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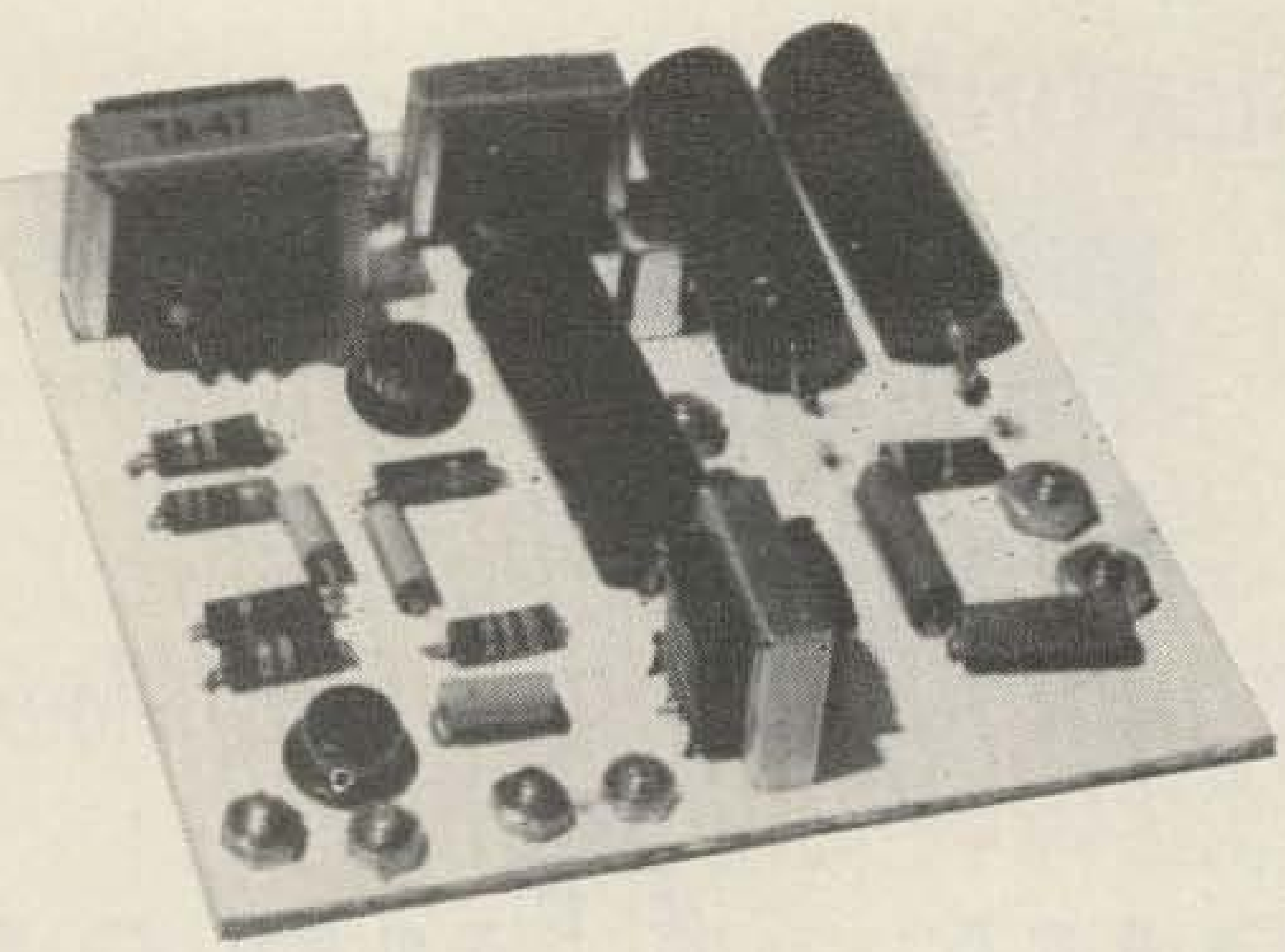
The Audio Booster



Jim Kyle, K5JKX/6
11953 Cameo Place
Granada Hills, Calif

How would you like to have 100 percent modulation at all times, instead of just on peaks?

Here's a gadget that hangs between your mike plug and the transmitter input that can do just that for you[1]. It's based on an unusual telephone-repeater circuit developed for use on a 26-mile intercom line. Addition of a gain-controlling channel produced The Audio Booster.

The original circuit was unique in that it amplified signals passing in either direction over the line, and had only one set of terminals which doubled as input and output. This feature has been retained, in case your rig puts an audio signal back into the microphone.

The quickest way to analyze circuit operation is to take a look at the block diagram, Fig. 1, and the input-bridge simplified schematic, Fig. 2, while reading the following paragraphs.

[1]You don't really want to adjust it that way, though. It would wipe out all amplitude variation, leaving only the frequency components to carry your voice, and the result is completely unintelligible!

Looking at Fig. 1, you'll see that a signal coming from the microphone passes through the input-bridge to the input sides of both amplifiers. Amplifier No. 1 boosts the signal some 40 db, then rectifies it to produce a positive control voltage. This control voltage is applied to Amplifier No. 2 to adjust its gain. With a strong signal, representing an audio peak, the gain of Amplifier No. 2 can be reduced to zero. With a weak signal, however, Amplifier No. 2 can produce some 50 db gain.

The amplified output from No. 2 is returned to the input-bridge circuit, from which it goes on to the transmitter. You can see that a strong signal, or peak, will not be affected by the presence of the Booster. Weaker signals, or "valleys", though, will receive some 40 db of boost. Since the dynamic range of your microphone's output is probably only about 20 to 25 db, this means that you have the ability to turn speech "inside out" amplitude-wise, if you like. By adjustment of the limiting threshold control in the AGC line, however, you can keep the signal right side up while reducing the dynamic range to only 3 or 4 db if you like.

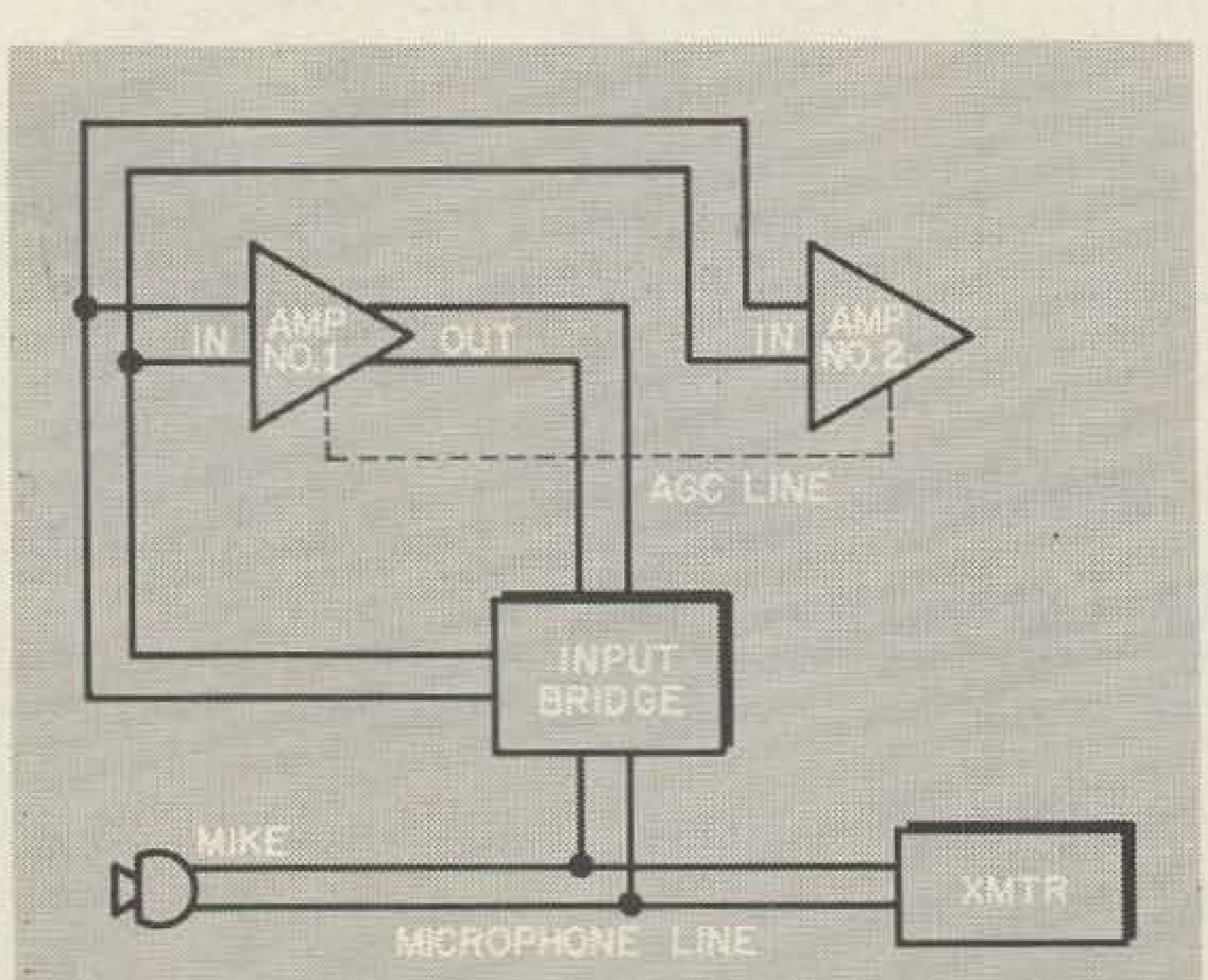


Fig. 1. Block diagram of the Audio Booster and its tie-in to your audio system. Operation is explained in the text.

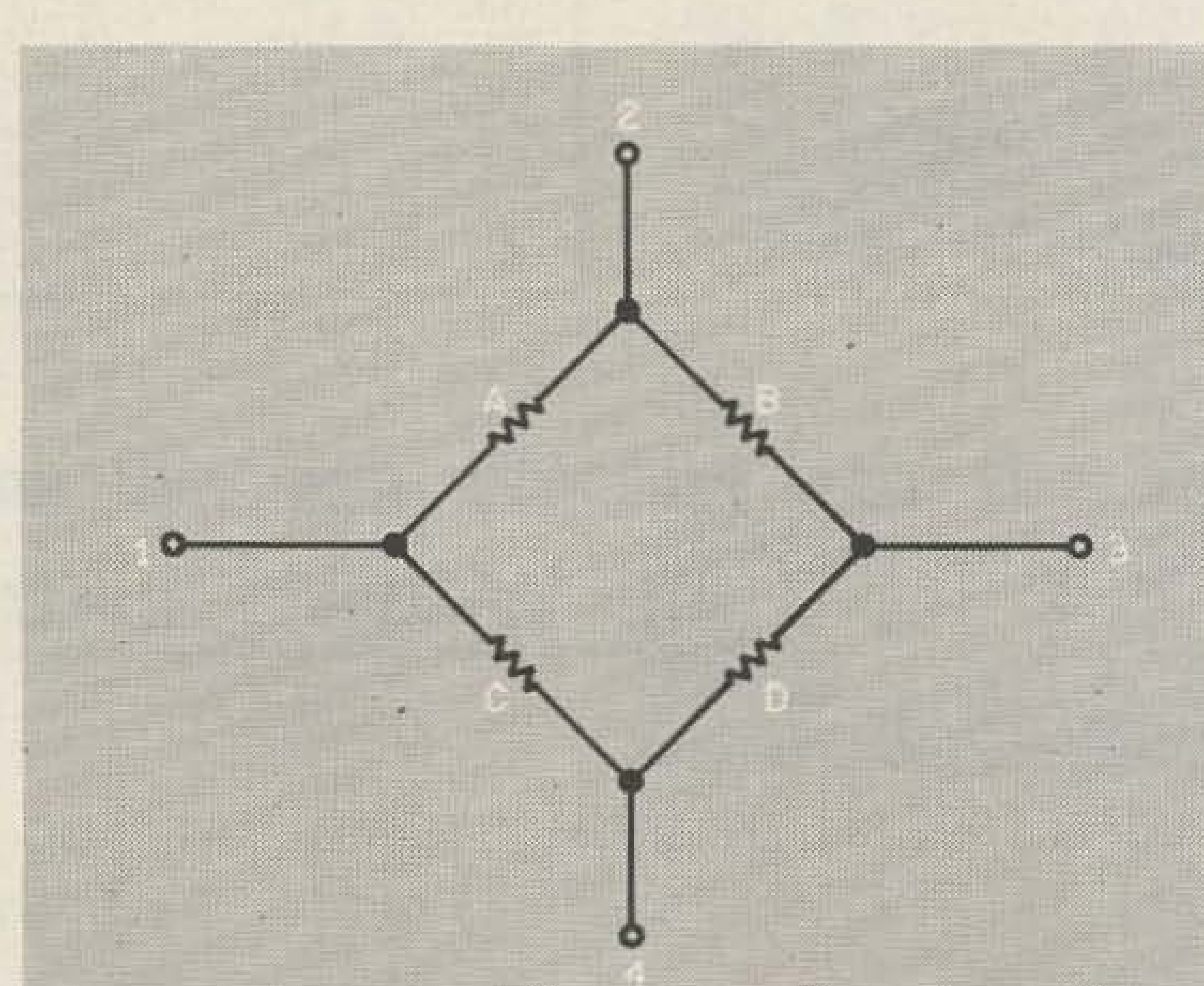
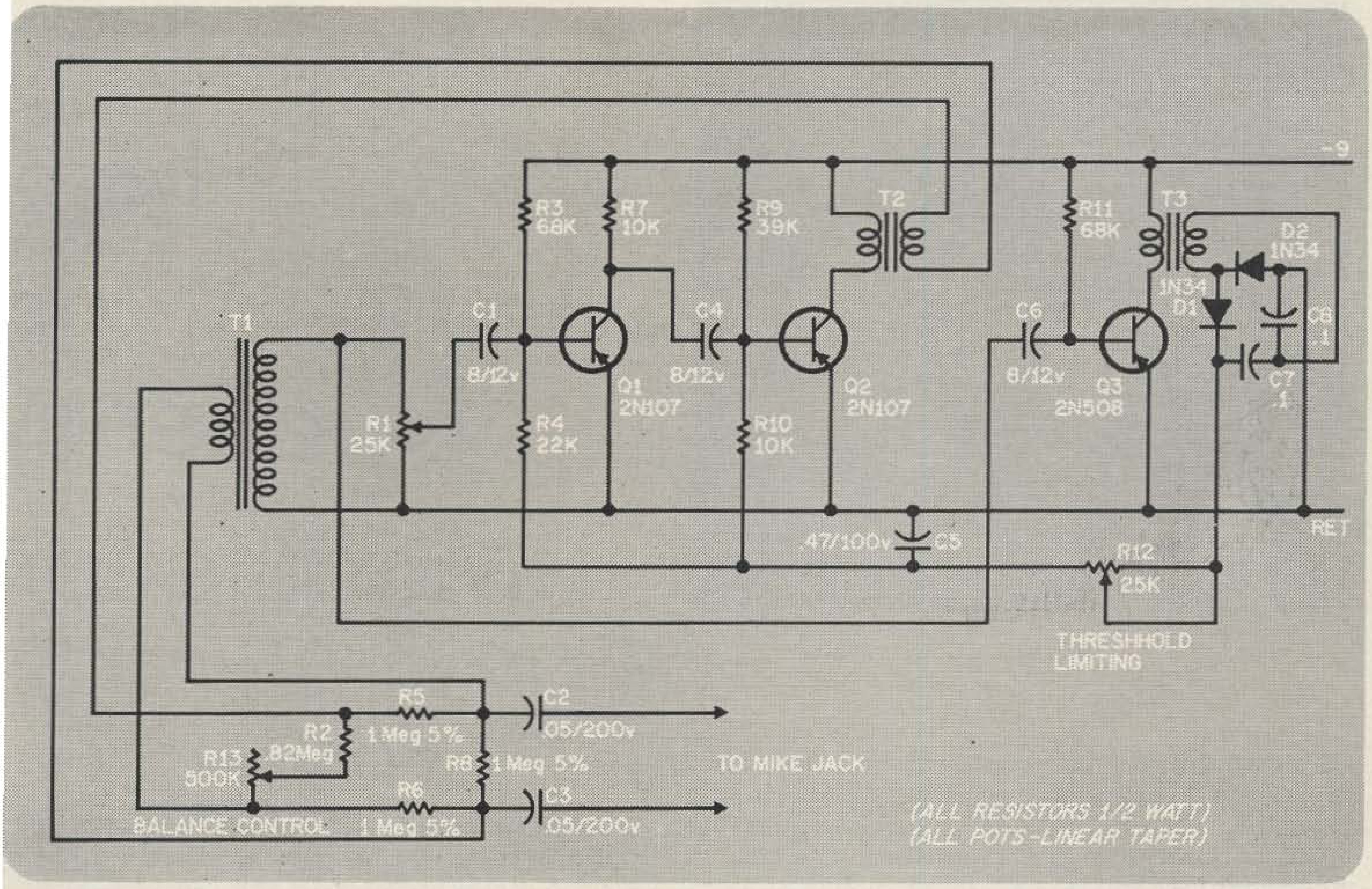


Fig. 2. Input-bridge circuit, simplified schematic diagram. If all resistance are equal, the bridge is balanced.



PARTS LIST

Transformers:

T1— Transistor input transformer, primary impedance .2 meg, secondary impedance 1 K (Stancor TA-47 with primary and secondary connections reversed, or equivalent)

T2— Transistor interstage transformer, primary impedance 10 K, secondary impedance .16 meg (Stancor TA-32 or equivalent)

T3— Transistor interstage transformer, primary impedance 10 K, secondary impedance 200 ohms (Stancor TA-34 or equivalent)

The input-bridge circuit is the feature borrowed from the airfield intercom design. Fig. 2 will probably look familiar to you as a Wheatstone bridge. The bridge, when balanced, produces infinite isolation between terminals 1 and 3 and terminals 2 and 4, and vice versa. However, if a signal is coupled across arm A only, it will show up at both sets of terminals. Conversely, a signal fed in at either pair of terminals will show up in arm A.

Therefore, arm A can be connected across an audio line, and any signal appearing on the line will show up at all four terminals of the bridge. Let's hook 1 and 3 up to the input of an amplifier, and 2 and 4 to the output[2]. Now, any signal coming in on the line will go to the amplifier input. After it has been amplified, it will come back in to the opposite and isolated bridge terminals, and be returned to the line from whence it came. Still, input and output of the amplifier are isolated and oscillation will not develop.

Theoretically, there's no limit to the amplification you can obtain with one of these. In practice, about 40 db. is the limit, since that's approaching the limit of isolation in a practical bridge circuit. If the line is non-reactive, and if you provide a fine balance adjustment (R13 in Fig. 3) and take care in construction to minimize stray coupling, a few more decibels may be squeezed out.

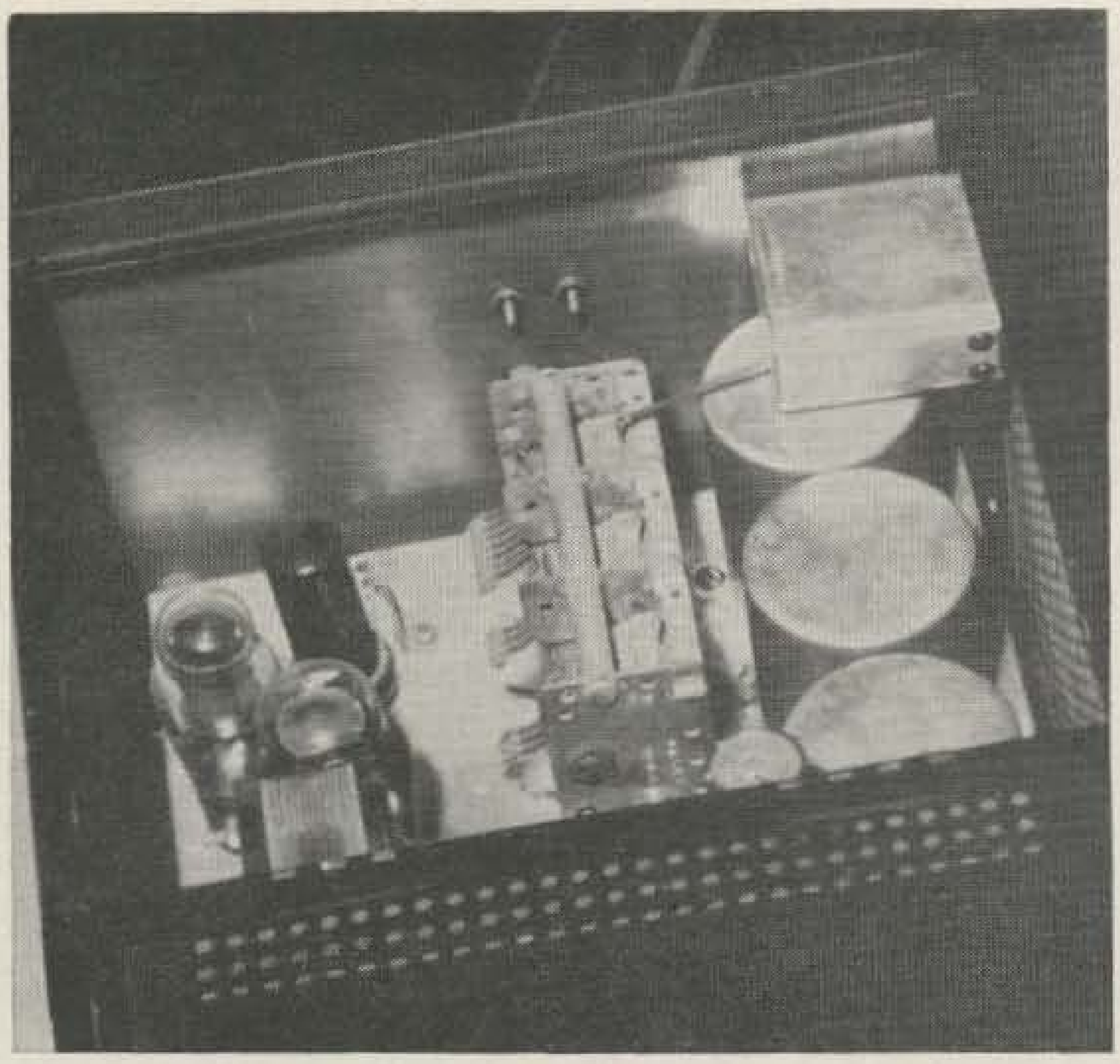
The only thing to watch out for in construction of the Booster is stray coupling around the bridge. This may limit your usable gain and consequently the compression ratio of the gadget. Otherwise, construction is according to usual transistor practices. An LMB No. 143 box chassis provides plenty of room for components. Locking-type potentiometers are recommended, but they're expensive. H. H. Smith lock nuts for standard volume controls work just as well.

To put the booster in operation, first hook it across the input of an amplifier connected to a speaker. R1, the floor level control, should be at minimum setting and the AGC line should be temporarily grounded to remove all control voltage from the boosting amplifier (connect a jumper from the base end of R12 to the return line).

Slowly advance R1 toward maximum. At some point, unless you're lucky and have per-

(Continued on page 46)

[2]Notice that both input and output of the amplifier must be isolated from ground. This means that transformer coupling is a must when using this circuit.



Something New in Frequency Modulation

R. E. Baird, W7CSD
Oregon Technical Institute

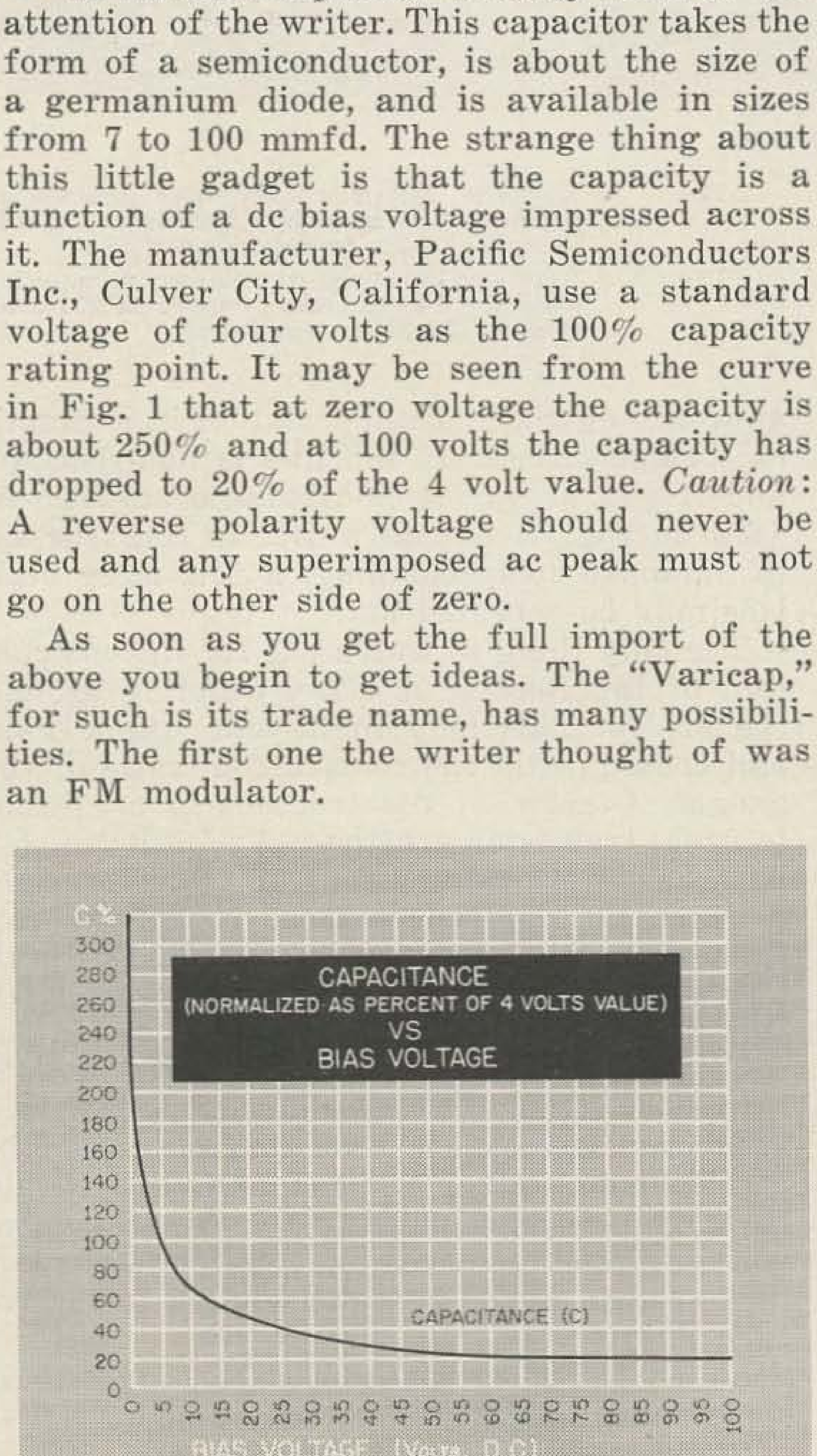
The production of a new and strange kind of variable capacitor recently came to the attention of the writer. This capacitor takes the form of a semiconductor, is about the size of a germanium diode, and is available in sizes from 7 to 100 mmfd. The strange thing about this little gadget is that the capacity is a function of a dc bias voltage impressed across it. The manufacturer, Pacific Semiconductors Inc., Culver City, California, use a standard voltage of four volts as the 100% capacity rating point. It may be seen from the curve in Fig. 1 that at zero voltage the capacity is about 250% and at 100 volts the capacity has dropped to 20% of the 4 volt value. *Caution*: A reverse polarity voltage should never be used and any superimposed ac peak must not go on the other side of zero.

As soon as you get the full import of the above you begin to get ideas. The "Varicap," for such is its trade name, has many possibilities. The first one the writer thought of was an FM modulator.

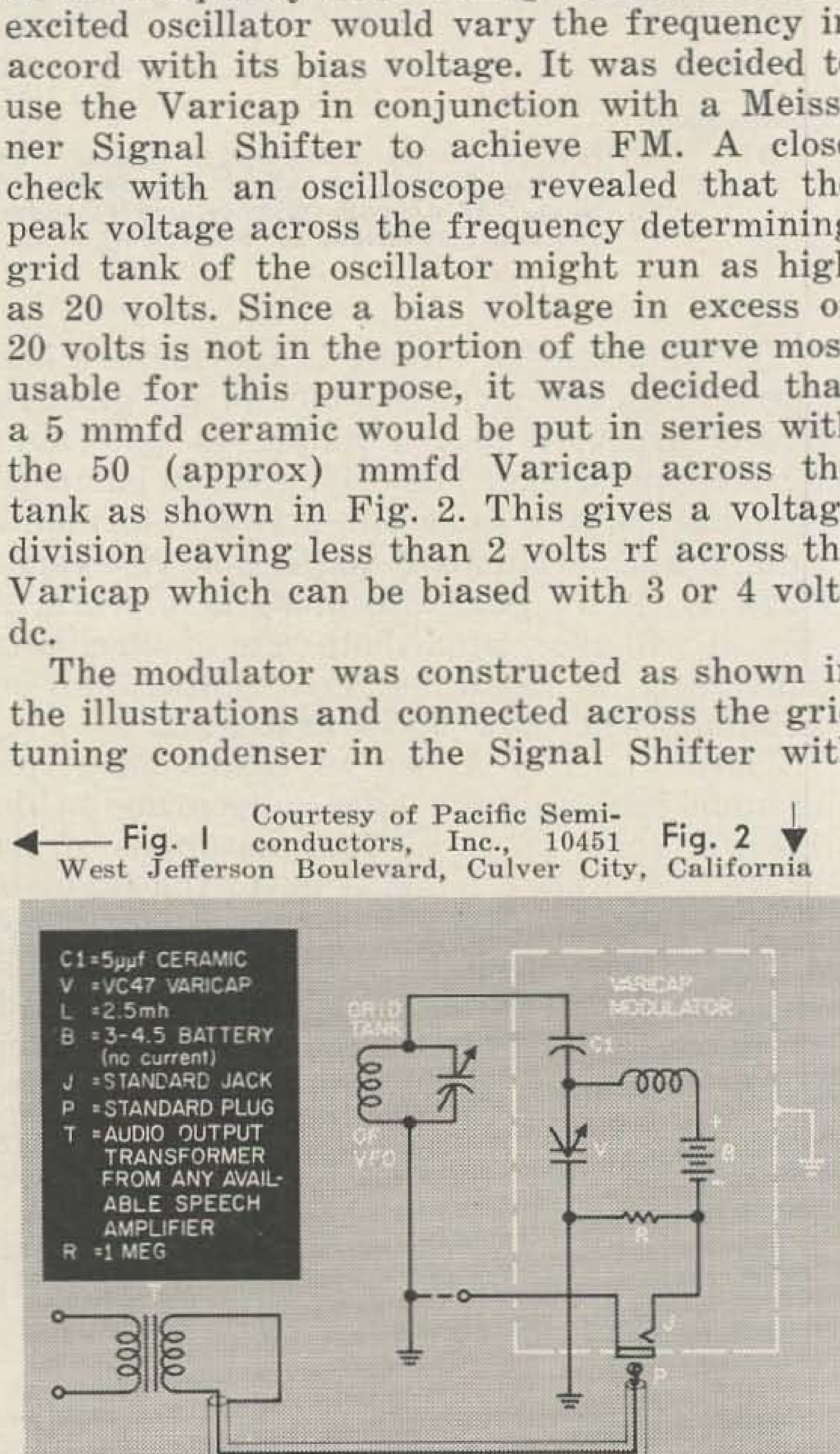
The Modulator

It is fairly obvious that the Varicap as par of the frequency determining circuit in a sel excited oscillator would vary the frequency ir accord with its bias voltage. It was decided t use the Varicap in conjunction with a Meissner Signal Shifter to achieve FM. A close check with an oscilloscope revealed that th peak voltage across the frequency determining grid tank of the oscillator might run as high as 20 volts. Since a bias voltage in excess o 20 volts is not in the portion of the curve mos usable for this purpose, it was decided tha a 5 mmfd ceramic would be put in series wit the 50 (approx) mmfd Varicap across th tank as shown in Fig. 2. This gives a voltag division leaving less than 2 volts rf across th Varicap which can be biased with 3 or 4 volt dc.

