 1 to 10 MHz range are becoming more popular. In general, the lower the frequency the greater the gain and selectivity, but we'll go into this in more detail later.

The detector, for AM reception, is almost always a direct equivalent of the crystal set. For CW and SSB, product detectors (which are special types of mixers) are used.

The superhet combines the best features of all the types of receivers it combines, while escaping for the most part their problems. It offers excellent sensitivity, and if properly designed can have extreme selec-

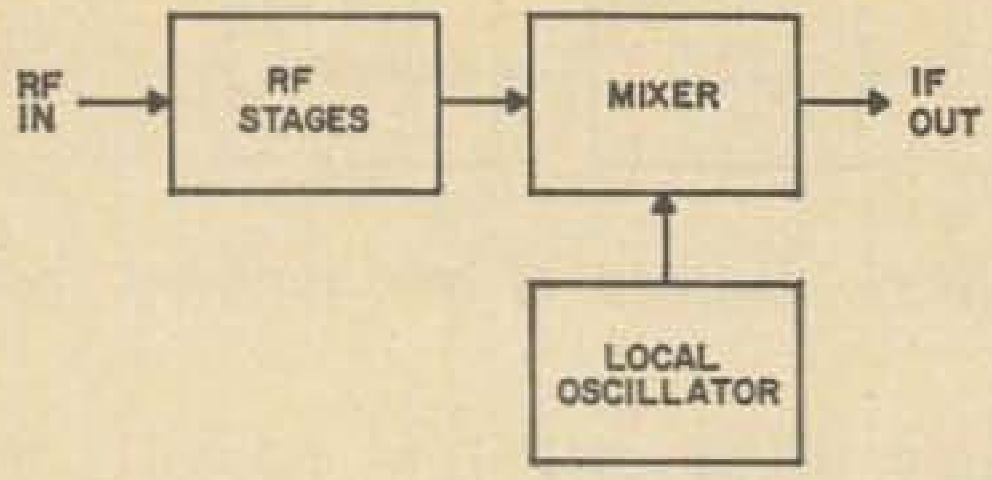

Fig. 2. Block diagram of superhet front end functions.

tivity and stability as well. For this reason, it has displaced all other designs as the "standard" receiver circuit—unless factors such as simplicity or economy happen to outweigh performance requirements in some special application such as the Sixer or Twoer!

How Does The Front End Operate? The "front end" of a superhet is the key to the entire receiver, and its operation contributes most noticeably to the operation of the receiver as a whole. **Fig. 2** is a block diagram of a typical "front end"; not all superhets include separate tubes for each block of **Fig. 2.** but all the functions are performed.

The basic idea behind the superhet is that of "beating" or mixing two radio frequencies in order to produce a sum or difference frequency, which carries all the modulation of both original frequencies. If one of the two original frequencies is the desired signal, and if the other is unmodulated and at a fixed distance in the spectrum from the first, then the difference frequency will carry the modulation of the desired signal, but will always be at a fixed frequency.

This fixed or "intermediate" frequency is equal to the separation between the frequency of the desired signal and that of the unmodulated second signal.

The functions shown in **Fig. 2** break down as follows: The *rf* Stages amplify the desired signal, thus increasing receiver sensitivity, and provide some selectivity as well. The Local Oscillator provides the unmodulated second signal; this oscillator is always tuned to a frequency which is separated from that of the desired signal by the *if* frequency, but may at times be tuned to a higher frequency than the signal (high-side injection) and at other times to a lower frequency than the signal (low-side injection). The Mixer combines the two *rf* signals to produce both the sum and difference frequencies; a tuned circuit in the Mixer's output portion selects only the difference frequency for passage to the *if* strip.

Since the local oscillator may operate on either the high side or the low side of the incoming signal, it follows that a *single* setting of the oscillator frequency permits reception of incoming signals at *two* different frequencies. One of these is above the oscillator frequency by the amount of the *if;* for it, the oscillator provides low-side injection. The other is below the oscillator frequency by the amount of the *if,* where the oscillator provides high-side injection.

One of these two frequencies represents the desired signal. The other represents an undesired response called the "image", and is one of the major disadvantages of the superhet receiver. The image is always separated from the desired signal by twice the intermediate frequency: If the *if* is low to provide gain and selectivity easily, the image will be close to the desired signal. If the *if* is made higher to move the image away from the desired response (the more separated the two signals are, the more readily the image can be rejected by the tuned circuits in the *rf* stages), both gain and selectivity suffer.

A standard *if* frequency is 455 kHz. In a receiver using this *if,* the local oscillator is always tuned 455 kHz away from the frequency to be received, and the images are always 910 kHz away from the desired responses.

Most BCB receivers operate with high-side injection to overcome tracking problems; this means that image response can be observed easily if you have a high-powered BC station operating above 1410 kHz near you. Simply tune to the *low* end of the band. At 500 kHz on the dial, a strong 1410-kHz signal will come through. At 690 kHz on the dial, powerful 1600-kHz signals can be heard. This is normal for a superhet.

To receive an incoming signal at 7.2 MHz with a 455-kHz *if,* you could set the local oscillator to either 6.745 MHz for low-side injection (with image at 6.290 MHz) or 7.655 MHz for high-side injection (with image at 8.110 MHz).

Both image frequencies are fairly close to the desired frequency in the previous example. By the time you move the operating frequency up to 10 meters or above, the image response may be just as strong as that to the desired signal. For this reason, many receivers use a higher *if*. If a high *if* is used for image control, and then converted to a lower *if* for its advantages, the receiver is known as a "double conversion" receiver. Incidentally, any receiver used with an outboard converter (as for VHF operation) is double conversion, since the outboard converter effectively becomes the receiver's front end.

If the *if* is properly chosen, the image situation can be used to advantage. For instance, to receive signals on either 40 or 80 meters, an *if* of 1750 kHz can be chosen. This puts the images 3.5 MHz away from the desired response, and if the oscillator frequency is selected to give high-side injection on 80 and low-side on 40, then one response will cover 3.5 to 4.0 MHz while the other response gets 7.0 to 7.5 MHz. No bandswitch is necessary!

Similar reasoning led to the choice of 9 MHz as the "standard" frequency for SSB sideband generation. Use of a 5-MHz conversion oscillator permitted output on either 80 or 20 meters without a bandswitch, by using "image" response techniques.

The local oscillator is important to the superhet for a number of reasons. Its frequency stability, for example, determines the stability of the entire receiver, because if the local oscillator drifts the *if* produced by a stable signal will drift out of the *if*-strip passband. It must also be relatively low in noise modulation, since any modulation present on it will appear in the output together with that of the desired signal.

The mixer must convert frequencies properly, but in the HF range its characteristics are not particularly important. At VHF, mixers must have low noise if full receiver sensitivity is to be used. At any frequency, they must be overload-resistant to avoid interference, but most common circuits resist overload to an acceptable extent.

The *rf* stages may be omitted in inexpensive receivers; in this case their key function is taken over by the mixer's tuned input circuit. This function is to select the desired frequency and reject as much as possible of the image response.

If *rf* stages are present, they add selectivity so far as images and interference by cross-modulation and mixer overload are concerned, but they have little effect upon adjacent-signal selectivity. That occurs in the *if* strip.

One major effect of the *rf* stages is to determine receiver sensitivity. Sensitivity is not the same as gain; sensitivity measures the weakest signal which can be received while gain measures the amount of amplification available through the receiver. A high-gain receiver without an *rf* stage and with a noisy mixer can easily fill the room with amplified noise, but it won't get many weak signals. A unit having lower gain, but with adequate *rf* amplification to overcome any mixer noise, may appear to be dead—until you tune across a "down in the mud" signal and copy it clearly.

Because of the difference between sensitivity and gain, simply counting the number of *rf* stages isn't much of a guide. A single, good *rf* stage is better than three which contribute little but noise.

If a receiver will show an increase in noise when an antenna is connected to it, its sensitivity is probably already at the usable limit. If no change can be detected, though, addition of another *rf* stage may prove profitable in increasing (and thus improving) sensitivity. This may be done by adding a preselector, outboard. A "preselector" is nothing but an outboard *rf* stage (or stages).

Note that *sensitivity* can be affected only by the *rf* stages; gain, on the other hand, can be increased in the *if* strip, or even after the audio is recovered from the signal. If no *rf* stage is present, it may be possible to modify the mixer's operation to improve sensitivity—but addition of a preselector is a far better solution.

What Does The if Strip Do? The front end selects any desired signal frequency within its operating range and converts it to a single fixed intermediate frequency. The *if* strip, then, accepts this intermediate frequency signal and amplifies it to a level suitable for the detector circuits. At the same time, unwanted signals at adjacent frequencies are rejected.

The *if* strip thus serves two purposes of equal importance. It provides gain for the selected signal—not to be confused with sensitivity—and also provides the major part of the receiver's selectivity.

Fig. 3 shows the arrangement of a typical 2-stage *if* strip. Any specific receiver may have more or less stages of *if* than this; the minimum is a single transformer, which provides only selectivity and no gain, while the maximum normally encountered is three.

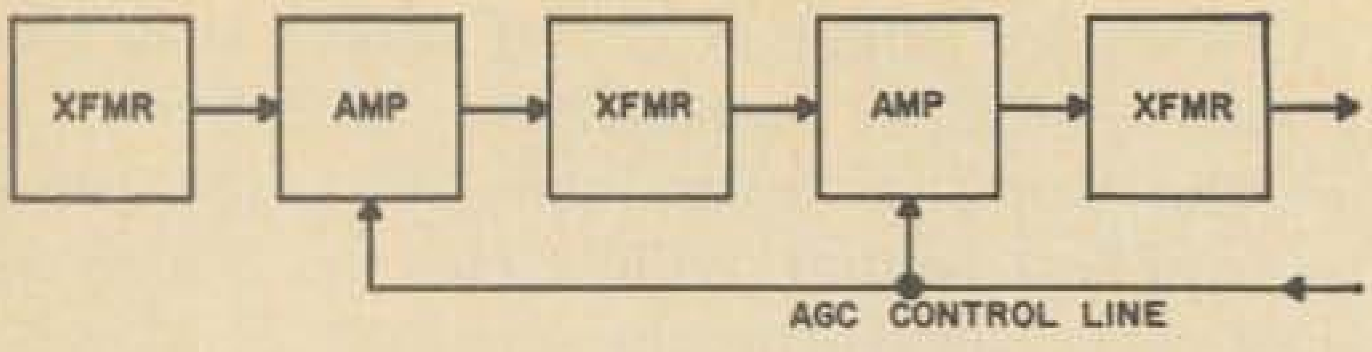

Fig. 3. Block diagram of two stage if strip (typical).

The amplifier blocks in **Fig. 3** may be occupied by tubes, transistors, or any other active device (such as field-effect transistors, etc.) which can provide gain. In general, the amplifiers provide the gain while the transformers provide the selectivity.

Normally, most receivers incorporate automatic gain control for AM signals at least. This is a feedback action which employs a dc voltage developed in the detector circuit to control the gain of the *if* strip, and frequently the gain of the *rf* stages as well. The result is that the receiver operates at maximum gain with weak signals (which develop little AGC voltage), and gain is automatically reduced by stronger signals.

AGC circuits are many and varied; we'll look at the means by which the AGC voltage is developed a little later, and that's where most of the variety occurs. In the *if* strip, the AGC acts only to reduce amplifier gain.

With tube-type circuits this is most often accomplished by use of "variable-mu" tubes. A variable-mu tube's grid is built with a graded grid-wire spacing. Some of the grid wires are close together while others are farther apart from each other. This permits a wider range of gain-control bias voltage to be applied, since the close-spaced parts of the grid reach cutoff with low bias values but a large bias voltage is necessary to cut off the widely spaced portions. Where a "sharp cutoff" tube may go from full conduction to full cutoff with a 10-volt swing of grid voltage, a "variable-mu" (sometimes called "remote cutoff") tube may require a 50-volt or greater swing. The variable-mu tube also acts as a linear amplifier over a greater range of control voltages. Thus, this tube acts as an electronically controlled gain controller.

Although **Fig. 3** shows the AGC voltage applied to both amplifiers, in many receivers only a portion (or even none at all) of the AGC voltage is applied to the final *if* amplifier stage. The purpose of this is to concentrate the control in the earlier stages and thus prevent any possible signal overload within the *if* strip. Having the final *if* tube operate at maximum gain at all times assures that even signals which are only moderate in strength will develop adequate control voltage in the AGC circuit.

When AGC is applied to the *rf* stages, it is often left off of the first *rf* or "antenna" stage (or only partially applied, through a voltage divider network). The reason for this is a bit different. For maximum sensitivity the first *rf* stage should always operate at maximum gain. Any reduction of gain in this stage reduces overall receiver sensitivity. Sometimes, though, partial application of AGC to the first stage is necessary in order to provide adequate control range.

While **Fig. 3** shows transformers as the coupling elements between input, amplifier stages, and output, a number of other devices may also be encountered. Transformers are, however, the most frequently used. They serve two purposes. The most obvious is that of coupling two stages together. The more important, though, from a performance standpoint, is to provide the major part of the receiver's selectivity. In fact, some designs have used cascaded transformers, with 2 to 4 transformers between each amplifier stage, in order to increase selectivity. The number and quality of transformers used is affected by many factors. If, for instance, an auxiliary filter is used, fewer transformers are required since the filter provides selectivity enough, alone.

Why Filter? In examining the previous question, we noted that the transformers in the *if* strip (**Fig. 3**) provide the major part of a receiver's selectivity. If this is the case, why should any receiver require a filter?

In the first place, a receiver actually *is* a filter of sorts if it selects only the desired signal from the mass of signals available to it.

And the transformers in an ordinary *if* strip permit some frequencies to pass while rejecting others, which is the function of any filter. This is accomplished by means of the selectivity inherent in any tuned circuit. Each transformer contains from 1 to 3 tuned circuits (depending upon the transformer design) and most contain 2.

The total number of tuned circuits in the *if* strip thus depends upon the number of transformers. But the *effect* of these tuned circuits increases exponentially. That is, if a single transformer has a certain amount of selectivity, adding another transformer to double the number of tuned circuits will roughly double the selectivity. Adding just one more transformer will approximately double it again, so that 3 transformers provide 4 times the selectivity of 1. This is the reason that receivers using several transformers between each *if* amplifier stage have been designed; the transformers improve selectivity, but the gain obtainable by adding more tubes just wasn't needed.

With any practical number of transformers. though, you eventually reach a limit of selectivity. And unfortunately, at the *if* frequencies most often used, this limit is still a bit broad for today's crowded spectrum—and impossible for SSB.

The selectivity provided by transformers depends upon the frequency-rejection characteristics of their tuned circuits. These, in turn, are composed of inductors and capacitors. It happens that inductors and capacitors can be combined in other types of circuits—and these circuits are of the kind generlly known as filters.

In the transformer, normally only two tuned circuits are involved, and each of these affects the operation of the other. Since the transformer also performs the function of coupling two stages together, the circuits are also affected by the characteristics of the stage supplying the signal and the loading of the stage to which the signal is supplied.

In the filter, however, the only function to be performed is that of frequency selection. The design of a filter circuit involves choice of inductor and capacitor values so that no one component has unwanted effects upon the total filter operation. Since the functions of frequency selection and of stage coupling are separated, the selectivity of a filter can be made much greater than that of a simple transformer.

However, when a filter is composed of only inductors and capacitors, a limit is still reached; to achieve still greater selectivity, *perfect* resistors and capacitors would be necessary, and these don't exist.

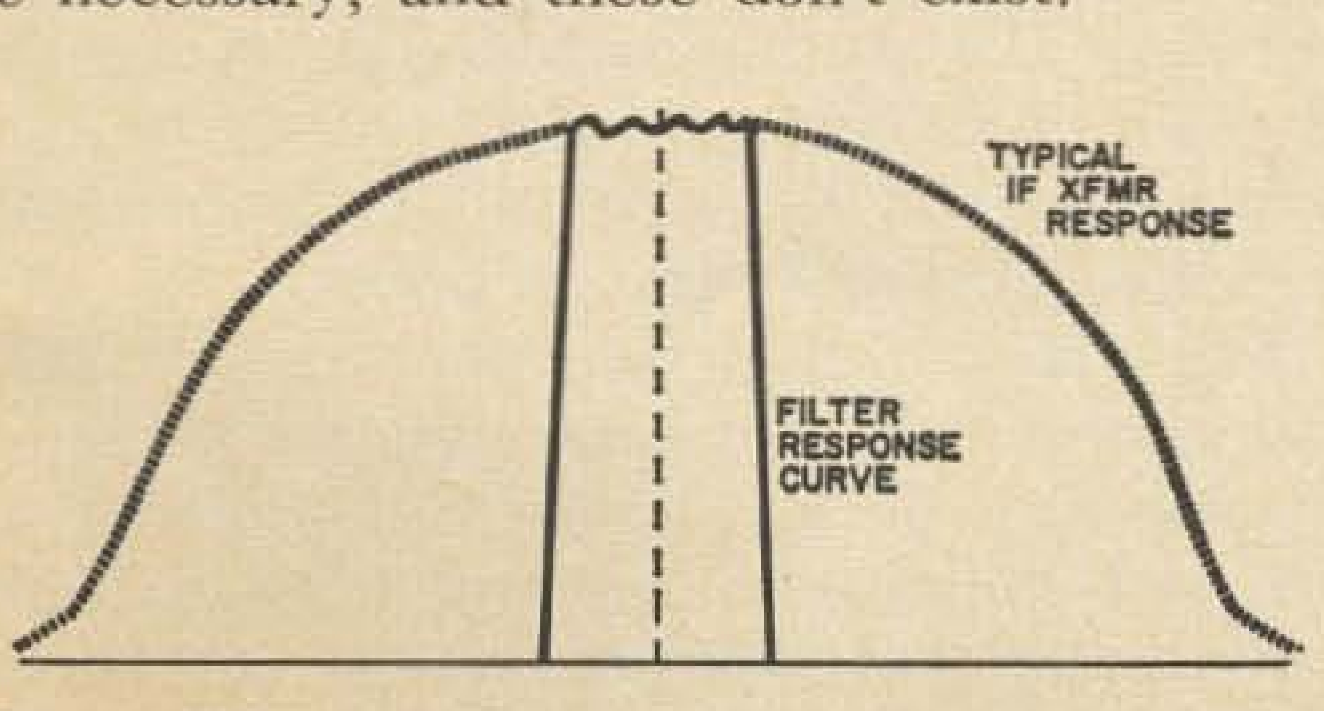

Fig. 4. Effect of filter on improving if selectivity.

