73 Amateur Radio

February 1964
Same old 40c

YOUR VOTE COUNTS

Place
4c Stamp
Here

Institute of Amateur Radio
Peterborough
New Hampshire

IT IS TIME TO BE COUNTED

The ARRL claims that there is no point in running a poll on matters of interest because too few amateurs ever take the trouble to answer the poll. Please tear or cut out the postcard below, fill it out, stamp it and mail it. If you are against shredding your magazine then use your QSL card or a regular postcard . . . send something with the information requested. When you have accomplished this then get on the air and get as many other fellows to send in cards as you can . . . get everyone at your radio club to send in a card. Get on the phone and get every ham you can think of to send in a card. Let's make this 100% for all 73 readers and 200% for their friends . . . or better. Vote yes, vote no . . . but vote.

The results of this poll will be published in 73 and will be made part of the record on the proposal on file with the FCC. We will also see that the ARRL Directors get a copy of the poll results.

THE PROPOSITION

The ARRL has submitted a proposal to the FCC to make the Advanced Class license available to anyone who has held a General Class license for at least one year and passes an additional technical examination under FCC supervision. This license would be available to Conditional class licensees who have been licensed for at least one year and who pass the additional technical exam and a 13 wpm code speed test under FCC supervision. The new technical exam would be somewhere between the present General and Extra class license exams in difficulty. The present Conditional licenses could only be renewed in cases of the handicapped, overseas military or other hardships.

The present phone bands would be restricted to Advanced and Extra Class licensees as follows:

20 meter phone .... July 1, 1965
40 and 15 meter phone .... July 1, 1966
75 meter phone .... July 1, 1967

No discussion of the arguments for or against this proposal will be given here. You can read the arguments in past issues of 73, QST, and CQ if you are not familiar with all of the problems involved.

Note - I voted (opposed to proposal) 1/21/64
121 REC

Name ______________________ Call ______________

Address ______________________________________

City ______________ State ____________ Zip/Zone ____________

I am a member of ARRL ____. I am in favor of the proposal ____.

I am not a member of ARRL ____. I am opposed to the proposal ____.

I am a member of IoAR ____. I don't care one way or the other ____.

Remarks:

73 Magazine

Wayne Green W2NSD/1
Editor, etcetera

February, 1964

Vol. XV, No. 2

73 Magazine is published monthly by 73, Inc., Peterborough, N. H. The phone number is 603-924-3873. Subscription rates have just been hiked (after considerable warning) to $4.00 per year, $7.00 for two years, $10 for three years world wide. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in the U.S.A.

Postmaster: please send form 3579 to 73 Magazine, Peterborough, New Hampshire.

de W2NSD/1

never say die

The turn of events would be comical if it weren't so serious. ARRL's bungling action has split our hobby catastrophically, making previous splits over such mundane matters as SSB/AM, AM/CW, Spark/CW, etc., appear like little wrinkles by comparison. As Mr. Kitrell of Hy-Gain points out in a letter to Mr. Hoover, "RM-499 is creating shameful dissension among amateur ranks. I do not believe that this dissension is a result of lack of information or anything other than the amateurs not believing in your incentive licensing program."

Or, as Milt de Reyna K4ZJF, General Manager of WEAR-TV, puts it, "You have the best answer to amateur radio's current problems in your editorial (January), only I wish you had given more space to it; we need a damned good Washington lobby so bad we can taste it. We need inept and downright misled and uninformed leadership such as Newington is providing about as bad as we need a good case of athlete's foot. As businessmen, you and I both know we'd fire, without a moment's hesitation, any employee who botched up a program as bad as ARRL has this one; I thought the last Chinese fire drill I saw was the classic example of a SNAFU, but I must defer to the new leader. I'm not now considering whether the ARRL proposal is good or bad; I'm talking about the League's almost naive lack of effort to sell the membership on its program, and above all, on the necessity of providing a united front to the FCC. We've now got one hell of a mess on our hands; the biggest thing we've lost is the League's standing in front of the FCC as a spokesman for the great majority of amateurs." Milt goes on to say, "The point is this—were it not for an experienced, excellent lobby, commercial television today could have been reduced to a shambles, and replaced by a government conceived utility that would have made us as potent as a newborn. I guarantee that amateur radio is going to have the benefit of the same type of thinking applied to it at some time in the future, and I wish to hell your warning in the current issue would have had a bit more mustard in it."

The ARRL Executive Committee met in early December and decided that everything was going all OK and that no changes needed to be made.

ARRL Executive Committee! ARRL Directors! Don't you fellows even read the articles in your own magazine? What are you thinking of? How can you desert us in this emergency? Did you miss the message which you printed in QST from the head of the amateur division of the FCC? Mr. Loucks spoke plainly and directly to *you*. He may have been addressing the QCWA, but he was talking to *you*. And *you* are not listening. Well fellows, some of us *are* listening. Didn't you even read the timely article by Prose Walker in QST? Prose has been on the U. S. delegations to ITU conferences for a long time now and you should *read* what he has to say.

The story from both Mr. Walker and Mr. Loucks is the same: things have slid long enough . . . changes must be made if we are to protect our wonderful hobby. And what have you gentlemen proposed as a course of action? You've handed us all a prize collection of clichés and a proposal for one of the most destructive rule changes imaginable. Thanks.

ARRL, you have failed not only the members you have pledged to represent, but you have failed all amateurs everywhere . . . and you've failed yourselves.

What *is* necessary for amateur radio to survive the next Geneva Conference with something resembling our present ham bands? What must we do to survive right here at home?

What changes must we make. What improvements are called for? While the amateur ranks are torn with dissension over RM-499 our date with fate at Geneva is drawing inexorably closer. We *must* act right now.

Here is what I propose we do.

1) Increase the Institute of Amateur Radio dues to $10 a year to provide the financing needed to have the Institute undertake tasks for which the ARRL is not now responsible. I feel that it is important that amateur radio be put back together, not split further, and therefore believe that we should attempt to have the Institute operate in areas which have been left open by the ARRL. This would make it important for amateurs to support both organizations rather than having to decide which one was the most important to support.

2) We have a great need for an office in Washington, manned by an amateur who can be reached whenever there is a question posed by any branch of the military, any government agency, or any Congressman. When matters of importance come up this man will know who to call for the best results. We can provide a steady stream of information about the service that amateur radio provides to Congress and government officials through such an office. We need badly to tell the story of public service that we render, the discoveries that are being made on the ham bands, and the international good will that we engender to everyone who can possibly help us. It is possible that we may even be able to expand to a full fledged lobby with our small Washington office as liason. We certainly have had adequate proof that we badly need all the push we can muster there. The ARRL has been under pressure for years to open a Washington office and has turned thumbs down time after time. One of the biggest allies we will be able to have on our side at Geneva next time is a U. S. delegation that has instructions to keep amateur radio strong. This was not part of the instructions last time . . . I know . . . I was there and I asked them.

3) Every now and then an amateur finds himself up against imposing legal odds. The usual result of this is that he puts in a panic call to the ARRL for help. The ARRL will give all the help it can in the way of legal references, but does not have funds available, as far as I know, to help the beleaguered amateur in his battle. This is not unreasonable, for this could easily run into hundreds of thousands of dollars a year. I do believe that there should

(Turn to page 83)

2 Meter SSB Rig

employing novel features

Richard Factor WA2IKL

Photo credit: Steve Schwartz WA2YDN

This project was started as an attempt to get on two meter SSB. That it was successful there is little doubt, but my aversion for controls and my desire to see what could be done with some of the more modern and unusual (for ham equipment) components led to the design pictured above. (Fig. 1). It is essentially a frequency synthesizer which adds the sum frequencies of two crystal oscillators and a VFO to give a frequency exactly 14 mc below any selected frequency in the two meter band. It is obvious that this frequency can be mixed with the output of any 14 mc rig to give two meter transmission and *reception*. Since this is possible, one can connect a transmitter and receiver tuned to 14 mc to the transceiving transverter and never have to tune either to operate transceive on two meters. Needless to say, it is a great advantage to have a tunable receiver, although a fixed-tuned one with a tunable transmitter could be used to work stations off frequency. Only the synthesizer and the associated control circuitry will be discussed here as the two meter receiving and transmitting converters are standard circuits. Many VHF men will be able to build the synthesizer portion and then plug its output into the crystal circuits of their two meter mixers.

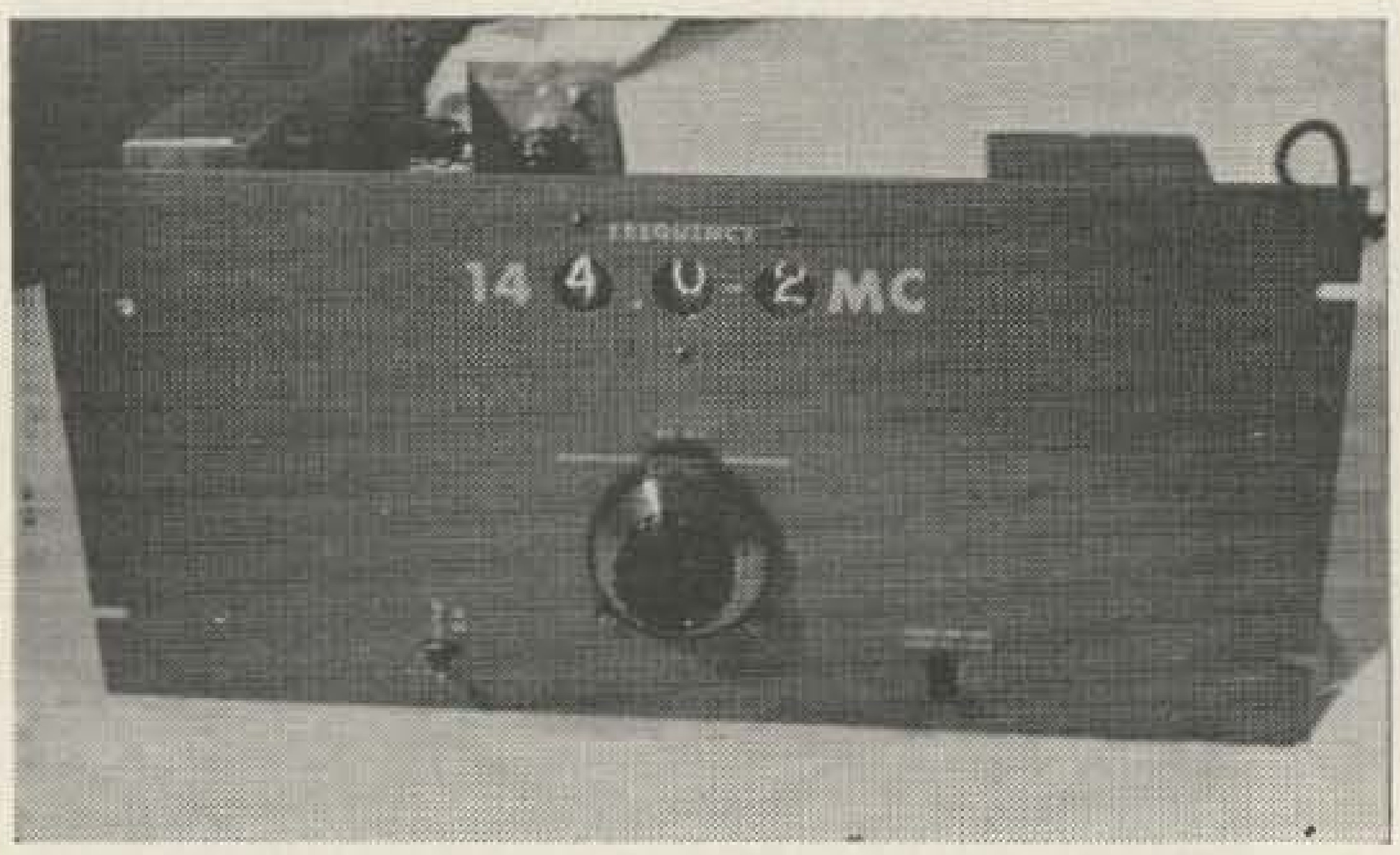

Fig. 1—Front view of unit: glowing numbers between the decals show the frequency range. The "interpolation oscillator" control —the VFO—is tuned by the vernier and the reading multiplied x 2 to give frequency in kc to be added to the above range.

Although I call the frequency determining circuit a synthesizer, it is not of the familiar kind in which many crystals are used to provide steps of 1 kc and a VXO to interpolate between individual kilocycles. For one thing, it is quite tedious to tune a band 4 mc wide by individual kilocycles. In addition, crystals are expensive. Therefore a VFO 200 kc wide is used for interpolation between ranges.

Many of you are wondering what the glowing numbers in Fig. 1 signify. The rest of you have a good idea and are wondering when I'll get to it. The author has always been impressed by the blinking of computer panels and industrial equipment and it has seemed a shame that almost all ham equipment has had nothing more impressive in it than a monitor scope or an occassional eye tube. Therefore, when I managed to acquire some Burroughs Nixie tubes, I was determined to do my best to alleviate this condition. Briefly, the Nixie is a neon filled tube with ten individual cathodes shaped in the form of the numbers one through zero. When a voltage greater than the firing voltage is placed across the anode and the selected cathode, a neon glow discharge occurs in the shape of the selected cathode. The method of controlling these tubes and the frequency is the second unusual feature of the unit.

The button labeled "Press for unit/Turn to cycle" controls a 26 position stepping relay which selects crystals, tunes the plate circuit of a crystal oscillator, and selects which cathode of each of the Nixie tubes is to be grounded.

The actual circuitry is neither unusual nor difficult to construct. Referring to Fig. 5 it can be seen that the output of a VFO is mixed with the output of a crystal oscillator. The crystal frequencies (Y1-Y5) were chosen mainly because that series is readily available from at least two mail order surplus houses at a price of 50c each. The VFO frequency, 5.000-5.200 mc was chosen to avoid as many spurious products as possible and because it is a very common VFO frequency, and many published circuits, as well as quite a few units, are on hand in SSB stations. The output of the mixer goes to an amplifier whose purpose is partially to provide increased drive for the second mixer but mainly to compensate for the difficulty of broadbanding a circuit whose center frequency is 12 mc by a whole mc. The output of the "bandpass" amplifier goes to the second mixer where it is mixed with the output of an overtone oscillator. The output of this mixer is the final injection frequency which is to be mixed with the fourteen mc of the existing station. It is amplified by the second "band pass amplifier," but this time the

Fig. 2—Rear view: The stepping relay is in the case in front of the power transformer. All shields have been removed for this and all other photographs. The Nixie panel is visible on top of the front panel. Sockets on back are in order: switched 115VAC for linear, SO-239 output to 14 mc receiver, and SO-239 input from SSB exciter. 144 mc output is on subchassis.

main purpose is amplification, as the mixer output is not very great. After this amplifier, the detailed description stops, as the other circuitry is likely to be in existence or can be built from many articles. The two subchassis contail separately the transmitting and receiving converters. The only unusual feature is that the transmitting converter has no plate tuning

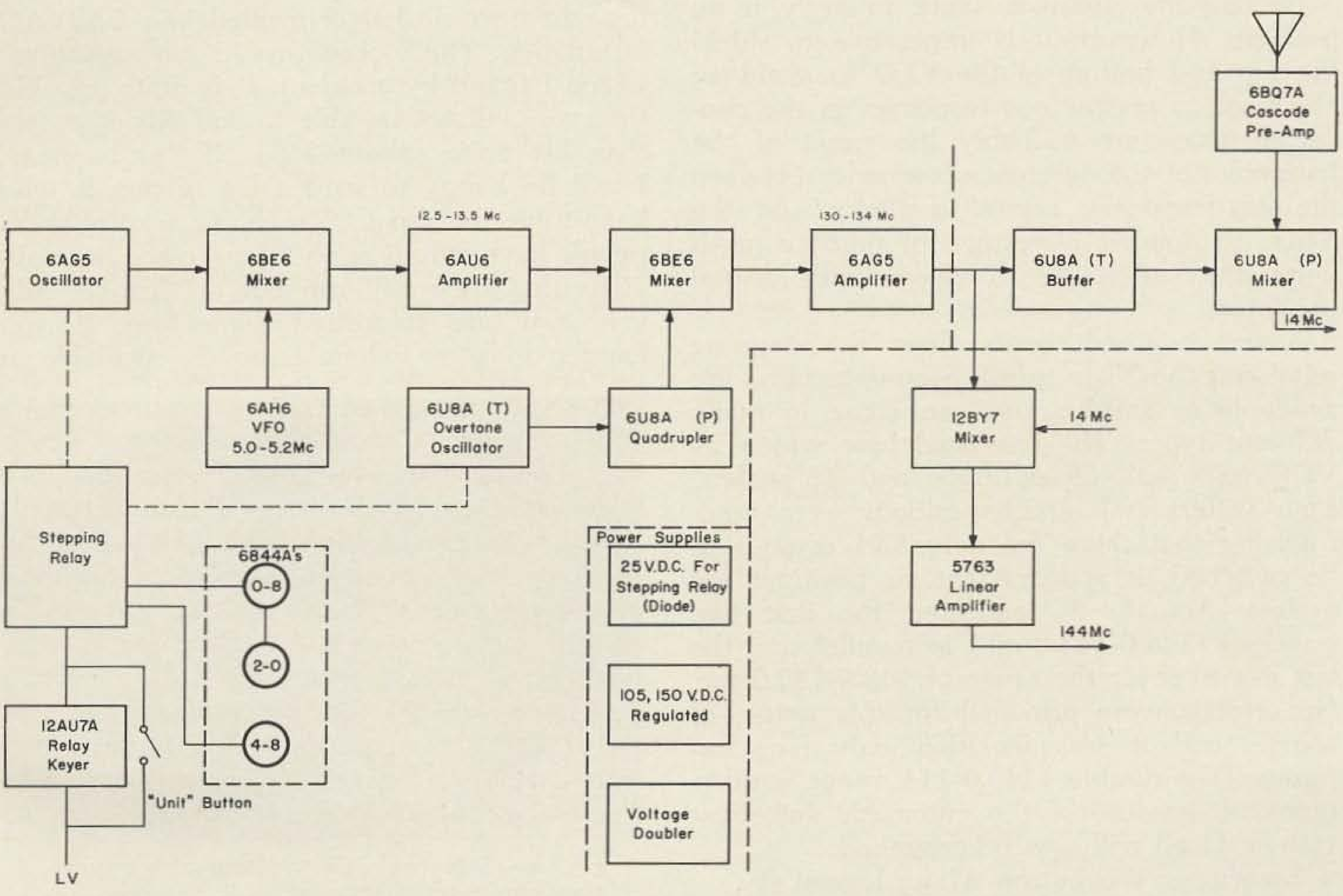

FIGURE 5

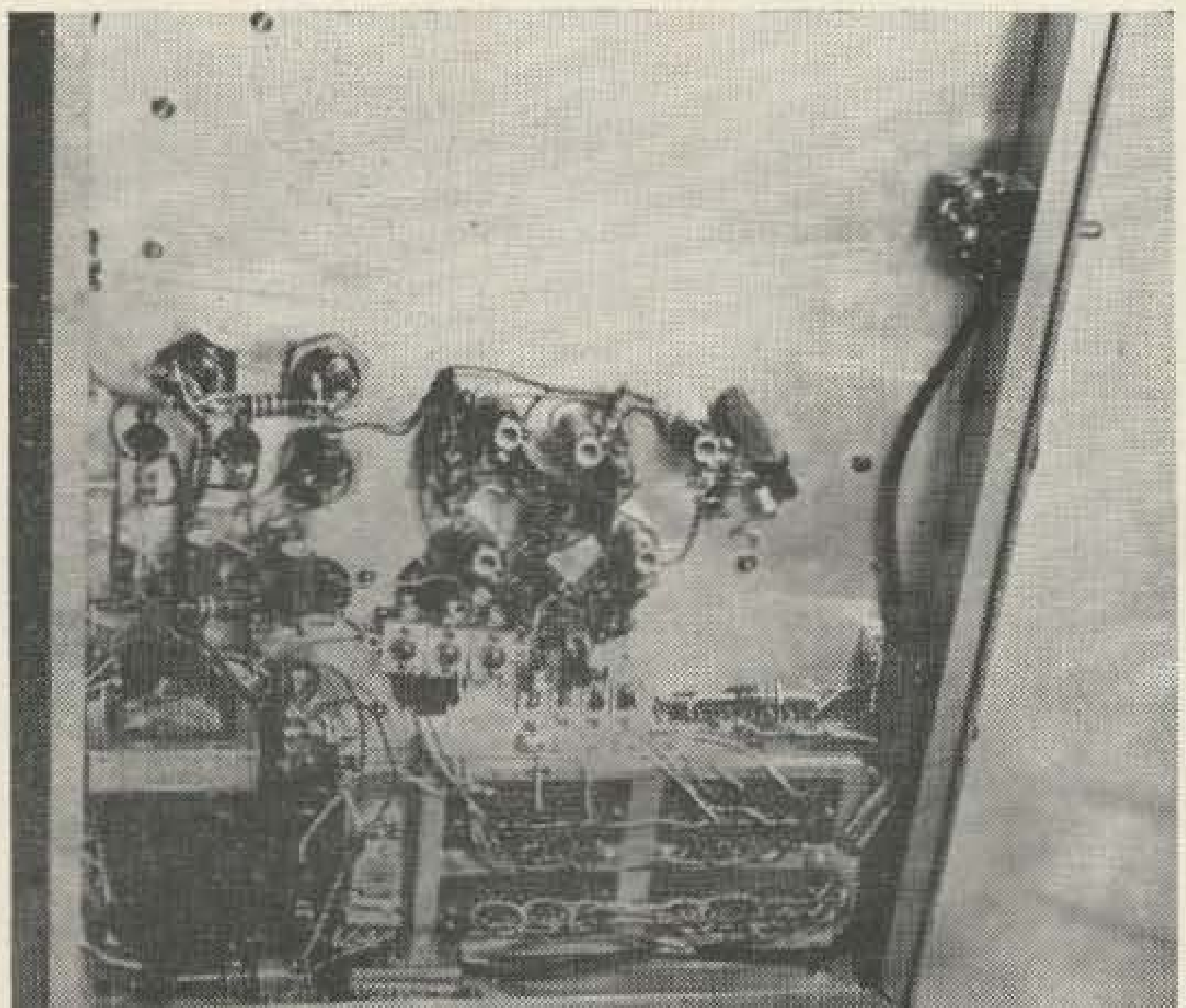

Fig. 3—Innards

control since the transverter is to be used with a linear amplifier with an AGC which will automatically compensate for non-uniform output. If it should ever be necessary to operate without a linear, all that has to be done is to drill a hole in the panel which will allow access to the tuning capacitor. (Incidentally, the large space on the bottom of the chassis is reserved for the addition of a fixed-frequency SSB exciter. This accounts for the absence of any complicated relay-switching arrangements.)

Getting the circuit to work properly is no problem. However, it is imperative to shield the top and bottom of the VFO to avoid an abomination of spurious responses in the converter which are probably the result of the harmonics of the difference frequency between the low-frequency crystal oscillator and the VFO. To remove all vestiges of spurious products, it is advisable to shield both crystal oscillators.

A few hundred words about the stepping relay and the Nixie tubes: Stepping relays are available as surplus and can come in many different types. The one used here was a 24 VDC unit with 26 positions and 12 wafers. Four wafers and all 26 positions were used. Figuring that there are only 5X4 crystals to be switched, it appears that six positions are useless. Actually I connected the first two positions (144.0-144.2 mc) in parallel, and the last five to cover the range of 148.0-149.0 mc. No crystals were provided for this range, of course, and it was included only for continuity. The double 1440.0-144. range is quite practical, because of the automatic switching system which will now be described.

Remember the button whose legend is . . . "Turn to cycle"? The button itself came from an old telephone and could easily be replaced by a center-off, spring return SPDT toggle switch. When the button is pressed, it grounds one end of the coil of the stepping relay, the other end of which is connected to a 25VDC supply. This advances the relay one step, giving a frequency range 200 KC higher. When the button is *turned,* it activates a modified POO-Key Jr. which is used to key the stepping relay at any speed the operator desires. No control is included to vary the speed because it is not anticipated that the operator will be in a hurry one day and not the next. If you feel yourself unpredictable, you can put a "QSY rate" control in. As a matter of interest, the stepping relay I used actually followed the 60 CPS of the power line, so set the keyer at as high a speed as you think your reflexes capable of. This is the reason the dual first position was included—to let the serious operator get home fast! Although I enjoy the relay very much, it is obvious that many will prefer switches to the expense of the relay and the somewhat tedious wiring required. The relay I used cost $10 on New York's "Radio Row," and similar ones are available from $3 to $12 depending upon condition and number of contacts.

The Nixie tubes used—Burroughs 6844A's—are the most readily available Nixie's. I was lucky enough to acquire a few which a friend thought were no longer needed in a UNIVAC installation. The sockets are 13 pin miniatures which I found by accident. It is quite possible that you will not be able to find Nixies at less than list price (about $15). If this happens, I will be happy to send a list of people who have tubes for about $5 each. As most of these people have only 6 or so tubes apiece, it is obvious that they will run out of them if only very few are interested. Therefore, if you happen to know where more are available at

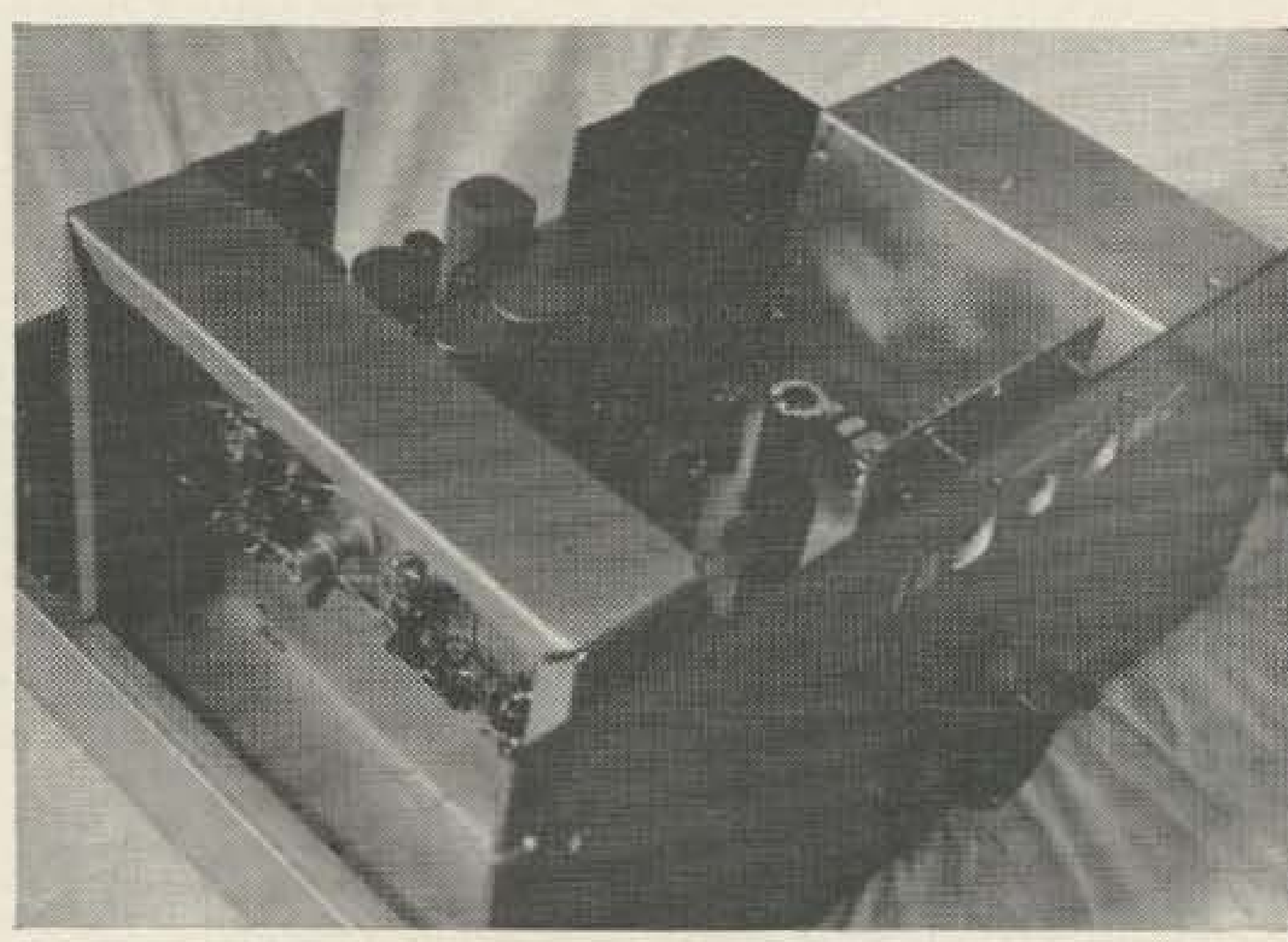

Fig. 4—Side-top view. Bottom of transmitting converter visible as well as some detail of the mounting of the Nixie's.

SBE

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Exceptional ... in its compactness ... in its high power ... in its modest price ... new 1000 watt P.E.P. four-band amplifier (80-40-20-15). **Small** ... a size match for **SB-33 transceiver** and a companion unit **to make up a pair without equal** as a multi-band mobile combination. But SB1-LA will also work with any SSB transceiver ... can boost its output to a full KW in fixed or mobile service.

This new linear incorporates every desirable modern feature. Stable, with passive grid input, it offers a 50 ohm resistive load for SSB exciters. Operation is Class AB-1 for low distortion. Output is conventional pi network.

SB1-LA applies the desirable technique of low plate voltage (only 800 volts) and high plate current. This lower plate voltage is far easier on capacitors—diode rectifiers—transformers—insures safer operation under environmental extremes.

All-solid-state, 117V AC heavy-duty power supply is **built in.** (No rectifier tubes).

Tubes used are 6JE6's—six of them, parallel connected. These are standard, low cost types, available anywhere. (See specifications below for other features.)

$279.50

Please send full information on SB1-LA Linear and SB-33 Transceiver.

NAME

NUMBER STREET

CITY ZONE STATE

Bands: 80-40-20-15 meter amateur bands.
Power rating: 1000 watts P.E.P. input. (750 watts 15 meters). 400 watts AM.
Drive requirements: Approx. 75 watts for full rated output.
Input impedance: 50 ohms resistive.
Output impedance: (antenna) 50 ohms, unbal. VSWR 1.5 or less.
Power supply: Built-in all solid-state, 117V AC.
Primary power requirements: 115V AC @ 12A max. at peak output. (DC) **Standby:** 12.6V (nom) @ 7.5A. **Peak:** 12.6V @ 110A.
Tubes: Six, type 6JE6. (parallel connected).
Control circuits: Antenna switching relays (2) built in. Rear terminals for transceiver relay control.
Size-Weight: 5½"H, 11¾"W, 11¾"D. Weight 35 lbs. approx.

SBE **SIDEBAND ENGINEERS**
317 Roebling Rd. So. San Francisco, Calif.

An operation of Webster Manufacturing

a substantial saving over list, please let me know. If you wish a list of the people who wish to part with the Nixie's (or have any questions about the article), please send a self-addressed, stamped envelope. If you feel the expense of the Nixie's is not worth the advantages, 10 neon pilot lights will do the job somewhat less elegantly (two of the Nixies are connected in parallel except for the fact that each electrode in I-3 is two greater than that in I-2).

Tuning the unit is not difficult if done systematically. The first step is to get the VFO to cover the proper range. If you use the one whose diagram is included, it is a matter of adjusting the VFO for five mc with the plates meshed by adjusting the shunt capacitor and the coil (either by adjusting the inductance with the slug if you use the surplus form or by spreading or compressing the turns if you use a commercial form). Then unmesh the plates. If the frequency is more than 200 kc higher, increase the capacitance of the shunt trimmer and reduce the inductance of the coil to preserve the five mc starting point. If less

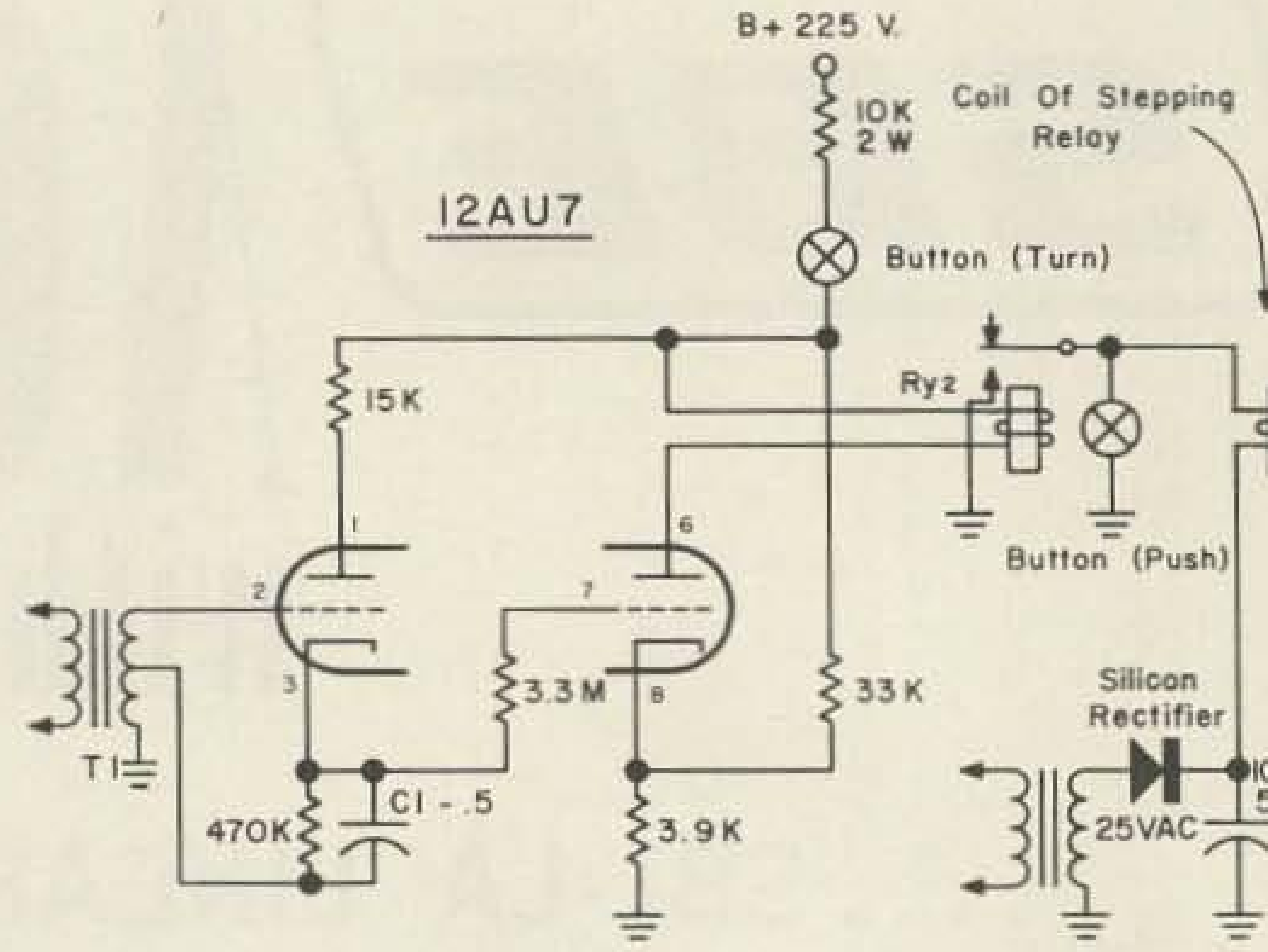


FIGURE 7

T1 Stancor A3856 or equiv, secondary not used.

RY2—6-10 K plate circuit (try to find one with not-too-flimsy contacts).

Button—see text.

C1—.5mfd, must be of high quality and low leakage.

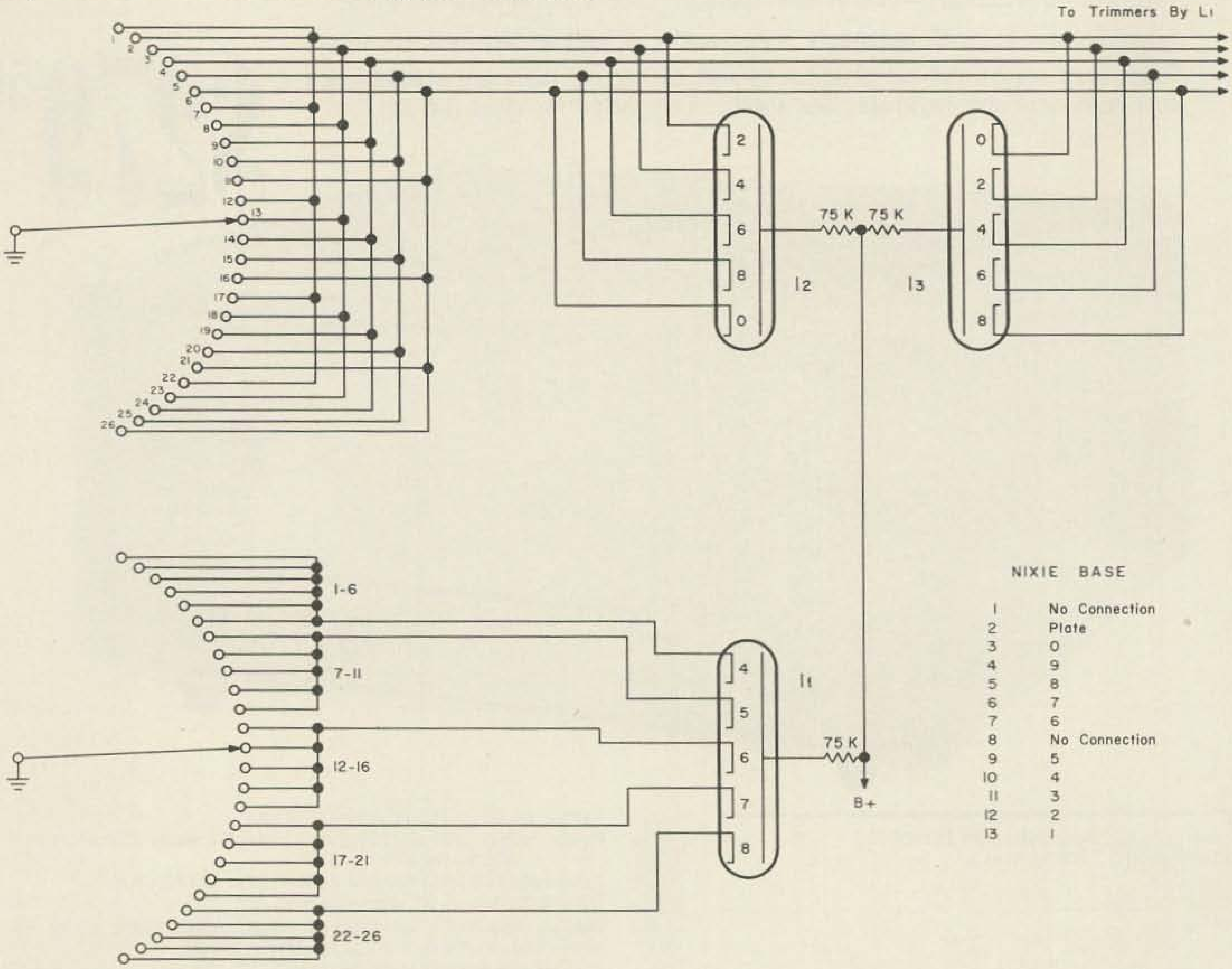


FIGURE 6

Diagram for wiring Nixie tubes to stepping relay. The crystal oscillators are wired similarly but to different wafers.

The capacitors connected to the top of L1 are trimmers for tuning the low frequency oscillator plate circuit.

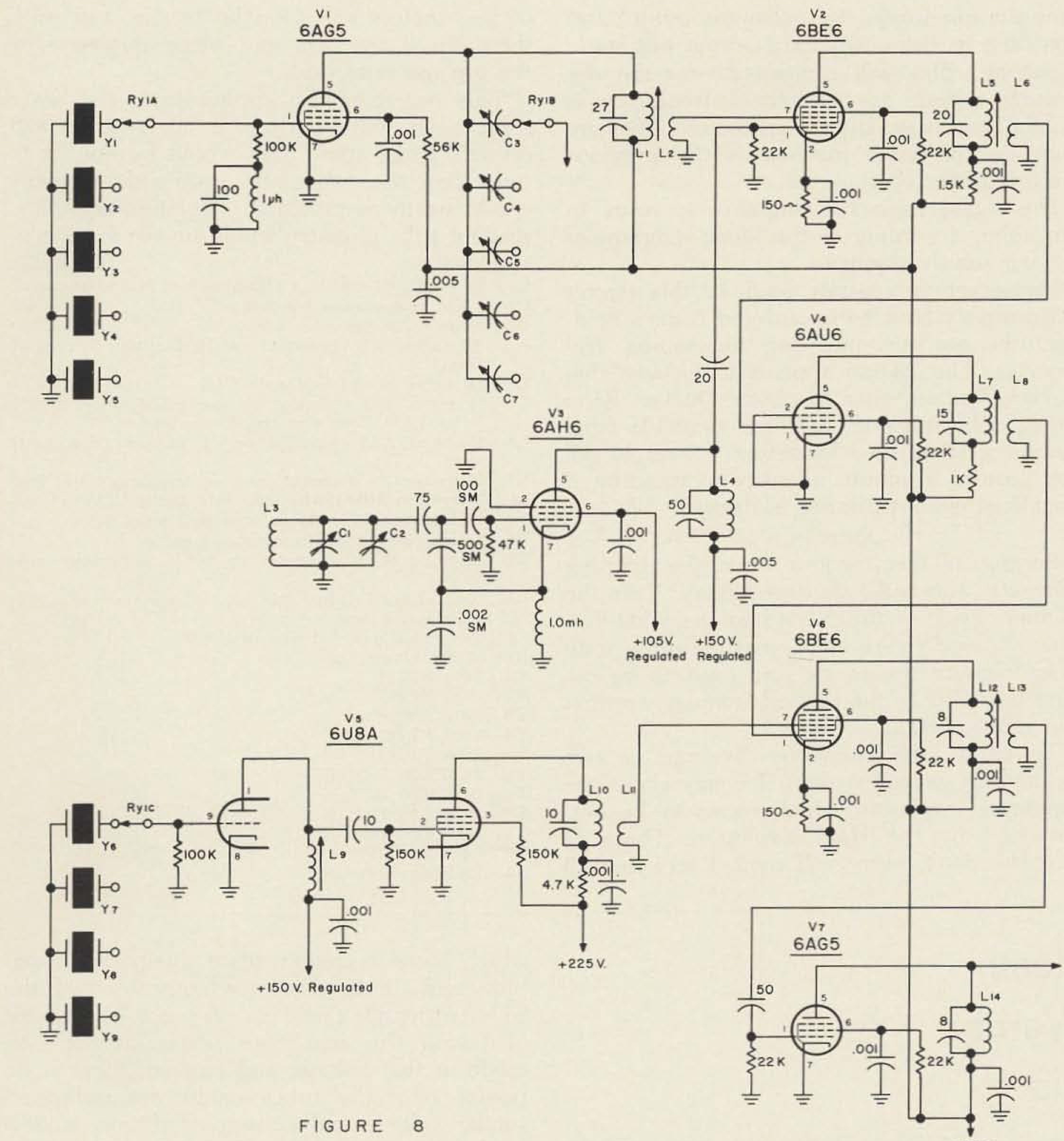


FIGURE 8

than 200 KC higher, do conversely. With the variable capacitor specified, tracking is excellent, varying by no more than 4 per cent at the middle of the dial. This is an error of 8 kc which is unimportant on 2 meters as it cannot put you out of the band. If greater accuracy is necessary, either a chart of reading vs. error can be compiled or you can experiment with other variable capacitors. The output coil is tuned for 5-1 mc and the output shouldn't vary significantly over ± 100 kc.

The first crystal oscillator is tuned individually for each frequency by the stepping relay. Set the relay in any five consecutive positions and adjust the associated trimmer across the output of the oscillator for maximum. If one extremely active crystal is encountered, tune the trimmer slightly off frequency so that the output is approximately constant.

The mixer output and the associated amplifier should first be tuned to 13 mc. Then one should be tuned lower and the other raised until substantially constant output is obtained over the 12.5-13.5 mc range.

The overtone oscillator and quadrupler should be tuned with the lowest frequency crystal in place (29.375 mc). The plate of the triode section of the 6U8A should be tuned through the third overtone frequency (that marked on the crystal) from the high end of the coil's range until oscillation starts. Then give the slug one more turn to insure stability.

Tune the quadrupler for maximum output and then raise its frequency until output just starts to fall off. This will compensate for the decreasing output as the crystal frequency is raised. The mixer output and the amplifier are tuned in the same manner as the previous mixer-amplifier combination.

The signal from the amplifier is yours to use, either according to the block diagram or in your own circuitry.

The overtone crystals used in this circuit will probably have to be ordered from a manufacturer as they are for uncommon frequencies. The 29.625 appears to be available in very limited quantity from Quaker Electronics. The other crystals are available from a number of surplus houses at 50c each. All may require a minute quantity of grinding if exact frequency tolerance is desired.

Operation

Because of the previous work, the stepping relay, etc., this is the shortest section: Turn the unit on. Look at the Nixie's to see what frequency range you're on. Turn the button until it switches to the range you want to be on. Turn the VFO to the desired frequency within that range. Period.

To many, the complete coverage of two meters may seem frivolous. I worry about the population explosion which seems to be outdistanced by the Ham Explosion. Those of you who don't worry will soon. I feel that all of two meters will soon be in use, and until then, there are nets and other reasons why the top mc is in use.

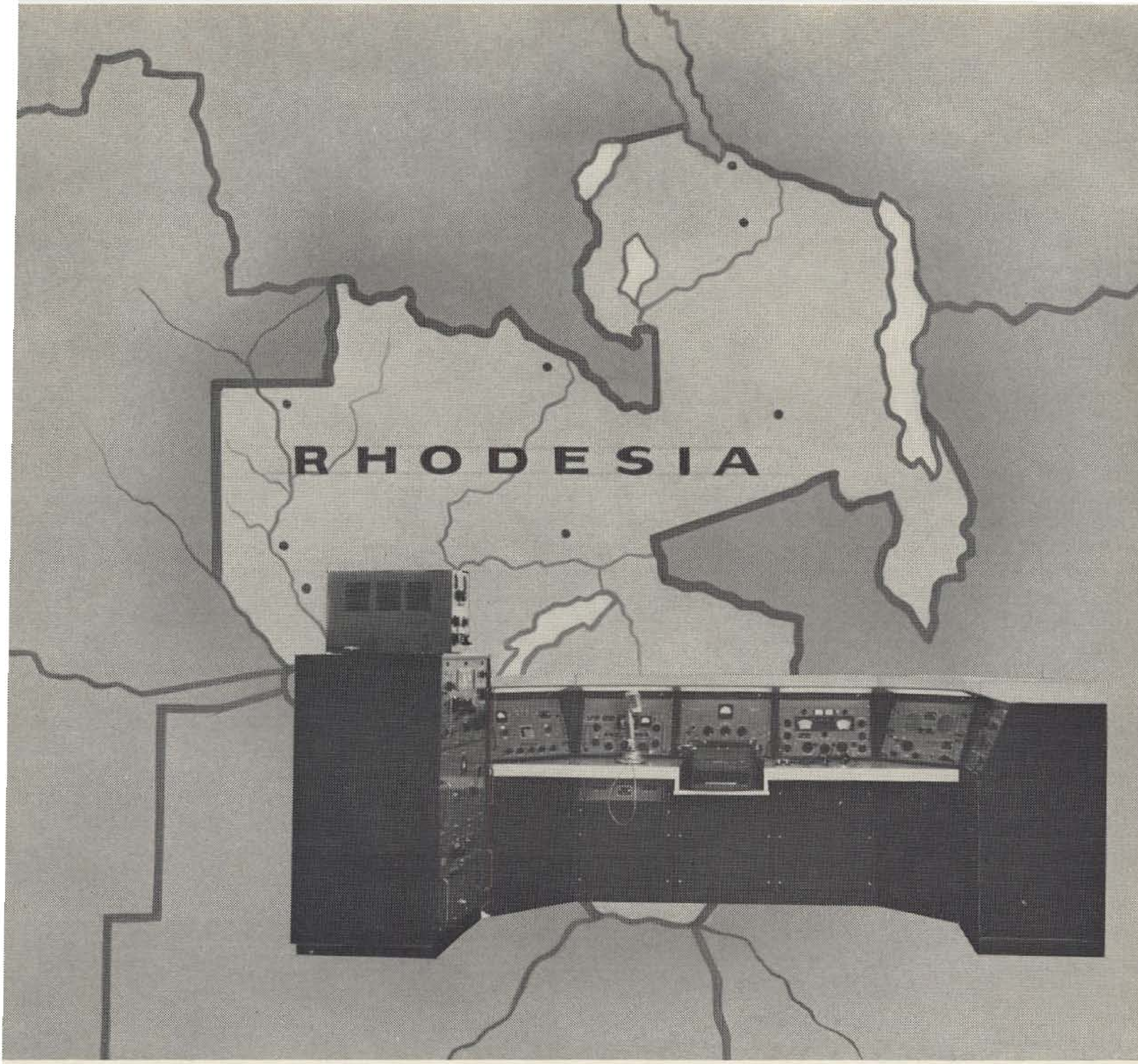
This system is also applicable to the lower frequencies, with perhaps a 20 kc VFO and crystals 20 kc apart. This would be simpler to tune than the two meter unit and for many would be more practical. The stepping relay-readout tube circuitry would be the same convenience. . . . WA2IKL

C1—50pf variable capacitor (Hammarlund MC-50 or equiv.)
C2—3-25pf compression trimmer
C3-C7—3-25pf compression trimmer
L-1—40 turns, #36 enameled on ⅜ in. iron slug tuned form
L2—2.5 turns around cold end of L1
L3—16 turns #22 enameled around coil form in BC458 series VFO (iron slug tuned) see text
L4—45 turns #36 enameled on ⅜ in. iron slug tuned form
L5—20 turns #28 enameled on ⅜ in. iron slug tuned form
L6—3 turns insulated wire over cold end of L5
L7—25 turns nr 28 on ⅜ in. iron slug tuned form
L8—2 turns insulated wire over cold end of L7
L9—20 turns nr 26 enameled on ¼ in. iron slug tuned form
L10, L12, L14, 5 turns #20 spaced one turn on ⅜ in. brass tuned form
L11—1.5 turns insulated wire over L10
L13—2 turns over L12
Y1—7500 FT243
Y2—7700 FT243
Y3—7900 FT243
Y4—8100 FT243
Y5—8300 FT243
Y6—29.375000 HC6/U
Y7—29.625000 HC6/U
Y8—29.875000 HC6/U
Y9—30.125000 HC6/U } All third overtone
RY1—see text
I-1—13 Nixies—see text

Heath Warrior Tip

Present owners of the Heathkit Warrior KW linear amplifier model HA-10 may be interested in making their linear really a true KW amplifier with a very slight modification. I installed a toggle switch between the Power-On switch and the high voltage indicator panel light. This switch is used to shunt the swinging choke in the power supply. The net result—the no load plate voltage increases from 1600 to beyond 2,000 volts. In the CW mode, with 500 MA indicating on the meter, the plate voltage drops to just a shade over 2,000 volts. In the SSB mode I have been able to kick the meter up to 400/500 MA with no evidence of distortion of flat topping. I might add that I did not try this gimmick with the original 811A tubes in the linear, but did use UE 572As which have a greater plate dissipation capability and are directly interchangeable with the 811s. Although the 811s may not be capable of taking this maximum power in the CW mode at that voltage and current, there is no reason why the tubes could not withstand similar voltage and current conditions in SSB application. Just a note of caution: after about three hours of continuous roundtable QSO on SSB, the power transformer gets pretty warm. It is suggested that the "high voltage" position be used when the going gets rough. With the switch in the off position the choke is in the circuit and the linear amplifier is operating normally. Incidentally, the increased voltage from the power supply has no adverse affect on the meter, as the increase beyond 2,000 volts seems to be within the tolerance parameters of the meter. Similarly, no other deterioration on components was noted. On-air reports indicate an increase of talk power under most conditions with the higher voltage application.

. . . W2DOR


RHODESIA

Simplified Receiver Design

become an instant expert

Larry Levy WA2INM/1

"Me design a receiver? You must be some kind of a nut! I don't even know exactly how they work" is the reaction of most amateurs when asked a question like that. Actually, most constructors are scared by the apparent complexity of a complete receiver schematic, and hesitate to consider building one, let alone design it. I must admit that starting with a blank sheet of paper and pencil can be quite a project, even for the technically experienced. Receivers, or any pieces of electronics equipment are not complex when broken down into individual circuits. The only difference between various receivers is the variation in circuit detail which are intended for different applications.

Basically, all receivers and converters are alike. There is usually one or more rf stages, the number and type depending upon the application, one or more mixers, one or more oscillators, one or more *if* stages, an audio amplifier and a power supply. The block diagrams of all receivers and converters are almost exactly alike even though the circuits may appear completely different. By having a selection of each type of circuit, a receiver can be designed for any purpose. In this article, I will try to explain how to combine several of the most useful circuits so as to make a good working receiver for almost any application.