The modulator was constructed as shown in the illustrations and connected across the gri tuning condenser in the Signal Shifter wit



← Fig. 1 — Courtesy of Pacific Semiconductors, Inc., 10451 West Jefferson Boulevard, Culver City, California — Fig. 2 ↓



audio input jack in the side of the cabinet. Tests indicated rather high quality speech, even using slope detection. In the shifter shown the oscillator frequency is 10.5 mc and output is on 21 mc. This in turn feeds a 400 watt power amplifier.

Side bands

For amateur use NFM has been defined as FM which takes up the same band width as conventional AM. The Varicap offers an unusual possibility in that the size of one side band may be greatly reduced. If the Varicap is biased at the knee of the curve, approximately four volts, a reduction of 2 volts will raise the capacity 50% while an increase of 2 volts will decrease the capacity only about 10%. With an ac signal it will be seen that the lower side band will be much wider than the upper side band; in fact, the upper side band almost disappears. You might say we have single side band FM, with carrier. If the bias is reduced to less than 3 volts, side bands approach the same size.

Quantitative Tests

The writer had never used FM in ham radio before, so it seemed that some tests as to its

effectiveness were in order.

Using a dummy antenna and tone modulation the transmitter was adjusted for 100% AM. An HQ-160 located about 100 yards distant was then adjusted so that the audio output indicated by a VTVM was 1 volt, when tuned for maximum signal. Without changing any volume control on the HQ-160, the AM was removed, and FM substituted. Tuned for maximum slope detection the audio measured .9 volts. The side band was observed to be 3 kc wide. This is certainly a pretty good argument for FM. For the CW man wanting to go on phone the economy would be hard to beat.

It just so happened that the power amplifier used was a pair of suppressor grid modulated 4E27A tubes. As such, in order to get 100% AM it is necessary to run at a high negative voltage on the suppressors and very inefficient carrier conditions. A second test was run with the suppressor grids grounded. This of course doubled the input and the efficiency giving about four times as much carrier power (with the tubes running cooler). The measured audio voltage at the output of the HQ-160 was exactly 2 volts. So it would seem that the FM has an efficiency modulated AM system beat by a ratio of 2 to 1. This assumes, of course, that the power supply can deliver the extra power. If such is the case the amplifier will put out twice as much talk power on FM as it will on efficiency modulated AM.

On the Air Tests

On the air tests have left nothing but satisfaction. Reports continually are received "I wouldn't have known it was FM if you hadn't told me." Comparison of AM and FM same carrier level have been just about a dead heat and with the power upped, as indicated above, the FM is way ahead.

One very peculiar report which has left the writer puzzled is that many hams who have received other FM signals say that FM by this method is much cleaner and easier to copy.

You would think that FM is FM no matter how you get it, but such seems not to be the case. Possibly the curve presented by the rate of change of capacity better complements the selectivity curve of most receivers than does reactance tube modulation or some other method. Discriminator detection has been reported as excellent.

The Varicap makes a first class FM modulator embodying simplicity itself. The reader might be interested to know that a high impedance mike driving a single transistor will operate the Varicap modulator. A kilowatt transmitter with one transistor as the only stage of audio is a little unusual to say the least. We will perhaps see many other uses for the Varicap in the future. 73

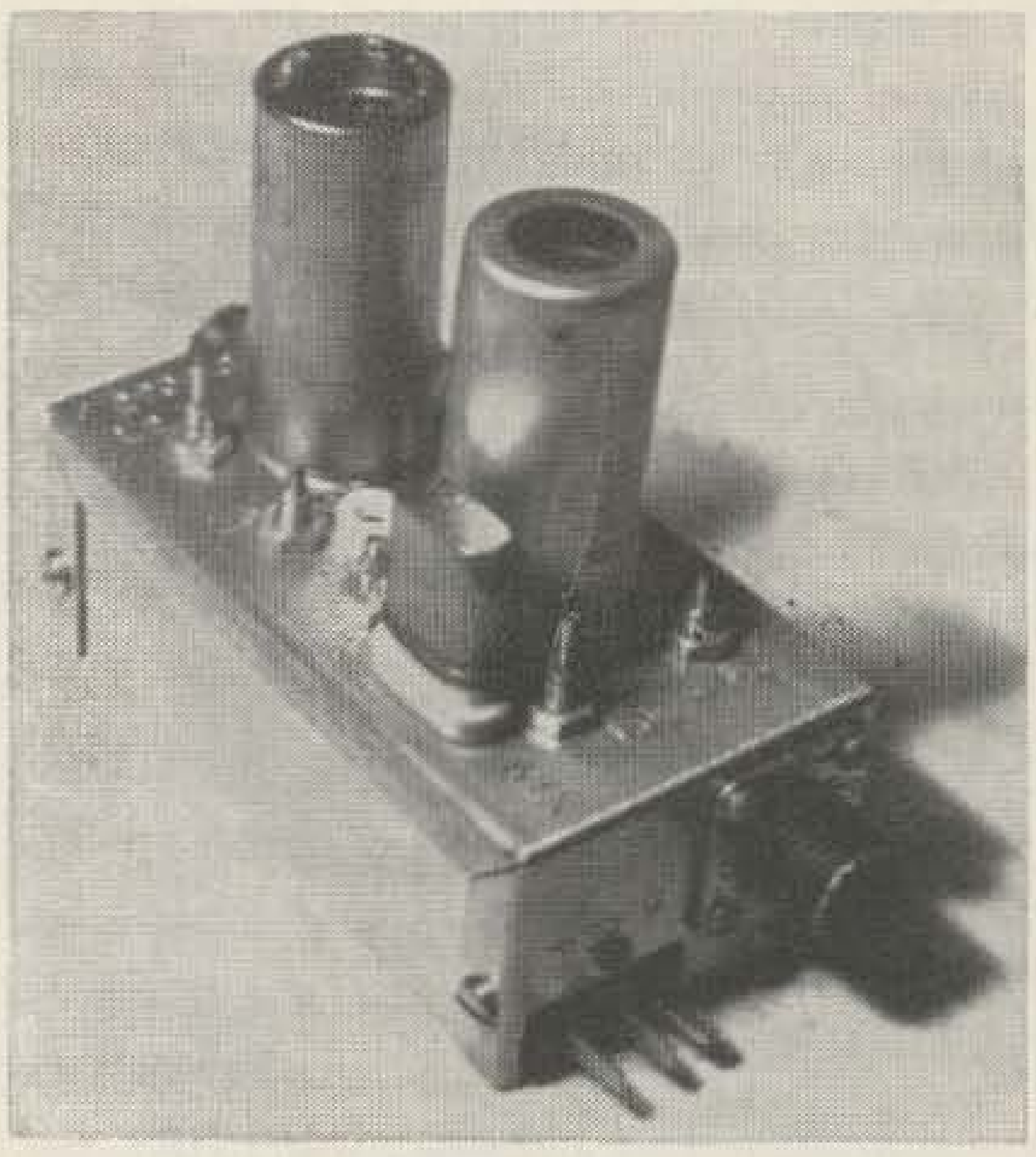
IN the past few years, since the VHF operations took deep roots, many manufacturers, together with some of the braver amateurs embarked on a rather new idea of building and marketing converters for most frequencies in the amateur spectrum. Each one claimed better performance, more gadgets and a lower price. Some of the manufacturers incorporated expensive tubes, others used common tubes with tricky dolled up circuits claiming ridiculously low noise figure that could only be achieved by parametric amplifiers or tunnel diodes.

The consensus of opinion among many brethen is that the more tubes and gadgets that are splattered in the circuit, the better the performance. Nothing is farther from the truth in the majority of cases. Of course there are circuits with desirable gadgets that can be found in many good converters whose specs can be checked and found as advertised. But there are many on the market that do not meet the advertised claims although they possess the same number of components or perhaps even more gadgets. Now, how is one to know without first buying and suffering with the unit until something better, or at least different, comes along for another bitter experience? That type of operation is not too bad for those that can easily afford it, but how about the ham with a limited budget and a burning desire to own something good the first time?

This article was written especially for those who want the most for their dollar and personal satisfaction in constructing a fine unit capable of maximum performance with the minimum of components. The simple bantam converters herewith described, we sparked about two years ago while exploring the possibilities of using a common drug-store variety of tubes to do a man size job in the VHF region. Making a page by page search in the tube manuals for data and curves on various inexpensive tubes, the 6U8 offered favorable answers and was given the acid test by building a 144 mc converter around them. Several circuits and components lay-outs were tried and evaluated in the frequency range of 50 mc to 220 mc and working models built. Upon completion of these models and optimizing of their circuits, reduction of components and miniaturization was undertaken for simplicity, space saving and reduction in cost. As you will notice, there are no superfluous gimmicks, rf chokes or expensive feed-thru capacitors that are almost universally used in commercial gear. These items were completely ignored by proper parts lay-out and point to point wiring that is clean and straight forward.

Bantam Converters

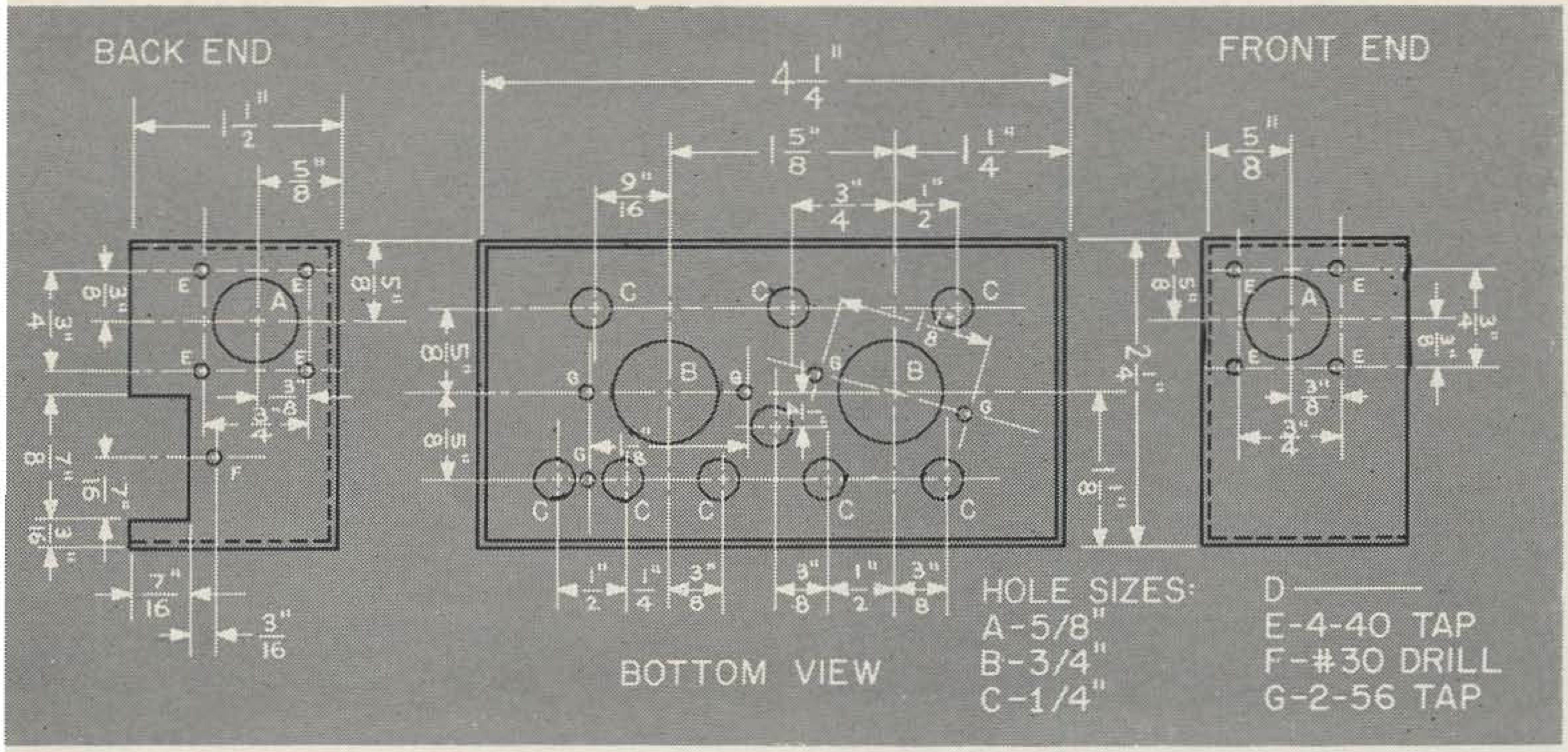
John Wonsowicz, W9DUT
4227 N. Oriole Avenue
Norridge 34, Illinois



Lay-out

The mechanical lay-out of all converters except the 220 mc are identical, and a typical chassis lay-out will serve them all. Coil forms are ⅜" O.D. C.T.C. slug tuned and all bias resistors and isolation resistors are typical. However, the by-pass capacitors and coupling capacitors are chosen for optimum performance at the operating frequencies and these are indicated in the parts list.

In laying out the mini-box chassis care must be exercised not to deviate from dimensions given for they are important in so far as proper coupling between coils and good shielding between input and output circuits is concerned. The mini-box chassis is a Bud product, No. CU-3016 (4¼ x 2¼ x 1½) natural finish aluminum. The shield, as seen in the photo, is 1/32" brass plate shaped and cut



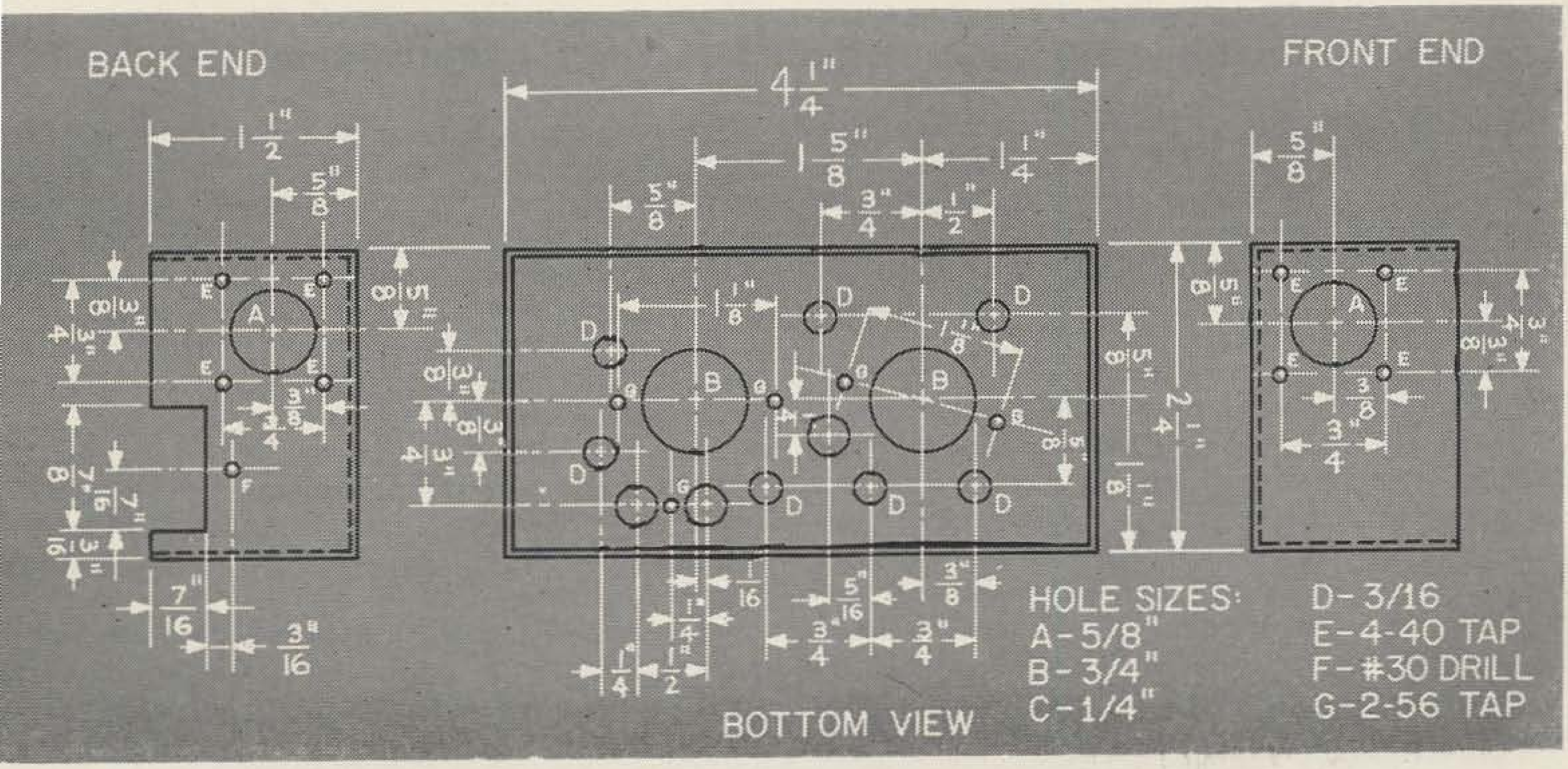
ut for the tube socket and mounted as shown n the drawing. It is held in place by two -56 screws and soldered to the center of the ube socket. This also serves as a low reistance ground plate to which all components eturning to ground are soldered.

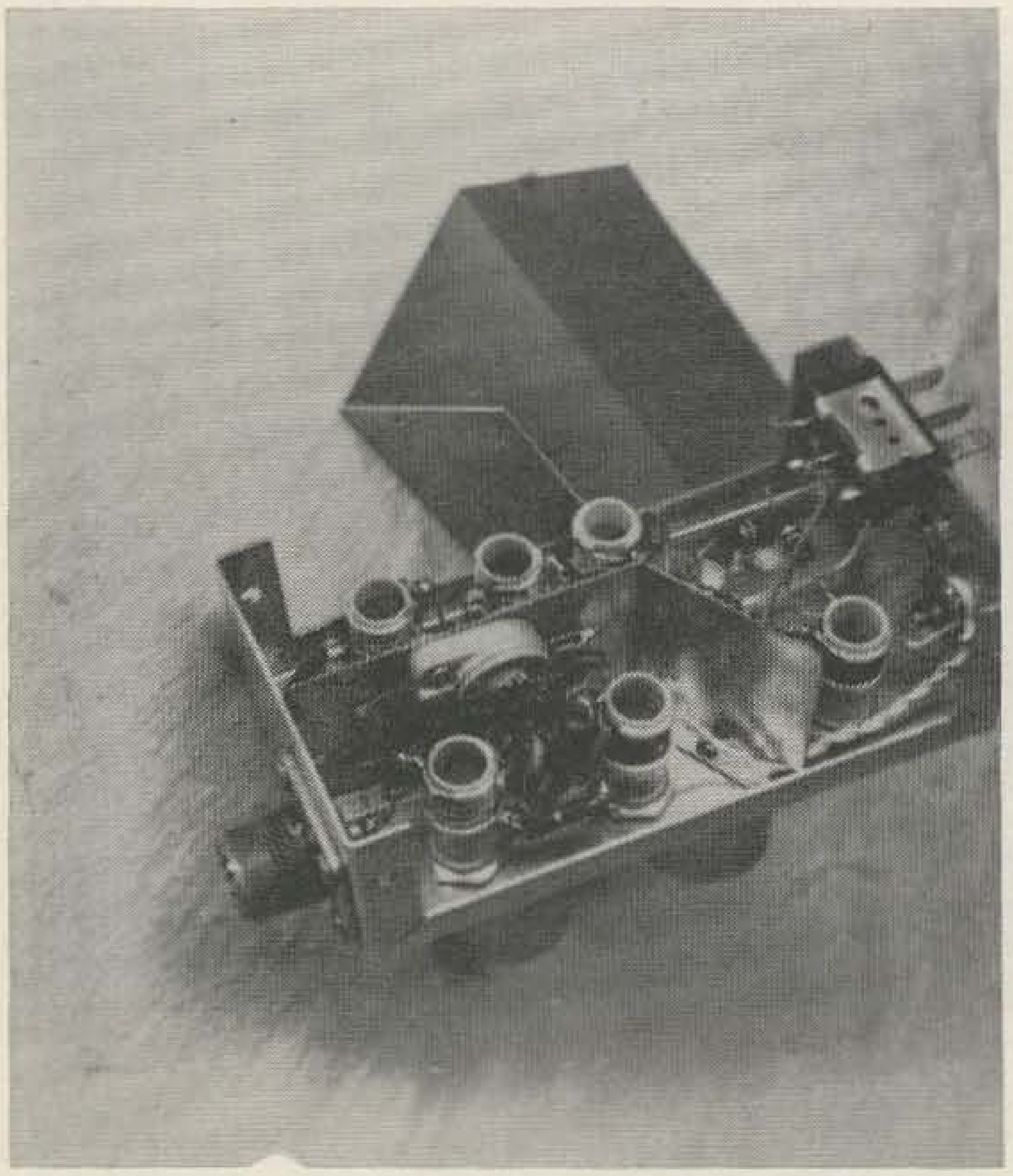
The mechanical difference in the 220 mc onverter is the addition of another 3/16" ole for an extra coil and slight juggling f other parts to fit the same type of chassis. This can be seen in the full size drawings.

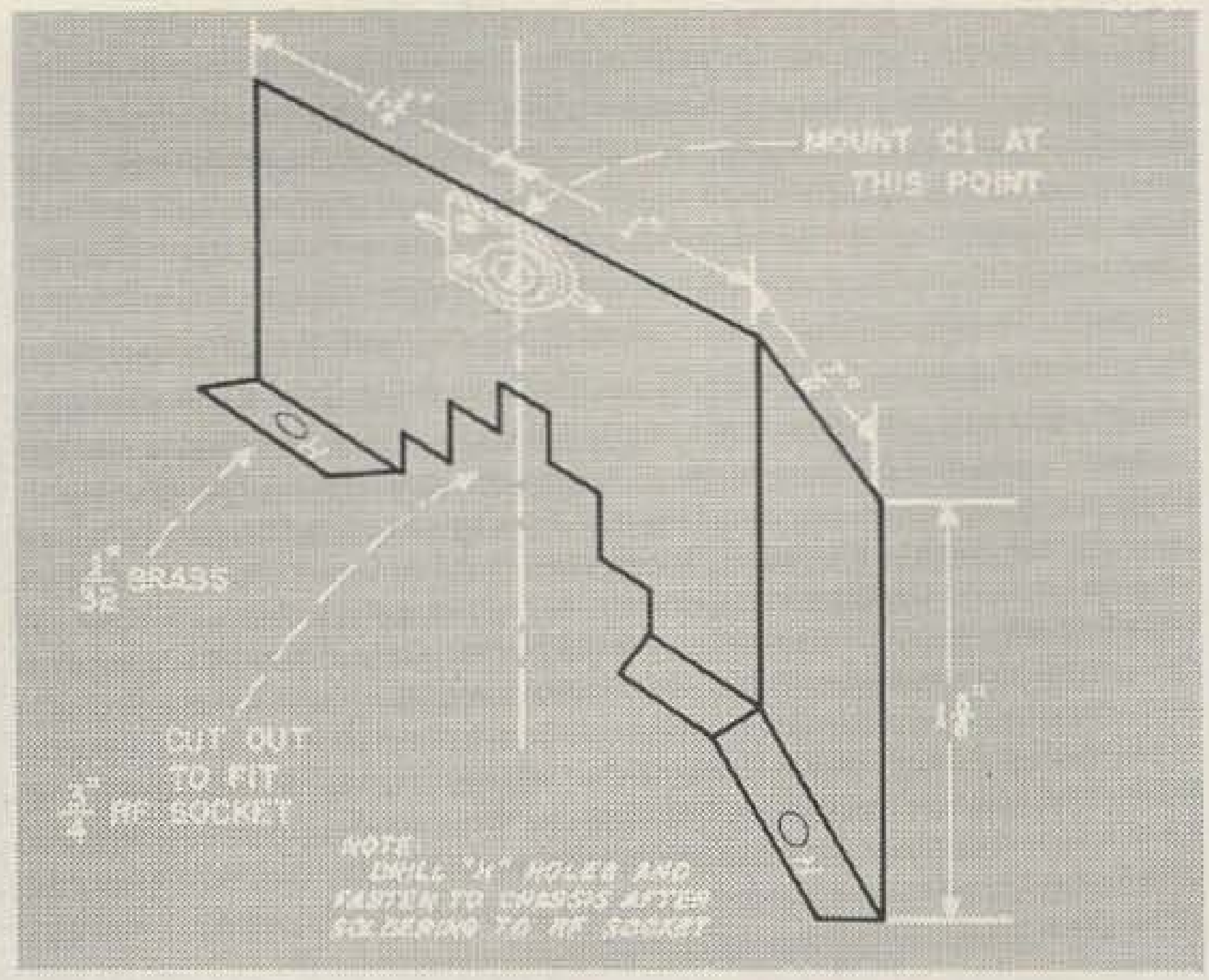
Circuits

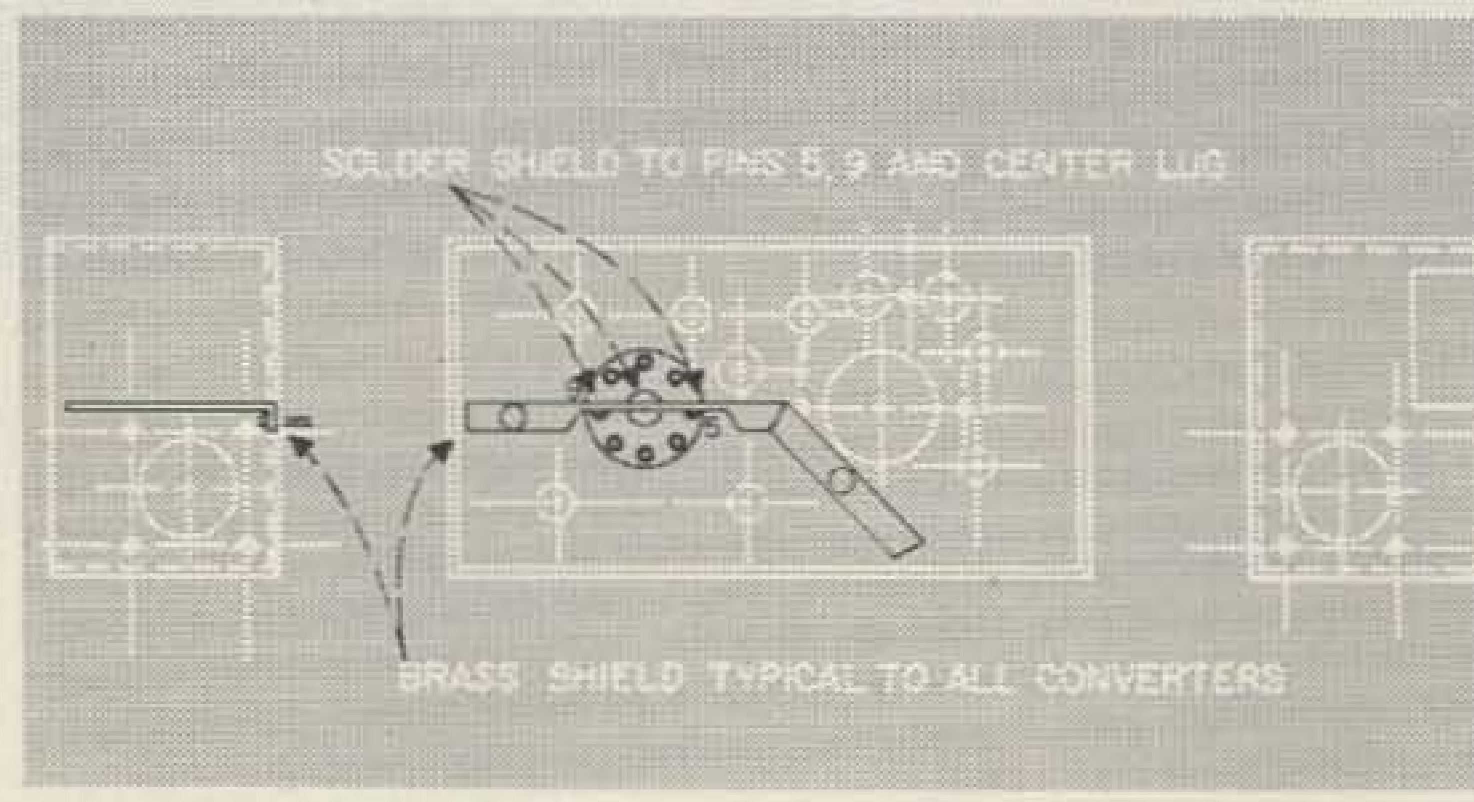
In describing the circuits lets start with he highest frequency converter first, the 220 nc unit. In this converter, as in all others, he first tube, a 6U8, performs two functions. The triode section is used as a low noise grounded grid amplifier and the pentode section is used as a mixer. The signal is fed through the variable capacitor C1 to a tap on the cathode coil L1 which is slug tuned, and the amplified signal at the plate of L2 is inductively coupled by the close proximity of the coils to the grid of the mixer. The grid is coupled to the coil by 13 mmf capacitor and a test point separated by two 470K resistors is provided for measuring oscillator injection, as will be explained in "testing". The plate of the mixer is tuned to 13 mc the if frequency and the output is link coupled for low impedance output to the receiver. Incidentally, this 13 mc if coil is ⅜" od C.T.C., the same size form as in all other converters.

The second 6U8 is a generator that provides









SHIELD DETAILS

three functions in one envelope; oscillator, tripler and doubler. The grid of the pentode section and its screen is used as a third overtone crystal oscillator. The screen is tuned to slightly higher than the crystal frequency of 34.5 mc. The signal appearing at the screen has a harmonic content strong enough so that the plate circuit can pick off the third harmonics and is tuned to 103.5 mc. This output is then capacitively coupled to the grid of the triode section and the plate of this triode is tuned to the second harmonic making it resonant at 207 mc. This signal, beating with the incoming signal of 220 mc produces an if frequency of 13 mc. Since the receiver tunes from 13 to 18 mc a coverage of 220 to 225 mc is achieved.

The 108, 144, and 152 mc converters use ⅜" od coil forms in all circuits and the first 6U8 performs the same function as in the 220 mc unit. However, the second 6U8 differs in that it is used as an oscillator in the triode section and a tripler in the pentode section, as shown in the schematic.

The 50 mc and lower frequency converters differ from the above by isolation of the crystal oscillator only. The triode section is used as the straight through crystal oscillator operating on the crystal fundamental frequency, and the pentode section is tuned to the oscillator frequency and controlled by adjusting the core in the output coil L5 for proper injection voltage to the mixer, by slightly detuning it. For best signal-to-noise ratio and best sensitivity of all these converters it was found that injection voltage of .6 to .8 volts at the test point measured with a Simpson Model 260 Volt-Ohmmeter was optimum. Higher or lower injection brought higher noise or lower sensitivity.

Although the author has built converters below 50 mc, the coil data is not given since most commercial receivers tune up to 30 mc. However, those interested in constructing converters below this range should use a grid dipper for resonating the coils and pick out the size and type of coils as a starter from the coil chart given under the heading of Res. Freq.

Construction

The construction of these converters is quite simple and components are inexpensive. However, proper sequence of parts placement is important for ease of assembly. Bear in mind that all components except the coils are placed and soldered in their respective positions; then make up the coils for the desired band, secure them to the chassis and solder in the necessary parts to the coils.

Step one. After the chassis has been layed out and drilled, fasten in the two sockets orienting them as shown. Next fasten in the brass shield soldering it to the center lug and pins 5 and 9 of the rf socket.

Step two. Fasten the antenna, if output and power connectors into place as shown in the photo and make the necessary connections to them.

Step three. Solder in the resistors and capa-itors.

Step four. Secure and solder in the coils. 'his sequence proved to be best for the many onverters that have been built and eliminated he scorching of components with the soldering ron or leaving cold solder joints in hard to ;et at places.