This is the point at which crystal and "mechanical" filters enter the picture. Actually, all non-electrical filters which are used to provide selectivity are mechanical in their operation, but the term "mechanical filter" has come to mean a specific type of filter which depends upon characteristics of a machined rod.

A crystal filter achieves performance superior to that of an L-C filter for precisely the same reason that a crystal oscillator is more stable than a VFO—its characteristics can be more precisely controlled.

A quartz crystal, if ground to some rather critical dimensions and in the proper shape, is mechanically resonant at several specific frequencies, and is also mechaniclly "anti-resonant" at at least one other frequency which is usually very close to one of the resonant frequencies. At the resonant frequencies, any vibration applied to one side of the crystal can pass through almost unchecked. At the anti-resonant frequency, the crystal offers a very high impedance to any signal transfer through it. This characteristic is similar to the series and parallel resonances of a tuned circuit, but since it is mechanical rather than electrical in origin the effect is much more pronounced—in radio terms, the Q is much higher.

A single quartz crystal can serve as a filter for any of its resonant frequencies if electrodes are held in contact with its surface so that the vibration can be induced electrically and can in turn reconvert the signal to electrical form. Such a filter has been a key part of CW receivers for many years, but its selectivity is far too great for most phone use. A good single-crystal filter can have a passband as narrow as 50 cycles at the half-power points, and only a few hundred cycles wide at the skirts of the response curve.

Today's crystal filters used in SSB generators and selectable sideband receivers, though, use several crystals and match the resonant frequencies of some with the anti-resonant frequenceis of others to produce selectivity curves which are like that shown in **Fig. 4.** The passband (top) is essentially fiat, so that the desired signal all comes through, while the rejection cuts in almost instantly at the edge of the passband to provide extreme rejection of all except the desired signal.

By contrast, the typical transformer response is many times as wide at the skirt (base) of the response curve as it is at the top.

The performance of any filter is measured by its "shape factor". Shape factor is the ratio of the bandwidth which the filter will pass at two specified power levels. Unless both power levels are specified, the shape factor has no meaning. General usage appears to be that the 6-db and 60-db passband widths are compared, but some authorities prefer the 3-db points for the upper level.

What this means is simply that the bandwidth a filter will pass depends upon how much rejection you require. If you consider *any* rejection enough, then even a 10% drop in signal level would be "rejection" of the signal. This, though, would permit an unwanted signal which was only 10% stronger than the desired signal to come through with the same strength.

The "passband" we usually think of at the top of a filter's curve is that from the 6-db points. These are the two points, one at either either side of the filter's center frequency, at which power transfer through the filter has dropped to ¼ of its maximum level. A 3-db reduction in power is the smallest we can detect by ear; a 6-db reduction amounts to cutting the signal voltage in half.

However, a 6-db rejection of a signal which is producing twice as much signal voltage as our desired signal will only make the undesired signal the same strength as the one we want. This shows that, in order to accomplish effective "rejection" of undesired signals, we must have much more than 6 db rejection.

We must, in fact, have whatever rejection it takes to *first* cut the undesired signal down to the same level as the desired one, and *then* push that undesired signal on down to a level however far we like *below* the desired one

In practice, a thousand-to-one ratio is usually considered good enough. That is, an undesired signal is effectively rejected if it can be reduced to one-one-thousandth the level of the desired one. And it's seldom that an undesired signal will be more than 1000 times as strong as the signal we want in the first place.

If the undesired signal *is* 1000 times as strong as the one we want, and we want to cut it down to 1/1000 the strength of our desired signal, then the total reduction we must make in its strength is one million times. That's 1000 times to get it down to the same level, and another 1000 times to get it only a thousandth as strong as that level.

In terms of decibels, that's 60 db of power loss. While in many cases far less than 60 db of rejection is necessary, this represents a severe case which is still quite possible to meet in practice, and so the general usuage calls for use of the 60-db point as the wider passband in calculation of shape factor.

A typical shape factor for a receiver without a filter (except for its transformers) might be 50. This would mean that the 60-db bandwith is 50 times as wide as the 6-db figure. If "bandwidth" is quoted as 10 kHz at 6 db, then a band 500 kHz wide would have less than 60 db rejection. The 60-db rejection would not be present within this much larger passband; you would naturally consider such selectivity poor since strong signals several hundred kHz away from the weak one you're trying to get would appear stronger than the weak one.

Extremely good filters, however, such as the mechanical types, may have shape factors as good as 1.8. If the 6-db passband of such a filter is 10 kHz, then the passband at the 60-db rejection points would be only 18 kHz. This means that an interferring signal would have to be within 18 kHz of the desired signal in order to escape the full rejection. While the 6-db passbands in both cases were the same, the effect in operation is quite different. This is why filter effectiveness is measured by "shape factor". Most good filters have a shape factor smaller than 3; no device can have a shape factor smaller than 1, and even 1 itself is impossible in practice.

How Does The Detector Section Work? The purpose of the entire receiver up to the detector section is merely to select a single signal out of all that are floating round and amplify it up to usuable strength for the detector. The detector itself does the major job, of converting *rf* to audio energy.

As we've already seen, in simple receivers only the detector section is present.

The detector itself operates upon a mixing principle. A product detector requires signals from a beat-frequency oscillator to mix with the *if* strip's output, while a diode detector for AM uses the carrier portion of the incoming signal to mix with the sidebands. We've already examined this process in other parts of this series. What we'll examine now, then, are the *other* functions accomplished in this part of a typical superhet.

We've already met AGC in the *if* strip and learned that a control voltage determines the gain of the amplifiers. This control voltage is developed in the detector section.

Communications receivers must frequently operate in the presence of strong impluse "noise" such as that produced by automobile ignition systems. This noise can be eliminated or at least greatly reduced, and this action too is done in the detector section.

Let's look at AGC first. And to keep things simple, let's restrict the operation to AM with a diode detector. After we see how the system works, then we'll examine AGC and SSB/CW.

When we're receiving AM, the incoming signal has a carrier which was essentially of constant strength when it left the transmitter. Fading and other transmission effects may cause its strength to change en route to the receiver, but we know that it was originally constant over a period of several tenths of a second.

In the process of mixing the carrier and its sidebands to recover the audio information, the detector produces a dc voltage which is proportional to the strength of the carrier. We can pass this dc voltage (which has the audio superimposed upon it) through a low-pass filter to eliminate the audio, and we have a voltage which indicates the signal strength.

We *could* apply this voltage directly to the *if* and *rf* amplifiers as AGC control voltage, and some receiver designs do. The disadvantage of this approach is that *any* signal will then cut back the gain of the amplifier stages, even if the signal is almost unreadably weak.

To avoid this disadvantage, most designs used "delayed" AGC. The delay is not in time, but in voltage; until the voltage produced by the detector is greater than some "threshold" level, no AGC control voltage is applied and the amplifier stages run wide open. After a signal is strong enough to produce a detector voltage above the threshold point, AGC is applied to reduce gain.

If you recall the exploration of "feedback" we made a couple of installments back, you may recognize our old friend feedback at work again here. An AGC system is, in effect, an amplifier with negative feedback put into it in such a manner that the *gain* of the amplifier is reduced by strong signals, but signal voltages themselves are kept out of the feedback path.

Notice that the only function of the dc voltage coming out of the AM detector is to give us a feedback signal which is proportional to the actual *rf* signal strength. If we can get such a feedback signal from any other source, the AM detector isn't necessary. When we're receiving CW or SSB, neither of which uses the AM detector, we obtain the feedback signal by taking a part of the audio itself and rectivying it. After rectifying it, we filter off the remaining audio hash, and presto! we have our desired AGC control signal.

When receiving SSB, or CW, we add a few extras to the system. For instance, if signal strength increases suddenly we want the AGC system to react rapidly. This happens at the beginning of each "dit" or "dah" during CW reception, or with each syllable when listening to SSB.

When no signal is coming in, we want gain to be maximum. However we don't want the gain to go up rapidly between "dits" or "dahs" in CW, or between syllables in SSB, because if it did we would be listening to a signal apparently buried in noise. The noise would be the normal background, but the receiver would have much more gain then than when signals were present.

For this reason, we want the gain to decrease rapidly when a signal appears, but to increase relatively slowly when the signal goes away. This will hold down background mud while preventing unpleasant "thumps" and bangs".

AGC systems for use with CW and SSB include this "fast attack slow decay" chracteristic as a part of their design. It is normally switched out when AM operation is chosen. **Fig. 5** shows one way of achieving this kind of action.

What about noise limiting?

Like AGC, noise limiters operate with a control signal which is usually derived from the source as the AGC control signal. This signal indicates average level at any instant.

Any modulation or audio on the signal is in the form of variations above and below the average level, but these are limited in

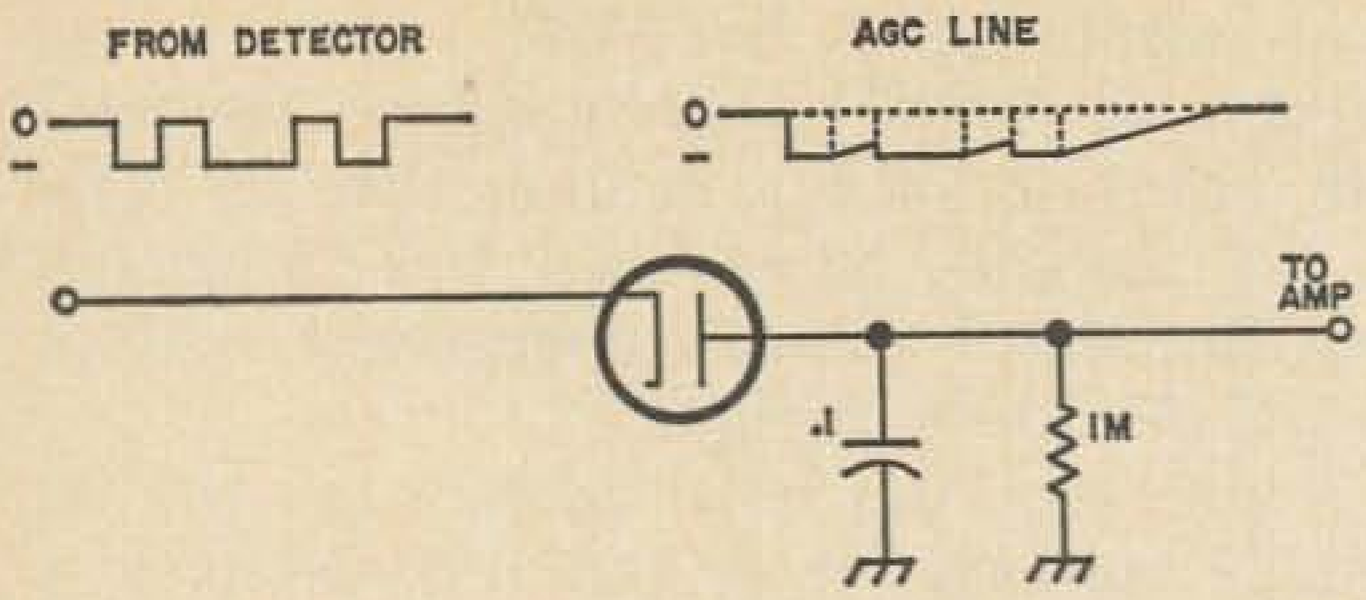

Fig. 5. Diode in series with AGC line provides fast-attack slow-decay action for use with SSB and CW signals. Waveforms produced by CW character "R" illustrate the action. When detector voltage goes negative at start of each code element, capacitor voltage follows almost instantly. When detector voltage goes positive, diode cuts off and only discharge path for capacitor is the high-value resistor shunting it. This permits AGC control voltage to rise toward ground level, but much more slowly. Receiver gain is restored eventually, but not before next code element arrives. In pauses between words or sentences, however, full gain is available.

the amount of variation by the percentage of modulation on the original signal, and in the speed of their variation by the upper-frequency limit imposed on the audio before transmission.

Impulse noise, on the other hand, is unaffected by either of these limits. It may be—and usually is—much stronger than the signal, and may swing much more rapidly. Since it does differ from the modulation on our desired signal in both these key characteristics, either characteristic may be used to distinguish between signal modulation and impluse noise in order to reject the noise and pass only the desired modulation.

If amplitude is the characteristic chosen to operate the rejection circuit, the resulting circuit may be called a "clipper" or a "limiter". If the speed of variation is the characteristic chosen to distinguish, the circuit may be called a "silencer". These labels are not strict, however. For example, the "rate of change" limiter circuit originally popularized in these pages some 7 years ago operates, as its name implies, upon the rate of change in signal, yet was termed a limiter. The Lamb noise silencer, similarly, operates upon amplitude of the signal yet is called a silencer.

Amplitude-limiting circuits, or clippers, operate by setting an arbitrary limit for audio output and restricting *all* audio to that limit or less. An impulse noise pulse is permitted to reach the limit, but not to exceed it. The limit is derived from the dc voltage, which in turn is derived from signal strength, so that the limit always bears a fixed relationship to the average signal strength. Normally, the limit is set at two times average signal strength. That is, the audio is permitted to rise to a level twice as great as the zero-audio carrier-only voltage. This permits reception of 100-percent modulated signals without distortion, but cuts off noise pulses at the 100-percent-modulation level.

This approach works primarily because noise pulses are so brief compared to the desired audio signals, and cannot mask the desired audio unless they are many times stronger—which, in fact, they normally are. By simply cutting the noise back to the same level as the signal, the signal is given a fighting chance.

Rate-of-change devices operate differently. The control voltage in a rate-of-change device is derived from the audio signal rather than from the carrier, and is filtered through a resistor-capacitor network which permits the control voltage to follow the audio signal level at frequencies below about 3 kHz or so. This is unlike the filtering for clippers or for AGC, where no audio is permitted to remain on the control-voltage line.

The audio is applied to one side of a switching diode and the control voltage

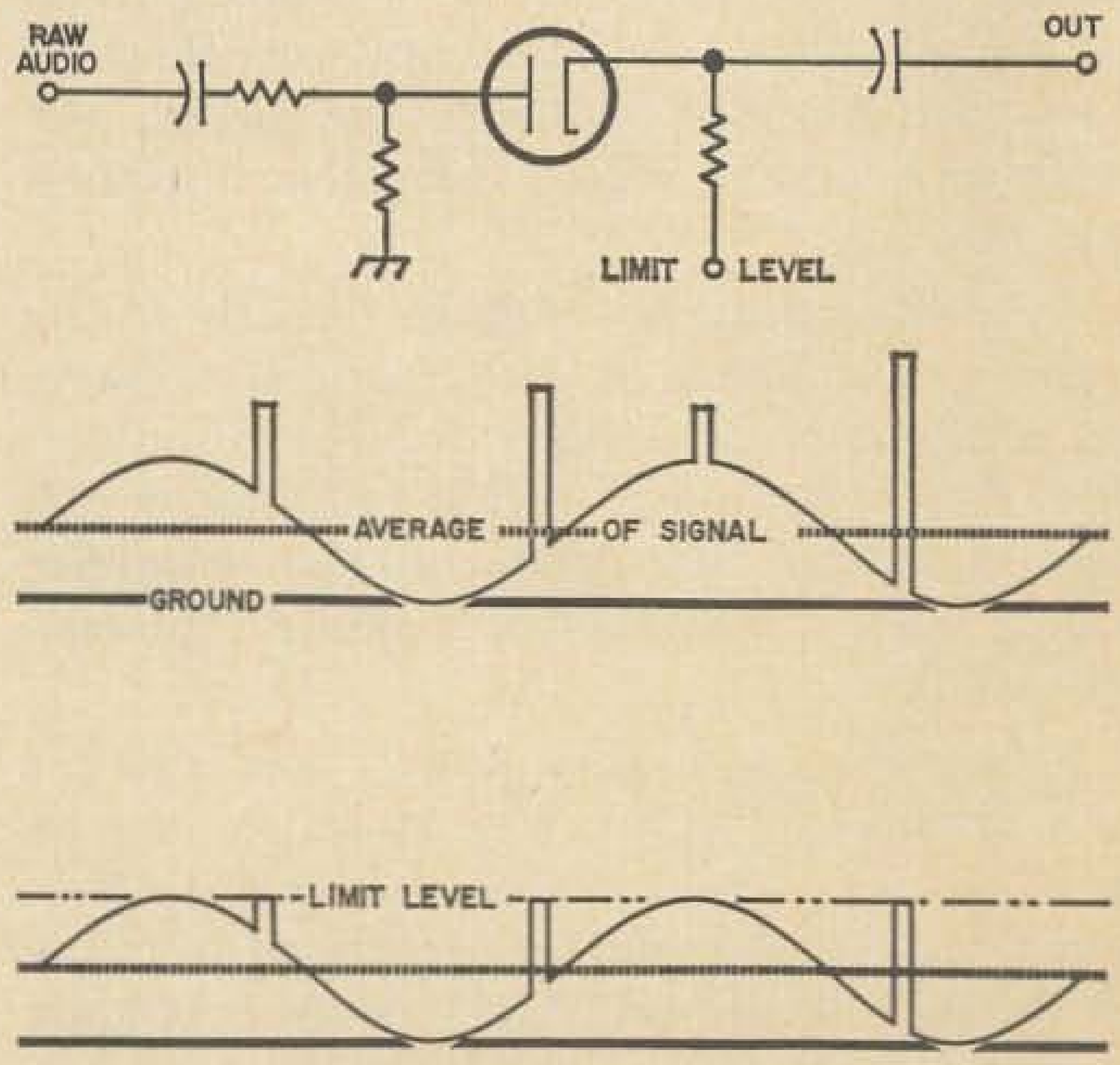

Fig. 6. Clipping type limiter uses diode as switching clamp to prevent signal voltage from rising above limit level. No action is taken upon noise pulses which fail to reach limit level. While "stumps" of noise pulses remain, their effect is far less than that of the original pulses.