To begin the design of the receiver, it is first necessary to know exactly what it has to do. The next step is to lay out a block diagram, listing each type of circuit (rf amplifier, mixer, oscillator, etc.). Next, choose the individual circuit of each type that most closely

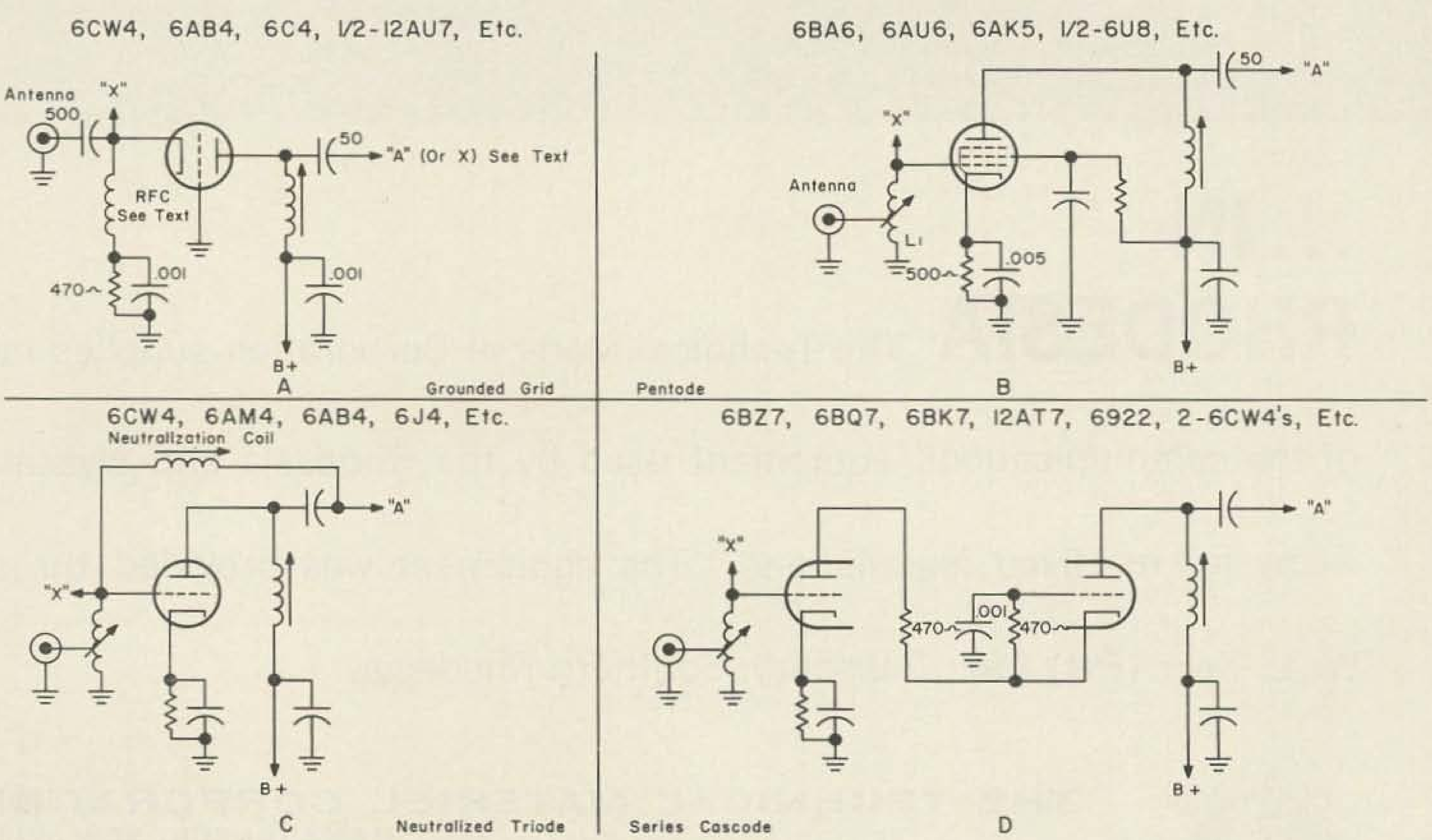


FIGURE 1
BASIC RF AMPLIFIERS

meets the requirements that you have set down. Then, it is only necessary to interconnect the points in the circuit that have the same letters, add the heater connections, and the design is complete. By using this method, even a newcomer can design a working receiver the first time.

The following is a list of the more useful circuits used in receiver design. While this does not come near covering all of the possible circuits, all of the more useful ones for most applications are included.

Rf Amplifiers

Fig. 1A. Grounded grid—A grounded grid amplifier is the simplest of the rf amplifiers given. It is extremely stable and will have an excellent noise figure when used with a low noise triode, such as the 6CW4 nuvistor. The disadvantages are low gain and possibilities of hum modulation. It is usually necessary to combine a grounded grid stage with another rf stage to have adequate gain. A circuit like the pentode shown in 1B will work fine. To combine them, it is only necessary to connect point "A" of the grounded grid stage to point "X" of one of the other stages shown. This will probably result in the best overall noise figure. The rf choke shown should be designed for the operating frequency.

Fig. 1B. Pentode—The Pentode is one of the easier rf amplifier circuits to use as it combines good gain with good stability. The noise figure is not as good as the triode circuits, but is quite useable on and below 50 mc. Only one stage is needed in most cases.

Fig. 1C. Neutralized Triode—The neutralized triode amplifier has good gain and a good noise figure. It does require some care and construction but will provide good performance with only one stage. It is more useful on VHF and when used with high gain low noise triodes like the 6CW4, 6AM4, 417A, and similar tubes.

Fig. 1D. Series Cascode—This circuit is widely used because of its high gain, good noise figure, good stability, and ease of construction. Its most common usage is in VHF circuits using any of the casode tubes available, although it could be used with two nuvistors, for example. On two meters, it may be necessary to replace the 470 ohm resistor with a small neutralizing coil to obtain the best noise figure.

Mixers

Fig 2A. Simple Triode—This is the simplest of the mixers given. The advantages are good overload characteristics, low noise, and simplicity of construction. The disadvantage is that the gain tends to be low.

Fig. 2B. Simple Pentode—This provides more gain than the circuit shown in 2A. It does not have the noise figure or overload resistance of the triode circuits but is adequate for most cases.

Fig. 2C. Cathode Injection—This circuit probably has the best characteristics for a single tube mixer. Its gain is better than 2A but not quite as good as 2C. It has very high overload resistance and low noise. It does require somewhat more oscillator injection and is recommended for circuits using crystal controlled oscillators. The high degree of isolation makes it good for tunable oscillators at the lower frequencies where adequate drive is available as it will reduce pulling by the received signal. Most oscillators will not have enough output above 28mc (tunable oscillators) to drive this properly unless the plate voltage is raised to a point where stability is effected.

Fig. 2D. Twin Triode—This mixer has the highest degree of isolation between oscillator and received signal. Its high sensitivity makes it ideal for VHF tunable converters. It has good noise characteristics, good gain, and high resistance to overload.

Fig. 2E. Double Conversion—This is an example of how two mixers are combined for double conversion. Both mixers shown are of the type given in 2A. It is possible to use any combination of mixers. *If* frequencies should be carefully considered. The first one should be high enough to eliminate images and the second should be low enough to get the desired selectivity.

Oscillators

Fig. 3A Hartley—The most simple and relia-

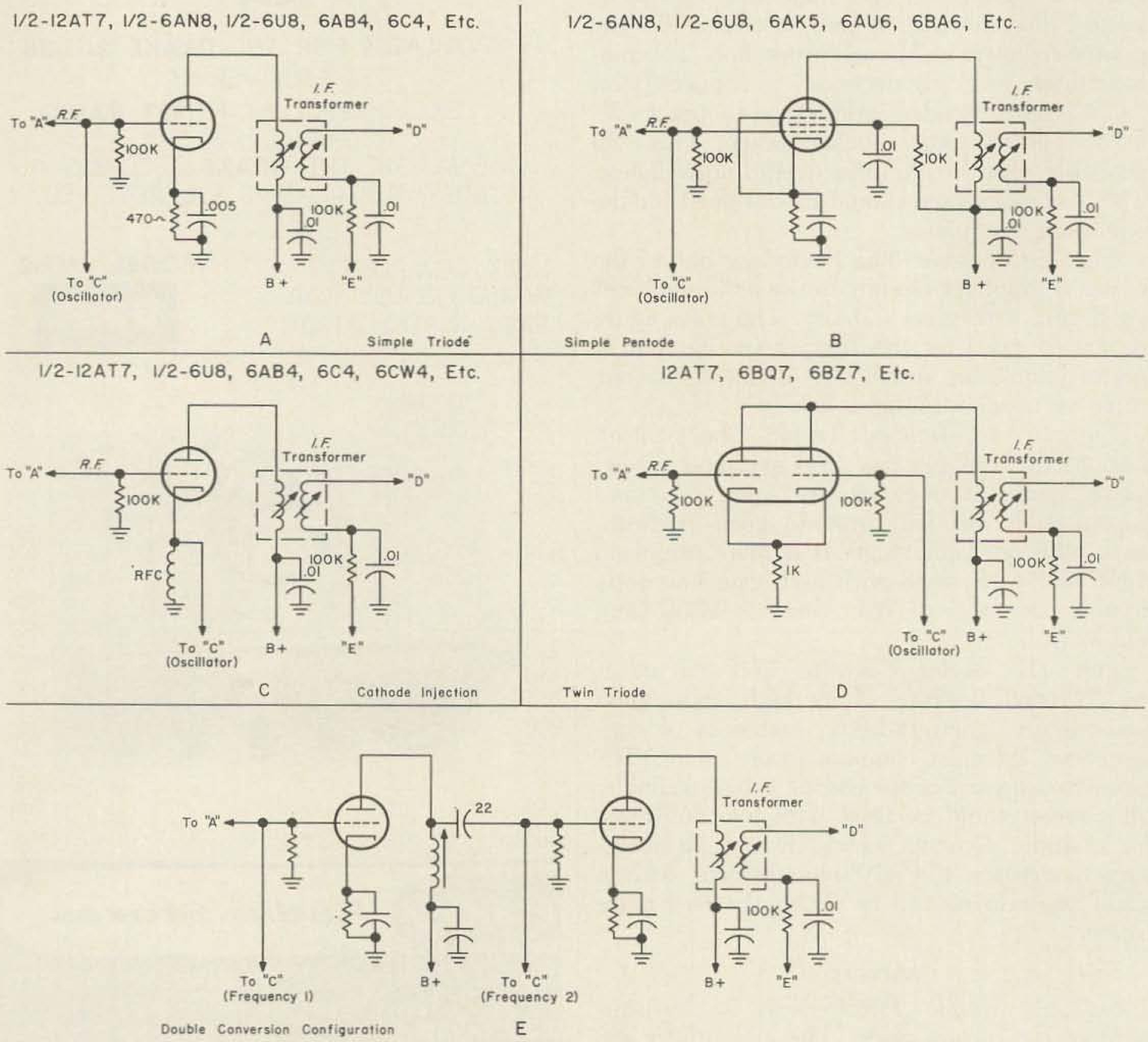


FIGURE 2
BASIC MIXERS

T.M.

COMPREAMP

WATERS "COMPREAMP" AUDIO PREAMPLIFIER/LIMITER — MODEL 358

The Waters Compreamp increases the effective speech power output of a transmitter up to four times. It is a self-contained, battery powered, two stage transistorized audio amplifier/limiter designed to be used with all types of radio transmitters.

The Compreamp is connected between the station microphone (50,000 ohm dynamic or high impedance ceramic) and the transmitter microphone input connector. No wiring changes are required in the transmitter. Provision is made for switching the Compreamp in and out of the circuit, and for adjustment of the Compression Level. The Compreamp may also be used with tape recorders and public address system amplifiers to increase effective speech power and dynamic range.

Specifications

Input Impedance	100 K ohms (nominal)
Input Level	.005 to .020 volts
Gain (voltage)	10 db (minimum)
Output Level	.060 volts
Output Impedance	50 K ohms (nominal)
Power Source	9 volt Burgess 2U6 or equivalent
Size	2¾" high, 3" wide, 4½" long
Price	**$27.95**, less battery

UNIVERSAL HYBRID COUPLER II

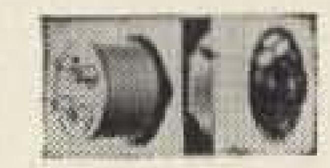
The NEW Waters Universal Hybrid Coupler (Model 3002) not only acts as a coupler between the phone and your transmitter and receiver (SSB too), but also has a built in compressor amplifier in the microphone circuit which can be adjusted from 0-12 db by a front panel control. This coupler can be used with a tape recorder if you aren't interested in phone patches. It can also be used with a tape recorder if you are interested in phone patching. Very versatile. **$69.95.**

RETROFIT KIT FOR UNIVERSAL HYBRID COUPLER I

The Compreamp Retrofit Kit for the Waters U.H.C. Model 3001 comes complete with printed circuit board assembly, potentiometer, toggle switch, escutcheon plate capacitor and battery holder assembly, all necessary mounting hardware, drilling templates and complete, step-by-step instructions and operating hints. Converts U.H.C. Model 3001 to U.H.C. Model 3002. Can also be used to "build-in" to your own equipment. Electrical specifications same as Model 359. **$19.95**, less battery.

OTHER STUFF

Dummy (no offense) Load Wattmeter.



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WATERS — WAYLAND MASS

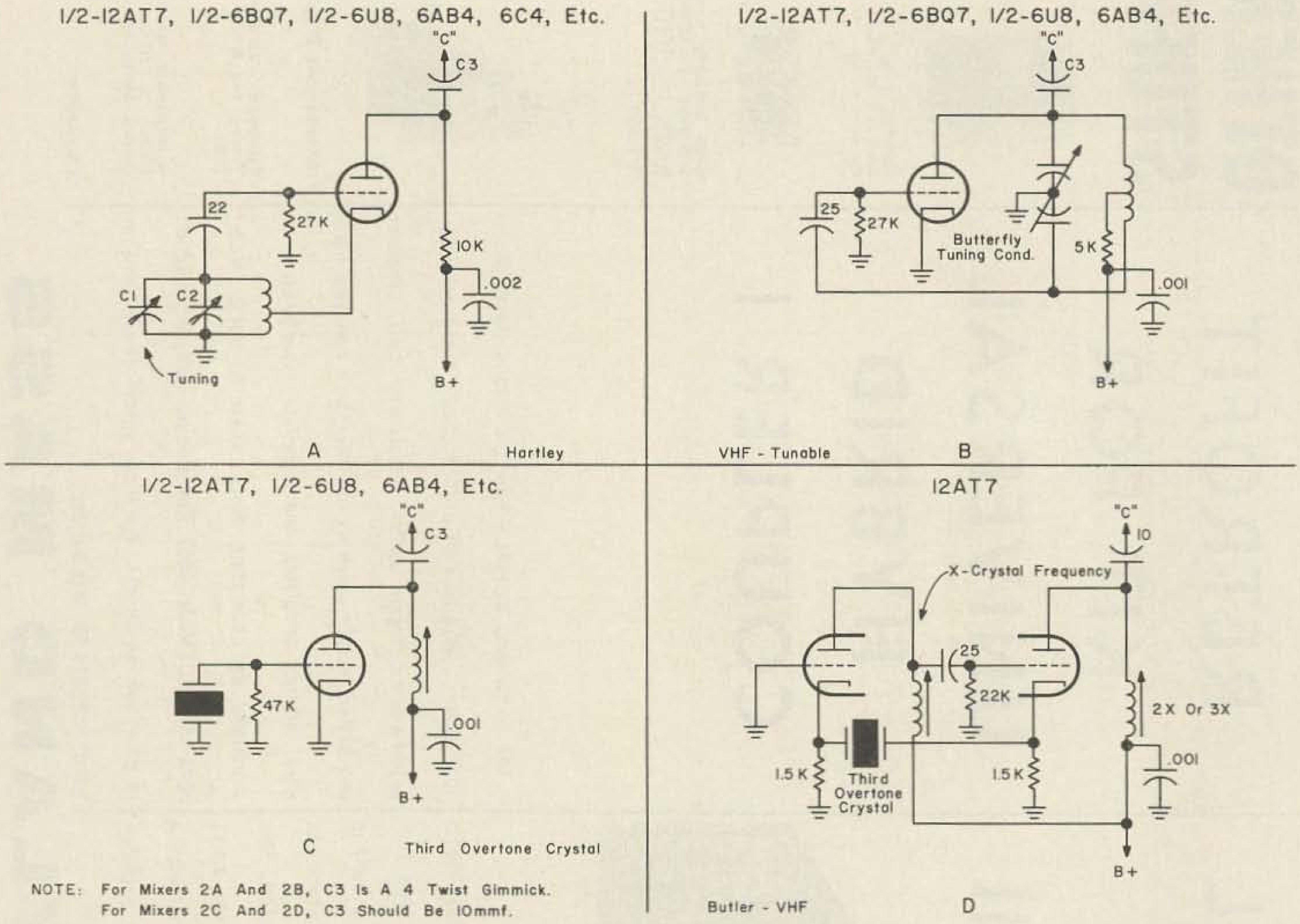


FIGURE 3
BASIC OSCILLATORS

ble oscillator for the lower frequencies. It has good stability and reasonably good output. The tap on the coil should be between 10 and 20% of the number of turns of the coil off the ground. C2 is a trimmer with a maximum capacity of between ⅛th and 1/3rd of C1. The circuit is good up to about 60 or 70mc.

Fig. 3B. VHF Tunable—This circuit should be used over 100mc because of its ease of construction. Using a butterfly condenser and a double-tuned coil, it is much easier to construct because of the size of the coil, which would be ridiculously minute in a single-tuned circuit. A very sturdy stiff-bearinged butterfly should be used, very securely mounted, with the coil soldered across the two terminals.

Fig. 3C. Third Overtone Crystal—This is used for fixed converters (tunable *ifs*) on VHF or the first conversion in a multiple conversion receiver. It has good stability and good output up to the frequency limit of the third overtone crystals.

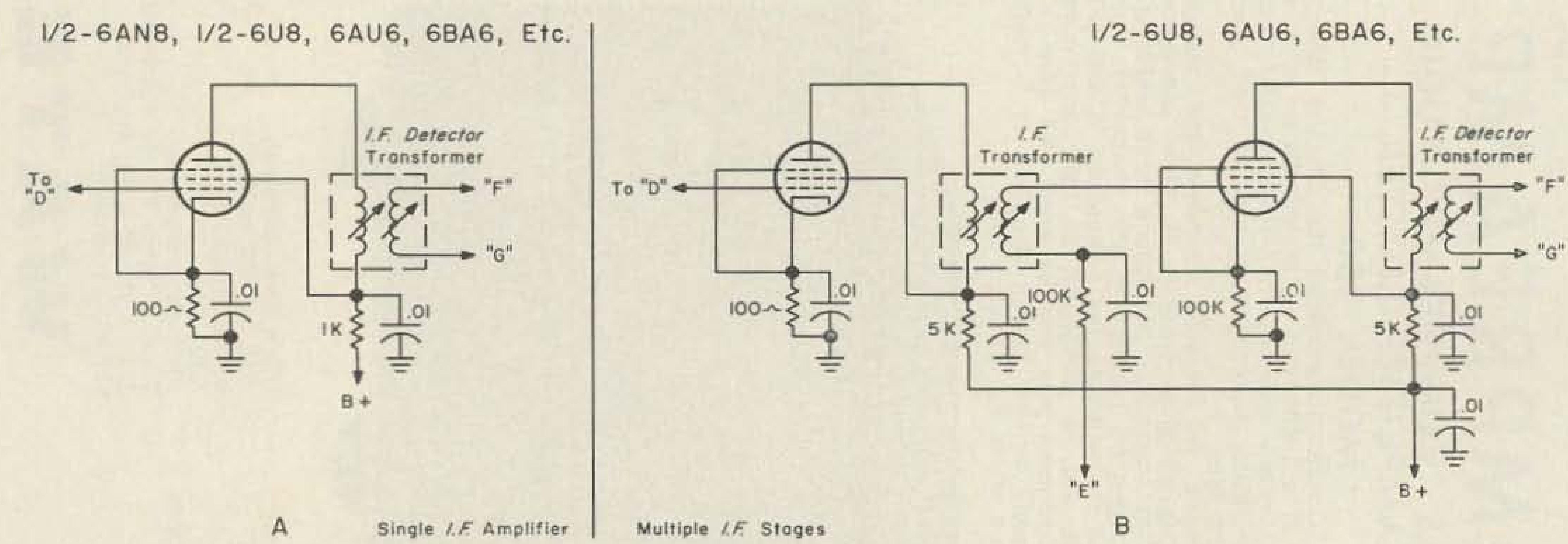


FIGURE 4
BASIC I.F. AMPLIFIERS

Fig. 3D. Butler—The modified butler oscillator is used for higher frequencies than can normally be obtained with third overtone crystals. Using a third overtone crystal, the output can be twice or three times the frequency, making possible easy converters for 220mc.

If Amplifiers

Fig. 4A. Single If—This provides adequate gain for most simple receivers. Using a reasonable frequency, satisfactory results, with respect to selectivity and sensitivity, can be obtained.

Fig. 4B. Multiple Ifs—These are used when a single *if* is inadequate. It is necessary to have more than one stage if a very low frequency is used for selectivity or gain will be low. It can also be used to build up selectivity using a high frequency with single conversion. Not

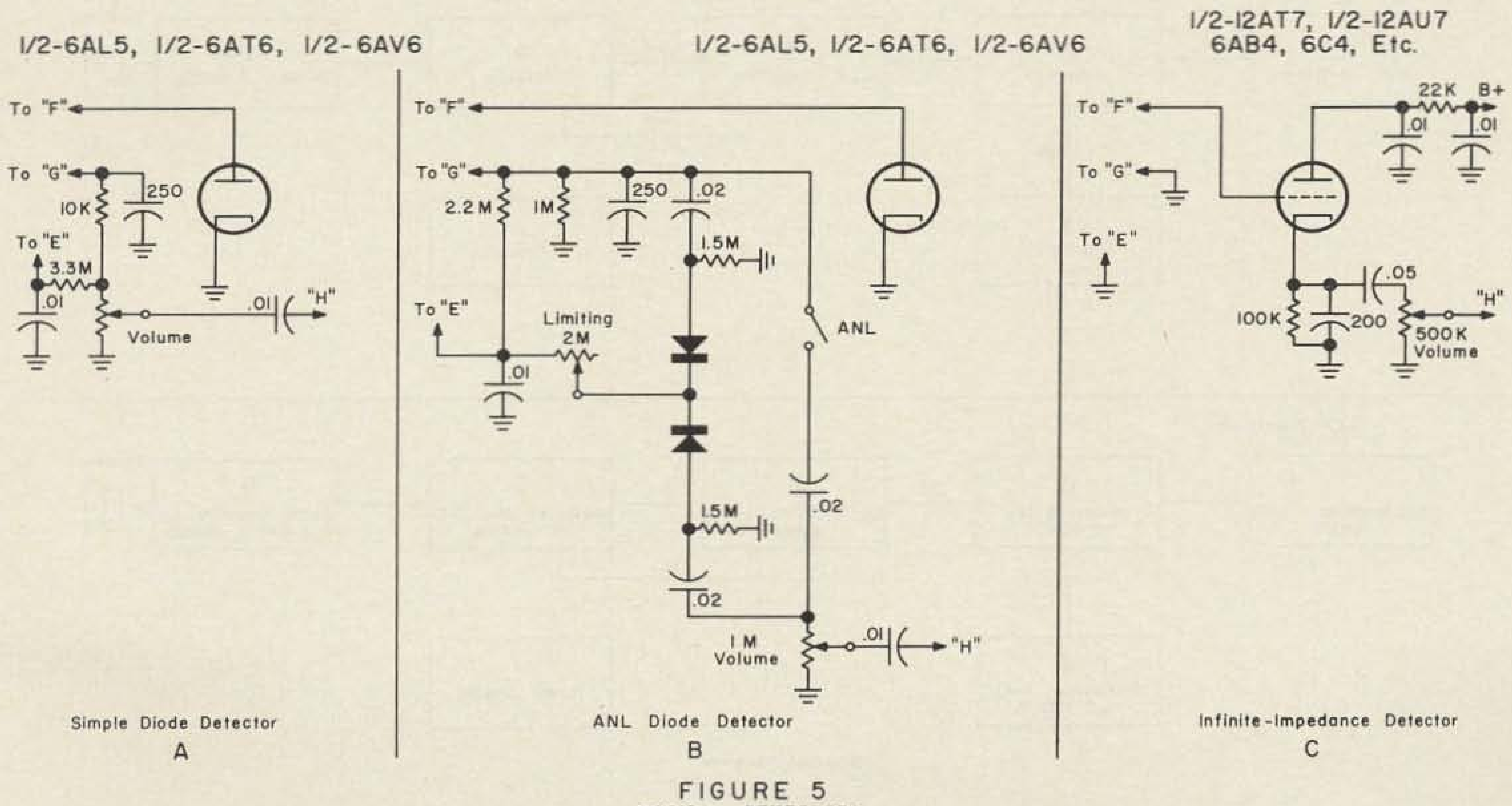


FIGURE 5
BASIC DETECTORS

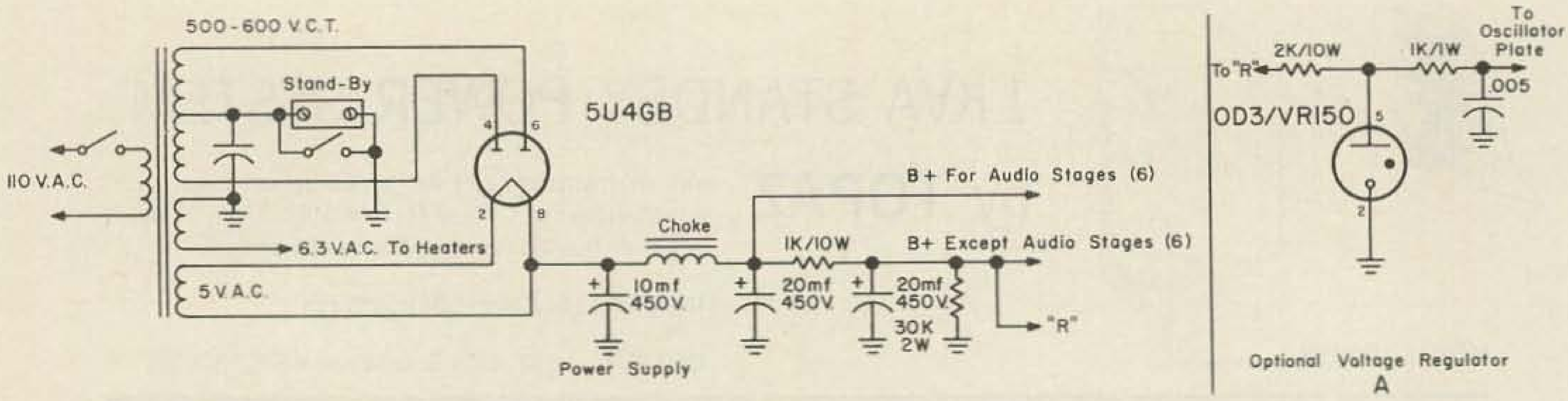


FIGURE 7

more than two stages are recommended, as stability becomes a problem.

Detectors

Fig. 5A. Simple Diode—This is the most commonly used detector. It has good output and provides adequate avc. It is usually found combined with some kind of a noise limiter.

Fig. 5B. ANL Diode Detector—This circuit combines the detector shown in Fig. 5A with a full wave series limiter. The limiting control should be adjusted for 100% modulation on an average signal.

Fig. 5C. Infinite Impedance—This detector, while not widely used, has one good advantage. It can be used to obtain high selectivity from a signal *if* stage as it does not load down the last *if* transfomer like a normal diode, therefore giving better selectivity. Overload resistance is very high. The disadvantage is that there is no avc.

Audio Amplifier

Fig. 6. Audio Section—This amplifier will

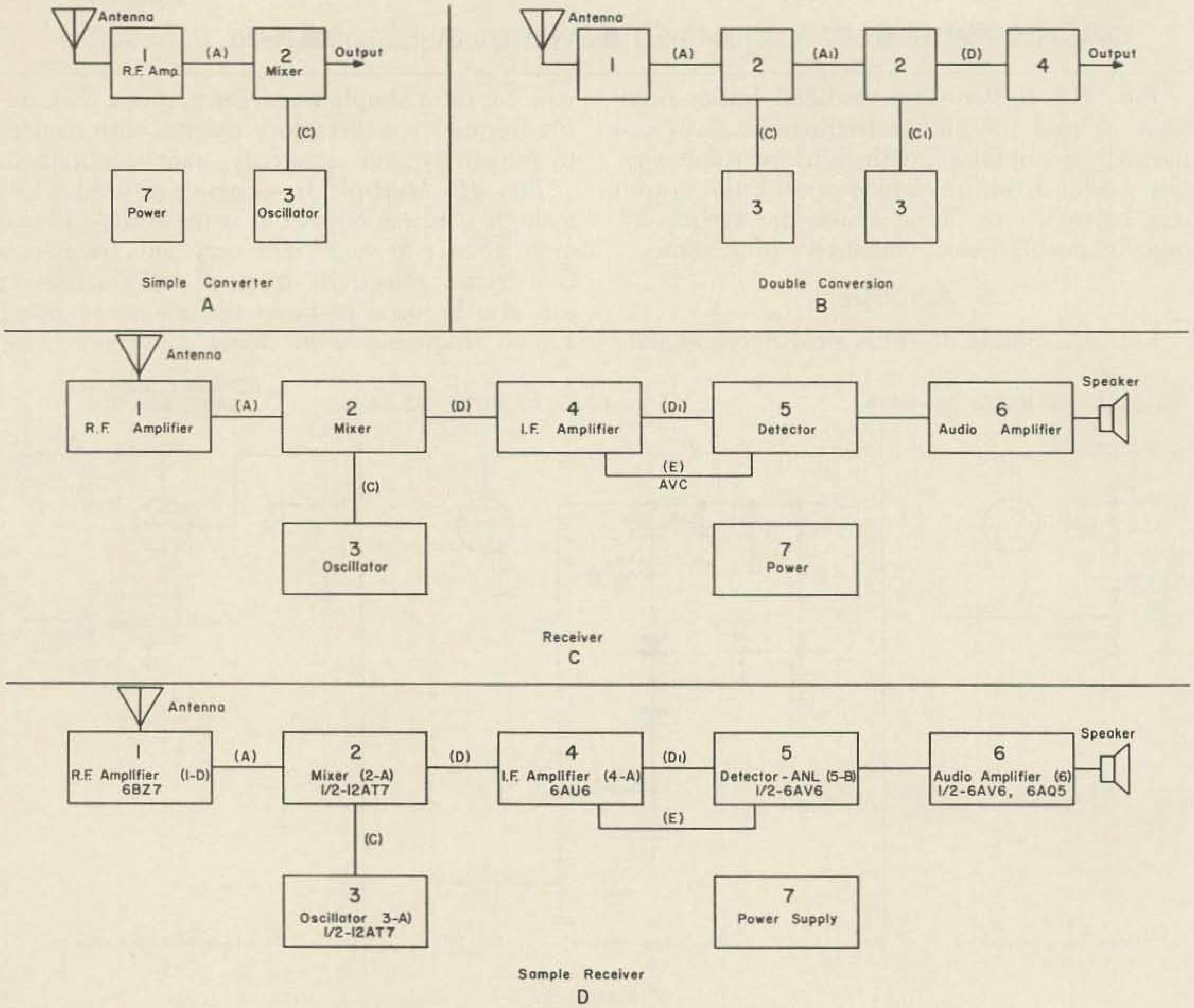


FIGURE 8

CORRECTION

In the Europe on $2000 a day article last month the printer got the fellows in the RSGB photo turned around. Apologies. We'll continue the story next month.

work well with all the circuits shown. It has good gain and adequate output.

Power Supply

Fig. 7. The power supply recommended is a full wave one giving about 250v output. Filtering should be good to prevent hum modulation of the oscillator. Silicon diodes can be used in place of the 5V4.

Block Diagrams

This is the real secret in receiver design. First calculate what characteristics a receiver should have. After deciding whether it should be a simple or complex, single or double conversion, etc. receiver, lay out block diagrams

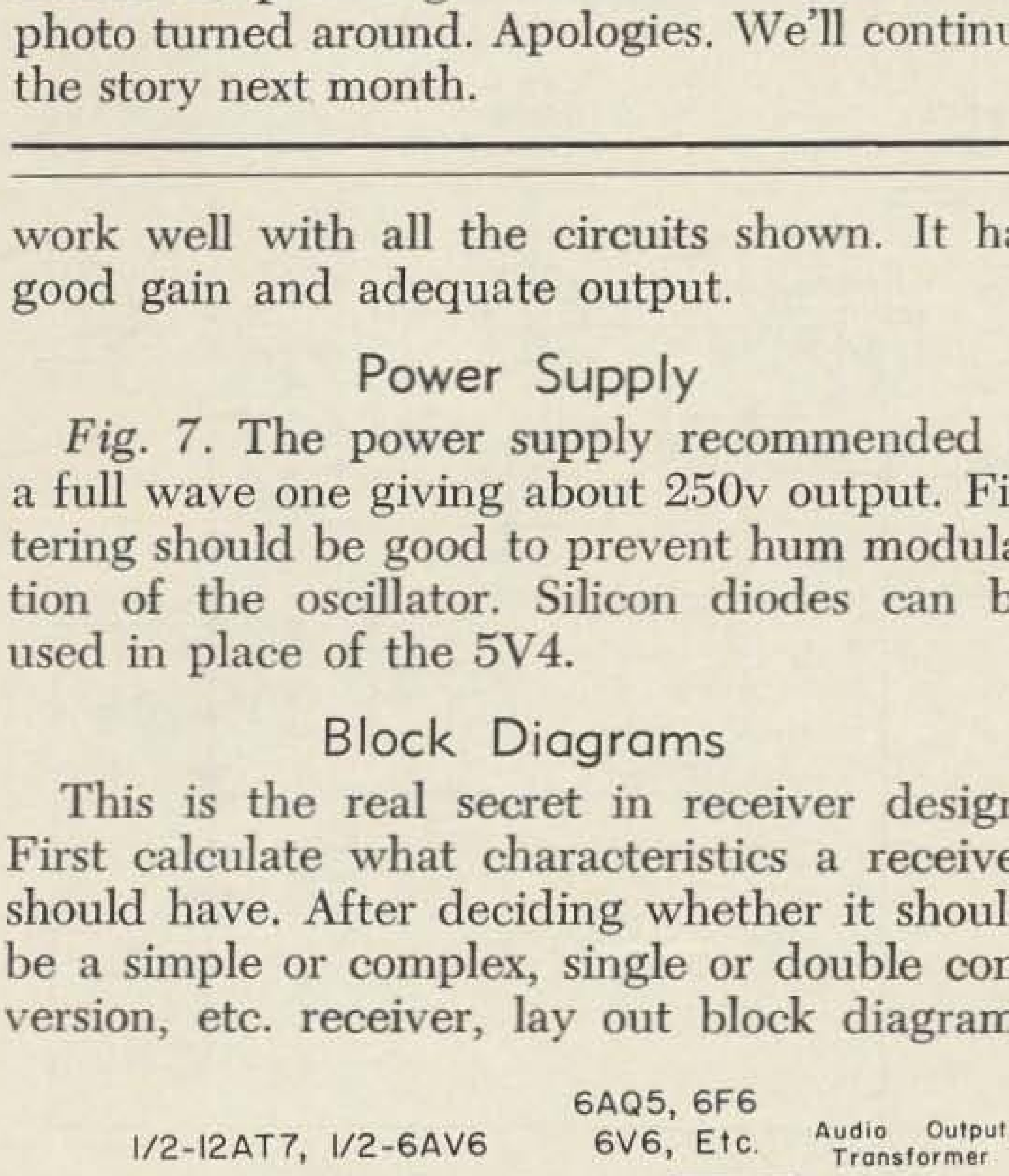
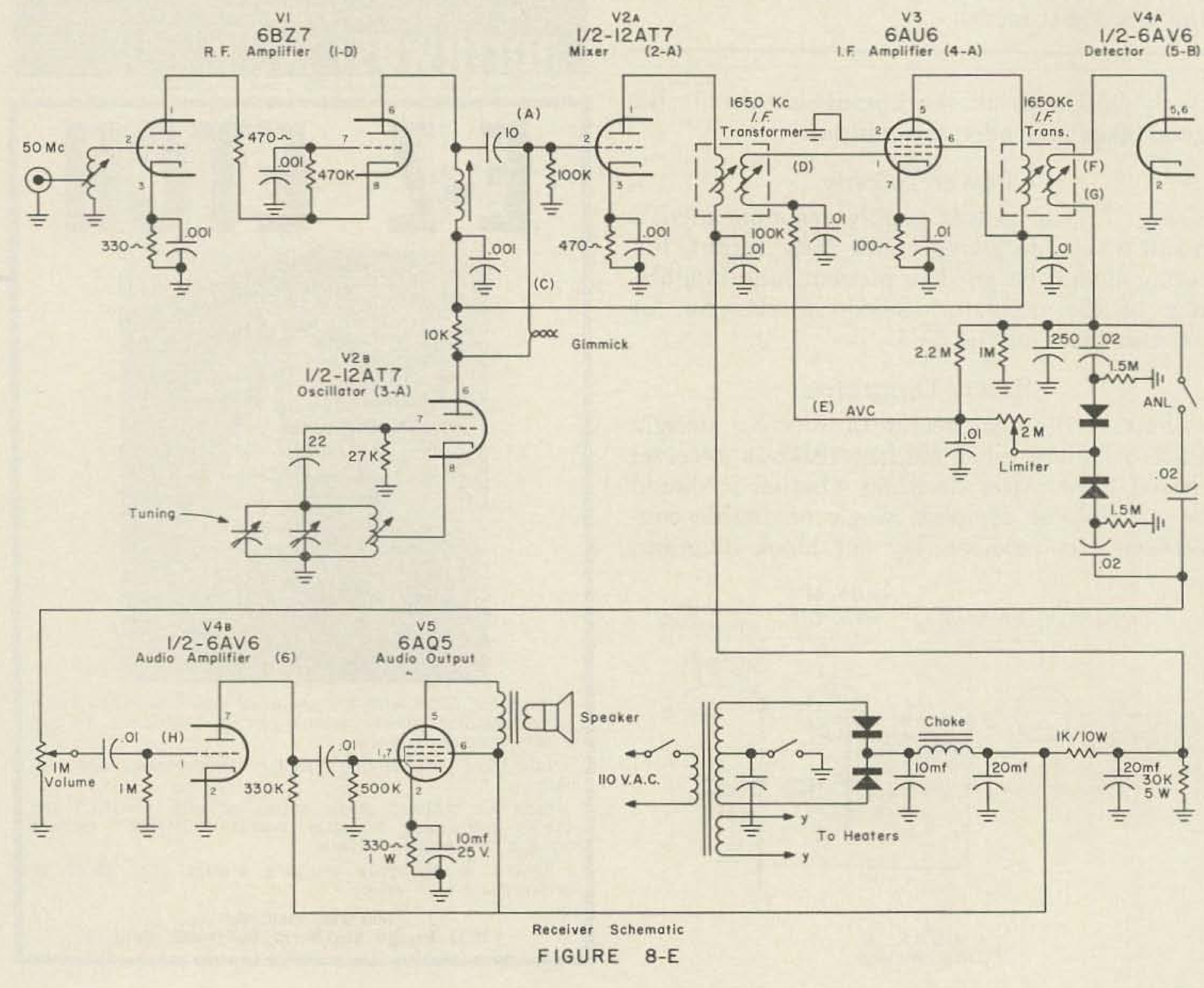


FIGURE 6
AUDIO SECTION

of the type shown in Figs. 8A, B, and C. Next determine performance characteristics by choosing the individual circuits to go in each box, using a combination of circuits to meet the various requirements you have chosen. All the circuits given here will work in any combination with satisfactory results, so it is therefore possible to use any oscillator with any mixer with any rf amplifier, etc. This leaves quite a large combination of possible receiver circuits that can be designed to meet any specific requirements. Fig. 8A shows a block diagram for a simple frequency converter. It can either be fixed or tunable, depending upon the oscillator circuit chosen. This would be the basic design for a VHF converter. Fig. 8B illustrates a double conversion configuration for a more advanced receiver. One of the two oscillators is tunable, almost invariably the second one. Fig. 8C shows a block diagram for a complete single conversion receiver. Just to illustrate a point, I am going to design a complete receiver using the block diagram shown in 8C. It is going to be a 6 meter single conversion receiver, designed for monitoring and general hamming. I want it to have reasonably good gain, a good noise figure, moderate overload resistance, somewhat broad selectivity so I can use it on nets, and a noise limiter. For this purpose, the best rf amplifier would be the Series Cascode. Looking in my junkbox I see a 12AT7 and a 6BZ7. I figure that the 6BZ7 would be good for the rf amplifier, so that I can use the 12AT7 as an oscillator-mxer. Consulting my chart, I find that mixer 2A, utilizing one-half of a 12AT7, meets the necessary requiremets. The other half is used as an oscillator in circuit 3A. Now that the front end is designed, pencil in the numbers of the diagrams and tubes into the boxes. Next add an *if* stage, the one shown in 4A being fine, a detector–arl as shown in 5B, an audio amplifier and a power supply. A 6AU6 makes a good *if* amplifier and a diode-triode like the 6AV6 is good for a detector and first audio. According to the requirements an *if* frequency of around 1650 kc is chosen as it combines good gain, moderate selectivity, and fair image rejection for a 50 mc receiver. It is also necessary that there be *if* transfomers available for the frequency chosen. Next, add the interconnecting lines, and the block dia-



Receiver Schematic

FIGURE 8-E

gram is complete. The next step is the drawing of the schematic. Look up the diagrams and copy them on paper, connecting signal points with similar letters. Now add B plus lines and heater leads from the power supply, and the design is complete. The complete schematic and block diagram for this receiver is shown in Figs. 8D and 8E. After checking the schematics for errors, get out your soldering iron and get to work.

. . . WA2INM/1

Making a High Value AC Capacitor

Jim Kyle K5JKX
1236 N. E. 44th St.
Oklahoma City, Okla.

The trick of making a high-value ac capacitor from a pair of electrolytics connected back-to-back as shown in Fig. 1 is so old it has a long gray beard.

But there's a way of doubling the capacitance of the resulting unit, as well as providing a little better voltage-rating protection of both electrolytics.

When connected back-to-back as in Fig. 1, the two electrolytics are effectively in series, so that the resulting ac capacitor has only half the capacitance of either unit alone. In addition, all the reverse-polarity voltage is impressed across whichever capacitor happens to be the "wrong way" during any half-cycle, so that a fairly high margin of safety is required in the voltage ratings.

But by adding a pair of semiconductor diodes connected as shown in Fig. 2, the ac is converted to dc so far as the capacitor is concerned. It remains ac, however, on the outside of the composite unit as each half-cycle passes

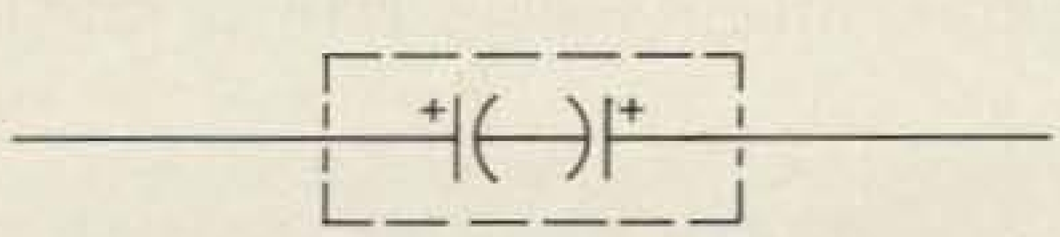


FIGURE 1

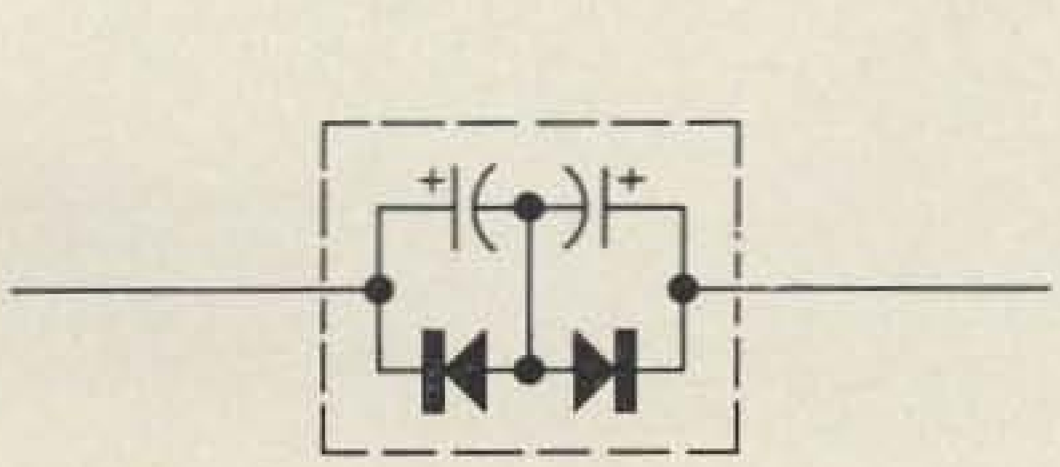


FIGURE 2

through its own diode and capacitor and the two halves are re-joined at the output.

Since only one capacitor is in the circuit at any time (the other being shorted out by its diode) the effective capacitance rating is equal to that of a single capacitor, or twice that of the simple back-to-back hookup.

And since reverse-polarity voltage is shorted out from the inactive capacitor, no excessive safety margin in voltage rating is necessary. The capacitors need only be rated to withstand dc equal to the *peak* value of the ac voltage impressed across them. The diodes must also be rated for this PIV.

In audio and similar applications, type 1N34 diodes may be used. In power applications, silicon power rectifiers are fine. A 120 mmfd 120 vac capacitor may be built using 120 mmfd 200 vdc electrolytics and 200 PIV rated diodes; 450-volt capacitors and 400 PIV diodes are good up to 275 V rms.

One of the more common ham applications of this trick is in repair of antenna rotators. Most of the present-day rotator designs use a large-value ac capacitor to control direction of rotation. Typical ratings are 100 to 150 mmfd, and the rms voltage is nominally 24 volts. Capacitors of this type are not usually found in our junkboxes, so that if the capacitor goes out we must order a replacement from the factory. Using this trick and a pair of 100 to 150 mmfd, 50 vdc electrolytics (of the same capacitance rating as the original unit) together with 50-PIV diodes (or the more common 400-PIV types if you happen to have them on hand) you can get the rotator back in action almost immediately.

. . . K5JKX

Heat Dissipating Tube Shields

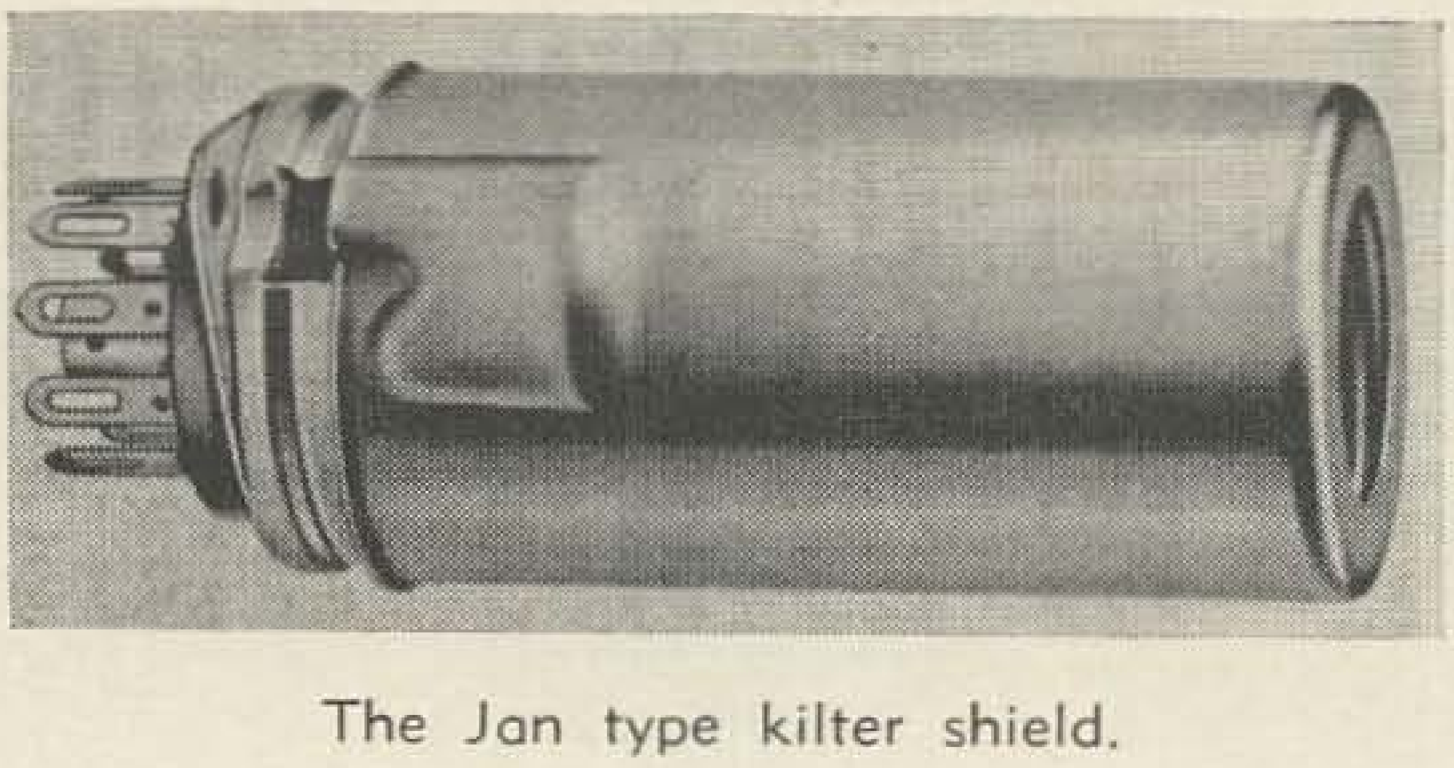
Michael Neidich K2ENN
931 Walt Whitman Rd.
Huntington Sta., N. Y.

"Show me a man who has never replaced a tube in his rig and I will show you a man who has not figured out how to turn his rig on."

The subject of amateur equipment failure is one which is often discussed like the weather, but no one ever does anything about it. The use of heat-producing vacuum tubes in receivers and transmitters is here to stay, at least until the time that transistors with their inherent longevity gain an increased measure of acceptance. For the moment, we are concerned with failures in any piece of equipment which uses heat-producing vacuum tubes.

Some of us may never have had to change or replace a tube or have had to send a rig back to the manufacturer for repair. This depends very heavily on the degree to which the rig is turned on. Also, if you trade it in very often, you won't have much of a servicing problem. What now follows will not be of much interest to this minority. We will be concerned with prolonging tube life, and as we shall see later, this is accomplished by reduction of tube operating temperatures.

Toward the end of World War II, the U. S. Military became interested in determining the cause of unreliability in electronic equipment. They performed many surveys and studies, directly and through contracts, the outcome of which showed two basic facts. First, resistors and capacitors caused between 6 and 7 percent of the failures, and vacuum tubes showed more than 75% of them. Secondly, the greatest single cause of tube failure is high operating temperature. While resistor and capacitor life is definitely affected adversely by elevated temperatures, their failure rate is small, com-



The Jan type kilter shield.

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Now the top favorite of VHF Amateurs everywhere, Clegg's INTERCEPTOR receiver, in 1964 offers even more spectacular performance.

The new "INTERCEPTOR B", now available at your dealers, is a dual conversion 50-54 mc receiver with a self-contained crystal controlled converter for 144-148 mc reception. A switchable crystal lattice filter permits extremely sharp selectivity for SSB and CW as well as providing 8 KC of bandpass for strong local signals and net operation. Both diode and product detection are provided. Automatic and variable threshold noise limiters function respectively for AM and SSB/CW reception. A new electrical band spread control provides ± 1 KC to the receivers main tuning dial for ease in tuning SSB and CW signals.

Converter input provides for 220 - 432 mc and up, as well as for excellent general coverage of the lower frequency bands using Clegg's new ALLBANDER converter/speaker combination (described to the right).

Space will not permit a complete description of this fine new receiver, but we'd like to suggest that you see one at your dealers or write to the factory for complete data

ADD SUPERB GENERAL COVERAGE 3 THROUGH 30 MC TO YOUR INTERCEPTOR RECEIVER (Either B or Earlier Model)

The new Clegg ALLBANDER converter/speaker combination, attractively packaged in a matching cabinet, now extends the tuning range of any INTERCEPTOR receiver to completely cover all frequencies (with the exception 22-27 MC) between 3 and 31 megacycles.

Frequency range and preselector controls provide easy selection and matching of the desired tuning range while the INTERCEPTOR contributes superb selectivity, sensitivity and stability. After adjustment to the desired frequency segment all tuning is accomplished with the INTERCEPTOR'S main tuning dial.

With the ALLBANDER your INTERCEPTOR will not only receive all ham bands between 3-30 MC but also intermediate frequencies where many desirable signals (WWV, Citizens Band, foreign broadcast, etc.) are found.

Operating power is supplied by the INTERCEPTOR.

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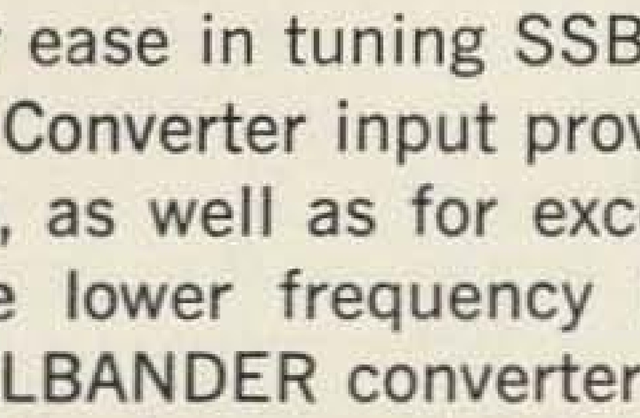
Visit your distributor today and see the famous Clegg family that is making VHF history.



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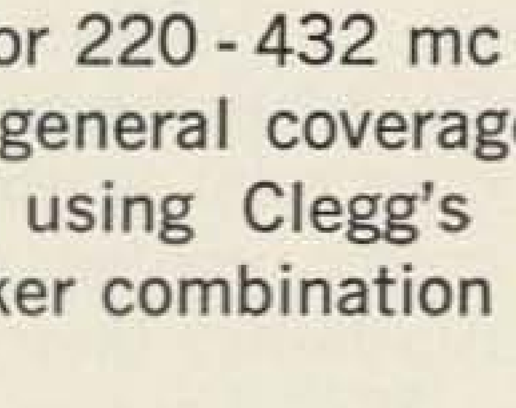

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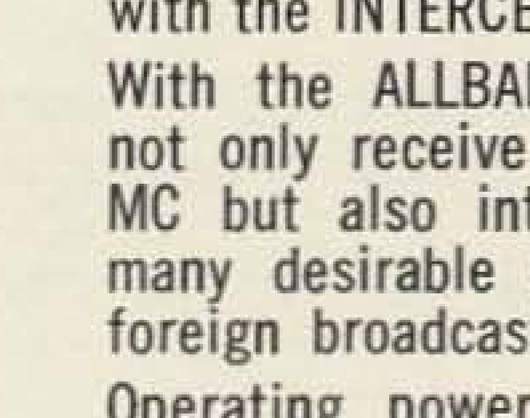

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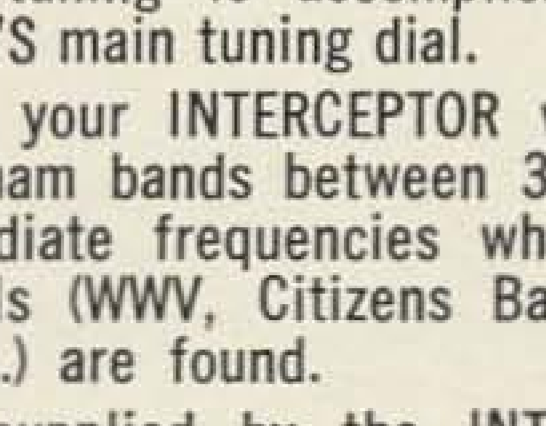

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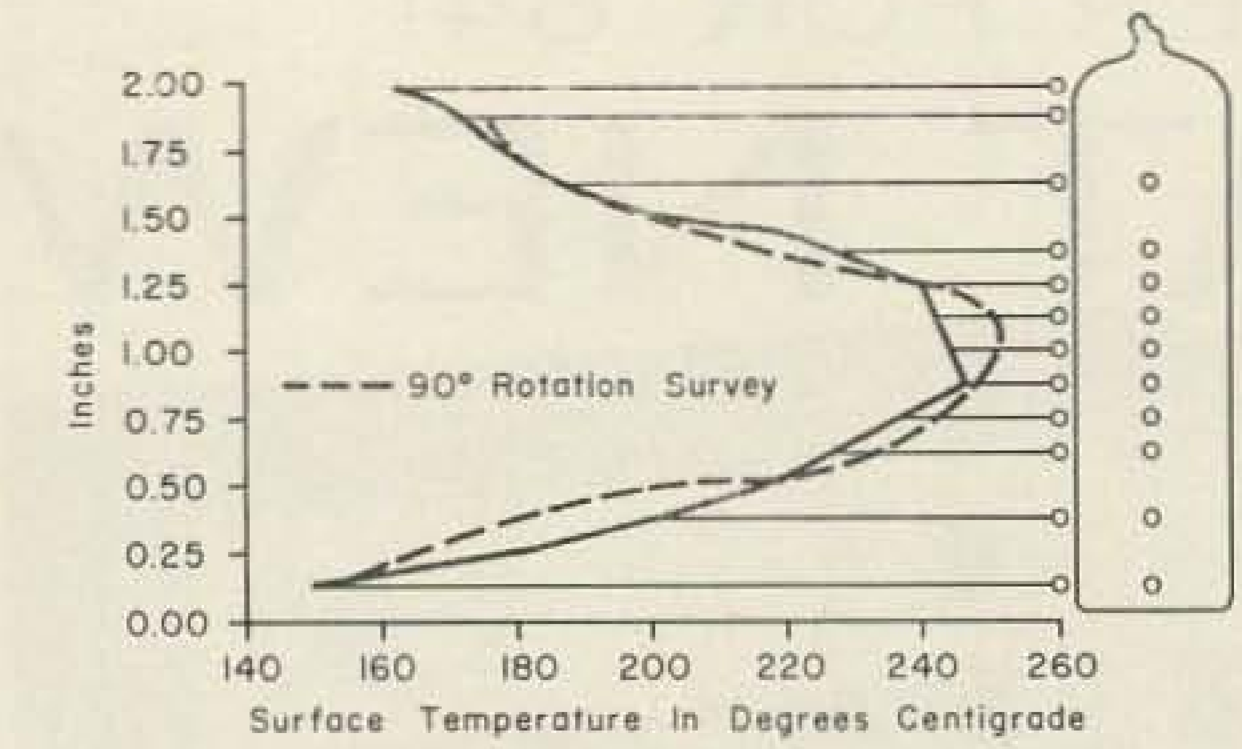


FIGURE 1

6005/6AQ5 operating at maximum plate dissipation (45° ambient temp).