Tuning

Tuning of all converters is rather typical; nly slight deviations may be necessary on ome frequencies, and these will be apparent o the builder.

Let's start tuning the most popular one, the .44 mc converter. If a grid dipper is handy, he entire unit can be closely tuned and then eaked on the air. However, to optimize the erformance, a noise generator should be ised. Assuming that neither is on hand let's tart by setting the cores in all coils about half vay; next, insert the negative lead of your 'olt-Ohmmeter into the test jack and the posi-ive lead to chassis. Set the Volt-meter to its owest dc range. Connect the antenna to the nput and if output to your receiver tuned to 14 mc. Apply power to the converter; 150 volts B+ and notice if your receiver S-meter kicks up with additional noise. If not, the oscillator is not working and the osc. core should be adjusted to slightly higher frequency. While adjusting this core observe the S-meter for a slight swing or listen to your speaker for an increase in noise, then leave the core set at this position. If the oscillator kicks out a good signal the voltmeter at the test point will also indicate a slight reading. Now, observing the voltmeter, tune the tripler coil L5 for the highest reading. Next, tune in a signal on your receiver and peak the rest of the coils for the loudest signal. After all coils are tuned, return to the tripler coil L5 and adjust the injection voltage for .6 to .8 volts. At this point the signal appears cleanest. During this adjustment it may be necessary to slightly touch up on the mixer grid coil L3. After this is done and the signal is tuned in, try playing with the cathode coil L1 and the series antenna capacitor C1, juggling them for the best signal-to-noise ratio.

In the 220 mc converter the tripler coil L7 should be peaked for the highest indication on the meter and left alone. Then juggle for injection voltage between the doubler coil L5,

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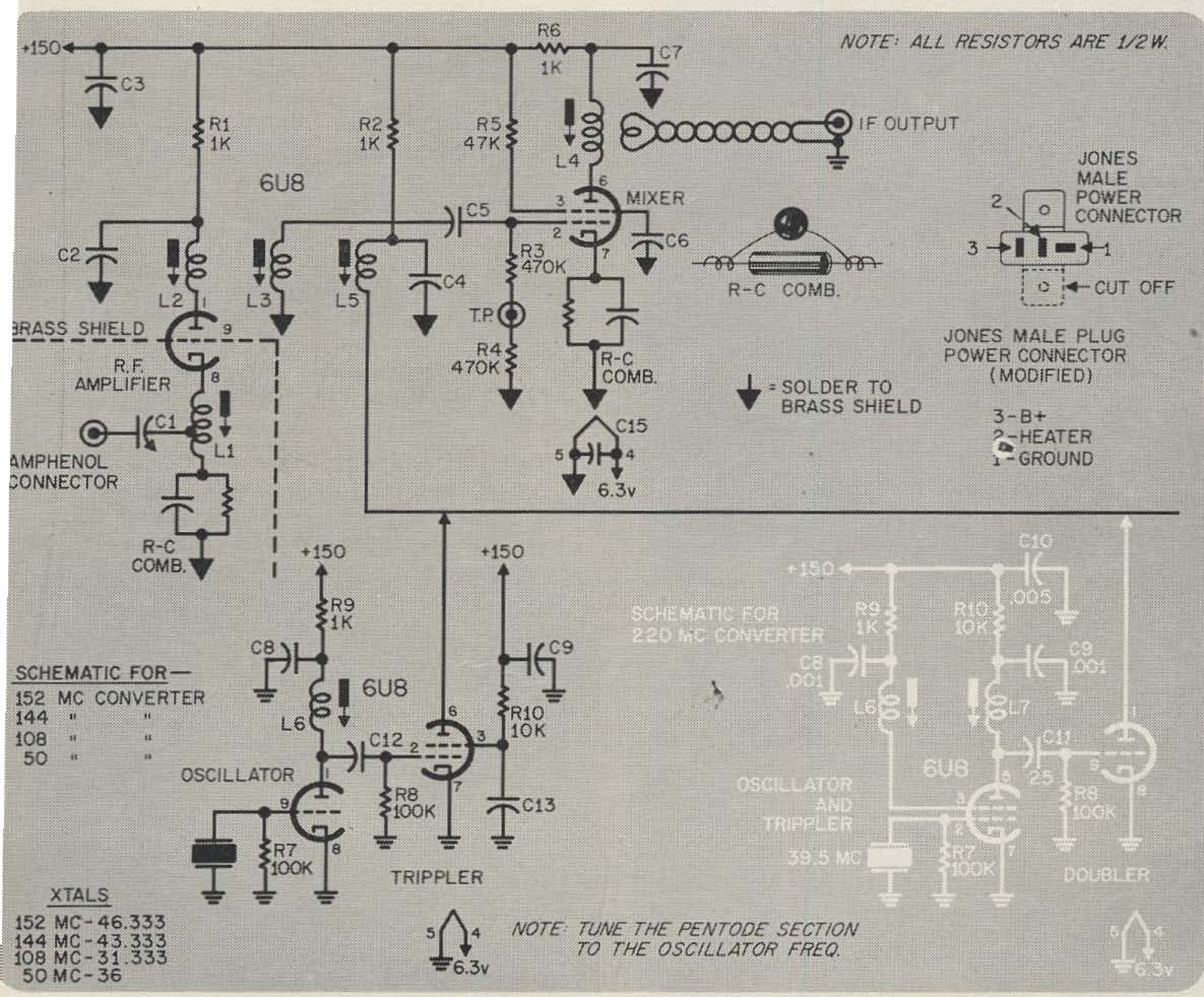


The Risky Hobby of Hamming

SOME folks think that hams are the world's worst athletes, but the truth is that amateur radio has put the daring young man on the flying trapeze in second place. The cause for the confusion may be that magazines usually picture a ham reclining in a plush swivel chair surveying a table full of gear, not giving the slightest hint that there is more to the game than meets the eye. How is the casual reader to know that the limp-looking guy in the photograph spent half the day wrapped around the weaving top of a 100-foot tower juggling a handful of tools and a fifteen pound rotator in a gale wind? As a general rule, it's safe to say that for every set of call letters heard on the bands, somebody huffed and puffed to tie a long wire or install a beam antenna.

"My XYL worries about extra pounds," says one limber fellow, "but all I have to do to stay trim is run up and down my tower a couple times a day."

Hams can still buy life insurance, but there are certainly lots less hazardous hobbies. The wildest game of tiddly-winks results in nothing worse than a sore tiddling finger, but anybody

← Worried about a few extra pounds? K9AMD advocates tower-climbing for loss of weight.

Part I of a 3-part Story:

W9EHH, Mike Hrindak, of Gary, Indiana, is "up a tree." With a beam antenna, lead-in, and tools, he's wondering "What'll I do now?" ↓

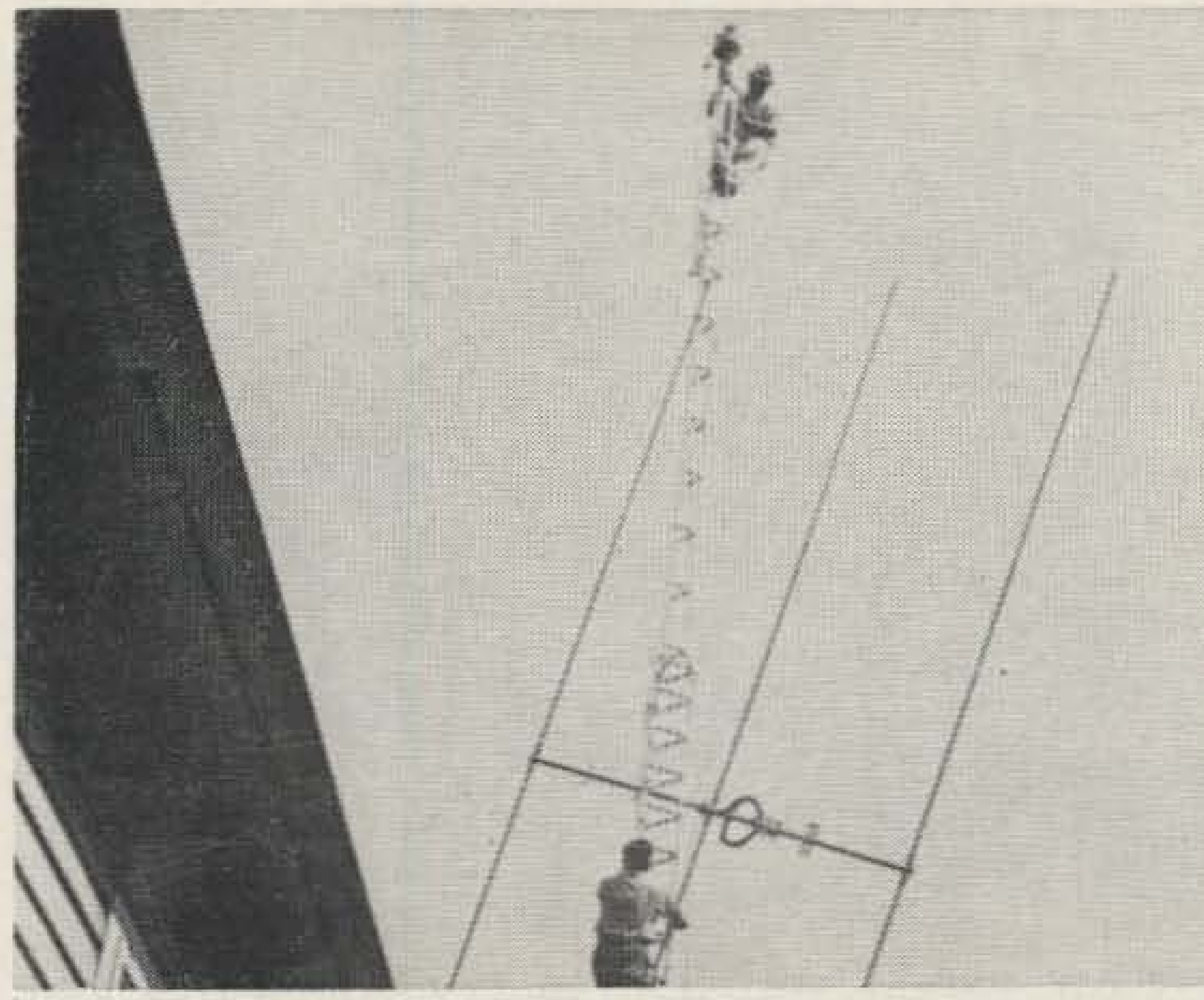
Carole F. Hoover K9AMD
401 East Wood Street
Hillsboro, Illinois

who takes an unchartered flight from a sloping roof or slippery pole may end up in enough plaster casts for an army to autograph.

Most neighbors beat it to the nearest window when "that electronic nut next door" starts scaling his roof or tower. The antics they see for free in his back yard beat television by a mile. A paid human fly won't tote thirty pounds of wobbling metal elements through tree limbs and power lines without a safety net below but a ham will, and gladly. Of course, the same fellow would shudder if offered a "risky" job like painting the house, and his wife has long since given up the perilous thought of getting him to fix the leaky roof.

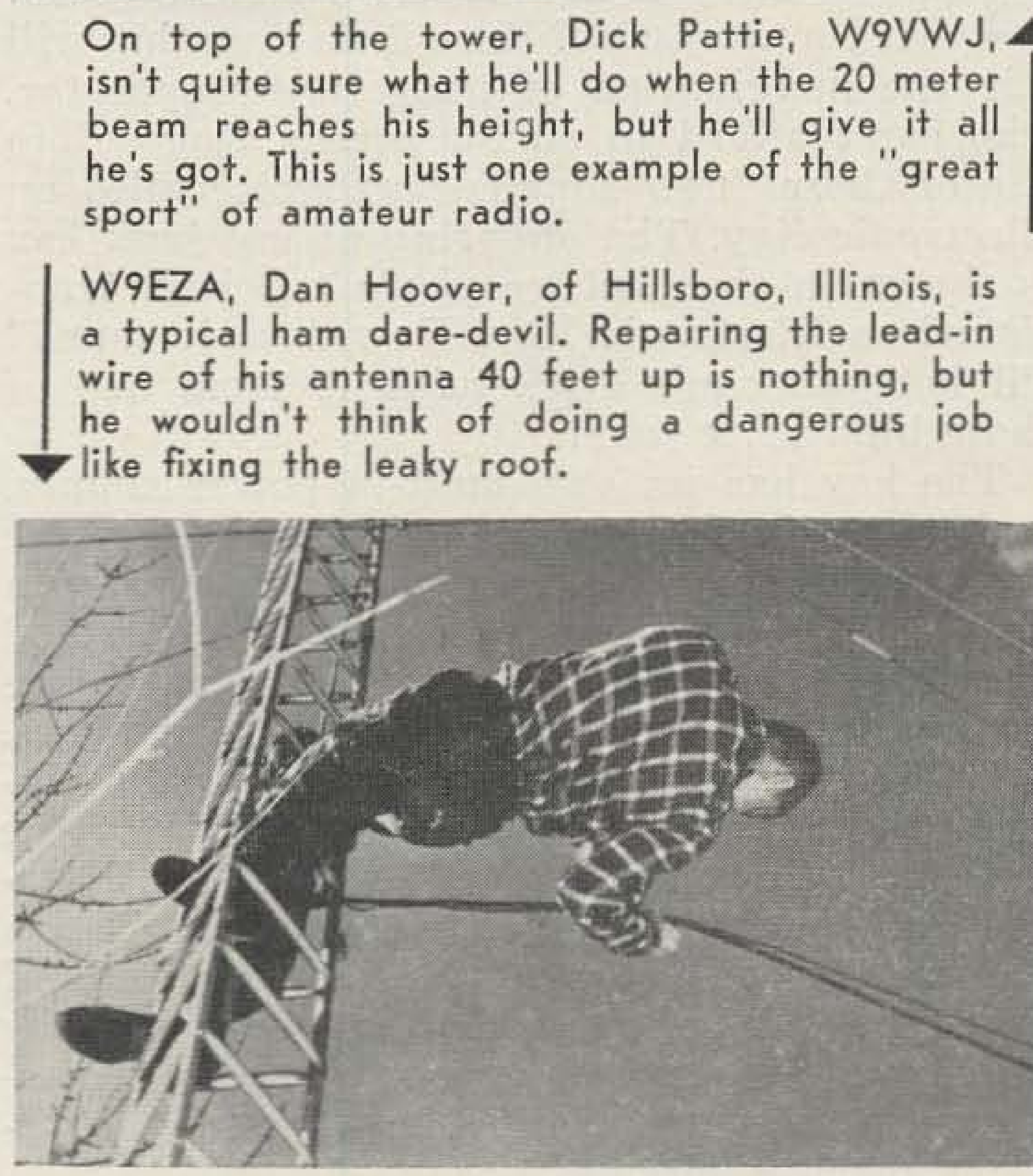
Compared to a red-hot signal report from Formosa or Nepal, the danger of a compound fracture is nothing, so without batting an eye, amateur radio operators scramble over rooftops, scale towers, and shinny up tree trunks to get their antennas in the best possible places. Answering the call of the wild blue yonder, they can be spotted almost anywhere, anytime. In fact, if you see some sky-high object that isn't a bird, plane, or an out-of-orbit astronaunt, it's probably a ham. 73

Part 2—something's caught! Jim, K9RUH, another Gary Ham, goes up to see if he can help get his buddy untangled. (Who says hams don't get exercise?)

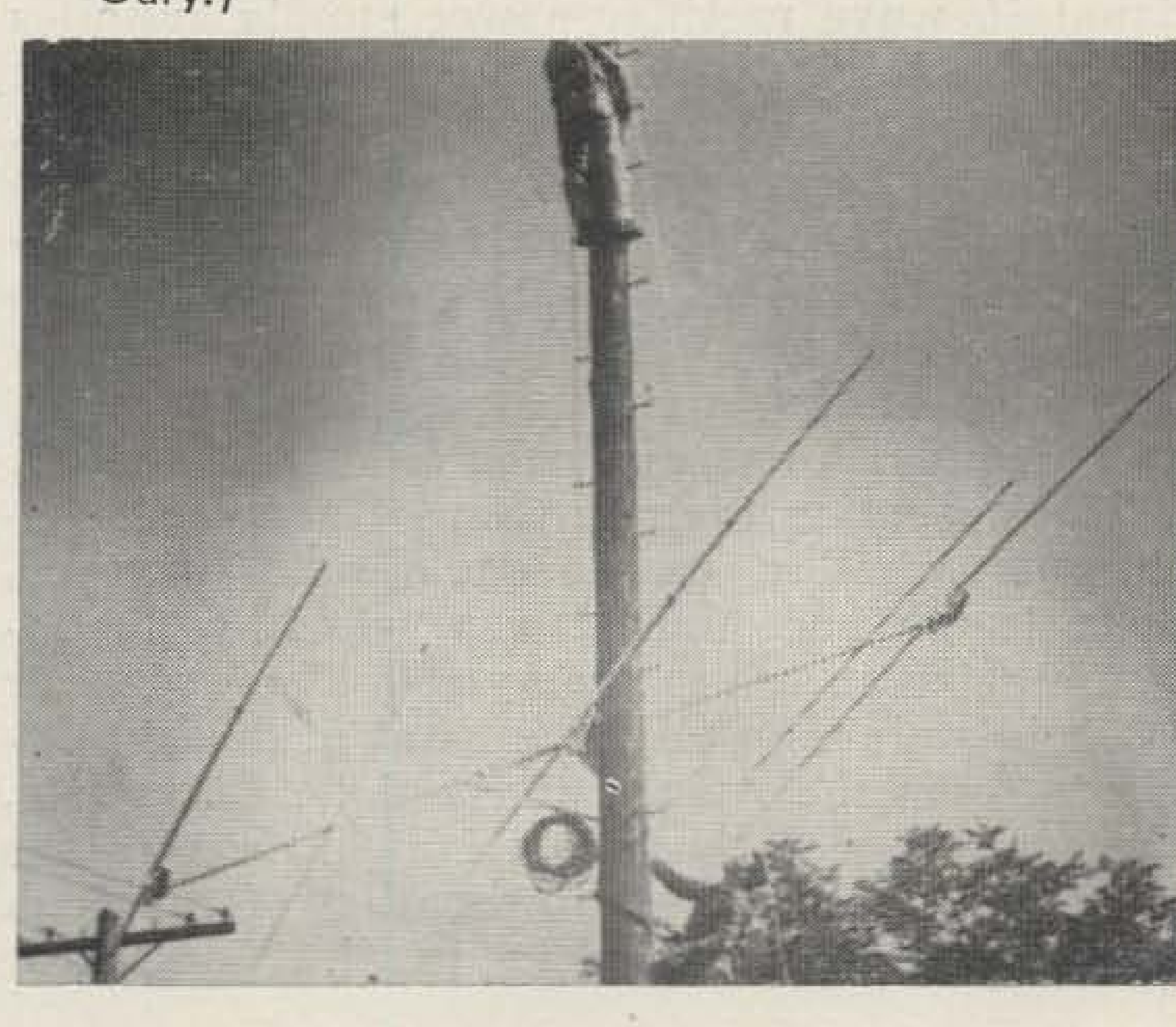


On top of the tower, Dick Pattie, W9VWJ, isn't quite sure what he'll do when the 20 meter beam reaches his height, but he'll give it all he's got. This is just one example of the "great sport" of amateur radio.

W9EZA, Dan Hoover, of Hillsboro, Illinois, is a typical ham dare-devil. Repairing the lead-in wire of his antenna 40 feet up is nothing, but he wouldn't think of doing a dangerous job like fixing the leaky roof.



Part 3—Mike is making progress now, but he has to leave the bean behind. When he gets to the top of the pole, he'll worry about the antenna. (This story has a happy ending as Mike has worked a lot of DX since this sunny day in Gary.)



Tubeless Electronic Key

How would you like to try something old, with a new twist? Here is an item that will stir the imagination of many a cw operator, who can't afford to sink a weeks wages into one of those "new fangled" gadgets called an Electronic Key. The offspring of my junk box is shown in the photograph; a tubeless, transistorless Electronic Key. How does it sound? I'll bet you can't distinguish it from one of those high price jobs!

The key has its own built-in power supply, and forms the dot and dash characters through the use of high impedance relays operating in simple RC time constant circuits. The dots and dashes are self-completing, and the spaces are automatically formed between the characters.

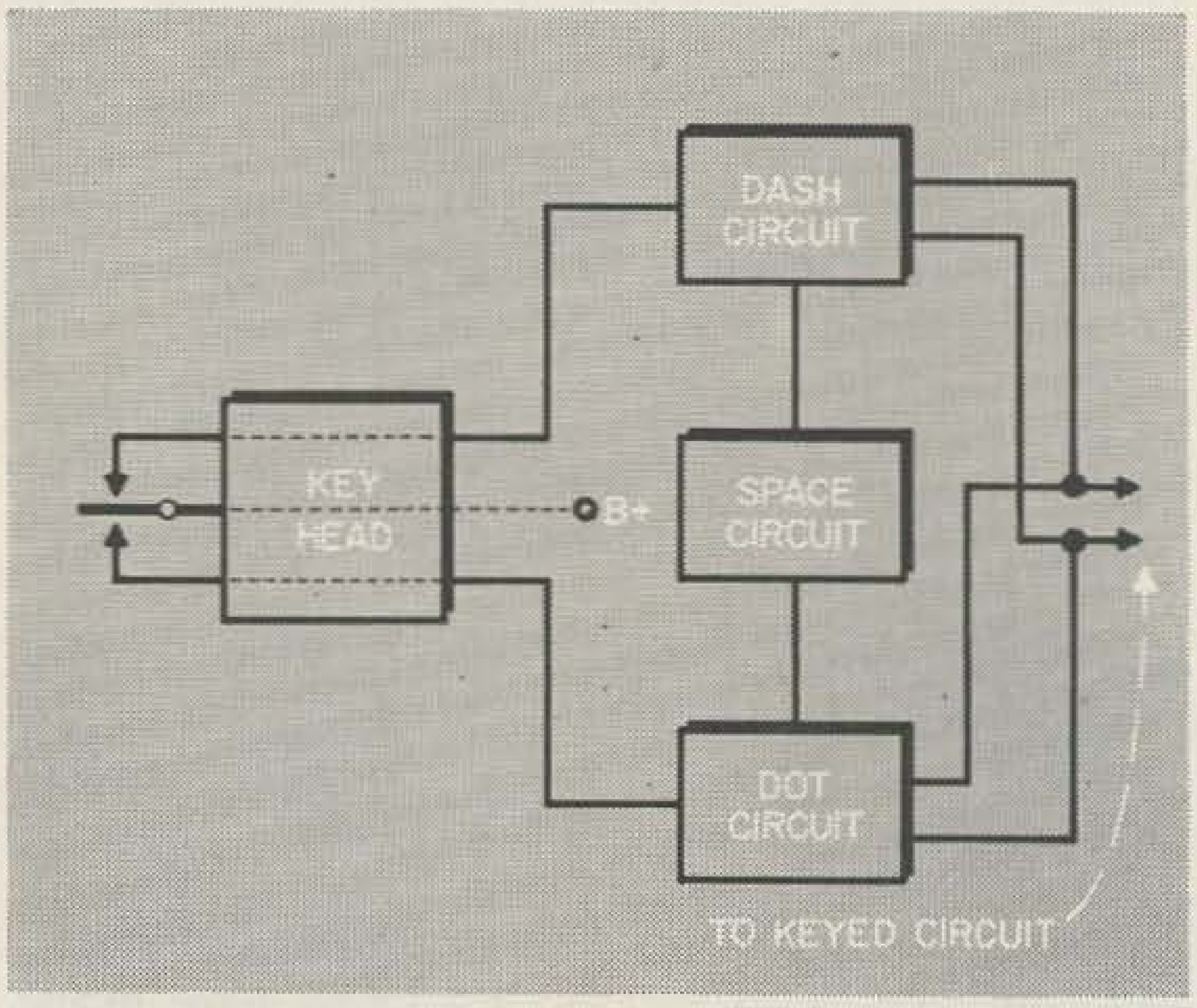
If the component values shown in the circuit diagram are used, the speed range of the unit will be approximately 10 to 25 wpm. However, after reading the circuit analysis (which follows) it will become clear that a circuit of this type can be modified to cover almost any speed range simply by changing the component values of the RC time constant, character forming circuits.

Circuit Analysis

Line power (115 v 60 cy) is applied to terminals 1 & 2 on the terminal strip. The conventional ½ wave rectifier power supply supplies approximately 90 v dc, which drops to about 75 v dc when the unit is keyed. Terminals 3, 4, and 5 on the terminal strip are wired to the key. Terminal 3 energizes the DASH relay (K1), terminal 4 is the common lead to the key, which supplies B+ power to terminals 3 or 5, depending upon the position of the key, and terminal 5 energizes the DOT relay (K3).

The operation of both the dot and dash circuits are similar. In the dot circuit, however, the actual speed of K3 is controlled by the potentiometer across the relay coil. The capacitor (C5) introduces a slight amount of delay helping to form the weight of the dots. Otherwise, the operation of the dot and dash circuits are identical; thus, only the operation of the dash circuit will be discussed in detail.

When terminal #4 is shorted to terminal #3 (the key being pushed to select a dash), dc power will be passed through a set of normally closed contacts on relay K2 (the space relay) directly to the coil of relay K1 (the dash relay), energizing relay K1 and charging capacitor C3. When K1 energizes, contacts on K1 apply dc power to the coil of K2, energizing K2 and charging capacitor C4. Another set of K1 contacts close, keying the transmitter. When K2 energizes, the dc power is removed from terminal #4 through action of another set of now open K2 contacts (assuming that the key is being held in the dash position). DC power is thus removed from K1. However, K1 does not release immediately due to the charge held by capacitor C3. When the charge



on capacitor C3 has fallen below the hold-in voltage of K1 (the time required depends upon the setting of P1), K1 de-energizes, breaking the transmitter circuit and removing dc power from the coil of relay K2. Relay K2 does not release immediately, due to the charge on capacitor C4 (the time interval depends upon the setting of P2). The set of K2 contacts in series with terminal #4 thus prevents B+ power from reaching the coil of K1 until C4 has fallen below the hold-in voltage of coil K2. When K2 does de-energize, K1 immediately fires

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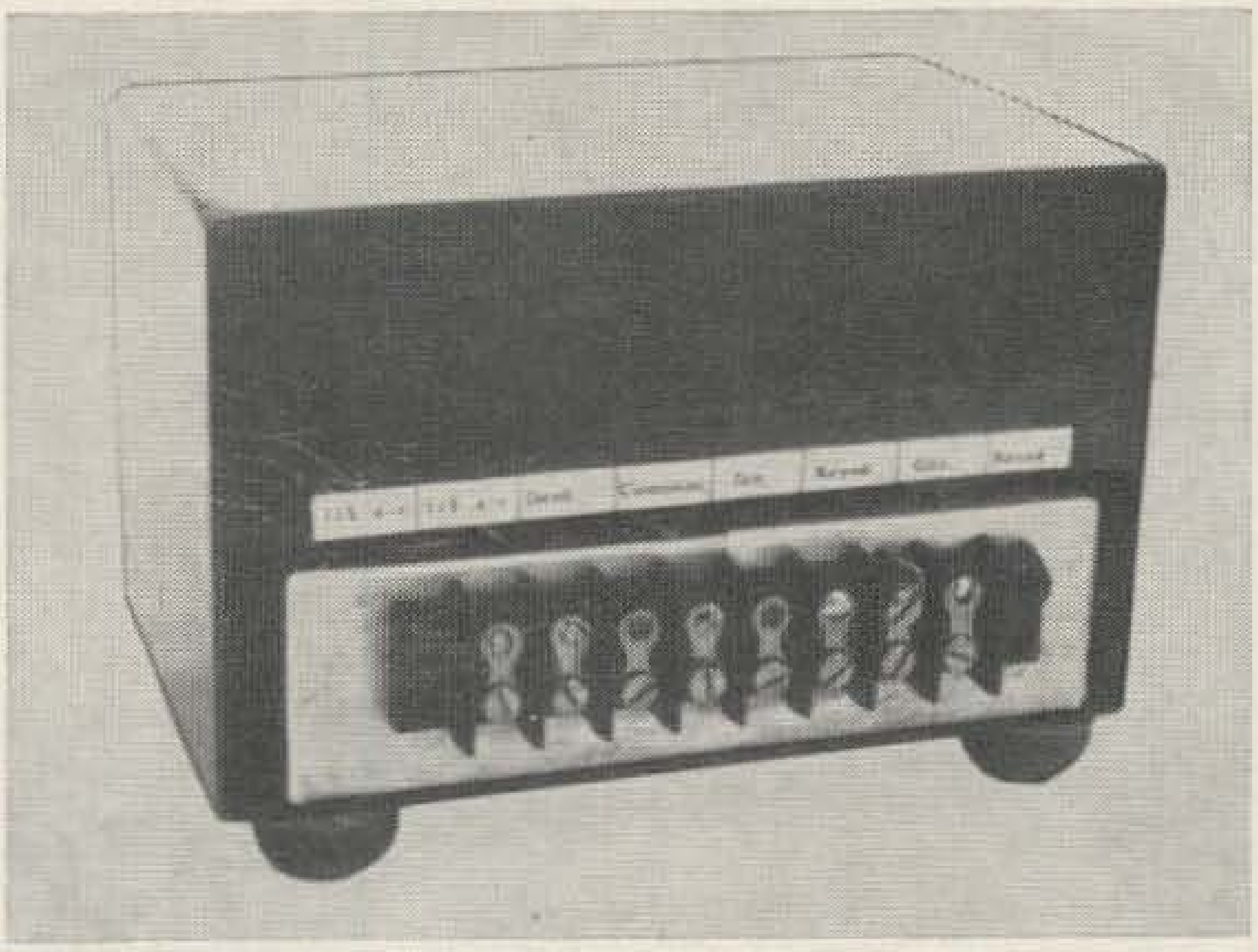
165 Matthews Street
RFD #2, Bristol, Conn.



again, and the cycle is repeated, provided the key is held closed.

Relay K3 (the dot relay) operates in the same manner as relay K1, in conjunction with relay K2, except for the differences pointed out earlier.

Normally open contacts on both K1 and K3 are wired in parallel across terminals #6 and #8, to which the keyed circuit is connected.

In some speed ranges, capacitor C5 does not control the actual weight (or length) of the dot character. The weight (or length) of the dot character is controlled by the shunting effect of P3, changing the pull-in and drop-out point of K3.