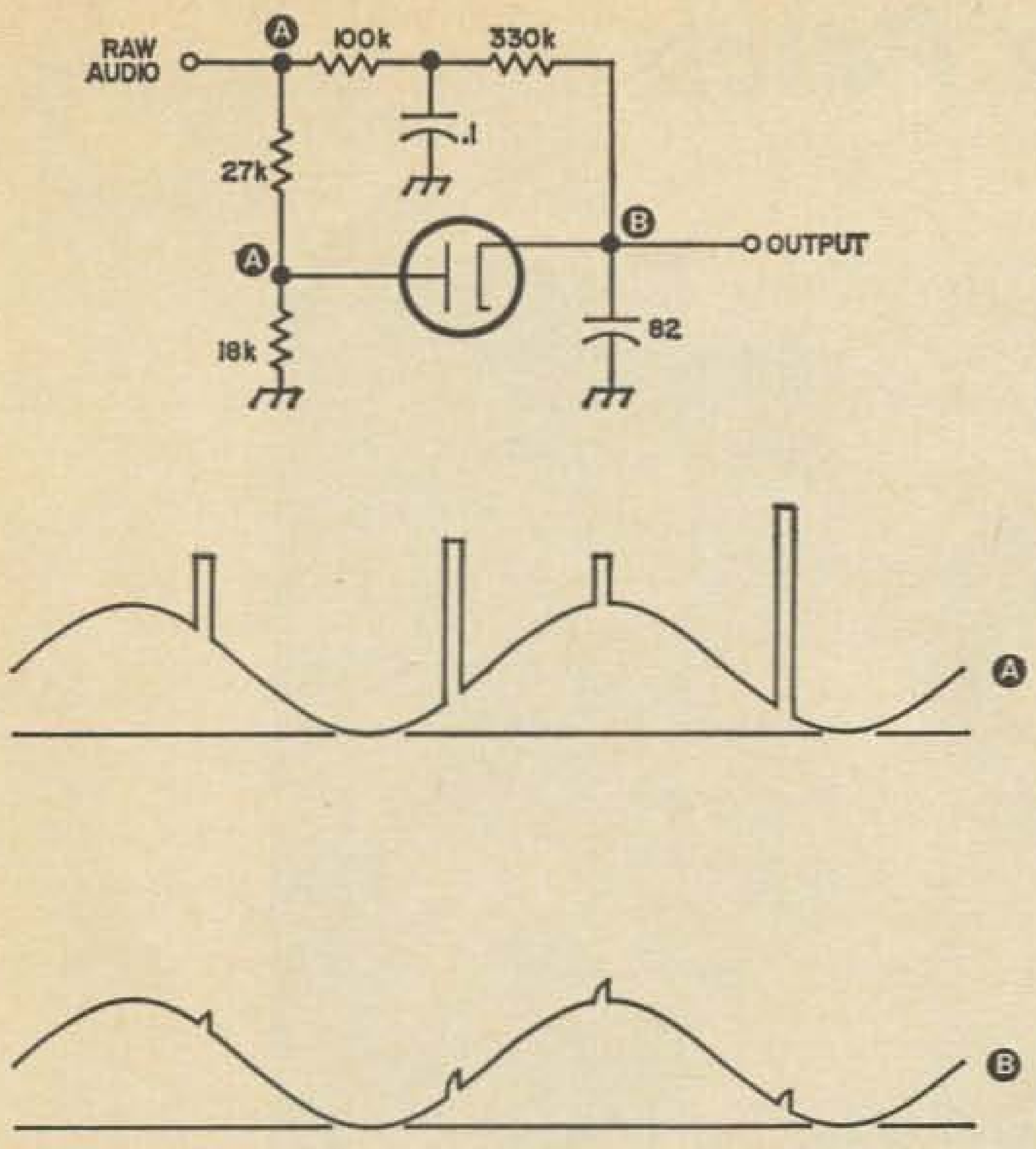

Fig. 7. Rate-of-change type of limiter uses diode switch to open audio path whenever noise pulse is present. Stumps as well as peaks of noise pulses are removed. Major difference in operation from Fig. 7 is characteristic of control-voltage filter, see text.

to the other side. Polarity of the diode and relative strengths of audio and control voltage are chosen so that the diode normally conducts, permitting the audio to go straight through it. That is, the audio voltage is normally slightly less than the control voltage level and the diode is connected in such a way that under this condition it is conducting.

When a rapid-rise noise pulse arrives, the audio voltage goes up sharply but the filtered control voltage cannot, because the filter limits its frequency response to about 3 kHz. The diode is then reverse-biased and turns "off", blocking the path from input to output of the circuit. Audio output is maintained at the same level by the control voltage filter for the duration of the pulse. When the pulse disappears, The control voltage level is again higher than the audio level and the diode turns "on" again. This action effectively punches the noise pulse *out* of the signal.

Figs. 6 and 7 show how these circuits operate. **Fig. 6** shows a typical half-wave clipper circuit together with the waveforms at appropriate points in the circuit. A full-wave clipper consists of two such circuits back to back so that both sides of the incoming signal are clipped; in many detector circuits the second clipper is unnecessary since the detector diode itself is an effective half-wave clipper in one direction.

Fig. 7 shows a typical rate-of-change limiter circuit together with its key waveforms. The same input signal is assumed for both **Fig. 6 and Fig. 7**, so that the outputs may be directly compared.

Next Time Around. This marks the halfway point in this series. Next month we'll return to the subject of "transmitters" and continue our examination of them. ■

John W. Gore Memorial Scholarship

The FOUNDATION FOR AMATEUR RADIO, INC., with headquarters in Washington, D.C. announces the sixth John W. Gore Memorial Scholarship for either graduate or under-graduate study. The Scholarship for 1968-1969 consists of a $500.00 award. It may be re-applied for in succeeding years.

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Scholarship applications should be mailed not later than August 31, 1968, and should be addressed to:

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P.O. Box #5902
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Philip L. Writer W6TRU
5226 Vickie Dr.
San Diego, Calif. 92109

Again and again you have heard: it's cheaper to buy it ready made, or as a kit . . . "This statement has been applied to just about anything you find around the average ham shack these days; however, I feel the phone patch described herein is an exception to that rule.

This phone patch uses a standard telephone pickup of the type found as a common accessory for use with a tape recorder. The price for these items will vary from sixty cents to three dollars, depending where you buy it (I paid ninety-nine cents for mine). The pickup is a high impedance magnetic device which is connected to the phone by a vacuum cup. This allows the output from the telephone to be entered into the mike jack of the transmitter. The pickup is left permanently connected in parallel with the station microphone.

The next problem is to get the output of the receiver into the phone. This was accomplished by placing a 2" speaker (the kind used on most small transistor portables) near the telephone's mike. At first various methods of mounting were tried i.e. clips, plastic holders etc. In all cases the idea was to place the speaker near, but not touching the mouth-piece. It was thought that this would be needed to allow the station operator to talk as well as the person on the phone. After trying various methods it was found that no air gap was needed. The speaker cone is very thin and is almost transparent to sound. In other words, you simply place the speaker flat on the telephone and then talk through the speaker.

Two methods of mounting have been tried (they both work well): The first method is to use a small piece of tape to permanently mount the speaker in place. This method works fine if the phone isn't used by the XYL (some how they just can't go along with progress . . .) The second, and simplest, is to simply hold the thing in place with your fingers while holding the phone. Since the speaker is in direct contact with the telephone mouth piece, there is very little noise generated by this technique.

Cost? Well here is a complete bill of materials:

Telephone pickup	$0.99
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This bill of materials does not include two short pieces of wire, however as I said before, I paid ninety-nine cents for an item I later saw for sixty cents. . . . W6TRU

When hams discuss 'OPTIMUM SPACING' in single band beams . . .

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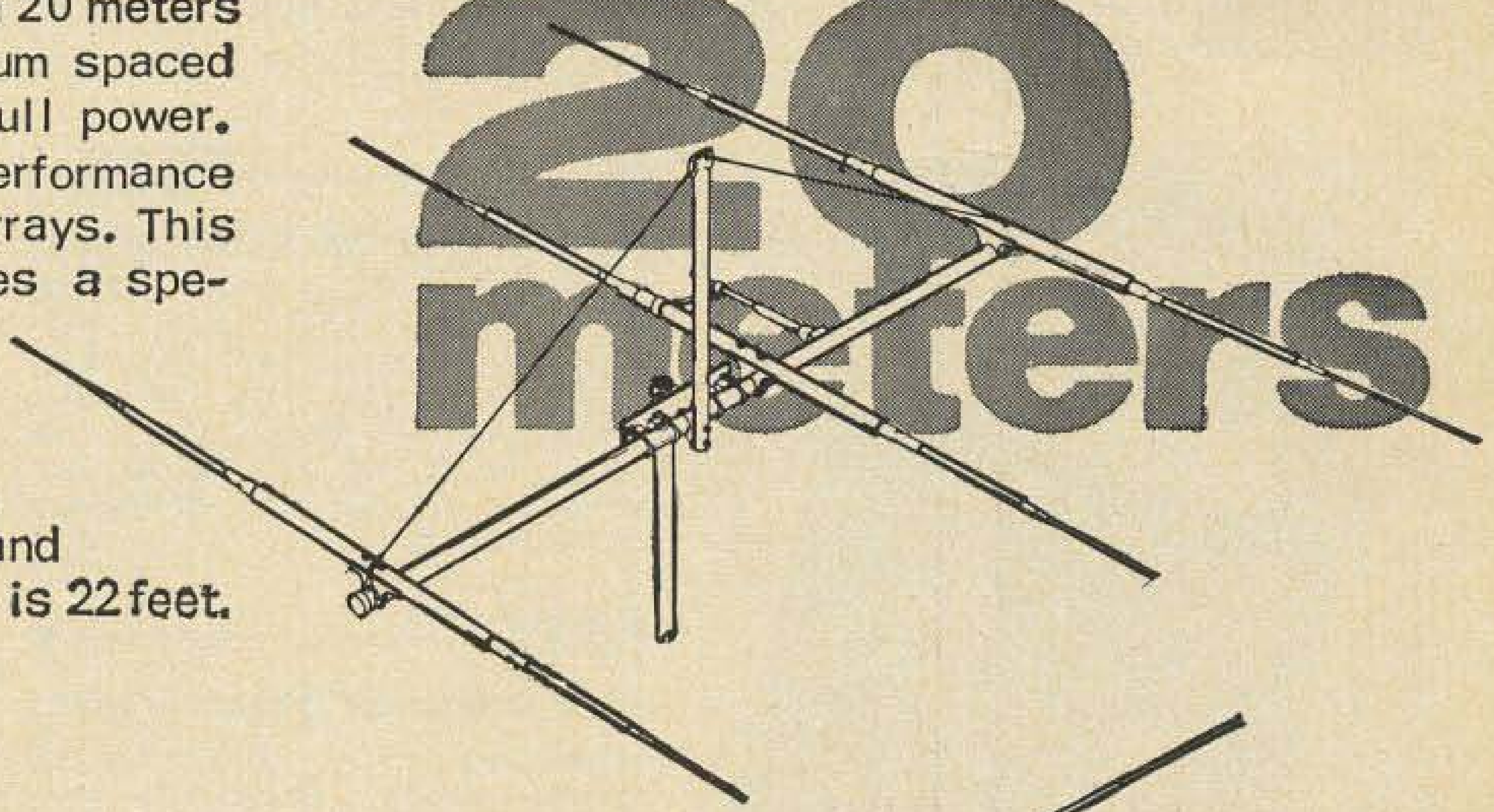

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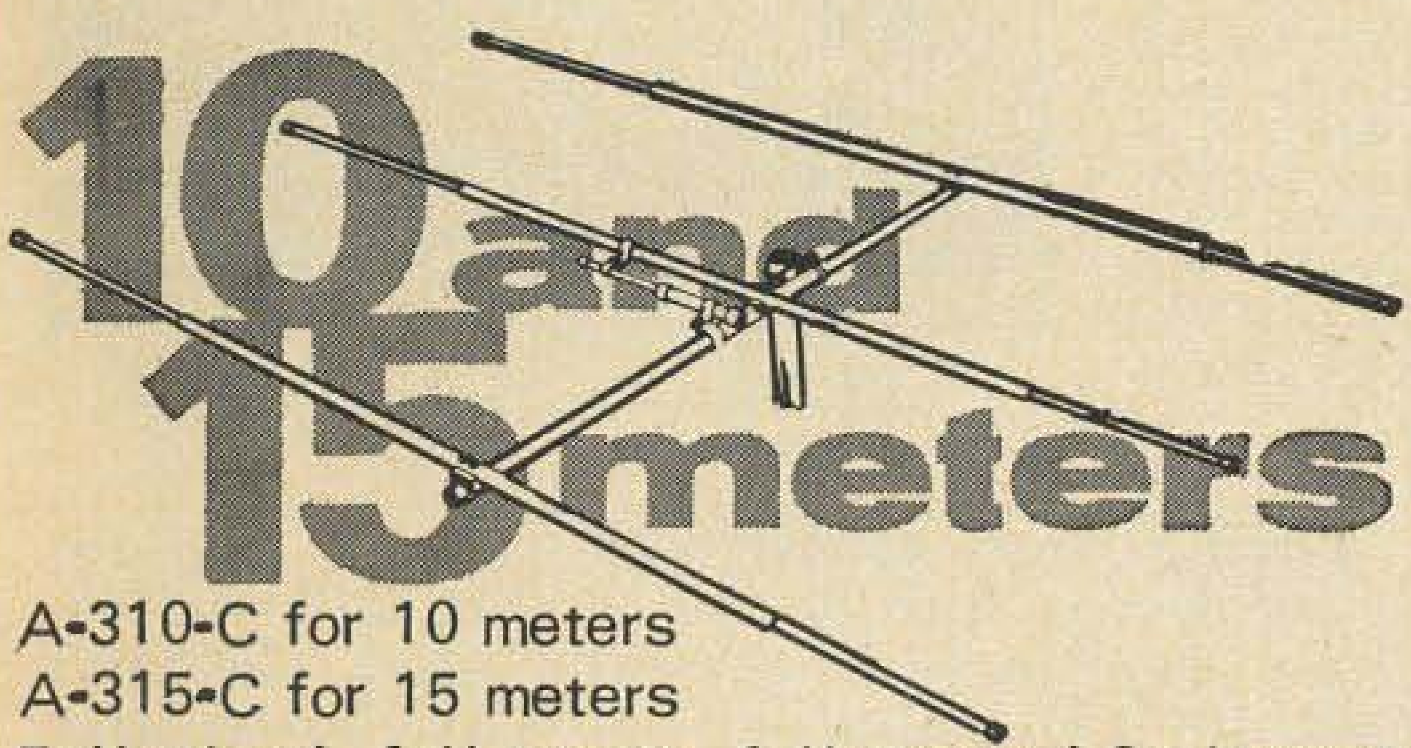