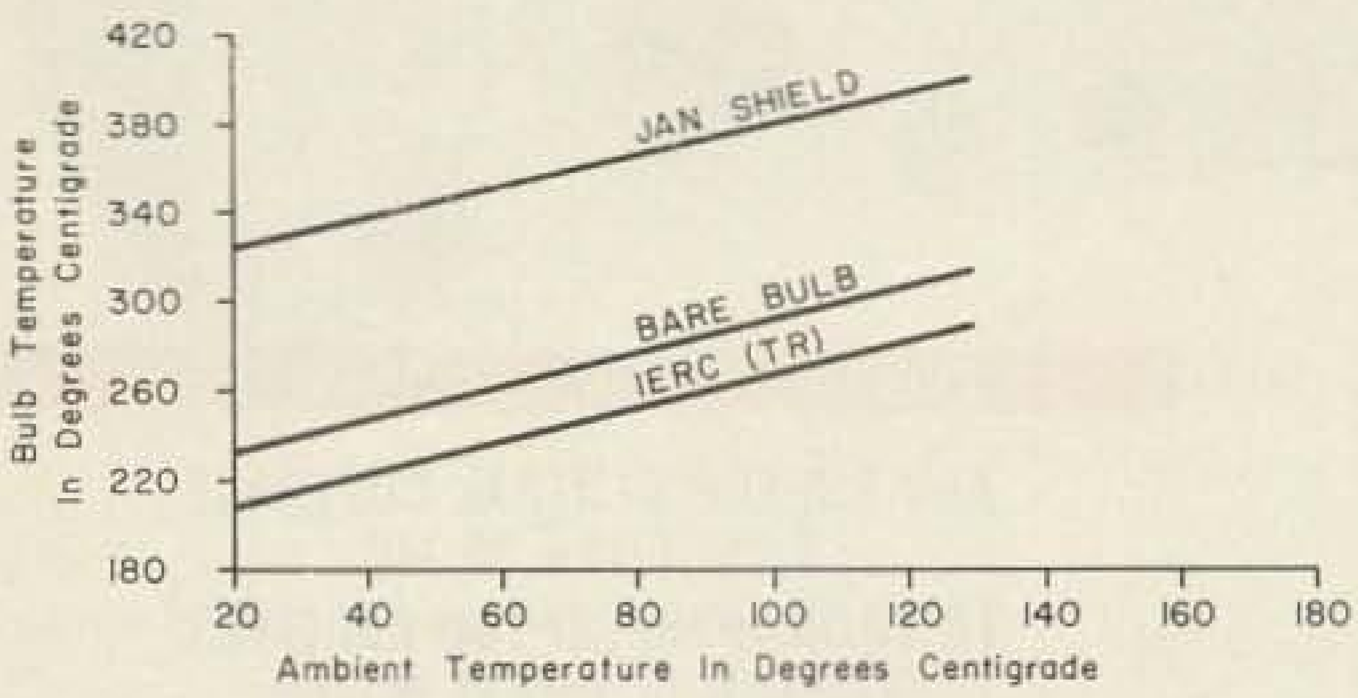


FIGURE 2

Bulb temperature vs. ambient temperature in 3 cases.

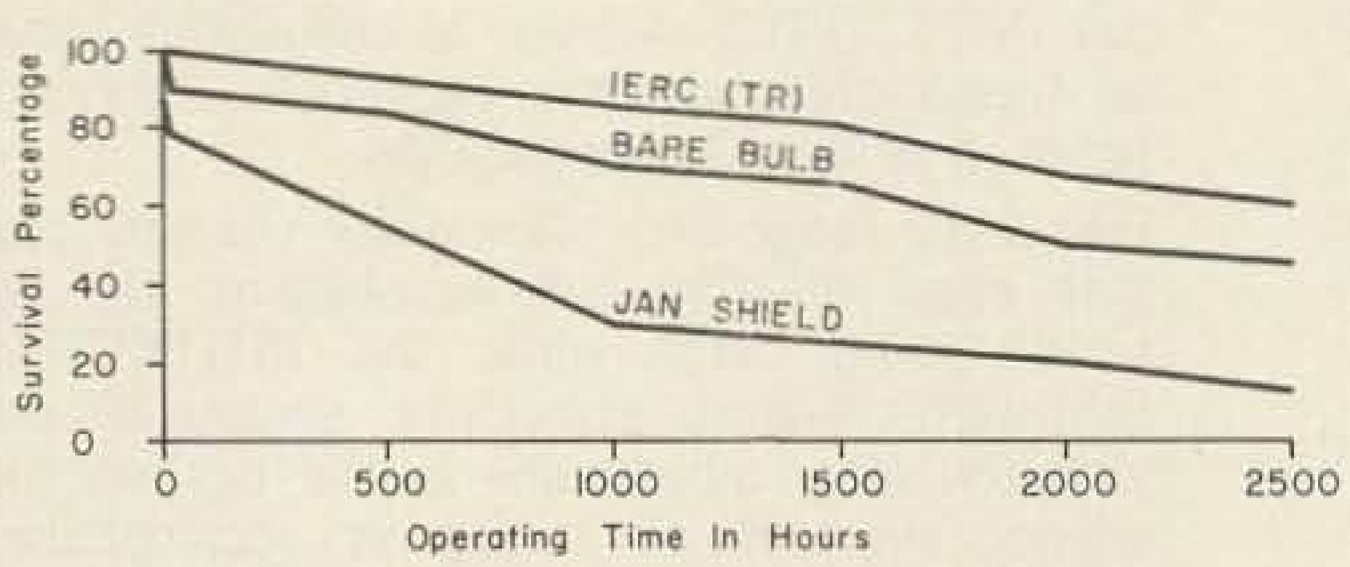


FIGURE 3

5654/6AK5W—total dissipation. 2.97 watts in 100° C ambient. Bare bulb temperature 190° C.
Envelope temperature's effect on tube life in 3 cases.

pared to that of tubes, and will not be discussed any further at this time.

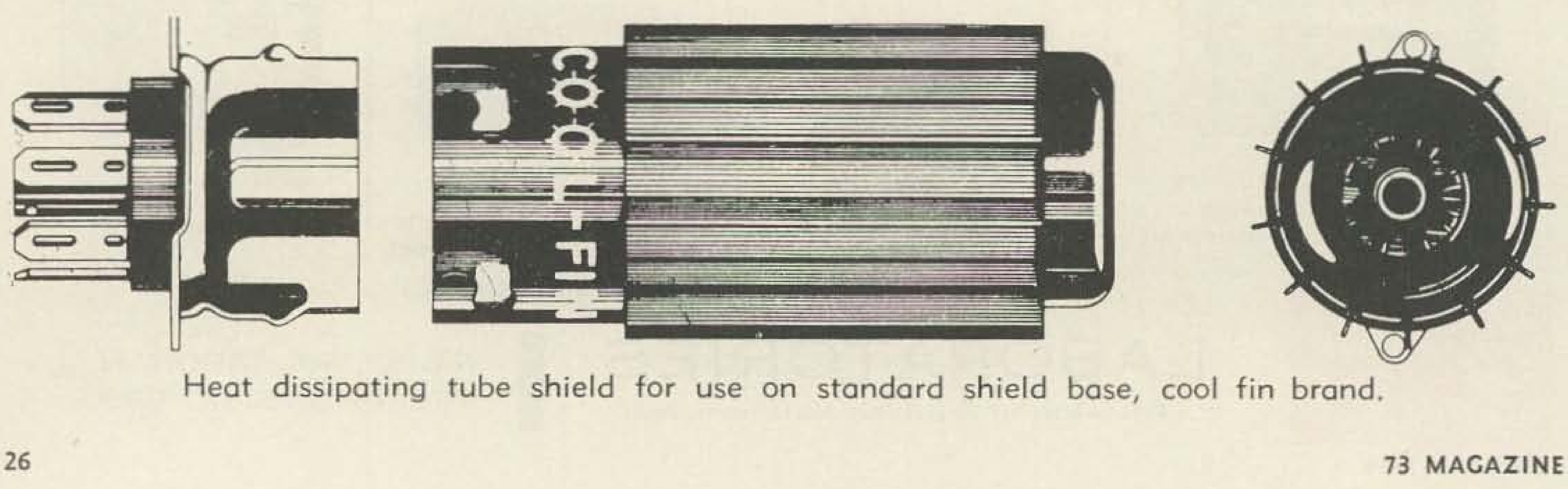
How are we as purchasers of commercial grade ham receivers, transmitters and tubes affected by this survey? First, the poor record of tube failure as stated above must be considered an optimistic one, for the tubes tested in the various studies were the pre-aged MIL variety. It would be difficult to say what we can expect, but we do know that many tubes exhibit premature failure. Yet we know of some tubes which have held up phenomenally well. Let us simply conclude that on the average, the commercial tubes which we use will never give performance which exceeds the military tubes.

What are the causes of tube failure? First, any equipment manufacturer who puts the shiny JAN type of tube shield on a tube to act as an electrostatic shield is planting a knife in the back of the consumer. As we will see, the shiny metal tube shield is a killer, and actually shortens the tube's life over no shield or bare-bulb operation by a considerable amount.

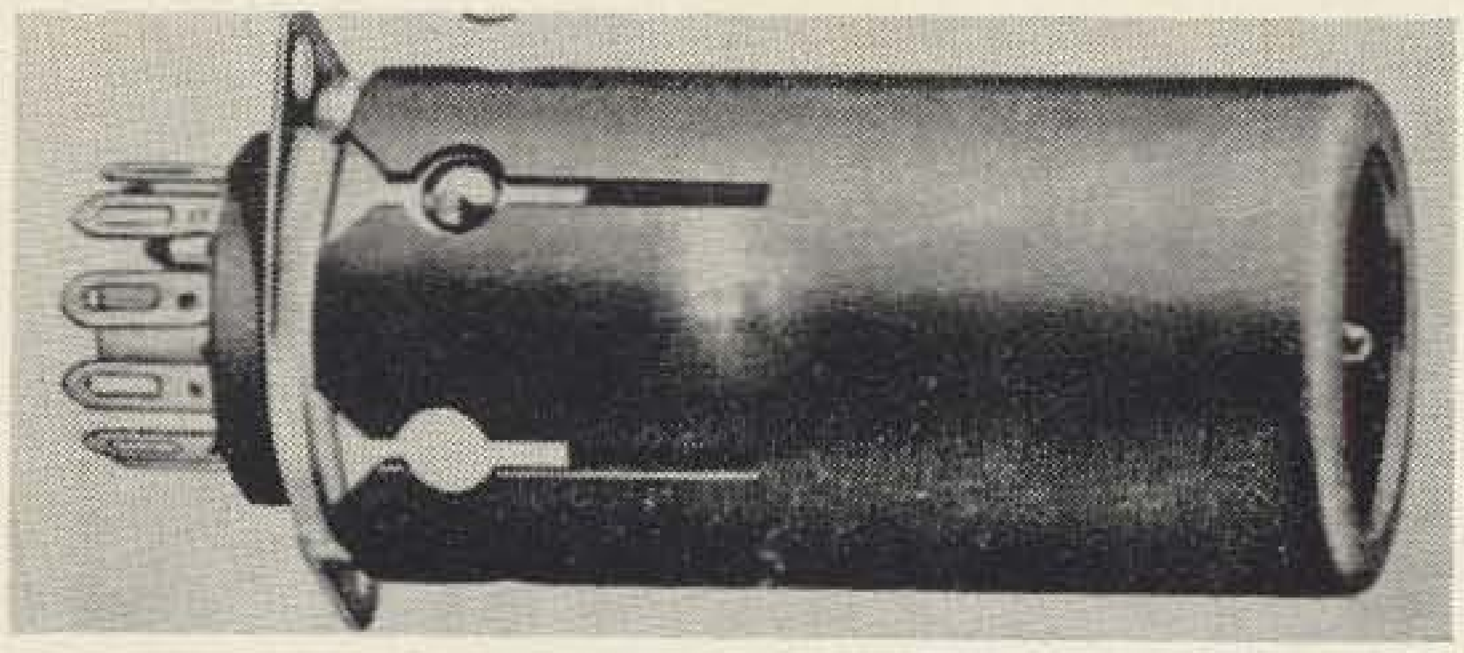
How hot do tubes get? Fig. 1 shows how the temperature of the bulb varies for the 6AQ5, a hot-running tube. The center of the plate is the hottest spot, and the adjacent glass bulb is nearly 100°C hotter than the coldest part of the bulb. Now we ask: how does the operating bulb temperature affect the tube's life? Intuition tells us that the hotter the tube runs, the shorter it will last. Finally we ask: how do we get the tubes to run cooler? To this question there are two answers. Forced air cooling, which is required of most high-power tetrodes, may be used. When forced air is applied properly by using a chimney, and in adequate volume, it effectively reduces the bulb temperature. It would be impractical to use chimneys for all of the tubes in an exciter. Very often a blower is furnished to move the air around, but unfortunately, not all of the tubes benefit by this action. If a hot-running tube is up-stream in the air flow from a cooler-running tube, the latter may actually run hotter than one without the forced air.

Well, if you read the title of this article, you can guess what the answer to the tube temperature problem is—the heat dissipating tube shield. This device does the same job of electrostatic shielding as the JAN type, but that is where the similarity ends.

As shown in Fig. 2, the bare bulb runs cooler than the JAN shielded combination, and the heat dissipating tube shields run cooler



Heat dissipating tube shield for use on standard shield base, cool fin brand.



Heat dissipation tube shield for use on standard shield base. (IERC brand).

than the bare bulb. This means that for maximum tube life, the heat dissipating tube shield should be used whether electrostatic shielding is a factor or not. Fig. 3 answers the obvious question of how tube envelope temperatures are related to tube life.

The typical heat dissipating shield consists of a metal shell which has been given a coat of flat black paint to maximize heat radiation. It contains a beryllium liner which has hundreds of fingers stamped into it. The fingers enable the liner to fit closely to the tube bulb and transfer the heat from the bulb to the black shell. From there, the heat is radiated away, convected by air currents and conducted down through the shield base and into the chassis. This results in the temperature reduction as shown in Fig. 2.

Sizes, types, availability and cost are all on the side of the consumer. The first producer of these shields is IERC, International Electronics Research Corp.[1] and a newer company with a somewhat different (and according to them, better) design but fewer different sizes is Cool-Fin Electronics Corp.[2] Both produce shields for all common 7 and 9 pin miniature tubes, and IERC has a full line ranging from subminiature tubes through 6146 types on to shields for Eimac 4-400A tubes.

If you are willing to make an investment in a heat dissipating tube shield which costs less than the price of the tube being protected, you should write to the manufacturers or their representatives for complete catalogs. Much data is available from them, and it is too much to be presented here. These shields are low-cost insurance which will minimize your rig's down time and your yearly tube replacement expenditure. They may be easily installed and later removed if you decide to trade in the rig.

. . . K2ENN

[1] 135 W. Magnolia Boulevard, Burbank, Calif. Distributed by B. B. Taylor Corp., 2270 Grand Ave., Baldwin, N. Y.
[2] 1717 N. Potrero Ave., South El Monte, Calif. Available direct.

Jim Kyle K5JKX
1236 N. E. 44th St.
Oklahoma City, Okla.

More on the Magic TR Switch

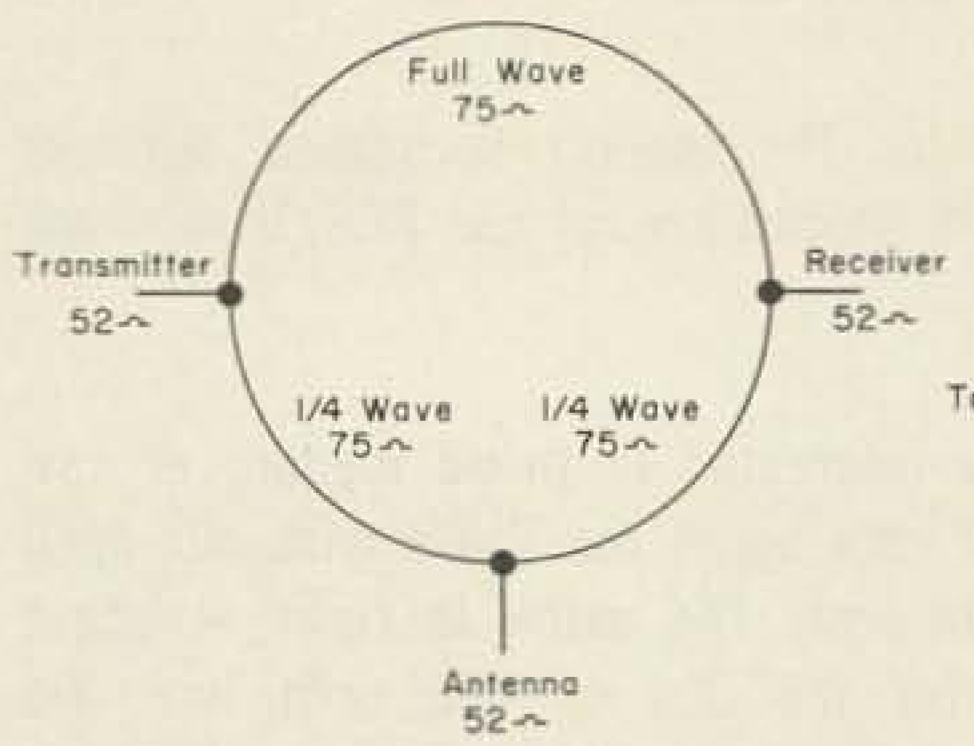


FIGURE 2

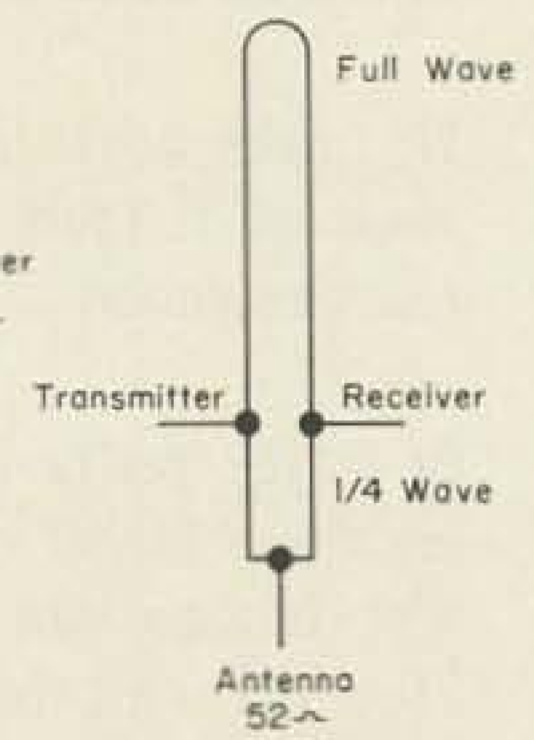


FIGURE 3

FIGURE 4

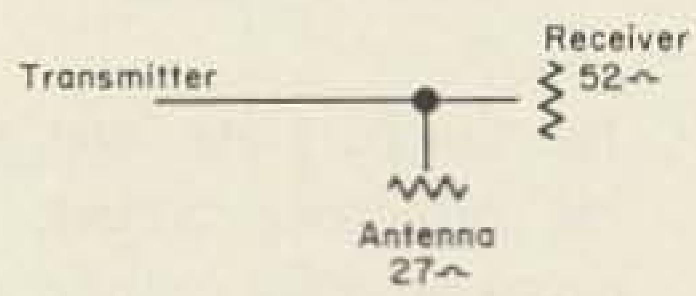


FIGURE 5

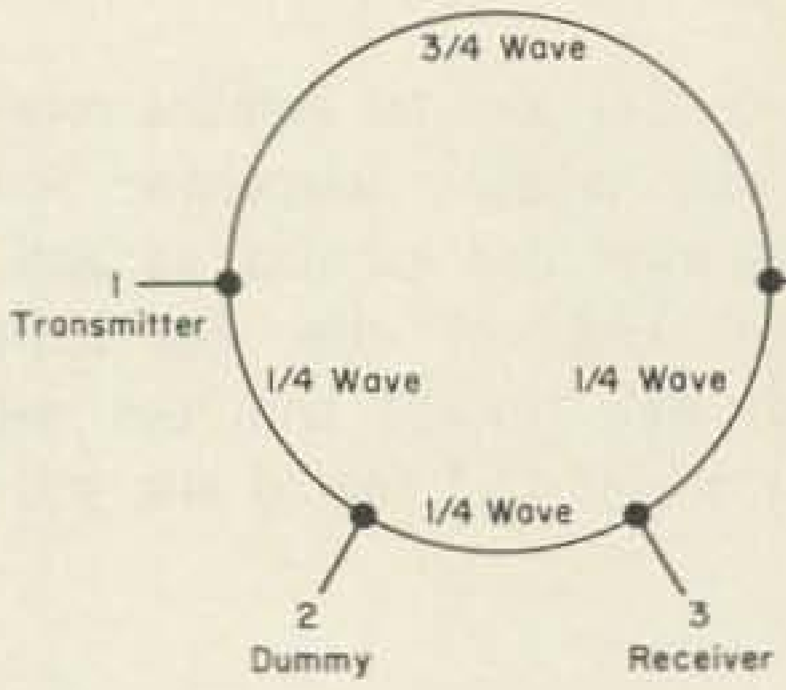


FIGURE 6

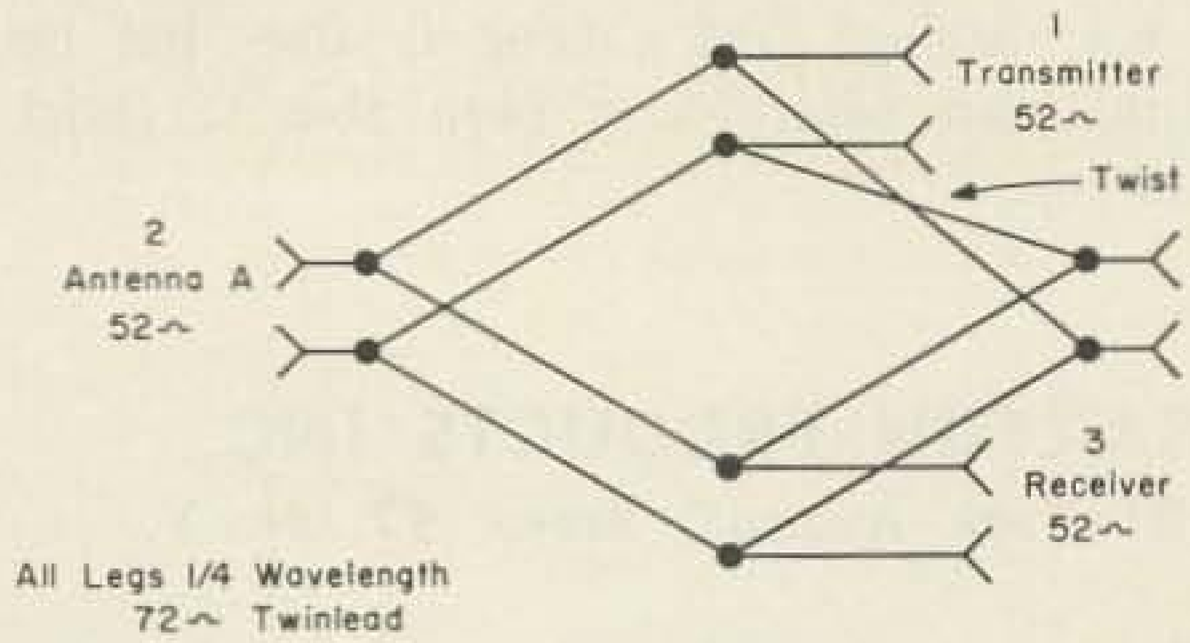


FIGURE 7

The ink was hardly dry on the August, 1963, issue of this magazine (which carried, on page 20, a description of the "Magic T-R" switch) when a letter arrived from Bob Flint W4MSK, who had some rather cogent objections to the idea.

"It isn't a balanced bridge the way he drew it," complained Bob, who then went on to prove his statement.

And so, despite checks by several rather knowledgeable antenna experts who liked the idea and like the author completely missed the flaw, it must be said that the original Magic T-R is one of those fine ideas which went astray.

But all is not lost! A method of overcoming the flaw has been found, and you can still use this no-moving-parts gadget. Before pointing out how, let's take a look at the details of Bob Flint's objection:

First we have to look at the accompanying sketches. There is no Fig. 1 so don't look for it. Fig. 2 is the same as Fig. 2 of the original article. Figs. 3, 4, and 5 were supplied by Bob in his proof why it was no good.

Note that Fig. 3 is the same as Fig. 2, except that the line has been arranged in a somewhat different shape. All connections and lengths, however, are identical. The full-wave line can be replaced by a direct short with no change in characteristics, which brings us to Fig. 4. Fig. 4 also shows the 75 ohm lines as a single 37.5 ohm line, which is their net effect.

Now we perform the impedance transformations to find out what the line from the transmiter sees, and come up with 27 ohms at the antenna port and 52 ohms at the receiver. With such a load, the antenna takes 66 percent of the power—and the converter input

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gets 34 percent! This is distinctly not good for converters.

So Bob is completely correct in his statement that "the only way such a Magic Tee, Rat-Race, or Hybird Ring can be used is to have proper terminations at the proper places."

But when you put a 52 ohm dummy load on port no. 2 of Fig. 6, then half the outgoing power reaches the antenna and the other half is dissipated in the load. Similarly, on receiving, half the incoming signal reaches the converter and the other half is lost in the dummy. No serious VHFer, or low-frequency man either for that matter, wants to take a 3 db loss in signal-to-noise ratio, so at this point it would appear that the Magic T-R is slightly dead.

However! Several years ago in a QST article, an important point regarding VHF dummy loads was made. Discussing tune-up of a 220 mc kilowatt, the writer of the QST article commented that "at this frequency and power level, probably the best dummy load available is a well-matched antenna mounted in the clear."

Many serious VHF operators are already using stacked beams of one sort or another. Others are using multi-element broadside arrays. In either case, it's usually not too much trouble to split the feedline arrangement in half and run two feedlines, so that one half of the array may be connected to port 2 and the other half to port 4! This arrangement employs an antenna as each dummy load, so that an outgoing signal will be fed to both antennas and no power will be lost. Power loss on an incoming signal should also be negligible.

One important point about this arrangement—signals at ports 2 and 4 are 180 degrees out of phase with each other. This anti-phasing must be corrected somewhere between the T-R and the antenna itself, either by lengthening one feedline a half-wave or by reversing connections to one set of antenna elements. Otherwise you'll end up with a null dead ahead and most of your power going off in unwanted directions.

Finally, Bob offered another bridge arrangement which takes up a little less space than the coax hybrid ring; it's shown in Fig. 7, and is made out of 72 ohm Kilowatt twinlead. The 180 degree extension between ports 1 and 4 is achieved by twisting the line a half turn. This design, Bob advises, is based on an article which appeared in the Proceedings of the IRE some 10 years ago.

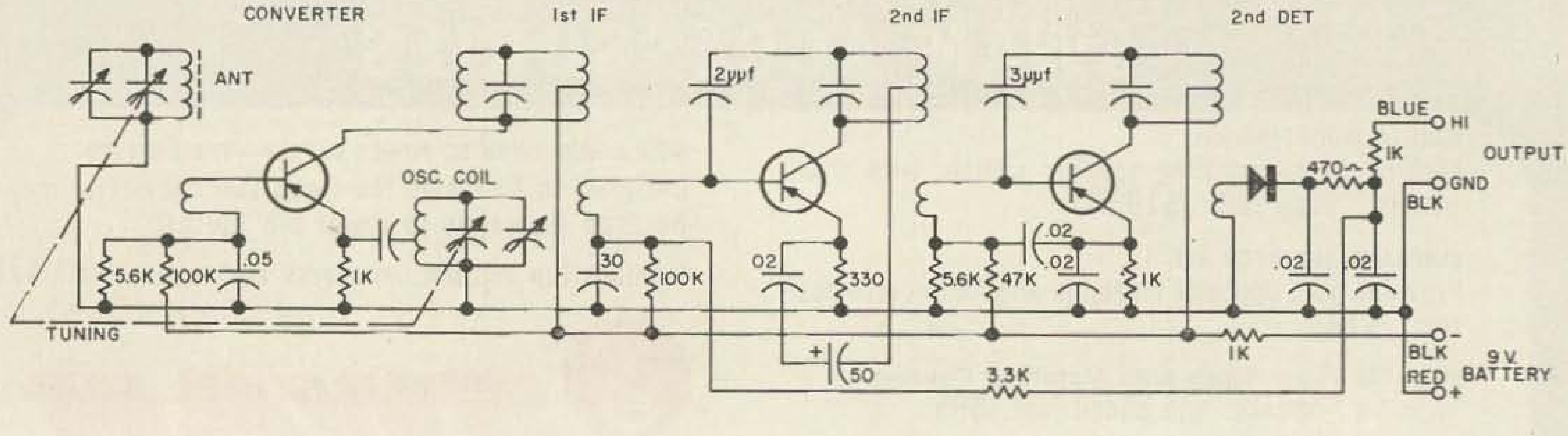
Isolation between transmitter and receiver in the coax version probably won't be greater than 35 db—which is about the same that is attainable at VHF with ordinary coax relays. The twinlead version offers better than 30 db isolation over a 2-to-1 frequency range. But these isolation figures are true *only* if all ports are properly terminated.

So, as we said the first time, try it and let us know how it works out. And many thanks to W4MSK for his comments!

Miniature, Transistorized, AM Broadcast Tuner

Rufus Turner K6AI
Photo courtesy of Lafayette Radio

There are many experimental uses for a small AM broadcast tuner, but few hobbyists will undertake to build one. The new Lafayette PK-633 subminiature printed circuit tuner is entirely factory-built and (at $7.95 net) costs less than its transistors and other parts. Because such a tuner is useful not only as a broadcast receiver but in many other applications, I



checked the performance of the PK-633 to obtain more data than is supplied by the manufacurer.

A full superhet circuit with avc is employed (no reflexing); the stage lineup consists of a converter, two *if* amplifiers, and a diode 2nd detector. Audio output (0.05 v rms on weak Los Angeles stations, 0.2 v rms on the strongest one) is sufficient to drive either a transistor- or tube-type audio amplifier. (The tuner even puts a comfortable signal into high-impedance headphones, without an amplifier.) Selectivity is close to 10 kc. Dc output is 0.1 v at 100 microamperes—enough to operate a 1-transistor dc relay. Powered by a 9-volt battery, the tuner draws 1.3 milliamperes.

Only 4″ long, 1¾″ wide, and 2″ high, it may be fitted neatly into other equipment. It weighs ½ pound and has only four leads: two for the battery and two for the output. Ferrite antenna is self-contained.

In addition to its intended use as an entertainment device, a miniature, ready-made, battery-operated AM broadcast tuner has the following experimental applications: (1) *if* and 2nd detector channel of a transistorized shortwave receiver or field strength meter, (2) remote control receiver, (3) metal detector receiver section, (4) tunable broadcast-band signal tracer, (5) broadcast-band field strength meter, (6) test probe for shield room inspection, (7) radio interference meter (8) sensitive capacitance relay, (9) baby sitter receiver section, and many others.

. . . K6AI

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Hector French W1JKZ
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Loud Speakers and Enclosures for Phone

You've just set up your umpteen-tube communication (it says here)-type receiver . . . dial lights are on . . . antenna is connected . . . all ready to go except for the speaker. Well, this one looks all right—came from that old AC-DC was kicking around here a few years back . . .

Hold on a minute there. That speaker is going to be the final link between the other fellow's mike and your ear-bones. That makes it a pretty important part of the system; how about finding out first how to pick out a better speaker for amateur phone use, or at least how to make the best use of the one you have? Sound reasonable?

One of the first things to think about, then, is the speaker's transient response. Transient response is hard to measure, and even harder to understand once you've measured it—but for us phone men, it's easy. After all, we know that "transient response" is only a conditioned-reflex noise an engineer makes when he can't figure out why his design doesn't do what it was supposed to (and hopes he'll find out before someone catches him at it). While for us phone men, "transient response" merely describes what the speaker does with a sharp pulse of interference—like one spark of ignition QRM.

Here's what one short, sharp pulse of interference could look like, for example. Fig. 1 shows the audio signal *into* speaker from the receiver.

You'll see the single noise pulse: higher amplitude than the audio, but of extremely short duration. Now see what a speaker with a poor transient response would do with it (Fig. 2).

What has happened is that the noise pulse has shock-excited the speaker into vibration, and wiped out a piece of the audio signal you're trying to hear. Worse than that, this burst of vibration has a masking effect, so that it sounds much louder and longer than it really is; this is all guaranteed to spoil the percent intelligibility.

Of course, any well-designed receiver will have some sort of noise clipper in it, or some other kind of circuit which is supposed to chop off these high-amplitude pulses before they get all the way to the speaker. But none of these circuits are perfect; a certain amount of interference will always come through somehow. Even the audio itself will have a lot of short, sharp pulses: the sounds corresponding to the letters "p" and "k," for example. A poor-transient-response speaker will react to the "p" and "k" just the same as for any other short, sharp pulse.

Luckily, there are some definite choices you can make to help assure that your speaker will probably have a good transient response. The first thing is to use a speaker with a heavy magnet. "Heavy" doesn't necessarily mean pounds; a few ounces of this year's magnet material will do the same job that a pound of

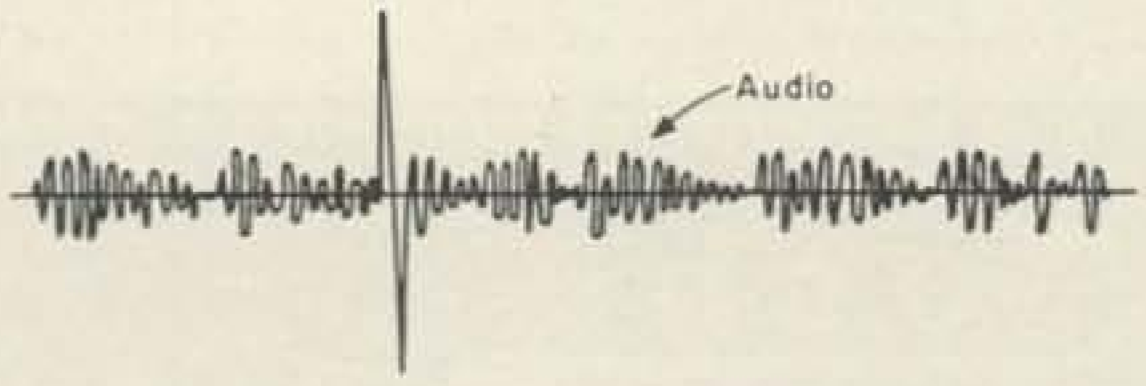


FIGURE 1

Audio signal to speaker, with single high-amplitude noise pulse.

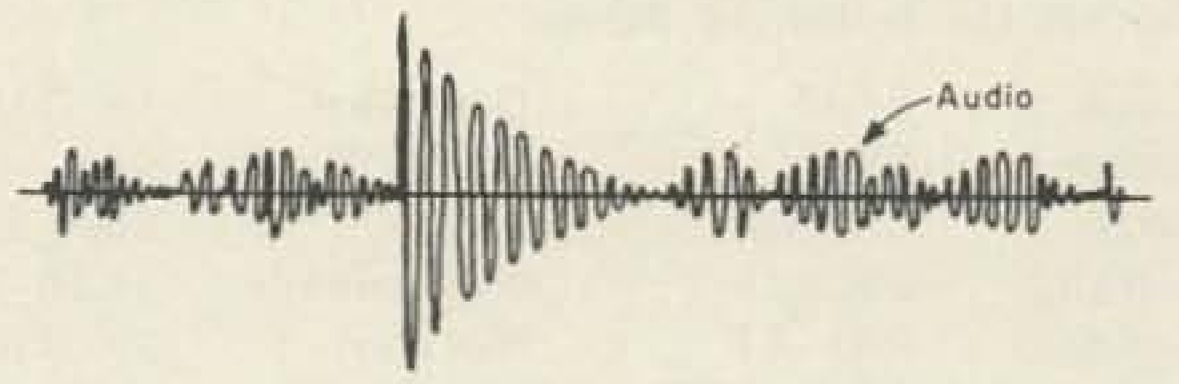


FIGURE 2

Sound from speaker, same electrical input as Fig. 1.

magnet was needed for, ten years ago. So as a usable rule-of-thumb, look for a heavy magnet.

Another detail is to drive the speaker from a low-impedance source. This will be more helpful with a heavy-magnet speaker than with a light. You're stuck with whatever audio stage you have in your receiver, so that short of re-designing the output, about all the help you can expect here is to use the low-impedance output tap: connect an eight or ten ohm speaker to a 3.2 ohm tap, for example.

You can also improve the transient response by acoustic damping; this comes up later on with the information on speaker mounting and enclosures.

Transient response isn't the whole story, though. You also have speaker linearity to think about. If your speaker is non-linear, it generates distortion components and cross-modulation products which weren't present in the signal fed to it. Bad enough to have QRM from the outside without generating any more of your own! With a linear speaker, you still have a chance of copying through the splatter from a neighboring phone station. With a non-linear speaker, this same interference isn't just an unwelcome intruder on your QSO—instead, it smears the signal you want to the point where you can't understand what the other fellow is saying.

Here's why: let's pick a moment when there happens to be only two frequencies coming into the speaker from the receiver (109 and 585 cycles, say) (Fig. 3).

A linear speaker would reproduce this audio pretty much as shown in Fig. 3—but now see what happens with a non-linear speaker:

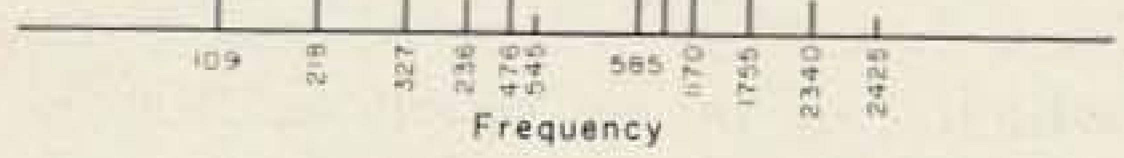


FIGURE 4

Sound output from non-linear speaker, showing harmonics and cross-modulation products, same input as Fig. 3.

The speaker has not only generated harmonics of each of the two frequencies, but has also generated the two sum-and-difference cross-modulation products—and this shows only what happens with two frequencies. You'll usually have five or ten different frequency components at the same time going into the speaker—can you imagine the mess that would come out of a non-linear speaker then?

Luckily, the non-linearity problem is handled the same as that of transient response;

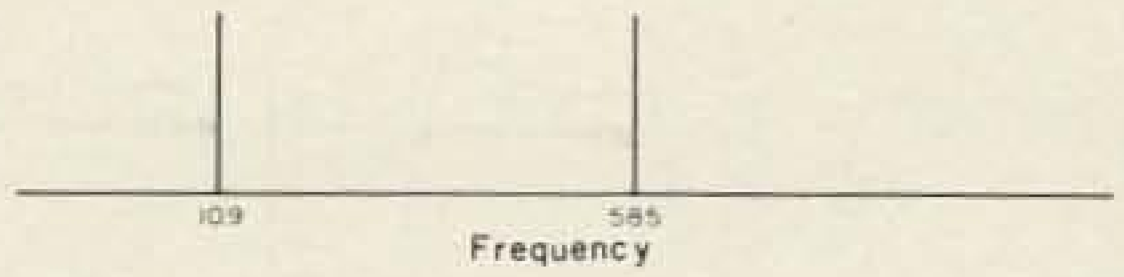


FIGURE 3

Frequency spectrum into speaker from receiver, at moment when only two frequencies are present.

the same recommendations apply. If you want to insure good linearity, look for a speaker having a heavy magnet and a generous power rating.

When it comes to frequency response, the old reliable 300-to-3,000-cycle rule-of-thumb is as good as any—but that's not the whole story, not by your Aunt Matilda's ear-trumpet, it isn't. What happens both inside and outside this band-width is important, too.

For instance: the response curve of a loudspeaker (if you can believe what the curve says) will always be a ragged and jagged sort of an affair. The only thing is, some speakers have a smoother response than others. The smoother the response, the better your chance of 100% intelligibility.

You'll want a reasonably flat response between these 300 and 3,000 cycle limits, too. The only thing better than a "reasonably flat" response is one which rises smoothly at the high end, and then drops off; this gives a little extra snap to the high-frequency speech components for a crisper voice quality. Avoid a response which includes a resonance peak, whether contributed by the speaker or its enclosure. A high-frequency resonance adds a harsh, gritty quality, while a mid or low frequency resonance obscures the high-frequency audio components, and makes "sh", "ch", "z", "s", and "th" all sound alike. No matter where the resonance is located, listening fatigue comes up, and the chances of a 100% QSO comes down.

So now comes the big question: how *do* you go about the job of picking a speaker to answer all these requirements? You'd have to be a loud-speaker engineer, seems as how.

Not so. There's a good rule-of-thumb here, too. If you'll study the catalogs put out by the

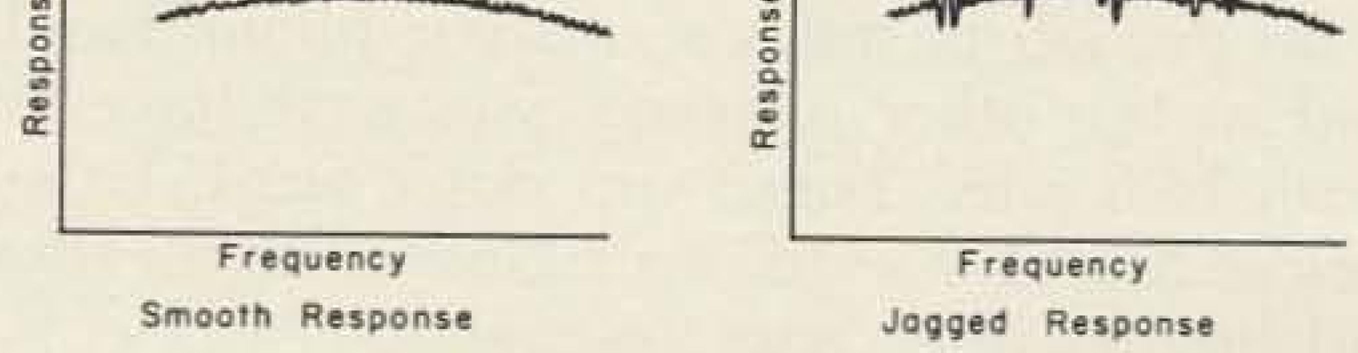


FIGURE 5

Comparison of smooth and jagged speaker response curve.

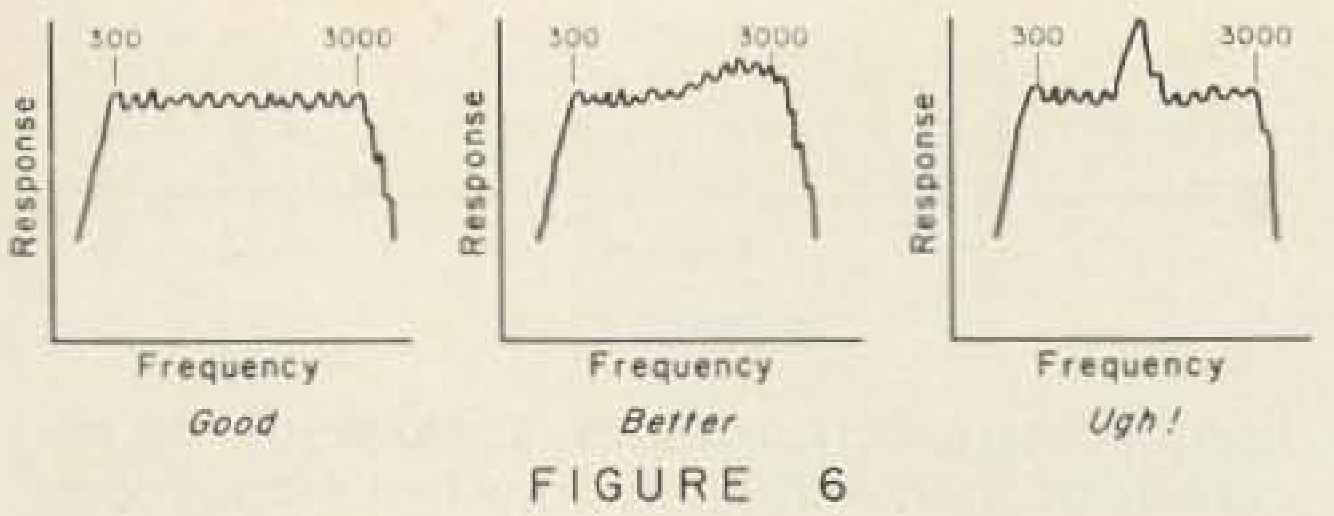


FIGURE 6

Comparison of response curves within voice range

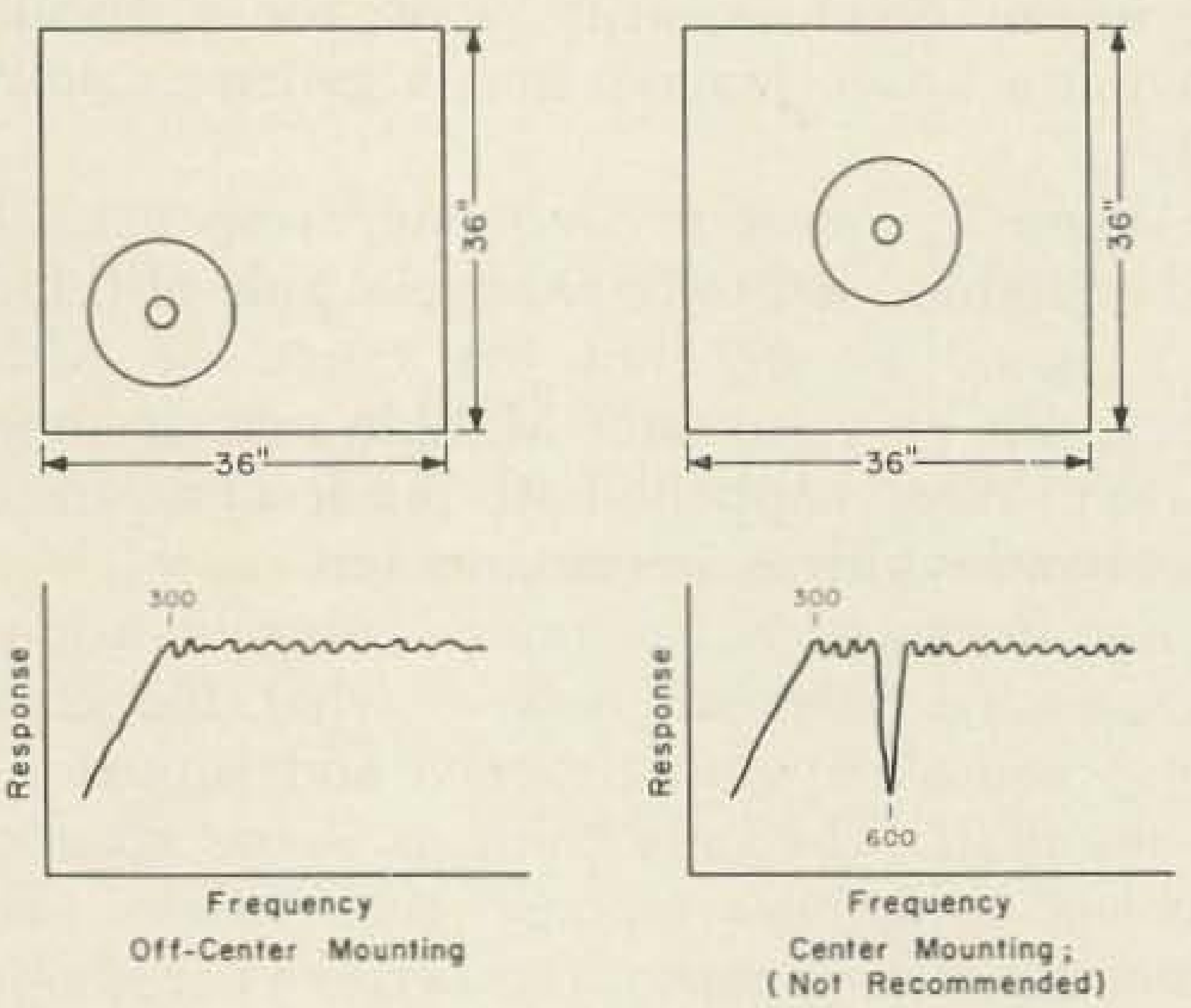


FIGURE 7

Speaker mounting on a flat baffle board.

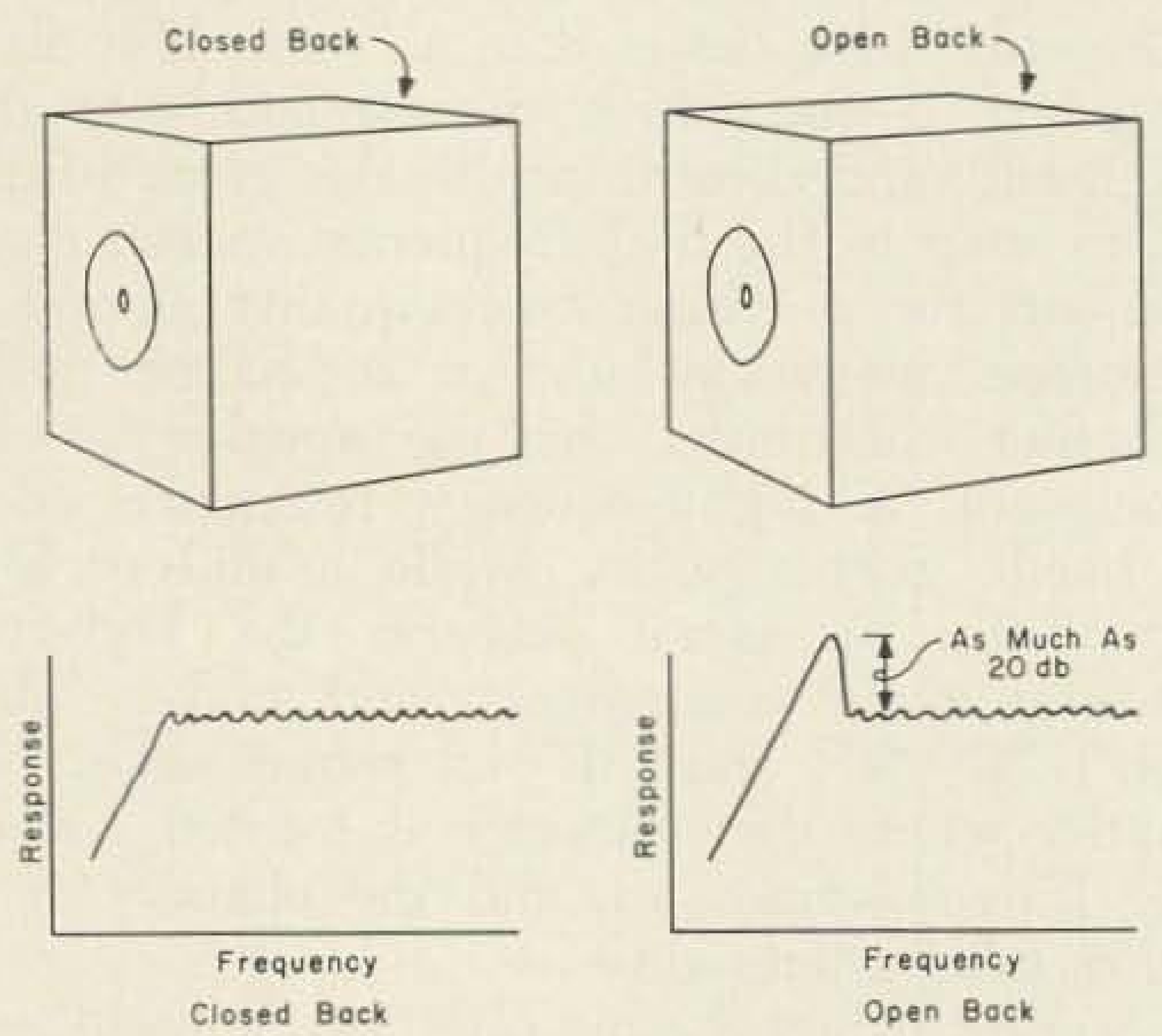


FIGURE 8

Speaker mounting in a wholly-enclosed box.

radio parts distributors, you'll find there are three classes of speakers. First, you have the cheap replacement-type speakers. These you don't want; they just don't have what it takes to do the job in today's amateur phone bands. And at the other extreme, you next have the plush hi-fi jobs. These you don't want, either; they're built for a different kind of application, and besides, they cost too much.

Then lastly you'll find the husky, work-horse speakers designed for use in PA systems. That's what to look for. These speakers generally have good transient and frequency response, are more linear than the replacement-type units, and are reasonably priced. They're built to deliver the goods, not for an appeal to bottom price, or for the snob appeal of a fancy layout. An 8" cone-type speaker built for public-address use (6" or 10" optional), with as much magnet and power rating as you can get, is probably your best buy.

Now that you have brought your speaker, or have decided that the one you have is husky enough—what then? You have to put it somewhere. This calls for an enclosure or some other kind of mounting procedure for the speaker.