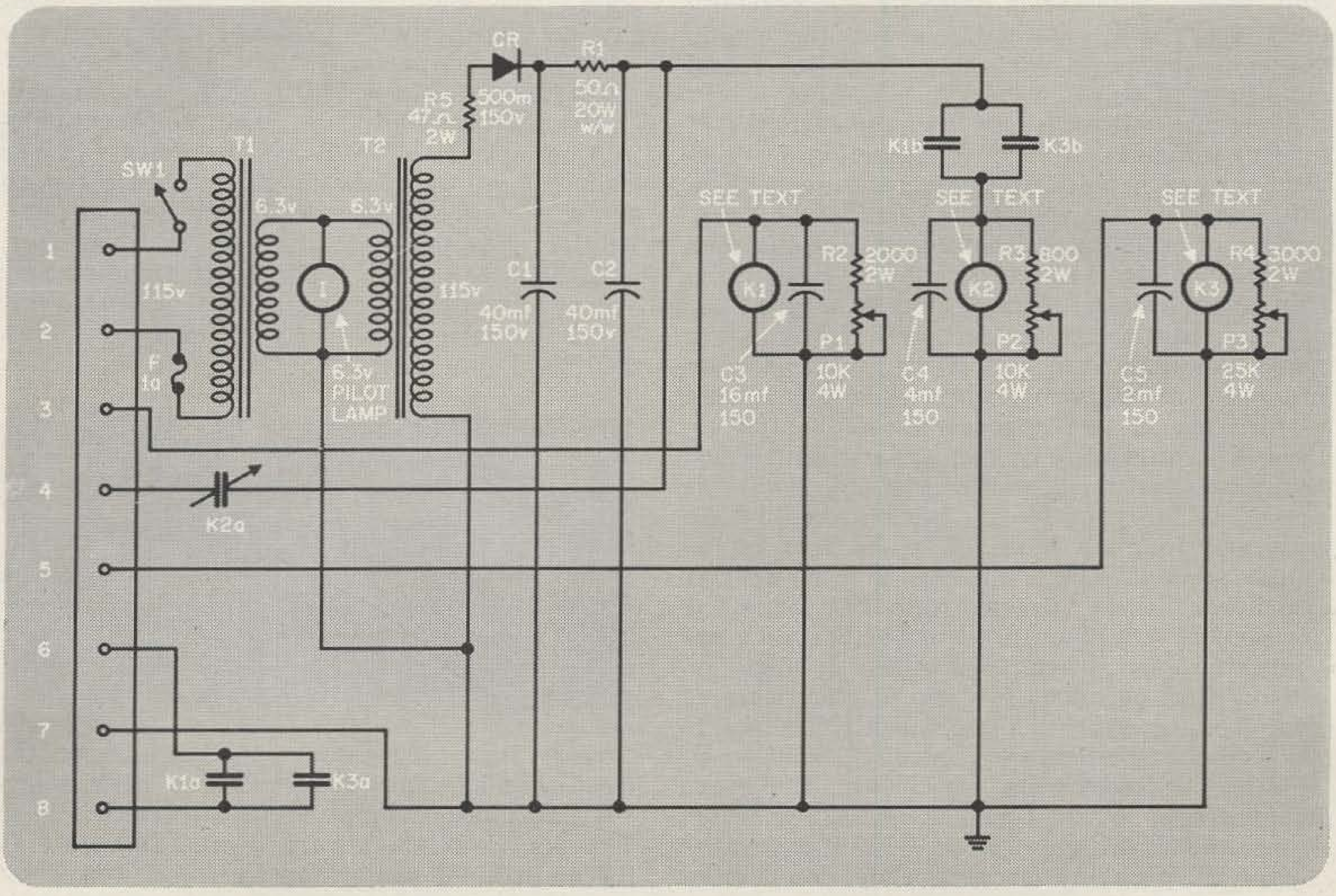
The extra set of contacts on K2 (see terminal #4) are not necessary, but were wired in parallel with the other set of K2 contacts because they were available and were used to help prolong relay life.

The power supply, as explained before, is a conventional ½ wave type. Although the circuit diagram shows 2 filament transformers back-to-back, a single isolation transformer may be used if one is available. If an isolation transformer is used, the pilot light should, of course, be changed to operate on 115 v ac.

Four factors should be pointed out when discussing the operation of this key. They are listed as follows:

1. Due to the mechanical and electrical limitations of the relays, complete coverage of the "speed range" is not

(Continued on page 56)



A Digest of Surplus

Radio Equipment

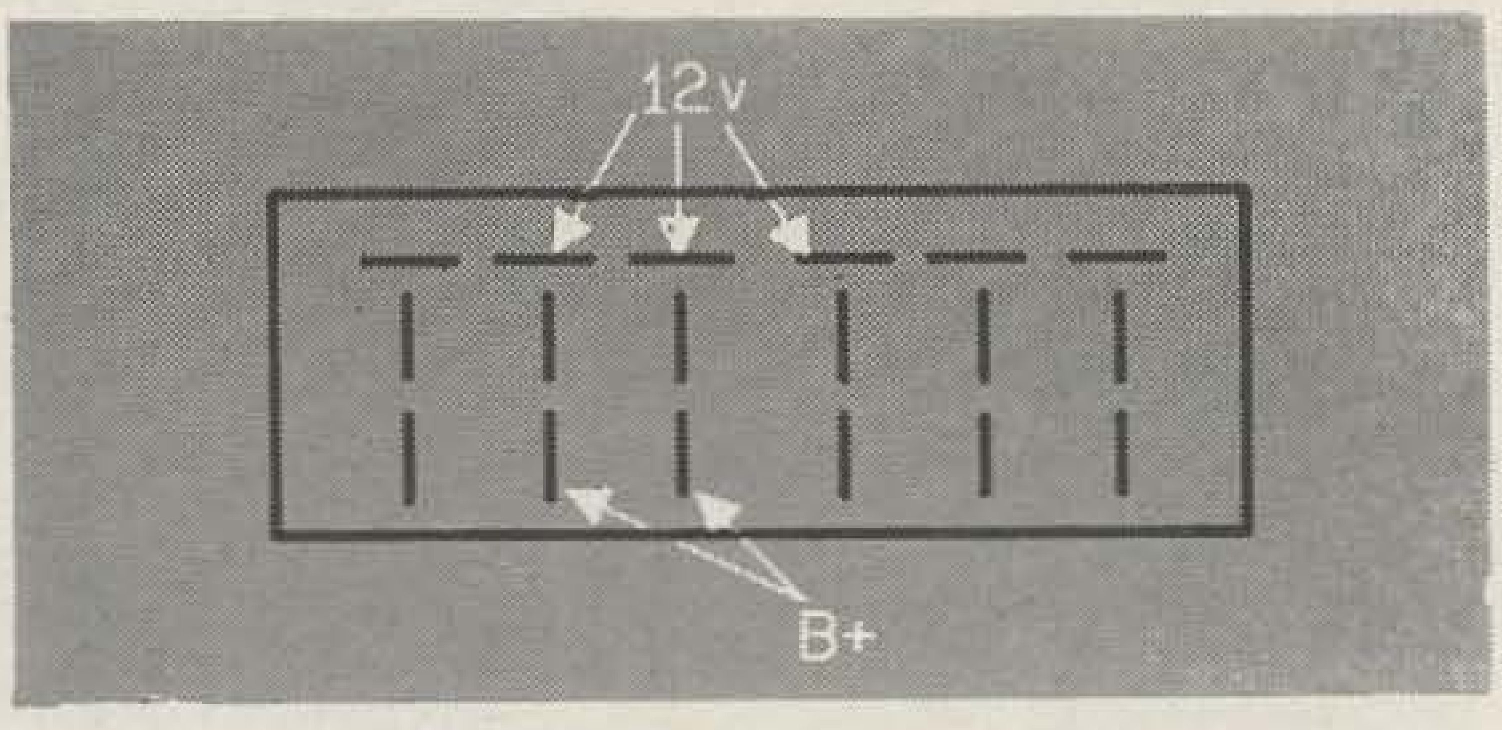
Gordon E. Hopper, W1MEG
75 Kendall Ave.
Framingham, Mass.

ARMY surplus radio equipment—today, after some twelve years of seeing ads and reading articles, even books, on it, we find is still with us. This article is written mainly to assist those who wish to experiment with commercially built equipment. It is a well-known fact that making changes in amateur commercially built gear will materially affect the resale value of the piece (as the author has found out the hard way).

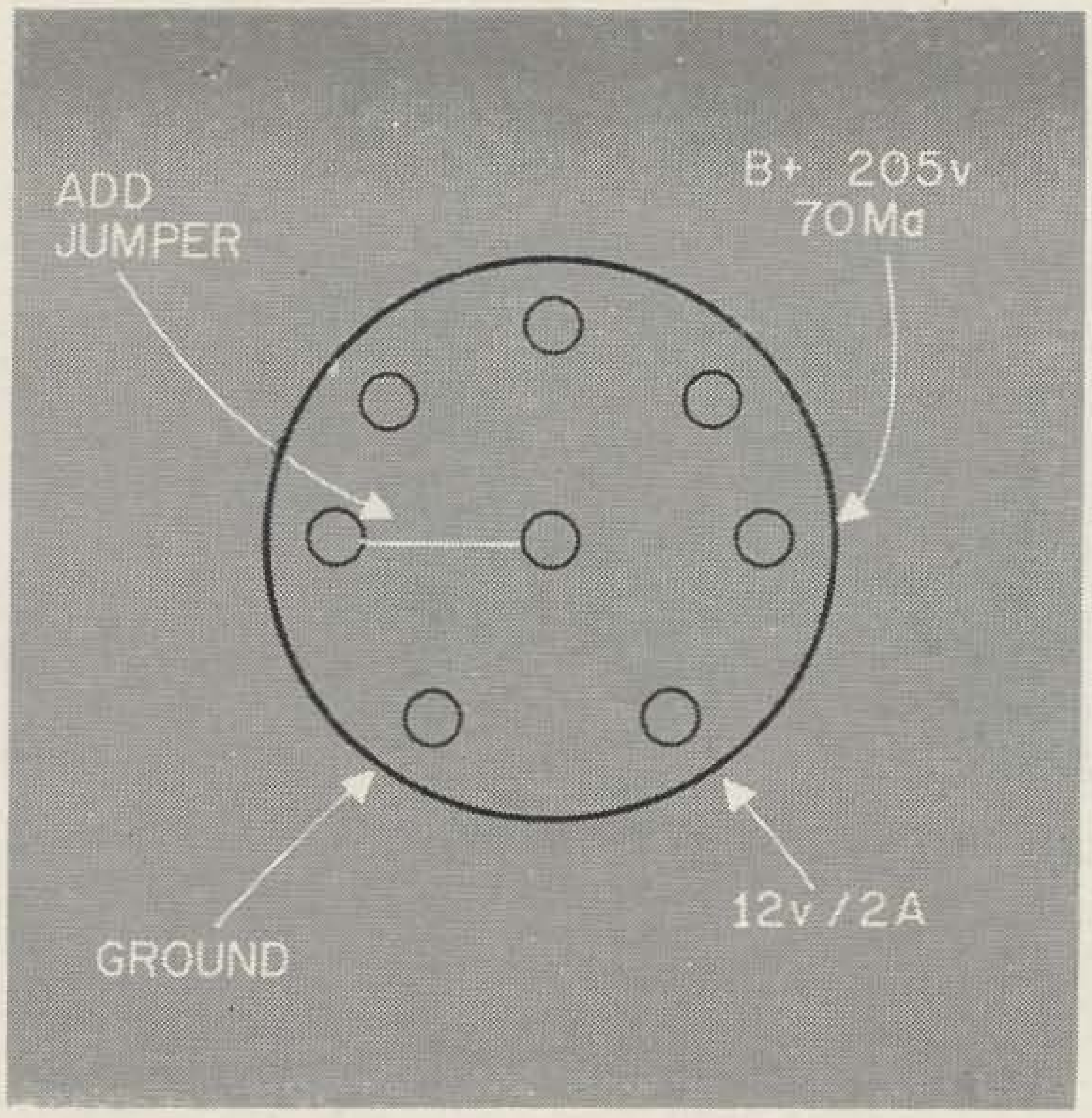
If you are the type of ham who thinks of making changes in the construction or performance of a piece of commercial gear, then, this article is for you. If you desire the satisfaction of seeing a piece of equipment designed for a specified service revamped into something that you, as a ham, can make good use of, then this article is for you. If you are a newcomer and want to get on the air with a minimum of cabbage outlay, then this article is for you. If you have read complicated articles on converting surplus gear and decided there was too much work involved, then this article is for you. If you have looked into a unit and found a maze of cables and multi-contact unidentified connectors and thought "I can never figure this out" then this article is for you. If you are a MARS member with unconverted gear, then this article is for you.

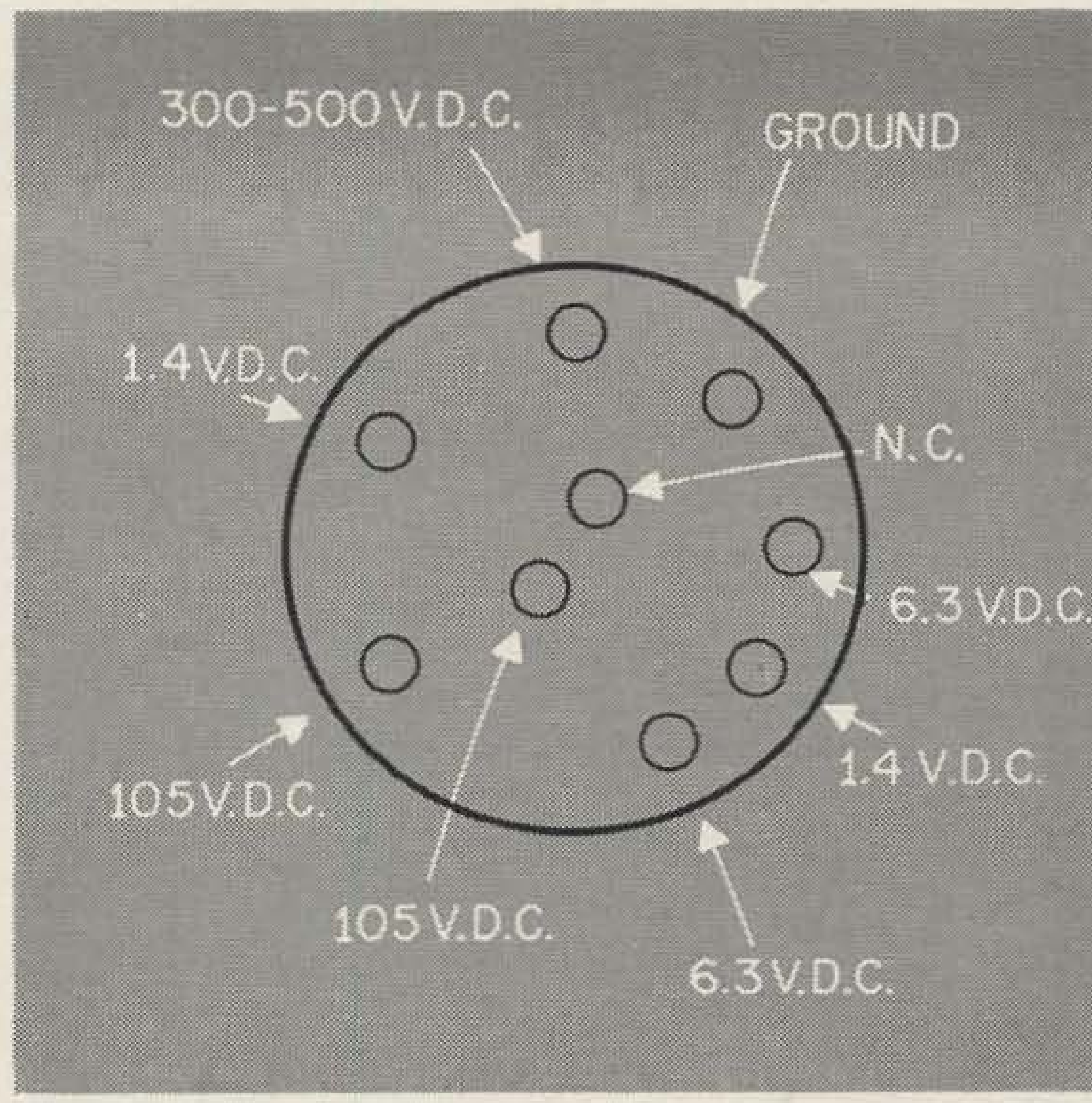
Now that everyone is digging out pieces of gear bought years ago, or getting ready to take off for their nearest surplus supplier, or starting to read more closely the numerous surplus ads, let us consider one thing. Most hams who have never converted any gear have refrained probably because they don't know where to start the job. This article will identify the power connectors of a few of the most usable and most easily obtained pieces. It will not show you how to completely convert a unit, but it will save you many hours of circuit tracing by showing you where to apply voltages. Once you get the unit operating then changes can be made to adapt it to your use.

The first connector to be shown is that of a BC-603, an FM receiver built like the proverbial brick battleship, designed to operate 20-27.9 mc. Articles in September and October 1958 CQ tell you how to get this receiver up to six meters AM, a formidable achievement. Applying voltages to the power connector, with no other changes, will get this receiver operating in the service it was designed for. Make the power supply connections to a Jones S-318CCT plug.



Next is the connector on the rear of the RBM-3 and RBM-4 receivers. The RBM-3 covers 2 to 20 mc. while the RBM-4 covers 20 to 2000 kc. Both are superhets and require only the addition of power supplies.

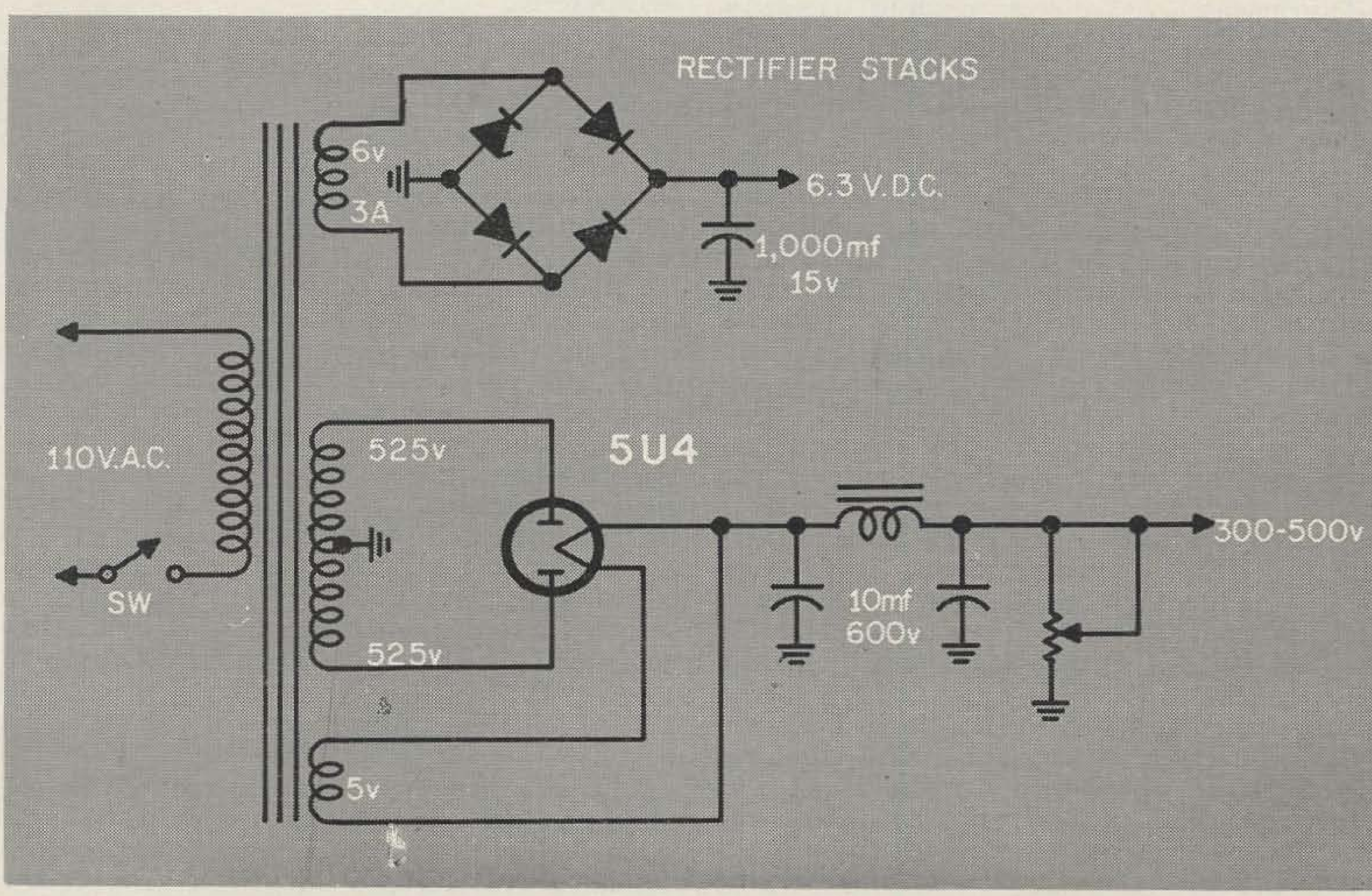




Now comes the BC-1306. This is a transmitter and receiver housed in one unit covering 3800 to 6500 kc. phone and cw. It requires an external dc power supply and no modifications. This unit has recently appeared on the surplus market and the following connector identification together with a suitable power supply should be of interest to these who are members of Army MARS who have not tried it yet. The author used a connector from a defunct BC-375E, however, suitable connectors can be obtained from Fair Radio Sales, 132 South Main St., Lima, Ohio, and from Connector Corp. of America, 137 Hamilton St., New Haven, Conn. Also worth nothing is the fact that a 6/12/24 volt mobile supply. PE-237, is available from the same Fair Radio Sales and also from Telemarine Communications, 140 West Broadway, N. Y. C.

(Continued on page 57)

A Suitable Power Supply for the BC 1306



Roy A. McCarthy, K6EAW
737 W. Maxzim Ave.
Fullerton, California

"The Capacity Meter is a compact yet versatile test instrument."

Direct Reading Capacity Meter

OF all the various methods of capacity measurement, the direct reading capacity meter has the greatest appeal from the standpoint of operating convenience and rapidity of measurement. The capacity meter is of course a great help to those who have difficulty remembering the myriad of color codes, as well as those of us who may have color perception deficiencies. Equally useful is the ability to measure the capacity of a length of coax cable to determine if there is a break close to the end where it is easily accessible for repair. Odd lengths of antenna can also be readily measured to enable calculating the amount of series inductance needed for resonance at lower than the natural resonant frequency of the antenna. Many other odd jobs can be quickly accomplished with the aid of a portable capacity meter, such as measuring stray wiring capacitance, locating breaks close to the surface in coils, breaks in line cords, etc. An ohmmeter will tell you a cord or cable is open, but a capacity meter will tell you where.

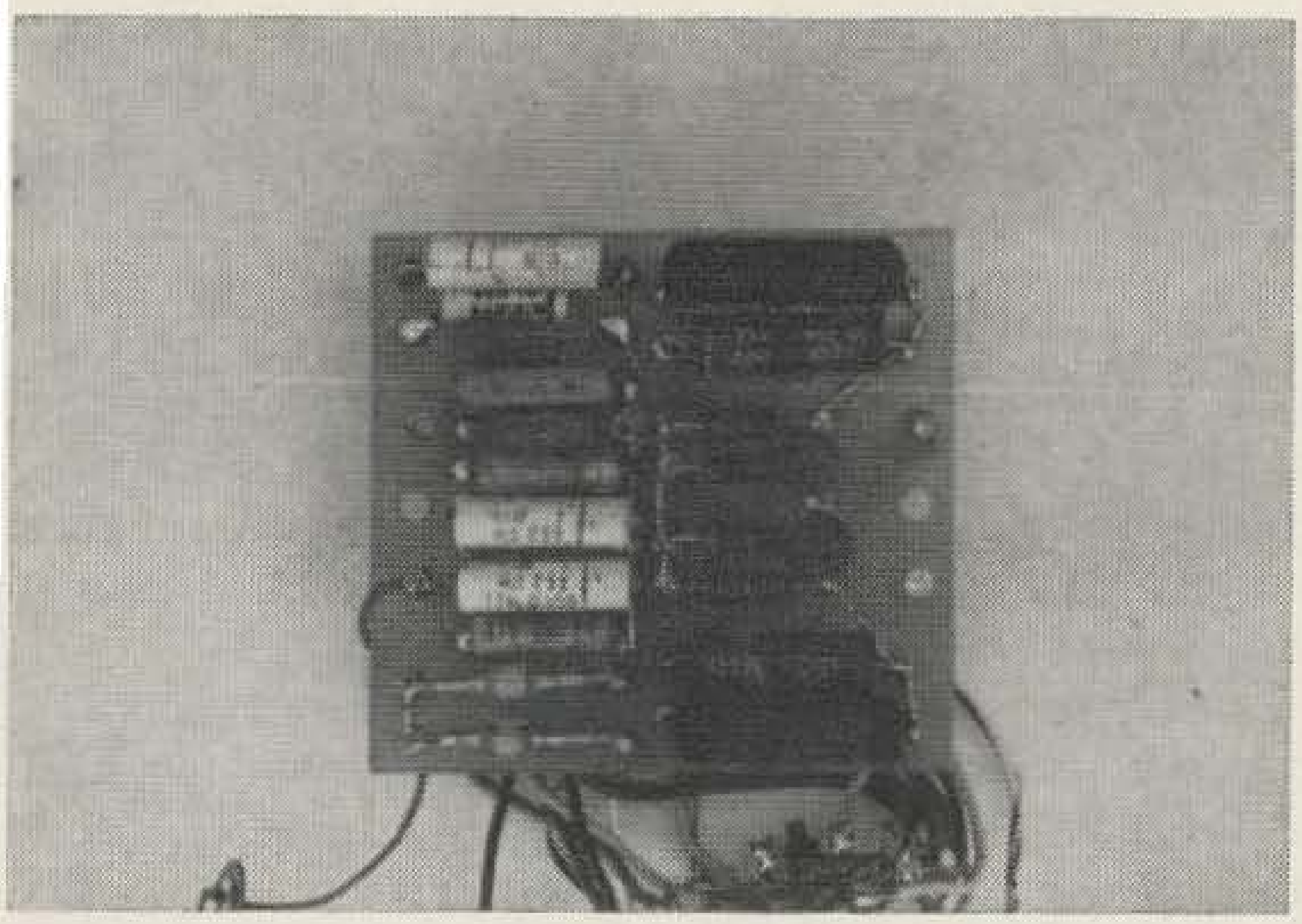
The instrument was transistorized to add to the convenience of operation and eliminate the need for power cords, or waiting for it to warm up and settle down. Along this same line, the meter is large and easy to read accurately, and the small case with a carrying handle compares favorably with most standard multimeters.

Ranges

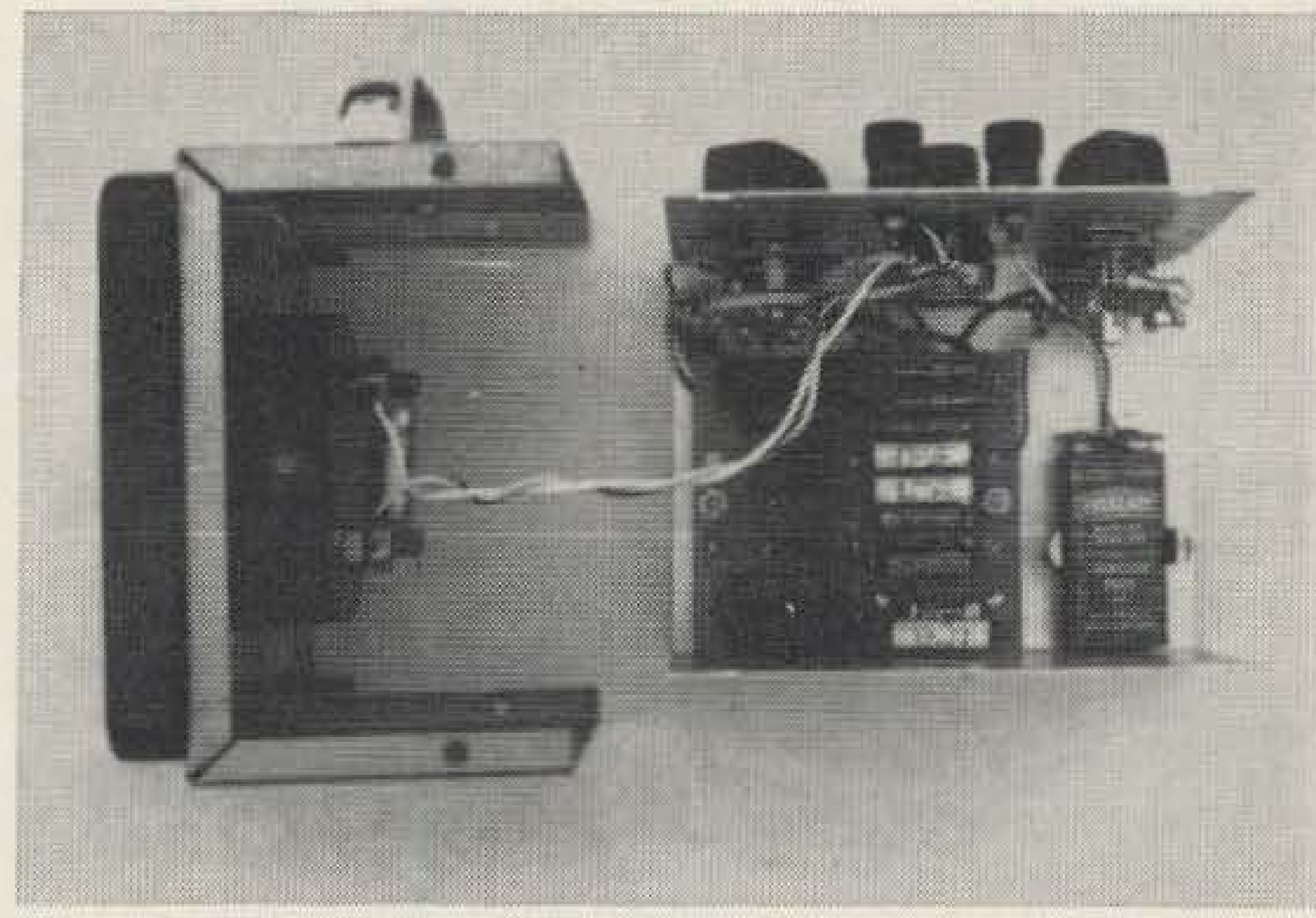
Four basic ranges were provided, calibrated at full scale by means of the built-in standard capacitors of 100 mmfd, 1000 mmfd, .01 mfd, and .1 mfd. By means of the built in standards and the calibration control other ranges may be used to increase the ease of measurement. For example, a capacity which read just off scale on one range would be slightly above 1/10 scale on the next range. Instead, by readjusting the calibration control, so the calibrating capacitor read ½ of full scale, an unknown capacitor just slightly larger can be readily determined, using a mental multiplier of two. Although the author's instrument has an apparent residual capacity of about 0.8 mmfd, capacitors as low as 1 mmfd can be measured if this residual capacity is allowed for and subtracted from the indicated reading.

Accuracy

The accuracy, as well as the cost of the instrument will depend mainly on the basic meter selected and the four standard or selected capacitors. The transistors are fairly



Use of a component board greatly simplifies wiring, with connections made to the underside of the board.



Inside view of the capacity meter shows the compact construction made possible by use of miniature components.