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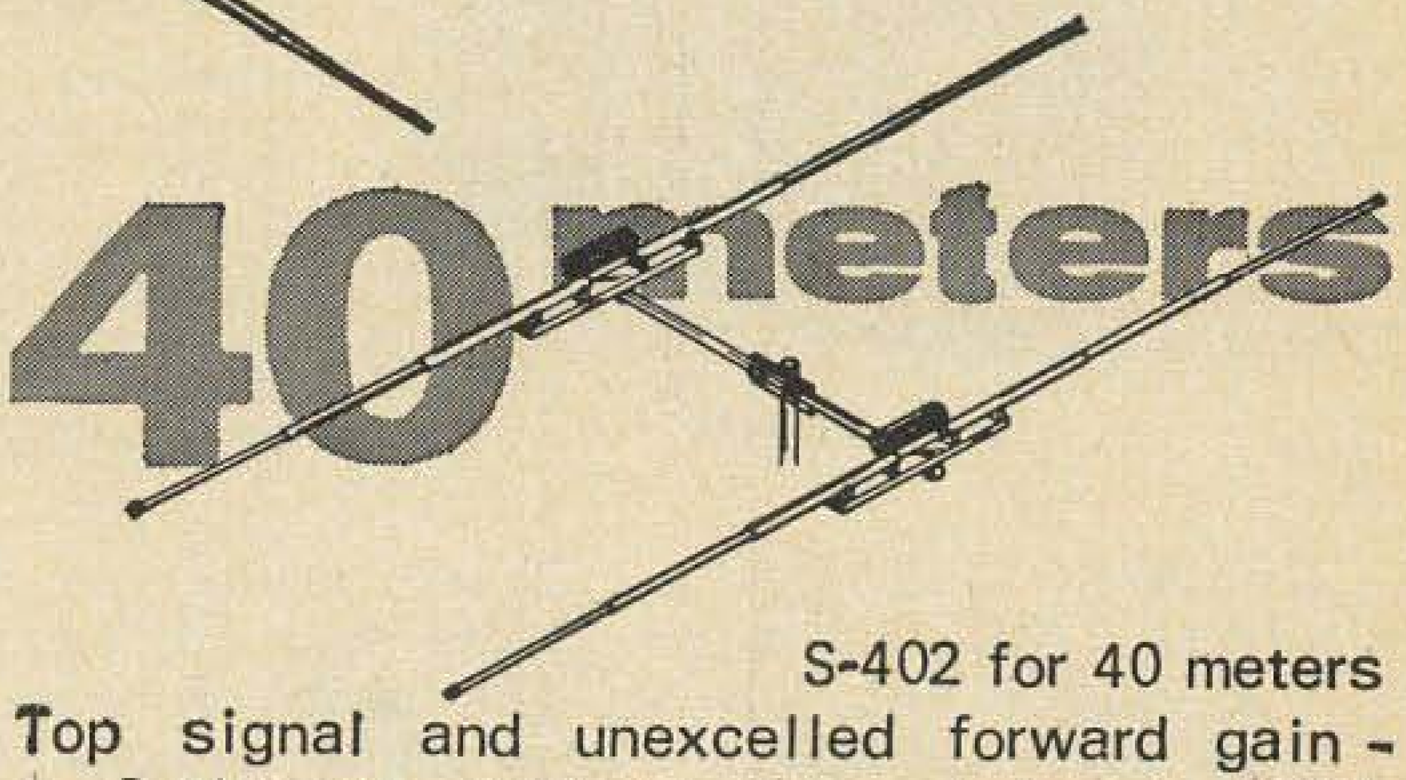

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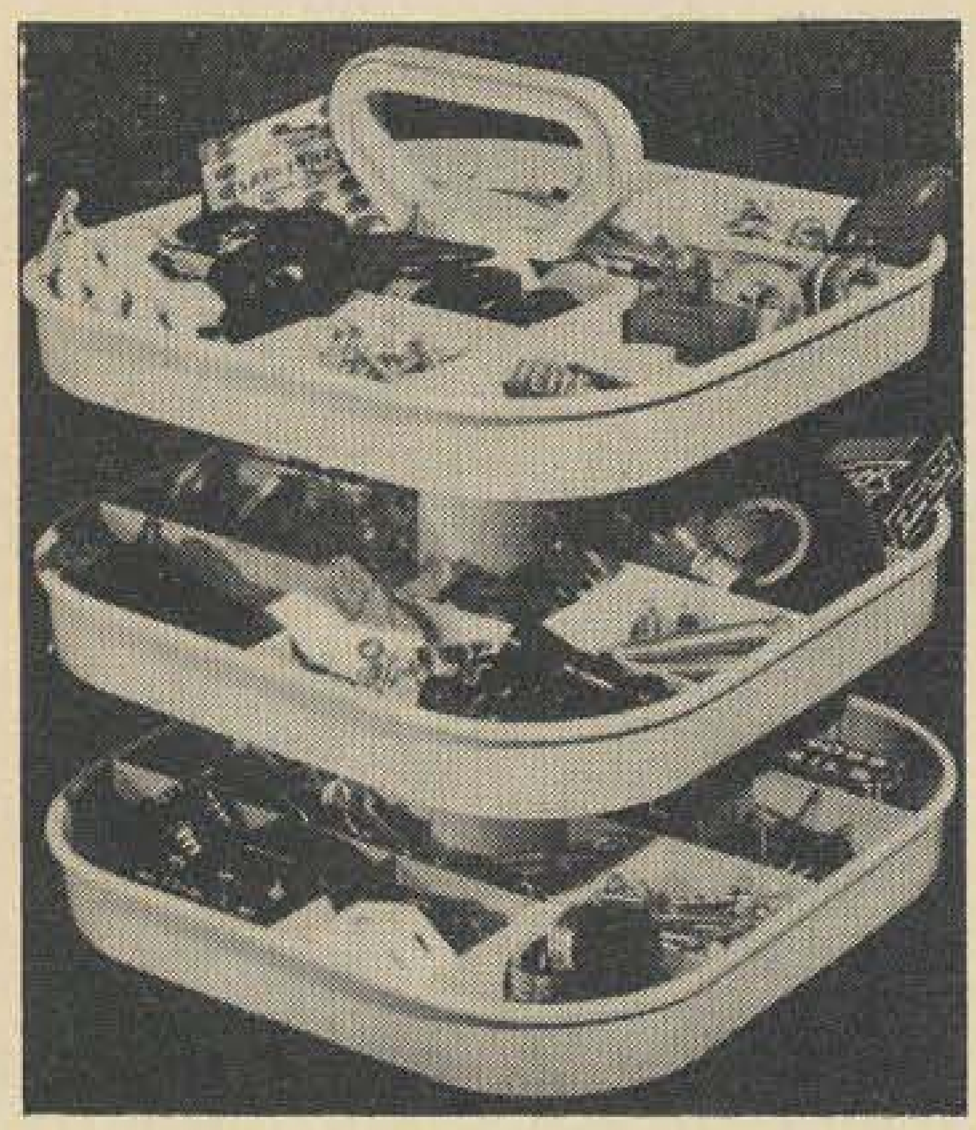

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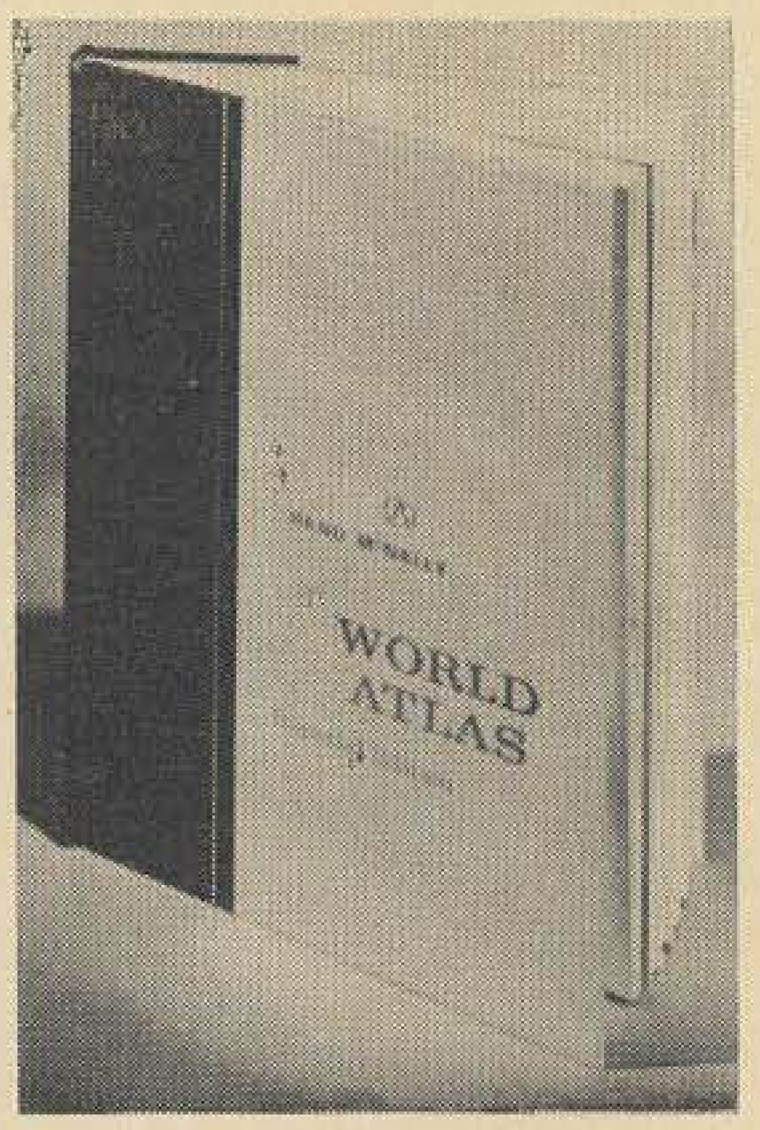

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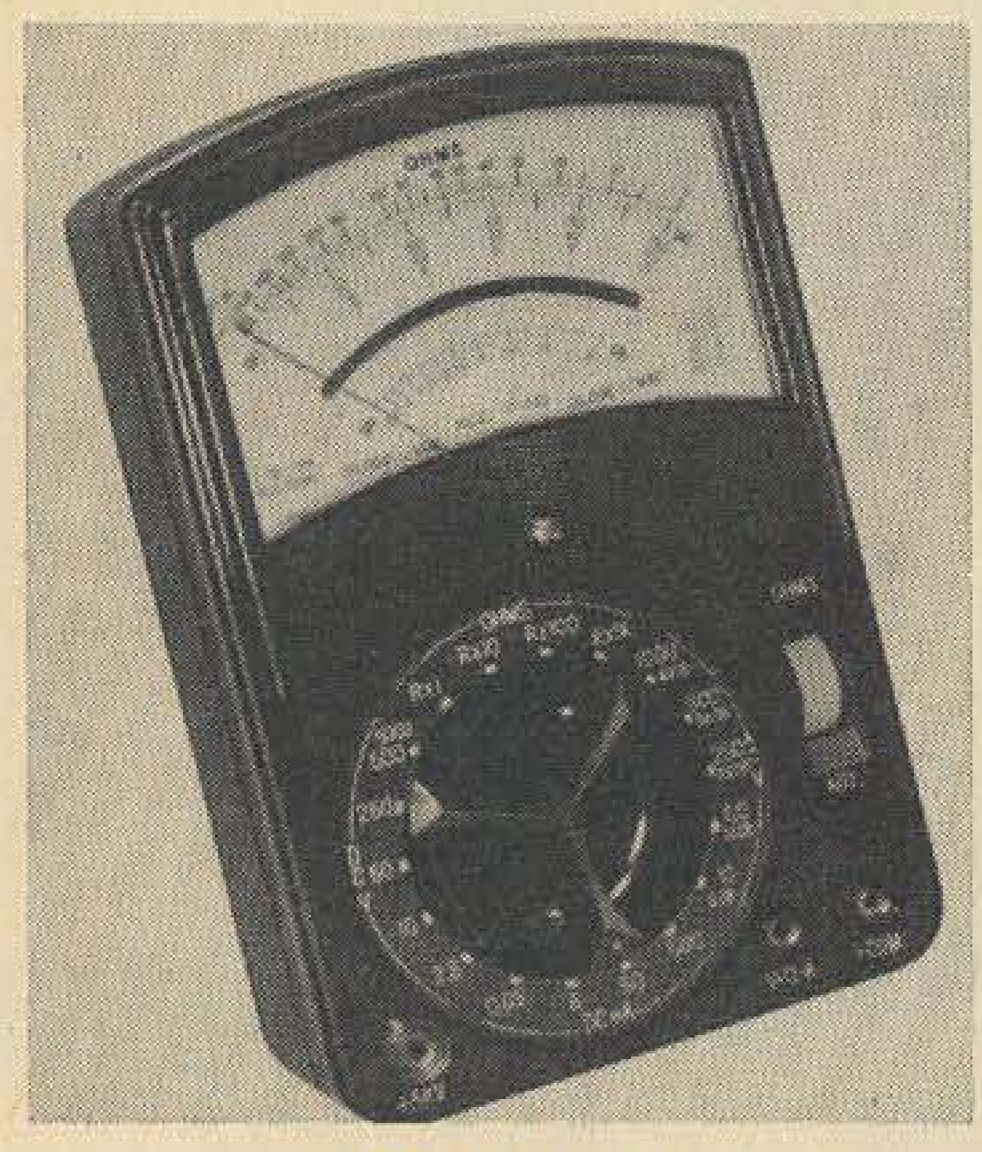
HOW COME? We added up the cost of soliciting new subscribers through the mail: mailing lists, brochures (paper, artwork, typesetting, printing, folding, delivery), envelopes (plus printing and shipping) for the brochures, return envelopes, putting brochures together, addressing, bundling by zip, plus postage. Multiply that by ten to account for the one in ten response and add the return postage. We decided to put all that money into premiums and give them to readers that sell new subscriptions to their friends and fellow club members. It seemed worth a try.



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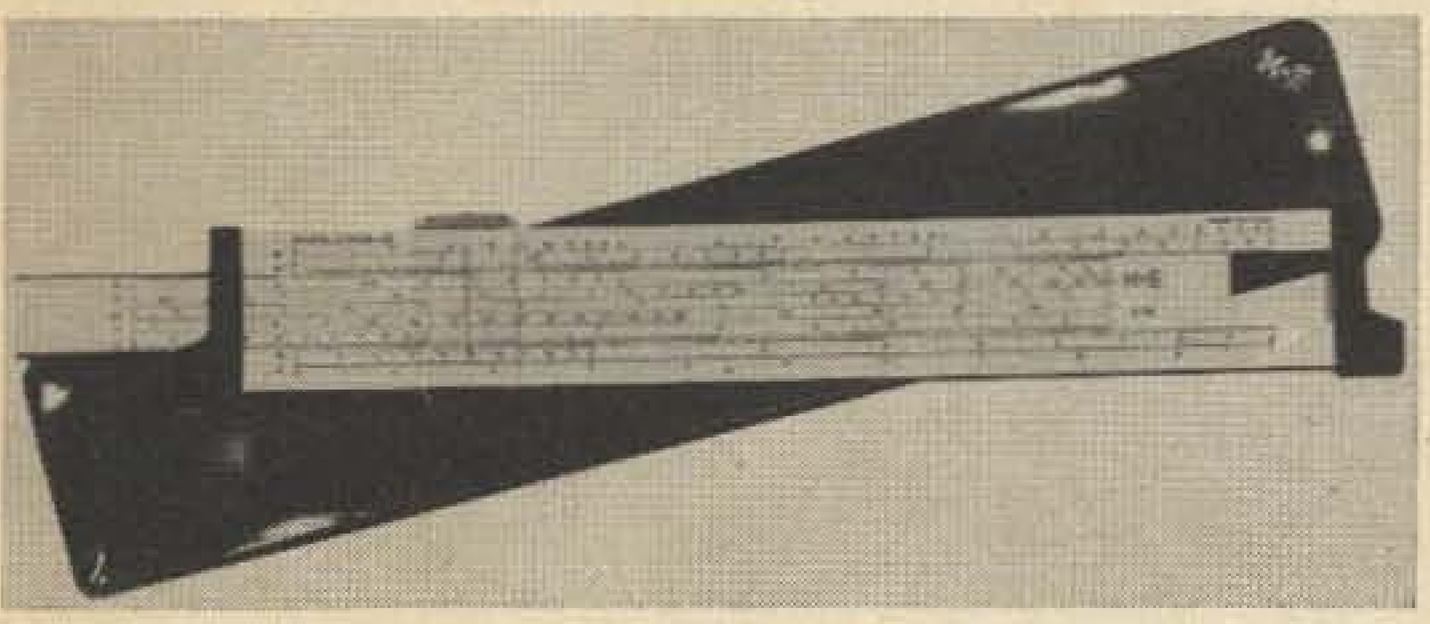

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73 MAGAZINE **PETERBOROUGH, N.H. 03458**

Trapping Strong Signals

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Box 1
La Canada, Calif. 91011

Comments on the receiving problems that arise from a strong nearby transmitter, were made in *73 Magazine* for December, 1967. Tests have been made with a series-resonant trap placed across the receiving antenna lead, as shown on page 90 of the May, 1967, issue. This trap offered a means of reducing further the deleterious, pernicious, baneful and detrimental interference from a nearby ham's transmissions, especially on bands where front-end filters, described on page 14 of *QST* for August, 1967, are not available.

The specific problem was to reduce the signal from a nearby station operating on about 14311 kHz so that the first rf stage would not become blocked on other bands, even though the grid return had been removed from the agc line and drained through an rf choke to the muting voltage. An rf attenuator did not show any promise because of the disappearance of the desired signal. Turning down the separate gain control of the rf stage was not sufficient for much the same reason. Diodes placed across the rf stage grid coil happened to have a high capacity which did not permit realigning the receiver with the trimmers alone, although other diodes used singly or in series have not yet been ruled out.