There are two best ways to handle this; the difference between them is largely a matter of preference. One way is to mount the speaker on a flat baffle, about 36" on a side, with the speaker midway between the center and one corner. (If you mount it in the middle, you'll have a hole in the response about 600 cycles.)

With this flat baffle mounting, the response of the speaker-and-baffle combination will drop off at 6 db per octave, below 300 cycles. Make it 24" on a side if you wish; then the response will drop off in the same way below 450 cycles.

The other way to mount the speaker is inside a wholly enclosed box of some sort, just big enough to hold the speaker comfortably. Wood is best; avoid metal because of wall resonance which can contribute some vicious resonances to the response. This construction is more work, but it gives a sharper cutoff than the baffle, at the rate of 12 db/octave. The low-end cutoff frequency depends on the size of the speaker and the box; it will be suitable for amateur phone work with almost any 6", 8", or 10" speaker. Be certain not to use an open-back box; this will give you a resonant peak which can be as much as 20 db high, just where it will do you the least good.

Now that you have your speaker successfully in place on a baffle board, or in a wholly enclosed box, you have to put it somewhere—you just can't stand there and hold it. The mathematics of the thing says that the best location is a three-way corner—like the corner formed by two walls and the bench top, for example, or two walls and the ceiling, or two walls and the floor. In this way, the speaker will radiate its acoustic energy into an octant of space (one-eighth of free-space radiation). This gives eight times as much acoustic loading on the speaker cone, plus the horn effect of the three-way corner. This all will have a healthy effect on the transient and frequency response, as well as on the linearity.

This allows a particularly convenient and efficient variation, which combines the best features of baffle-board mounting and of enclosed-box mounting. That is to mount the speaker in the middle of a triangular wood baffle, which is then fastened tightly between two walls and the bench top. Resulting characteristics are even better than those of the wholly-enclosed box, is easier to build, and takes up less space.

Even though there may be some mathematically "best spots" for the speaker, the practical amateur will want to put it where it is the most convenient, and the XYL (if she is allowed in the shack, and she shouldn't) will want to put it where it is the prettiest. Obviously—especially where women are concerned—there is no one best answer; old fashioned try-it-and-see is still the best approach.

Don't forget, though, that most of us older hams have a high-frequency hearing loss which starts to be measurable in the late 20's. A good idea here is to think about aiming the speaker right at the operating position, to get the highs on a direct beam. Too many highs can be tuned down with a ton control, or by aiming the speaker somewhere else, while if the speaker placement doesn't let the highs come through, this can make all the difference between getting the call the first time, and asking for a repeat.

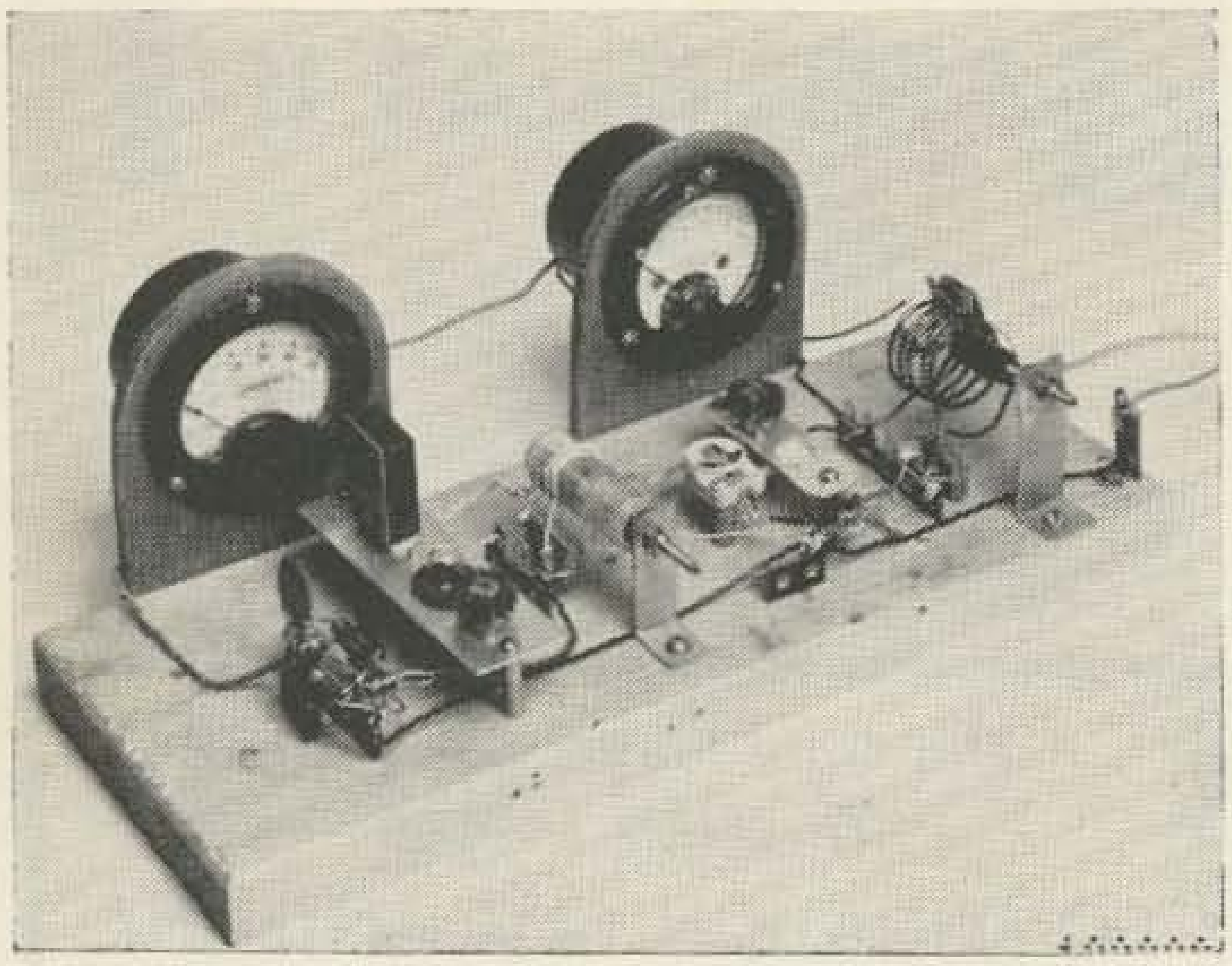
. . . W1JKZ

Polaroid Print Coater Protects Panel Engraving

The Print Coater brush that comes with every roll of Polaroid film provides a handy means of protecting surfaces against wear, abrasion and fading.

A typical use for the Print Coater in the electronics lab or model shop is varnishing instrument panel engravings. Any polished surface will retain its lustre and resist tarnishing indefinitely after an application with the Print Coater. The great convenience of the Coater lies in the fact that the brush requires no dipping or cleaning, does not harden, and comes in its own container.

. . . W2WYM



Photograph of Experimental Transmitter. The oscillator is on the left and the amplifier on the right. The "large" diameter plate tank coil was used to facilitate experimentation.

2 Watt 7 MC Transistor CW Transmitter

Howard Lawrence W2RHD
Munn Lane
Cherry Hill, N. J.

A transistorized transmitter has many advantages over a tube transmitter when battery operated portable use is contemplated. The advantages are especially great when cw operation is desired. Unlike a tube transmitter, the transistorized version draws no current from the battery when the key is not down: the transmitting key itself turns everything on and off in the transmitter that draws power.

The transmitter to be described was designed for portable operation, using a small 45 volt "B" battery with a 22½ volt tap for tuning. One anticipated application requires installation in a small cruising sailboat which does not have an engine, and therefore no generator to charge batteries. Coupled with a transistorized communications receiver, long operating time from a small battery will be possible.

The schematic of the transmitter is shown in Fig. 1. A breadboard transmitter employing this circuit is shown in Fig. 2. This transmitter uses two 2N697 silicon transistors, one as an oscillator and one as an rf amplifier. The price

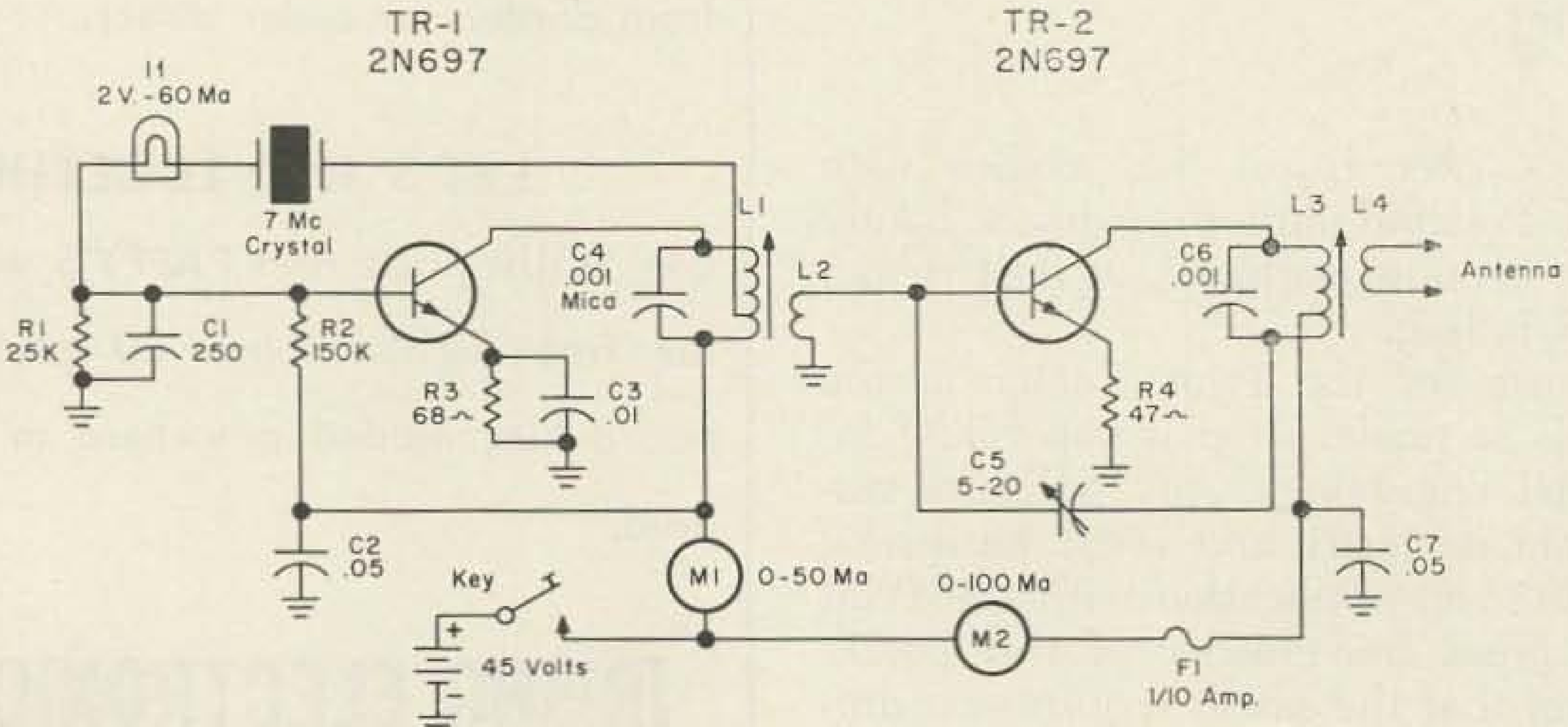


FIGURE 1

Schematic of Two Watt 7 Megacycle CW Transistor Transmitter.

of this transistor is now about $2.00, making it economically feasible for amateur use. It is rugged and will handle a fair amount of short time overloading.

A Pierce oscillator circuit is employed with the crystal feeding energy from the collector resonant circuit, L1 and C4, to the base of the oscillator transistor, TR-1. I-1 is a two-volt 60 ma pilot light (pink bead) used to monitor crystal current. This light is very handy for tune-up and once the operator becomes familiar with its indications, the current meter I-1 can be eliminated. The oscillator transistor is run well below ratings and therefore can operate continuously. The resonant circuit is interesting because it is designed to have a low impedance to match into the 2N697 collector circuit. C-4 is a 1,000 pf mica capacitor and the tuning inductance L-1 looks more like one used at 50 megacycles than one used at 7 megacycles. L-1 is seven turns of number 22 wire on a ½ inch form, the coil winding being ½ inch long. It is iron core tuned. The crystal is tapped on this coil at its center.

The power amplifier, TR-2, is another 2N697 biased past collector current cut-off. It draws no current when not being driven by the oscillator. The coupling coil to the amplifier, L-2, is two turns close-wound over the cold end of L-1.

It is necessary to neutralize the amplifier to prevent the whole system from running away when not properly tuned. Such a run-away can damage the transistors. C-5 is a small ceramic trimmer capacitor used for neutralization. The tap on L-3 is adjusted as part of the neutralizing procedure. It is important that the fuse, F-1, 1/10 ampere, be included to prevent loss of the power amplifier transistor due to severe mistuning or oscillation which may occur before the transmitter is neutralized.

A large 1″ diameter amplifier collector output coil was used to facilitate experimentation. The collector circuit is fine-tuned with a ½″ diameter powered iron core after the circuit has been roughly tuned by adjusting the length of the coil. The output stage is coupled to the antenna by a 6-turn close wound coil of insulated wire.

In the photograph, the oscillator is on the left and the rf amplifier on the right. A 4-terminal strip carries all of the resistors and capacitors associated with the oscillator except for the output tank capacitor, C-4. Heat sinks are used on the transistors. The neutralizing capacitor is mounted next to the amplifier transistor. The fuse for the final amplifier is mounted below the meter, behind the mounting bracket.

Adjustment Procedure

Oscillator adjustment should be made with a 22 volt supply. No voltage should be applied to the amplifier but the amplifier transistor should be in its socket. The crystal oscillator is tuned by adjusting the core in L-1 until oscillation starts. Oscillation is determined either by a drop in the reading of meter M-1 or by listening to the oscillator on a receiver. The pilot light, I-1, may glow dimly. The transistor will draw about 8 ma at 22.5 volts when oscillating properly. When the battery voltage is increased to 45 volts current (M-1) will be about 16 ma. The variation in the oscillator collector current as the resonant circuit is tuned is the same as the variation of a tube crystal oscillator plate current.

The rf amplifier stage is next adjusted. Connect the tap on L-3 to the center of the coil and set the neutralizing capacitor C-5 at mid value. If a grid dip meter is available, the output circuit can be resonated before power is applied, after first calibrating the grid dip meter against the transmitter oscillator. With 22.5 volts on both oscillator adn amplifier and no antenna or other load connected, adjust the core in L-3 to obtain a dip on meter M-2. M-2 will read about 20 ma. Be sure the 1/10 ampere fuse is in the circuit; it may save a transistor.

Neutralization is most easily accomplished with 22.5 volts applied to both oscillator and amplifier. Set the oscillator core so I-1 glows dimly. Tune the output circuit in one direction (screw core into coil, for example) and note effect on I-1. Return core to original position. If I-1 increases or decreases in brightness, change adjustment of C-5 and recheck effect of screwing core into coil. When the amplifier is neutralized the brightness of I-1 will not change when L-3 is tuned. If neutralization can not be obtained, move the coil tap one turn toward the end of L-3 connected to C-5 and repeat the above process.

Antenna Coupling

Inductive coupling to the antenna is most convenient to use. The size of the coupling coil will depend on the particular antenna to be matched. To feed a half-wave dipole at its center a 6-turn random close wound coil of number 22 insulated wire 1¼ inches in diameter was used as a coupling coil. Series tuning was used. A grid dip meter set at the transmitter frequency can be used to make initial antenna adjustments. The antenna coupling coil is loosely coupled to the grid dip meter coil and the antenna tuning capacitor(s) adjusted until resonance is indicated.

Initial adjustment with the transmitter is made in a similar manner, very loose coupling being used until the antenna is resonated, after which coupling is increased. Care should be taken not to couple so tightly that the transmitter is overloaded. Since impedances and voltages are low, the antenna coupling coil can be pushed between turns of L-3. Insertion about half-way into L-3 will give proper coupling. When properly tuned and loaded, the amplifier current will be 60 to 70 ma at 45 volts. The crystal current indicator, I-1, will show a dim but white color.

The measured output power on the model ran about 1.5 watts with slightly under 3 watts input, giving an efficiency of better than 50%. It should be remembered that the output transistor can be run at this power level only intermittently (cw) without overheating. Care must be taken not to hold the key down for long periods with full plate voltage applied.

Single Transistor Transmitter

If desired, the crystal oscillator can be operated directly into an antenna with a few minor modifications. The bias on the base of TR-1 is raised by changing R-2 from 150K to 50K. For convenience, the large plate tank coil, L-3, is used with the oscillator instead of L-1. The tap for the crystal is made to the center turn. A 1/10 ampere or smaller fuse should be used in the battery lead for protection. Over-coupling to the antenna will cause the oscillator to chirp or even stop. The model tested gave an output power of 1/3 watt with 0.9 watts input for an efficiency of 38%. A 45 volt supply was used. Current drain (M-1) was 20 ma. Under these conditions the oscillator transistor must be operated intermittently.

Parts List

R-1—25K ohms, ½ watt
R-2—150K ohms, ½ watt (50K if amplifier is not used)
R-3—68 ohms, ½ watt
R-4—47 ohms, ½ watt
C-1—250 pf, 100 volt mica or ceramic
C-2—0.05 mf, 100 volt ceramic or paper
C-3—0.01 mf, 100 volt ceramic or paper
C-4—0.001 mf, 100 volt mica
C-5—5 - 20 pf, ceramic or air trimmer
C-6—0.001 mf, 100 volt mica
C-7—0.05 mf, 100 volt ceramic or paper
L-1—7 turns #22 wire, ½ inch long on ½ inch iron core tuned form
L-2—2 turns #22 insulated wire close-wound over cold end of L-1
L-3—5 turns #14 wire, 1 inch diameter, 1 inch long, air wound
L-4—6 turns #22 insulated wire random close-wound (see text)
TR-1, TR-2—type 2N697 transistors
I-1—2 volt 60 ma, pilot light (pink bead)
F-1—1/10 ampere fuse

Quieting Small Cooling Fans

In many small and medium-sized amateur installations, localized heating is a serious problem. Standard remedy for this is the installation of a small cooling fan, usually drawing less than 100 watts. This drives a blast of cooler air into the "hot spot", lowering the temperature appreciably.

The cooling fan is usually mounted on a bracket, firmly bolted to some part of the assembly. As this is usually of thin metal, the fan vibration is communicated to the rest of the chassis, which acts like a resonator, so that the noise power output of the fan seemingly exceeds its "blow power".

This noise nuisance can usually be abated by mounting the fan on a massive bracket—as massive as possible—and by attaching that bracket to the chassis by means of shock mounts. A sample mounting of this type is shown in Fig. 1. This procedure lowers the natural period of vibration of the fan assembly; and then prevents most or all of this vibration from reaching the chassis. In happy consequence, there is less or no noise output—a bass drum is silent if you don't bang on it.

Noise can be reduced further if the fan

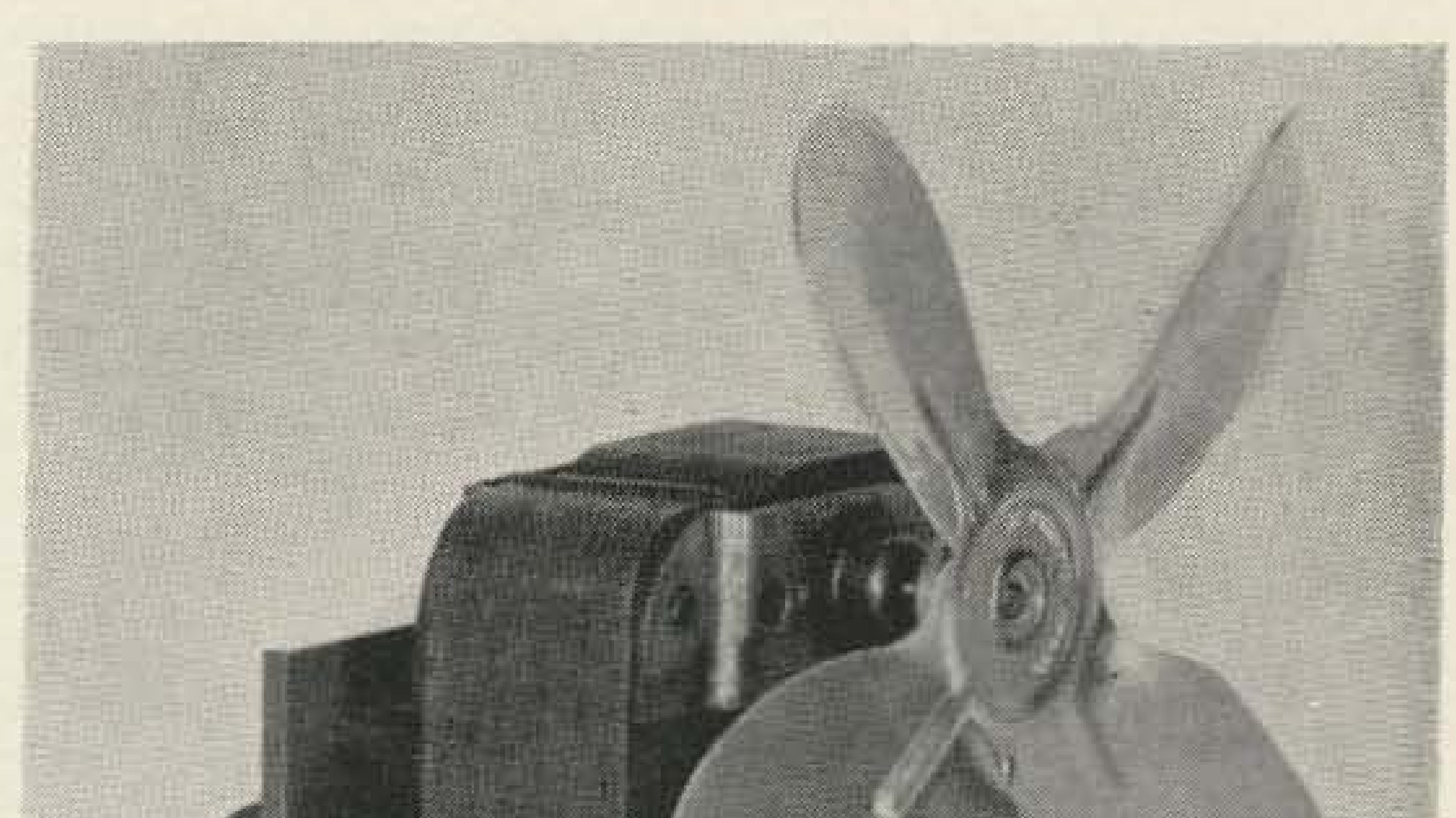


Fig. 1: Noise-reducing fan mount

blades are trued up; and very high-pitched fan noise can be minimized by carefully rounding the edges of the fan blades with emery cloth.

Fan mount stability is desirable to prevent slow oscillation of the assembly. This calls for at least a three-point mounting. Four shock mounts may be used if desired, but additional mounts, beyond three, bring about little improvement of stability.

A Few Unusual Receiver Circuits

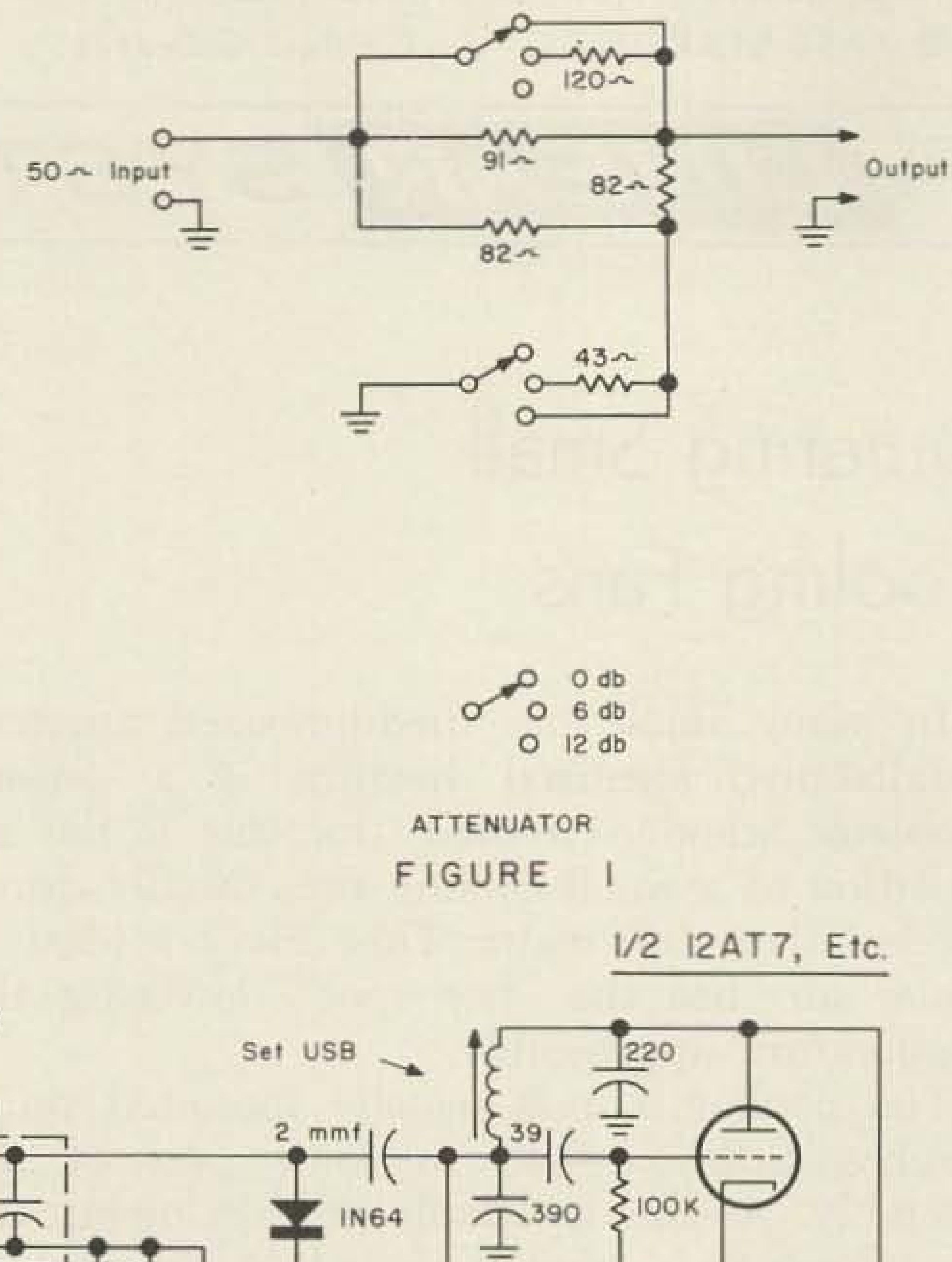
Henry Cross W1OOP

In the last receiver I made, which was a "converter if" tuning 14 to 18 mc/s, most of the circuit was pretty ordinary. There were a couple of features which may not be novel, but are not found in the usual handbooks.

1. Input attenuator. Using a cheap 2-pole 3 position switch (Centralab 1473) we get 0-6-12 db attenuation in a 50 ohm circuit. Handy for avoiding overload situations, also gives a quick check on the S-meter.

2. Noise limiter. The circuit shown is critical as to diode type, but can be used in receivers like the rax and auto radios where other noise limiters are too hard to put in. It also works on ssb, even without a product detector. Recommended diodes are silicon computer types rated for very low capacitance and ultra-fast recovery, such as the MA-4244 or MA-4441 (for hybrid auto radio or transistor circuits, the Microwave Associates type 1N903 or 1N904 will be satisfactoy), Fairchild 1N916a, Transitron SG 5000, etc. The action is to clip short pulses (ignition noise pulses have a length roughly the reciprocal of the if bandwidth, ie, about 500 microseconds for many modern communications receivers more like 200 microsec for auto radios) while following the envelope of the signal at voice frequencies. To turn off the limiter, open at point x.

3. AGC delay using silicon diode. The circuit shown uses a 1N64 as detector, and the slight positive bias on the AGC bus actually



ATTENUATOR

FIGURE 1

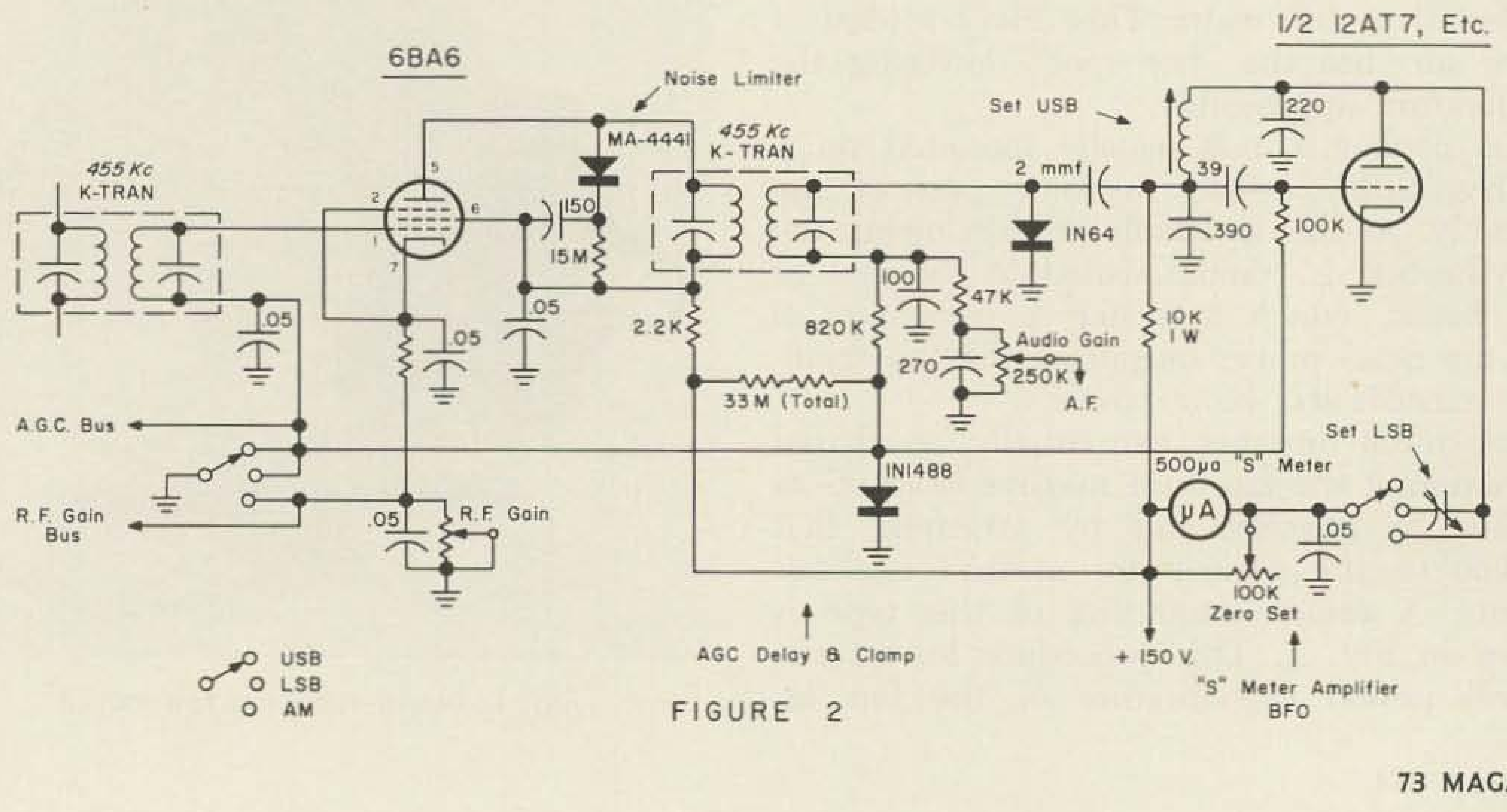
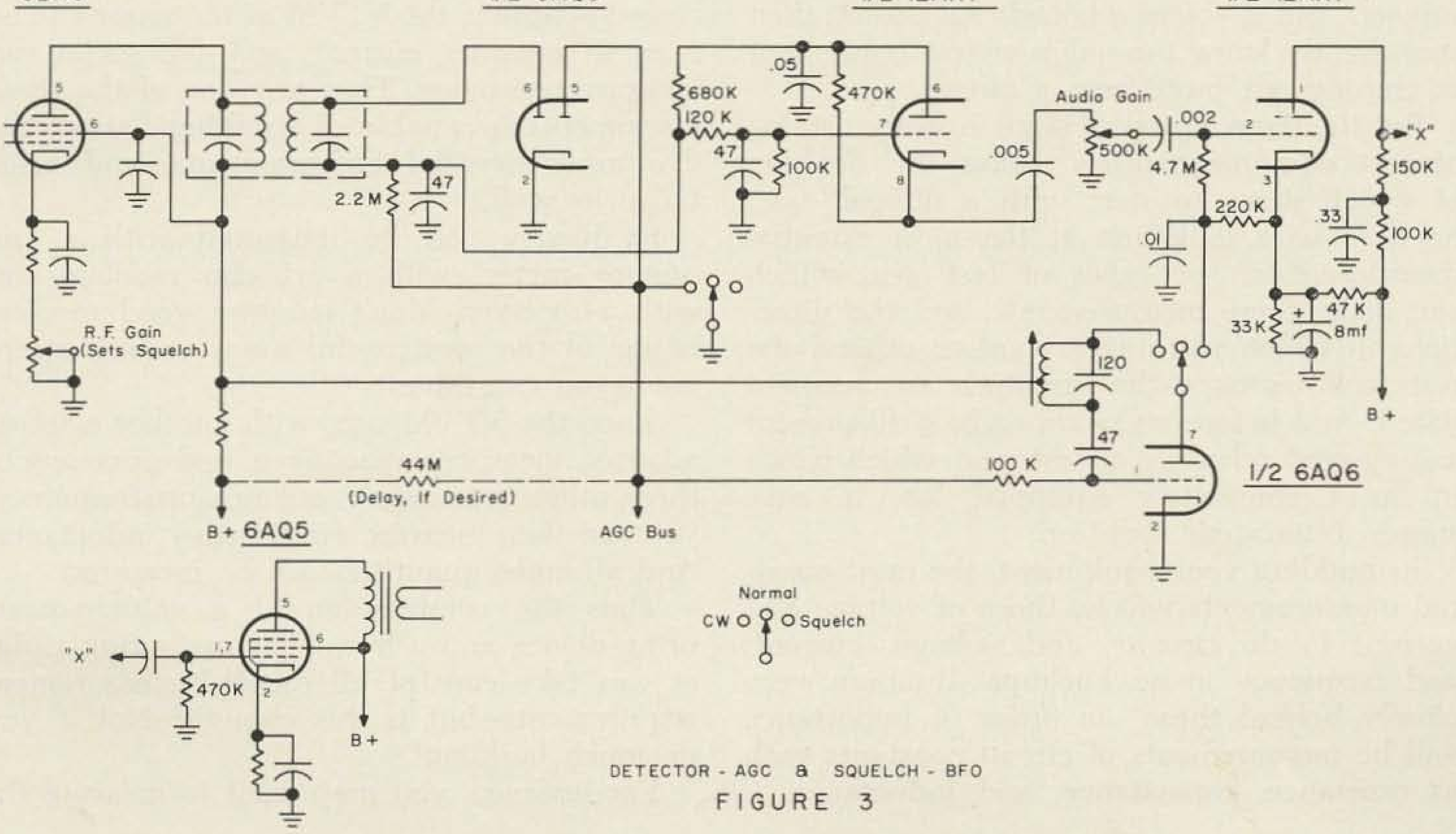


FIGURE 2

helps detection. The advantage of this circuit is that the amount of AGC delay can be easily adjusted without the detector having to be "off of ground". Any good silicon junction diode will do the job—1N1490, 1N457, 1N629, 1N903 all work. The AGC bus will be about ½ volt positive with no signal, which is all to the good.

4. Bfo and S-meter. Economy demand that all tubes stay busy during all types of reception. Fig. 2 shows the noise limiter, detector, agc, s-meter and bfo circuits. The bfo has no pitch



DETECTOR - AGC & SQUELCH - BFO
FIGURE 3

control, merely preset frequencies at the two edges of the pass band for upper band lower sideband reception. In the phone position, the bfo is stopped by putting an RF ground on its plate, and a backward-reading type S meter is hooked in the circuit. I used a 500 microamp surplus unit.

Another double-duty arrangement is shown in Fig. 3, where a 6AV6 or 6AQ6 is used as detector, agc clamp, bfo and squelch. A dpdt center-off toggle switch may be used here, giving Squelch, Normal, and CW. I suppose the tube could run an s meter in the normal position, but as I never tried it I will not describe it.

. . . W1OOP

A Long Look at Test Equipment

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"Who, me?" do we hear you asking? "What do I want to know about test equipment for? I don't have any."

Which may, sadly enough, be so. But nobody yet ever put a transmitter on the air without at least a rudimentary amount of test equipment (even if it was nothing more than the built-in meter or lamp-bulb substitutes), so every ham should know a little about the subject. And if you're a homebrew addict, then you already know the value of test equipment in chasing out bugs from a circuit.

But the page on top of page in every catalog of test equipment often makes the decision of which items to start with a difficult one. So here we'll look first at the most essential measurements, the types of test gear which can make these measurements, and the directions in which you might want to expand the test facilities once the essentials are accomodated. And before we're through, we'll present a suggested schedule of test gear which winds up as a completely equipped lab, in easy stages. Interested? Read on:

In building your equipment, the most essential measurements will be those of voltage and current in dc circuits, and voltage, current, and frequency in ac hookups. Running very closely behind these in order of importance will be measurements of circuit constants such as resistance, capacitance, and inductance.

Voltage, current, and resistance can be measured by the gadget know as a VOM (for volt-ohm-milliammeter); voltage and resistance can be measured with the VTVM (vacuum-tube voltmeter); and voltage itself can be measured with an oscilloscope. All these instruments are capable of measuring either ac or dc, although to measure dc with an inexpensive scope takes some special technique. With some easily-rigged adapters, the VTVM or the scope can be used to measure current, and the scope can measure resistance. Thus any one of the three instruments is capable of handling four of the five most essential measurements, and resistance as well.

Frequency can be measured with a frequency meter, with a grid-dip oscillator, or with a receiver (don't laugh—a good receiver is one of the most useful items of test equipment you can have).

Since the VTVM can, with another external adapter, measure capacitance, and since any of three other instruments will measure frequency, you can then measure (indirectly) inductance. And all eight quantities can be measured.

Thus the combination of a voltage-measuring device and a frequency-measuring gadget can take care of all esential measurement requirements—but is this enough? Not if you do much building!

For instance, you may want to measure the

OBJECTIVES OF THE INSTITUTE OF AMATEUR RADIO

1. Establish an office in Washington, D. C. with a full time representative to keep in contact with Congress, the Administration and all government officials in any way involved with amateur radio matters.

2. Supply Congress, the FCC, government officials and news services with news releases on amateur public service, and other achievements.

3. Compile a list of the officials of foreign governments who are involved with amateur radio or who are good possibilities as delegates to the coming Geneva conference and provide a steady stream of information to them about the values of having a strong amateur service, the accomplishments of amateurs everywhere, and news of important changes in amateur regulations world-wide.

4. Send representatives to visit foreign officials and do everything possible to see that amateur radio is understood and appreciated world-wide. Help newer and underdeveloped countries to establish a strong amateur service in every way possible.

5. Provide funds to help fight important court battles in our own country which could set a precident which would be harmful to amateur radio.

6. Set up a program of technical achievement with certificates and awards.

7. Establish a country-wide organization to provide an exchange of information on current amateur affairs between all government and other interested parties and the amateurs themselves.

8. Work in cooperation with the ARRL and through 73 Magazine to improve operating practices on our bands and to encourage a wider use of our many ham bands.

9. Work in cooperation with the RSGB to remove and discourage foreign commercial and broadcast stations operating in our ham bands against international regulations.

10. Work to strengthen the ARRL and help it in all ways possible to carry on its many beneficial programs.

The Institute of Amateur Radio, a non-profit corporation, with your support, will immediately start working on the programs outlined above. If you have any question about the immediacy of the situation then please take the time to read the articles by Prose Walker in the October QST on page 48 and by Ivan Loucks on page 82 of the December QST.

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impedance of your new antenna. Or the SWR on the feedline. You may have need to check our your modulator, or adjust an audio filter. If you're a sidebander you probably have occasion to check band and pass of a circuit from time to time, and in any event you will someday need to test a tube. So just what will you need?

Let's back off and look at a generous helping of the test gear commercially available for ham use (without regard to brand name or model number), to see just what it is and what it can do. Then we'll look at some unconventional ways to use some of it, and by the time we're through you will probably have a pretty good idea of what you need to fit your own needs.

The VOM

A good starting place is the lowly VOM; these gadgets are available for as little as $4.95, or you can pay up to nearly $100. As in everything else, you get about what you pay for. A good, serviceable instrument can, however, be obtained for from $8 to $15 from most mail-order houses—this is less than it would cost to build for yourself.

The VOM consists of a sensitive current meter; it usually uses a 0-1 milliammeter, or a 0-50 microammeter, although other types are found occasionally. In addition to the meter,

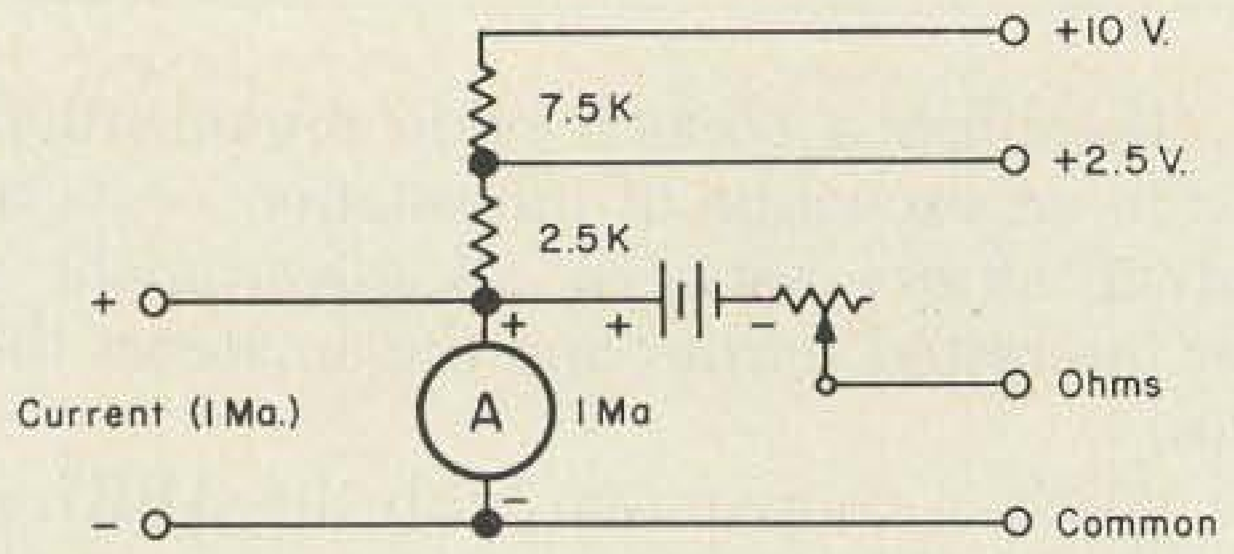


FIGURE I

Simplified VOM circuit

shunts, and multipliers are provided so that you can measure either voltage or current on several scales. A battery and calibration resistor provide the capability of measuring dc resistance, while a rectifier allows voltage or current readings on ac as well as dc.

VOM's are usually rated in "ohms per volt" with 1,000 ohms/volt, 10,000 ohms/volt, and 20,000 ohms/volt as common ratings. The higher this rating, the more accurately the meter will measure in high-impedance circuits. Also, the more expensive the meter as it must have a more sensitive basic movement.

In addition to the ohms/volt rating, the things to look for in a VOM include the number of scales provided, the ranges of the scales, and the general operating convenience of the instrument.

How can a VOM be used? It's a natural for measuring power-supply voltages, as well as for measuring current to stages not already metered. Its resistance ranges can be used to identify resistors, and also for continuity checking in cables. The VOM has one great advantage over other voltage-measuring devices; it is fully self-contained and as a result is exceptionally portable. Regardless of your other test gear, you should have at least one VOM around!

The Grid-Dip Oscillator

First described in the early 30's, the GDO was one of the "forgotten" instruments of test equipment until resurrected about 1945; now at least a dozen are available commercially, in both tube–and transistor-type varieties.

The GDO is basically a variable frequency oscillator with a grid-current meter; plug-in coils allow it to cover a wide range of frequencies. When the oscillator is running, the meter indicates the amount of grid current. If the oscillator is coupled to a resonant circuit and the oscillator frequency is varied, power will be transferred to the coupled circuit when the oscillator reaches the frequency at which the coupled circuit is resonant. The power coupled out is no longer available to provide grid circuit, so the meter needle dips. This is where the device gets its name.

Most present-day GDO's also incorporate a switch to turn off plate voltage to the oscillator but leave everything else on. In this case, the instrument becomes an indicating wavemeter. The meter needle will not leave zero until rf is coupled into the GDO tank circuit from an external source; when that happens, the rf is rectified in the diode formed by grid and cathode (or base and emitter) of the oscillator, and grid current flows. The amount of grid current indicates roughly the amount of rf, so it can be used as a field- strength meter or rough comparison device.

Provision is also made to plug in a headphone in place of the meter; when the oscillator is on, you can hear a beat note as the oscillator frequency approaches that of an rf source coupled to the tank, and with the oscillator off, you have a rudimentary crystal set usable for phone monitoring.

The normal use of the GDO is to determine the resonant frequency of a tank circuit, either one under construction or in pre-tuning a transmitter before turning on plate voltage. However, with a couple of "standard" units—one a capacitor of accurately known value and the other an inductor of similarly known value—the gadget can measure inductance and capacitance. To measure inductance, connect the standard capacitor to the unknown inductance and use the GDO in normal fashion to find the resonant frequency of the combination. Then solve the resonance equation to determine what inductance resonates at the frequency with that capacitance. The equation, in terms of L, is $L = 25,330/f^2C$, with L in microhenries, C in picofarads, and f in megacycles.

To find capacitance, follow the same procedure. The formula then becomes $C = 25,330/f^2L$, in the same units as before.

In the indicating-wavemeter mode, the GDO is a good neutralization indicator for a trans-

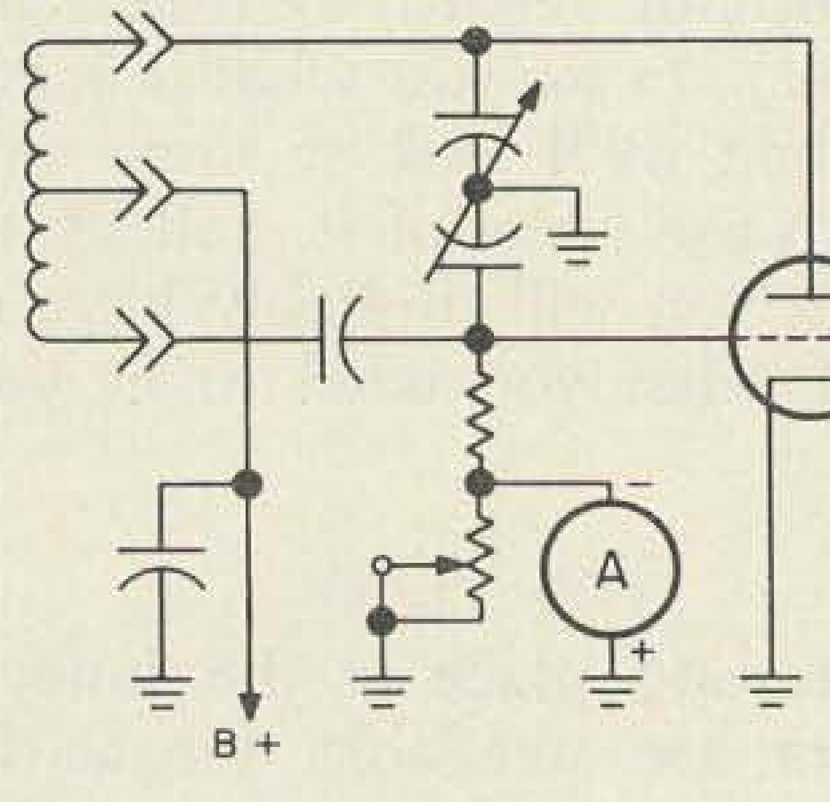


FIGURE 2
GDO Typical circuit

mitter tune-up. Couple the GDO to the final tank and remove plate and screen voltage from the final. Tune all preceding stages for maximum grid current in the final and maximum indication on the GDO. Adjust neutralization for minimum reading on the GDO while retaining maximum final grid current (retune the final grid circuit each time to maximum grid current). When the GDO indication reaches zero, you're neutralized. Remove GDO and hook up plate and screen voltages.

The Receiver

Uses of a receiver as an item of test equipment are many. One of the most common is to check that an oscillator is operating properly. If the oscillator output produces a clean, clear note when received with the BFO on, and shows no tendency to jump frequency, you can assume that it's working right.

But the receiver as a test instrument is not limited to checking oscillators. For instance, a general-coverage receiver can be used for the same purpose as a GDO in finding the resonance point of a tank circuit, if the tank can be connected in series with the antenna lead. A parallel-resonant circuit has high impedance at its resonant frequency, and so if it is inserted in the antenna lead signals or external noise will be greatly reduced at this frequency and no other.

When turned to WWV, the receiver produces a source of audio tones to known frequency, as well as being an aid to calibration of frequency standards.

In adjusting a SSB rig, a receiver equipped with an S-meter becomes an exceptionally sensitive rf VTVM, aloing comparison of levels of wanted and unwanted sidebands, as well as providing a good indicator of carrier balance. And when neutralizing any transmitter, the receiver can be used instead of the GDO as the output indicator for a much more sensitive indication.

Of course, there's no need to say "Buy a receiver" because almost everyone has one. But for test-equipment usuage, important points include general coverage and S-meter indications. Many hams have found it worthwhile to add a second inexpensive receiver of this sort to their stations for testing purposes, to back up their more specialized ham-bands-only communications jobs!

The Vacuum-Tube Voltmeter

VTVM's come in three basic categories: most common is the "general-purpose" type,

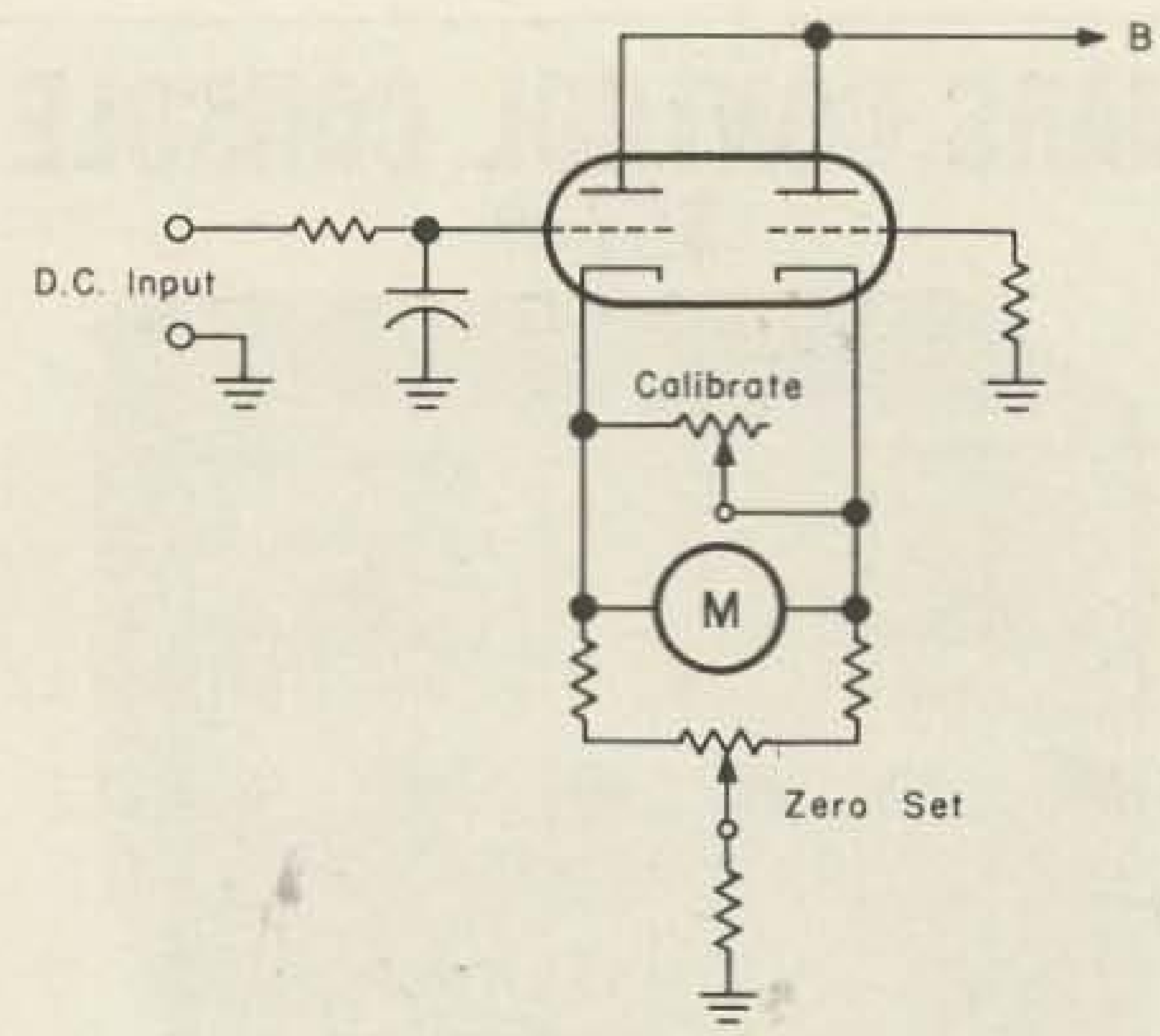


FIGURE 3
VTVM bridge circuit

which is also the most useful for ham purposes. The other types are the "AC VTVM", used for measuring very small ac voltages, and the Digital Volt meter or DVM which is as useful as a general-purpose job, more accurate to boot, but costs upwards of several thousand dollars!

The general-purpose VTVM usually contains two or three tubes; it consists basically of a balanced-bridge dc amplifier with a sensitive meter movement to indicate the degree of unbalance. With no input, the bridge is balanced and the meter reads zero. With dc input to the bridge, unbalance results and the meter indication shows the amount of dc applied. The other tubes act as rectifiers for ac signals and for power-supply purposes.

Major advantage of the VTVM over the VOM is that the VTVM is a voltage-operated device with exceptionally high input impedance. The VOM, on the other hand, is a current-operated device with lower input impedance. The high input impedance of the VTVM means it loads the circuit being measured much less, and readings are more accurate. It also allows a wider range of resistance measurements to be made. Typical circuits of VTVM bridges and ohmmeter sections appear in Figs. 3 and 4.

However, to measure current with a VTVM we must proceed indirectly by putting a resistor in series with the circuit and measuring the voltage drop across the resistor. If the resistor is 1000 ohms, every ma of current through it will produce 1 volt across it; thus the voltage reading tells us the current. The VOM can measure current directly.