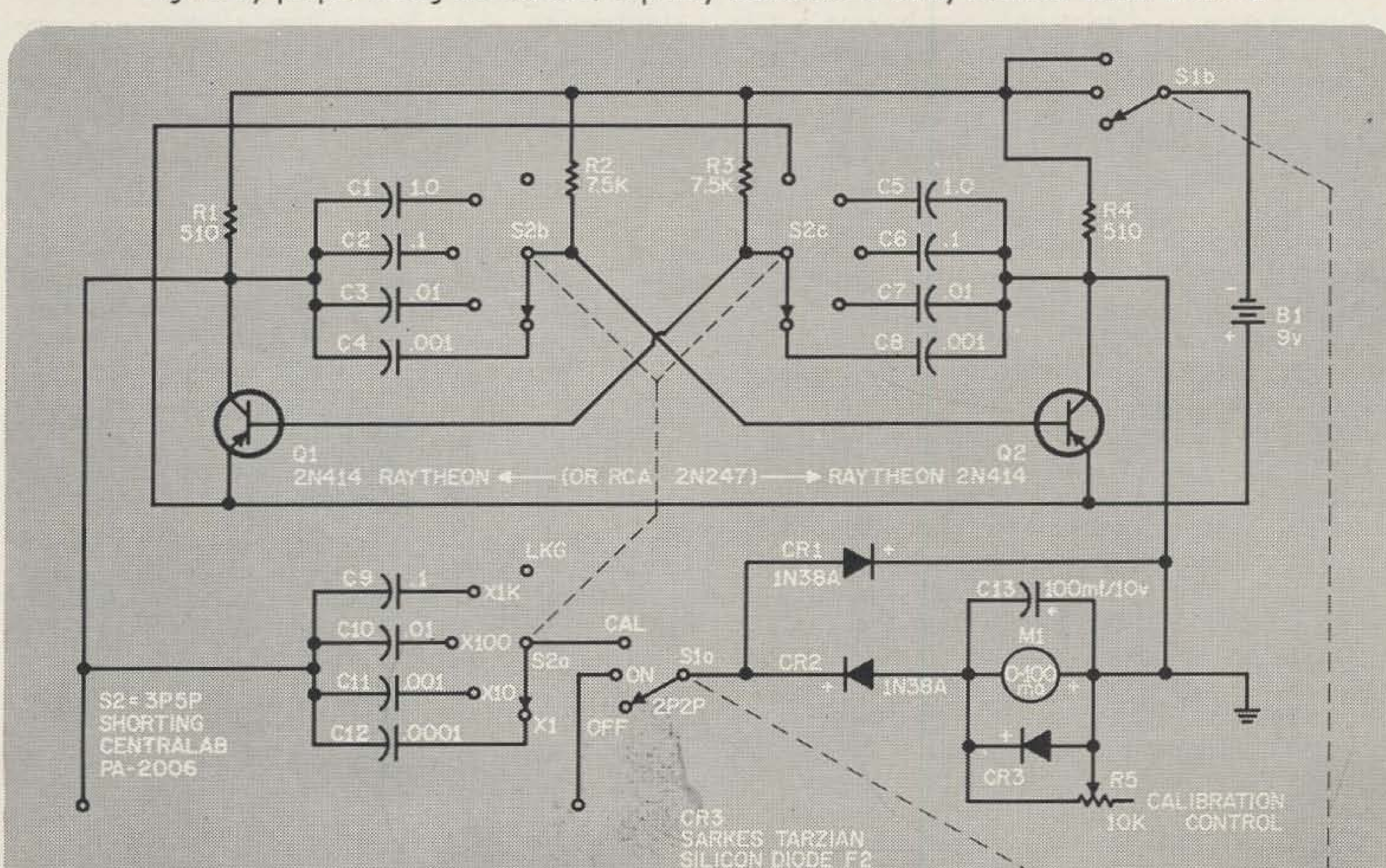
inexpensive rf or if type PNP units. The mercury battery shown in the photographs is not really a necessity for any dry-cell type can be used if it has enough voltage and can maintain a steady full scale reading on all operating ranges. The multivibrator used in the circuit is quite stable, hardly changing frequency over wide supply voltage variations, and in any case each range is normally calibrated by the built-in standards before use. The author obtained 1.0% of full scale accuracy on the three higher ranges, and 3 to 4% of full scale accuracy on the 100 mmfd range. This does not mean that a very low capacity may be off 3 or 4 mmfd, since zero is mechanically set by the meter adjustment screw. The error was greatest near the center of the scale.

Theory of Operation

The circuit operates by measuring the amount of charge which the capacitor under test receives by the application of a squarewave from the multivibrator. A pair of diodes in a simple rectifier circuit enable a microammeter to be used as the indicator. Since the amount of charge on a capacitor, with a given voltage applied, is directly proportional to the

(Continued on page 41)

Fig. 1. By proper wiring the residual capacity indication is easily reduced below 1 mmfd.



TRAFFIC through the medium of the "phone patch" is becoming increasingly popular and is another service added to the already long list of those provided by the radio amateur.

Disregarding the technical aspects of the "phone patch", this type of traffic is tricky to handle. This is due to the human element injected by the usually uninitiated person on the other end of the telephone line. There are several do's and don'ts that are well worth your attention if you handle or intend to handle this type of traffic.

Before placing the telephone call, be sure you have all of the necessary information; that is, the addressee's name and complete phone number, as well as the name of the originator. You should also check to see if there is any toll charge involved. If there is, be sure to get the approval of the originator before placing a collect call.

cause of amateur radio. Who knows, this person may be the one who's giving the "ham", two doors down the block from him, multiple fits with his TVI complaints. Don't miss the chance. Explain briefly, but thoroughly, what is going to take place. Be sure to mention that, as a radio amateur, both you and the operator of the originating station are proud and happy that your hobby permits you to perform this service for him. Also, inform him that there is no charge or obligation on his part.

Determine whether or not he is familiar with "phone patch" operation. If not, instruct him as to the procedure you wish him to follow and to speak slowly and clearly so that his voice may be easily understood at the receiving station.

After switching the "patch" into the circuits, it may be advisable to turn it back to the originating station. This is particularly useful when the person is not used to "patch-

"Gotta' Phone Patch?"

Ken Johnson W6NKE
21835 Rodax Street
Canoga Park, California

The "phone patch" should not be switched into your station's circuits while you are placing the call. In some cases, your transmitter will be on the air and the initial remarks made by the party you are calling may be confusing or even disastrous. For example, the following reaction of surprise could happen. Suppose you've just informed the person on the other end of the line that his old service buddy, Joe, is going to talk to him through your amateur radio station. "Joe! My old buddy, Joe", the voice on the other end of the line says, "the h— you say! I haven't heard from that dogface for ten years. Put him on so's I can hear his d— old ugly voice".

See what I mean? It may read funny but can't you just see yourself frantically snatching at the switches?

This, too, is important while placing a collect call. Most telephone operators seem to be familiar with amateur radio and phone patches. It has been my experience that all of them are cooperative. However, occasionally it becomes necessary to explain what you are trying to do and it's needless to put the ensuing conversation on the air. Also, her placement of the call may create some excitement and confusion on the part of the addressee until he understands what is going on. There is the possibility of unnecessary embarrassment if your patch is in the circuit during this time.

When you have the addressee on the line, you have one of the most desirable situations possible to do a little publicity work for the

ing". It shifts the responsibility of starting the conversation to the originator who has had plenty of time to think of what he wants to say.

Carefully monitor the conversation from beginning to end. Remember that there are definite regulations as to the type of traffic that may be handled via amateur radio. Remember also the type of language that may

(Continued on page 54)

"FRANTICALLY GRABBING FOR THE SWITCHES"

(. . . de W2NSD from page 4)
advertisers that you see in these pages. Make this generosity worth their while . . . read the ads carefully . . . send for more information on their products . . . give them a boost . . . maybe even drop them a card of appreciation.

And when you write to them *be sure to tell 'em you saw it in 73.*

Coming Up

Naturally we wanted to put a lot of goodies in this first issue of 73. But we were careful not to unbalance it at the expense of future issues. Here are some of the articles scheduled for the November issue that may be of interest to you:

"VHF Receiver" This is a rather complete basic receiver that is designed to go with the *Bantam Converters* described in this issue. It gives you everything you could ask. This is quite an elaborate construction article, running to five pages, but you'll have a heck of a job fighting off the urge to build when you see it.

"Four Band Crystal Converters" This is a combination product report and construction article which shows how to use the International Crystal converters to good advantage. In this package we find the 20-15-10-6 meter converters all built into one band-switching converter unit, complete with power supply.

"An FM VFO Exciter" A BC-459 is converted into an FM VFO for use on 10, 6 and 2 meters, using either narrow-band or wide-band FM. With more and more FM turning up in our ham VHF bands it is nice to have an exciter around that will generate a usable signal for either FM or AM type VHF receivers.

"Notes On Mobile Power" Higher power from the car using an alternator and a three-phase power supply. Output is 520 volts at 500 ma.

"Stop That Noise" In this issue we have a good technical article on modulation. In November we go into detail on the subject of noise limiters and give the circuits of all the popular types, complete with an interesting discussion of the advantages and disadvantages of each.

"$5 Frequency Meter" Two transistors are used in a new type of circuit which will probably be turning up in a commercial unit very shortly. This will give you a direct reading of any frequency in the ranges of 300 cps, 1 kc, 3 kc, 10 kc, and 30 kc. If this article doesn't get you to the work bench then you're an out and out non-building type ham.

There will be about ten other articles. We don't want to give away the whole thing right here. It will be a good issue and worth well over the yearly subscription price all by itself.

Policies

Here are the basic policies which will guide 73.

Policy #1: We are not mad at anybody.

Policy #2: Amateur Radio, in its dual role as a means of arousing the interest of youngsters and providing the basic training for entry into the field of electronics, one of the largest and most promising fields we can see ahead, and as one of the most important means of communications between the peoples of the world on a people-to-people basis instead of through the press or government channels, is probably the most important hobby in the world today. We can keep it important by being aware of what is going on in our hobby and by being technically up to date. 73 Magazine is dedicated to bringing into focus the frontiers of amateur radio. It will strive to broaden the technical interest of the amateurs and to encourage them to higher technical attainments and abilities by means of technical and construction articles written by the best talent available.

Policy #3: Few talented writers have continued to buck the present system whereby they either receive nothing for their efforts or else have to wait from one to three years for minimal pay. 73 has established the policy of paying for all accepted articles with immediate cash. This seems to be bringing new life to the field for we are receiving top notch articles by some of the best authors in the hobby.

Policy #4: It is our intention, the SEC permitting, to open the ownership of Amateur Radio Publishing, Inc., to interested amateurs so that the ownership of the magazine can be widespread and the magazine will be truly owned and run entirely by licensed hams. 73 is being run under a very tight economy until the break-even point of 15,000 circulation is reached.

Policy #5: We intend to encourage and promote the publication of bulletins to bring specialized operating news of the many facets of amateur radio: VHF, RTTY, DX, Traffic Handling, TV, etc. The Club Bulletin of Marvin Lipton VE3DQX will be one of the first under this program. This publication, which is sent to the editors of all known ham club bulletins to provide them with a means of exchanging ideas, should be back in business this fall.

DeLuxe Three-Way Power Supply

Donald A. Smith W3UZN
P.O. Box 45
Hagerstown, Maryland

Do you have need for a 6 or 12 volt power supply for your new Citizens Band transceiver or amateur rig? Would you also like to use the same supply for line voltage operation? Do you have a six volt automobile now and have held off building a mobile supply because you are going to buy a new car with a 12 volt system in the near future? Here is a power supply which will fit these requirements and more!

The power supply shown in the photos has these features:

1. The supply will operate from 6 or 12 volts dc and 120 volts ac.
2. NO circuit changes are required to change from one input voltage to another!
3. The supply has built-in change over relay, permitting B+ output voltage to be switched from receiver to transmitter.
4. This B+ change over may be accomplished by throwing the switch marked "HI VOLTAGE," or it may be done from a remote location.
5. The antenna is also switched from receiver to transmitter when this switch is thrown.
6. A green pilot lamp indicates when the power supply is on and a red one lights when the supply has been switched from receiver to transmitter.

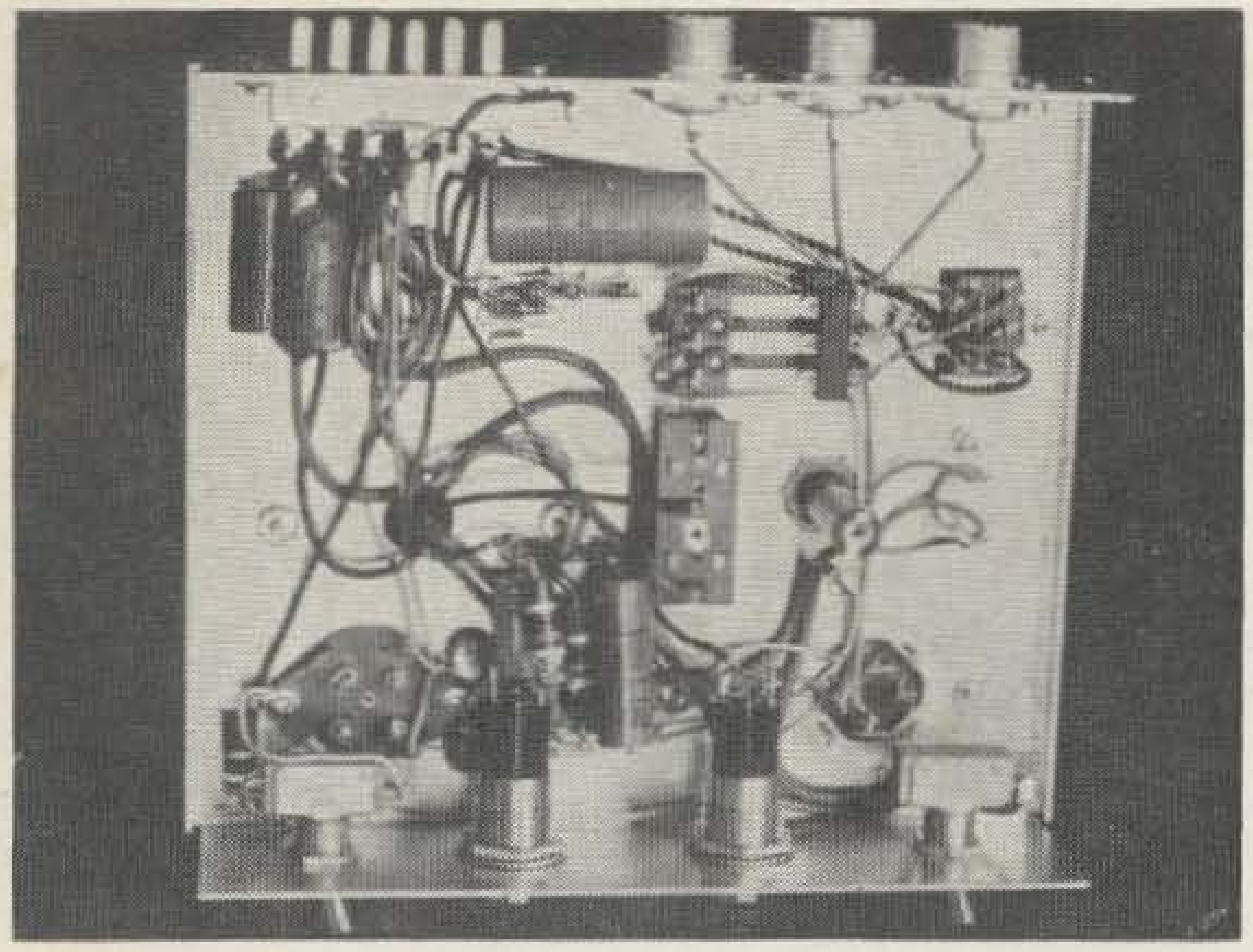
This changing from one input voltage to another is accomplished by making a separate power cord for each input voltage. As can be seen in the photographs and the diagram, an 18 prong Jones plug is used as the input voltage connection. Depending on what input voltage is desired, a Jones plug is wired for the connections required for that voltage. For using the supply on all three input voltages, three different cords are made. The connections for each input voltage are shown in the table.

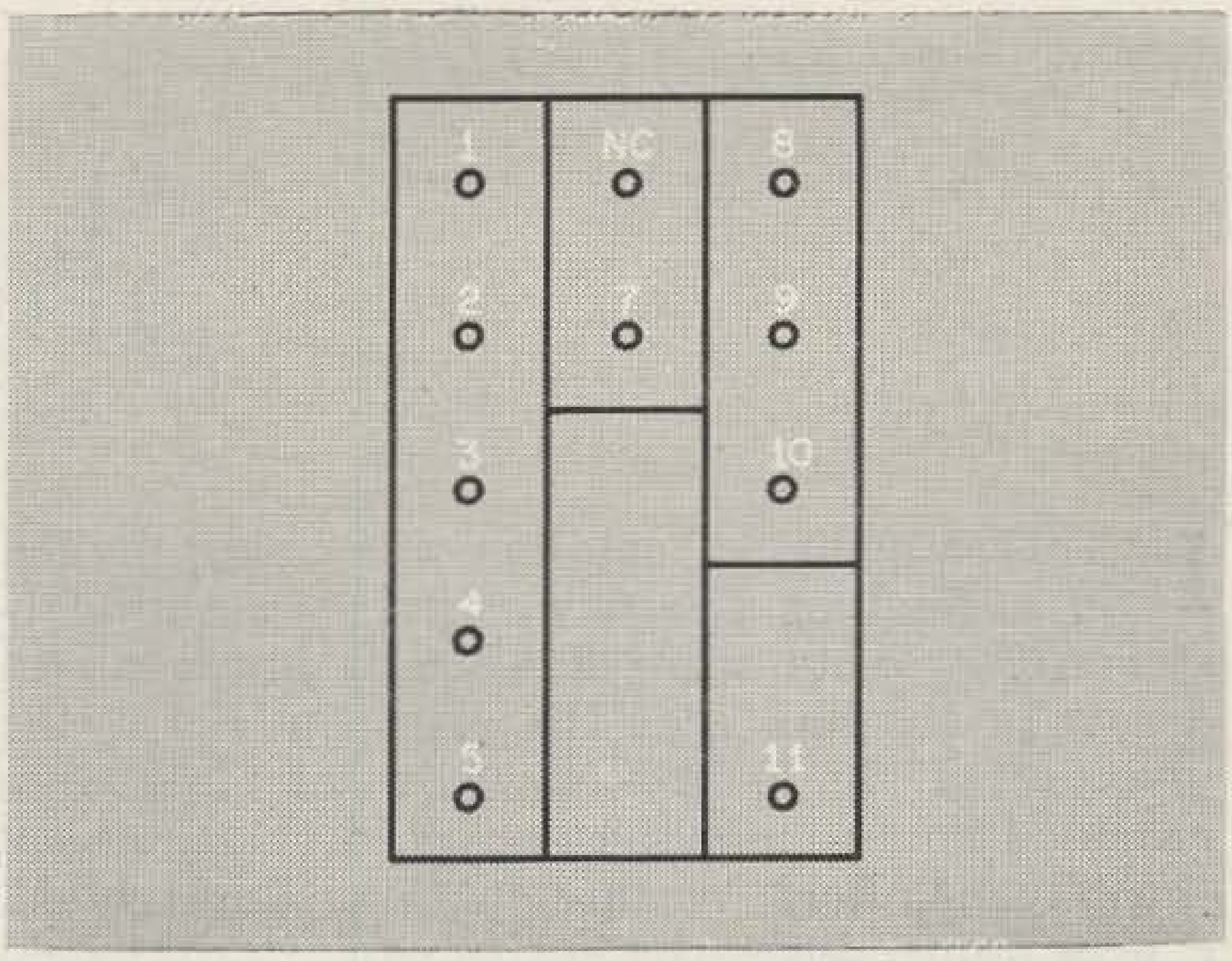
Output from the supply is approximately 275 volts dc at 100 ma, more than ample for many Citizens Band rigs which do not have this three way feature, as well as a number of amateur transmitters. If desired, the supply can be used to operate your favorite communications receiver in your car. Many of these receivers are provided with a connector on the rear of the chassis for just such a purpose.

The supply uses the parts from two basic kits available from International Crystal Co. in Oklahoma City. The additional parts required are listed in the parts list. These two kits are used rather than purchasing the parts individually because the power Xformer is special, and the cost of the individual parts is considerably higher than the price of the two kits. The total price of the Deluxe Three-Way Supply should be around $35.00, if you have no parts on hand.

Note that only one Jones power connector comes with the kit. It may of course be wired for any of the three input voltages. Additional plugs may be purchased from International, or from your local parts supplier. The part number is Jones S-318-CCT. Amphenol UHF jacks are used for the antenna connectors to keep losses to a minimum. These are positioned on the rear of the box chassis as shown in the photos.

(Continued on page 46)





View, Facing Relay Connections (Relay Has No Numbers)

CONNECTIONS FOR INPUT VOLTAGE POWER PLUGS—

6 Volts dc

6 Volt "Hot" lead (May be either + or —) Pin 1
6 Volt Ground lead—Pin 14
Place Jumpers between the following pins
2 & 5
6 & 8
8 & 11
7 & 10
9 & 12
5 & 17
15 & 18
15 & 16

12 Volts dc

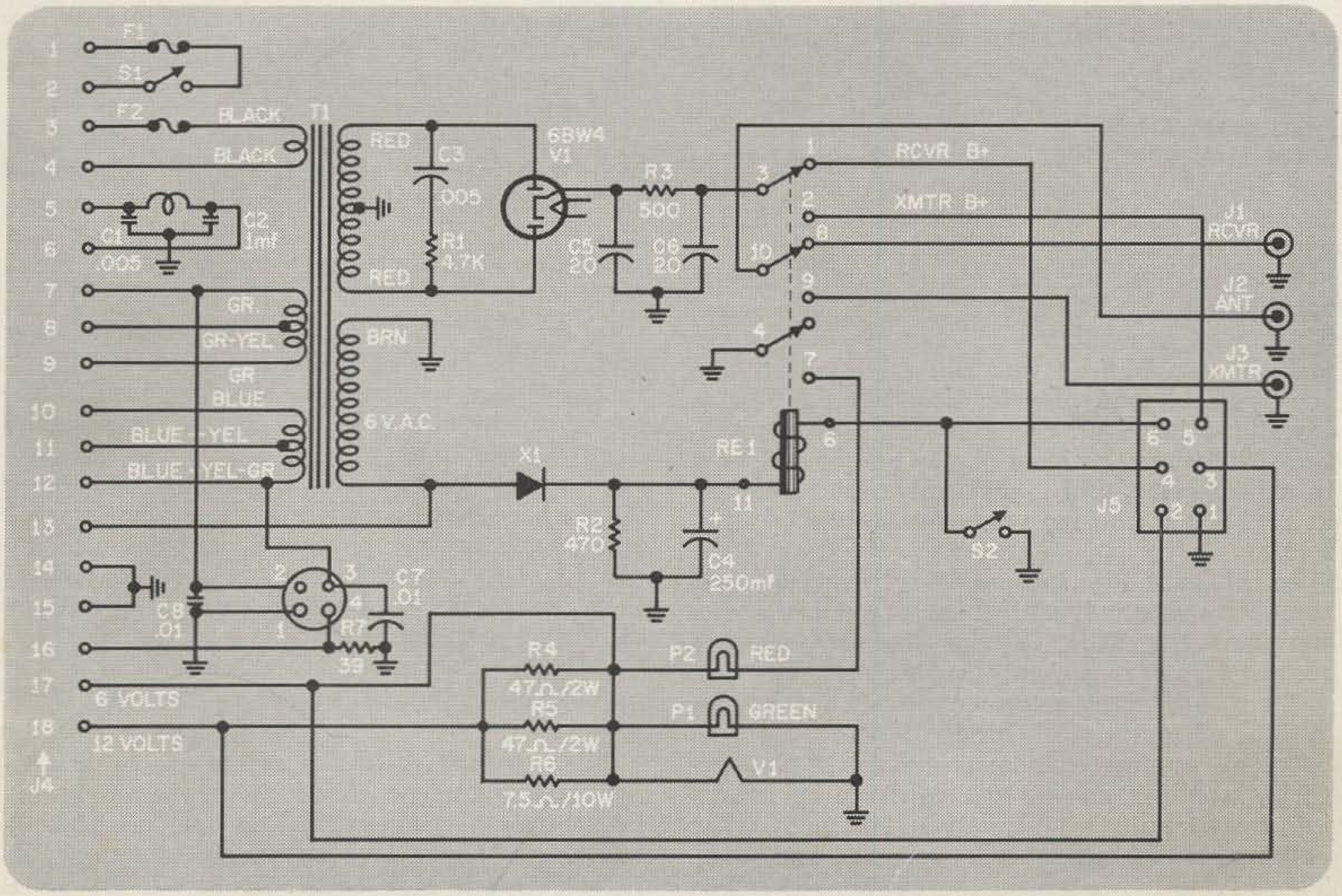
12 Volt "Hot" lead (May be either + or —) Pin 1
12 Volt Ground lead—Pin 14
Place Jumpers between the following pins
2 & 5
6 & 9
9 & 10
5 & 18

120 Volt ac

Line cord, one lead to Pin 1 and the other to Pin 4
Jumpers between the following pins
2 & 3
13 & 17
15 & 18

PARTS LIST

1—Three way basic power supply kit, PW-2F.
1—Relay Kit for above.
(The above from International Crystal Co., 18 N. Lee St., Oklahoma City, Okla.).
1—L.M.B. Box chassis No. 20.
P1—Jones #S-306AB, 6 prong power output plug.
S1—S2 Single pole, single throw toggle switches.
J1—J2—J3 Amphenol UHF connectors, #83-IR.
P1—P2 Dialco #81410-111 Jeweled pilot lamp holders. Red for P2 (transmitter) and green for P1.
R4—47 ohm, 2 watt resistor.
R5—47 ohm, 2 watt resistor.
R6—7.5 ohm, 10 watt resistor.
NOTE: All other parts are supplied with the two kits listed above.



Capt. John J. Sury K8NIC/5
139 Nebraska Road
Dyess AFB, Texas

Tube Tube Tube
Watt Watt Watt Watt Watt
Meter Meter Meter Meter Meter Meter

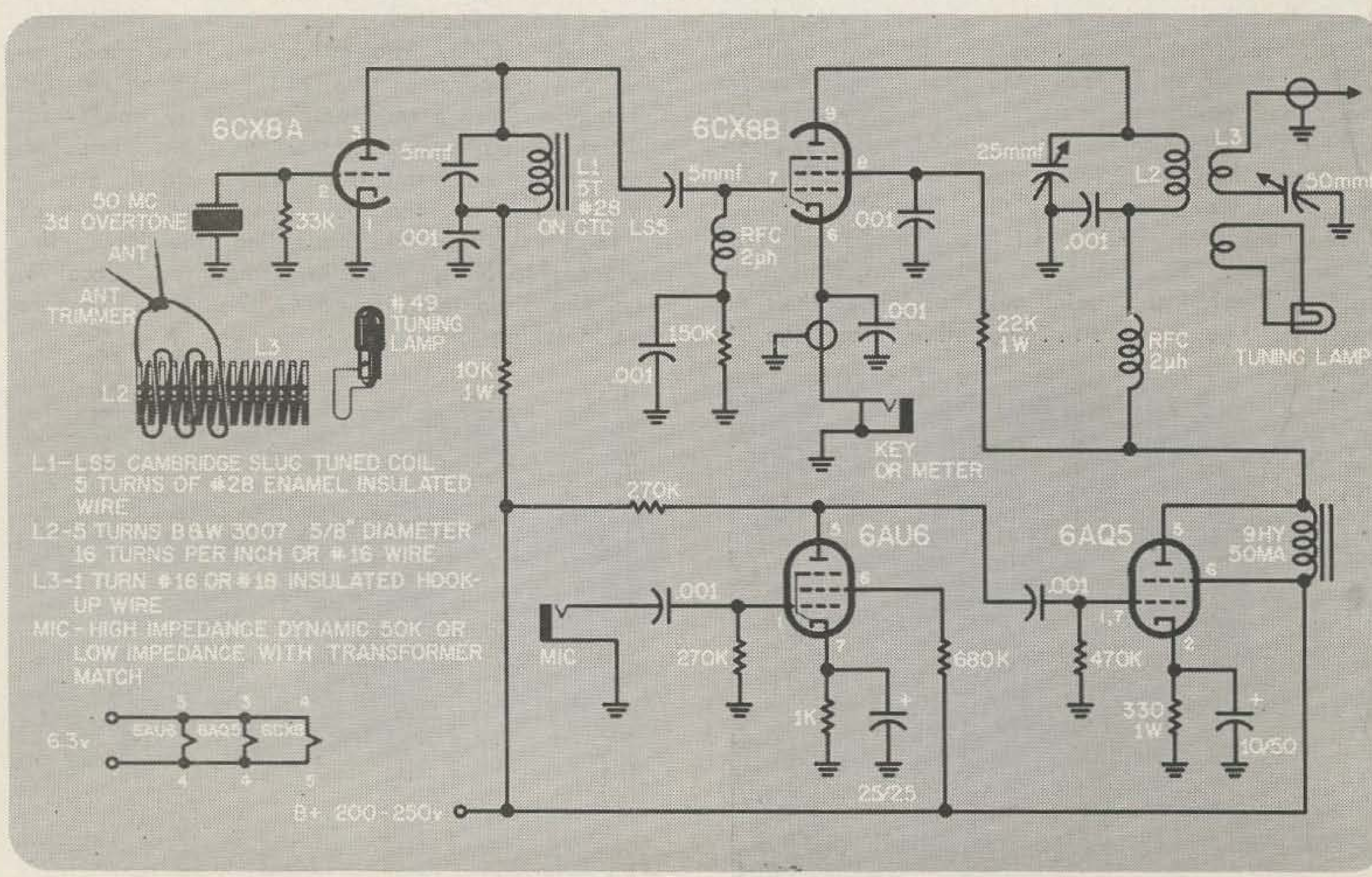
Tube Tube Tube
Watt Watt Watt Watt Watt
Meter Meter Meter Meter Meter Meter

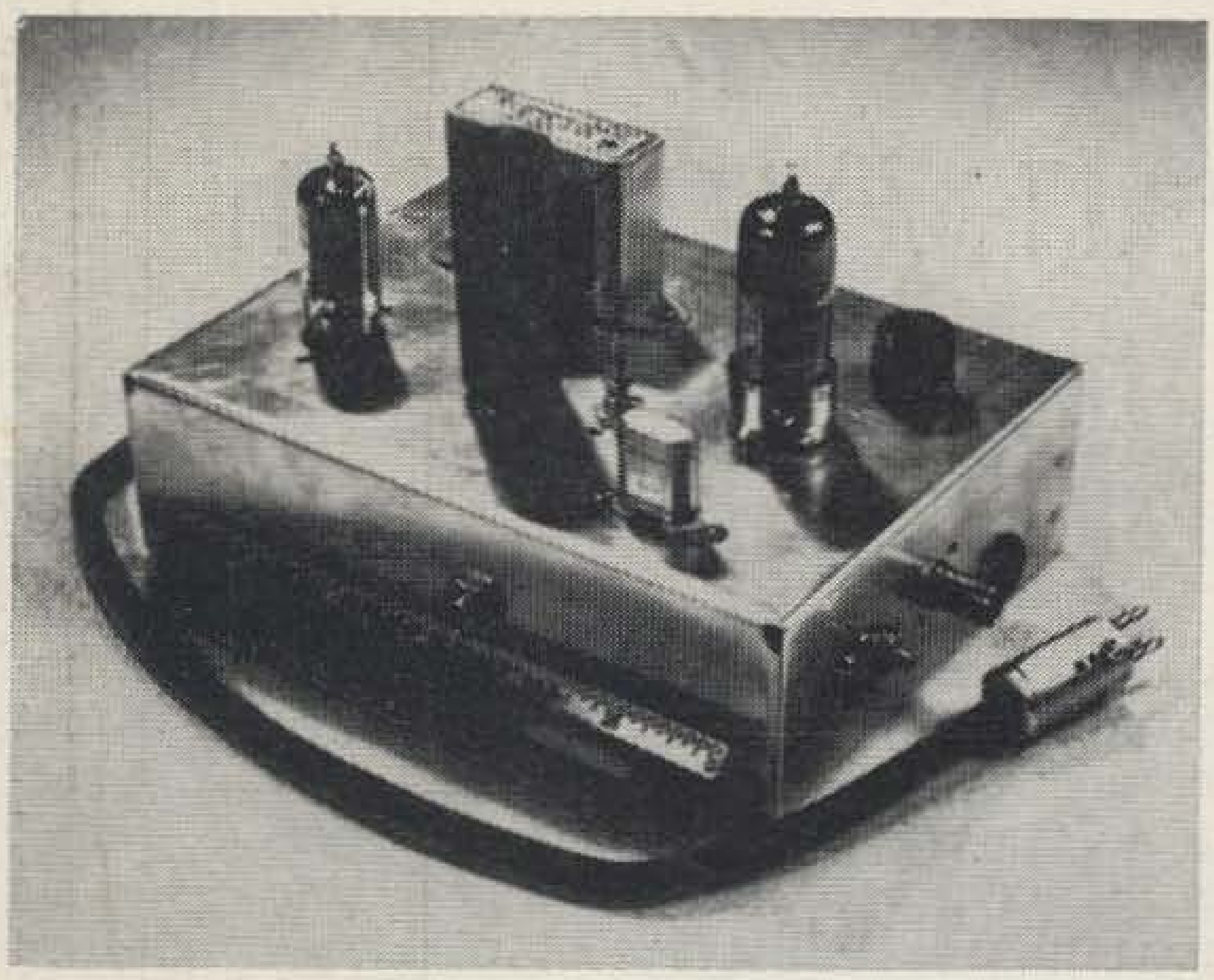
THREE tubes, five watts, six meters. And this li'l 'ol peanut whistle really puts out a bird call: I've worked over 30 miles with an indoor halo antenna plus many fine DX sessions when the band opened. Which isn't bad for a little handful of stuff which knocks together in a couple hours and won't even slim down that big fat wallet of yours to where it will stop wearing out your back pocket.