The following measurements show that a 14,310 kHz series-resonant circuit consisting of a 50 $\mu\mu$F variable capacitor and about a 3 μH coil, placed across the antenna input to the receiver, can bring about some improvement without seriously reducing desired signals removed more than 100 kHz in frequency:

Frequency	db change in SN/N ratio
7.0 kHz	0
14.0	3 gain
14.1	1 loss
14.2	8 loss
14.3	22 loss
14.35	25 loss
14.4	19 loss
21.0	0
28.0	0

The gain in receiver sensitivity at one frequency has been reported in the May, 1967 issue, and is presumed to result from an improvement in matching caused by the reactance of the series-tuned circuit placed across the coaxial line.

It will be seen that there can be some improvement in the 14 MHz DX Phone and CW bands, and considerable on other bands, when the series-resonant trap is tuned to the frequency of the nearby 14.3 MHz station. More than one trap can be used.

. . . K6KA

The Plan AHe$_{ad}$ Antenna

A don't do it yourself project

Richard Mollentine WAØKKC
19 Edgemore Court
Olathe, Kansas 66061

Obviously, from the photo, this is not the usual antenna article complete with dimensions, SWR readings, etc. An "April Fool" type structure, it is in reality a cut down eleven meter three element beam now resonating at six meters.

Originally I was happy with the three elements, however, like all things in life, we are trying to improve our lot. Because the mast was too small in diameter, the three element beam kept slipping. After trying C clamps, vice grips, shims, etc. I finally ran a bolt through the boom and mast, which eliminated the slipping, but made it impossible to move the forward or backward.

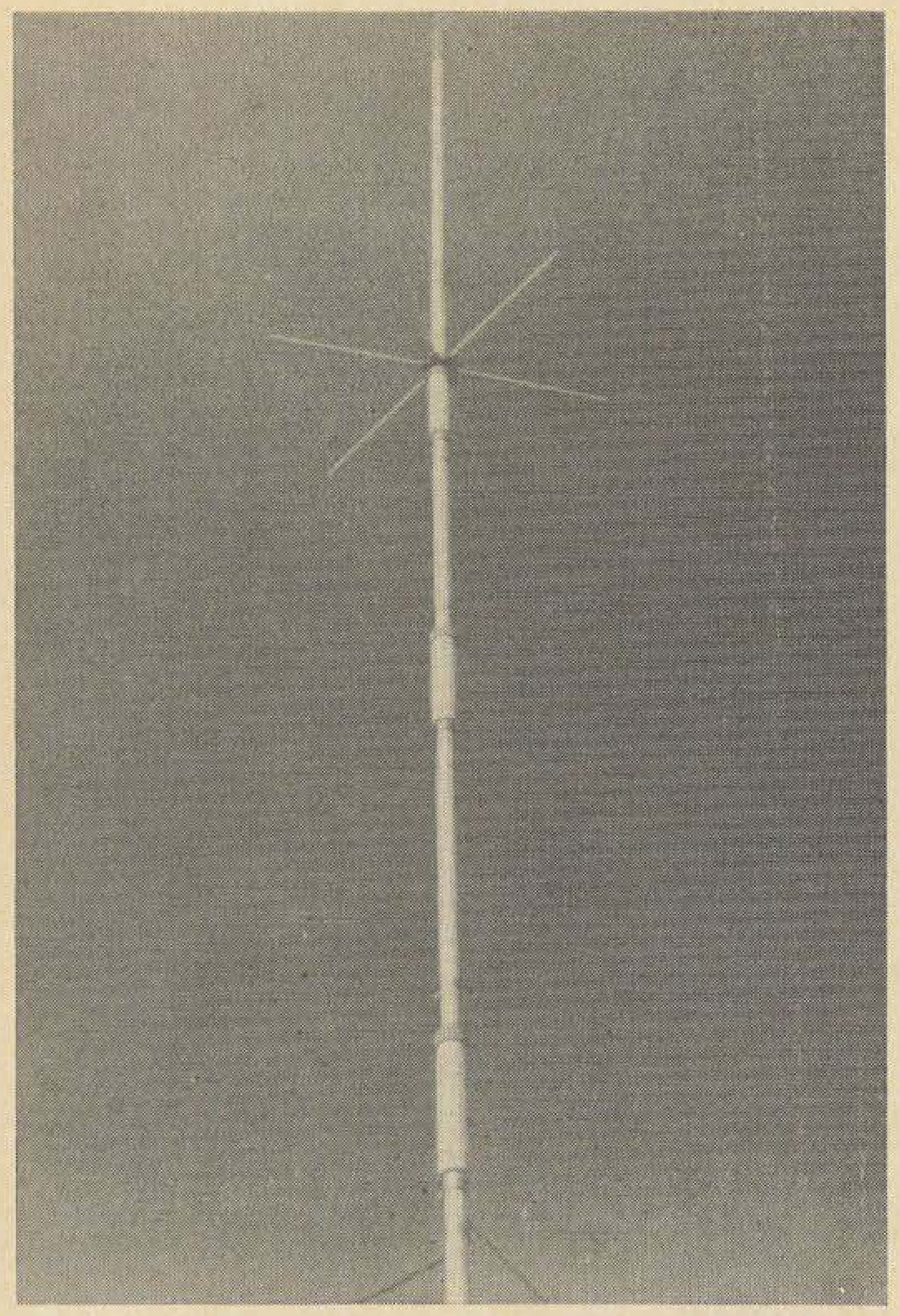
Looking up and surveying the puny three element array, I thought why not add one more element. After all, another element, another db gain. The antenna is only twelve feet above the roof, so it was a relatively easy matter to add additional elements just by standing on a ladder. So . . . one at a time, I added "just one millimeter more" and eventually wound up with this grossly off center monstrosity.

Nylon guys help to support the sag. I considered adding a weight at the reflector end to help counter balance the dead weight, but apparently the AR 22R Rotor which powers it is able to take the side thrust with no trouble.

So, although my antenna has the usual good forward gain, low SWR, and turns freely (even in the wind), this is an excellent example of the now quite familiar "PLAN AHEAD" sign. Anyway, how does one go about taking it down? Besides, with just one more element I could get an additional gain of —?

. . . WAØKKC

The Hustler 4-BTV Fixed Station Trap Vertical Antenna



Peter A. Lovelock W6AJZ,
235 *Montana Avenue*
Santa Monica, California 90403

I had been listening to glowing reports on the Hustler 4-BTV trap vertical antenna for almost a year before I decided to try one. A couple of previous experiences with trap verticals had left me somewhat hard to convince. Didn't they radiate equally badly in all directions, have bandwidths restricted to either the CW *or* phone bands, or change resonance in accordance with the relative humidity? However my California cliff dwelling precluded a beam, and horizontal dipoles fifteen feet above a metal flashed roof do not have the greatest vertical radiation angle.

Thumbing through the New-Tronics flyer, I was impressed by two claims. The 4-BTV was ruggedly constructed and would cover *all* of the 10, 15, 20 and 40 meter bands with no more than 1.6:1 SWR. There was even the option of 75 meter operation with a Hustler mobile loading coil added to the top of the 4-BTV. This permits 100 kHz bandwidth with no shorting of the loading coil to operate the four higher bands. The RM-75-S will take a full 2KW PEP while the lower cost RM-75 is good for most moderate powered transceivers, like mine.

Unpacking my new investment revealed the real truth in claims for the mechanical construction. The knocked down 4-BTV comprises four sections of heavy duty structural aluminum tubing, three thoroughly weather tight traps, a capacitive top hat assembly and a very heavy cadmium plated steel base for pipe mounting. The clamps for assembling the traps to the mast sections are fabricated from stainless steel. All parts are deburred and free from the hazardous edges that might interrupt assembly operations with an interlude for first aid.

Assembling the 4-BTV in accordance with the New-Tronics step-by-step instructions took all of twenty minutes. Three alternative methods for mounting the antenna are recommended: (a) at ground level with ground rods; (b) at ground level with radials and (c) roof mounted on a five foot pipe mast with radials. The last method is considered the best and was the one I used.

Radials are not supplied and the basic four band antenna requires approximately 145 feet of wire to provide two radials for each band. If the optional 75 meter top loading is used then 275 feet of radial wire is required. Any good quality antenna wire is suitable. A five foot TV mast section and a vent pipe clamp are also required for roof mounting.

Since the radials are attached to the mounting base with hardware supplied, it is easy to attach and detach the antenna without disturbing the radials, should you have to adjust for resonance at a desired frequency.

The sight of the 33 foot assembled 4-BTV with the RM-75 mounted on top gave me momentary qualms about attempting to hoist it into position unaided. Such fears were unfounded and I can attest that one average middle-ager can heft this lightweight onto it's mount single-handed, unless there happens to be a strong wind blowing.

Having carefully adjusted the section lengths and cut the radials according to instructions, I now anticipated a little pruning. But again I was wrong, the darn thing resonated just about in the middle of each band. Only for 75 meters was it necessary to loosen the clamp on the RM-75 and adjust the sliding top whip for exact resonance on my favorite frequency.

A SWR check on the completed antenna was highly gratifying. On the 10, 15, 20 and 40 meter bands, SWR at resonance was 1.5:1. At band edges maximum SWR was 1.25:1 compared to the 1.6:1 claimed. On 75 meters SWR at resonance was 1:31:1, while the bandwidth for an allowable SWR of 2:1 was a full 150 kHz rather than the 100 kHz advertised.

In operation, the performance of the 4-BTV surpassed my hopes and many satisfactory SSB and CW QSOs have been made all over the world using the moderate power of my Galavy V Mk 2 barefoot. During a recent CW contest WAC was made in the first 40 minutes. 40 meter DX has been excellent with S9 plus reports from the JA gang being commonplace. A slight drop-off in the shortest skip signal strengths on 75 meters, has been more than offset by the transcontinental contacts made possible by the lower angle of radiation compared to my previous dipole.

In these days of exaggerated superlatives it is a rare pleasure to find a product that outstrips its advertised claims. In my opinion those New-Tronics people are a conservative bunch, and the 4-BTV is a worthwhile investment for any ham who craves maximum performance under conditions of limited antenna space.

. . . W6AJZ

Specifications.

Length (basic 4-BTV)	21′ 5″
Impedance	Nominal 50 ohms
Power capability	full legal limit on SSB
Weight	15 lbs.
SWR at resonance (typical)	1.15:1
Bandwidth	1.6:1 at band edges 10 through 40 meters
Wind Loading	29 lbs. at 70 mph.

Propagation Chart

AUGUST 1968

ISSUED JUNE 1

J. H. Nelson

EASTERN UNITED STATES TO:

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

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

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

A. Next higher frequency may be useful at this hour.

B. Very difficult circuit at this hour.

Good: 1, 2, 8-13, 16, 17, 19-27

Fair: 3, 4, 6, 7, 14, 18, 28-31

Poor: 5, 14

Note: VHF forecasts have been discontinued due to lack of reliable information.

Robert A. MacArthur K9UYA
724 S. Granfield Ave.
Hensdale, Ill.

Transit Time—SO?

I read in a book that the velocity of an electron toward the plate of a tube is $5.9^7 \cdot 10^7\sqrt{E}$ at the plate, where E is the plate-cathode voltage. Call this $6 \cdot 10^7\sqrt{E}$.

I learned such radio as I know before there was any such thing as transit time, and while I recognize that the scientific people have gotten around the poor behavior of the good old tubes at high frequencies by such things as klystrons, magnetrons, travelling wave tubes and such exotica, these diodes appear to me to be neither fair to an old timer nor necessary to a full life in amateur radio. Except that electrons in tubes are out where you can see them move, these new-fangled affairs are as bad as transistors.

This is a good place to take a swipe at the Engineers and the Handbooks, *all* of them. The latter show elaborate means of biasing the transistor and then they proceed to show circuit after circuit with the biasing resistors omitted . . . and not one word about why. The writers of handbooks and encyclopedias seem to feel that everybody already knows anything *they* know, and therefore leave it out. Or maybe they don't know anything. Either way we end up buying them all with no notable increase in knowledge. Anyhow, this bias thing puzzled me so much that I took a short evening course in transistors. I learned two things. One is that conduction in transistors is in part by holes. Nonsense. Conduction is moving charges and moving charges are not holes. You will not count holes on an ammeter—ammeters count electrons, not the places where they were. I also learned that transistors are "current operated". I know of very few electrical devices other than the electrostatic electrometer which are *not* current operated, but I never heard of a current that wasn't produced by a voltage applied to something. The purists will set up a clamor "what about a generator? Electrons are pushed aside by the magnetic field and set up the voltage". Not so, if they believe their own books. I take no responsibility for it, but the basic equation for the generator is:

$$E = N\, d\emptyset/dt$$

where E is the voltage across N turns of wire cutting Ø lines of force in one second. So!

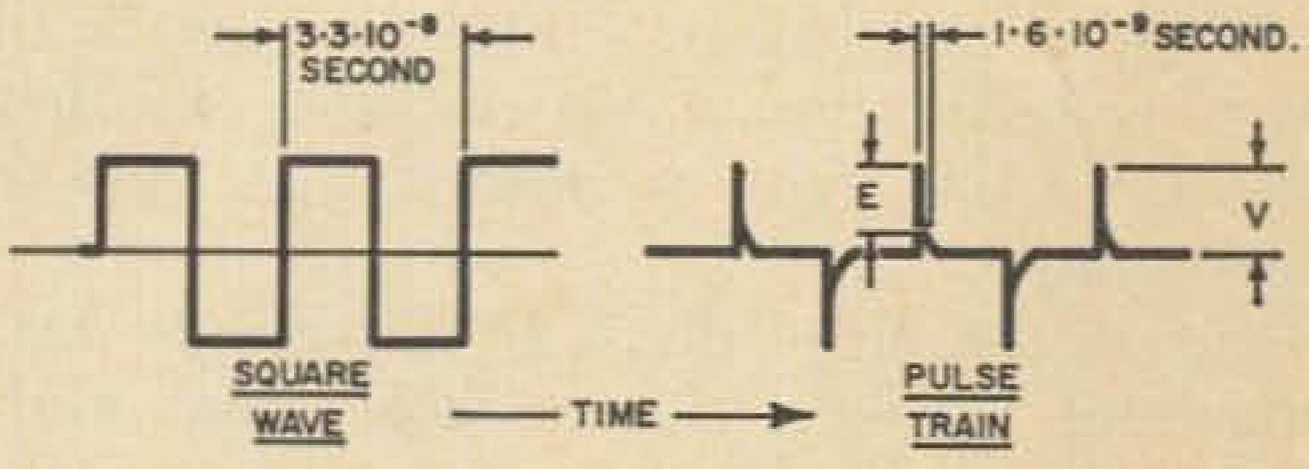


Fig. 1. Differentiate a square wave to make the pulses.

I didn't learn about the missing bias resistors. I figured that for myself. In no reference have I seen the clear statement that the resistance between the base and the emitter *is* a resistance and *is in parallel* with *any biasing resistor across the same elements.* I know very well that there are plenty of people who don't know this, so I will tell it here. If you want a bias of one volt on a transistor, don't put a 9000 ohm and a 1000 ohm resistor across 10 volts. Your 1000 ohm resistor is shunted by the base-emitter resistance of a few hundred ohms or less. Use a potentiometer and a milliameter in the emitter lead.

Getting back to the "current operated," if a class B2 tube is current operated, I'll swallow my words. I think the grid current is due to the positive grid voltage. I also think transistor base current is due to control element voltage. And I know that in both cases the current is something we would much much rather not put up with. How nice it would be if transistor input impedance were a megohm or so.

Now let's get technical. Although I can do a fair job of snarling up my bad neighbors TV with a wire hung on my grid dipper, I feel no harm is done by at least being able to provide more power at higher frequencies, what with UHF TV and all, if I can do it with my standard equipment.

I got the formula at the beginning of this paper from page 275 of Terman's "Radio Engineers' Handbook," McGraw-Hill, 1943. We'll engineer around transit time and we'll do it with any triodes you can lay your hand

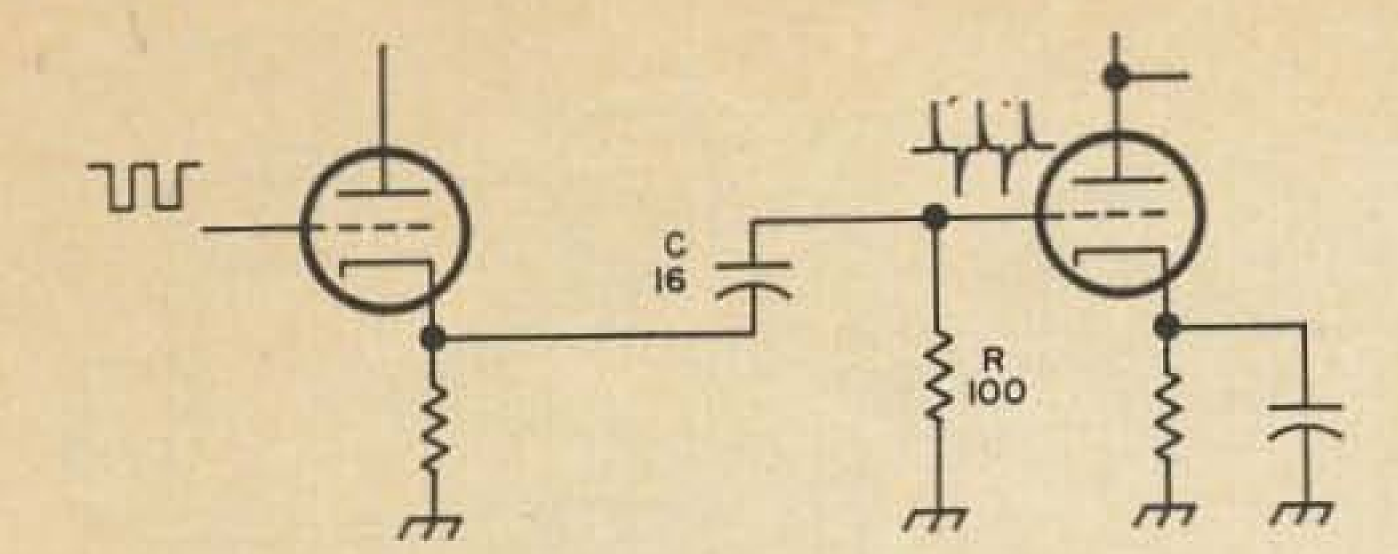


Fig. 2. Differentiator circuit.

on. From now on lets stick with Terman so that any objections you may have should be referred to him.