The high input inpedance of the VTVM allows its use for many measurements which cannot be made with the VOM. For instance, both capacitance and large values of inductance can be measured by the VTVM, by connecting the capacitor or inductor in series with an adjustable resistor as shown in Fig. 5 and applying ac of know frequency (60-cycle from the power line is usually used) across the series pair. Adjust the resistor's value until the VTVM indicates the same amount of voltage across the resistor and across the capacitor or inductor; then remove the ac and measure the resistance of the resistor. This will be equal to the reactance of the capacitor or inductor at the chosen frequency, and the value in microfarads or henries can then be calculated from the reactance formula. For 60 cycle ac, capacitance will be equal to $2720/X_c$, where $X_c = R$ in ohms and capacitance is in microfarads. Inductance will be equal to $0.000272X_1$, where $X_1 = R$ in ohms and inductance is in henries.

Another method of measuring capacitance with a VTVM, first described by John Janning, W8QCN, in the August 1959 issue of Radio-

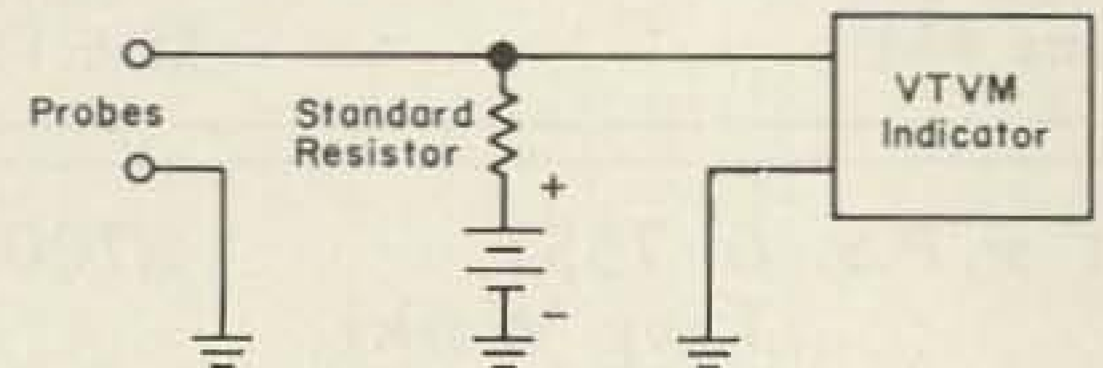


FIGURE 4
VTVM ohmmeter circuit

Electronics magazine, makes use of the circuit shown in Fig. 6. This is a rectifier which produces pulsating dc, and the average dc level available at the output is directly proportional to the amount of capacitance in the filter. Thus the scale of the VTVM can be calibrated to indicate capacitance when measuring the voltage at the output. For full details, see the original article.

In conjunction with a good rf choke at the tip of the probe, a VTVM can be used to measure grid bias on an operating rf stage. This helps both in tuneup of a transmitter or in adjusting the value of the grid-leak during an experimental design.

VTVM's are available from a number of manufacturers; prices range from about \$25 up, depending on the number of features included, whether you get a kit or a factory-wired instrument, etc.

The Oscilloscope

Not so awfully many years ago the oscillo-

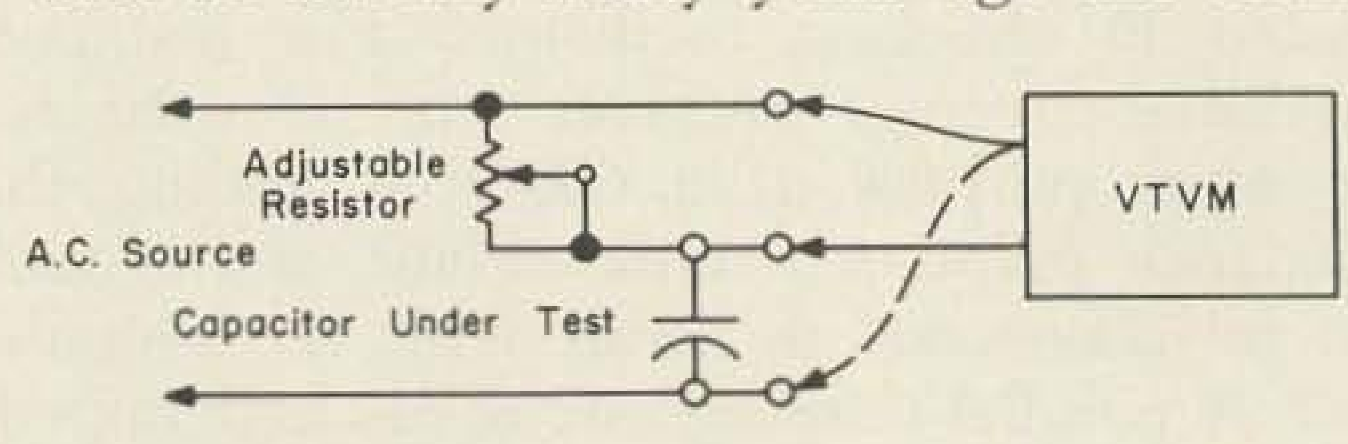


FIGURE 5
Capacitance measurement with VTVM

scope was strictly a laboratory instrument; television changed all that in the years after 1945, so that today a good scope can be purchased for as little as $50.

The purpose of the scope is to present a visual image of what goes on in a circuit; this may seem to be a rather limited purpose, but it is actually exceptionally broad in its implications.

The scope is possibly the most versatile item of test equipment in existence; it may be used equally well for checking transmitters, receivers, audio circuits, rf stages, power supplies, or any other combination of electronic components. It is the only type of measuring instrument which shows directly and visually just what is happening at the point to which it is connected, and is the only instrument capable of making accurate measurements of complex ac waveforms.

The key component of the scope is the cathode-ray tube; this is a special tube having an "electron gun" which focuses electrons leaving the cathode into a straight, tight beam, two or more pairs of deflection plates which enable the beam to be moved to any position, and a fluorescent screen at the far end where the electron beam is made visible. Any device incorporating a cathode-ray tube of this general description is an oscilloscope—but most scopes have additional components to enable wider uses of them.

Most essential of these additional components are the horizontal and vertical amplifiers. The deflection plates of the CRT require quite high voltages to achieve adequate deflection of the electron beam, and these amplifiers raise small input voltages to the levels required by the CRT.

The characteristics of the vertical amplifier usually determine the scope's performance characteristics; this amplifier may be either of the ac variety like most audio amplifiers, or direct coupled so that dc inputs will result in spot deflection. The frequency limits of this amplifier may be either narrow, as in most audio amplifiers, or wide, as in a video amplifier. Most common TV-service scopes have vertical amplifiers rated from about 5 to 10 cps at the low end up to about 500 kc at the top; "color-TV" scopes go on up to about 4 mc at

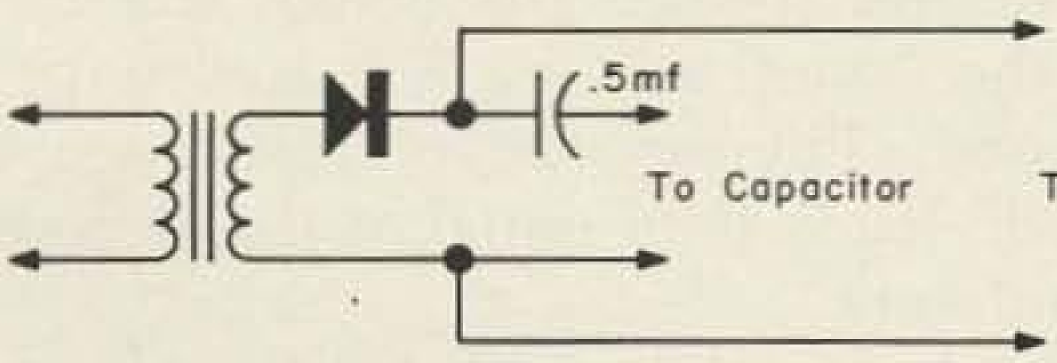


FIGURE 6
WBQCN measurement technique

the top, while the more expensive laboratory instruments go, in some cases, higher than 50 mc.

The horizontal amplifier is less critical; so long as it reproduces the sweep waveform properly it his little effect on scope operation. Some scopes have identical vertical and horizontal amplifiers, but most have restricted bandpass in the horizontal circuit.

For general-purpose usage, another important component of the scope is the "timebase" or horizontal sweep generater. This is a circuit which moves the electron beam across the scope tube face at a constant rate of speed; the exact speed at which the beam moves is determined by the sweep-frequency settings on the scope control panel, and usually ranges from a low of about 60 inches per second up to about 2,000,000 inches per second (15 cps and 500 kc, respectively, on a 5-inch screen).

Normal use of the scope in most ham shacks is to check on the waveshape of ac voltages; for this purpose the vertical input is connected to the point at which the voltage to be viewed is present and the horizontal sweep controls are set for a convenient, stationary display. Vertical and horizontal amplifier gain controls are set for a display of convenient size, and brightness and focus are set for a comfortable light level on the screen. Then by watching the displayed waveform as various adjustments are tried, the effect of each adjustment on the circuit under test can be determined immediately.

Another widespread use of the scope is to check modulation. To do this, some of the modulated rf output is coupled directly to the vertical deflection plates of the CRT; a two-turn link usually will pick up enough from the final tank to get a good display. Setting the horizontal sweep controls to a convenient sweep rate will give a wave-envelope display, so that you can easily see if any distortion or overmodulation is present. Connecting the horizontal input of the scope to the output side of the modulator will give a triangular or trapezoid display, which is actually a graph of the modulation linearity of the stage. The object is a triangle with perfectly straight sides. Details of this display have been described elsewhere so many times they won't be gone into here.

But the scope can also be used as a voltmeter; a dc scope works for both dc and ac voltages, while an ac scope checks only ac unless an adapter of some sort is added. Start with a known source of voltage and adjust the vertical gain controls for a convenient number of squares height of the display; any trace with the same height will have the same voltage level, if the gain controls are not disturbed. To read current with a scope, or to take a current waveform, follow the same technique described for the VTVM earlier.

To measure inductance or capacitance, you can use the same technique described for the VTVM but it becomes even simpler. Connect the junction between capacitor and resistor to the ground point of the scope, then connect the other end of the capacitor to the vertical input and of the resistor to the horizontal input. Set the vertical and horizontal gain controls for identical gain through each amplifier (this will not necessarily be identical settings of the controls themselves) and then vary the resistor, with ac applied across the pair, until the screen pattern has equal width and height. The pattern will usually be an ellipse, but may at times resemble a straight line inclined at 45 degrees. At this point, the voltage across resistor and capacitor are equal, and the resistance value can be measured and used in the reactance formula to determine capacitance.

Unlike most other test instruments, the scope's unlimited versatility makes a complete description of its uses too long to include here. Even the John F. Rider "Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses," measuring 998 9x12-inch pages packed with print, fails to include *all* the uses of the scope.

Prices of present day scopes range from about $66 for 3-inch (screen size) kit up into the thousands of dollars for Tektronix laboratory instruments; for general ham use, a relatively inexpensive dc-coupled unit is advisable. It should cost about $70 in kit form or $110 factory-wired.

Antenna Impedance Meter

An interesting item of ham test equipment is the antenna impedance meter or antennascope, which measures rf resistance of antennas and feedlines. For the antenna experimenter, one of these devices is almost a necessity. They measure resistive impedance from near zero to greater than 100 ohms, allowing proper design of matching networks to insure perfect antenna-feedline matches.

The basic instrument consists of an rf bridge with a variable "standard" arm; with the antenna or feedline connected as the "unknown" leg of the bridge and a small amount of rf energy of the proper frequency fed into the bridge, the "standard" leg is varied until a null is indicated. The amount of resistance in the "standard" leg is then equal to the rf resistance of the antenna.

While designed primarily to measure rf resistance, the device can also be used as an SWR bridge by simply setting the "standard" leg to the desired feedline impedance and seeing if a null is achieved. Machining adjustments can then be varied until a null is indicated. However, this instrument will not give a direct or an accurate indication of the amount of SWR, if no match is achieved.

SWR Meters

An approximately accurate determination of the amount of SWR can be achieved only with an SWR meter, which measures both the outgoing power and that reflected back which creates standing waves, then compares them to determine the SWR.

Three basic types of these meters exist. One measures power going up and power coming back, leaving the calculation up to you, while the other types measure voltage out and voltage back, and usually give direct readings of SWR. At high SWR values, the power variety proves more accurate, but below an SWR value of 2 to 1, the voltage-reading type provides a more expanded, hence more accurate, indication.

An older type of SWR meter is the bridge, operating similarly to the Antenna Impedance Bridge just described but with a fixed "standard" leg. This type has been almost completely superceded by the newer types, since the newer models can remain in the feedline at all times to be used as power indicators during tune-up or operation.

With the voltage-reading types of SWR meters (typical price, about $30 to $50), you simply switch the meter to "forward" and adjust the knob for a full-scale meter reading, then switch back to "reflected" and read the SWP from the meter face. For a more perfect match, once you have SWR down so low the meter deflection is almost unnoticeable, you can crank the knob all the way open and simply adjust for a null on the meaer. The readings won't be accurate in value when you do this, but since under normal reading conditions you can easily measure SWR as low as 1.05 to 1, you will know that final SWR is lower than that.

No SWR bridge can be accurate when used at the transmitter end of a long run of lossy feedline, since the reflected voltage or power which is the basis of its measurement will be reduced by the feedline loss. For most accurate results, especially in initial tuning, the meter should be placed directly at the antenna terminals. Afterward, of course, it can be placed at the transmitter for a running check on tuning of the rig.

Field-Strength Meters

A common item of ham test equipment is the field-strength meter, or FSM. This is simply an indicating wavemeter, fitted with a short pickup antenna, to indicate the relative amount of rf floating around wherever the FSM happens to be located.

Major use of the FSM is to indicate proper tuning of a transmitter or to indicate antenna output. Many of these devices are sold and used, but either a GDO in the wavemeter mode or one of the newer types of SWR meters will do the same job—and several others as well. One major advantage the FSM has is that it is usually completely portable, requiring no source of power. However, its restricted usefulness tends to cancel this advantage out.

Audio Generators

If you're a CW man, you can skip this section. But if you operate any type of fone station, either am, fm, or sideband you will need an audio signal generator at some time or another. The generally used whistle is nowhere near the best way to determine how well an audio section is working—for one thing, it's hard to keep exactly the same volume for a half hour without a pause!

Almost as many kinds of audio signal generators—or oscillators, if you prefer that name—are around as you can imagine. Most of them, fortunately, bear fairly low prices because of the hi-fi boom. All you have to have is something which will produce sine waves at two or three spot frequencies, such as for instance 300 cps, 1500 cps, and 3000 cps. The upper and lower frequencies allow you to check performance at the limits of the generally accepted speech band, while the 1500 cps is a convenient value for general trouble-shooting.

But a hi-fi type of generator, covering 20 cps to 20 kc or so, is just as inexpensive and can make life much simpler. With one of these, you can check your audio shaping circuits accurately, and find out just how many db down you are at 9700 cps, etc.

Some of the more versatile commercial audio generators contain provisions to supply either sine-wave output, or square waves. The average ham experimenter will almost never have need of square waves, but if the provisions come at no exetra cost you might as well have it. For one thing, a square-wave generator can be set to 100 kc and a high-order harmonic of this zero-beat with WWV to give you a good, accurate (for short periods of time) frequency standard. Just remember that a square-wave contains odd harmonics only; the second, fourth, sixth, etc., will be absent.

Prices for this item range from about $30 on up. Look for one with wide frequency range and some sort of output calibration so you can easily get the output level you want.

Many use only a simple pot in the output, and this can be horribly confusing at times.

Sweep Generator

The sweep generator produces a frequency-modulated rf signal, which can be used to adjust the bandpass of if strips, converter output circuits, transmitter interstage networks, etc. While it is designed for TV service work, it's also mighty handy in the ham shack.

Most sweep generators use a hetrodyne technique, in which the swept generator operates at a fixed frequency region and its FM output is mixed with that of a non-swept VFO; most of them have output in the TV and FM bands only, but many come down as low as 10 mc.

Sweep widths are usually continuously adjustable from zero to 10 mc. For ham use, about 5 mc is the maximum sweep usually needed. More often, you'll be using only a few kc of sweep.

The sweep generator can be used only with a scope, and the two together provide you a picture of the passband of the item under test. Sweep generator output is connected to the item, and the rf passing through the item is detected by an rf probe and displayed on the scope. It's the fastest method know for adjusting a bandpass circuit to exactly the desired characteristics.

Price of a typical kit-form sweep generator is about $40. It won't be one of the first items of test equipment you need, but once you use it you'll find yourself wondering how you ever managed without it for its special purposes.

Tube Testers

Say "test equipment" to the average guy in the street and chances are the first thing he'll think of is a tube tester. This is one everybody knows. Yet it's bringing up the end of the line here. Why?

The answer is that for ham use, a tube tester is probably the least-needed item of test equipment. In the first place, commercial testers will handle only receiving tubes and a few of the lowest powered transmitting bottles. Secondly, if you want to use a tester you can find one at almost any supermarket or drugstore.

And at the bottom of it all is the fact that the only sure test for a tube is to substitute a new one and see what happens. In ham applications this is more true than ever, since we so often use tubes for purposes their designers never dreamed of.

Tube testers come in two basic types, called "emission" and "transconductance" testers. Most of the drugstore type are emission testers; these kind check all tubes as diodes, and tell you how well the cathode is emitting electrons. The idea is that as a tube gets weaker its emission drops.

The transconductance tester, on the other hand, tells you how much control over the plate current the control grid still has. Emission is tested by implication here, but the control is the important thing. Since this is a closer approximation to true operating conditions, this is generally thought to be a better test.

Emission testers may be purchased for around $15 to $30. The transconductance types cost several times as much, and the top model of transconductance tester will set you back well over $1,000.

The Complete Ham Lab

Way back at the beginning, we promised you a schedule of test equipment purchases (or projects) which could be taken on in easy stages and would wind up as a complete lab. Here it is.

At the start, there's no question. Get a VOM. Make it a compact one so you can carry it around easily, but don't compromise too much with quality. You'll want it to be at least 20,000 ohms per volt. Expect to spend about $25 here.

Recommended next step is a grid-dip occillator, most easily obtained either in kit form or as a homebrew project. This assumes you already have a receiver; if not, get one before proceeding farther.

With the VOM, GDO, and receiver, you're in position to go for a goodly while with no additional expenditures. But you'll probably want to expand sooner or later, and the recommended next step is a scope.

The scope you get should have at least a 3-inch screen and 5-inch is better. Avoid 7-inch units; they take up too much room for what you get. DC coupling is good, but wide bandpass isn't necessary.

The SWR Meters, frequency standards, and field strength meters will probably have been purchased as station accessories rather than as test equipment. If not, add an SWR meter at this stage.

You may notice that no mention has been made yet of the VTVM; the scope should come before the VTVM, as it will do almost anything of which a VTVM is capable. The VTVM can be added at any subsequent time.

Next major item should be an audio generator, followed later by an rf sweep generator. You can add a tube tester as the last item if you like, but it's not really essential.

If you want to be really exotic, you can add a "Microvolter" or highly calibrated rf signal generator to the lineup; this is a lab instrument and costs accordingly. However, it will allow you to say "My receiver has a 10 db S/N ratio at 0.5 microvolts on 40 meters" and know whereof you speak. If you don't want to go this far, you really won't need an rf signal generator at all; the GDO will handle that job too.

For the VHF/UHF addict, a noise generator should be added between the grid-dipper and the scope. This is an exceptionally simple homebrew project, or can be purchased for less than $10.

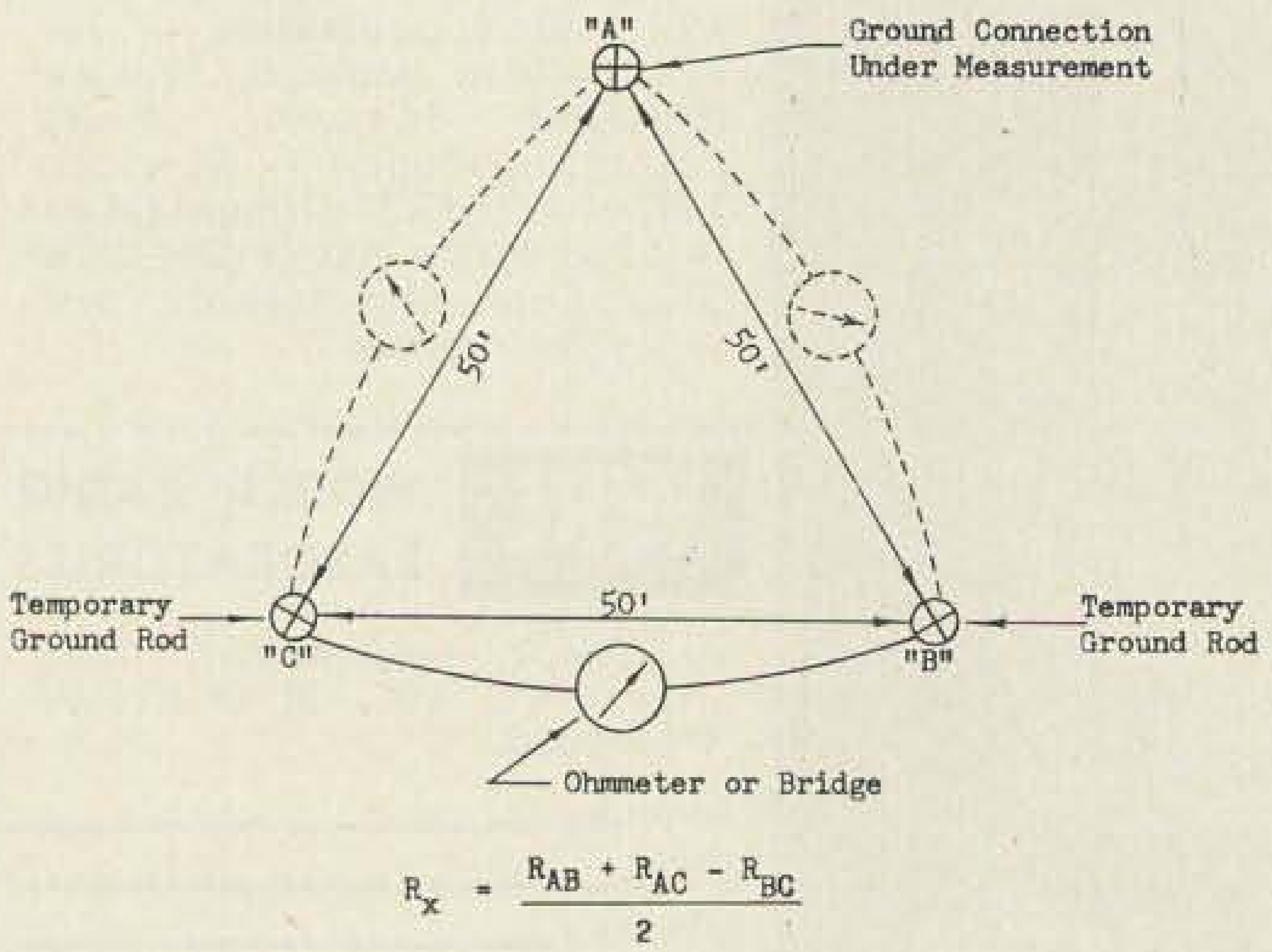
Once you have all this equipment assembled, you should be able to handle almost any problem. The only question will be whether you know how to use it properly—and that's a subject for several dozen more articles!

. . . K5JKX

J. R. Fisk WA6BSO

Practical Ground Systems for Radio Communications

Proper grounding is one of the basic requirements for any communications station, and yet, little published information is available concerning their design. Since antenna performace is standarized with reference to the ground as a perfectly conducting plane, the ground system must approach that condition if the performance of the antenna is to be predictable, dependable and efficient. Although the majority of antenna classics note that an "adequate" ground system is essential, further definition or description is left to the reader's imagination. This lack of information led to the preparation of this article to be used by the amateur as a general guide to the proper installation of good ground systems. It should be pointed out that during the research several discrepancies were found between various technical textbooks and publications. Therefore the data contained herein may be found to be in variance with some established beliefs.



$$R_x = \frac{R_{AB} + R_{AC} - R_{BC}}{2}$$

R_x = Ground connection resistance to be determined

Ground system resistance measurement.

Since the effectiveness of a ground system depends upon the resistivity of the earth, the resistivity encountered at a particular location will be a guide to just how extensive a ground system will be required for reliable high frequency communications. The ground resistivity in meter-ohms may be simply measured by driving two ground rods five feet into the earth, five feet apart. The resistance measured between the rods, in ohms, approximates the earth resistivity in meter-ohms, for the area in question. This earth resistivity is a measure of volume soil resistivity and should not be confused with the resistance of a grounding connection or system.

If the earth resistivity is found to be on the order of 100 meter-ohms or less, a fairly efficient grounding system may be had by the simple expedient of driving an eight foot ground stake. On the other hand, the resistivity is usually found to be somewhat in excess of 100 meters-ohms, and a more extensive ground system is in order.

The ground resistance of a particular grounding system, whether it be a ground rod or a group of ground rods and radials, may be measured by the method outlined in Fig. 1. Here the ground system being measured is designated "A" and two ground stakes are driven into the earth at points "B" and "C", forming an equilateral triangle, fifty feet on a side. Using an ohmmeter or bridge, the resistance of each of the sides is measured. Several precautions should be taken when making the resistance measurements to insure that accurate measurements are obtained. First, when zeroing the ohmmeter, use the probes that will be used in the actual measurement. Since these wire leads will be in excess of twenty-five feet, care must be taken during the zeroing process to preclude significant errors during measurement. Secondly, when measuring each side of the triangle, take several readings, reverse the leads and take several more. Reversing the leads and averaging the readings will tend to neutralize errors due to stray earth currents which may be in the area under measurement.

After obtaining the necessary measurements, the ground resistance of the ground system may be determined by using the following formula:

$$R_X = \frac{R_{AB} + R_{AC} - R_{BC}}{2}$$

Where: R_X = Ground resistance in ohms
R_{AB} = Resistance measured between "A" and "B"
R_{AC} = Resistance measured between "A" and "C"
R_{BC} = Resistance measured between "B" and "C"

In the event the ground system under measurement consists of a single ground rod, the spacing of the temporary rods can be reduced to ten feet for convenience, if the same configuration is maintained.

When the ground resistance is found to be too high, it may be reduced by using additional ground rods or ground wires, longer ground stakes, chemical treatment of the soil, or a combination of these methods. Each method has its particular usefulness and local factors will govern the selection.

Additional ground stakes are one of the best

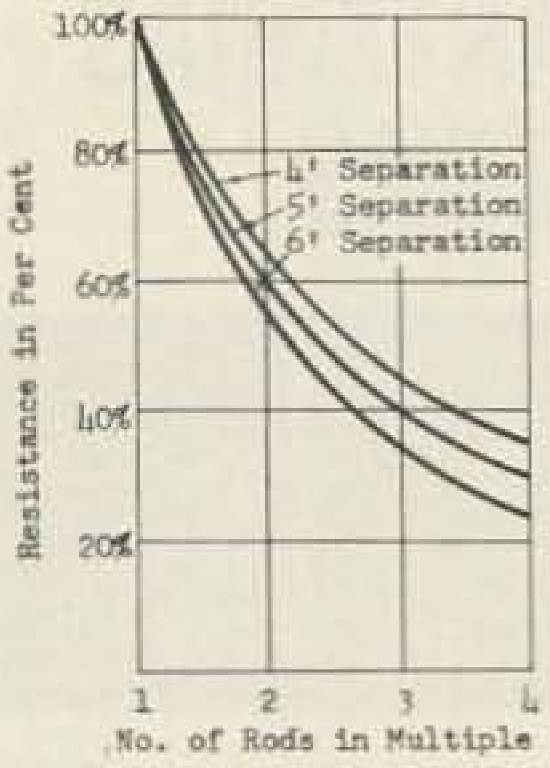


Fig. 2

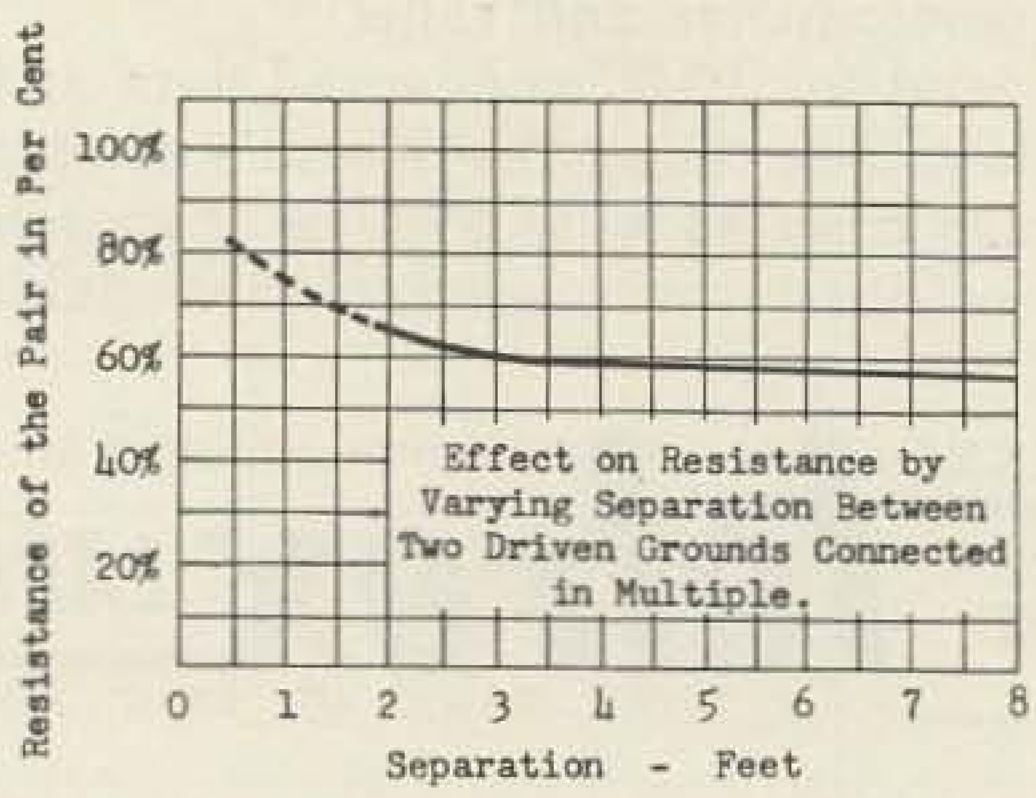


Fig. 3

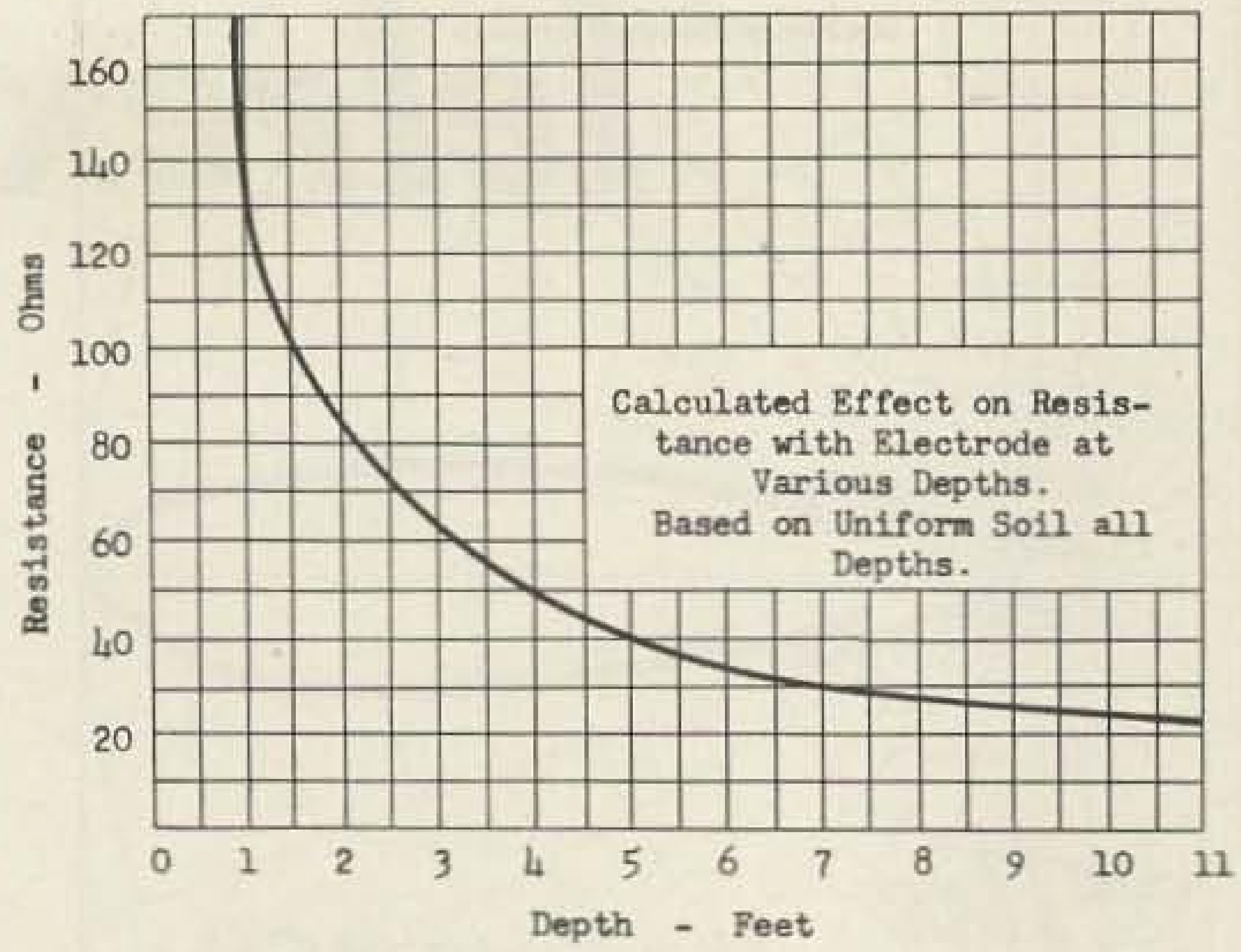


Fig. 4

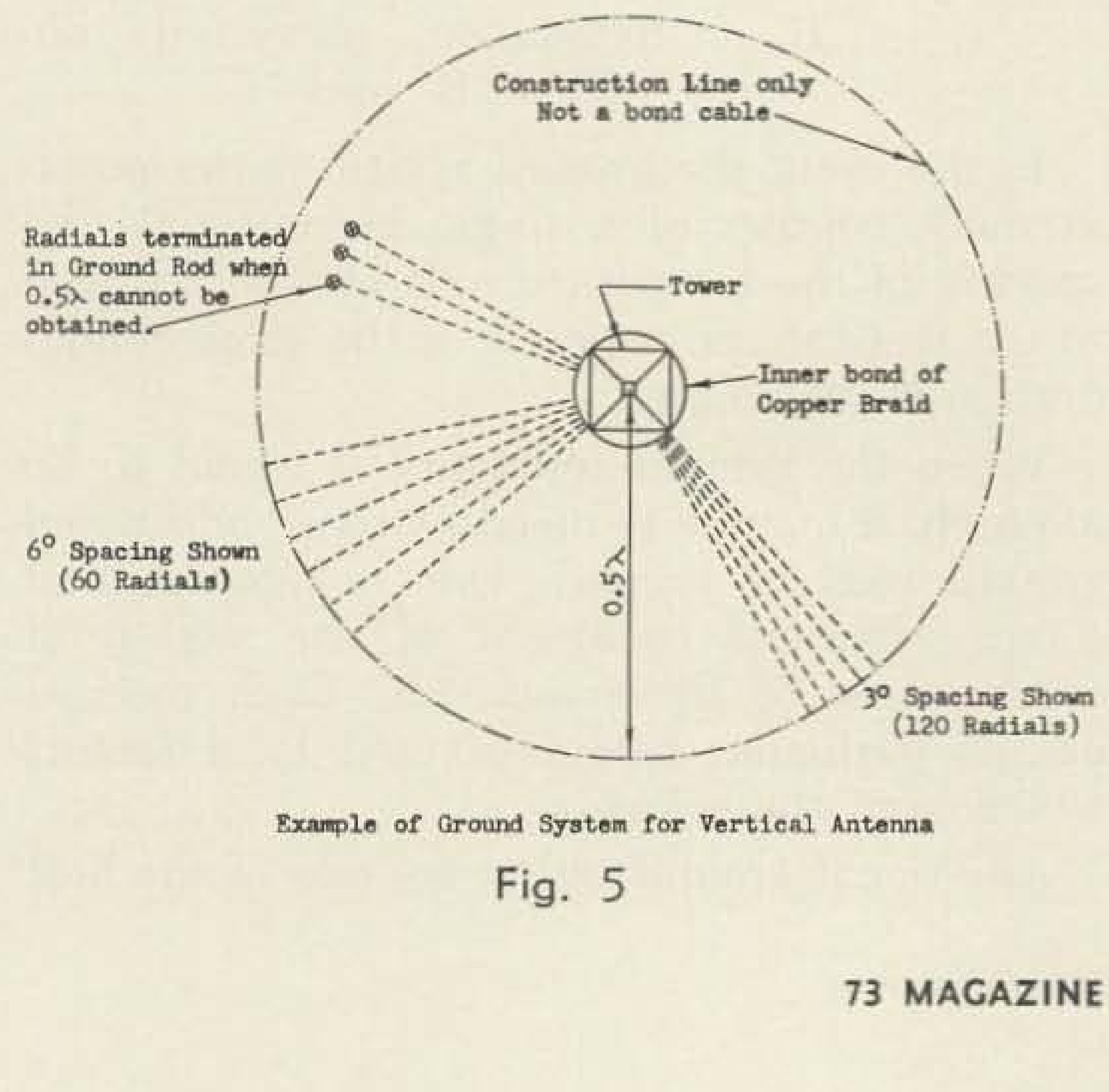
methods for reducing the resistance of grounds. For example, the ground resistance of a single ground rod may be reduced by 40% by using two properly spaced, parallel connected ground stakes. A 60% reduction may be realized by the use of three properly spaced, parallel connected rods. As the number of rods is increased beyond four, the percentage gain will fall off progressively and economic factors will rule out an excessive number of multiple rods (see Fig. 2). A spacing of five feet minimum between ground rods is much more effective than closer spacing, and may be considered optimum under most conditions where wider spacing is impractical (see Fig. 3).

Copper clad steel rods have properties which make them particularly well suited as driven ground electrodes. They are protected from rusting by a thick exterior of copper molten-welded to a high strength steel core which provides rigidity for driving. Rods less than six feet long and less than ⅝ inches in diameter are usually poor economy because they drive poorly and seldom reach to depths that provide low resistance grounds (see Fig. 4). Eight and ten foot rods can show ground resistance reductions of 22% to 35% over six foot rods in uniform soil. Even greater reductions may be realized over the shorter rods in cases where the longer rods penetrate a water table or other more conductive strata.

From a practical standpoint, however, the rod lengths are often limited by other factors such as handling or driving and the maximum depth to which a rod can be driven due to rock strata or other obstructions. For this reason, the ¾ inch diameter, eight foot copper clad steel rod is usually considered as the standard, with longer rods being used for special applications. Increasing the rod diameter above ¾ inch does not materially reduce the ground resistance and considerably increases the rod cost due to the added weight of necessary metal.

No vertical antenna can perform efficiently without an adequate ground system, since the conducting ground serves as a part of the antenna system. A line of electric force extends from the top of the antenna through surrounding space to earth. Upon entering a perfectly conducting earth it becomes a conduction current which returns to the base of the antenna and becomes a portion of the antenna current. Although other types of antennas are not as dependent upon a ground system as the vertical, a good ground system will increase the efficiency of nearly any antenna system.

The configuration of the ground wires of a buried or surface ground is dictated by the natural path for return ground currents. Therefore, they will lie radially about the base of the



Example of Ground System for Vertical Antenna

Fig. 5

antenna or supporting tower. At the tower base they should connect to a heavy girdle of cable or flat bus which is connected to the tower base elements in the case of a grounded tower, or to the insulator base in the case of an insulated antenna. Electronic components of the antenna tuning unit which are at ground potential should also be bonded to this bus. If the radials are 0.4 to 0.5 wavelengths long at the lower operating frequency, there will be a resultant zero current at the ends of the radials, and there is no need for terminating the radials in ground rods. If the radials cannot be made sufficiently long due to property boundaries or other restrictions, ground rods at the periphery should be used. Contrary to popular belief, circular bonds along the length of the radials are undesirable because they cause indirect return paths and eddy current losses in the closed loop circuits of the mesh formed by such bonds (see Fig. 5).

The theoretical perfect ground is approached when 120 radials (one every 3°) is employed, each radial being 0.5 wavelength long at the lowest operating frequency. For practical purposes, half the number of radials (one every 6°) will be 95% as effective as 120 at a 50% saving in copper and labor. Thirty (one every 12°) will be about 90% effective as 120 and is a good compromise. Normally, less than 30 radials should not be considered in a permanent installation (see Fig. 6 and 7). The inherent configuration of the radials allows the amateur to initially install the number of radials commensurate with the family budget, and then to add more at a later time when funds become available.

Conductor size is not too important except from the mechanical viewpoint. For a permanent installation, wire smaller than #12 AWG is not practical due to corrosion loss. The wire depth is not at all critical and three to six

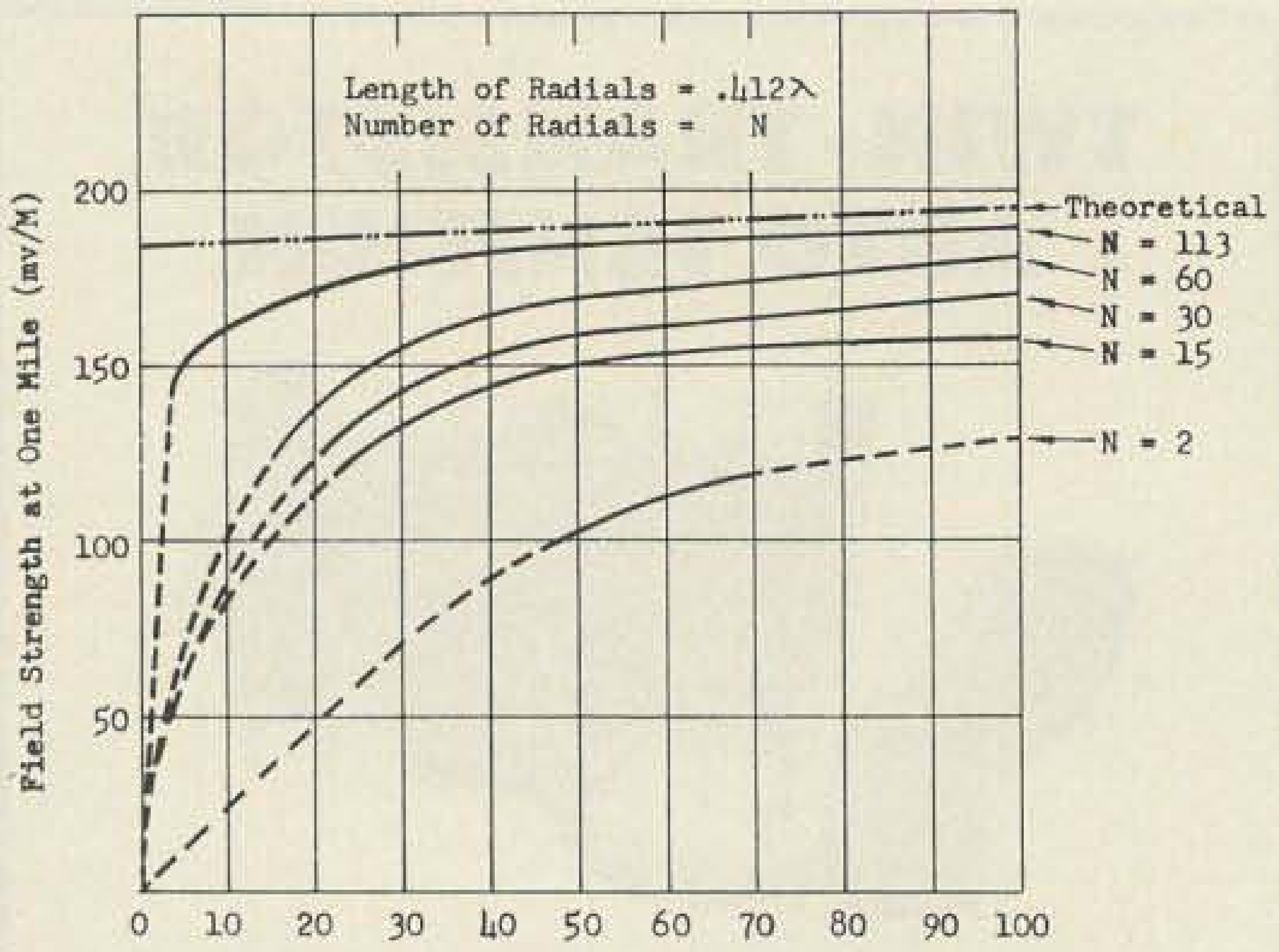


Fig. 6

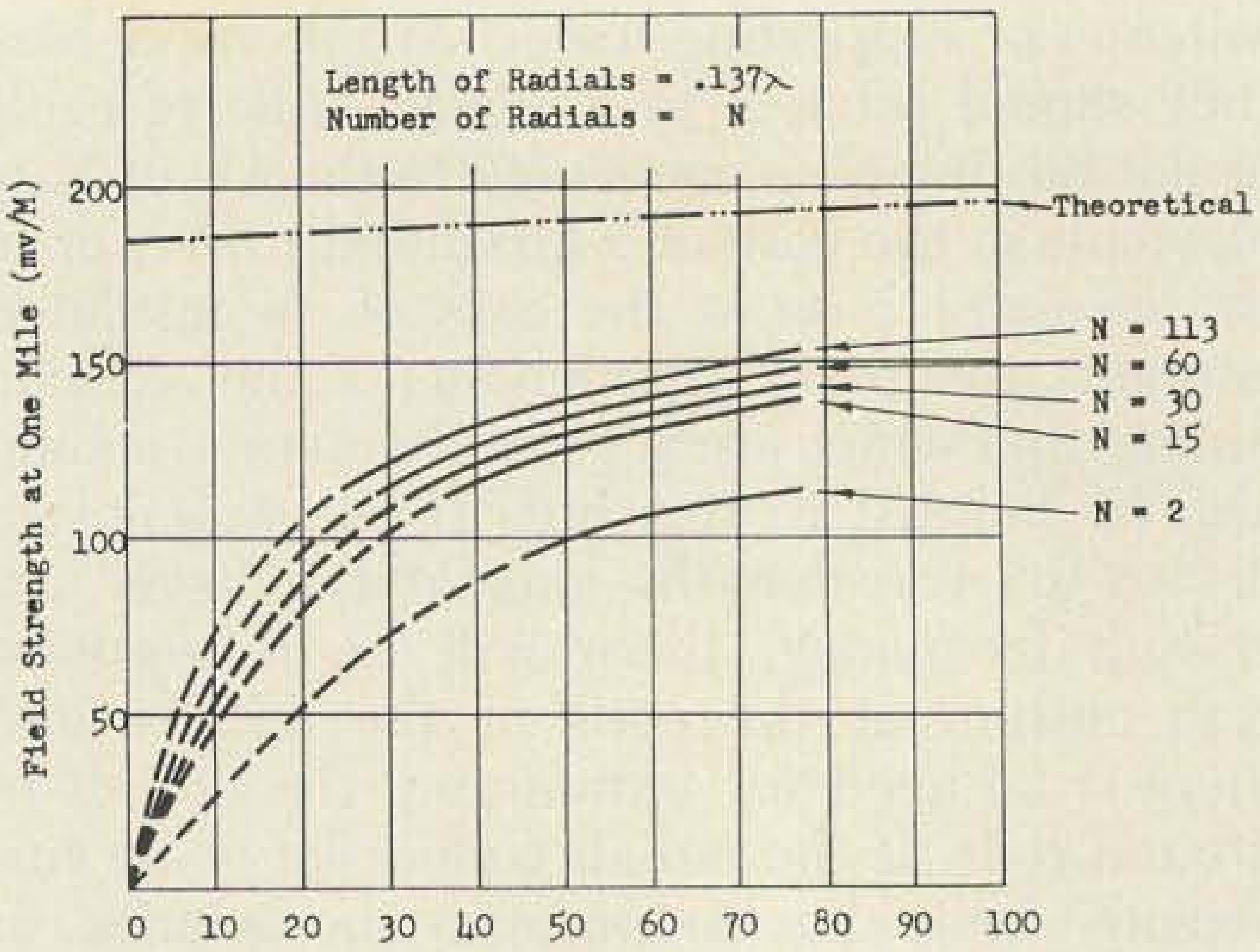


Fig. 7

inches is a good compromise between ease in laying and mechanical protection. Laying the wire on the surface without cover should be avoided except as a temporary measure.

Treating the soil around ground rods is a reliable and effective method of reducing ground resistance, particularly in the case of very high resistance grounds. It is possible for soil treatment to reduce a 1000 ohm ground by as much as 90% (see Fig. 8). However, a similar treatment of a 30 ohm ground would only decrease its resistance by approximately 50%. This method is particularly advantageous when rock strata prevents deep driving of ground rods. Copper sulphate, magnesium sulphate or common rock salt are common chemicals used for soil treatment. The chemicals should be placed in a circular trench about the driven rod (see Fig. 9), or in an adjacent porous container (see Fig. 10), but not in direct contact with the ground rod. The addition of water tends to disperse the chemicals downward by leaching action. improving the result. Normally a protective earth cover is provided the circular trench.

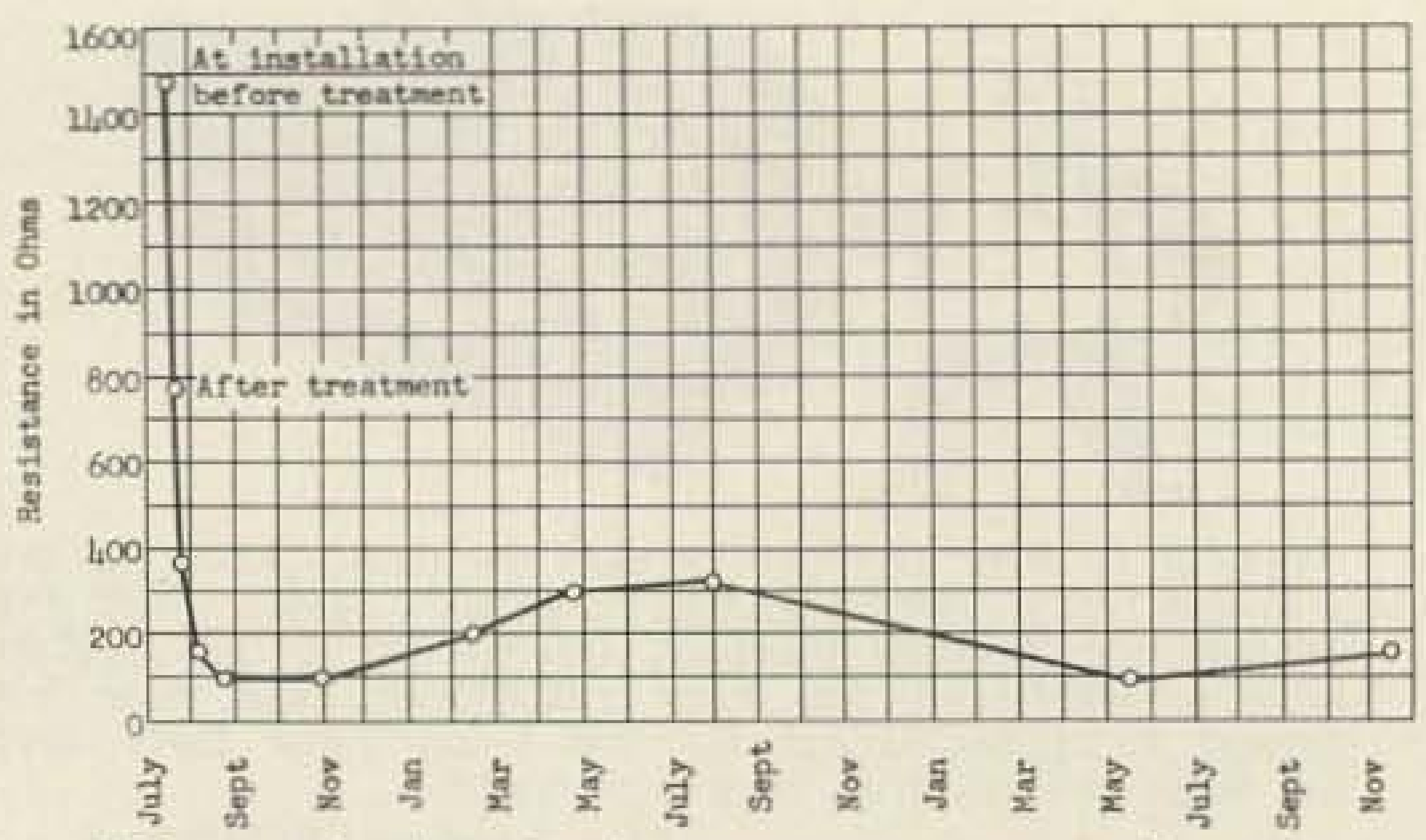
Many ham shacks are located on elevated hills or mountains where they provide the highest elevation in the vicinity. These sites are usually dry and rocky and the soil resistivity is consequently high. Often the rocky ground precludes the driving of ground rods in the immediate vicinity of the station. For such installations the grounding system should take the form of buried radial wires or even surface conductors if the rocky surface precludes burial. However, some burial is usually possible and should be employed if at all possible. The radial wires should be connected to a girdle of heavy cable at the pole or tower and building site. By extending multiple radials downhill fifty to seventy-five feet, natural catch basins of soil can usually be located where the ground rod terminations of the radial wires may be driven. This soil should be thoroughly treated with chemicals to improve its conductivity and catchment basins of earth prepared to trap surface water over the ground rods. Since these elevated locations are especially vulnerable to lightning, sheet metal buildings, coaxial lines and antenna support hardware should be grounded as well as the radio equipment (see Fig. 11).