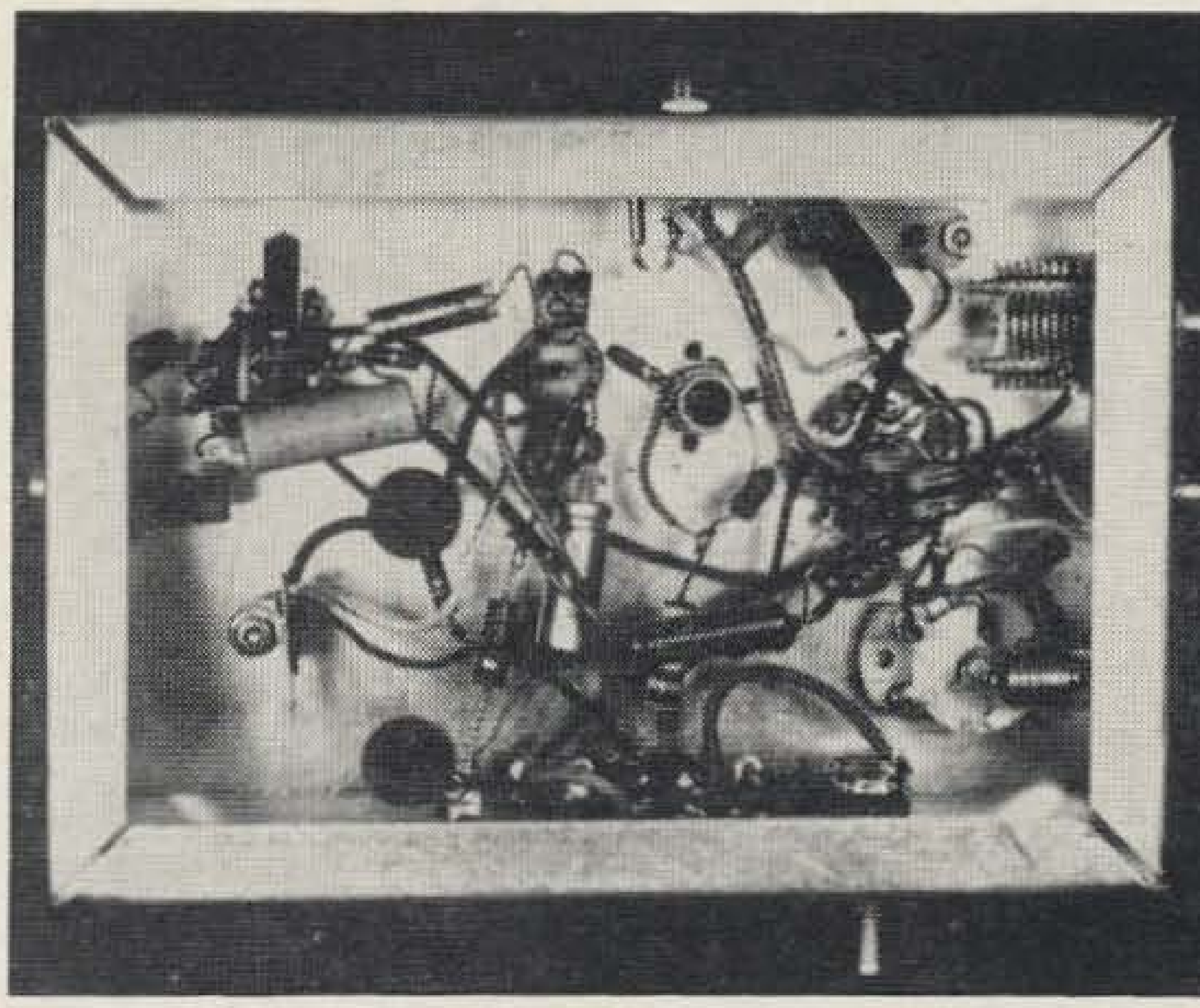
Simplicity, simplicity. An overtone oscillator and power amplifier occupy one set of tube prongs with the number 6CX8 above them. There may be a good pentode-tetrode tube around, but since I didn't have one I used a 6AU6 speech amplifier with a 6AQ5 Heising modulator. What you lose in modulation you make up in savings when you price a cheap filter choke for the executive position usually occupied by a modulation transformer. No one will ever notice the difference anyway, so why fuss about it.

While not much artistic effort went into the layout, it is electronically OK and may be imitated by you if you are in a rubber stamp mood, or if you're not sure enough of yourself to venture off the beated paths. A 5" X 7" X 2" aluminum chassis was used.

The oscillator coil was made by winding five turns of #28 enamel coated wire on a Cambridge (CTC) slug tuned coil form type LS5 (or equivalent). The coil is shunted with a 5 mmfd ceramic capacitor. L2 is five turns







Photographs taken by S/Sgt. Wilson Dodson, Dyess Air Force Base.

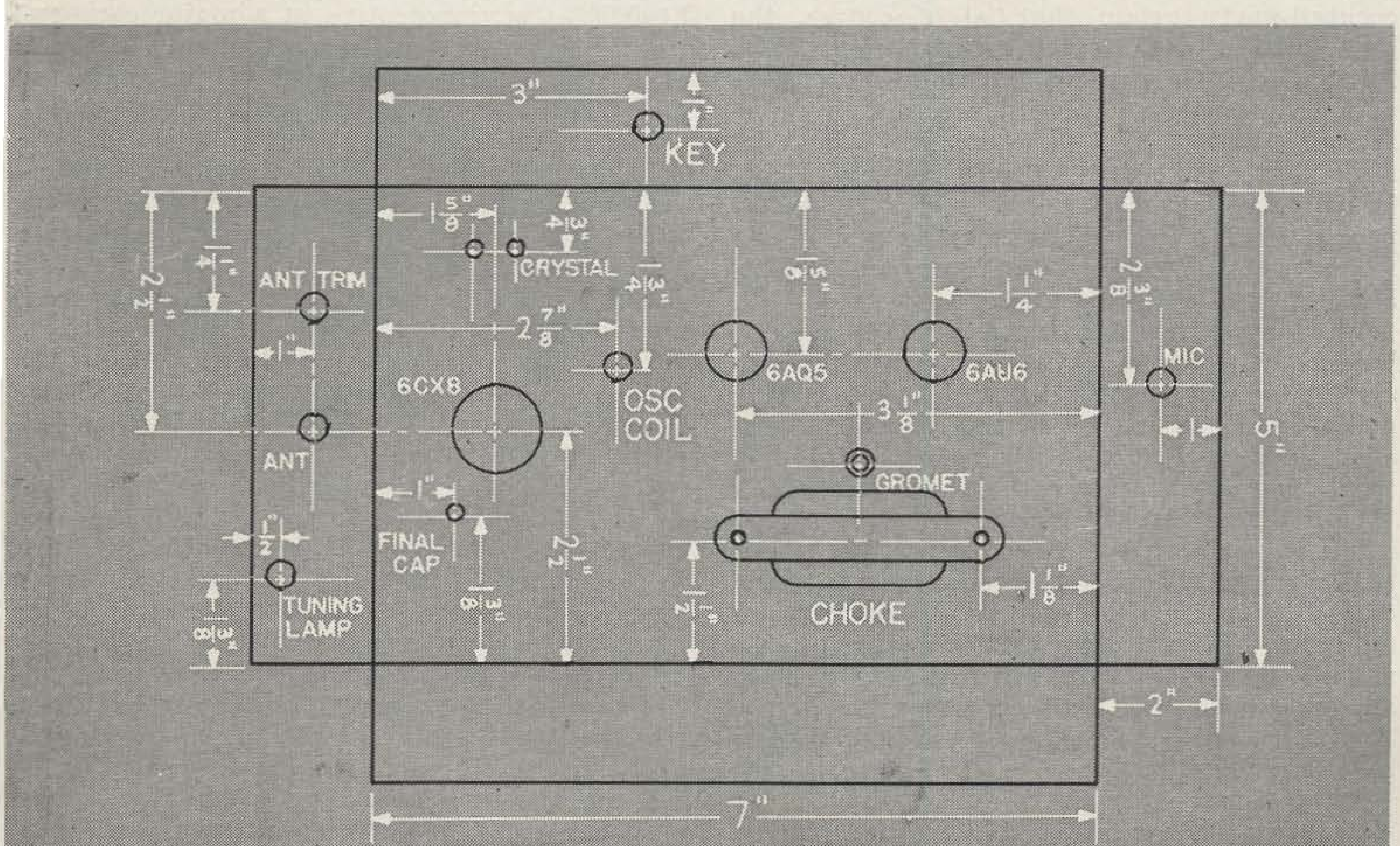
of a B&W #3007 or Air Dux 516T coil (⅝" diameter, 16 turns to the inch, #16 wire). The antenna coupler is one turn of solid hook-up wire.

Since there will be fairly high voltage on the choke leads it is prudent to grommetize the feedthrough hole.

Power Supply. Surely you must have something around that will give 200-250 vdc @ 90 ma. With 250 v you will have an input of 5 watts (20 ma) to the PA section of the 6CX8. This may go up to 25 ma with modulation.

Tuning is easy. You can always build in several dollars worth of panel meters, but you get the same end results by making a #49 pilot lamp and soldering it to a ¾" loop of hook-up wire. Hold the loop close to L1 and adjust the slug for maximum brightness. Next hold it near the final coil and tune the final tank and antenna trimmer for maximum brightness. An rf wattmeter or field-strength meter will also tell you all you need to know for tuning.

The rig is designed for a high impedance dynamic mike and will give plenty of punch with most of the inexpensive ones on the market. Ditto crystal mikes. Just about any type of antenna will load up easily. A halo is fine for general ragchewing, a beam is better for DXing. Give the rig a try and join the local gang on six meters, you'll get a lot of fun out of it.



Testing the Heath Mohican (GC-1A) Transistor Communications Receiver

Donald A. Smith, W3UZN
Associate Editor
P.O. Box 45
Hagerstown, Maryland

PERHAPS you can imagine the doubts which would build up in your mind if you were to take on the job of writing something good about a one hundred dollar "Communications" receiver. Add to this, that it is transistorized and you've had sour experiences with previously available amateur transistor gear.

After the receiver had been assembled (Heath sells *kits*, you know), which took me about 30 hours, the receiver was ready for alignment. I followed the rather complete and thorough instructions provided. Alignment requires a signal generator (like the Heath SG-7) and a VTVM (like the Heath V-7a). Once aligned, I antenna'd it with the whip which comes with the kit and started tuning to determine the magnitude of the disaster.

HMMM, Well, what do you know? HMMM. HMMMMMMMMM! Well I'll be darned! By George! Hey! This thing is really something. The advertised specs of 2 microvolts sensitivity (except on the broadcast band), were found to be quite conservative, even on the ten meter band where most receivers are strangely quiet. This little box of parts held its own right alongside of receivers costing up to twice as much. Let's see what makes it tick.

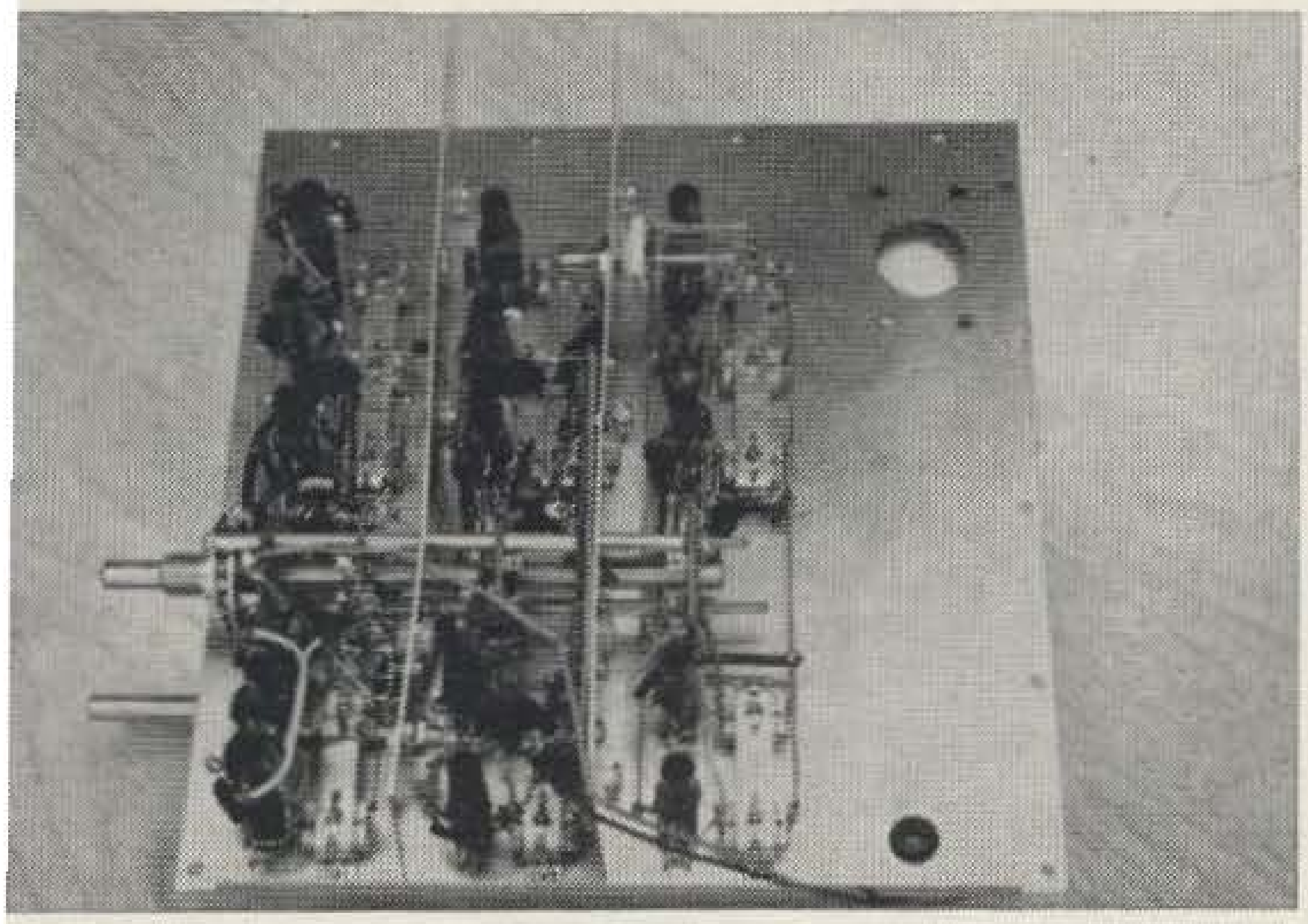
The biggest secret is probably in the front end. After all, if it doesn't have it up front, it doesn't have it. Three transistors are used in the front end. One for rf amplifier, one each for oscillator and mixer. These transistors are not run of the mill jobs, but are good at frequencies up to 100 mc! Thus it's not much of a problem getting performance up to 30 mc. The way the front end layout was designed helps to keep leads short. The transistors are mounted on shields and the band change switch is installed through these shields.

By using adjustable coils in the front end, plus trimmer capacitors, fairly constant sensitivity across the dial is obtained. This eliminates the "dead spots" that we all have experienced.

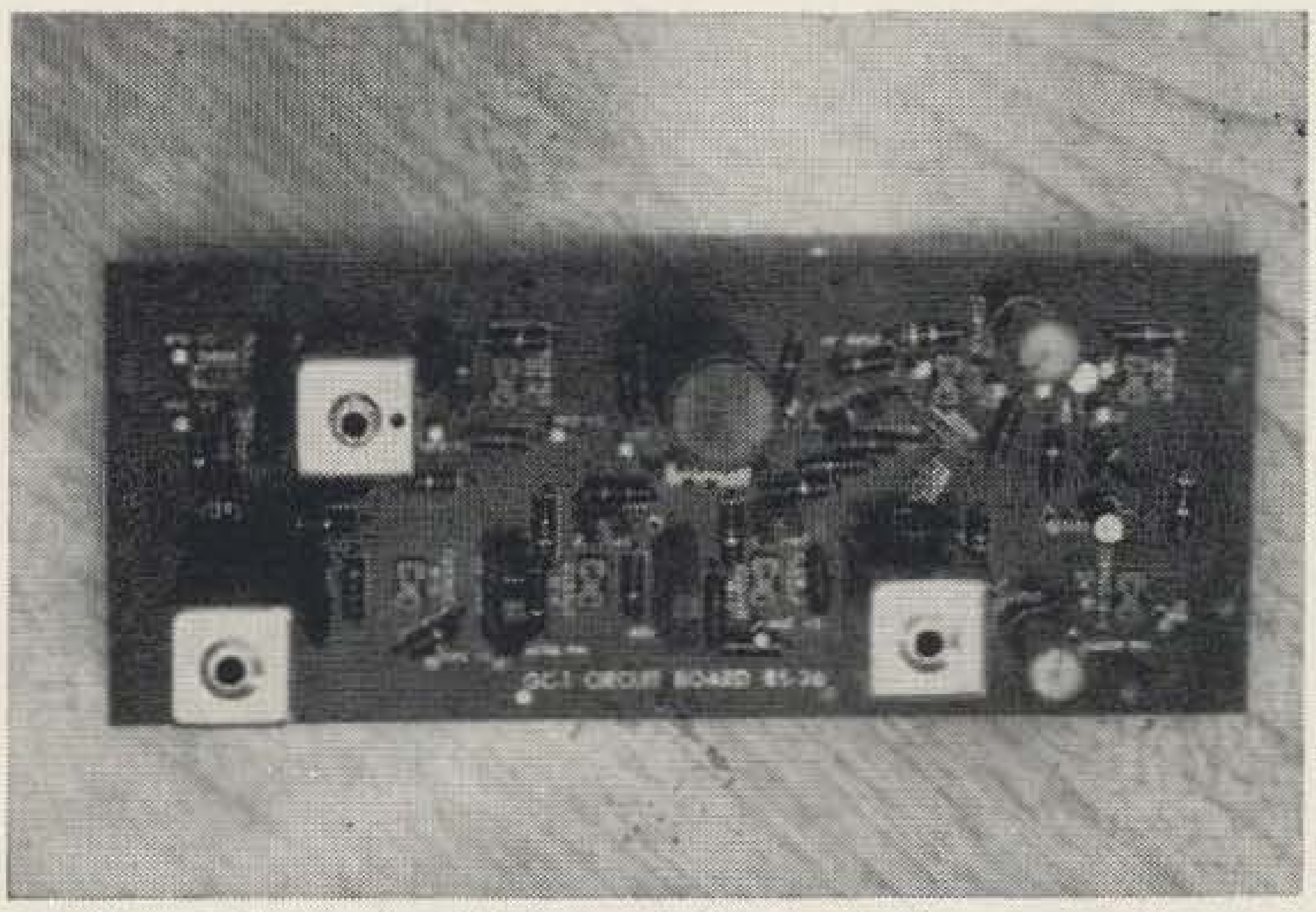
What about selectivity? The figures are 3 kc to the half power point (6 db down), which is made possible by the use of "transfilters". These little jobs are unusual in that they do the job of an if transformer, crystal filter and coupling capacitor, but are none of these. They are somewhat similar to a crystal lattice filter in their operation, though not as efficient. They give much better selectivity than could be achieved from standard if transformers, are rugged and never need adjustment! (Though they have been used by the Signal Corps, this is the first commercial application of them).

What's the line up? 10 transistors, 3 germanium diodes, 2 compensating diodes and 1 voltage regulating Zener diode are used. This gives an rf stage, a separate oscillator and mixer, three if stages, a diode detector, an audio driver and a push-pull output stage. A separate transistor is used for the variable BFO. Diodes are used for automatic noise limiter and AVC.

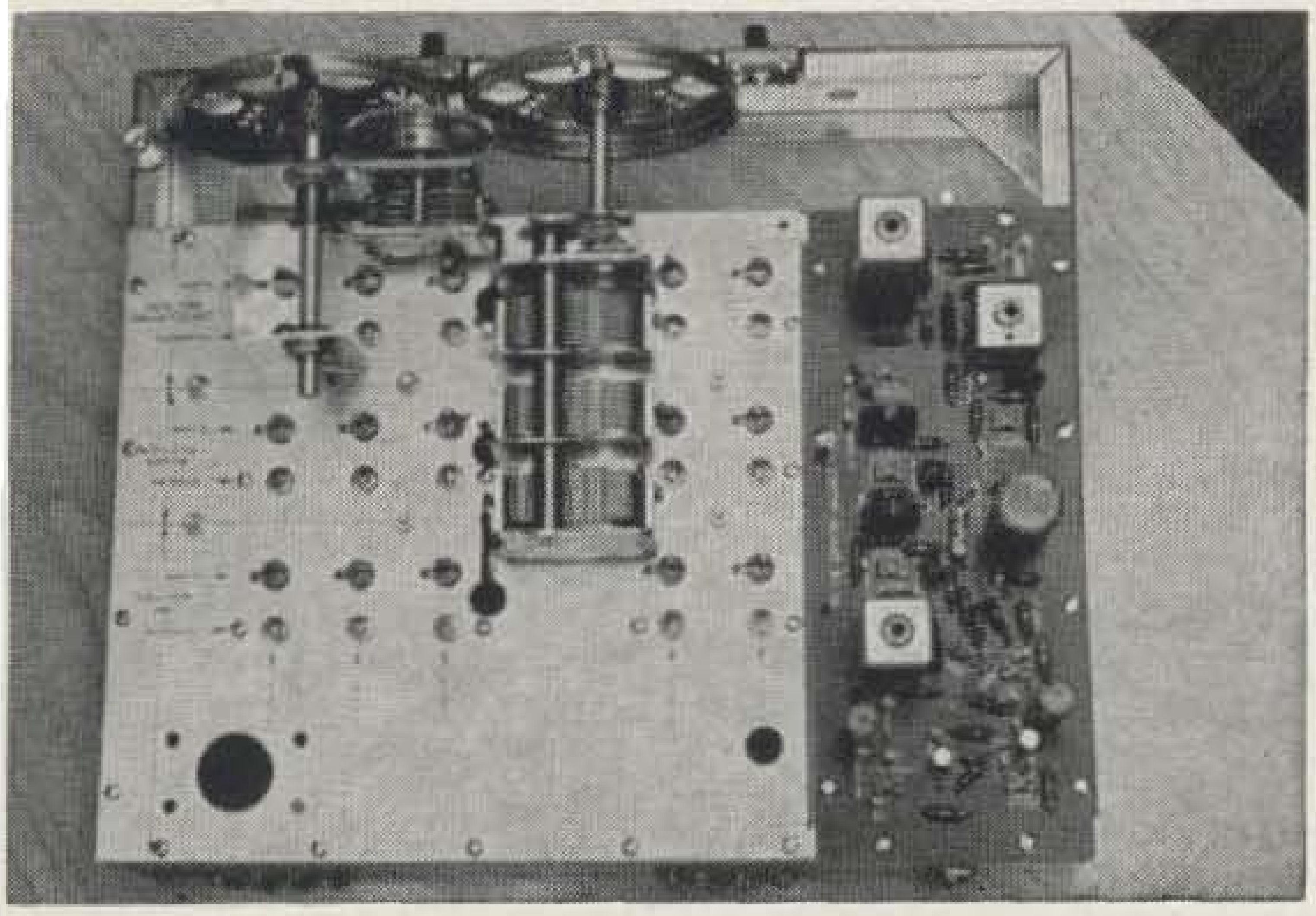
And that's not all! A Zener diode is used



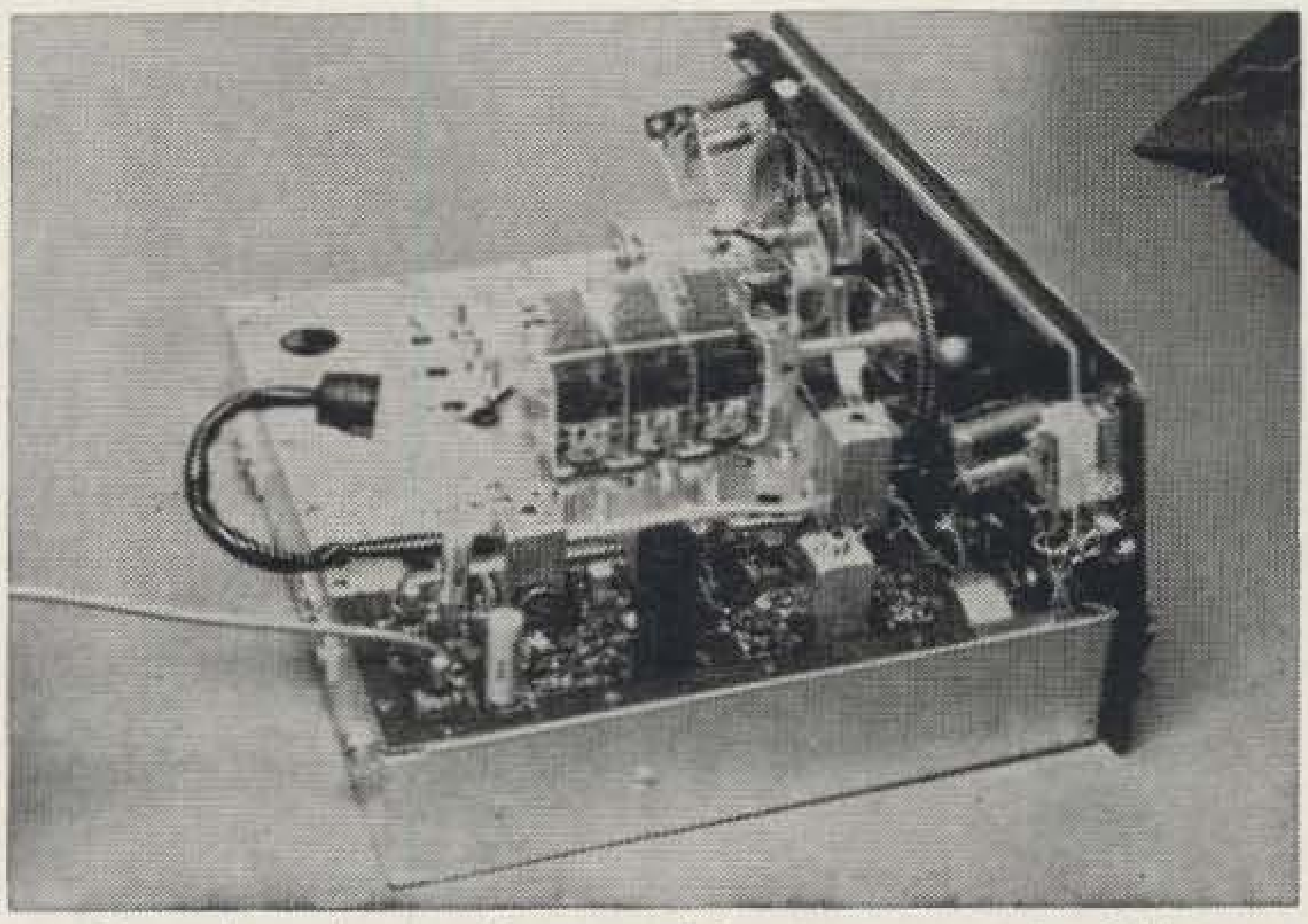
The *rf* section is constructed first. Note that all parts are mounted on a flat sheet, simplifying construction.



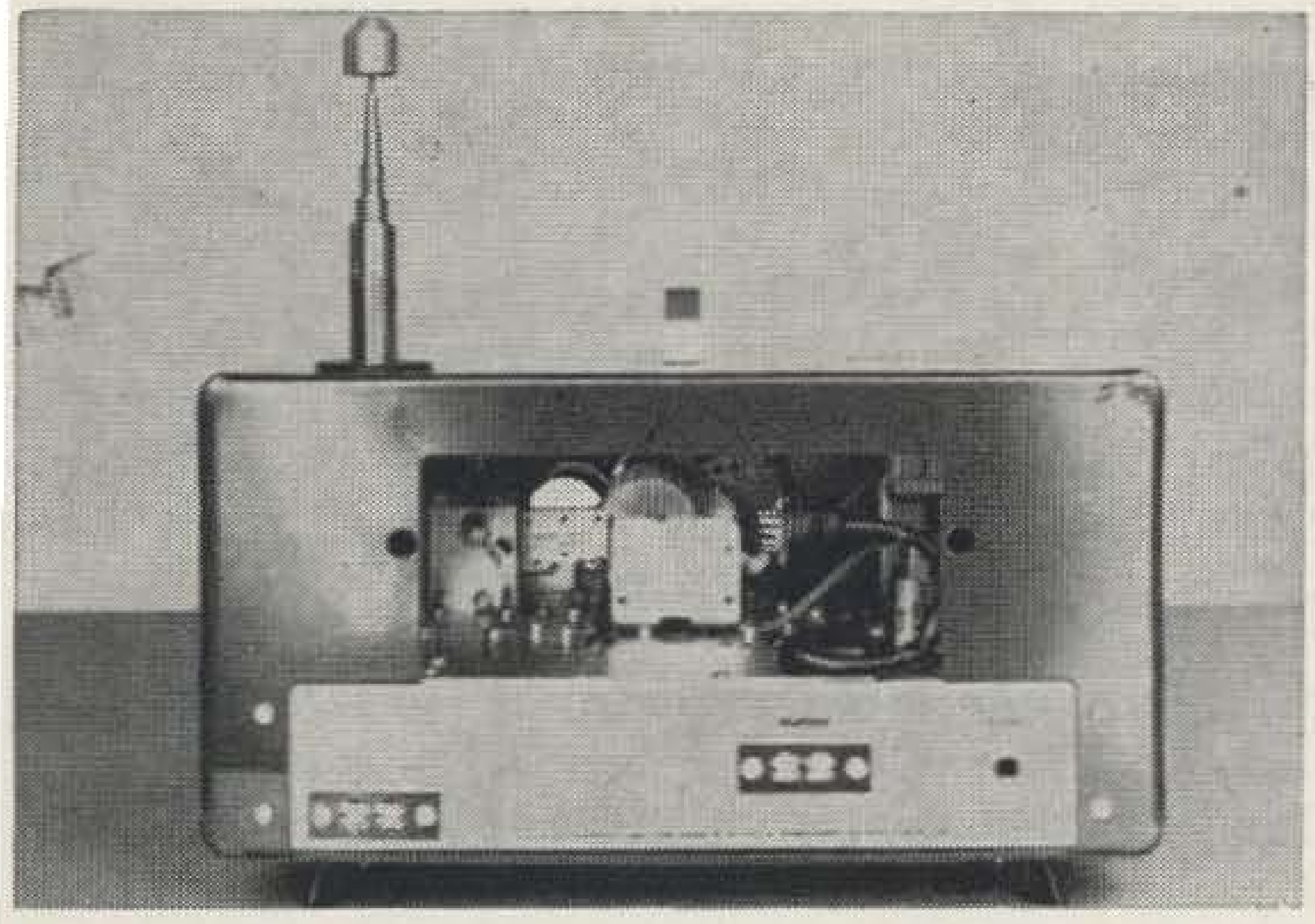
A printed circuit board is used for mounting and wiring of the *if* and audio sections of the receiver.