We're going to design a 300 MHz transmitter, and we'll use a duplex triode or two triodes as finals. Any power you want.

We first make a square wave. This is no problem at 30 MHz so we'll make it at that frequency using techniques that may be found almost anywhere in the literature. We will then differentiate the wave to provide the pulses, as shown in **Fig. 1.**

A suitable circuit is shown in **Fig. 2.** You will note that in this day and space age, 30 MHz is practically dc, so no problems.

With C and R 16 $\mu\mu f$ and 100 ohms, respectively, the width of the pulse to the standard 37% of maximum, as obtained from the formula:

$$V = E\,e^{-t/RC}$$

is conveniently 1/20 of one Hertz at MHz, or a time of about $.0016 \cdot 10^{-6}$ seconds or $1.6 \cdot 10^{-9}$ seconds. If we use only the positive going pulses, we are going to get our 300 MHz power. If we use a standard inversion process, we can flip the negative pulses over and get 600 MHz power.

We apply these pulses—let's take the positive only—to the grid of a power tube. We'll also apply 225 volts to the plate of the tube. (We choose 225 volts because the square root is easy. We could also use 900 volts or 1600 volts and so on until our tubes are putting out real power).

From the Terman formula, the speed component of the velocity of the electrons near the plate is:

$$6 \cdot 10^7\sqrt{225} = 90 \cdot 10^7 = 9 \cdot 10^8 \text{ cm/sec.}$$

They are, see above, $1.6 \cdot 10^{-9}$ seconds long. They extend in the tube a radial distance equal to speed multiplied by time:

$$vt = 1.6 \cdot 10^{-9} \times 9 \cdot 10^8 = \text{about } 1.5 \text{ cm.}$$

This little blob of electrons will be completely absorbed by the plate in $1.6 \cdot 10^{-9}$ seconds.

Now what to do? we have another grid and plate either in the same tube (necessary for kilomegacyle power) or in another tube. We feed *this* grid with the same pulse delayed by $1.6 \cdot 10^{-9}$ seconds.

The delay is conveniently provided by a section of transmission line, as shown in the circuit **Fig. 3.** For open line, the length required is the velocity of light multiplied by the time the pulse spends in the line:

$$1.6 \cdot 10^{-9} \times 3 \cdot 10^{10} = 48 \text{ cm, call it } 50 \text{ cm.}$$

We shorten insulated coax cable by the velocity factor.

Now we connect the two plates together by a length of line. This can conveniently be folded into a quarter wave line as shown in **Fig. 3,** but note that this line has a total length of one half wave. What is the magnitude of this half wave? One end was hit by a pulse of electrons $1.6 \cdot 10^{-9}$ seconds before the other end. This corresponds to a half wave length of $1.6 \cdot 10^{-9}$ seconds, or a wavelength time of $3.2 \cdot 10^{-9}$ seconds. This is:

$$3.2 \cdot 10^{-9} \times 3 \cdot 10^{10} = 100 \text{ cm} = 300 \text{ MHz.}$$

We have the 300 MHz, but what is it's nature? We have applied one Hertz of excitation to our transmission line tank. We have to determine what practical value this has. Because of the pulse frequency of 30 MHz, or 1/10 of the 300 MHz power frequency, this circuit is jogged once every 10 Hz.

The ringing time of a resonant circuit is defined as the time for the amplitude of oscillatory energy to decay 3 dB, and is found by the formula:

$$t = \frac{2\pi Q}{\omega} \text{ seconds}$$

A Q of 1000 is nothing for a good line tank, so ringing time of our tank is

$$\frac{2\,\pi \cdot 1000}{300 \cdot 2\,\pi : 10^6} = 3.3\ 10^{-6} \text{ seconds.}$$

This corresponds to

$$300\ 10^6 \cdot 3.3\ 10^{-6} = 1000 \text{ rf Hz.}$$

We note above, however that the tank is kicked every 10 Hz, well within the ringing time. Even with a (loaded) Q of 10, the signal is very nearly continuous wave. From all I read, I gather that the little bit of 30 MHz hum modulation can easily be filtered out.

It also follows that with a 1 MHz signal and a Q of 100, the decay includes 100 Hz and the tank is jogged about every 33 Hz. KMHz power is obviously practical. There is no reason why the tank cannot comprise a jumper across two pins of a duplex triode.

The bad thing about transit time at high frequencies is that the element that starts electrons moving changes its mind before they get where they are going. I would point out again that the cheapest of surplus tubes can be used in this system because the tubes are operating at only 30 MHz. The 300 or KMHz voltage on the plates, as far as 30 MHz is concerned, averages the dc plate voltage. We've all seen a dc voltmeter tremble when measuring a mixture of dc and 60 Hz ac—it still reads dc correctly.

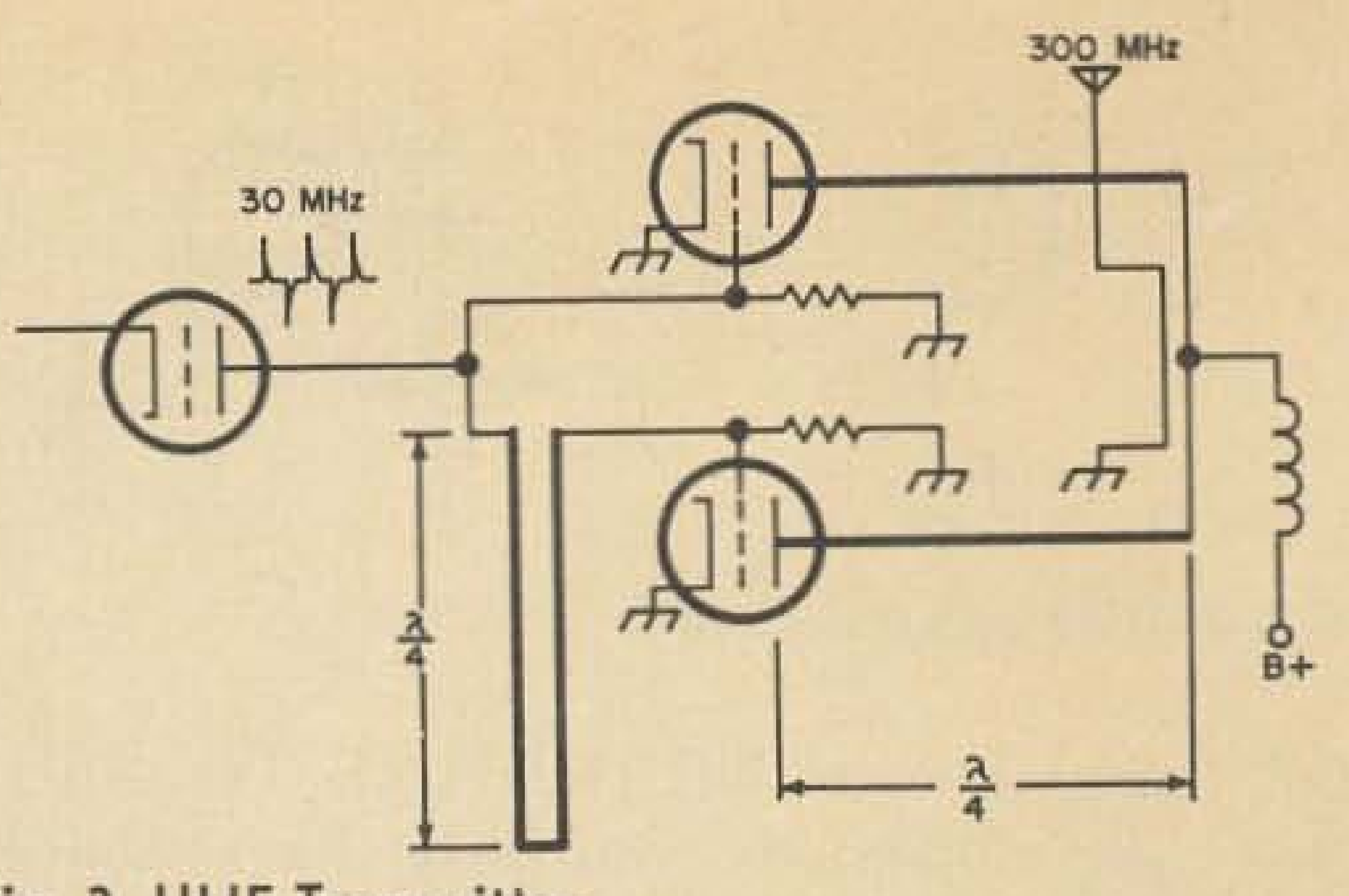


Fig. 3. UHF Transmitter.

Whose afraid of transit time?

. . . K9UYA

INDIANA QSO PARTY RULES

August 17-18, 1968

All radio amateurs are invited to participate in Indiana's QSO Party sponsored by the Indiana Radio Club Council, Inc., Certificate hunters will find this party an excellent time to work for the Hoosier "500" Award. For full particulars on HFA, SASE to Hewitt Mills, WA9LTI, IRCC Sec'y, 289 West Sumner Ave, Martinsville, Ind.

QSO Party Rules: 1) The Party will begin at 2300 GMT Saturday August 17 and end at 2300 GMT Sunday August 18, 1968. 2) The general call will be "CQ IND" with Indiana stations adding "from IND" to avoid confusing with other ninth call area stations. 3) All bands and modes may be used. Valid contacts are made between stations on the same band and mode. Same stations may be worked on different bands or mode for additional contacts only. 4) Exchanges must include contact number, call, Indiana county, state, province, or country. Indiana stations may add HFA points after county. 5) QSO Party scoring: Indiana stations multiply all contacts by number of different states, provinces, or countries worked. Others multiply the number of contacts by the different Indiana counties worked. 6) Awards: Plaque to highest scoring station within and outside of Indiana. Certificates to highest scoring station in each Indiana county, each state, province, or country. Multi-op stations are eligible for certificates only. Judges decisions final. 7) Submit logs showing date, time, contact number, calls, mode, band, county, state, province, or country, and point summary. Block print your call, mailing address including zip code, and operating address if different. Include signed statement that all rules have been observed. Send logs (no HFA, please) to Robert A. Lyles, K9HYV, 706 Spring St., Michigan City, Ind. 46360 on or before September 16, 1968. Please enclose SASE for copy of results. Good luck!

City of New Orleans Commemoration

In commemoration of the celebration of the 250th anniversary of the founding of the City of New Orleans in 1718 by Jean Baptiste Le Moyne, Sieur de Bienville, the Greater New Orleans Amateur Radio Club is offering a commemorative certificate. This certificate is available to any amateur radio operator who submits a log extract indicating two-way communication on any bands, in any mode, with three Metropolitan New Orleans Area amateurs during 1968.

In addition to the log extract, interested hams should send a large self-addressed stamped envelope to the Greater New Orleans Amateur Radio Club, 2935 International Trade Mart Tower, 2 Canal Street, New Orleans, La. 70130. The certificate for this award has been designed by John Chase, internationally known political and editorial cartoonist.

WCARS

The all day, every day net

More than 500 radio amateurs from all over the Western United States and Northern Mexico belong to a network called the West Coast Amateur Radio Service dedicated to maintaining one clear channel on the amateur bands—7255 kHz. Participants monitor this frequency so long as conditions permit during the daylight hours for the purpose of providing service to the public and other amateurs. Any amateur station requiring any kind of assistance can get help merely by calling in. The Service is a kind of giant intercom or party line throughout the West that is instantly available for communicating information and requesting assistance in any emergency.

WCARS participants with mobile equipment called in 60 unreported highway accidents in 1967 for relay by base stations to the proper authorities. Mobiles also reported many freeway hazards and motorists needing assistance. Other vital communications included those relating to blizzards in California, Arizona, and New Mexico; floods in Alaska, hurricanes in Mexico, fires, lost planes, boats, and people as well as medical information to such widespread spots as Thailand and Peru. Aside from the urgent incidents, hundreds of routine communications are handled or arranged. For example, Navy and other ships in the Pacific call in regularly to arrange phone patches to their families back home.

The California Highway Patrol is a member of the Net with three patrol owned amateur transceivers with CHP amateur operators available to maintain liaison during extended emergencies. 3952 kHz has been designated as an alternate frequency when required for night time operation. ■

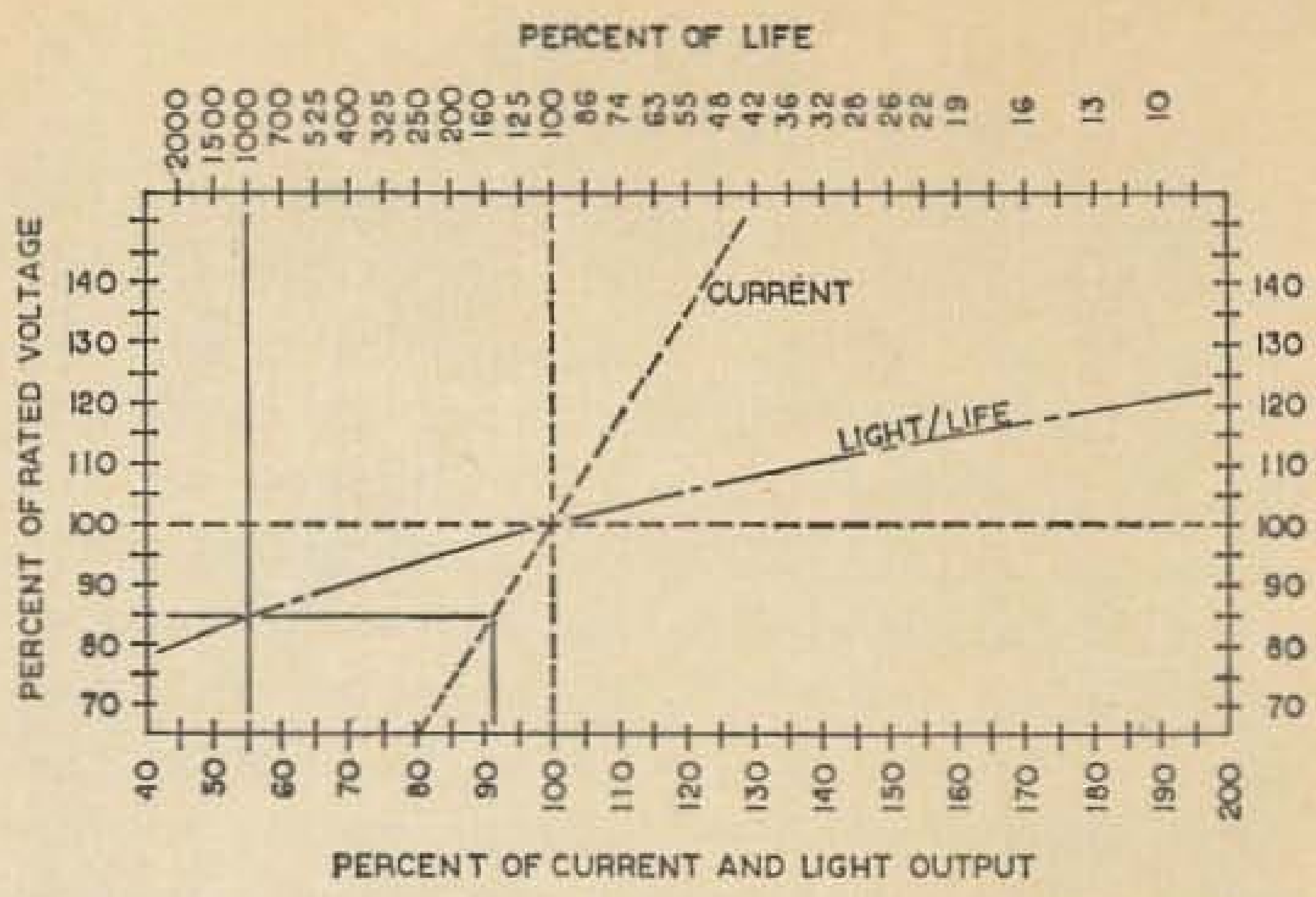
SUBSCRIBERS

We want to make absolutely sure that no one is using our 73 mailing list. We do not rent this list out as do other magazines. If your address label from 73 is distinctive and you find that you are getting any mail addressed in the same distinctive way please let us know immediately and send us the envelope or wrapper that you received so we can take appropriate action. Your help in this will be very much appreciated.