With the installation of a good ground system, certain procedures should be followed when grounding the pieces of station equipment. Grounds for transmitters should be as short as possible and lead directly to an earth connection. This can best be accomplished by

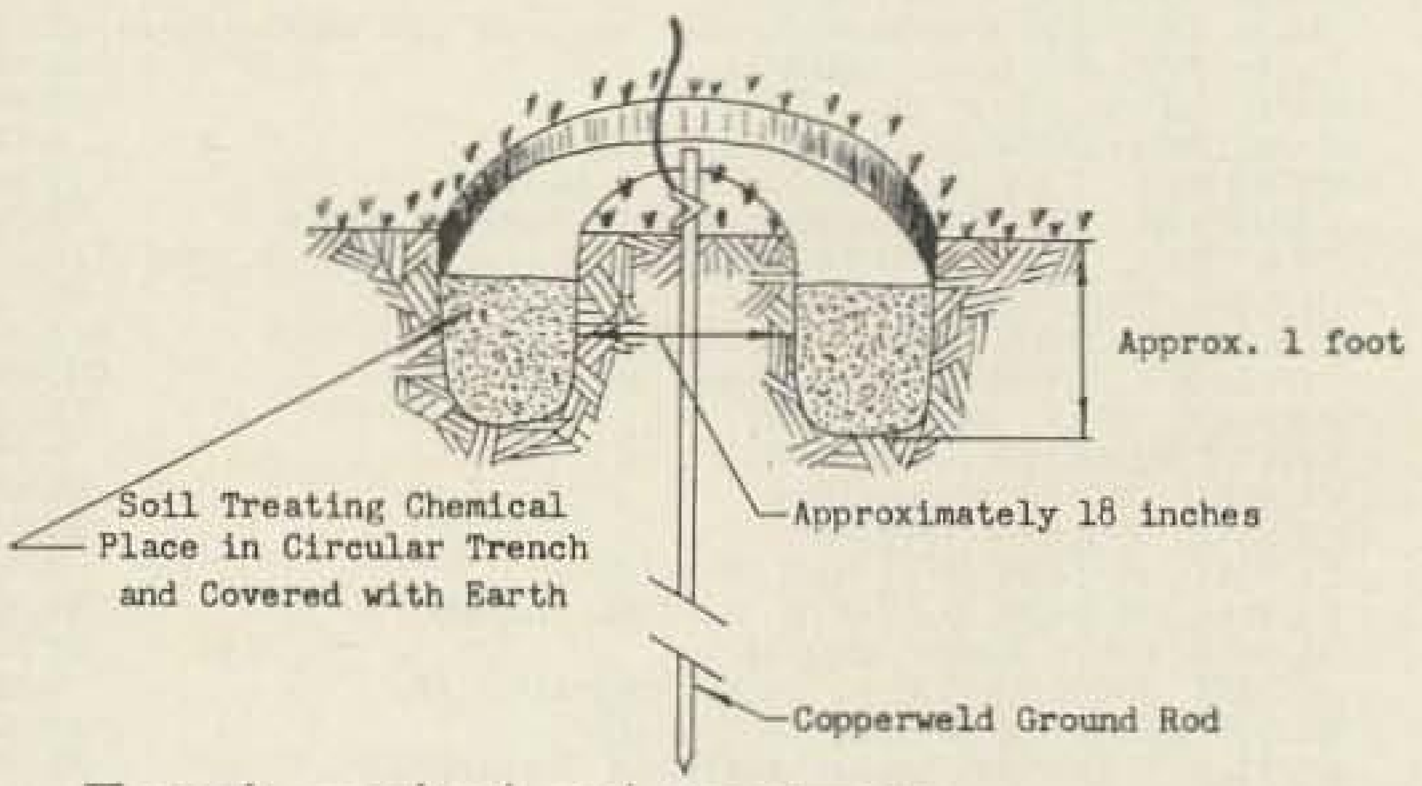
TABLE I

Acceptable Levels Of Ground Resistance

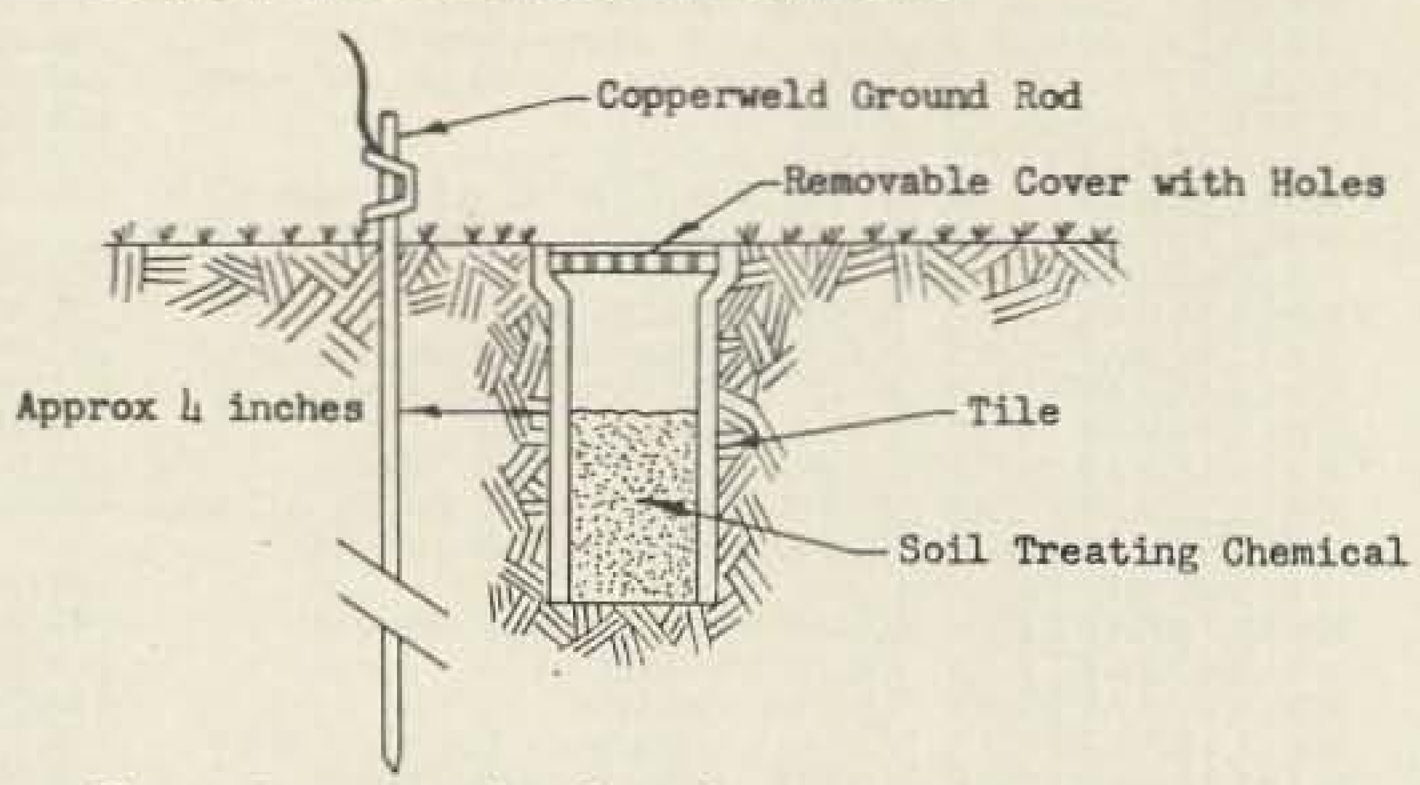
Type of Equipment	Acceptable Resistance (Ohms)	Type of Ground System
Antenna tuning units, outdoor	5	Ground radials and driven rods
Transmitting stations, high frequency	10	Ground radials and driven rods
Receiving stations, high frequency	10	Ground radials and driven rods
Transmitting stations, VHF and UHF	25	Ground radials or driven rods
Receiving stations, VHF and UHF	10	Ground radials and driven rods
Microwave station	30	Ground radials or driven rods
RTTY equipment	30	Driven rods
Telephone pole supports	10	Driven rods
Antenna towers (lighting protection)	10	Driven rods



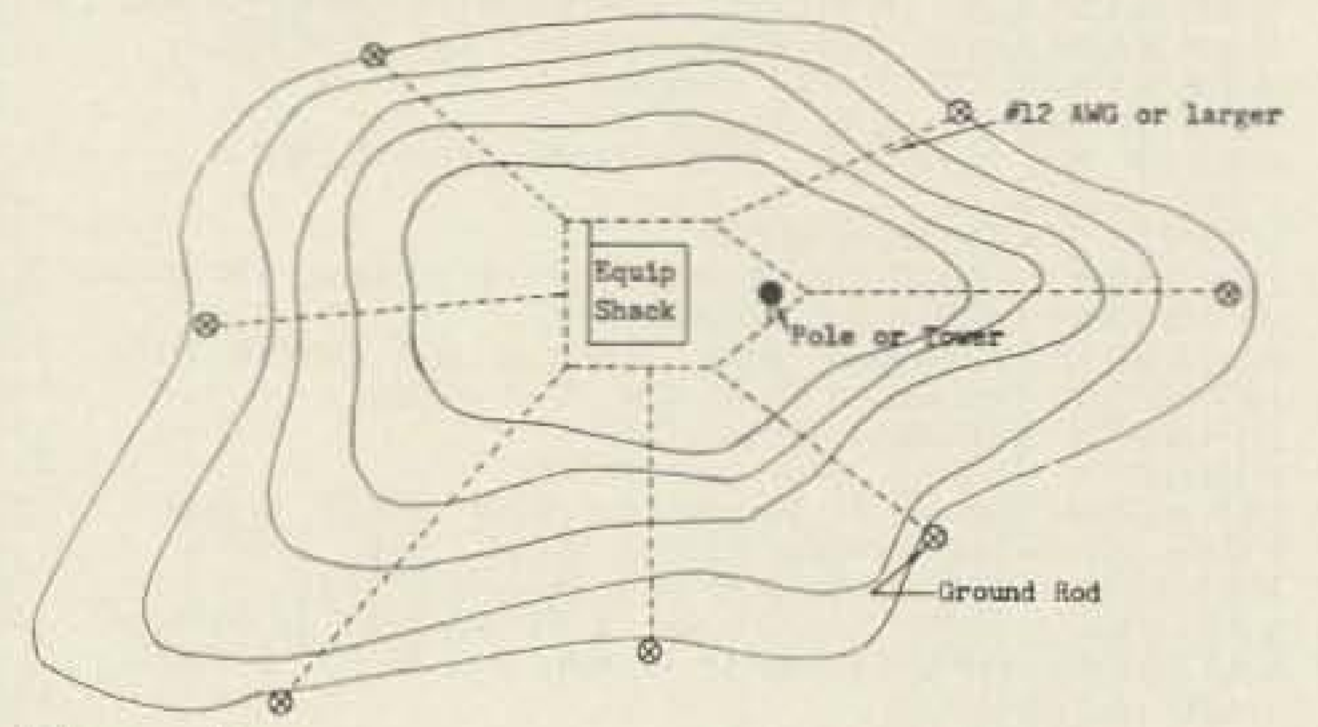
Effect of chemical treatment on soil resistance.



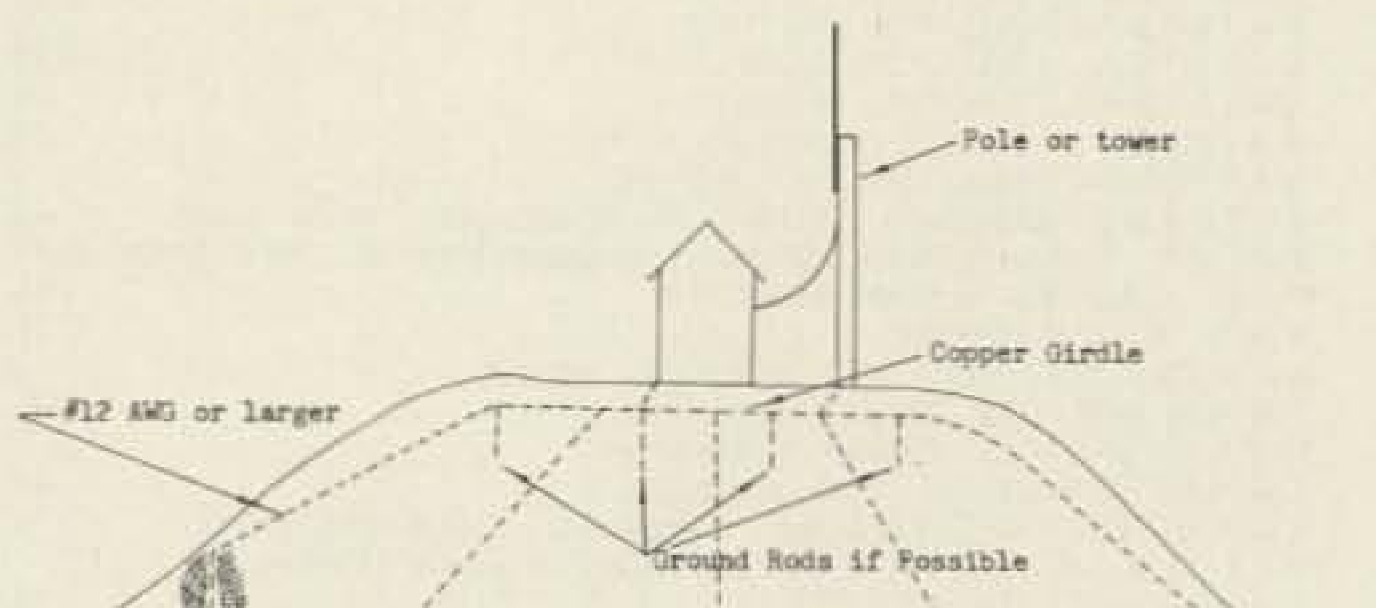
Trench method soil treatment.



Container method soil treatment.



Plan view



Elevation

Grounding and lightning protection of a hilltop site.

placing the ham shack on the ground floor, but in the case of cliff dwellers, is usually impossible. The use of wide, flat busses (such as flashing copper) for ground leads provides a much lower radio frequency resistance than stranded cables or round conductors of the same cross section, and their use is recommended whenever possible. Transmitters with improper grounds or elevated above ground usually have cabinets that are hot with radio frequency energy with consequental tuning difficulties and resultant TVI complaints. Sometimes improper ground of high power transmitters will allow radio frequency hot spots (voltage anti-nodes) to develop on ac house wiring, causing eventual insulation breakdown.

The ground conductors for radio receiving equipment should be carried to a low resistance ground without contact with grounds that serve alternating current power systems. Eventual connection, either planed or accidental, is inevitable, but this should not occur before the receiver ground is firmly connected to earth. For this purpose, the grid provided by a copper piped sprinkler system under an extensive lawn is an excellent receiving ground system. Thus, the use of a "noisy" ground, which would increase the noise threshold of the receiver, is avoided.

Special care must be taken when grounding the shields of audio and microphone circuits where any considerable length is involved. The ground should be applied to one end only, usually the equipment end, and the microphone, pickup or speaker end is allowed to float above ground. This procedure avoids inductive loops which would result if another ground, either planned or accidental, were added to the line. In low level lines a small amount of inductive pickup usually results in excessive hum and undesirable noise in the amplified output.

Although the ground system of an amateur station is usually approached form the standpoint of improved communications, a good ground system is very necessary for proper lightning protection. Metallic radio towers are a natural target for lightning and grounding which will harmlessly dissipate the energy is essential. If the tower is used as a support for a rotary beam, it may be directly bonded to ground rods through a heavy bonding cable securely lugged and bolted to the tower (see Fig. 12). If the tower is insulated from ground as with some vertical radiators, the ground system is connected to the lower member of the antenna insulator which will arc over for lightning protection, but will not beak down under normally applied radio frequency energy.

Telephone poles being used to support open wire line or antenna cable may be protected from shattering by severe lightning by running a #8 AWG copper or aluminum wire from the top of the pole to the ground. A continuous ground wire from the top of the pole is also used on antenna poles which carry coaxial leads or require a ground for antenna coupling units or terminating resistor boxes in the case of a rhombic antenna system. Where an equipment ground is not required and only lighting protection is necessary, the wire running the length of the pole should be divided into a series of short lengths not over a quarter wavelength long. Lengths of ten feet are suitable up to 20 mc, and lengths of seven feet to 30 mc. Each length is terminated in a rounded loop stapled to the pole, but drawn away at an angle of about 45°. The adjacent wire should be spaced to form a gap of ⅜ inch between loops. The top of each pole should be equipped with an eight foot copperweld ground rod clamped in upright position to extend six feet above the top of the pole and securely attached to the ground wire. The ground wire should be terminated at the butt of the pole by forming a spiral of several turns stapled in place. Additionally, an eight foot ground rod is driven into

(Turn to page 62)

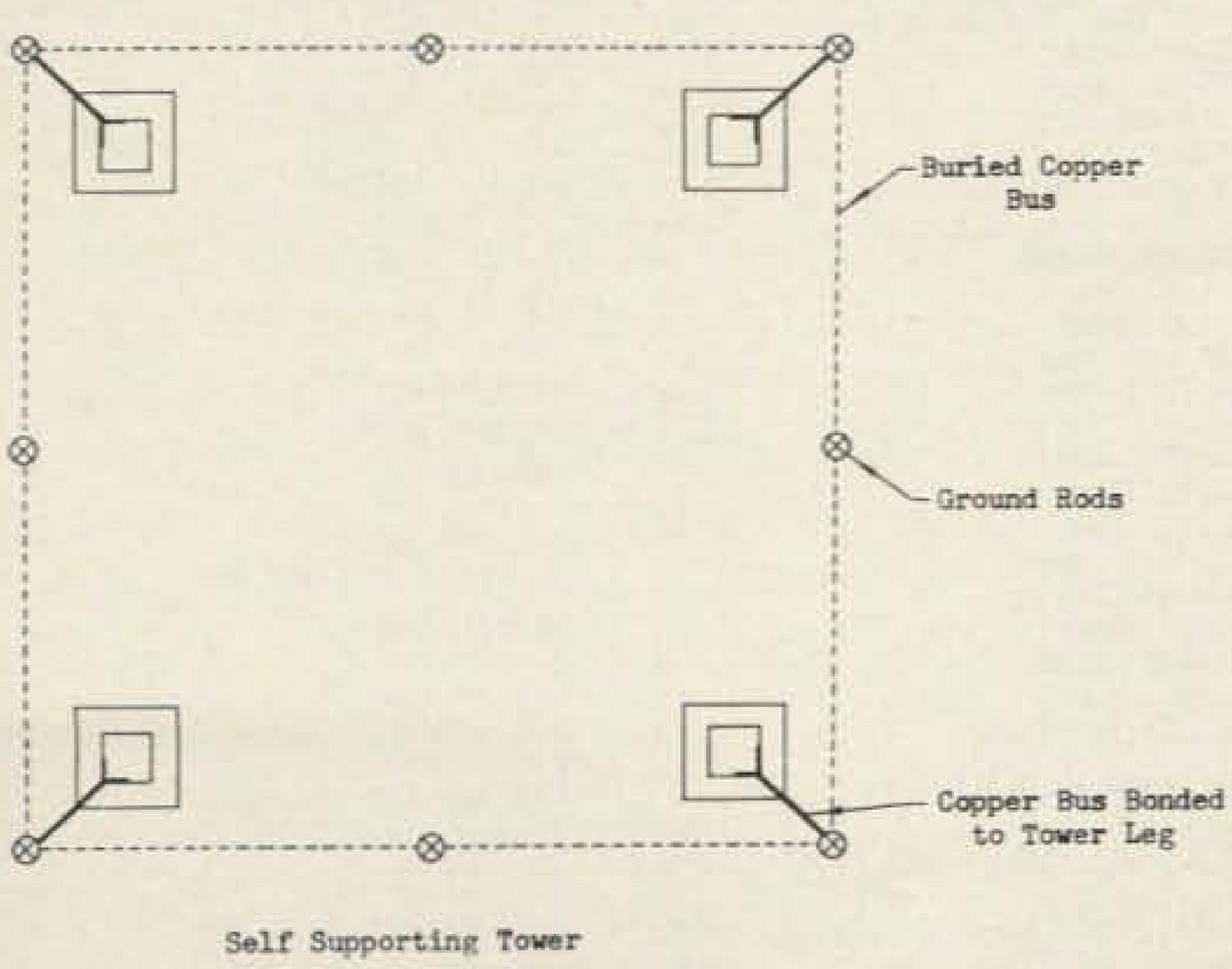


Fig. 12a

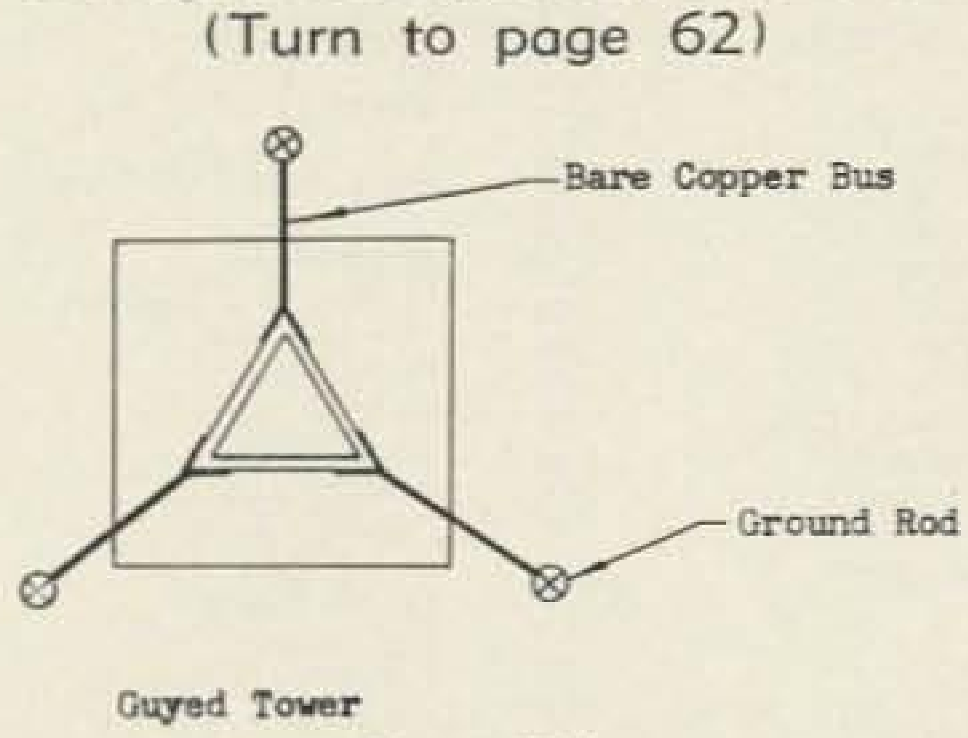
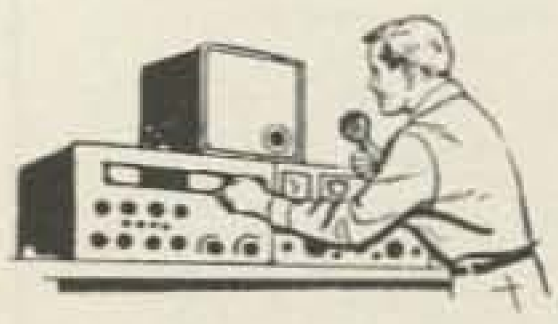


Fig. 12b

Lightning protection of towers.

NOTE:
Ground cables connect to base of tower. In the case of insulated radiators, ground cables connect to lower member of insulator.



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75S-2/blanker	425
13A6-1 Blanker	49
399B-1 DX adaptor	49
312B-4 Console	149
312B-5 Console	275
351D-1 Mount	49
351D-2 Mount	89
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PRM-6A Rec	49
PMR-7 Rec	69
*PMR-8 Rec	109
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PSR-12 DC supply	9
A-54 Xmtr	39
A-54H Xmtr	44
AF-67 Xmtr	59
*AF-68 Xmtr	119
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S-38E Rec	34
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S-40B Rec	59
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SX-42 Rec	129
SX-43 Rec	89
S-52 Rec	49
S-53 Rec	44
S-53A Rec	49
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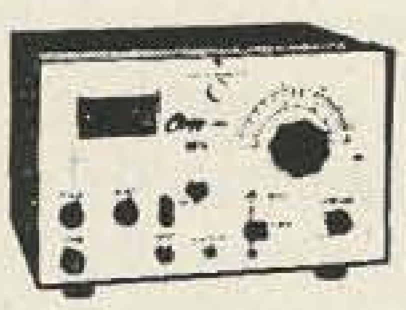
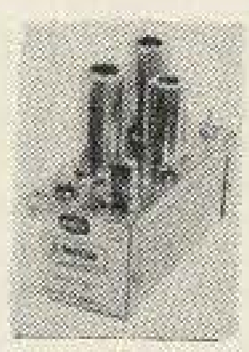

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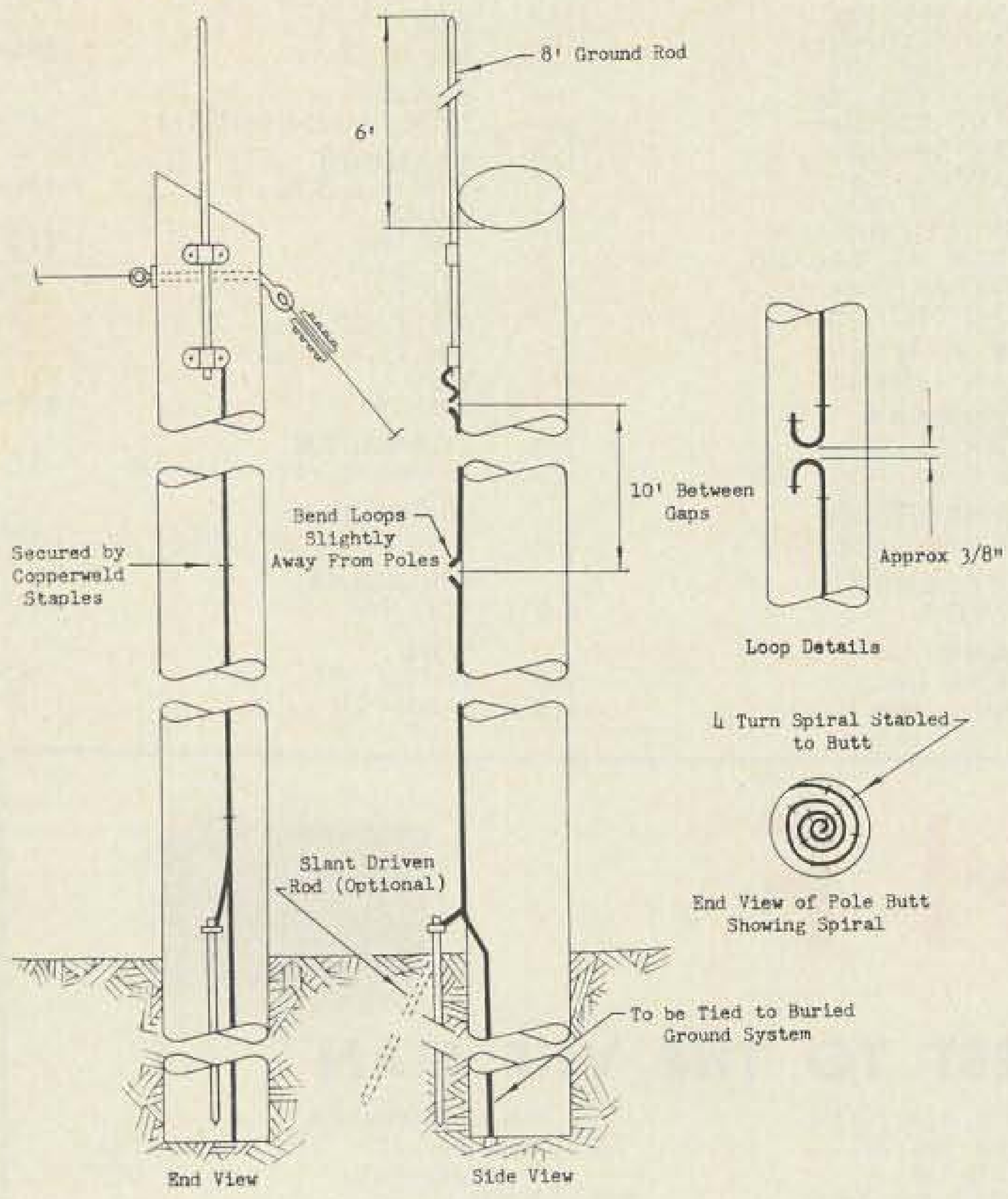
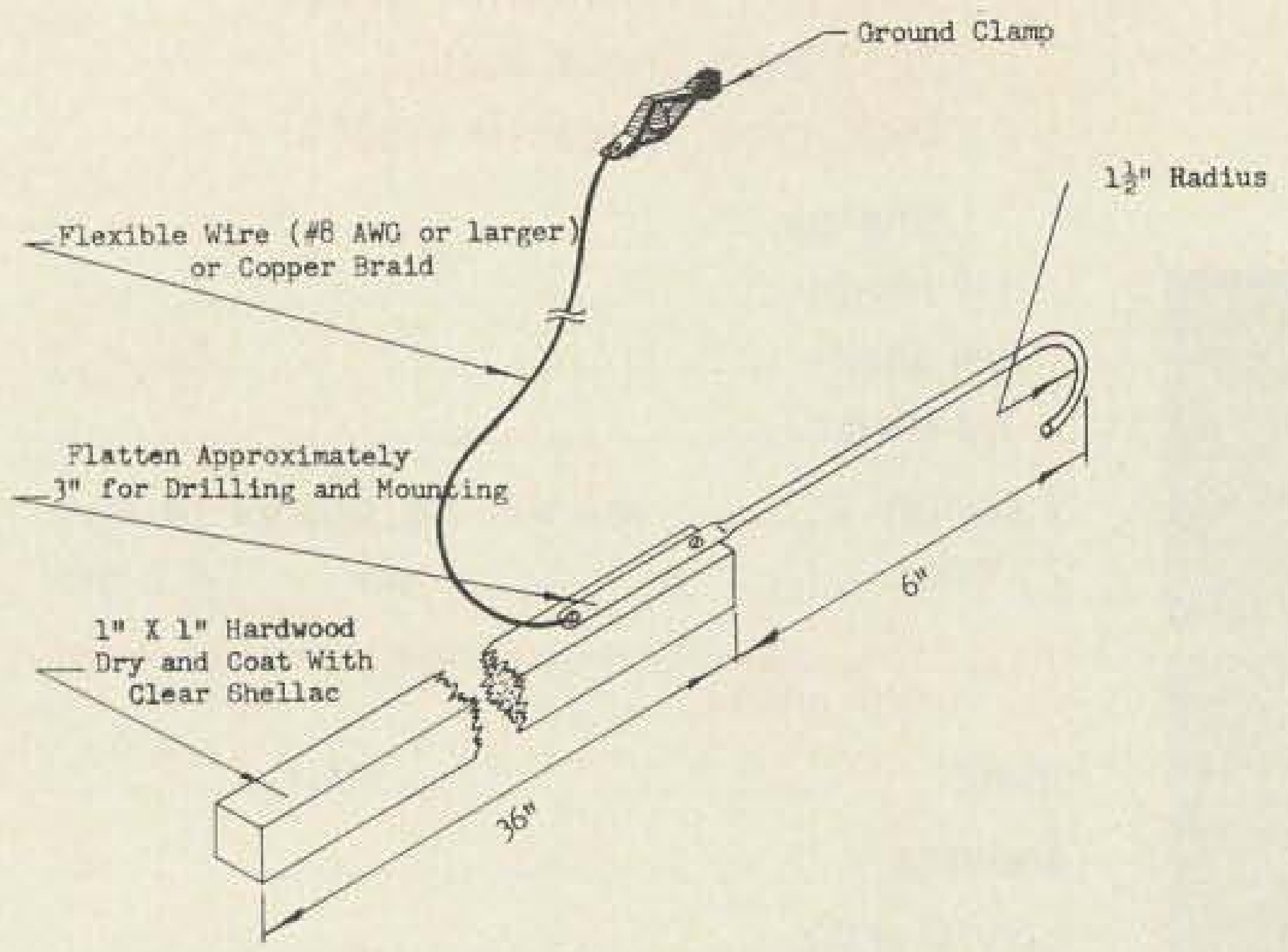


Radio pole protection.

the earth one or two feet from the base of the pole and attached to the ground wire with a heavy cable. Slanting the rod away from the pole to contact undisturbed earth often increases the rod's effectiveness. Copperweld staples should be used throughout the installation due to the deterioration of the ground wire due to electrolysis if galvanized staples are used. (See Fig. 13).



Construction of shorting stick.

NOTE:
Solder all connections to insure low resistance path to ground.
Connect ground clamp to ground before using probe. Remove shorting stick before turning power on.

Grounded frames and chassis form a large part of most electronic equipment in a properly grounded installation. To a person in contact with a part of the circuit above ground potential, contact with a grounded member can have a lethal effect. For this reason, the old adage about working on a transmitter with one hand in your pocket was developed. However, this is not enough if your knee or your head is in contact with the grounded surface. Therefore, when working on a transmitter or other piece of equipment where dangerous potentials are normally applied, the power should be disconnected and a grounding hook applied to the part of the equipment to be worked on.

The grounding hook can be composed of a hook of ¼ inch copper tubing attached to an insulated handle and carrying a length of flexible braid terminated with a good sized battery clip. The clip is attached to the grounded frame or chassis, and then, holding the insulated handle, the copper hook is hung on the exposed high voltage members. The individual is then protected against charged capacitors, accidental application of power, or failure of interlock devices since the ground path provided by the grounding hook will shunt the potential to ground and trip the circuit breaker or blow the fuse. Momentarily grounding the circuit with a screwdriver is no protection against accidental reapplication of power or high voltage capacitors which require a continued discharge path to drain their charge (see Fig. 14).

The information contained herein is definately not all inclusive, but by following these proven grounding procedures, the amateur can be assured of an installation comparable to any high frequency communications facility. Results will be in the form of more reliable, dependable communications and peace of mind as to lightning protection and safety.

. . . WA6BSO

BFO

Mike Schwartz K1YVB
9 Mague Pl.
Newton 65, Mass.

A standard superhet short-wave receiver may be unable to be used for CW (code) work because it lacks a beat frequency oscillator.

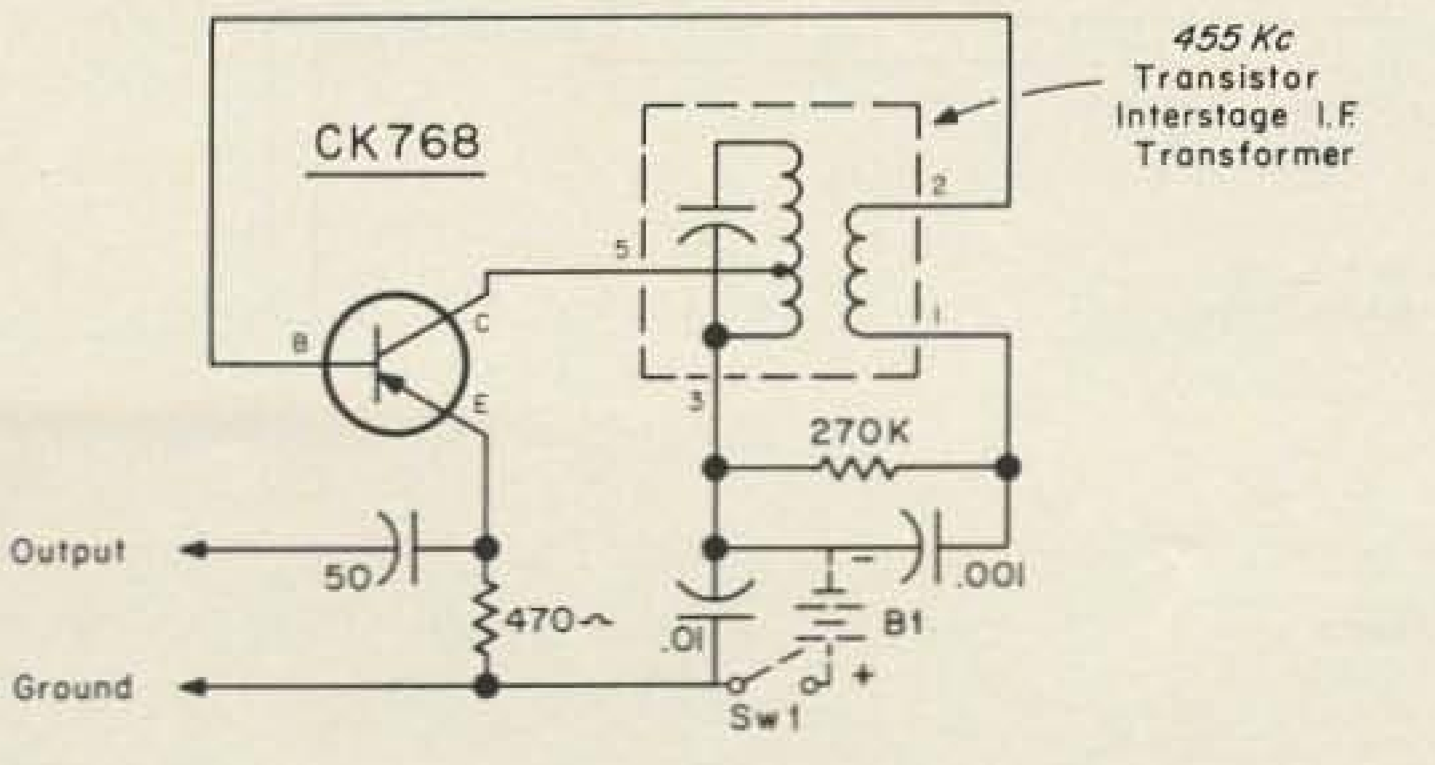
The bfo does this job by providing a fixed signal at a frequency close to the receiver's if. The bfo's signal is combined with the receivers if signal and the resulting signal is a beat that is audible through a pair of headphones of a loudspeaker. All communications receivers have built in bfo's but few short wave receivers have this feature. However, a transistorized bfo can be added to any super-het receiver.

Refering to the schematic diagram we see that a CK768 rf transistor is used as a common emitter oscillator.

In operation, the oscillator's frequency is determined by the turned primary winding of the if transformer, with the feedback necessary to start it oscillating. The output signal is obtained across the emitter R_1 through the coupling capicator C_1.

Operating power is obtained from a 6-9 volt battery.

The bfo switch should be mounted on the front panel of the receiver. A lead is run from the bfo's output terminal to the last if stage in



the receiver and wrapped around the last if amplifier's grid lead, forming a gimmick capacitor.

To adjust the bfo, connect a standard rf signal generator to the receiver and turn the receiver and the signal generator on but leave the bfo in the off position. Adjusting the signal generator to supply a modulated rf signal, carefully tune in this signal and switch the modulation to off and turn the bfo on. Adjust the bfo's operating frequency until a tone can be heard in the loudspeaker. Do this by using an insulated alignment tool to adjust the bfo's if transformer's iron-slug.

After this preliminary adjustment the bfo may be readjusted to give the tone you prefer.

. . . K1YVB

The Z-L Special for Forty

Leopold Scharpf
101 S. Illinois Ave.
Atlantic City, N. J.

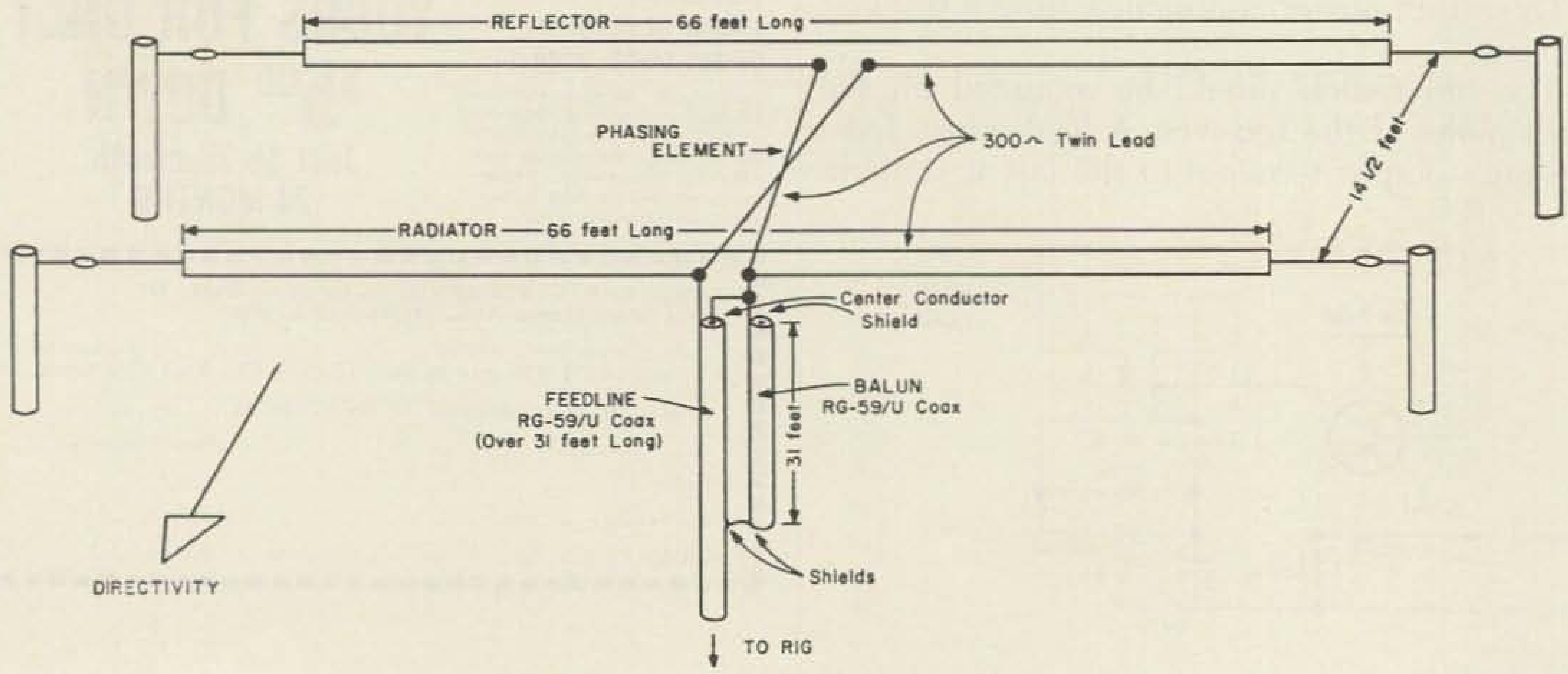
With the present calamity of those ever decreasing sunspots (bless them) casting its horrible wrath upon humanity for an (oh woe is us) eleven year duration, many a DX man creeps forth from his established twenty meter haunt and emits some wild ideas of operating on forty. His hot-idea cools down to a solid as soon as he pages through his catalogue and recovers from those staggering prices on commercial beams for that band (no one would dream of using a dipole).

Here's where I come in. It is my intention to interest you in a beam antenna array with at least 7 db gain over the dipole, and none of those earth-shaking dimensions exhibited by such monsters as the rhombic. The most interesting factor about this antenna is that it can be had for as little as the cost of two strips of 300 ohm twin line, each 66 feet long, some insulators and coax feedline. That's right, no mismatch in this antenna and you feed it with your existing RG-59/U.

Physical dimensions? The directive array consists of radiator and reflector elements spaced 14½ feet apart. Good results were obtained by feeding the two 66 foot lengths of 300 ohm line with a simple balancing balun (Fig. 1), consisting of a 31 foot length of coax taped to the feedline.

In comparative tests between the forty meter ZL special and other conventional antennas, such as the dipole, inverted V, V-Beam, long wire, and a two element commercial beam proved that those 7 db's are nothing to be sneered at. All tests showed similar results between the commercial beam and the ZL.

Refinements in construction are possible, but the simplicity proves that an effective forty meter array is not as hard to come by as one might think.



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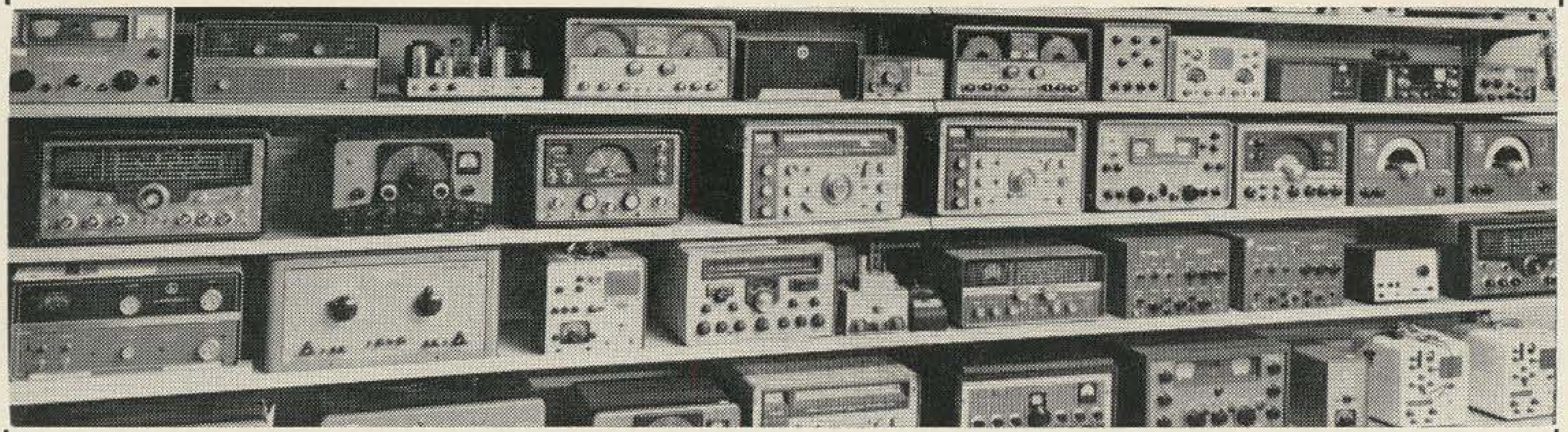

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The Rx Audio Probe

F. R. O'Kelly W5VOH
418 East Hickom
Midland, Texas

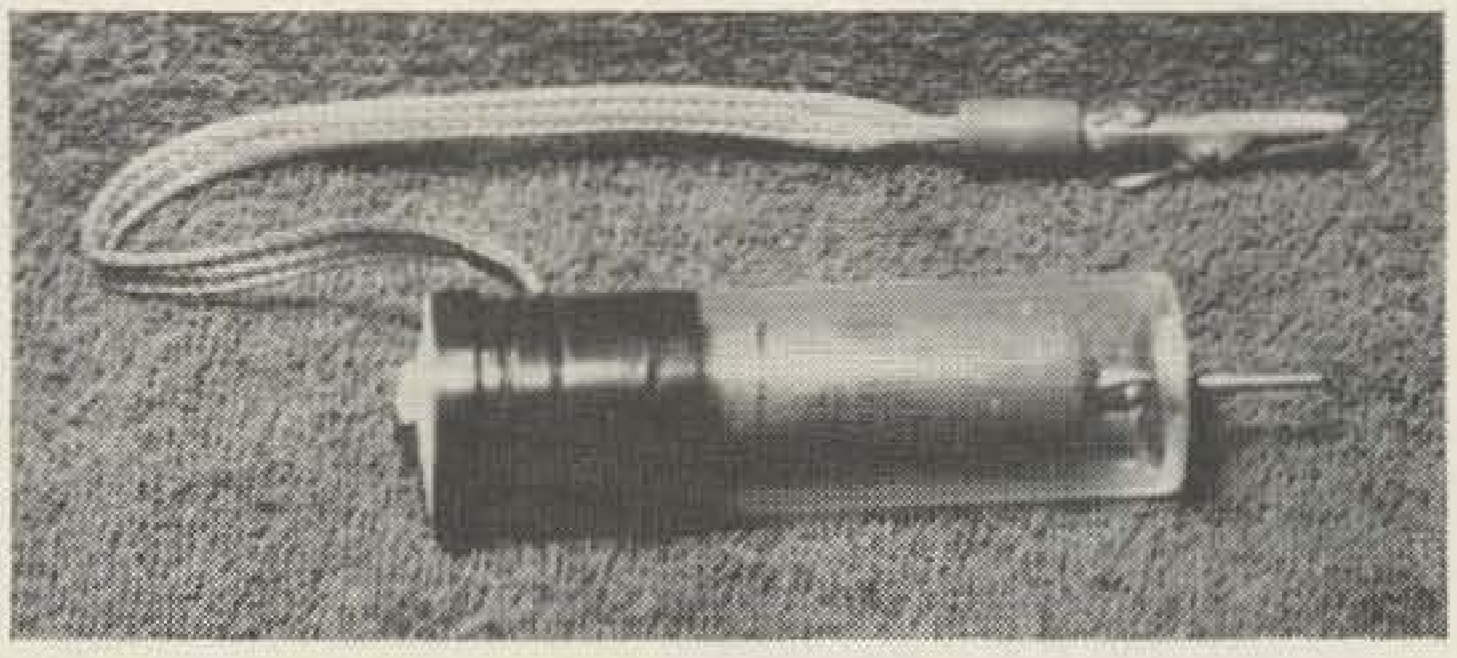
A need for a simple method of checking audio stages prompted the development of the Rx probe. The unit is basically a blocking condenser for headphones or a small speaker. Headphones are usually preferred to a speaker, particularly when checking stages associated with microphone input. The headphones permit one to use a microphone for testing without contending with feedback.

The "probe" has been used for several years for trouble shooting such audio problems as checking for non-operative stages, hum, loss of gain, or distortion, and in units such as Vox to determine if absence of audio is resulting in poor Vox action, etc. I would suggest that the probe not be used to check audio stages such as the output of a five hundred watt modulator —if you do, please notify the next of kin before the explosion! Seriously, the little unit is very handy for working on almost all low level audio stages or small amplifiers.

The construction of the "probe" is very simple and will take only a short time to complete. The case is a small plastic medicine bottle ¾ inch in diameter and 3-¼ inches long (total cost $8.75, including pills). These are used extensively throughout the country in distributing patented medicines and should be found at almost any drug store.

CORRECTION

In the 50 mc DSB article, page 16, Dec. '63, please change the 12AU7 plate RFC to ground instead of B+ on the schematic.



Drill a small hole in the bottom of the bottle to accomodate the metal tip. The one shown in the photograph was removed from an old VTVM probe (these tips are available separately from the radio supply stores). Drill a 5/16" hole in the bottle top and mount a headphone jack in it using half-inch diameter washers on each side of the top for support. Cut a small slit in the bottle ¼" wide and about ¾" down from the top. The slit provides a convenient exit for a braid that is used for the headphones ground return. Solder the braid to one of the phone jack lugs and connect the negative end of a .25 mmfd 400 volt condenser to the remaining lug. Solder the positive end of the condenser to the metal tip and slip the components into the bottle. Snap the top on and bolt the tip to the bottom. Pull the excess braid out of the bottle and solder an alligator clip to the protruding end to complete the construction.

Operation of the Rx probe is quite simple. Just plug a set or headphones in the jack, connect the alligator clip to the audio ground, place the probe on the plate of an amplifier tube, and the input signal to the amplifier should be heard in the headphones. Only experience and good judgement will now assist you in evaluating the received signal. However, these hints should enhance your experience factor.

(1) A deep low hum sometimes modulating the broadcast or amplified signal: check the power supply filter condensers and rectifier tubes.
(2) An undue weak signal: check for tubes with low emission, faulty by-pass condensers, or low screen or plate voltages.
(3) Erratic signal: check for cold solder joints, faulty volume control, coupling condensers, and voltage dropping resistors, or an intermittent short in a tube.

This list could continue on into the night and never be complete, so couple some common sense to some good basic electronic study and the experience factor will grow like a weed in a flower garden.

One word of caution—*Do not exceed the voltage rating of the condenser used.* Also, I have found it saves the ear drums to ground the probe after checking each tube element, because the discharge of a condenser over the earphones clamped to your head aproaches the repercussion of being hit on the head with a baseball bat. . . . W5VOH

Neutralization

Jim Kyle K5JKX
1236 N. E. 44th St.
Oklahoma City, Okla.

Ever hear of a "neutrodyne" receiver? Or see a transmitter composed of three or four big bulbous bottles with neutralizing condensers of equal size reposing alongside, all mounted on a long wooden board?

If you're an old-timer, of course you have. But to those of us who have entered the radio game in the last decade or so, neutralization may easily be a slightly strange and little-understood subject. After all, beam power tubes don't really require neutralization, nor do the high-performance pentodes which mark all present receivers. Or do they?

To unsnarl a bit of the confusion, we're going to take a deeper-than-usual look at the subject of neutralization. We'll first see why it's needed, then dig into just what it really amounts to, and finally run through the various ways of putting all this into practice—including one way which (though described first some 6 years ago) has been apparently ignored by almost everybody, yet seems to be the fastest and simplest of all.

Want to come along? Let's go!

First, let's find out why neutralization is needed. Before we can do this, we'll have to define the term "neutralization", and to make our trip as meaningful as possible we're going to use a definition not normally seen in ham circles. We'll call neutralization "the process of providing only one route from input to output of a single stage."

Why such a cumbersome and "oddball" definition? For one thing, it includes all the more conventional definitions. For another, it makes our findings apply to transistor circuits as well as to tube types (transistor neutralization is usually called "unilateralization" by the engineers, which is just a squeezing of our definition down into one rather long word).

The usual answer to the question "Why neutralize?" is "To prevent oscillation." It's pretty easy to see that if any of the output of an amplifying stage gets back to the input, it will be amplified still more and this round-robin leads to oscillation. The technical term for this, which we're sure most of you already know, is "positive feedback", and the more usual ham slang is "regeneration".

Note that nothing is said about the route by which the output makes it back to the input. However, any circuit component except a perfect tube (one without interelectrode capacitances) will allow signals to pass about as well one way as the other. Even a crystal diode will let part of an ac signal through in the back direction. And *any* route will allow some regeneration.

Putting that last paragraph all together begins to answer the question of "Why neutralize?" No tube is perfect; there's always some interelectrode capacitance. This capacitance provides a route for output energy to get back to the input. There, it can cause regeneration—and if regeneration is great enough, the stage will oscillate.

This is shown schematically in Fig. 1. The tubes in Fig. 1 are considered to be "perfect" and have no capacitances; the actual capacitances present are shown as capacitors outside the tube.

In the triode, Fig. 1A, we have only three such capacitors to bother with. Cin can be considered as merely part of the input tank at rf, and Cout is merged into the output tank the same way. However, Cg-p is a route—and a pretty good one—for output to get back to input. This route is so good that it's a rule of thumb; triode rf stages must be neutralized to prevent oscillation.