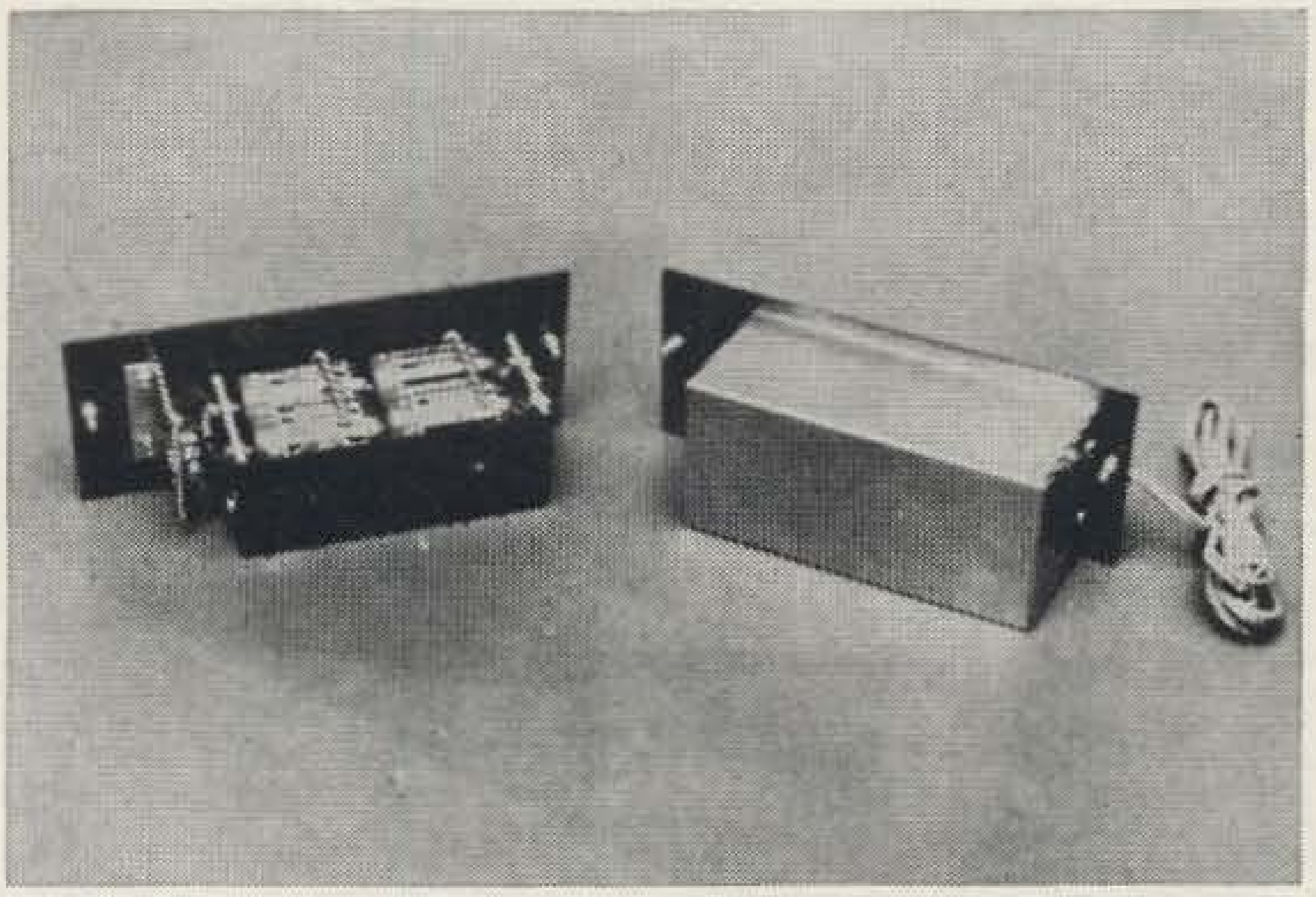
The completed *rf* section and the printed circuit board are mounted on the main chassis and wired to each other.



Completed receiver, cabinet removed. Wire going off to the left connects to speaker mounted in cabinet. Large hole in upper left corner is where "Whip" antenna goes.



Rear of completed receiver with power supply removed. Plug shown in the cut-out, is power plug which is plugged into power supply.

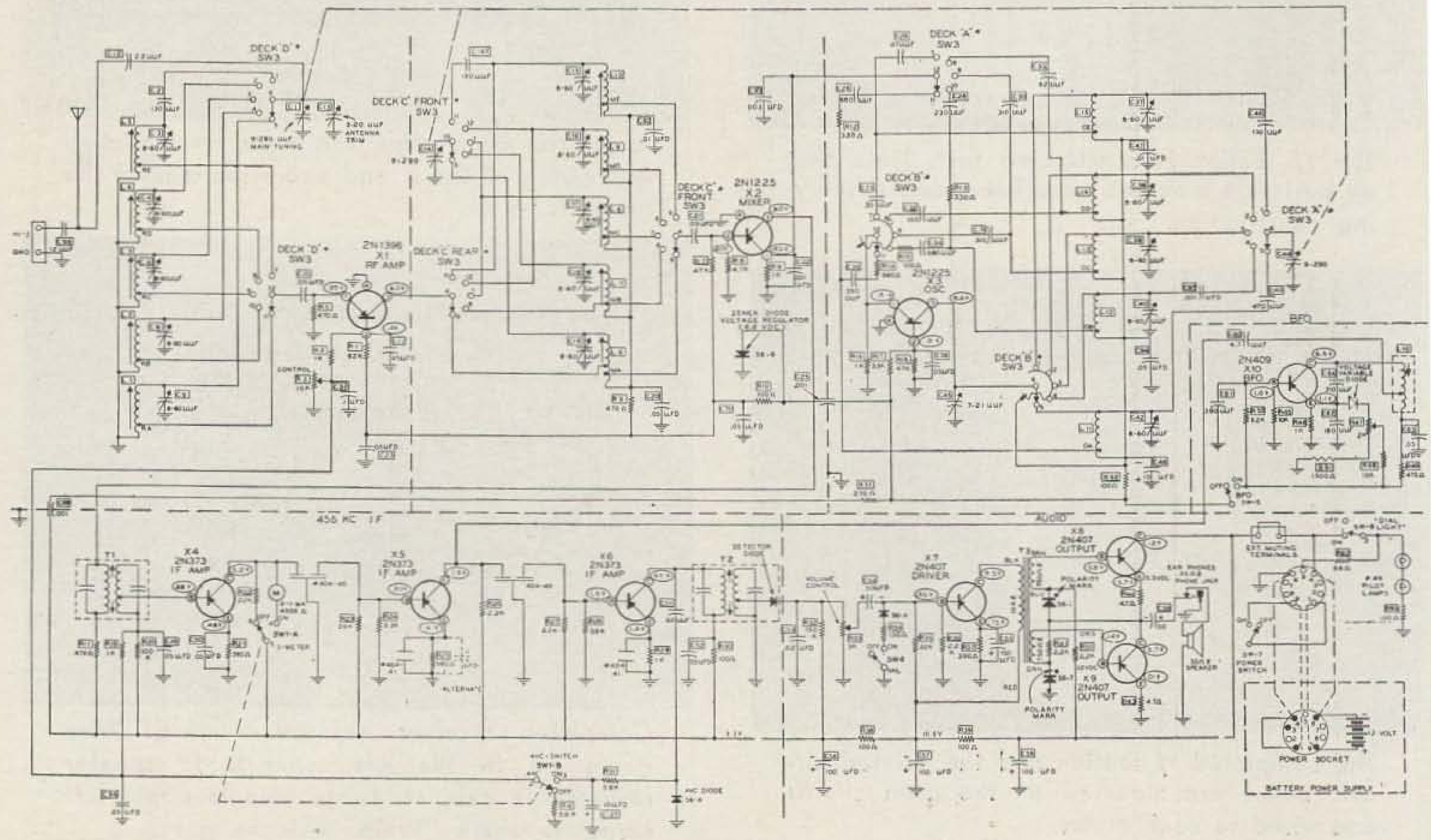


Battery supply on left is furnished with the kit, (less batteries). The supply on the right is *ac* operated supply which is purchased separately, if desired.

as a voltage regulator for the local oscillator. -6.8 volts is applied from the diode to the transistor oscillator base, holding drift down to a *very* low amount. It is the nature of a Zener diode that when a voltage is applied to the diode backwards, reverse current is very low. If the voltage should exceed this amount, the breakdown potential of the diode occurs and the reverse current through the diode increases, bring the voltage back down to the pre-set amount, which is -6.8v in our case.

Another interesting circuit is in the push-pull audio output stage. Two 1N2326 compensating diodes are used, one in each of the output stages, connected to the transistor base circuits. These diodes have a negative temperature coefficient so that as the transistors increase in temperature (as class B transistor output stages do) the diodes will compensate for this increase. By so doing, excessive battery drain is prevented and audio quality is maintained.

These same two diodes also act like voltage regulators, which is important for battery life. As the batteries begin to fall off, they compensate for it (within certain limits, of



course). Perhaps you have noticed how the audio becomes distorted as soon as the battery voltage begins to decrease a little in your transistor portable.

By using a push-pull class B output stage more than enough audio is available. A 35 ohm (low impedance) phone jack is provided on the rear of the receiver chassis. The volume is considerably lower if high impedance earphones are used.

Ordinary flashlight batteries of the "C" size are used and they last up to 400 hours! Replacement costs you less than one dollar. Not bad eh? If you intend using the receiver mostly for shack operation an ac power supply is available for $9.95 which fits in the space provided for the battery case.

Mechanical Aspects

Steel construction gives excellent mechanical and electrical stability. The front end is built on a single sheet of steel, simplifying to some extent this important part of the receiver. The coils, trimmers, band-switch, shields and transistors are built on this plate as a separate section. Steel is also used for the main chassis and the cabinet.

The tuning capacitors (both the bandspread and main tuning capacitors), have anti-backlash gears which are quite effective in providing good vernier tuning. The bandspread, by the way, is good.

Construction begins with the assembling of the front end and the printed circuit board which contains the if stages, audio noise limiter, and BFO. These two sections are then bolted to the main chassis and interconnected. Tuning capacitors and front panel follow. No difficulty was experienced.

In Use

The GC-1A was tested rather thoroughly using the built-in whip, the regular station antennas, and at beach parties. It pulls 'em in no matter how you use it. After several weeks of constant use I was convinced that it did everything I wanted or expected it to do. The selectivity and sensitivity were fine, it worked well on SSB (though a product detector would be somewhat easier to use, of course), and it was a gem for use with my 6 and 2 meter converters.

The spring loaded pilot lamp switch lets you light up the dials when needed and conserves the batteries for more important uses of the amperes.

A close look at the photos will tell you all about the controls on the receiver. It has about everything you really need, including the S-meter. Quite a bundle for the low price and one you'll have a ball with if you give it a try. 73

(CAPACITY METER from page 23)

capacitance, the scale is linear and there is no need for other than full-scale calibration. Hence, a variable resistor, R5 in Fig. 1, is used to shunt a bit of extra current around the meter, to allow for battery aging and also to eliminate the necessity of setting the multivibrator exactly on frequency.

By operating the MV at four fixed frequencies, in decades, the range of operation covers practically all small color-coded capacitors. The frequencies used are 100 cycles, 1 kc, 10 kc and 100 kc.

The MV, in Fig. 1, has three possible states of normal operation. They are: Q1 conducting and Q2 cut off, or Q2 on and Q1 cut off, or a transitional state where both conduct. When the power switch, S1, is first turned on either Q1 or Q2 starts to conduct more readily than the other due to inherent circuit unbalance. Due to the regenerative action of the cross coupled amplifiers one or the other soon is driven to saturation, with the opposite amplifier cut off by the large positive bias developed by the charge on the coupling capacitor. The plus charge drains off toward the B− thru the base bias resistor, and at about —0.1 volts of base bias, the cut off transistor then conducts, and regeneration quickly causes this transistor to become saturated, with the opposite one cut off. This process repeats itself at a rate governed mainly by the base bias resistors, R2 and R3 in Fig. 1, and the intercoupling capacitors, C1 thru C8. The result is more or less a square-wave. A capacitor, Cx, is connected across the terminals J1 and J2 with the instrument turned on. When Q1 is conducting and Q2 is cut off, Cx is charged to practically the full battery voltage thru CR1. On the next half cycle Cx discharges thru CR2 and the meter, M1, and recharges again in the opposite polarity, to the supply potential. The result is, of course, a

(Continued on page 50)

New Product

Telrex Catalog

Drop a card to Telrex Labs, Asbury Park, New Jersey and ask for their catalog PL-77. They've listed rather complete data on 100 different ham band antennas that they manufacture, priced from $6.50 for a 10 Meter Mini-Bowtie to $985 for a four band 10-15-20-40 Meter array. And, say, when you're writing, be sure to tell 'em about 73.

Letters to the Editor

Dear Leader:

Just a note to remind you that we retired air marshalls and admirals tending our beds of flowering concubines and scarlet pandemoniums in the Golden Sunset west of the smog bank—uh, where was I? Anyhow don't forget to enter our subscription and bill us when you get that magazine for adult amateurs printed and passed by the post office, the legion of decency and Alexander King. Hope you haven't reneged on the project, Wayne, there's so much good hard work to be done. Meanwhile, hang onto the boat and let the water support most of your weight.

Ken Cole W7IDF
Vashon, Washington

To: Herr Wayne Green

Dear Wayne:

What Hoppen? Here I sit, patiently waiting for the appearance of "73". Put me on the list to start with Vol. 1, No. 1. I will take any long-term subs deal you come up with, assuming that your original figures of $3 a year, five for two years, etc. Five years for ten bucks? I'll take it. How about a "Lifetime" deal for, say, 25 bucks? We both gamble—you bet that I don't live too long and I bet that 73 does. (I am damned well sure that any good technical magazine will survive and make money.) . . .

73 es all that rot,
Fritz Hervey W9IIU
Chilton, Wisconsin

Dear Mr. Green:

Briefly, more power to you.

By keeping the technical level above that of the beginner, but below that of the professional (each of which has his own specialized literature now), the magazine should be a success. A format of technical articles rather than of operating details should have considerable appeal. Might I suggest, however, that you nevertheless have a variety. CW and FSK right through to sideband and antennas. Although I'm not really a desk jockey, it seems to me that intelligent component and equipment manufacturers would be most willing to buy space in the mag. . . .

Jim W5SUC
Ft. Rucker, Alabama

Dear Wayne,

I am very happy to hear about 73 Magazine, and I want to wish you every success. Your proposed editorial policy sounds like just what is needed in a ham radio magazine. I realize that I am probably in the minority, but I don't like to see ham radio becoming so "commercialized." Most beginning hams today seem to be concerned mainly with which factory built equipment to buy. Maybe they shouldn't be blamed for this, after being subjected to a barrage of advertising, but somebody should tell them that this is a technical hobby, and there won't be much justification for our use of the amateur bands if we degenerate into a bunch of "citizen's band broadcasters" who never build any equipment, and have to send the rig back to the factory for repairs. I hope 73 sells plenty of advertising space, but at the same time, if it can steer hams into doing more experimenting and construction work, I'm all for it. Please put me down as a charter subscriber.

I hope I have understood the first paragraph of your letter correctly, with regard to emphasizing technical and construction articles, and will be eagerly awaiting your first issue. I might even whip up a few articles myself for your consideration. Lots of luck!

R. V. McGraw W2LYH

Modulation Fundamentals

Robert W. Schoening, WφTKX
10040 Brookside Avenue
Minneapolis 20, Minn.

MODULATION systems used by radio amateurs today are increasingly complex. Perhaps in attempting to understand them all, we have neglected the fundamentals. Whatever the reason, the bases of amplitude modulation are widely misunderstood. The same basic theory applies to all the variations of AM, no matter how many sidebands or carriers are transmitted. Here, then, is a review of the AM picture, with a glimpse of the future of radiotelephony.

First, let us define a few terms. "*Splatter*" is a somewhat ambiguous expression, but as used here it means "side-frequencies corresponding to components which are not present at the output of the modulator." Side-freqencies which correspond to audio frequencies which are not in the original intelligence, but are produced somewhere in the audio system of a radiotelephone transmitter, are not necessarily malignant, and will not be termed splatter here.

"*Carrier shift*" is a disease properly defined as any "change in carrier amplitude during modulation". In spite of widespread misinterpretations, there is a great deal of difference between carrier shift and simple asymmetry of the modulating function. Of course, carrier shift implies nothing with respect to carrier frequency . . . only its amplitude. "Positive carrier shift" is an increase in carrier amplitude during modulation, while "negative carrier shift" is the opposite. A change in carrier amplitude (in voltage or current) is indicated by a change in the *average* voltage or current output of the transmitter when amplitude modulated. Remember that while the rms antenna current (and hence the rms voltage) increases during modulation, and while the peak antenna voltage and current double on 100% positive modulation peaks, the average values should remain constant.

"*Downward modulation*" is negative carrier shift so severe that the decrease in carrier output is greater than the sideband power produced by modulation. With downward modulation a decrease in total power output occurs when modulation is applied and the antenna ammeter (or neon bulb) kicks down instead of up.

"*Radiated modulating power*" is a good description of sideband power. The more of this that actually gets to the receiver detector, the greater the volume of sound produced at the loudspeaker. In order to be useful, the audio produced at the receiver should be that which contributes to intelligibility. There are two types of sideband power which do no good: the power contained in sidebands which do not get to the detector due to receiver selectivity; and the power, which, when detected, merely excites the loudspeaker cone without contributing to the intelligibility. For this reason, simply increasing the radiated modulating power is no assurance that the signal will "get out" better. Even a decrease in total sideband power may improve signal reception on a selective receiver at a distant point, if the sideband components remaining are rearranged to do their job properly.

It is important to remember (as if the SSB contingent would allow us to forget) that the carrier's function in AM is only to accommodate the intelligence-bearing components. Leaving sideband power and distribution unchanged and increasing the carrier power will make absolutely no change in the volume at the receiver. Did you ever try this and find that the signal became weaker as you increased the carrier thus decreasing the modulation percentage? If so, you forgot to disable the avc, so that the receiver's gain was reduced as you fed in more carrier. There is some advantage, however, to a strong carrier. The signal will not overmodulate itself so asily when selective fading is encountered at he receiver, and the heterodynes from adja-ent carriers may seem less objectionable. 'here are, in spite of some semi-serious alle-ations to the contrary, absolutely no logical rguments in favor of reducing the carrier un-ess the power saved can be utilized in increas-ng the radiated modulating power, as with SSB.

Methods of extending the positive modula-ion peaks do not, as has been suggested, offer nore sideband power without splatter; nor lo they necessarily improve the received sig-ial's intelligibility. Any system which produces arrier shift must produce splatter; moreover splatter may exist without carrier shift.

The normal dc plate input to the final radio requency amplifier produces the carrier. For his reason, carrier shift can occur only if his dc power changes as the result of modu-ation, or if the efficiency of the modulated (or linear) amplifier does not behave accord-ng to the requirements for the type of modu-ation used. Since dc cannot "get through" a transformer, nothing we do in the audio sys-em short of overmodulation can possibly cause carrier shift. No matter how lop-sided or dis-torted the modulating waveform becomes in the modulator, it cannot produce splatter as we define it. We automatically rule out defec-tive modulation transformers, autotransform-ers and choke coupling, of course.

A pure ac wave is one which has an average value of zero because the two alternations en-close exactly equal areas. The two alternations need not be the same shape nor have the same peak amplitude; however if the peak of one alternation goes farther from zero than that of the other, the lower alternation's values stay near their peak longer. When such a waveform is used to modulate a radio fre-quency wave, the maximum increase and de-crease in rf wave amplitude need not be equal, but if the increase (positive modulation peak) is greater, the decrease (negative modulation peak) must last longer. Since the average in-crease and decrease are then equal, the aver-age amplitude of the rf voltage is unchanged from its unmodulated level—no carrier shift occurs. When we view "modulated envelope" patterns on an oscilloscope, we do not see the individual rf cycles, but only the envelope (whose height is proportional to the peak to peak rf voltage) as it varies in amplitude at some rate corresponding to the modulating function. The top or bottom outline of the envelope corresponds to the actual modulating waveform, whether or not this is the modula-tor's output waveform. A linear detector re-ceiving the signal will produce an output voltage in this form.

If no modulation is applied, the rf envelope height remains constant as in Fig. 1-A. Fig. 1-B shows the envelope sinusoidally modulated at about 70%, and if nothing unsanitary hap-

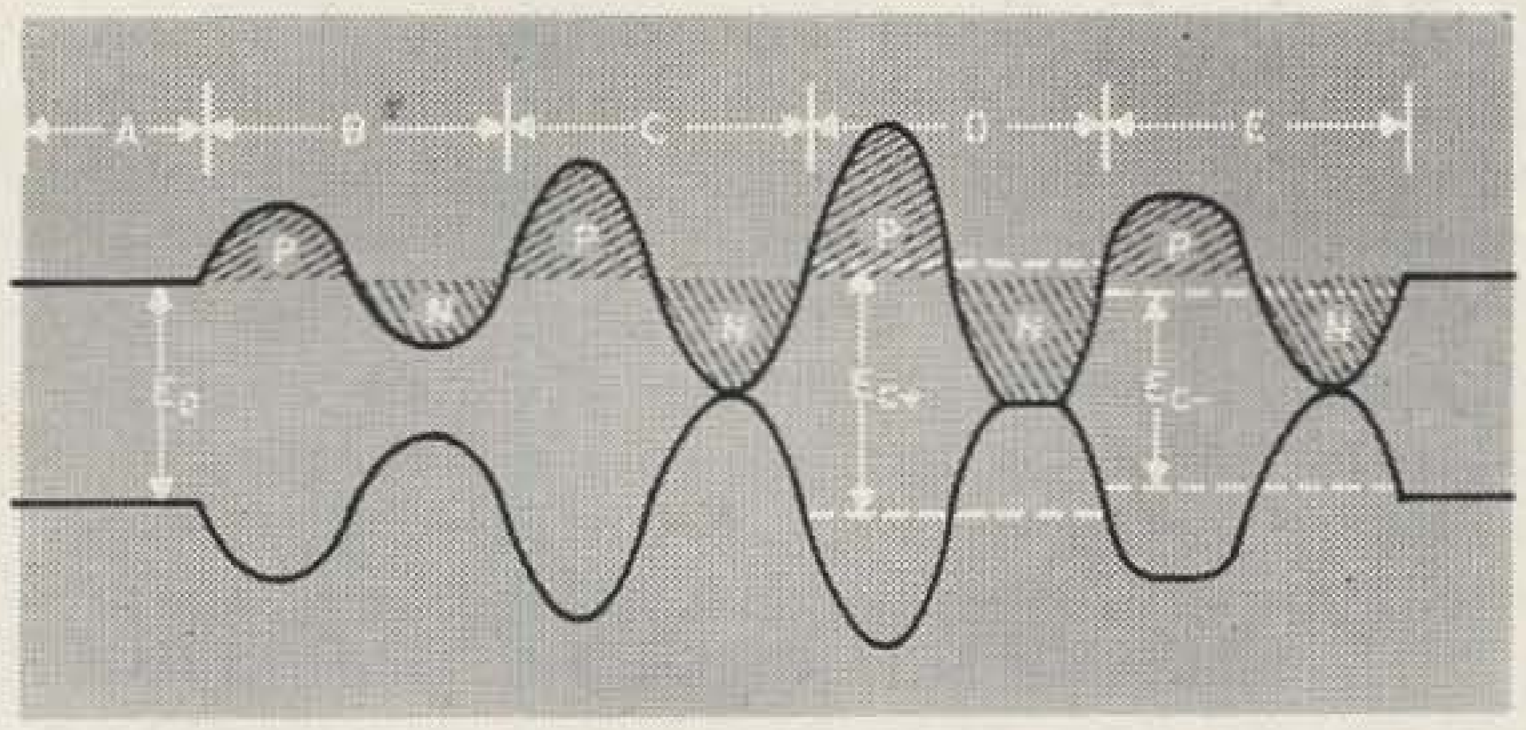


Fig. 1

pens in the process, the positive peaks (P) and the negative peaks (N) will include pre-cisely the same area. The average height of the rf wave envelope is still Ec, just as it was with no modulation.

With a good transmitter, we should be able to increase the amplitude of the modulating signal to obtain 100% modulation (Fig. 1-C) while still maintaining an average amplitude of Ec: no carrier shift.

If the transmitter is capable of extended positive peak modulation (and few really are), a further increase in the modulation gives the pattern of Fig. 1-D. Here the transmitter shuts itself off for a brief portion of the nega-tive peak, so that the positive peaks' areas (P) are greater than those of the negative peaks (N). Now the average rf amplitude in-creases to Ec+: positive carrier shift. The clipped negative peaks represent a source of vicious splatter. Their sharp corners corres-pond to modulating frequencies much higher than the actual output of the modulator, and the resulting sidebands are much farther from the carrier than normal. Modulating frequen-cies this high would not ordinarily be passed by the modulation transformer, so that the broadening will be more severe than that which audio distortion alone could cause.

If the transmitter distorts the positive peaks, splatter may also be produced. In Fig. 1-E the negative peak is the same as 1-C, but the flattened positive peak makes area P less than area N, so that a negative shift in car-rier amplitude occurs, and the average rf am-plitude becomes Ec—. Actually this flattening is usually more gradual than in 1-D, so the signal may not be quite as broad. It can still clutter up several adjacent channels, however.

Let us consider the causes of condition 1-E. First the flattening did not occur in the audio system, for if it had, the modulation trans-former would have automatically made areas P and N equal and no carrier shift could have occurred. The wave might have looked almost the same on the 'scope, but the areas would have been re-distributed symmetrically around the average amplitude, Ec.

With plate modulation, positive modulation peaks occur when the positive audio alterna-tion adds to the dc plate voltage to increase the plate voltage on the modulated rf ampli-fier stage. During this peak, plate current should rise in direct proportion, and rf amplifier efficiency should remain constant. Insufficient reserve of cathode emission could prevent a linear increase in plate current. Perhaps the rf amplifier uses a screen grid tube and the screen voltage (which has considerably more effect on plate current than the plate voltage) is not being increased along with the plate voltage. Maybe the tube is running too close to cut-off bias, so that while it remains in class C on negative peaks (reduced plate voltages), it enters class B or even class A as the plate voltage rises. This could produce a drop-off in efficiency on the positive peaks. Remember that "cut-off bias" is proportional to plate voltage, so that an rf amplifier with bias beyond cut-off and 1000 volts on the plate may be running at less than cut-off when the plate voltage doubles as on positive peaks of 100% amplitude modulation.

A very common cause of negative carrier shift in this sort of stage is insufficient rf grid drive. Excitation may suffice for the normal unmodulated plate voltage, but on positive modulation peaks the limit of possible plate current (a function of load impedance and plate voltage) increases, so that more drive is necessary to maintain full plate efficiency during these peaks.

If Fig. 1-E represents the output of a linear rf amplifier or a grid-modulated stage, other causes suggest themselves. In these systems, the rf amplifiers' plate efficiency must approximately double on positive modulation peaks, so if the grid drive is too high, the unmodulated efficiency will run too high and the positive peaks must suffer. Some relief is available here by using a lower plate load impedance to raise the limit of plate current. By juggling drive and loading, we can usually restore the positive peak.

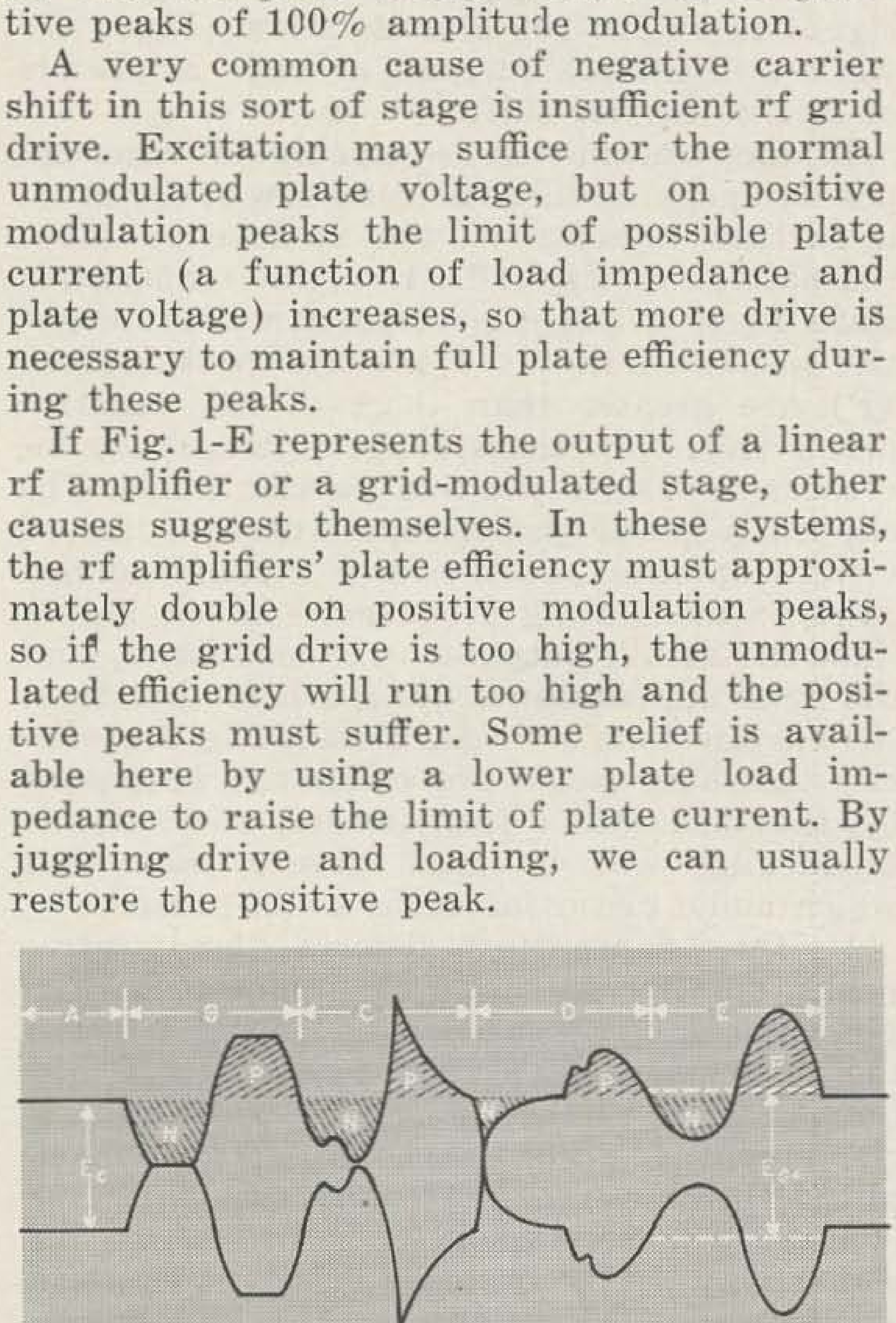


Fig. 2

Figure 2-B shows that two wrongs don't make a right. Here a rare combination of circumstances has resulted in overmodulation without carrier shift, since positive peak flattening exactly matches the negative clipping caused by overmodulation. The average rf amplitude is unchanged from its unmodulated value (Fig. 2-A). Splatter, however, is abundant . . . . the modulator is putting out a sine wave. What if the modulator's output waveform actually was that shown? In that case we would have no splatter by our definition, although the wave would occupy exactly the same spectrum and include the same interference potential. Remember, however, that modulation with this sharp-cornered waveform would be in some special service (hardly telephony unless the modulating frequency is a very low one), and a suitable spectrum assignment would be provided.

Figures 2-C and 2-D show the reasoning behind "extended positive peak" modulation. Voice and music modulation often produces waveforms with unequal peaks. Here a waveform of that type is shown; 100% modulating a radio wave, first in one polarity and then in the other. The drawing is intended to indicate that in both cases the positive peak (P) and the negative peak (N) include the same area. In Fig. 2-C however, the smaller peak is applied negatively, and (assuming again that the transmitter can handle the extended positive peak) modulation in the positive direction can actually exceed 125% without splatter. No carrier shift exists. If, as in Fig. 2-D, the modulating signal is applied in the opposite polarity, the gain control must be backed off, and the sideband power decreased accordingly to prevent negative peak overmodulation, carrier shift, and splatter. The correct polarity for your particular voice may be found by reversing any two wires in the audio system . . . . or even, with some types of microphones, by speaking into the other side of the microphone. The pattern is most easily interpreted for voice modulation if a slow linear sweep (under 100 cycles) is applied to the horizontal plates and the transmitter's rf output sample directly to the vertical plates of the 'scope.