Increasing Pilot Lamp Life

Burned out pilot lamps are annoying, particularly so when equipment has to be disassembled to gain access to bulbs which is the case with my Heath HW32A transceiver. After a couple of disassemblies, I decided to eliminate the problem once and for all. A 200 volt, ½ ampere diode (because it was available) was inserted in place of the jumper wire that connected the two HW32A lamps in series (the diode operating as a rectifier eliminates one-half of the ac wave, thus, causing half normal voltage to be applied to the lamps). Of course, the light output from the lamps is reduced; however, there is still sufficient light to accomplish the intended purpose of the lamps.

Curious as to just what percentage increase in lamp life could be expected by reducing lamp voltage, the following chart was put to use to see what happens when lamp voltage is decreased just 15 percent, draw a horizontal line from the 85 percent mark on the Percent of Rated Voltage scale until it intersects the "Life/Light" curve. Then draw a vertical line from this point to hit the upper and lower scales. Note that light output will drop to 54 percent and lamp life will increase to 1000 percent. To check the effect on current by decreasing lamp voltage, continue the horizontal line across until it intersects the dotted line representing current. Draw a vertical line from this point down to the bottom scale, and see that current will drop eight percent.



Since I have reduced lamp voltage by 50 percent, my previous statement that I'd fix the lamp problem "once and for all" appears to be no idle remark. Those lamps might outlast me. . . . WB6ZOA

De-Humming the Swan

Some hams prefer to receive with a good loudspeaker or crystal headphones, rather than with those of limited frequency response. When this is done, 60-cycle and 120-cycle hum can be much more evident. The problem is to cure the hum.

In the Swan 350 and 500, the audio line also is used for the ac heater current, producing 0.1 volt of ac at the headphones. If a step-up transformer is used to match crystal phones, the ac measures 12 volts without a signal! The quick and easy answer is to connect a low-resistance braid or group of parallel wires between the transceiver and its power supply. A connection at the power supply is easy—with lock washers, put a machine screw through a lower louvre slot, tighten the nut, and put a soldering lug (soldered to the braid or wires) under a second nut. If the wires are short to the transceiver ground terminal, and connections are low resistance, the hum practically disappears.

A more sophistcated cure is to add a wire in the cable between pins #11 which are unused. At the power supply, pin #11 can be connected to #6 or, better, to the grounded headphone jack. In the Swan 350, the ground can be lifted from the output transformer and the latter connected to pin #11; in the Swan 500, the ground can be lifted from terminal #3 of relay K2, and the terminal #3 connected to pin #11. This avoids having a common conductor carrying the audio and ac filament current.

Those bothered with 120-cycle hum in the Heathkit SB-300 may add the approved field-change which puts another section of RC filter on the power supply. If there is 60 cycle hum, remove the output transformer from the rear apron below the power transformer, and mount it on the convenient aluminum shield above a printed-circuit board about 8 inches forward.

E. H. Conklin K6KA

Hamfests

Selling subscriptions at hamfests and conventions is an exercise in frustration these days. At least 75% of the visitors to our booth come up to tell us how much they like 73 and how many years they have been subscribing. This is nice, but it doesn't do much to defray the enormous expenses involved in exhibiting.

Kayla represented us at Dayton this year. The ARRL has apparently relaxed a bit and 73 was permitted to exhibit at Swampscott and the National Convention at San Antonio. At Swampscott they even let me show slides of my trip to Africa and Nepal. I didn't expect very much of an audience with the shows scheduled for the very first and very last spots on the program, but the rooms filled to overflowing for each show.

Lin and I had a wonderful time visiting Hemisfair in San Antonio. I put on four pounds in as many days eating at the hundred or so little food booths. We ate steadily of Mexican, Belgian, German, Swiss, French, and Texan food, rarely repeating ourselves. The lines were mercifully short at the interesting movies and exhibits, so we got to see all of the fascinating things that we missed at Expo last year. The National Convention was well done, but I suspect that the remoteness of San Antonio and the fear of escalated prices due to the fair may have kept many away. We found prices very reasonable, though I must admit that we "lucked" out of eating at some of the really expensive restaurants. I believe that the registration was on the order of 1500 for the convention. I know I missed a lot of the faces that I usually expect to see at a national convention.

MOVING?

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

Surplus 220 Volt AC Circuit

There have been cases in the last couple of years when odd values of ac were needed for simple experiments here at WB6NWW, and since there are no 220 volt lines installed in the shack a little ham ingenuity and a few phone calls to the local Old Timers brought the answer: use a 110 volt transformer and a 220 volt transformer with secondaries of the same voltage and current back-to-back. This seemed like a FB idea so a few minutes rummaging through the junk box (mine is quite large) brought up two ideal army surplus transformers which had been lying idle ever since their purchase at a local swap meet. The wattage capability of this circuit is limited to the capacity of the voltage and current of the secondaries of the transformers. Both of my transformers were rated at 28 volts at 10 amps, so a little bit of Ohms Law told me that I could draw about 280 watts from the 220 volt "output" side. Incidently, for our foreign readers: the primaries of this circuit can be reversed if 110 volts is desired from a 220 volt source.

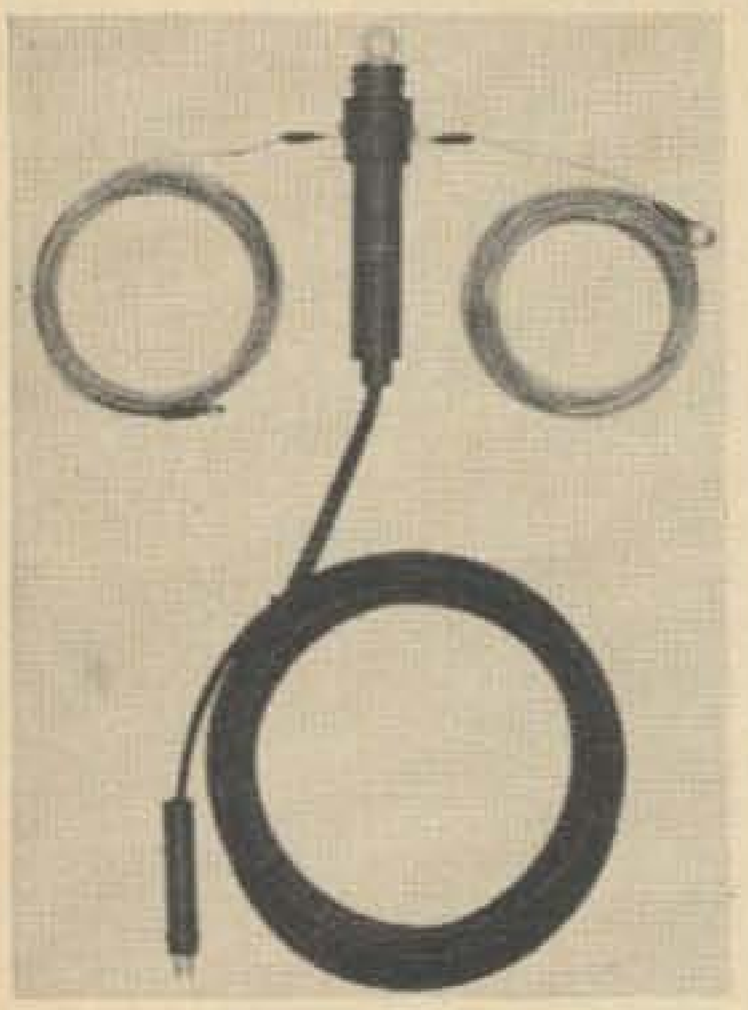
A quick look through the pages of surplus catalogs or a look through the advertisements in this magazine will more than likely locate you a set of transformers with the required voltage and current values at a modest price.

. . . Marty Hartstein WB6NWW

New Ways to Diagnose Electronic Troubles

Things do inevitably break down. You, as an electronic genius, are supposed to be able to fix them, according to your neighbors. This book will help bail you out of almost any scrape you may get into along this line and might even save you a trip to Leger Labs the next time that little curl of smoke comes out of the rig.

Published by Tab Books, Blue Ridge Summit, PA 17214, this $3.95 paperbound book makes even the most complicated circuits seem simple, from radios right up through color TV. Service men work out shortcuts for finding difficulties, though this usually takes years of experience. Seldom do you find one exposing what are considered trade secrets the way this book does.



Letters

Dear 73,

Lately I've read a few comments on the intruders in the 40 meter band. It is my opinion they present us with a golden opportunity to demonstrate our skill as radio operators.

Having seen the Heath SB-101 with its 400 Hz filter, it is my opinion that anybody with this kind of equipment could work as close as 200 Hz from the intruder's carrier.

This suggests a contest. I hope somebody with more experience and skill than I agrees to organize some.

Ron F. Harbin WA8DBO

Dear 73,

I agree 100% with the May editorial on Foreign Broadcast interference. Yesterday and today I logged the following intruders on our 15 meter band: May 9, 1530-1600, 21.32 MHz; Armed Forces Radio and TV Network . . . S5-6. May 10, 1800-1830, 21.445 MHz; Voice of Democratic German Republic (transmits in French). 1800-1830, 21.360; Radio Prague. 1930-2030, 21.437 MHz; Voice of Africa in Arabic. S7-8.

Why not devote a section of 73 to reports of freq., times, and identity of these new intruders. Then other hams could log the intruders, confirm their call and have something definite to say when protesting to FCC, ARRL, and the intruder stations themselves. I'm willing to spend some of my valuable operating time listening to these intruders, logging them and writing letters. Let's get as many hams doing that as possible. Complacency will only result in 15 becoming like 40 is now. There is no time to lose!

Gabe Gargiulo WA1GFJ

Sounds good to me. Send your logs and I'll list them each issue. Then we can turn them over to the proper authorities.

Dear 73,

I am 100% for your policies against broadcasting intruders and hope that every ham will participate in eliminating them from our bands.

Edwin Barnett WN2DYD

Dear 73,

Your "Editorial Liberties" in the May issue touches on one of the most crucial problems facing amateur radio today. The steady influx of international broadcasters on our bands is without a doubt gradually pushing us off the air.

Will we be ultimately driven off our reservation and relegated to the dummy antenna "happy hunting ground" on these frequencies? The answer is an emphatic "yes," unless we start using these frequencies and reduce the listening audience with QRM.

I refer you to the excellent article by WB2CPG in the March 1968 issue wherein he states that the FM mode requires only 6 db or two times the signal strength of the interfering signal to wipe out an AM signal using a discriminator detector. Here then is the answer to joint frequency occupancy on these bands. There are a lot of old AM rigs around with NBFM capability and a simple NBFM adaptor for the receiver should be well within the construction abilities of most hams

How about it? Let's form a QRM net on 40 on a transcontinental basis as a beginning. Perhaps this would be a good place for the UFO net to operate. It might even offer the amateur a good opportunity to develop a "new" communication technique and thus further the electronic art.

F. J. Bauer W6FPO

Dear 73,

A recent editorial in 73 mentioned the illegal operation going on in the Citizen's Band. I was surprised to hear this existed, so I built a simple converter for my NCX-3 which tuned 11 meters. When I tuned across the band, I got the shock of my ham career. Profanity, music, hate messages, all the rules set by FCC were being broken by hundreds of "bootleg" stations. The legal operations were having no easy time trying to carry on communications.

It seems the FCC has their hands full because of the multitude of these illegal stations. They don't have enough men and equipment to track down all these stations. The legal stations are not organized enough to do much on their own. Did we give up 11 meters to create a playground for any illegal station that wanted to amuse himself at the expense of the legal CB stations? If you find all this activity hard to swallow, get an 11 meter receiver and take a listen.

Now, after you've become interested, you want to know what we as amateurs can do. By helping the CB operators we might also gain a little goodwill. We can start by letting the FCC know we want to help. Then we can get out the old direction finding loop, 11 meter converter, and track these illegal stations. We can then report them to FCC and let them investigate further. Besides, it might be more fun than a club transmitter hunt! In this effort, we will also be involved in public service. But, if we remain uninterested, we might find them taking over **our bands!**

Jim Brenner WA6NEV

Dear Wayne,

I have been sitting back and reading 73 without much real complaint. But being a human being and a fellow ham, here I go. On page four of the June 1968 issue, the E.I.A. has flipped!

1. Novice code speed is simple as all hell. Even I got that **two years** before I mastered the theory, and I'm only 14.
2. I was on two meter AM for a while, and it spoiled me. It took a while to get my speed up to 15 wpm; AM simply ruined me. I think Novices should have no phone privileges at all.
3. The only thing wrong with this part is that above 29.1 megahertz, it's dead. True, this would be ideal for Novices, but isn't 15 meters enough?
4. If the Novice was renewable, think of all the crummy QRM we'd have. And five years? Who would graduate? A straight 2-year license (mine was one year) is good enough, and enough time is provided for the Novice to decide whether he wants to continue it.
5. Why? After a Novice expires, he is supposed to advance, or (God forbid) quit.

Paul T. Snyder WA3HWI

Dear Wayne,

In regard to your comments on the E.I.A. and it's proposals concerning Novices in the June issue, I am almost in complete agreement. There are two points on which I disagree, however. I don't think Novices should be allowed phone privileges on **any** band. This may sound strange since I am a Novice at present. I feel that if Novices were allowed to work phone on 29.5-29.6 MHz, he would spend all of his time working DX on phone. I know that if I had had this privilege, I would probably give up hamming when I had to face a General exam at the end of my license term.

Good code proficiency is, I believe, necessary to hams. I am not cutting down AM and SSB ops, but I think it takes a better operator to work CW efficiently than it does to talk into a mike. I now wait with bowed head for the storm.

Larry Irwin WN4HLX

Dear 73,

Basically I am not a home brew man; in fact I deplore it due to a visual problem. Nevertheless, I enjoyed the June Surplus issue. I picked up many tips that I would like to try in my shack. I would like to see more issues of this type. Very good issue.

Paul J. Rilling WA3HIT

Dear Wayne,

Opportunity knocks! I understand that a "Tornado-belt" senator, taking advantage of a rare tornado warning in the Capitol City, rammed through a measure to initiate a study on how a tornado warning system could be built. The news article also implied that he stated that the biggest single problem would be rapid communications from one community to another. Then I remembered your editorial about the UFO Net.

A net on eighty would provide appropriate coverage day or night. One or more enterprising hams in each county in these parts of the country could make contact with the ESSA man. Usually there is an office with friendly, helpful weather men at a good sized airport. (and they have land-line teletype to other offices.)

An effective tornado alert net would be well within our capabilities, would perform a very valuable public service, and might aid those who would like to study these still unpredictable destructive storms. One would be obligated to have emergency power to be a serious contender, since power is often interrupted. Such a net might also prove the value of the UFO net idea in a dress rehearsal with an immediate motivator for a goodly number of hams.

I only wish I had been paying closer attention to the radio when the original news item was broadcast. This is a MARS station AB8AG in NHA TRANG, Viet Nam, and we were running phone patches with A6NAZ at the time. Even listen to a newscast and run a phone patch at the same time?

K1VYQ

W1EMV from page 2

circle and the first one would whisper a sentence into the next person's ear. By the time the sentence reached the last person, it was completely different. On the ham bands one person would report the actual fact that Alan Biggs' boat had taken on water and they had asked for aid from the Coast Guard. This would be passed on as "Hey, did you hear that Alan Biggs is lost at sea and is sinking. It was, unfortunately, the wild exaggerations which reached the newspapers.

Ham radio can do a lot of good by maintaining good liason with services such as the Coast Guard, but I doubt if those services appreciate the false newspaper reports which sometimes follow. If you are involved in such a situation as the one I have described, report only the facts as they happened and of which you have first hand knowledge. Don't report rumors. This can only hurt our public image.