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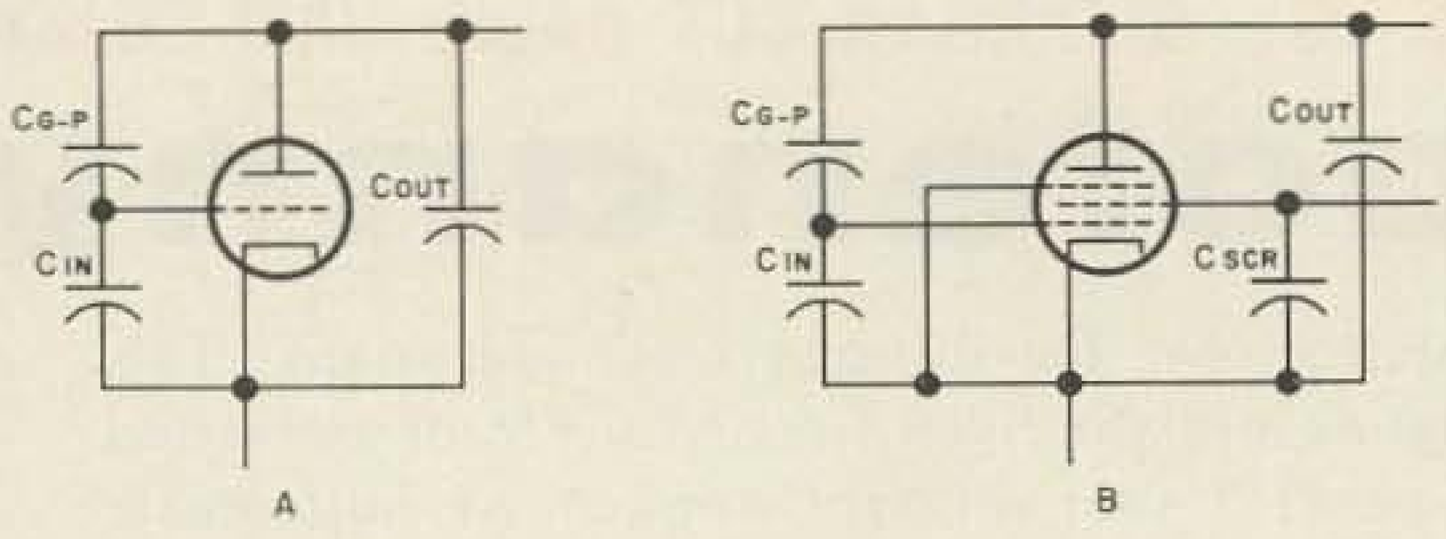

FIGURE 1

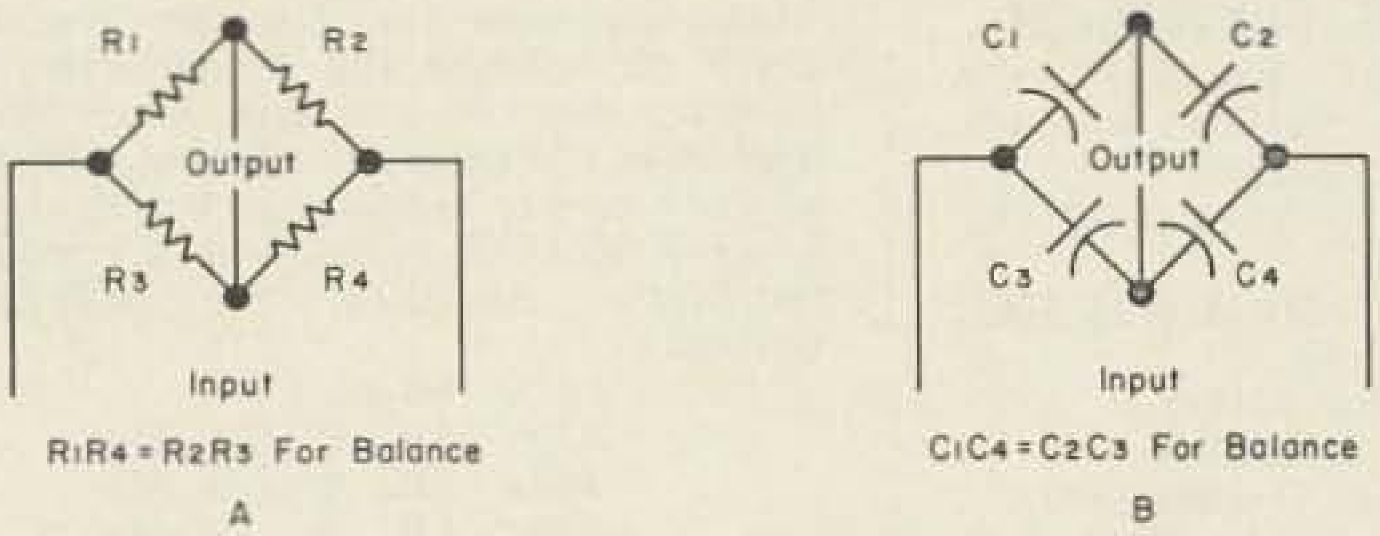

FIGURE 2

How about the pentode, Fig. 1B? Here we have a whole lot more capacitors; not all are shown in the figure. The four which are shown are the most important. Cin and Cout disappear as before; at low frequencies Cscr tends to disappear into the bypass capactor. However, Cg-p remains as before.

The difference, of course, is that Cg-p in a pentode is much lower than in a triode, since it is composed of three capacitances in series and both the screen and suppressor grids are assumed to be at ground potential. Thus at low frequencies or at low power levels the pentode is usually considered to need no neutralizing.

However, as the frequency goes up the screen may no longer really be at ground potential; thus at higher frequencies even the pentode may require neutralizing. We also discover frequently that with the high gain of present pentodes and beam-power tubes even the tiny Cg-p still remaining is enough to mess up the signal, so again neutralization is indicated.

With transistors, of course, the two-way path exists right in the semiconductor itself and so neutralization is almost always indicated.

So now we know that we need to block that Cg-p path from output back to input almost all the time. However, it's built right into our tubes. How can we block it?

We have two basic choices. One depends on the bridge principle, while the other depends on resonances. In addition, a third route exists but has been used only slightly in recent years. This one depends on phasing, and is rather critical in adjustment.

The bridge principle starts with the idea that in a perfectly balanced wheatstone bridge, Fig. 2, none of the signal fed in shows up at the output terminals. The balance of the bridge doesn't depend at all upon the values of the bridge legs, but only upon their ratios.

Since we're dealing with rf energy, the resistors of Fig. 2A can be replaced with capacitors as in Fig. 2B with no change in performance. Now if we can just put this idea to work we can make sure that no path exists from input to output because the bridge can be balanced to eliminate any path.

At first glance, though, the idea seems to explode in our faces. Both input and output to any stage are normally grounded. However, in a bridge, there is no common terminal between input and output. So how can we use it.

Take a look at Fig. 3 and the answer may begin to show up. Fig. 3A is a schematic of a typical pentode rf amplifier stage, without neutralization. Fig. 3B is a representation of the input and output conditions of the stage, redrawn in bridge form.

You can see that the input circuit is not really grounded; it goes to ground through a bypass capacitor, and if an additional capacitor Cn is added from plate to the cold end of the grid coil then we have all the requirements of a bridge, which can be balanced by adjusting the ratios of any pair of adjacent arms to match those of the other pair of adjacent arms.

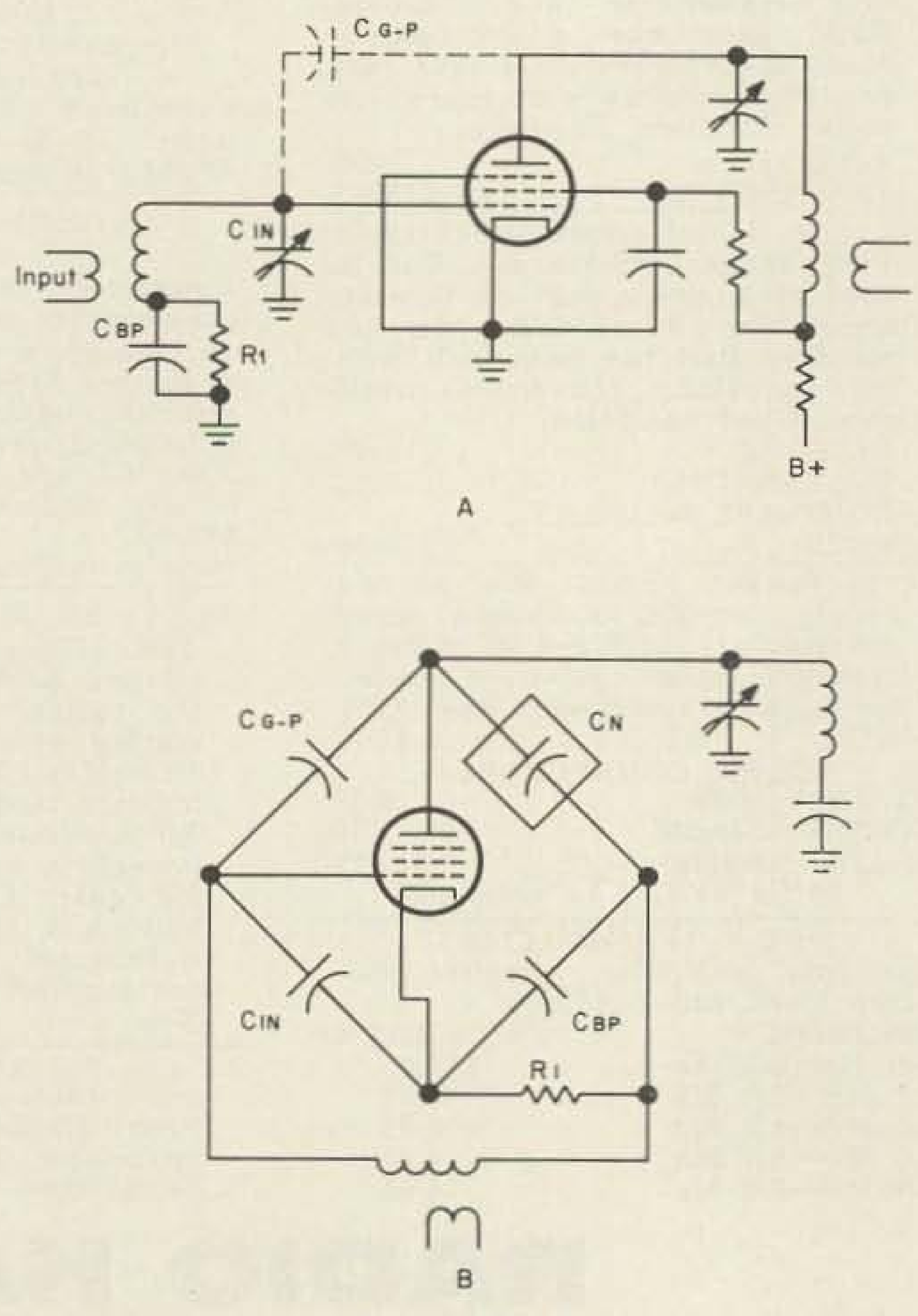

FIGURE 3

Cg-p is fixed. Cin is also fixed but is absorbed in the input tank tuning capacitance, so this can be adjusted. Cn can also be changed as required, as can Cbp. This, then, is a fully practical neutralization technique. Later on we'll see how it is put into practice.

The resonance principle of neutralization depends on the fact that a parallel-resonant circuit acts as a roadblock to any energy at the frequency of resonance.

Thus, all we need to do to cancel out the effects of Cg-p is to add a coil in parallel with it, adjusted to be resonant at the operating frequency. Fig. 4 shows how it looks; since the coil is connected from plate to grid, a large-value blocking capacitor is used to keep high dc voltage off the grid.

This circuit was much used in the long ago, and was resurrected originally in the Wallman cascode circuit for VHF reception. From there, it was adopted in the first Nuvistor preamp used by hams, and has continued to be popular as a result.

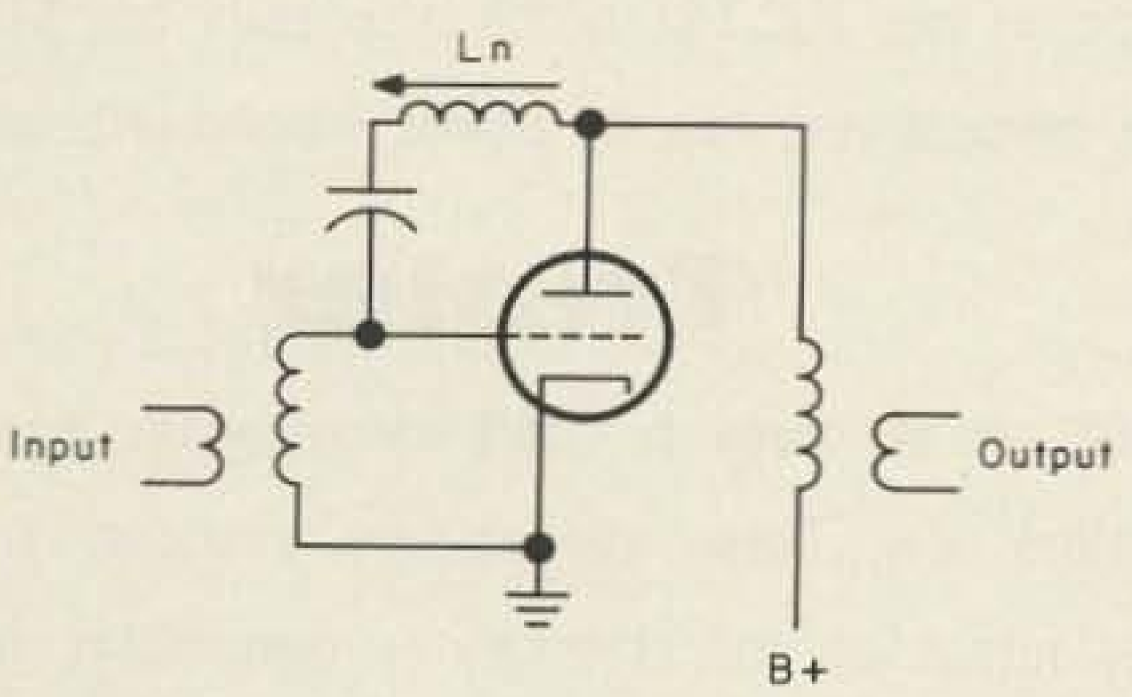

FIGURE 4

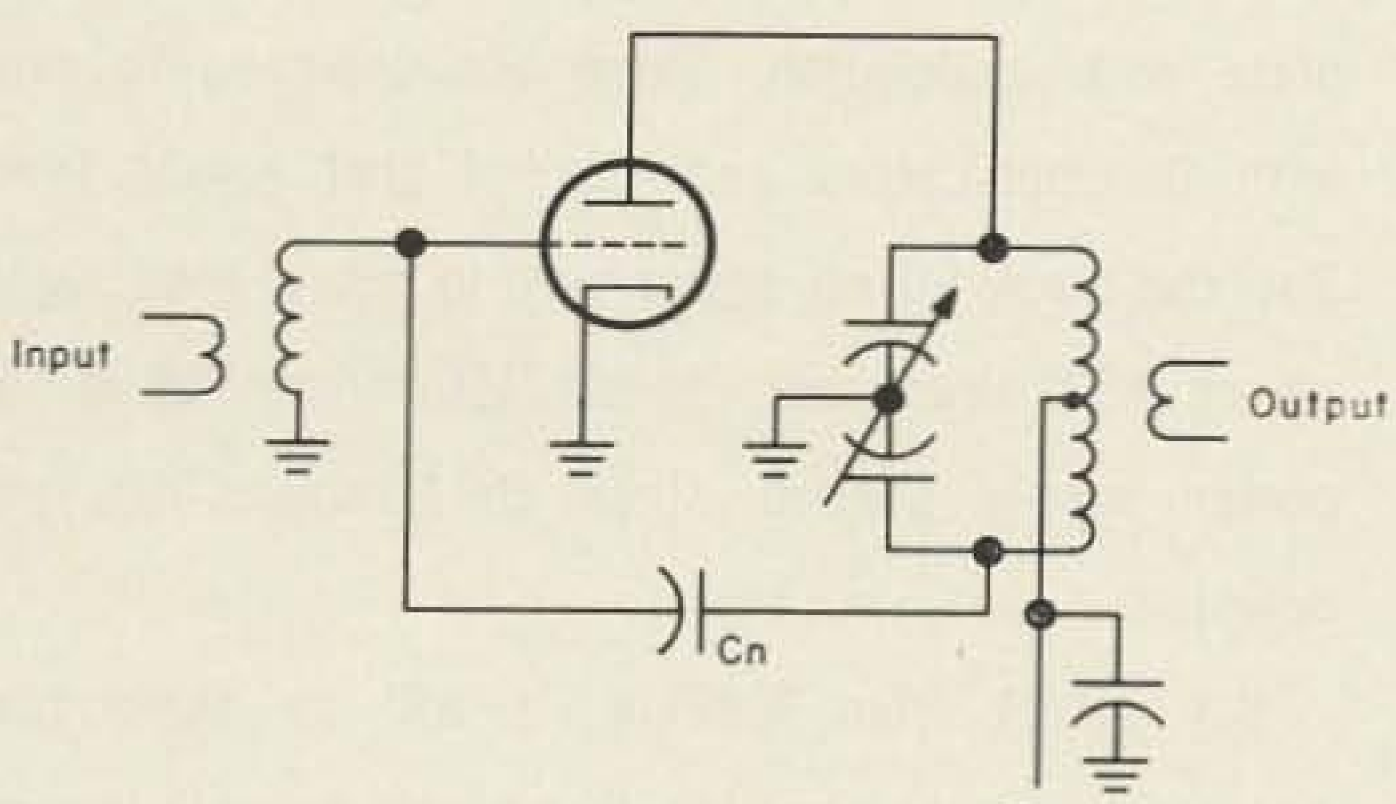

FIGURE 5

However, it has its faults. One—not mentioned in print before to our knowledge—is the fact that if a slug-tuned coil is used to make adjustment easier, and if the slug is grounded (as most are) then any adjustment of the coil will upset tuning of either the grid tank, the plate tank, or both. This comes about because of capacitance between the coil itself and the grounded slug, which appears across the input or output circuit. The remedy is to use a coil form with a floating slug, such as the cheap

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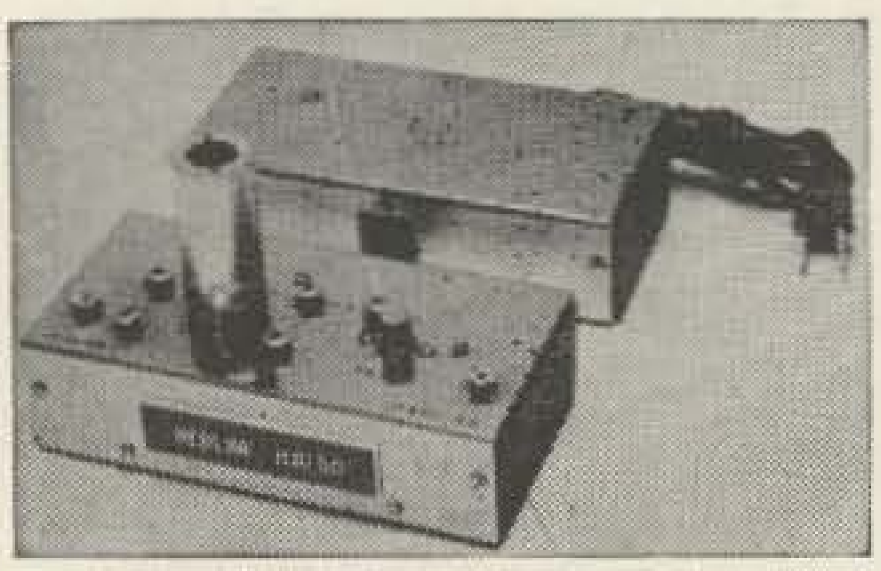
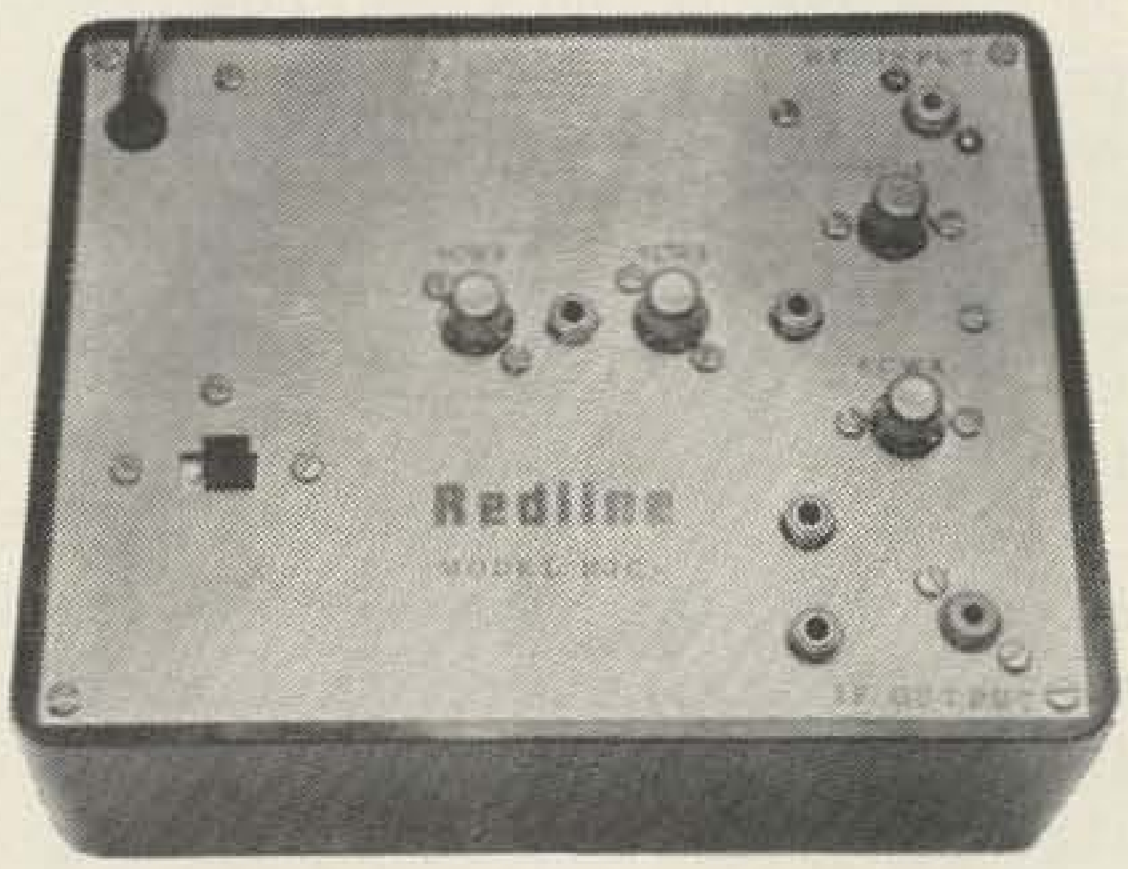


HJS

HJC-50

HJC
144



$31.95 and power supply HJS for $9.95. These will soon be supplanted by our HJCWBIPS-50 models which will sell for $49.95. These are six meter converters with 14-18 mc output. They work fine. The HJCWBIPS has the power supply built in. This is the same as our HJC-144 which also sells for $49.95 at the moment and has its power supply self-contained.

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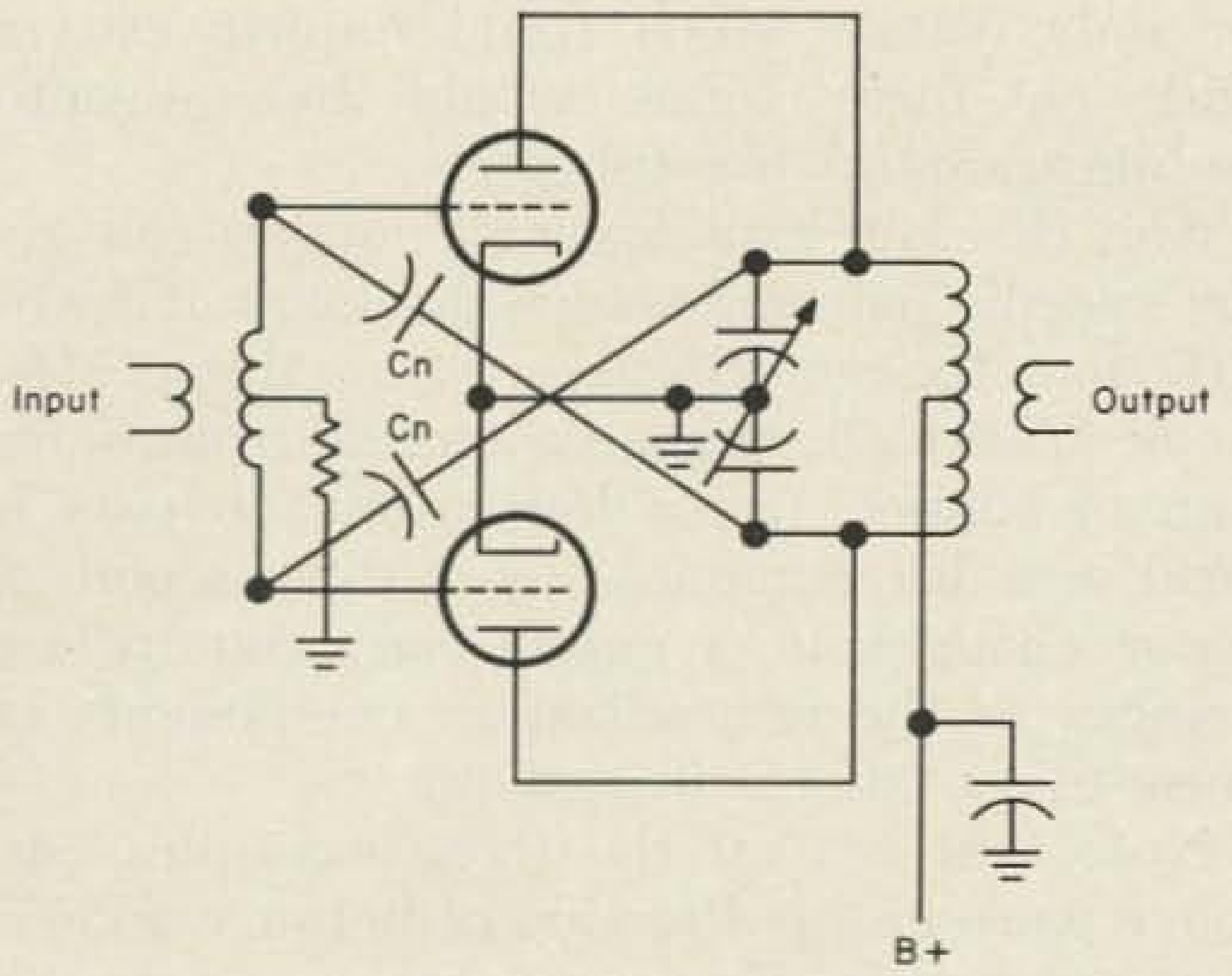

FIGURE 6

little TV jobs with hex-holes in the slug and no external adjustment screw.

Now to the phasing techniques. There are several, all gone into in some detail in the ARRL handbook despite their relative lack of popularity. One of the simplest makes use of a balanced plate (or grid) tank circuit for an otherwise single-ended stage, as shown in Fig. 5. A capacitor exactly equal in value to Cg-p is connected to the otherwise-free end of the tank, and ties back to the grid itself.

Now, any output energy which gets back to the grid through Cg-p will meet an exactly equal amount of energy—but of opposite phaze—which comes back through Cn. The two will cancel out because they are equal in strength and opposite in phase, and the result will be neutralization.

This phasing circuit is not subject to the criticalness mentioned earlier as an objection to phasing circuits in general. However, because this requires a balanced tank for a single-ended circuit it is yeilding in use to the bridge techniques.

In push-pull amplifiers, Fig. 6, you have a horse of a different color indeed. Here, the balanced tanks are already required, and all that must be added for neutralization are a pair of capacitors. This type of neutralization is usually called "cross neutralizing" since the energy "crosses" the zero-line of pushing or pulling.

Many tubes intended for VHF service have cross-neutralization capacitors built right into them. Some of these tubes include the 6360, 6252, etc. Occasionally, however, you may find that even with such a factory-neutralized tube you must still do something, since neutralizing *in the rig* also corrects for such things as coupling between output and input tanks, etc.

Another phasing type of neutralization is shown in Fig. 7. Here, a bit of output is picked

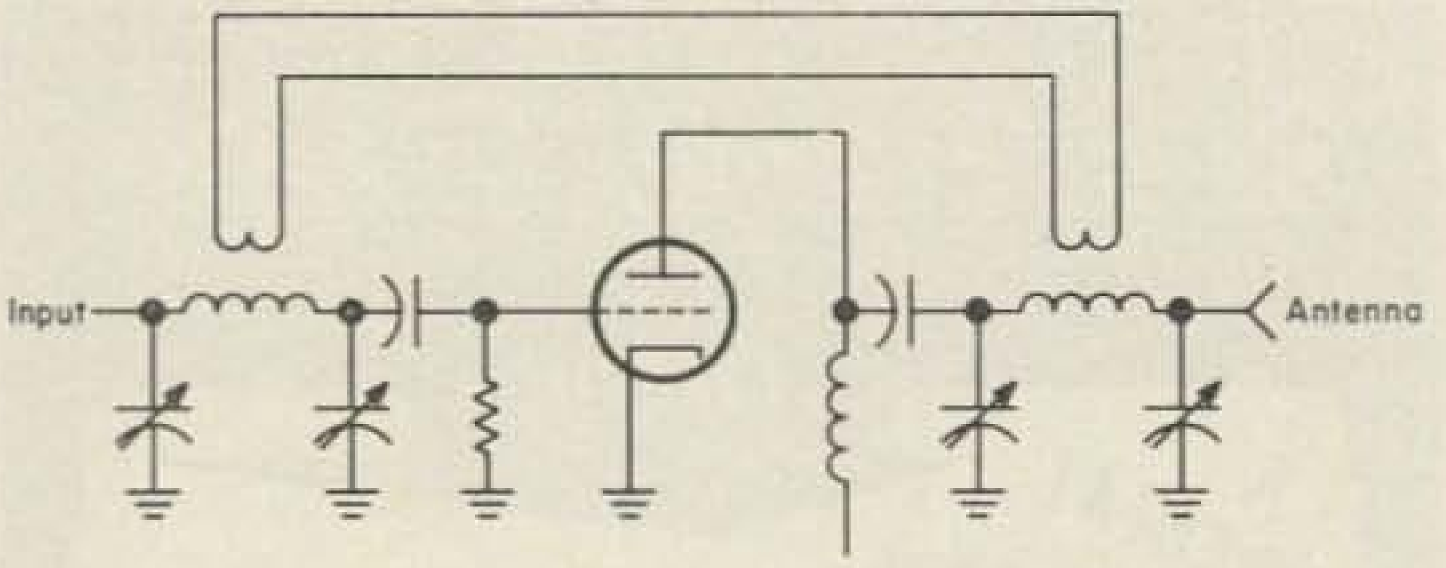

FIGURE 7

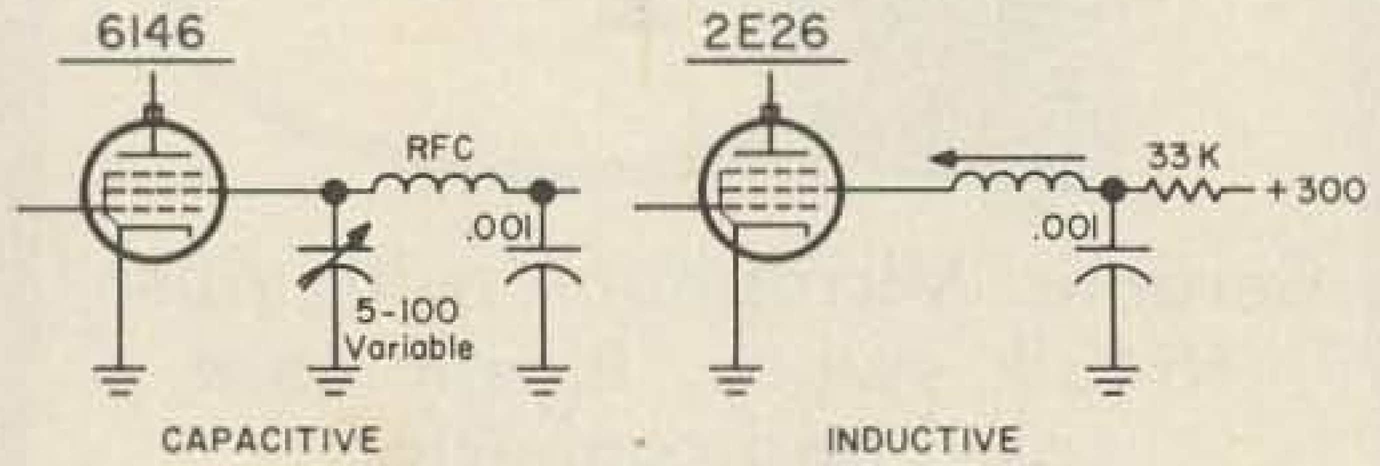

FIGURE 8

off by a loop coupled to the output coil, and is coupled back to the input in a similar manner. This has been claimed to be the only type of neutralization possible for a stage fed from a pi-network and looking at another pi-net for output, although the capacity-bridge will do as well.

This one *is* critical. The coils must be placed and coupled so that both phase and size of the signal passed back is right to cancel the unwanted signal. Since the placement varies not one but two factors at the same time, it's mostly a matter of trial and error. And once you get it set, if you QSY very doggone far you have it all to do over again.

Something that bears attention here, before we go in to the various ways of putting neutralization knowledge into practice, is the idea of just what we're doing when we neutralize a stage. You'll remember our oddball definition: "the process of providing only one route from input to output of a single stage". Now all the way through we've been looking at one special case of an unwanted input-output route; this is grid-plate capacitance. But it's far from being the only route.

For instance, there may be a trace of inductive coupling between the output and input coils. You might even have some feedback via the power supply from one stage to the preceding one, then back to the second-stage grid through normal coupling arrangements. Capacitance across the tube socket is no smaller offender.

And before a stage can be called completely neutralized, all of these unwanted routes must be blocked.

This was hinted at a few paragraphs back when discussing factory-neutralized tubes. We have never yet used one of these tubes which did not require some external neutralization; the only reason which could require external work on these tubes would be unwanted coupling around the tube.

And this fact explains why nobody can give you specific, cut-and-solder-and-know-it'll-work directions for neutralization of anything. Move a coil 1/16 inch, change a chassis from aluminum to copper, use a button-mica bypass instead of a disc ceramic—any of these seemingly minor changes in a circuit *may* require vast changes in the neutralization components because of variations of coupling.

Note that two of the three examples cited above were in the direction of better workmanship, not poorer. However, since neutralization takes care of all other ills (if successful) then reduction of unwanted coupling through better bypassing or more conductive grounds could result only in *over*neutralization when original specifications of the neutralizing circuit are followed.

And overnetralization can hardly be distinguished from underneutralization; both give the same symptoms.

Speaking of overneutralization leads us straight to some thing found only at VHF. Below a region which begins around 50 mc, the representation which we used back in Fig. 1B for a pentode completely valid. However, the lead from the actual screen inside the tube out to the tube pin has some inductance, as do all the other leads, and at some frequency (usually above 50 mc) this screen-lead inductance resonates with the screen-to-cathode capacitance to form a series-resonant bypass circuit.

At the specific frequency at which this resonance occurs, the screen is almost perfectly grounded for rf. At a slightly higher frequency, the screen circuit is equivalent to an inductance rather than a capacitance, like all resonant circuits on the high side of resonance. This inductive component reflects back into the tube through electrode interaction to resonate with Cg-p, and the ultimate result is that at some frequency in the VHF region, any tube is neutralized by this effect, without external neutralizing devices.

This might look rather attractive, unless we stop to realize that the various factors which determine just what frequency the effect shows up at are determined primarily by the physical size and placement of the tube's elements, and are not under our control at all.

And few tubes indeed have "self-neutralizing" frequencies which fall into a useful region for ham purposes. One notable exception is the 5894, which self-neutralizes around 50 mc.

The main reason for devoting all this space to self-neutralization is that *above* the self-resonant frequency any attempts to neutralize a stage by conventional methods will only make things worse! This comes about because above the frequency at which a tube self-neutralizes, additional external neutralization only adds to the over-neutralization present to start with.

The cure is to reverse normal procedures; in other words, to use the "resonance" type of neutralization, employ a capacitor rather than a coil (because now Cg-p is effectively inductive rather than a capacitance).

This effect is of importance only at 2 meters and above, since most transmitting tubes self-neutralize between 50 and 130 mc.

In this frequency region, one of the simplest ways to combat the problem is to add a method of tuning the screen circuit. Either a variable bypass capacitor, or an adjustable coil in the screen lead, will suffice. By adjusting this control, the self-neutralizing frequency can be pulled somewhat, to move it to the frequency in use. Such a circuit has been used for years in the popular ARRL 2-band 120-watt final for 6 and 2, and the basic circuits for both capacative and inductive screen tuning appear in Fig. 8.

Now to see how to put our ideas into practice. First, of course, we must choose which of the various neutralization methods we intend to use. In general, the resonance technique is currently used most widely in receiver applications, while either the capacity-bridge or the first phasing method is favored for transmitters.

However, the Ameco Nuvistor converters and preamps, which enjoy a wide reputation for fine performance (no plug intended), use the capacity-bridge technique for neutralization rather than the more common resonance idea. So for a start, let's plan out how to neutralize a stage by the capacity-bridge technique.

Looking back at Fig. 3b, we see that the key elements of the bridge are Cin (plus tank capacitance), Cg-p, Cn, and Cbp. The bridge will be balanced when Cin/Cg-p=Cbp/Cn, and also when Cn/Cg-p = Cbp/Cin. Either relationship can be used with equal results, but the two lead to quite different values of Cbp and Cn at times.

Assuming that the stage we want to neutralize uses a 6146, and that the total grid tank capacitance (Cin plus Ctank) is equal to 20 mmfd, let's develop the other values.

The tube handbooks tell us that Cg-p for a 6146 equals 0.24 mmfd. Using the first relation above and dividing Cin by Cg-p to get our ratio, we find 20/0.25 or 83.3 as the value

TOUR OF SCANDINAVIA

The Institute of Amateur Radio invites you to go with a group of amateurs (and their wives in many cases) on a three week all-expenses (almost) paid tour which will include Oslo, Stockholm, Helsinki, Berlin and Copenhagen. The tour will start from Idlewild airport on August 30th and fly by jet to Oslo. We are planning to have hamfests in each city so you will be able to meet the local amateurs and get to know the countries better. The cost of the trip is expected to be $600 (unless air fares change up or down considerably) and this will include all air fares, transportation to and from the airports, baggage handling, hotels and breakfasts. Your only expenses will be lunches, dinners and sight-seeing. The normal economy air fare for this trip is $657. You must be a member of the Institute of Amateur Radio for at least six months before the flight. Membership is $10. We are planning on limiting this trip to 73 people, so get your reservations in early. Send $300 for the reservation, with the remainder due 60 days before the flight. You may have a full refund up to 60 days before the flight. We'll have the details on refunds at later dates for you when the new regulations are firm. Send in your reservation early and be sure of getting first choice on accommodations. Make check payable to the Institute of Amateur Radio, and send to the Institute at Peterborough, New Hampshire.

TOUR OF EUROPE

The Institute of Amateur Radio's second tour of Europe is now being set up with representatives in the countries we shall be visiting. The tour plans to leave Idlewild on September 21, flying to London by jet. We will spend about four days each in London, Paris, Geneva, Rome and Berlin, flying by jet all the way. The price for the whole shebang is just $600 and that includes all flights, baggage handling, busses to and from hotels, hotel bills, and breakfasts. It will also include a sightseeing trip or two, particularly one into East Berlin, something you'll never forget. Lunches and dinners are your own responsibility. Most of the folks on the 1963 tour found that they spent about $200 on food, sightseeing, and souvenirs, although some spent less than $100.

One of the persons from each family going must be a member of the Institute of Amateur Radio. This costs $10 a year. We must have your reservation of $300 each as soon as possible.

It is highly unlikely that you'll ever get a chance to travel at low rates like this again. We know the inexpensive, but nice hotels where the rooms are fine, the food good and the location central. And please, if you're going to Europe, don't pass up the book, "Europe on $5 a Day" which is sold by Radio Bookshop for $1.95 postpaid. This book is worth many times its price.

We are planning to have Pierre Catala F2BO as your guide on this trip. Pierre speaks almost accentless American and absolutely accentless French. He knows Europe very well and can give you a lot of valuable ideas on things to see and do.

Now, about those reservations . . . better hurry.
Institute of Amateur Radio **Peterborough, N. H.**

which Cbp/Cn must equal. This tells us that if we use a .001 mmfd bypass capacitor, which is the same as 1000 mmfd, we will need a value for Cn of Cbp/83.3, or 1000/83.3, which comes out as 12 mmfd.

However, neither Cg-p nor the precise value of Cin is that predictable, so we make Cn variable over rather wide limits. Acceptable range would be from 3 to 30 mmfd for this example.

When the stage is built, Cn should initially be set to about 12 mmfd. Drive and voltages are then applied, and the stage is ready to be neutralized.

A number of techniques exist for accomplishing this. The time-honored method is to adjust tuning for maximum drive, and dip the plate circuit. If the grid current flickers downward as the plate circuit is tuned, the stage is not neutralized. Move the setting of Cn a hair (caution—high voltage) and try again. If the flicker is larger you went the wrong way. By making it a round-robin technique, you can sooner or later find the point at which maximum grid current and minimum plate current coincide, and this point is taken as perfect neutralization.

A faster and simpler technique is to remove plate and screen voltage from the stage being neutralized, and connect that stage's output circuit to a sensitive rf indicator. W6ZW uses a VTVM equipped with rf probe, K5INC uses an C-meter equipped receiver, and others prefer to use a sensitive SWR bride (when dealing with high enough power levels).

At any rate, no matter what the indicator, drive is adjusted for maximum indication of "leak-through" power. Then the neutralization is adjusted for a null of the leak-through. A virtually perfect null should be obtained unless the indicator is so sensitive that it is picking up signal from the driving stage as well as via feedthrough (a receiver with S-meter can easily do this).

In low-power applications such as receivers, the filament voltage may be removed instead of the B+; this is the usually recommended way to neutralize Nuvistor converters. However, Cg-p may change somewhat when the tube is cold as compared to that at operating temperature, so removing the B+ usually gives a more accurate adjustment.

Once you get the null, the adjustment is complete and you're ready to operate.

However, if you're shooting for really precise adjustment you may discover that Cg-p is not constant with changes in plate current, and Cin varies somewhat as you tune over a band if you adjust the grid tuning capacitor. Both of these effects can un-neutralize your carefully achieved adjustment rather easily.

To combat this problem, T. J. Brooks, Jr., W5OSL, made a modification of the standard capacitiy-bridge circuit which has several advantages. For one thing, the neutralization can be adjusted with the rig on the air, even if the power supply voltage runs into the kilovolt region. For another, adjustment is "band-spreaded" so that it becomes much easier.

As described in the January 1958 issue of CQ (edited at the time by an iconoclast from Brooklyn whose call we can't quite place at the moment), the Brooks circuit is identical to the conventional capacity bridge, except that Cbp is the adjustment rather than Cn.

Moving back a moment to Fig. 3B and our previous example, we can determine from the bridge relationships that for neutralization to be accomplished, Cbp must equal Cin times Cn, all divided by Cg-p. If all except Cbp are fixed, then adjustment of the value of the bypass will accomplish neutralization.

Let's run through the previous example again from this viewpoint. Cin will remain, as before, 20 mmfd, while Cg-p is fixed at 0.24 mmfd. Let's use a 4.7 mmfd 3-KV capacitor for Cn, though, instead of the conventional adjustable type, and see what we come out with.

Plugging in the figures we find that Cbp must equal 20 times 4.7, or 94, divided by 0.24. This works out to be 392 mmfd. A standard 365 mmfd BC variable, shunted by a 100 mmfd fixed capacitor, would give plenty of range.

Now let's see what happens if we retune to the low end of the band and Cin rises to 25 mmfd. The figures are now 25 times 4.7, or 117.5, divided by 0.24, which works out to be 490 mmfd. Our 100 mmfd padder wouldn't quite make it, but a 220 mmfd fixed unit would and would still work at the high end as well.

Similarly, if Cg-p changes under the influence of plate current, the variable bypass can quickly be shifted to restore neutralization.

Using the Brooks system, the null technique of actually performing the neutralization can be employed only to find the preliminary setting. Adjustments under full power must be of the grid-current/plate-current type, with grid peak coinciding with plate null.

In the original description, Brooks described use of his system with a 750-watt rig employing a pair of 4-125A's; his variable bypass was a 20-470 mmfd unit. Voltage rating need not be large since only the bias voltage for the stage appears across it.

A similar technique was described in QST by W1HZE, except that he used the variable only for breadboarding to find the proper value of bypass capacitor so that the bridge could be easily balanced with available conventional neutralizing capacitors. He suggested using a triple-section 365mmfd broadcast variable, and for those of us who dislike even the slight arithmetic needed to calculate bypass values it's a good trick.

Now for a bit of wrap-up. It appears that nowhere in these paragraphs did we really show any good reason for neutralizing receiver stages except to avoid oscillation (not that it's not a good reason in itself).

It may get a bit sticky here and there to show why, but we'll have a go at it. From the definition we have established for the process called neutralization, it follows automatically that perfect neutralization eliminates all regeneration or positive feedback.

Now in an amplifier stage, positive feedback isn't a real good thing even if it's not strong enough to cause oscillation. It will give greater gain, but along with the greater gain comes excessive noise and unpredictable variations of the shape of the passband.

The biggest villain, of course, is the noise. A regenerating front end at higher frequencies (15 meters and up) can at times make the difference between hearing and not hearing the signal. What signal is there comes through stronger, yes—but the added noise is also stronger, and overpowers the signal along the way.

This, then, is the reason for accurate neutralization of a receiver stage. When no regeneration is present, the stage will contribute as little extra noise as it possibly can—and we have a better chance of reading those "down-in-the-mud" signals which are usually good DX.

So there it is; an organized tour through the strange mysteries of "neutralization". Now all we ask is that you don't trample us in the rush to fix up the rig the right way.

. . . K5JKX

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More Comments on "Incentive Licensing"

Mr. Collett, a former Director of the ARRL, has a few words for us all.

Over the past ten months the placid surface that normally covers the body politics of Amateur Radio has been slightly agitated.

Beginning in February with the QST editorial. . . . "Restricted voice bands again?" . . . (as a serious and searching question this heading can now be considered meaningless and academic). As events over the months from February indicate; the editorial was planted, the outcome of "favorable" Board action assured and the ARRL Program show "was on the road." However, careful measures were employed to give the entire charade an aura of democratic action.

Last May the ARRL Board acting out the tableau, adopted Director Chaffee's sweeping motion to extend and re-establish an advanced type of license and to thereby give to the ARRL officers—the originators of the "Program"—carte blanche—a blank paper, if you will—to write their own ticket. What the F.C.C. received last October 3rd comprised that ticket. Had the composers of this "ticket" possessed a historical sense they would realize that the era of ARRL "ticket writing" ended in 1948, as we shall presently chronicle.

ARRL's "Program" was filed at F.C.C. in the cause for, and in the name of . . . "the officers and directors of the League—the elected representatives of the more than 80,000 amateurs licensed by this Commission" . . .

To even the casual student of ARRL's speckled and vascillating political career, the assumption of such embracing rights of blanket representation is appalling.

Tedious as history is to many, a review is necessary of the past 15 or so years of ARRL's poiltical conduct in order to evaluate and understand why the American Amateurs stand today unprepared to battle any and all foes of the uncertain future; or even to correct, as of this date, his faults as charged of him by BOTH his ARRL and the F.C.C.

Before we go back to the earlier beginnings of our present dilemma, let us consider various recriminations which the Commission and ARRL spokesmen, salaried and otherwise, have employed in their finger pointing.

F.C.C. spokesmen point up the Amateur's disinclination to emergency matters without realistically acknowledging the partisan character of many of the Civil Defense radio installations. Further, the Commission seems fascinated by sheer numbers rather than the quality of performance in emergency communications achievements. Can this attitude project an atmosphere for future CB frequencies to be considered?

Conversely, the ARRL requests the Commission to enact it's "Program" even though it will be . . . "perhaps unpopular"; which by innuendo infers previous laxity by the enforcement agency, and that the Amateur's present plight is the responsibility of the F.C.C.

After more than 40 years of assuming ENTIRE . . . "representation of the radio amateur in legislative matters" . . . the League officers seem to unwittingly and belatedly confess of their lack of requisite leadership in Amateur affairs.

"Act," the League's counsel urges, "promptly and favorably on this petition" . . . and prior to this the astute counsellor states, . . . "the warning signs are too numerous to be ignored" . . . Who, may we inquire woke this gentleman up? And what, we pray, has the capable Mr. Paul Segal been doing all these years?

The thousands of amateurs that built the successful publishing business that is QST today, that bought and paid for a new building where QST is housed, are now ironically charged in QST pages and F.C.C. petition with a delinquency they are little aware they possess. Cannot the truism about . . . "no delinquent children just delinquent parents" . . . be restated here?

To now argue or re-emphasize that Amateur Radio is a service and not a hobby is at this late date merely a scapegoat rebuttal by League officials to escape their basic responsibility. Tacitly it is an admission of lost opportunities, a spilled milk philosophy.

Let us, historically, now review some of these lost chances to provide true leadership to the then, and now, rudderless and bewildered Amateurs that make up the membership of the ARRL.

At its Board meeting in May, 1948, the ARRL Board was offered this motion by then—Director Richelieu of Milwaukee . . . "Moved, that a League (ARRL) branch office be established and maintained in Washington, D. C., and manned by capable personnel well versed and trained in Amateur Radio practices with regard to public relations and governmental contacts so essential in organizational welfare."

Did ARRL Officers and Directors embrace this plan to further the Amateur cause on a National scale? Or similar motions of the same category offered by other Directors throughout the late 40s and early 50s? Or would the League's official family even condescend to consider another motion made at the 1948 meeting . . . "Moved, that a permanent committee be formed to study and recommend all possible means of (to) solidify the Amateur's position with the general public and the Government of the United States. . . ."

QST for July 1948 marks the burial crypt of these motions. These blueprints for leadership offered the League so very long ago, are, by their disinterment an indictment of the League's perpetual policy of remaining inactive as respects politics on either the National or International scale through the IARU. The compelling reason for the ARRL's continued silence and non-political policy is to assure a continuation of the League's tax exemption status. The cost of this administrative engrossment with fiscal frugality can be incalculable. We have no desire to be the world's richest FORMER license-holders.

Activities by other tax exempt groups along the Potomac, lobbying for their special interests seems to go unnoticed by our League leaders. Acknowledgedly, to successfully project the value of Amateur Radio far and wide costs money, and at the minuscule membership fee of $5.00 little in the field of exploiting our virtues can be accomplished. This pittance for a years' membership, paid for by many that blow a $25.00 tube with a philosophical shrug, is inexcusable and further marks the lack of leadership at ARRL Board level. Let the League take prompt and positive action to enhance our image, at home and overseas and then dare to hand the bill for such necessary and long overdue work to the membership of the ARRL. Political suicide? Well, minus such action by SOME GROUP, SOMEWHERE, all members of the ARRL Board will unquestionably be referred to in the previous sense . . . in any case.

Raising membership fees would take guts and a vision that transcends thoughts of re-election. To state a fact of political life perfunctorily, to assure yourself second place, skimp on the buck!

If present League officers are uncertain that bedrock political activity here and now, and especially to and with foreign delegates will not better our position at the next International conference, then they should have their respective noses wiped and be replaced by a realistic Board of Directors. Amateur Radio can no longer enjoy the luxury of such political naivete.

In Amateur Radio's future there should be more than entertaining and exciting QSO parties wherein bigger and bigger scores have been the innocent way of life for so many of us. In its "Program," seeking . . . "upper-level incentive licensing" . . . the ARRL officers ask, seemingly for a new broom with which the cobwebs of operational decadence can be hopefully swept away. In all that we have read and heard since the February editorial emerged, there has never been mentioned printed or said as to what group of Amateur Radio representatives MIGHT be responsible for the cobwebs of our present day indifference to the style and manner of our conduct, now, suddenly so important to our ARRL officers. The membership could wisely use a new broom, also.

The history of Amateur Radio is one of constant and ever present insecurity. To have continued under such precarious conditions is almost entirely due to the efforts of Hiram Percy Maxim going back, now, to 45 years; and aside from this life-saving work of our first ARRL President and League founder, it grows increasingly obvious that Ham Radio's political fences have had little attention since his era.

Only one important ARRL Board meeting has ever been held in the Nation's Capitol, and that only because of F.C.C.'s Docket 9295, and the rapid growth of organizations other than ARRL purporting to represent Amateur Radio. The true history of the Docket 9295 has never appeared in the pages of QST either for the enlightenment or education of the League's membership. In retrospect this omission now takes on significance. An uninformed membership makes few demands on those empowered to represent them.

Briefly, Docket 9295 original concept flowed out of the 1948 Board meeting of the ARRL and the failure of that body to adopt many of the proposals thereupon offered. The historic votes of 14 to 2 crushed much of the progressive program offered the 1948 Board that conceivably would have strengthened the ARRL policies then and forestalled the present predicament.

Many leading Amateurs, in and out of Government service, in the area of the District of Columbia importuned the F.C.C. to take action to halt amateur radio's drift along a leaderless path to obsolescence. To these and many other amateurs, the ARRL no longer deserved the long enjoyed—albeit unofficial privilege of writing its "own ticket." During this fateful year for Ham Radio the services of its most skillful politician were lost through the passing of K. B. Warner. This, likewise, had an impact on subsequent events that culminated in shaping Docket 9295.

Late in the fall of 1948, League Secretary Budlong was invited to review the draft of 9295 in Washington. One hurried reading made "Bud" realize he had ahold of a 'hot potato"; that the passage of the Docket would have tremendous effect on amateur radio. He immediately informed the then League President Bailey of the Docket's content. This individual did not officially inform his Board of Directors of the Docket for several months, thus not allowing ample time for the Directors to contact their membership. At the time the plea was advanced that League officials were sworn to secrecy. The Docket to become a law had first to be made public, as required by law, and fortunately this is, not yet, a country of secret laws! Bailey's oversight, whether by design or accidental is said to have inspired his retirement at the next ARRL presidential election by the Board. The final Docket 9295, as referred in the League's "Program" petition in November QST, was passed very much watered down from it's original draft. Briefly, however, there was some unprecedented accord within Amateur ranks, but, unfortunately, only briefly.

Regretfully, after many years, these events are recorded for the first time, not to demean or calumniate any individual but rather to reveal wherein a system of reposing our complete faith in a single image has a fallacious foundation and an end of positive finality.

To most Amateurs the image of ARRL parallels the respect with which they hold their religion. To many this faith is absolute—and blind. As normal citizens most Amateurs give weightful thought as to their selection of a national representative; even occasionally writing these members of Congress. As Amateurs—when they vote for their League Directors, they question the incumbent NOT, but term after term return him to office This political insouciance in ARRL political affairs stemming, perhaps from the hobby image breeds official indifference the like of which can be detected in the genesis of ARRL's petition on Incentive licensing.

For this "Program" may we suggest the epitaph, "Alas, so very little and so very late."

Len Collett, KZ5LC
Box 736
Balboa, Canal Zone

Still Move on "Incentive Licensing"

The story behind this release should be of interest to those who have read Prose Walker's article in the October 1963 issue of QST.

Last April Prose Walker of Collins Radio, formerly an FCC expert at ITU conferences, clearly indicated to a number of key ARRL people and the writer that unless a major effort was made well in advance of the next ITU conference we amateurs were quite probably going to lose our HF assignments.

This release was prepared and distributed to the ARRL Executive Committee, hoping some evidence of action would be forth coming from this Committee. No evidence of action, even of any interest, has been fed back to the writer.

The question can be answered and should be answered promptly by the leaders of the ARRL. Does the ARRL Executive Committee believe our HF assignments are in serious danger? If the answer is negative, quite obviously others who feel differently about the matter should initiate action in accordance with their own beliefs.

If the ARRL Exec. Commttee feels there is a real and ever growing danger, is it willing to battle with all the tools of the trade used by our enemies or is it committed to a policy of being nice guys with martinis for everyone in the house after we have lost the battle.

The basic question seems to be, do the amateurs really want to put up a real fight on a "no hold barred basis" for the retention of our high frequency bands?

1. Can the ARRL make the tremendous effort needed to stem the tide of frequency grabbing from the amateur radio service now in the making between the international broadcasting and point to point radio services of 30 odd new governments and a substantial number of the 70 old so-called old countries.