. . . Kayla W1EMV

Afghanistan Operation

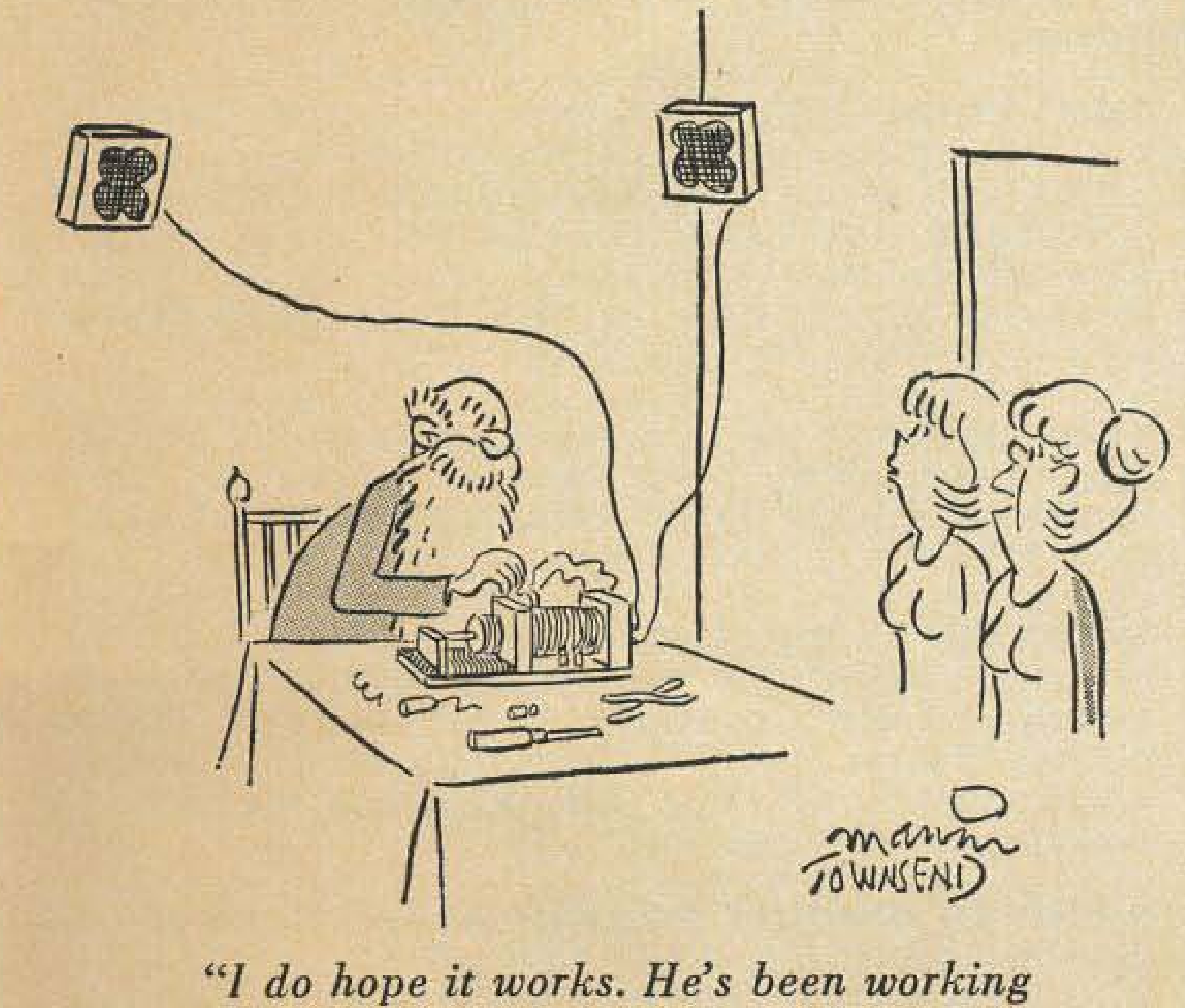
V. P. "Peyt" Lager, K9HWI, has disclosed that immediately following the end of the school year at Barrington, Illinois, High School he will leave for a two year stay at Kabul, Afghanistan, where he expects to operate as YA2HWI.

Peyt, head of the Industrial Arts Department at Barrington High School, will be Supervisor of Building Trades at the Kabul Institute of Technology, under the United States A.I.D. program.

Including a complete ham station within the baggage allowance, while still shipping a full two year's supply of basic necessities for himself, his wife, and his daughter, has taken close planning. Peyt will be running a Heath SB101 transceiver and a Heath SB200 linear into a tri-band beam. For 40 meter operation he will load the mast or erect a long wire antenna. The present Hallicrafters station receiver will also make the trip, but to be used as the family radio.

Most operation will be on the low ends of 20 and 40, and in the novice portion of 40. the exact date on which operation will commence is undetermined, and will depend on the demands of the new job, establishing living quarters, awaiting the arrival of equipment traveling by surface shipment, and getting the station set up.

YA2HWI's Stateside manager will be W9FLJ of Barrington, Illinois. No replies without s.a.s.e. or I.R.C.



"I do hope it works. He's been working on it for thirty years."

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HAM-TV, CCTV CAMERA $110.00, Toshiba 7038 Vidicon—$15.00, Elgeet 4" (102 mm) F:2.7 lens, Toshiba 7038 Vidicon—$8.00. WB2GKF Stan Nazimek, 506 Mt. Prospect Avenue, Clifton, New Jersey 07012.

NORTH ALABAMA HAMFEST ASSOCIATION, Inc. Hamfest to be held in Huntsville, Alabama, August 17 and 18, 1968 at The Mall. Contact James A. Brashear, WB4EKJ, for details.

TIE CLIPS: Gold plastic with your call letters engraved in black. Satisfaction guaranteed. $1.25 each. Elderkin Engraving, Box 5622, Pasadena, Calif. 91107.

DX-60A with PTT built-in, $65; HG-10B VFO, $30; Lafayette HA-63 .540 to 31 mHz. with speaker, $40. Want HT-37. WA9TEB, 67 Bowen St., Oshkosh, Wis.

WANTED: Used Davco DR-30 Receiver in operating or repairable cond. Price and description to N. F. Moss, 7535 Perry Rd., Bell Gardens, California.

TRY YOUR DOLLARS where they are worth more. Send for free list. TR4—495.00—AC4—79.00—SW4A—275.00—RB4-T-4XB—both 750.00—MN4—75.00—NCL2000—495.00—NC200+AC200—395.00—SWAN 350—375.00—500—495.00—All Units New. Freck Radio & Supply Co., Inc. We trade, 38 Biltmore Ave., Asheville, N. Car. 2801.

QSL CARDS, 1 color $8.40, 2 color $10.40, per M. High gloss card, 7-day service. Write for free brochure. Pacific Litho Print, Box 156, Waldport, Ore. 97394.

WANTED: Young, aggressive, full charge amateur store manager for full line Florida amateur stores. Health insurance, profit-sharing, stock option. Please submit brief resume with salary requirements to: Box 868, 73 Magazine, Peterborough, N.H. 03458.

PRINTED CIRCUIT BOARDS made to your specifications from schematic to finished board. Stafford Electronics, Greensboro, North Carolina 27401.

TRADE EVEN: Have new boxed Swan 500C with 117XC for any of the following surplus sets: SG-1A/ARN with PP-348; SG-2/GRM-4; SG-13/ARN; MD-83A/ARN; ARM-47; UPM-98 or 99; R-390A/URR; ARC 102; 618T; Phone collect for trade (813) 722-1843, Bill Slep, W4FHY, Slep Electronics Company, 4214 Highway 301, Ellenton, Florida 33532.

"SAROC" FOURTH ANNUAL fun convention scheduled January 8-12, 1969, in Hotel Sahara's new space convention center, Las Vegas, Nevada. Advance registration closes January 1, 1969. Ladies program in Don the Beachcomber. Technical seminars, FM, MARS, RTTY, QCWA, WCARS-7255. Registration $12.00 per person entitles "SAROC" participants to special room rate $10.00 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Sahara's late show, Sunday breakfast equal to any banquet dinner, ask any "SAROC" veteran. Brochure planned November mailing for details QSP QSL card with ZIP Southern Nevada ARC, Box 73, Boulder City, Nevada 89005.

DRAKE 2-C RECEIVER with 2-CQ Q Multiplier and 2-AC crystal calibrator, 2-NT transmitter with 40 and 80 meter novice crystals. Mint condition. $295.00. Gary M. McGlothlen WAØRAM, 911 Fairview Place, Fairfield, Iowa 52556.

PEORIA HAMFEST: September 15, Peoria, Illinois —same place as last year. Advance registration: $1.50. Write: Ferrel Lytle, W9DHE, 419 Stonegate Road, Peoria, Illinois 61614.

SELL CQ most 52 through 67, QST many 37 through 54, 20¢ each post paid. D. Sinner W6IWO, 15310 El Camino Ave., Paramount, Calif. 90723.

JULY 1966 ISSUE OF "73" NEEDED. Anyone care to sell me their copy? E. E. Merkel, 9204 Mintwood St., Silver Spring, Md. 20901.

SALE: HT32 and RME6900 in good condition. No shipping. $390.00 takes both. K1LBK, 17 Brownehill Ct., Lincoln, R.I.

TRANSCEIVERS: HW-12 $79.75, Eico-753 $119.95, Galaxy III $179.00. All in excellent condition, never used mobile. First certified check. Alfred Wilson, Jr., Rte 1, Box 450-B, London, Ky., 40741.

FOR SALE: Swan-240 with AC supply. 240 watts pep; 80, 40, and 20 meters. Excellent condition with all manuals. $240 or best offer. Ben Lowe K4VOW/5, Apt. 180, 900 W. Spring Valley Rd., Richardson, Texas 75080.

POWER SUPLY REGULATOR zero to 20 volts continuously adjustable at currents to one ampere. Spec sheet free, catalog 25¢. RADEVCO, Box 8450, Baltimore, Md., 21234.

SELL: Heath HA10 amp., $165. Link 1907 FM basestation with mobile transmitter and receiver, $125. My handicap limits "hamming." Ron Perry, WA2CGA, RD #1, Fishkill, N.Y.

SWAN 250+ 117xc P.S. $350 or trade, mint condix. WA2DOP Bob Gilmartin, 1 Brook Run Dr., Mount Holly, N.J. 08060.

HAM TV—2 camera chains; Packard Bell vidicon camera, rack electronics, 14" monitor, tripod, studio cables. Orig. cost $3,800 ea. $425 ea or trade HF linear or mobile SSB Xcvr of equiv. value. Extra monitor $40. WA6JMF, 12712D S. Ramona, Hawthorne, Calif. 90250.

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0C3	.60	6AQ5 ...	.55	2D21 ..	.45	811A ...	3.75
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80	1.15	10Y	.59	1625 (asme as 807-12V)			.95
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Aug 1968

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GLEGG THOR 6 with AC power supply, manual, good condition. $140.00. Firm. Money order, shipping your expense. Zig Porada, 40 So. Glenwood Dr., Bergenfield, N.J. 07621. WA2ZWB.

SO. CALIF.—DuMont 304H Oscilloscope; clean, unmodified, with complete Manual. Perfect operation. $50 or trade. J. Sandberg K6YPU, 1138 E. Rustic Rd., Escondido, Ca. 92025.

GONSET G-76 100 watt 80-6 Meters transceiver, $150. Hallicrafter SX-100 $100. Hornet tri-bander beam w/rotator $50. Tandberg 6 tape recorder $150. All in excellent condition w/manuals. K6QAT, 13709 Ardis, Bellflower, Calif.

TELETYPE MOD. 14 reperforator w/automatic tape take up rewinder, new, unused, $69.95 . . . 4-400's $14.95 . . . transformers: plate 5KV-1.6ADC $59.95 . . . modulator 811As $35 . . . filament 12.6VCT-10A $4.95, ideal for transistor supply, battery charger . . . catalog 10¢. Fertik's, 5249A "D", Philadelphia, Pa. 19120.

31ST ANNUAL HAMFEST of the South Hills Brass Pounders and Modulators, Inc. of Pittsburgh, Pa. will be held Sunday, August 4, 1968 from 1 to 6 p.m. at St. Clair Beach (Old Paris Lake) 5 miles south of Mt. Lebanon on Route 19. Plenty of picnic space for the family. Check-ins on the Club Station W5PIQ on 10 and 6 meters. Registration for door prizes $2.00 at the door or $1.50 in advance. For further information or pre-registration write Leonard R. Hendry, WA3GKL, 248 Skyport Dr., West Mifflin, Pa. 15122.

NATIONAL INCENTIVE LICENSING POLL RESULTS—639 against and 178 for. Our ads were in the three leading ham magazines. WB2NOD, Box 685, Moravia, N.Y. 13118.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

LOUISVILLE HAM KENVENTION, Saturday, August 31 at the Executive Inn, featuring Dealers and Manufacturers; Technical Forums; Prizes; Contests; Fashions for the Ladies. 648 South Fourth Street 40202.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB. P. Wandelt, RD # 1, Unadilla, New York 13849.

THE QUAD CITY AMATEUR RADIO CLUB has scheduled its annual Mississippi Valley Hamfest for August 18, 1968 at the Rock Island Arsenal, Rock Island, Illinois. The site this year is an all-weather site with adequate display facilities. Lunch will be served in the cafeteria. Price for tickets is $1.50. Contact John E. Greve, W9DGV, 2210-30 St., Rock Island, Ill. 61201 for advanced tickets. Frequencies to be monitored are 3900 50.4 and 146.94 mc.

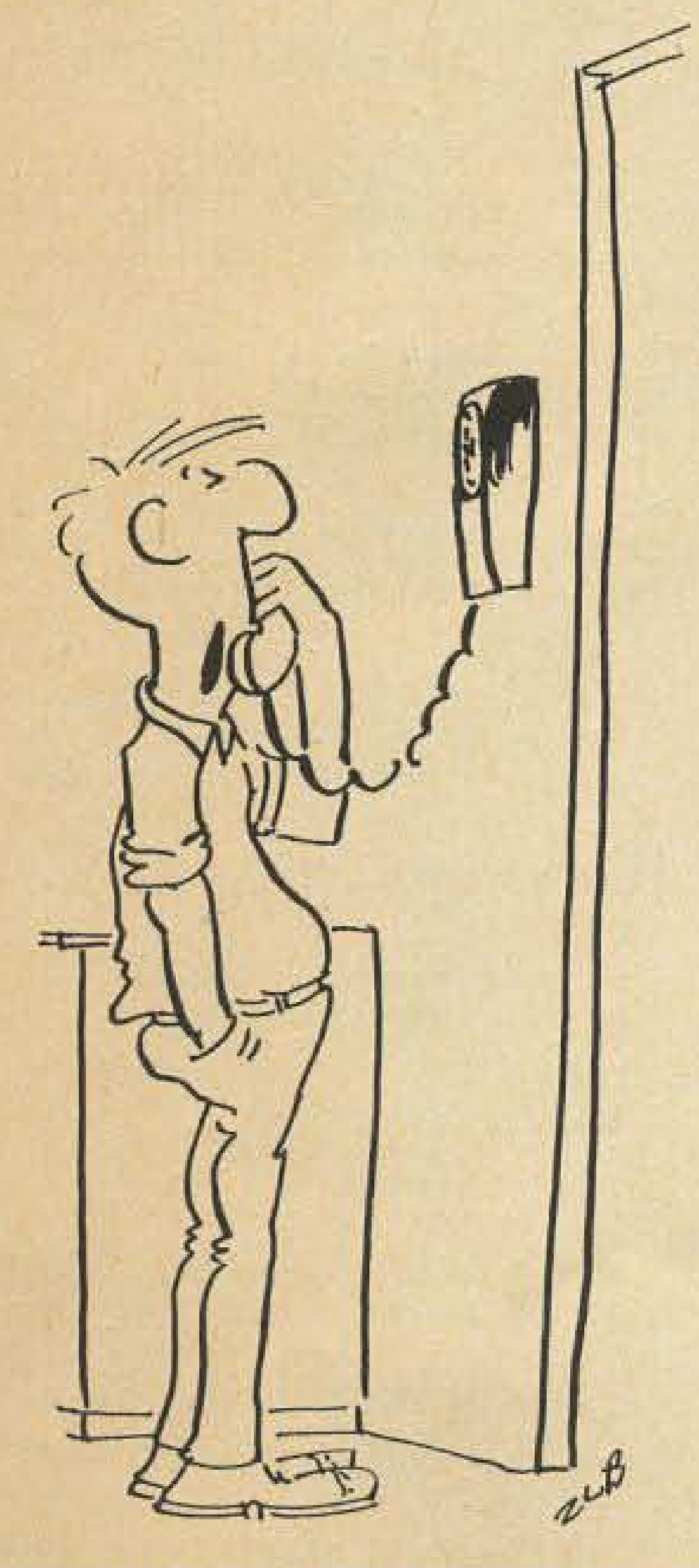
THE MT. AIRY V.H.F. RADIO CLUB is holding its 13th Annual Family Day and Picnic on Sunday, August 11 (rain date August 18) at Fort Washington State Park, Flourtown, Pa., in cooperation with the Delaware Valley Chapter of the QCWA. Come and get together with your families and friends for an old time outing of games, cook-out and just plain relaxing for a day away from home. There will be games for the kids and activities for the YL's and XYL's. Free soda for all. No reservations required. $2.00 per family.

SELL: Hallicrafters "Hurricane" Transceiver SR-2000 PS-2000 Factory sealed, unopened cartons. Warantee. Sacrifice offers. E. Crieco, 54 Andrew St., Meriden, Conn. 06450. (203) 235-9944.

WANTED: Drake T4X transmitter and power supply or Heath HX-10 Marauder transmitter. Must be in excellent condition and not modified. Reply Box 8, 73, Peterborough, N.H. 03458.

THE CENTRAL NEW JERSEY VHF SOCIETY is holding another antenna measuring contest this year. The antenna measuring contest will be for both 432 and 1296 MHz, with improved technique (improper gains were measured last year due to reflections picked up by the reference dipole). The contest will be held as part of our Hamfest on August 18, 1968 at Johnson's Park, New Brunswick, N.J. For further information contact Paul Wade WA2ZZF, 48 Warrenville Rd., Middlesex, N.J. 08846.

432MC CONVERTER. Convert to 7-30MC. Removed from missile guidance system, size 2" x 3" x 3½", 2 tubes-2 diodes, complete with schematic & instructions less crystal. Unused $14.95 each. Also 1000V PIV, 1.5A Epoxy diodes, 45¢ each, 10 for $3.99. Tubes 6146A, unused, $1.00 each. We pay postage on prepaid orders. Alpha-Tronics, Dept. A, 14251 East Colfax, Aurora, Colo. 80010.



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INDEX TO ADVERTISERS

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This fully transistorized sine and square wave generator is the smallest and lightest in the world. It covers from 10 Hz to 100 kHz in four bands.

The output is maintained at minimum distortion and at a constant level by means of an FET oscillator with a thermistor and intensive reverse feedback.

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Output impedance: 600 ohms $\pm$ 100 ohms unbalanced.

Output-frequency response: $\pm$ 1 dBm at 1 kHz

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