2. Is it geared to such an effort management wise and/or tradition wise.

3. The record at ITU conferences for the past 40 years clearly indicates that the only service to lose frequencies at these conferences is the radio amateur service.

4. With recent addition of 30 new countries all wanting frequencies it is quite obvious that unless some constructive work is done, pressures to eliminate the radio amateur service from the high frequency portion of the spectrum at the next ITU conference will reach an all time high.

5. Are the ARRL officers and directors afraid to do battle with one or more segments of our own government, particularly the Voice of America section of the State Department?

In all probability the answer is yes. Like the majority of Americans benumbed mentally by the stupendous magnitude of our Federal Government they have forgotten this is still a Republic and still is of and for the people (if they will get up off the floor and fight) and still has the checks and balances of the Congress the Presidency and the Supreme Court.

They probably will have tremendous doubts of the strength of a lobby which can be established to work for our continued existence in the high frequency portion of the spectrum and therefore abandon hope at the outset.

6. Would they authorize the expenditure of the funds necessary to a good job? This too is highly questionable as this might cost as much as $100,000 a year for three or four years at least.

7. To sum up the situation, the ARRL leadership, while it is clearly aware of the dangers to our continued existence on the high frequency bands is on the horns of a dilemma.

This is the cheap way out but even an idiot can tell this will mean total disaster at the next ITU meeting.

The concept of hiring professional lobbyists and technical consultants to do a professional job in a highly specialized professional field is just too much to expect from most ARRL leaders.

Is it really worthwhile to retain our amateur simon purity intact and let others disembowel us behind the scenes with every dirty trick in the book?

8. Is the best way out the formation of a new organization of amateurs primarily with professional radio background who are fully aware of the realities of dirty politics, back room deals, how to stir up Congressional pressure in the Administration when necessary and all the professional tricks of the trade which are as little known at Newington, Conn., as they are in Elko, Nevada.

Such a group will need a mouth piece in the form of a magazine. It will also need lots of cash. Both should be readily obtainable, particularly when the average ham with better than $1000 worth of gear finds out what his chances are of converting it to the scrap heap, unless drastic action is started immediately to protect his interests.

9. The hardest task is to get the ARRL leadership to commit themselves. Instead of holding an Executive Committee meeting for a week with an agenda devoted to this subject exclusively, meetings are held for one day on important matters like League Affiliation grants to various radio clubs, incentive licensing (which is a big mistake) when amateur unity is needed and it can not possibly eliminate operating malpractice.

In short, if the ARRL leadership would throw in the sponge officially on backing an aggressive campaign to preserve the amateur HF bands the way would immediately be left open for a new group to step in and put on a real campaign.

The alternate to these concepts is to have parallel efforts going on at the same time. Competition is called the life of trade. Perhaps it will provide continued amateur operation on the HF bands after the ITU conferences in 1965 and 1969.

10. What are some of the things that should be considered as elements of a hard hitting campaign? First of all we certainly need a reasonably accurate idea of who is for and who is against amateur radio in all of the 100 odd countries who have a stake in the ITU grab bag (conference).

This will require the assembly of an organization chart of all of the governments concerned showing the relationships and personnel involved in the department sections of the equivalent of our FCC, DOD and State Departments. In most countries these are the Post Office, the military and the Foreign Office. To assemble this data in organization chart form and personnel data in card file form is quite a chore for a good lobbyist to start work on.

By keeping it up to date and contacting the people involved we can maintain an accurate barometer of world opinion. The IARU could help immensely in accumulating this data, but of course they too have to be sold on the idea of helping themselves to maintain our current rights.

11. While much debate can take place in a more or less circular pattern leading nowhere. The Achilles heel insofar as frequency allocation is concerned is that it started out when very little was known about ionospheric radio transmission. Frequencies were allocated pretty much on a grab bag basis and as a result there are serious inefficiencies built into the allocation plan.

This is no secret. Most of the savvy professionals throughout the world know it. They shudder at the thought of reworking it into an efficient plan and up until now there have always been sections of the ham bands to take away from these peace loving dupes.

12. Now the situation is completely changed for the first time since 1927. If all the HF amateur bands are taken away, this will not solve the requirements for point to point and international broadcasting channels by a long shot.

A much greater source of channels lies in the built-in inefficiencies and channel hogging practices of the first countries with their noses in the grab bag. Our own dear Uncle Sam is the biggest hog having 50,000 of the 250,000 channels now assigned on a world wide basis.

Of course we need much more statistical data than this. Of course we must release more of it with the passage of time to every ITU delegate country, to its people who count after we find out who they are.

For example we need to know how many point to point and short wave broadcasting channels are assigned to each country. How many point to point channels are commercial and how many are exclusively military.

What channel widths are available in each instance so the total band width per country can be calculated.

Unquestionably other data will be heeded as we dig deeper and get more professional minds at work on our side.

We must harp and harp on the inefficiencies and injustices. Further we can and should come up with formulae which will produce an equitable division of channels between countries based upon their actual needs. We can again become LEADERS instead of standing around hat in hand hoping for a handout.

Yes Algernon, we will step on some painful corns both here and abroad. Some people aren't going to like us at all, particularly the dog in the manger types. On the other hand we might make some darned good friends if we show how the "have not" countries can force the disgorgement of unused channels from the "have too much" countries, so there will be an equitable and efficient frequency distribution.

Yes, Algy, there is a lot of work to do and it will take a lot of time and cost a lot of money or we can just sit back and wait until we are moved up to 1200 mc.

Dana Griffen W2AOE

Listen . . . . Fellow Radio Amateur, cont . . .

Dear Wayne,

I know you will permit me a bit of space in 73 Magazine to answer the remarks of K9COG in reference to my article "Listen . . . Fellow Radio Amateur" which appeared in the November issue of your magazine.

I rest my case by quoting a portion of a speech given before the Quarter Century Wireless Association on October 25, 1963, in New York City. The speech was titled "Amateur Radio and Public Service." The speaker was Ivan H. Loucks, W3GD, Chief of the Amateur and Citizens Radio Division, Federal Communimations Commission. This is what Mr. Loucks said:

"In passing, it might be well to mention that many persons seem to confuse their own personal interests or convenience with that of the public at large. The high incidence of 'problem children' among the Class D station licenses in the Citizens Radio Service is a very glaring example of this, but I am afraid that the attitude is also seeping over into the Amateur ranks. Nothing could prove more fatal to amateur radio, as such, than to have that attitude become dominant. You have heard before, and you will undoubtedly hear again, that amateur radio must justify itself as a 'service'—if it becomes merely a 'hobby' there will be no defense against the other communication services which are continually looking for more frequencies on which to transmit their necessary traffic. Ships, aircraft, international telephone and telegraph circuits, private and governmental users of all kinds and, yes, international broadcasting are all cramped for spectrum space and are very possibly eyeing our amateur bands as a means of relief. It is up to all of us, as dedicated amateurs, to justify our frequency bands and our Amateur Radio Service, on the scales of Public interest, convenience and necessity."

Appliance operators! Take note!

William I. Orr W6SAI

Notes

Belgium Rally

Another international mobile rally is being planed for August 1964. This one will be in Ardennes, Belgium and we understand that foreign radio amateurs will be granted a three weeks temporary mobile license. 80 and 2 meters are the bands being planned for.

Tech-Ceiver Improvement

A note from W1UAD points out that he increased the sensitivity of his WRL TC-6A transceiver by substituting a 6DC6 for the 6CB6 rf amplifier. This required a 220 ohm ½ watt cathode resistor bypased with a .001 disc to limit the current through the tube. Jack says it works like a charm.

New Products

More Swan

The fellows out at Swan have apparently not been spending all of their time trying to keep up with the orders on their three-bander sideband transceiver. Now they've come up with a little unit that makes the Swan 240 into a full bilateral transceiver. The Swan TCU (Transmitter Control Unit) contains a VFO for the three (20-40-75) bands covered with the 240, a VOX unit with anti-trip, a 100 kc calibrator, a 15 mc channel for WWV reception, and a built-in speaker. The TCU plugs into the 240 and in no way impairs its mobile operation. Either the transceiver or the TCU may be used to control the frequency of the transmitter or receiver, or either can be used to transceive. $115.

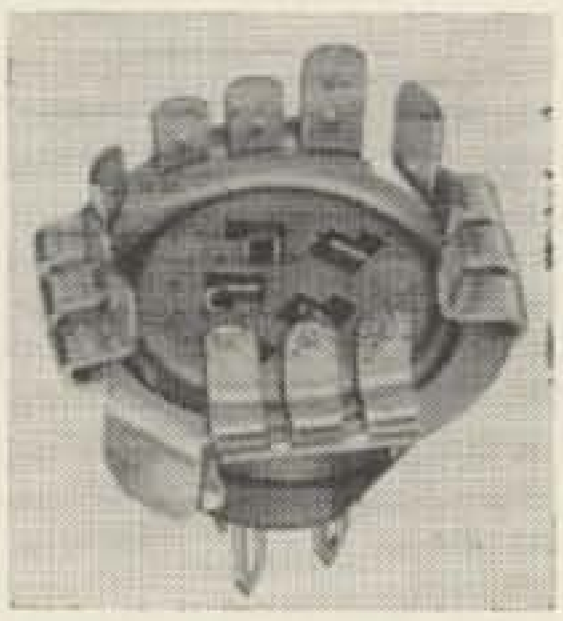
Swan has a new ac supply that is designed to fit in the TCU case, resulting in a complete home station in the matching 240 and TCU cabinets. This supply, the SW-117B, sells for $75.

Universal Power Supply

Linear Systems (Adcom) have announced a new power converter which will supply the right voltages for all of the mobile transceivers now on the market. The Linear Century converts 12-15 vdc to 650-850 vdc at 500/400 ma, 250-325 vdc at 200 ma, and 0-120 vdc negative at 20 ma. The output voltage drops only 8% from no load to full load and the operating efficiency is an amazing 91% with 275 watts output. It is short-circuit proof. The Century weighs in at 7 lbs. and is 3½" x 6" x 7". Price is $145. More data? Write Adcom at 605 University, Los Gatos 2, California.

World Radio Catalog

Just in case you have been improvident enough not to be sure you are on the list for WRL's 1964 catalog, you would do well to drop them a card and get this exclusive ham catalog. Free. Write Box 919, Council Bluffs, Iowa 51504.



Nu Nuvistor Socket

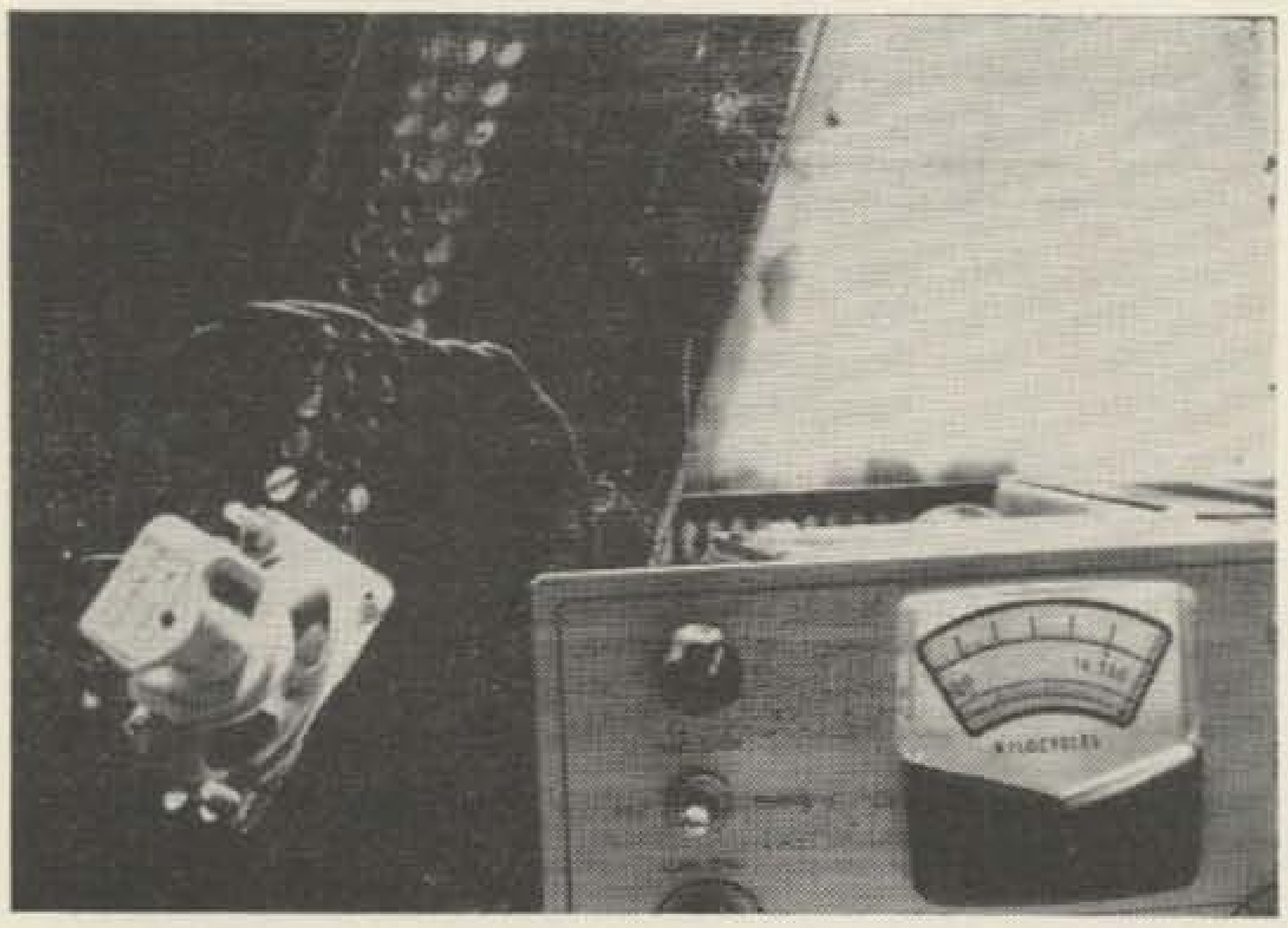
The first heat dissipating nuvistor socket is now on the market. They didn't say how much, but if you drop a line to Cinch, 1026 S. Homan Ave., Chicago, Ill., 60624, you may find out.

Letters

Dear Wayne,

Here is a tip for Swan owners. I got tired of dragging a speaker with me every time I took my Swan from the car to the house and mounted one of those transistor portable size 2" x 2½" x 1½" speakers in the left side nestled among the 12AX7 product detector and the XBA6 carrier oscillator. The speaker leads go through the grommet carrying the leads for carrier balance gain and are connected to pins 6 and 12 on the Jones plug.

Dennis McCarthy KØYTI



ATT WAYNE GREEN

After six months of intensive inregestan I have discovered some most interesting facts. Trying to give you a even break for your so called non-profit enterprise would be fair—if you warrented as much! You might want to know, some of your forner reader have turned over to me, documented copys of your letters and, testomials you sent them.

Your derogatary, and rash statements must certainly make your existance more pleasurable, by expressing "DICTATORIAL" ideas. Their must be a great feeling to cancel out anyones subscription, who might not agree with you, our your articials.

A word to you about amateur radio that you must know, "their is no station in life ideas" when we indulge in our hobby. Remember even when off the air working as a groupe or alone, a persons background or, financial status is not to be noticed.

In con clusion to this letter I must add that all reports and letters are in the process of beig turned over to A.R.R.L. for their use. I am not pressing any friction anong any legal operation. I'll let them be the judge and jury.

Knowing that their is no regular letters to the editor collam in "73" magazine, their for I have no real reason to think you'll follow up this letter, ... except with a reply, "OK your no longer able to purchase any item from our supplys"

Signed F.D. Rosnberg W6NYG
555 Airport Circle #76
Santa Maria, Calif

(W2NSD from page 4)

be an emergency fund available to help in those cases where there seems a reasonable possibility that a precident might be established which could alter the history of amateur radio.

For instance, if I may digress a moment, there is a case about to come up in California where the City of Santa Barbara has asked the Superior Court for an injunction to stop the operation of amateur stations K6GHU, K6KCI and WA6IBR at their local residence on the grounds that they are a Public Nuisance. This is going to be tried in a local court. If this case goes against us it could spark an avalanche of similar cases all over the country. This is a particularly good case since there are no side issues involved. The FCC has checked the stations and found them clean. This is strictly an attempt by the local authorities to regulate federally licensed transmitters. The Santa Barbara Amateur Radio Club estimates that the defense of this case would probably cost about $1500. Isn't something like this important enough to warrant funds being made available by the Institute?

4) On the international scene there also is important work to be done. The Institute could set up an international mailing list of all foreign government officials who have any influence on amateur radio in their country or who are likely to be members of a delegation at the next Geneva Conference and keep a supply of information about amateur radio going to them.

(Turn page)

We have an important story to tell of the value of amateur radio in the U. S. and we should be able to help amateurs in other countries by making our story known world-wide. Further, we can meet these officials personally and try to help them with their problems. Newer countries may need a hand in establishing an amateur service and our representatives can not only provide answers to all questions, but can undoubtedly make arrangements to provide a good deal of equipment donated by interested U. S. amateurs and manufacturers.

A world-wide amateur study of the occupancy of the commercial bands would undoubtedly give us valuable ammunition to counter the demands for amateur frequencies at Geneva. Something like this must be done by a large organization.

5) Through the pages of 73 we can encourage amateurs to bend every possible effort to improve their image and step up their work in public service. We need a program emphasizing on-the-air manners, courtesy, politeness, consideration and responsibility.

This means we need a lot of members of the Institute. This in turn means that *you* are needed not only to support the Institute with your membership dues, but that your help is needed to get as many other fellows as possible to join in this battle for our survival. This has to be talked up on the air, at clubs, and everywhere that amateurs get together. Here is an opportunity for every amateur to stand up and be counted.

We will send a beautiful Institute of Amateur Radio Membership Certificate suitable for framing as well as an attractive membership card to all new members. Charter and present members will receive the new membership cards and certificate by sending their present card with $9.00 to the Institute. This card will be returned.

Send your name, call, address and $10.00 to the Institute of Amateur Radio, Peterborough, New Hampshire. Please send it quickly so we can get our program started.

ARRL

How will the sudden expansion of the Institute of Amateur Radio affect the ARRL? Well, you can bet that it will startle the Executive Committee and Directors. It may even occur to them that they have erred in dismissing the pleas of Dana Griffin W2AOE and many others who took the time to write to them and suggest that the ARRL step in and do something to keep our hobby going. They may wish that they had heeded my past editorials suggesting action instead of unending deliberation. I'm sure that the Institute will make them a lot more sensitive to the feelings of their members. It may also spur the League into more action and less talk about improving amateur radio. I don't see any area where amateur radio will do anything but benefit from a strong Institute.

73 can, I believe, do a lot to bring the ARRL back to life. We're going to really try for I feel that the ARRL is very necessary to amateur radio. One of the great problems that has beset the League is the censorship which seems to have been a fixed rule in QST. This has made it virtually impossible for the members to get anything except the "official" side of any matter. 73, I think we have adequately demonstrated, can fill in this gap by making every attempt to cover both sides of all issues. One serious weak point in the ARRL makeup has been the dearth of information available for the members to use in making up their minds about who to vote for at Director voting time. The little card which accompanies each ballot seems to many to be heavily weighted and there is a strong feeling that the publishing of fuller information on all candidates would be helpful. This is an area where 73 can probably help the ARRL back to health.

I'm sure that many of the past directors have a lot of good ideas which might further benefit both the ARRL and our hobby. I'd like to hear from them and anyone else interested.

About 73

Visitors here at 73 headquarters are almost always astounded to find that I haven't been kidding about how we are putting out the magazine. Our offices fill several rooms of a 170 year old New England mansion and we have at the moment six hams living with us and working on the magazine. Most of them put in about twelve hours a day at work and the salaries vary from $30 to $60 a week.

To say that I have my hands full is an understatement. Hams, as you well know, are not normal people and our ham collection here is no exception. Some do a marvelous job, others make me wonder if it wouldn't be better to wave goodbye and do their job myself, thereby saving me considerable time. I find that editing and publishing 73 takes just about full time for me and by the time I have added in the demands of the Radio Bookshop, the many 73 Products, our Kits, the Tours, management of our house and grounds, our vast collection of pets and livestock. our daughter Tully, 6UP, the Porsche and VW busses, ad infinitum, I can see why I have been so reluctant to increase the scope of the Institute of Amateur Radio.

I have given this a lot of thought, trying to figure some way to do what I know has to be done to keep ham radio going, and the only possibility seems to be for me to expand the Institute and get things started. You can't imagine how much I wish that the ARRL would shoulder these responsibilities, leaving me to gradually build up 73. Then I ask myself, "build up 73 for what?" What will be the need of 73 if ham radio ceases to exist?

Though 73 really can't afford it as yet, I'm going to go out on a limb and hire two or three more amateurs to take over many of my responsibilities so I can work hard to get the Institute of Amateur Radio set up as a truly democratic club and start the most important immediate functions going.

Time is our worst enemy. I'm counting on you to join the Institute of Amateur Radio, Inc. (a non-profit corporation), and look deeply within yourself to see how much you love amateur radio and how much you are willing to give of yourself to keep our wonderful hobby (service) alive. Can you get others to join? Can you devote some time to work in your area?

I expect that my motives will be questioned . . . I'm used to that. What is this guy Green really after? He wants to get rich! He wants power! No, mostly I want to be of some value to the world before I leave it. I've chosen the field of amateur radio because it is one that I dearly love. Those of you who have visited our place probably understand. Let me quote from a piece by Doug DeMaw W8HHS out of the September issue of the VHFR ($2 a year), which he publishes. "The trip would not have been complete without a visit to '73 Acres' in Peterborough, N. H. Never before have we been greeted with such hospitality and friendliness. No one should sojourn through N. H. without meeting this decidated man, his wife and staff who have completely thrown themselves into the cause of improved amateur radio conditions. We enjoyed our overnight stay at W2NSD. A personally prepared waffle breakfast by the 'ed' himself, with New Hampshire pure maple syrup and all the trimmings and garnished with a vigorous discussion related to the controversial matters of the day (which are destined to affect all ham radio operators) was very invigorating. For many months I tried to understand this man Green's motives and his attacks on other publishers and organizations, but until I met this guy face to face, I could not properly evaluate his thoughts. I am convinced through seeing the results of his publishing house efforts, listening to his explanation of his convictions and hearing him relate his hopes for the ham fraternity and its future, that he is neither vindictive nor radical. He believes in what he is doing and is willing to fight for those who share his beliefs."

Geneva will be upon us before we know it. The next conference could come anytime between 1965 and 1970, with the educated money riding on 1967. This gives us precious little time to prepare. It is important that we get right at the work that has to be done and do it now, this year. By 1967 we can have the story of amateur radio known by every delegate at Geneva and every official with authority in the field back in the home country. We may be able not only to make these people friends of amateur radio, but may, even in that short time, be able to start an increase in the number of DX amateurs.

OK? Can we get started? That's Institute of Amateur Radio, Peterborough, New Hampshire. $10.

Rumors, Rumors

It is only natural, I suppose, for a lot of silly rumors to be circulated when something as controversial as RM499 is demanding attention. One of the strangest I've heard so far suggests that the whole incentive licensing bit, complete with the petition to the FCC, is a plot by a manufacturer to introduce a temporary depression in the amateur equipment industry to force most of the smaller manufacturers who don't have sizeable military and other production out of business so they will have clearer sailing later on when things perk up again.

Even though this would answer several otherwise difficult to answer questions, it is much too far fetched to consider seriously.

Good Reading

While the fellows who pushed the Executive Committee of the ARRL into okaying the petition are waiting for the FCC to make a decision on RM-499 they might find it interesting to pull out a September 1962 issue of QST, turn to page 65 and read #4 paragraph. This is an interesting decision from the FCC in answer to a chap who suggested that amateurs have to pass a special microwave exam before they could operate on 220 mc and above. The FCC had this to say regarding their decision not to adopt the proposal: "(1) The bulk of the licensed amateurs, excluding Novice and Technician classes, are now authorized all amateur operating priviliges. Many have a considerable investment in equipment for operation, not only in the 220-250 mc/s band, but also in higher bands. Such a restriction would, in many cases, result in an unwarranted financial loss on this equipment as well as a dimunition of operating privileges. (2) Many General Class amateurs, as well as the former Class A and Advanced Class holders, have held their licenses for many years, and it does not appear reasonable now to require them to be examined in order to use privileges which they have previously been authorized to use."

The Board of Directors may find that interesting too for it certainly is a strong precident that the Executive Committee, which the Directors set up in its present throne of power, is trying to buck. Or did anyone bother to read this musty-dusty old FCC decision before charging ahead?

Our Image

The ruckus stirred up by the ARRL has done one good thing . . . it got Bill Orr to tell us how rotten we are and this in turn got a lot of fellows worrying about what to do about it before the ARRL tries to get the FCC to pass laws against being rotten.

Even I've been thinking, and those of you that have the courage to frequent this obscure section of 73 with any regularity know that this can not possibly mean anything but watch out.

I think that we can clean house all by ourserves without daddy standing over us with a big stick. We can de-rotten ourselves by screwing up the courage of our convictions, planting our tongue firmly in our cheek and stumbling ahead blindly. Or, if you want a de-metaphorized translation of that, when you hear an ass on the air get on there and bray at him.

There is always a great danger of seriousness setting in. When a fellow pulls a blunder he is very likely to get mad when informed. It is a lot easier to get mad at someone who is correcting you than to admit, even to yourself, that you did something stupid. I suggest that amateurs who are forced by a poor childhood into taking everything seriously go about their regular operating business and leave the band cleaning up to those with a more mature outlook.

How then should we go about clobbering offenders? I expect we'll get better results by joshing them about their blunders than by reprimanding. All of us hear the occasional bursts of insanity and childishness on our bands, we just haven't taken it upon ourselves to step in and do something about it. Isn't it about time that we faced ourselves and shouldered some responsibility for the way things are? After all, it isn't so much the fellows who are making the mistakes that are in the wrong as it is us who hear them and don't speak up.

To sugar coat the reprimands a bit we might use a reporting system on the order of RST. This might be on the OPU (Operating procedure, unrecommended) scale of 0-9. Long CQ's might rate an OPU-5 report. "Break-Break-Break" could get OPU-6, with additional points for each two additional breaks. Inexcusable language could get as high as OPU-9. Calling CQ without checking the frequency certainly would be on the order of OPU-7, unless there is a net on the channel, which would increase the report to an 8. Over-long transmissions could get an OPU-3. Etc.

There has been considerable warning about what our do-gooders should call themselves. The word "Police" is definitely frowned upon. "Official" is too strong. I say let's call a club a club and form the OGPU, the Official Gestapo Police Vigilantes (libraries use V's for U's, so let's even things up). If you feel that you need even more authorization, you can identify yourself with OGPU plus your zip number. Oh, don't forget to include your FCC call or else you'll rate an OPU-4 report yourself. OPU-3 at least if you get serious about reprimands.

OK, all OGPU'ers get in there and pitch.

If it will be any help we will publish an Official List of OPU points as suggested by OGPU'ers.

Scrounge Dept.

Having just invested in a final designed to work with 4-400's and not having any 4-400's, I'm wondering if any readers might have a used one, perhaps from a BC rig, which would have some spirit left and still be reasonable.

Sideband Dinner

Just about everyone who is anyone, to coin a phrase, makes it a point not to miss the yearly Sideband Dinner in New York at the time of the I.E.E.E. show. It will be held Tuesday March 24th at the Statler-Hilton Hotel, 33rd Street and 7th Avenue. Equipment displays open at noon and the buffet style dinner starts at 7:30 PM. Tickets are $10 each. Order from W2JKN, 4665 Iselin Ave., New York 71, N. Y.

. . . Wayne

73 parts kits

In the interests of making home construction simpler for those readers with anemic junk boxes 73 has gathered together the parts required for building our less complicated projects. These kits are as complete as we can make them, containing good quality parts. Except where the chassis or case is integral to a unit we do not supply it. We will mention when we do supply a case or chassis. We do supply tubes, sockets, condensers, resistors, transformers, connectors, etc. The kits are kept in stock to the best of our ability, though sometimes the distributors who supply us delay us a bit.

TWO METER PREAMPLIFIER. Uses two 6CW4 nuvistors in a grounded grid input circuit (March '63 p8) and one 6CW4 nuvistor grounded grid output. Complete with power supply. Uses 50 volts on the plates for extraordinary noise figure. Full scale drilling template supplied.
W9DUT-1 .... $18.50

15-20 METER NUVISTOR PREAMPLIFIER. Need more hop on these bands? This simple to build preamp will bring up those signals. This is particularly good for inexpensive and surplus receivers. See April '63 page 40
W6SFM-1 .... $4.00

TRANSISTOR TRANSCEIVER. One of the most popular kits we've ever assembled is this six meter miniscule transistorized transceiver. Really works. Hundreds built. See page 8 in the May '63 issue. Five transistors.
K3NHI $25.00

CW MONITOR. Connects right across your key and gives you a tone for monitoring your bug. Page 44, June '63.
WA2WFW $4.25

TWOER MODIFICATION. Increase your selectivity considerably by installing a new triode 7587 nuvistor stage. This is our best selling kit to date. Everything you need for the modification is included. See June '63 page 56
K6JCN $6.50

SIX METER CONVERTER, DELUXE. 6EW6 low noise front end, 6U8 oscillator and mixer. Output is 10.7 mc (easy to change to suit your needs). This is a tunable converter with fixed frequency output, not the usual converter that requires you to tune the receiver. This helps considerably on eliminating interference from nearby high power stations. See page 8, July '63.
W9DUT-2 .... $20.00

NOISE GENERATOR. Invaluable test instrument for tuning up rf stages, converters, etc., voltage regulated by a Zener diode. Kit includes even the battery and mini-box. See page 15, Aug. '63.
K9ONT $5.00

QRP TRANSMITTER. Have fun with this little one half watt CW rig on 40 meters. Uses any 40M surplus crystal. Kit supplies 1S4 tube and socket, condensers, resistors, coil, rf choke, terminal trip, etc. Runs from flashlight battery for filament and portable radio 67½ volt B-battery. See March '63 p22
W1MEL $6.00

CAST IRON BALUN. Eentsy balun using ferite core, covers 6-40 meters, will handle up to 20 watts, complete with cabinet, connectors, etc. See September 1963 page 8.
W4WKM-1 .... $3.00

BOURBON S-METER. Much better than the usual Scotch S-meter. Here is an S-meter kit for those of you with receivers without S-meters. Includes tube, adjusting pot., socket, resistors, and meter. See September 1963 page 18.
W6TKA-2 .... $6.50

TONE MODULATED CRYSTAL STANDARD. Uses one tube and one mc crystal to generate 1 mc markers all the way up through 225 mc. The built in tone generator makes it possible to easily identify the markers. Including Minibox, tube, vrystal, etc. See Oct. '62 p 26.
W9DUT-3 .... $15.00

TRANSISTORIZED MODULATOR. 40 watt modulator, excellent for plate modulating mobile rigs, four transistors, uses 12 volts dc, only draws 250 ma while resting with peaks of 4-5 amperes. Kit includes transistors, transformers, resistors, condensers, etc. See Sept. 62 p 24.
VE7QL $27.50

SHORT WAVE CONVERTER FOR HAMBAND RECEIVERS. One tube short wave converter so you can tune SW broadcast stations. Power supply included. See Aug. 62 p 38.
W2LLZ $13.00

RECEIVER-DECEIVER. Substitute local oscillator for your receiver for sideband reception, complete with power supply, tubes, voltage regulator, etc.
W2RWJ $19.95

HAM BAND AUTOMOBILE CONVERTER. Listen to the hambands instead of that rocky-roll junk. Transistor converter, complete with battery, etc., to tune 20 meter band. Crystal controlled.
VE2AUB $6.95

WRETCHED K2PMM

BADGES $1.00 each.

Individually engraved badges: $1.00 Room for first name and call, 3" x ¾", with pin and safety lock. Specify whether you prefer red with white letters or black with white letters.

BADGES FOR CLUB MEETINGS & HAMFESTS

Club badges 3" x 1" with name or initials of club on one line and first name and call on second, in groups of five or more: $1.50 each.

Order from

73 Peterborough, N. H.

OTHER 73 BULLETINS AND BOOKS

6UP Magazine. Now in its fifth month with back issues getting rarer and rarer. This VHF monthly magazine is edited by Jim Kyle K5JKX and presents up to the minute reports on activities on all VHF and UHF bands, technical articles of interest to VHF'ers, and other general information not to be found elsewhere. This is the only strictly VHF magazine being published now. If you are a VHF'er you won't want to miss a single issue of 6up . . . you should support it. Subscriptions are only $2 per year, back issues are available at present for those who would like a retroactive subscription.

ATV Bulletin. In direct refutation to the ARRL claim that amateurs are lagging technically are the 2000 readers of the semi-monthly Amateur Television Experimenter Bulletin, edited by W0KYQ. If you are at all interested in amateur television you should subscribe to ATV, the only source of operating and technical info on this amazing branch of our hobby. Back issues are virtually all sold out, so don't put off subscribing. $1 a year for six issues.

Ham-RTTY. This is the most complete book on the subject. Written for the beginning TT'er as well as the expert. More complete and authoriative than books at twice the price. Pictures and descriptions of all popular machines, where to get them, how much, etc. $2.00

Bound Volume 2. Complete library volume containing the 1962 issues of 73. $15.00

Binders. Bright red leather binding. Specify which year you want stamped on them: 60-1, 62, 63. Darbs. $3.00 each.

Care and Feeding of Ham Clubs—K9AMD. Carole did a thorough research job on over a hundred ham clubs to find out what aspects went to make them successful and what seemed to lead to their demise. This book tells all and will be invaluable to all club officers or anyone interested in forming a successful ham club. Hundreds of grateful letters have been received from clubs who have applied the ideas in this book. $1.00

Simplified Math for the Hamshack—K8LFI. This is the simplest and easiest to fathem explanation of Ohm's Law, squares, roots, powers, frequency/meters, logs, slide rules, etc. If our schools ever got wind of this amazing method of understanding basic math our kids would have a lot less trouble. 50¢

Index to Surplus—W4WKM. This is a complete list of every article ever published on the conversion of surplus equipment. Gives a brief rundown on the article and source. $1.50

Ham-TV—WØKYQ. Covers the basics of ham-TV, complete with how to get on the air for under $50. Not the usual theory manual, but a how-to-do-it book. $3.00

Surplus TV Schematics. You can save a lot of building time in TV if you take advantage of the real bargains available in surplus. This book gives the circuit diagrams and info on the popularly available surplus TV gear. $1.00

AN/ARC-2 Conversion. This transceiver sells in the surplus market for from $40 to $50 and is easily converted into a fine little ham transceiver. Covers 29 mc (160-80-75-40 meters). This booklet gives you the complete schematic and detailed conversion instructions. $1.00

AN/VRC-2 Conversion. Completely different from the ARC-2. This book gives you complete instructions on converting the inexpensive VRC surplus gear into a six meter wide band FM transceiver. There are probably over a thousand stations now operating on 52.525 mc around the country. Join the crowd. Fun. $1.00

Coils—K8BYN. Basic book which covers the theory and practical aspects of the many different types of coils found in ham work. Well illustrated. 50¢

CW—W6SFM. Anyone can learn the code. This book, by an expert, lays in a good foundation for later high speed CW ability. 50¢

3D Map of World. Maybe you've been eating your heart out for one of these beautiful relief maps after seeing one at a friend's shack. Comes complete with one year subscription or extension to 73. $9.95

3D Map of U. S. Complete with one year sub to 73. $9.95

Mickey Miker—WØOPA. Complete instructions for building a simple precision capacity tester. Illustrated. 50¢

Frequency Measuring—WØHKF. Ever want to set yourself up to measure frequency right down to the gnat's eyebrow? An expert lets you in on all of the secrets. Join Bob high up on the list of Frequency Measuring Test winners. $1.00

Impedance Bridge. Full scale construction prints for the bridge described in the August 1961 issue of 73. Comes complete with a reprint of the article. Watch out General Radio! $1.00

SSB Transceiver Schematic—W6BUV. Giant size schematic of the transceiver that appeared in the November 1961 issue of 73. Complete with extra November issue. $1.00

Radio Bookshop

Transistor Radio Handbook

Editors and Engineers, publishers of the Radio Handbook, have just published a new transistor book. This one starts with simplified theory and goes into a wealth of practical construction projects including audio and speech amplifiers, VHF transmitting and receiving equipment, single sideband exciters and a complete sideband transceiver. **Order Number 113**

5—ANTENNAS—Kraus (W8JK). The most complete book on antennas in print, but largely design and theory, complete with math. **$12.00**

11—16TH EDITION RADIO HANDBOOK—by Bill Orr W6SAI. This fantastic book is loaded with the most understandable theory course now available in our hobby plus dozens of great construction projects. This is the best ham handbook in print by a wide margin. Easily worth twice the price. **$9.50**

13—REFERENCE DATA FOR RADIO ENGINEERS. Tables, formulas, graphs. You will find this reference book on the desk of almost every electronic engineer in the country. Published by International Telephone and Telegraph. **$6.00**

16—HAM REGISTER—Lewis (W3VKD). Thumbnail sketches of 10,000 of the active and well known hams on the air today. This is the Who's Who of ham radio. Fascinating reading. Only edition. Now only **$2.50**

18—SO YOU WANT TO BE A HAM—Hertzberg (W2DJJ). Second edition. Good introduction to the hobby. Has photos and brief descriptions of almost every commercially available transmitter and receiver, plus accessories. Lavishly illustrated and readable.. **$2.95**

21—VHF HANDBOOK—Johnson (W6-QKI). Types of VHF propogation, VHF circuitry, component limitations, antenna design and construction, test equipment. Very thorough book and one that should be in every VHF shack. **$2.95**

22—BEAM ANTENNA HANDBOOK—Orr (W6SAI). Basics, theory and construction of beams, transmission lines, matching devices, and test equipment. Almost all ham stations need a beam of some sort . . . here is the only source of basic info to help you decide what beam to build or buy, to install it, how to tune it. **$2.70**

23—NOVICE & TECHNICIAN HANDBOOK—Stoner (W6TNS). Sugar coated theory: receivers, transmitters, power supplies, antennas; simple construction of a complete station, converting surplus equipment. How to get a ham license and build a station. **$2.85**

24—BETTER SHORT WAVE RECEPTION—Orr (W6SAI). How to buy a receiver, how to tune it, align it; building accessories; better antennas; QSL's, maps, aurora zones, CW reception, SSB reception, etc. Handbook for short wave listeners and radio amateurs. **$2.85**

26—S9 SIGNALS—Orr (W6SAI). A manual of practical detailed data covering design and construction of highly efficient, inexpensive antennas for the amateur bands that you can build yourself. **$1.00**

27—QUAD ANTENNAS—Orr (W6SAI). Theory, design, construction, and operation of cubical quads. Build-it yourself info. Feed systems, tuning. **$2.85**

28—TELEVISION INTERFERENCE—Rand (W1DBM). This is the authoritative book on the subject of getting TVI out of your rigs and the neighbors sets. **$1.75**

32—RCA RADIOTRON DESIGNERS HANDBOOK—1500 pages of design notes on every possible type of circuit. Fabulous. Every design engineer needs this one. **$7.50**

36—CALL LETTER LICENSE PLATE—Regulation size license plate. Please give your call and the color of letters and background. **$3.00**

37—101 WAYS TO USE YOUR HAM TEST EQUIPMENT—Middleton. Grid-dip meters, antenna impedance meters, oscilloscopes, bridges, simple noise generators, and reflected power meters are covered. Tells how to chase trouble out of ham gear. 168 pages. **$2.50**

49—ELECTRONIC COMMUNICATION—Shrader. Huge book aimed at giving all information necessary for FCC Commercial and amateur licenses. **$13.00**

52—HOW TO READ SCHEMATIC DIAGRAMS—Marks. Components & Diagrams; electrical, electronic, ac, dc, audio, rf, TV. Starts with individual circuits and carriers through complete equipments. **$3.50**

55—TRANSISTOR CIRCUIT HANDBOOK—Simple, easy to understand explanation of transistor circuits. Dozens of interesting applications. **$4.95**

63—GE TRANSISTOR MANUAL—6th edition. This is one of the best buys around: 22 chapters, 440 pages, diagrams by the gross, data, facts, charts, etc. If you don't have this one you just aren't up to date. only **$2.00**

67—TRANSISTOR CIRCUIT ANALYSIS AND DESIGN by Fitchen. Written primarily as a college text to teach circuit design. **$13.00**

68—HANDBOOK OF TRANSISTOR CIRCUIT DESIGN BY PULLEN—This is a handbook which teaches a systematic system for transistor circuit design. Highly recommended by radio schools. **$13.00**

> SPECIAL SPECIAL SPECIAL
>
> **Radio Handbook, 15th Edition,** written by Bill Orr W6SAI, over 800 pages. Covers every phase of amateur radio from the very basics right up through the construction of just about everything you could want in ham gear. Originally published at $8.50. Superceded by the new 16th edition which is the same except for new construction projects and selling for $9.50 (see number 11). Special, until the last few copies are gone, only **$5.95!**

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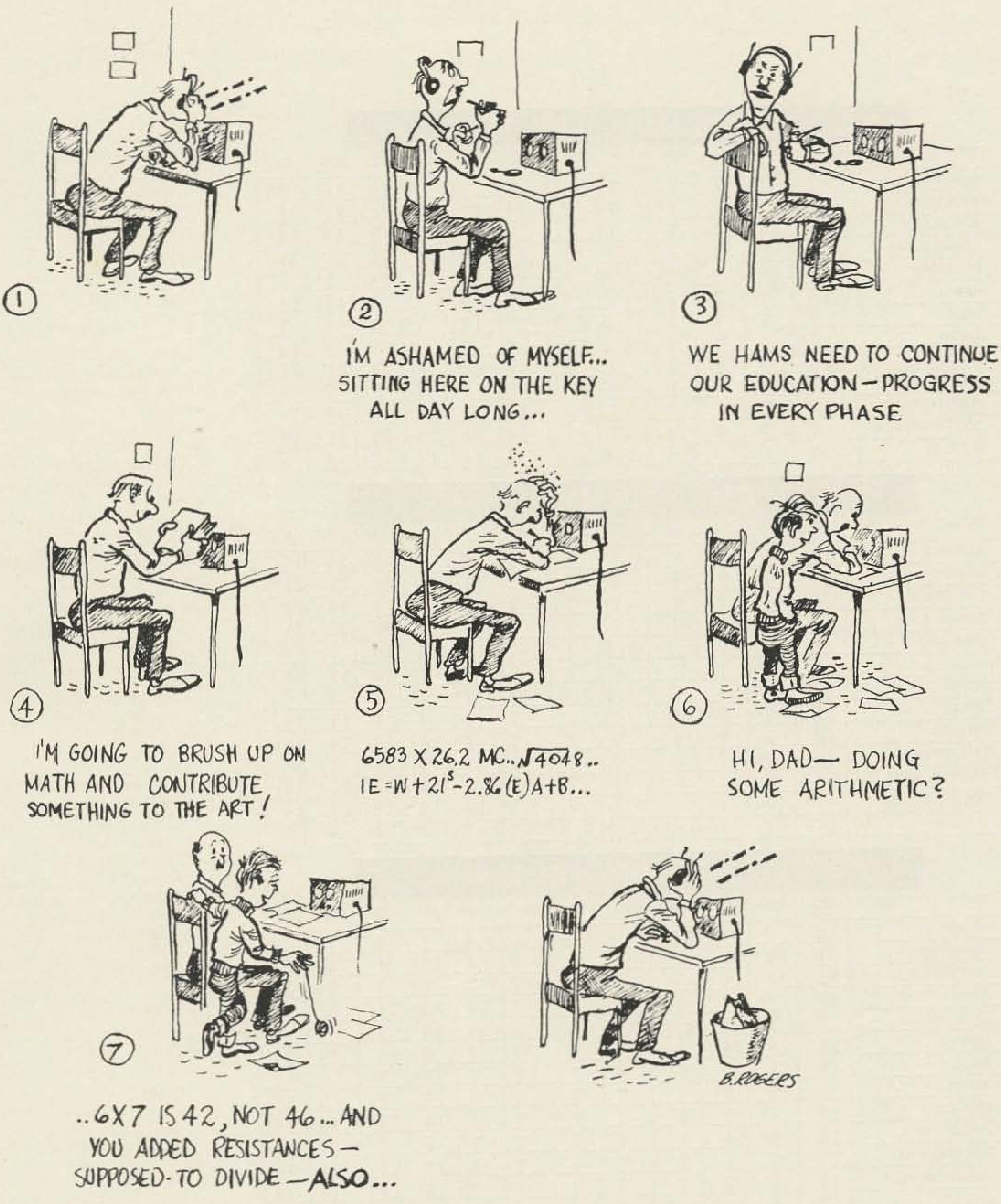
1
2
I'M ASHAMED OF MYSELF...
SITTING HERE ON THE KEY
ALL DAY LONG...
3
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4
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SOMETHING TO THE ART!
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6583 X 26.2 MC.. √4048..
IE=W+21³-2.86(E)A+B...
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7
..6X7 IS 42, NOT 46... AND
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SUPPOSED-TO DIVIDE—ALSO...
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GMT-	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	7	7	7	7	7	3.5	7	7	7*	14	14	7*
ARGENTINA	14	7	7	7	7	7	14	21	21	21	21*	21
AUSTRALIA	14	7*	7	7	7	7	7	14	7*	7	14	14*
CANAL ZONE	14	7	7	7	7	7	14	14	21	21	21	21
ENGLAND	7	7	7	3.5	3.5	7	14	14	14	14	7*	7
HAWAII	14	7	7	7	7	7	7	7	7*	14	14*	14
INDIA	7	7	7	7	3.5	3.5	7*	14	7*	7	7	7
JAPAN	7*	7	7	7	3.5	3.5	7	7	7	7	7	14
MEXICO	14	7	7	7	7	7	7	14	14	21	21	21
PHILIPPINES	7*	7	7	7	7	3.5	7	7	7	7	7	7
PUERTO RICO	7	7	7	7	7	7	14	14	14*	14	14	14
SOUTH AFRICA	7	7	7	7	7	7	14	21	21	21	21	14
U.S.S.R.	7	7	7	3.5	3.5	3.5	7*	14	14	7	7	7

CENTRAL UNITED STATES TO:

GMT-	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	7	7	7	7	7	7	7*	14	14
ARGENTINA	14	7	7	7	7	7	7	14	21	21	21	21*
AUSTRALIA	21	14	7	7	7	7	7	7	7*	7	14	21
CANAL ZONE	14	7	7	7	7	7	7	14	21	21	21	21
ENGLAND	7	7	7	3.5	3.5	7	7	14	14	14	7	7
HAWAII	14	14	7	7	7	7	7	7	7*	14	14	21
INDIA	7	7	7	7	3.5	3.5	7	7*	7*	7	7	7
JAPAN	14	7*	7	7	7	7	7	7	7	7	7	14
MEXICO	14	7	7	7	7	7	7	7*	14	14	14	14
PHILIPPINES	14	7*	7	7	7	7	7	7	7	7	7	14
PUERTO RICO	14	7	7	7	7	7	14	14	14	21	21	14
SOUTH AFRICA	7*	7	7	7	7	7	7*	14	14	14	14	14
U.S.S.R.	7	7	7	3.5	3.5	3.5	7	7*	7*	7	7	7

WESTERN UNITED STATES TO:

GMT-	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	3.5	3.5	3.5	3.5	3.5	7	7	14	14
ARGENTINA	21	14	7	7	7	7	7	14	14*	21	21	21*
AUSTRALIA	21*	21	14	7	7	7	7	7	7*	7	14	21
CANAL ZONE	14	7*	7	7	7	7	7	14	14*	21	21	21
ENGLAND	7	7	7	3.5	3.5	3.5	7	7	14	7*	7	7
HAWAII	21	14	14	7	7	7	7	7	7	14	14*	21
INDIA	7	14	7	7	7	7	7	7	7*	7	7	7
JAPAN	14	14	7*	7	7	7	7	7	7	7	7	14
MEXICO	14	7*	7	7	7	7	7	7	14	14	14*	14*
PHILIPPINES	14	14	14	7	7	7	7	7	7	7	7	14
PUERTO RICO	14	7	7	7	7	7	7	14	14	21	21	14
SOUTH AFRICA	14	7	7	7	7	7	7	7*	14	14*	14	14
U.S.S.R.	7	7	7	3.5	7	3.5	7	7	7*	7	7	7

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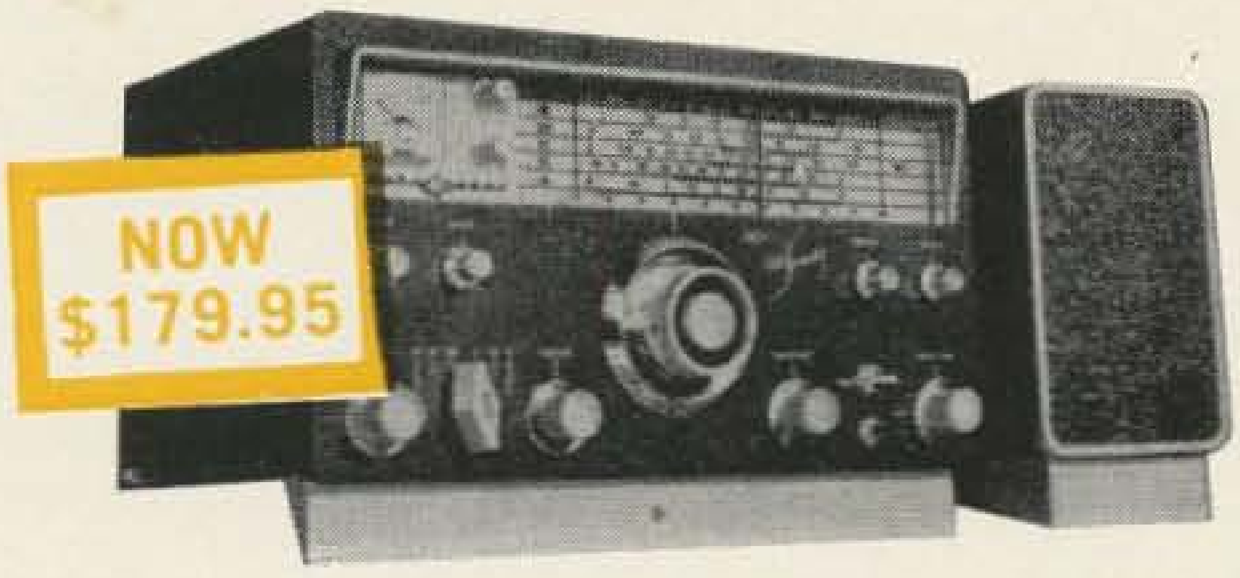

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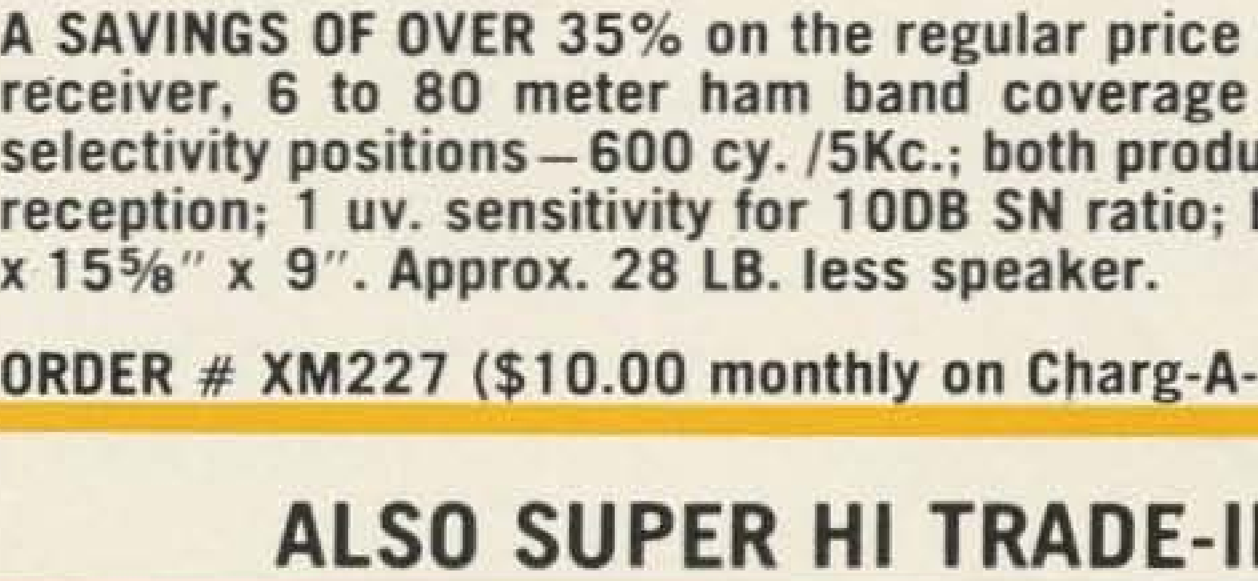

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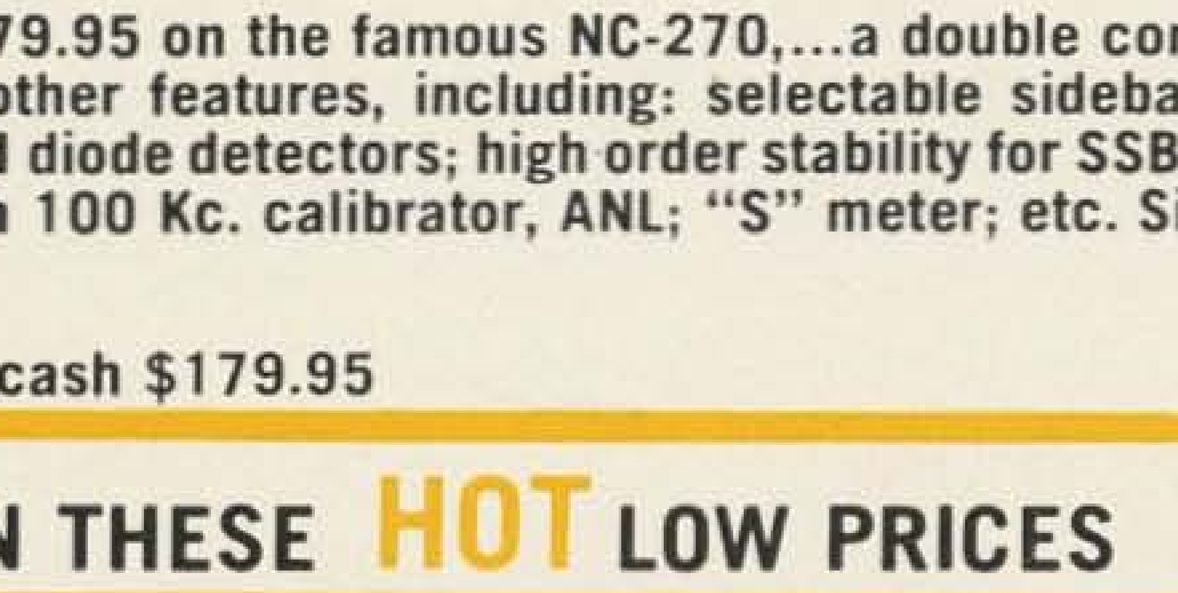

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