Even if your voice waveform exhibits as much unbalance as in Fig. 2-C, there is a very good possibility that your transmitter cannot handle the extension of positive peaks, for the reasons listed in reference to Fig. 1-E. If you decide to carry the extension farther than can be done by finding the favorable audio polarity, systems have been evolved where a sine wave output from the modulator causes extended positive peak modulation as in Fig. 2-E. We recognize this as carrier shift, and we must admit that it will produce splatter since the modulated wave outline does not conform to the modulator's output waveform. There is a possibility that, if not carried to excess, the spurious side-frequencies produced will not cause serious adjacent channel interference. We have no assurance that the additional sideband power that we attain in this way will not be objectionable, or that it will contribute to intelligibility at the receiver. Systems of this sort which have been suggested in amateur publications do not guarantee against adjacent channel interference even though the negative peaks are not clipped; nor do they put all the extra sideband power through the selective portions of the receiver into the detector. Only by shaping the modulating signal *before* it gets through the modulation transformer, and by carefully distributing its content through the desired audio range can we be sure (assuming a healthy rf amplifier system in the transmitter) that by enhancing the sideband power transmitted, we really improve the signal.

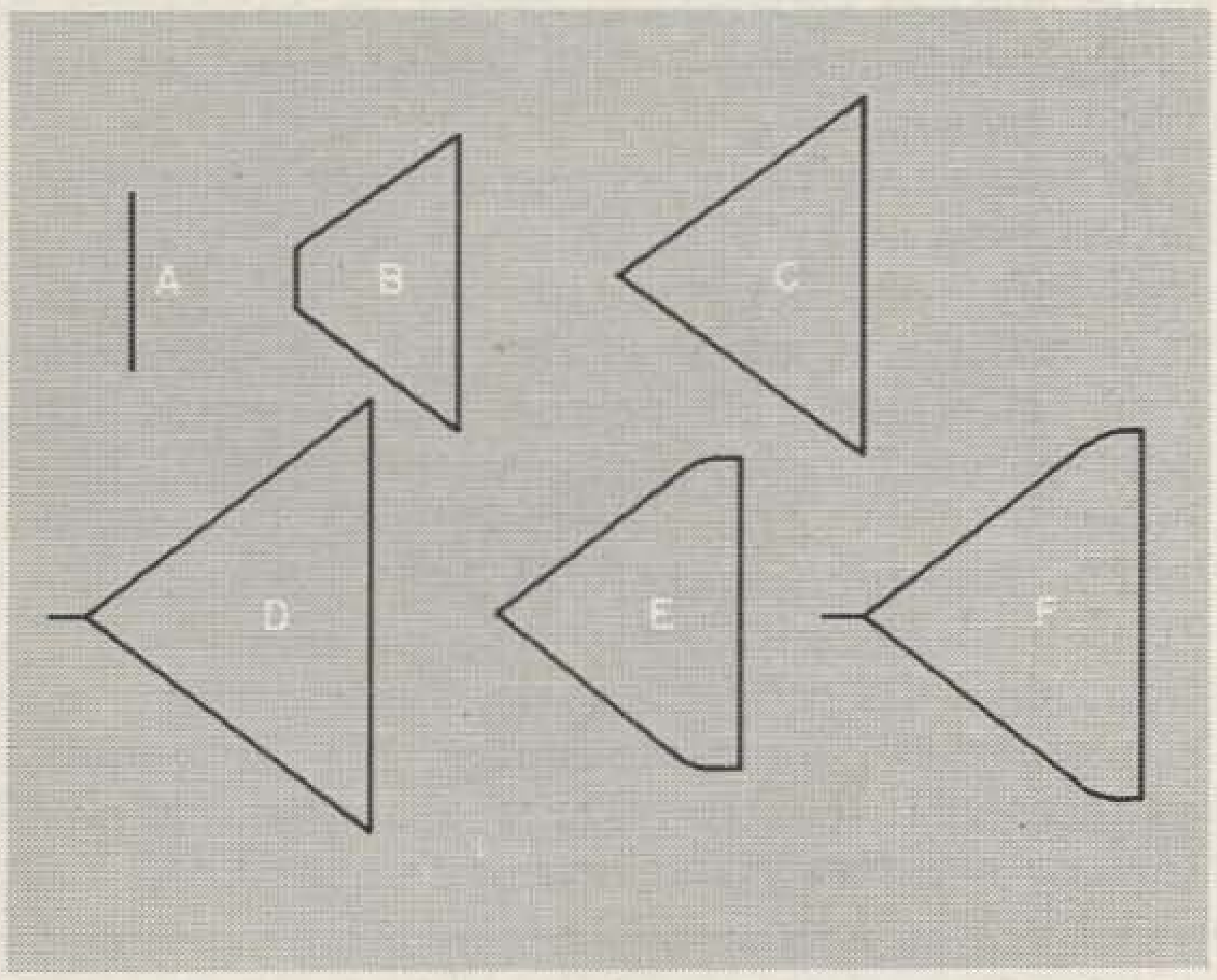


Fig. 3 — 1

Before we make any suggestions, let us review the 'scope patterns by inspecting their corresponding trapezoidal displays. Fig. 3-A, of course, represents the trapezoidal pattern for no modulation. Figs. 3-B, C, D, and E correspond to Figs. 1-B, C, D, and E respectively. Fig. 3-F shows the highly improbable case outlined as a modulated envelope in Fig. 2-B. Drawn to the same scale, Fig. 3-G, in its entirety, is larger (by the cross-hatched area) than 3-C. Due to the greater peak amplitudes obtained with the extended positive peak modulation encountered in the corresponding Fig. 2-C. The shaded triangle of 3-G shows the reduction of positive peaks necessary to prevent overmodulation with improperly polarized audio (2-D). You may have noticed that any bends or corners in the non-parallel sides of our trapezoid represent carrier shift. In 3-D, E, and F, the departures from linearity are abrupt. In 3-H, the bending is gradual, but carrier shift still exists, reflecting the condition (2-E) of artificially extended positive peaks.

Trapezoidal patterns are useful for monitoring voice modulation, but they must be produced correctly to prevent misleading indications. If the audio wave used for horizontal deflection is taken from any point in the audio system other than the secondary of the actual modulation transformer, non-linearities may appear which do not indicate carrier shift. If, on the other hand, the audio deflection is obtained from a detector which rectifies the rf signal, perfect linearity might be indicated even though carrier shift exists. It is often inconvenient or even dangerous, especially with plate modulation, to sample the secondary of the modulation transformer, but this is the only way to get a coherent trapezoid. Readers unfamiliar with these common 'scope displays are advised to look up the connections required in any reference book or handbook covering radiotelephony, and to examine the corresponding patterns shown here, piece by piece, until the relationship is clear.

How can we increase our radiated modulating power without producing side frequencies which are either redundant or unsportsmanlike? It must be done within the audio system, and our old friends clipping and filtering seem to offer the best path for telephone communications. Filtering alone can improve intelligibility by removing lows (long on power which clutters up your audio channel's capabilities, and short on intelligibility). The experts recommend taking out everything below 300 cycles. If this is done, your voice quality will not be appreciably affected, but you will be able to advance the gain control to get more sideband power corresponding to the important audio areas. If you want to go all the way (good for DX but a little extreme for local rag-chewing), attenuate everything below 800 cycles.

Removing the high frequencies above 2500 or 3000 cycles should be done at the last possible point in the audio system; the modulation transformer. This will not, in fact, affect the sound of your voice noticeably—try singing 2500 cycles and see. The components filtered out will be, for the most part, distortion products. If filtering takes place too early, subsequent audio stages may re-introduce high frequency distortion components which while not splatter (by our definition) can cause side-frequencies which your neighbors will resent. Most communications-quality modulation transformers drop off quite well by themselves around 5000 cycles, so "building out" the windings with a bit of shunt capacitance can take care of the highs; especially if low-level filtering is also employed.

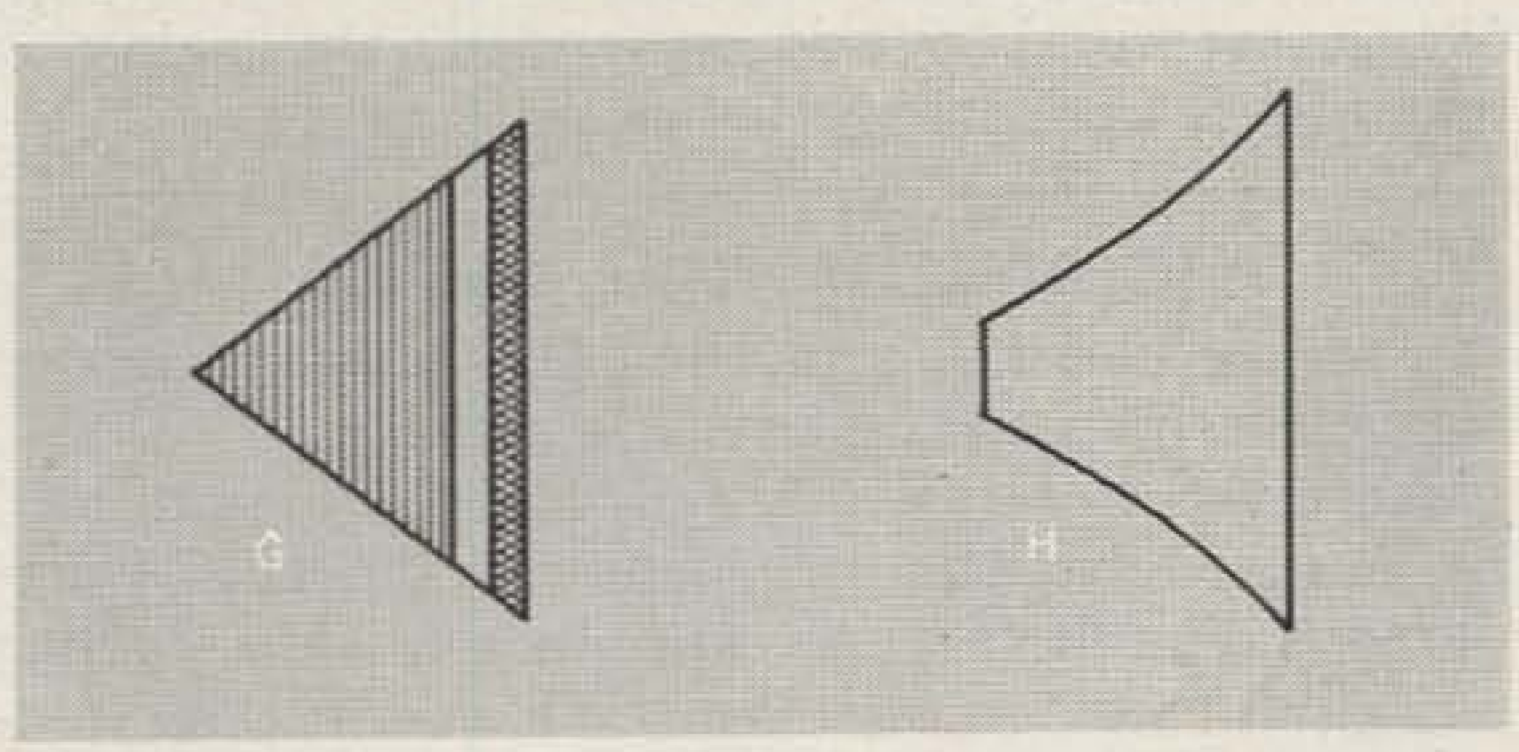


Fig. 3 — 2

Peak-clipping can give tremendous sock to a signal, by increasing average sideband power to a level which would require perhaps ten times as much carrier power were clipping not employed. Volume compression without clipping (as used by broadcasters) can at

(Continued on page 54)

(AUDIO BOOSTER from page 9)

fect balance to begin with, oscillation will develop. Adjust R13, the balance control, until the howls stop. Advance R1 some more, readjusting R13 as necessary, until it becomes impossible to stop oscillations by adjusting R13. This will mark the usable limit of the Booster's gain.

Adjust your transmitter for 100 percent modulation on peaks, using your favorite method of monitoring modulation depth. Then remove the short from the Booster's AGC line and connect it to the microphone input using a Y-type connector. Set the limiting threshold control, R12, at maximum resistance.

Say a few words and check modulation depth. Advance R12 toward minimum resistance until your voice begins to sound like a monotone without inflection[3]. Lock R12 at that position and advance R1 toward minimum resistance until the sound of your voice is satisfactory again. All operating adjustments after initial calibration are made with R1, which can be marked in db. of limiting if desired. At minimum resistance of R1 the Booster is effectively out of the circuit, while at the maximum usable setting compression ratio will be in the neighborhood of 25 db (depending upon your mike).

If you're using a scope to check your modulation, you should at this point be able to see the difference between the modulation percentage with and without the Booster. So far as your effective talk-power is concerned, that gets boosted right along with the modulation index.

The Booster is not limited to AM use, either. It will work with any type of voice modulation, since its only effect on the waveform is to compress the dynamic range. No distortion is generated in the Booster; consequently, no filters or splatter chokes are necessary. 73

[3]At this point, your voice will have long since ceased to sound natural. Our objective in this adjustment is to set the limiting threshold so that the booster completely washes out all amplitude variation in the signal (see note 1). Operating adjustment to regain naturalness in the voice is made with R1.

(POWER SUPPLY from page 27)

A circuit breaker device is used for power supply protection when the supply is used on the 120 volt ac line. If a short should exist in your equipment, loading the supply too heavily, it will cut out, removing the ac supply voltage. To reset it, simply press the bottom on top of the cut-out. On dc operation a fuse is used instead. The circuit layout is not at all critical, though the wires from UHF jacks to the relay should be kept short.

Notice that all outputs from the supply, (filament and B+ voltage, as well as relay), are brought out of the supply through the use of a 6 terminal Jones socket. Terminal #6 is used to control the B+ - Antenna change over relay. If you desire to operate the change over relay from a location other then the chassis of the supply it is only necessary to connect a lead from #6 through a switch to ground. When terminal #6 is grounded, the relay is energized, operating the changeover.

The change-over relay, which is a 6 volt dc type, operates on any of the three input voltages. This is accomplished with a miniature power supply to furnish the proper voltage. Looking at the diagram you will see that a small rectifier, X1, is connected to the 6 volt winding of the power transformer, T1. On 120 volt ac operation, the 6 volts ac is rectified by X1 and filtered into good dc by R2 and C4 for the relay. On 6 and 12 volt dc operation, even though no filament voltages are furnished by the power transformer, X1 and its filter circuit is still receiving 6 volts ac, permitting operation of the relay on all three input voltages.

The power supply shown has been used in both 6 volt and 12 volt cars and in a 12 volt airplane! It has been used extensively on 120 volts ac as well. Neither the vibration of mobile operation, nor the constant changing from one input supply voltage to another has caused any trouble with the unit. 73

(CONVERTERS from page 15)

the mixer coil L3, and then the antenna series capacitor C1 and the cathode coil L1.

After you have aligned the unit you will be amazed by the performance of this inexpensive converter. As simple as it is, it has out-performed many fancy brothers using expensive tubes and many more components.

The noise generator, using a 5722 Sylvania diode, used for evaluation was built and carefully calibrated by the author, using the circuit and method of calibration from the VHF handbook by William I. Orr and H. G. Johnson. The sensitivity tests were made with a Measurements Corporation signal generator Model 80.

Tests performed and evaluated on many typical converters in the frequency range of 220, 144, 108, and 50 mc the averages are as follows:

FREQUENCY	NOISE FIGURE	SENSITIVITY
220 mc	5½ db	.2 µv
144 mc	4½ db	.1 µv
108 mc	4 db	.1 µv
50 mc	3½ db	.1 µv

In conclusion the author wishes to extend his thanks to Joe Kwetnewski W9UTD for his excellent photography. 73

COIL DATA is on page 47 →

CAPACITOR VALUES

FREQUENCIES OF CONVERTERS

(W9DUT CONVERTERS)

C	M.C. 220	M.C. 152	M.C. 144	M.C. 108	M.C. 50	50 M.C. and Lower		
C 1	4-35	4-35	4-35	4-35	4-35	MMF	CERAMIC	TRIMMER
C 2	270	470	470	.001	.001	RMC	TYPE B	
C 3	.001	.001	.01	.01	.01	"	" B	
C 4	270	470	470	.001	.001	"	" B	
C 5	13	15	27	33	50	"	" NPO	
C 6	.001	.001	.001	.01	.01	"	" B	
C 7	.001	.001	.001	.01	.01	"	" B	
C 8	.001	.001	.001	.01	.01	"	" B	
C 9	.001	—	—	—	—			
C10	.005	.005	.01	.01	.02	"	" B	
C11	25	—	—	—	—			
C12	—	25	33	50	50	"	" NPO	
C13	—	470	470	680	.001	"	" B	
C14	—	.005	.01	.01	.02	"	" B	
C15	.001	.001	.001	.001	.001	"	" B	

RC COMBINATION

						(R. F. AMPLIFIER) (CATHODE BIAS) (AND MIXER BIAS)	
R—	68Ω	68Ω	68Ω	68Ω	68Ω		
C—	270	470	470	.001	.001	RMC	TYPE B

RESISTOR VALUES

ALL RESISTOR ½ WATT

COIL DATA

Coil	Res. Freq. M.C.	No. Turns	Wire Size	Length of Winding	All Coil Forms CTC Slug Tuned		
				(220 M.C. CONVERTER)			
O.D. Inches							
L1 ¼	220	3	#22	¼"	Space	wound	(Tap at 1¼T)
L2 "	220	2½	"	¼"	"	"	
L3 "	220	2	"	3/16"	"	"	
L4 ⅜	13	45	#30		Close	"	(2T Link at Cold End)
L5 ¼	207	4	#22	5/16"	Space	"	
L6 "	34.5	23	#30		Close	"	
L7 "	103.5	4	#24	5/16"	Space	"	
				(144 M.C. CONVERTER)			
O.D. Inches							
L1 ⅜	144	3½	#22	5/16"	Space	wound	(Tap at 1¼T)
L2 "	144	3	"	¼"	"	"	
L3 "	144	4	"	¼"	"	"	
L4 "	14	40	#30		Close	"	(2T Link at Cold End)
L5 "	130	4½	#22	¼"	Space	"	
L6 "	43.+	12	#24		Close	"	
				(152 M.C. CONVERTER)			
O.D. Inches							
L1 ⅜	152	3	#22	¼"	Space	wound	(Tap at 1T)
L2 "	152	2½	"	¼"	"	"	
L3 "	152	3	"	¼"	"	"	
L4 "	13	45	#30		Close	"	(2T Link at Cold End)
L5 "	139	4	#22	5/16"	Space	"	
L6 "	46.+	10	#24		Close	"	
				(108 M.C. CONVERTER)			
O.D. Inches							
L1 ⅜	108	6	#22	⅜"	Space	wound	(Tap at 2T)
L2 "	108	5	"	⅜"	"	"	
L3 "	108	7	"	⅜"	"	"	
L4 "	14	40	#30		Close	"	(2T Link at Cold End)
L5 "	94	6	#24	⅜"	Space	"	
L6 "	31.+	26	#30		Close	"	
				(50 M.C. CONVERTER)			
O.D. Inches							
L1 ⅜	50	10	#24		Close	wound	(Tap at 3T)
L2 "	50	12	"		"	"	
L3 "	50	12	"		"	"	
L4 "	14	40	#30		"	"	(2T Link at Cold End)
L5 "	36	16	#24		"	"	
L6 "	36	11	"		"	"	

(CAPACITY METER from page 41)

current indication on the meter, the exact value depending upon the supply voltage, the capacity of Cx, and the rate at which this charge and discharge effect takes place.

In order to protect the meter from damage due to shorted capacitors, CR3, a silicon diode biased in its forward conduction direction, was included. This limits the maximum voltage across the meter to about 0.5 or 0.6 volts. The meter movement itself was thus protected, but spikes due to the capacitor charge caused erroneous readings when the diode conducted prematurely. To prevent this, C13 was included, and in addition C13 provides damping which further prevents meter damage.

In actual use, the range switch is set to a position which gives an on-scale reading. The power switch is then set to CALIBRATE, and R5 is set to give a reading of 100. Then switch back to ON, read the meter, and use the appropriate multiplier indicated on the range switch. Since leaky capacitors would give erroneous indications, a leakage test position was included on the range switch. For this test, Q1 is cut off, Q2 conducting, and the full battery voltage connected across J1 and J2. Any indication of course means a defective capacitor.

Construction

The entire circuit including the battery and a 4½ inch panel meter was built into a 3 x 4 x 5 inch LMB chassis box. Most of the components were mounted on a piece of 1/16 inch epoxy glass board, using eyelets and jumper wires. Use of 100 volt rating capacitors helped cut down the size. The 9 volt mercury battery was mounted in a clip from a cabinet latch. The current drain is in the order of 20 ma, and the required voltage slightly above 6 volts, so a 7.5 or 9.0 volt dry battery could be substituted if desired.

The range switch, S2, should be of the shorting type to prevent the multivibrator from stopping when switching ranges, which would require turning the power switch off, then on again. Aside from the usual precautions to observe polarity of the diodes and battery, the only critical wiring is in the need for short direct leads to J2 from the power switch, and from the power switch, S2, to CR1 and CR2. The capacity of the lead to the standard 100 mmfd capacitor, C12, was about 3 mmfd in the authors instrument, and was allowed for in the selection process. The standard capacitors (C9-10-11-12) were measured on an accurate bridge, and were padded where necessary to obtain the correct value. All other capacitors can be whatever is on hand in the range required, either paper or mylar dielectric type being suitable. For reduction of stray capacity effects a ground from the meter circuit to the case is quite essential. Only type 2N414 and 2N247 transistors have been tried, but similar types should be satisfactory. The silicon diodes recommended for CR3 were the least expensive available, and other types should do as well. Use of decals helps improve the appearance and operating convenience of the unit, but if the meter case is opened, use care to avoid dust or other damage. 73

(PHONE PATCH from page 24)

be used. Occasionally during the excitement of hearing from a friend or loved one, the person may blurt out some expression that violates the FCC rules. If this happens, "hit the switch", then firmly but courteously inform him of the regulations regarding such action.

Try not to let the conversation drag. Once in a while a little well timed prompting on your part will eliminate the long and embarrassing pauses that appear when the parties are not used to the "phone patch" system.

Upon conclusion of the patch, again assure the person that there is no charge or obligation involved and that this service is part of the enjoyment that you and your fellow operators get from their hobby.

As to "phone patch" procedure, this may vary between stations. However, the most practical for AM is to have each party say "over" as he finishes talking. This signals each operator to switch from "send" to "receive" without the necessity of signing each time.

Patches should have a reasonable time limitation. If the traffic is of a critical nature and time consuming, don't forget to break for station identification at the proper period of time.

Since the advent of the "phone patch", many operators have been personally involved in dramatic and touching situations. This is especially true of the patches run between members of our Armed Forces and their families at home. From both a technical and service standpoint, each amateur operator should attempt to handle "phone patch" traffic with all the efficiency and courtesy possible. Here again is another chance to benefit humanity through the most fabulous hobby of all—Amateur Radio. 73

(MODULATION from page 45)

least double the radiated modulating power without objectionable distortion. In either case, the modulator will be furnishing more average power than if no limiting were employed, so that extra power-handling capability must be available in the audio system. Normal design limits usually allow your modulator at least 3 db of this reserve without modification.

When clipping is used, filtering must follow to ease the rate of change represented by the flattened audio peaks. When carried to an unusual degree, audio quality becomes less pleasant at first, (who wants to sound pleasant and be buried by QRM?) and then intelligibility begins to suffer. Going beyond this point is useless when the signal is received normally, but there is some indication that a special translation system used at the receiver can reclaim speech waveforms clipped well beyond intelligibility. Perhaps this is a route worth exploring for future applications.

With single-sideband suppressed-carrier radiotelephony, the clipping and filtering techniques are even more rewarding, since the additional radiated modulating power is concentrated in one sideband where most of it must find its way to the detector which will then give even more push to the loudspeaker cone.

What other means might we find to narrow and intensify our radio telephone signals? What about suppressing the audio carrier generated by your vocal chords? Speech, when analyzed, consists of the generation of an audible tone which is amplitude, frequency, and phase modulated, simultaneously, at a syllabic rate. The syllables themselves are subaudio and if only their information were transmitted our radio telephone signals could be as narrow as fast telegraphy. Speech can be re-built around a mechanically-generated tone as is done by persons whose vocal chords do not function. This sort of speech is monotonous, but perfectly readable. The main obstacle with transmitting only the syllabic information and re-inserting the audio tone at the receiver is the loss of un-voiced sounds: the hissing and clicking which contributes to intelligibility, and requires a wider-range audio system than purely syllabic modulation would allow. At any rate, here's a project to consider.

Already with us is the multiple channel AM transmitter which can use a single carrier for several simultaneous communications. Present bandwidth requirements for these systems are quite reasonable. The Kahn AM stereo system for example, occuping no more spectrum than a single dual-sideband station modulating with similar audio frequencies. Broadband systems such as FM broadcasting and television, permit the use of subcarriers (as with FM multiplexing or color television) for a considerable quantity of useful information, and with no increase in bandwidth. Amateurs haven't found much use for these techniques yet. Perhaps some of the ham families could use a single transmitter with channels labelled "his" and "hers".

Let us, first of all, concentrate our intelligence-bearing sidebands into as narrow a band as possible, and put as much power as possible into this band. This should be done before the modulation transformer. The time is here when, even with a single sideband, we must do this to keep pace with the competition. As present techniques become fully exploited, let us thoroughly analyze any new ideas which come along and even develop systems of our own. With present communications speeds in the thousands-of-words-per-minute rate available, it's hard to justify even a six kilocycle bandwidth for simply talking. The CW operator is an artist who does not have to justify his methods on scientific bases. The phone man, however, should have some technical achievements of which he can be proud. Let's get busy: don't wait for the commercial manufacturers to do it!

Technical Broadcasts

The Air Force MARS has a very interesting technical series going every Sunday afternoon. This month the subject is semi-conductors. Time: 2 pm to 4 pm. Tune in and listen. The frequencies are: 3295 kc, 7540 kc, and 15,715 kc.

Oct. 2—Walter S. Miller (Arma Corp.), The Diode
Oct. 9—C. D. Simmons (Philco), Transistor Parameters
Oct. 16—Bud Merrihew (Philco), Transistor Circuits
Oct. 23—John Ekiss (Philco), Tunnel Diode Applications
Oct. 30—Charles Gray (Philco), Transistor Applications

(ELECTRONIC KEY from page 19)

practical *in a single unit.* With the components shown in the circuit diagram, the speed range of the unit is approximately 10 to 25 wpm. Speeds above this range may be obtained simply by changing the component values of the time constant circuits forming the characters. A switching arrangement could be inserted to perform this function, but for simplicity sake it was omitted (and 25 wpm is almost my tops anyway!).

2. When changing speeds, all three potentiometers must be adjusted to obtain the desired speed and weight of keying at the chosen speed. If the controls were ganged, the unit *would not* be as versatile.
3. Potter & Brumfield LM-11 (5K coil) relays are used in my particular unit. However, any high speed plate relay with a high impedance coil should operate satisfactorily. Relays with tail spring adjustments should be used so that additional control of the pull-in and drop-out point of the relays may be obtained when adjusting the key, prior to using it on the air.
4. When all relay adjustments have been completed the adjustments should be locked with a drop of glue.

The unit shown in the photograph is built on a 5"x7"x2" chassis. The cabinet is home brew (aluminum), and was made to fit this particular unit. All connections to this unit are made at the terminal strip bolted to the back of the chassis.

One word of caution: The key terminals are hot (90v dc), so a suitable lucite or plastic shield should be used.

The Key Head

The key head used with an electronic key is essentially a SPDT switch. Recently there have been several of these put on the market. The Vibroplex Company has the Vibrokeyer which sells for $15.95 and the Electrophysics Corporation has the Autronic Key for $16.95. Both of these units will work well with this keyer.

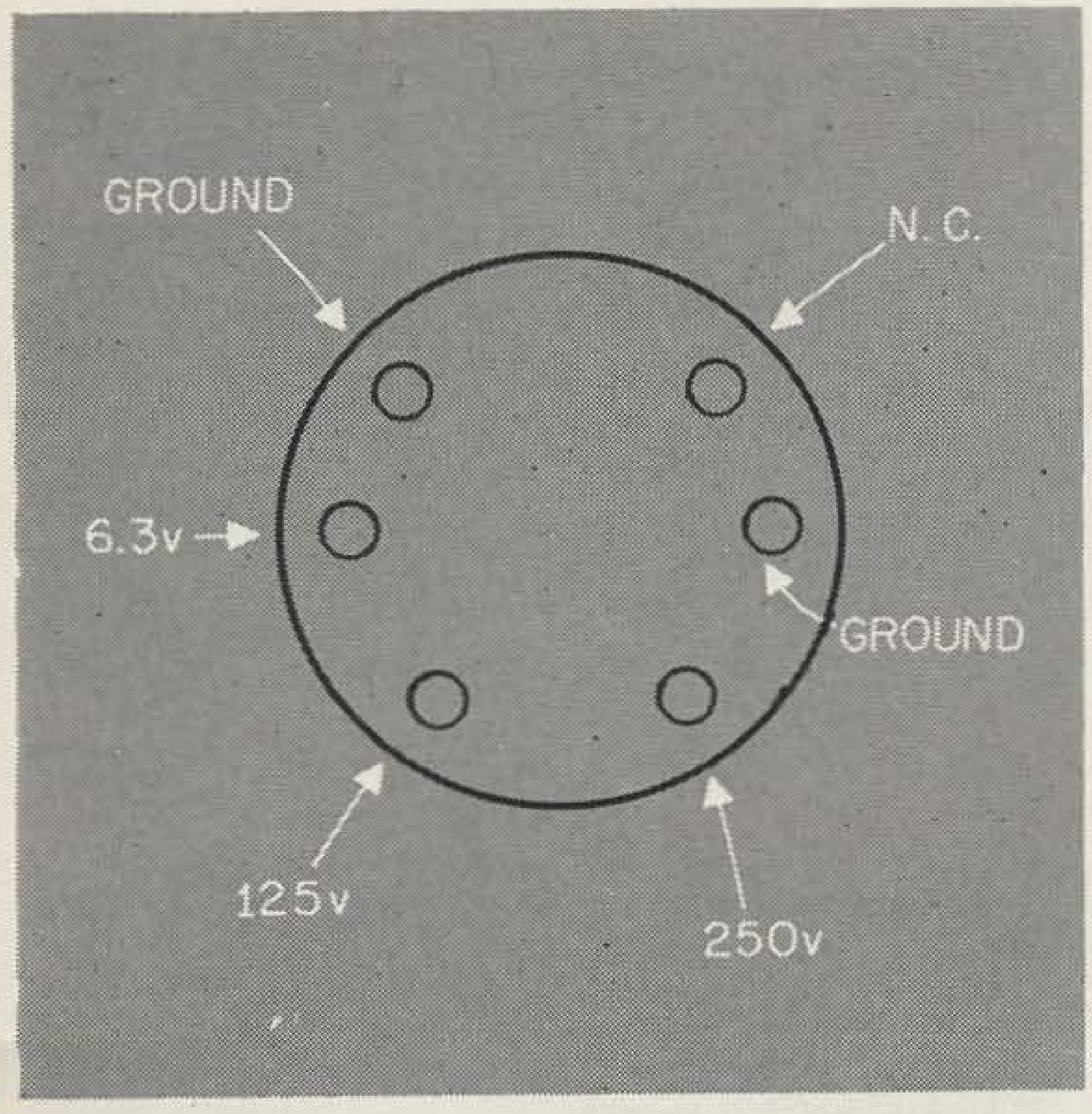
A cheaper solution is to convert your bug. This can be done easily by the addition of an extra terminal. On the bug the dot and dash contacts are connected together. All you have to do to convert for an electronic keyer is run the dot and dash contacts to separate terminals. Connect the dash contact to Terminal #3, the key arm to #4 and the dot contact to #5. This will put 115 vdc between the key base and ground so it is a good idea to make a lucite shield to keep you from being electrocuted.

Adjustment of the key is simple. Move the vibrator weight as far as it will go toward the key handle and tighten the thumb screw. Adjust the dot contact until it just touches the dot contact on the arm. Turn the dot contact screw ¼ turn counter-clockwise. The dot and dash stops should be adjusted to suit your own fist.

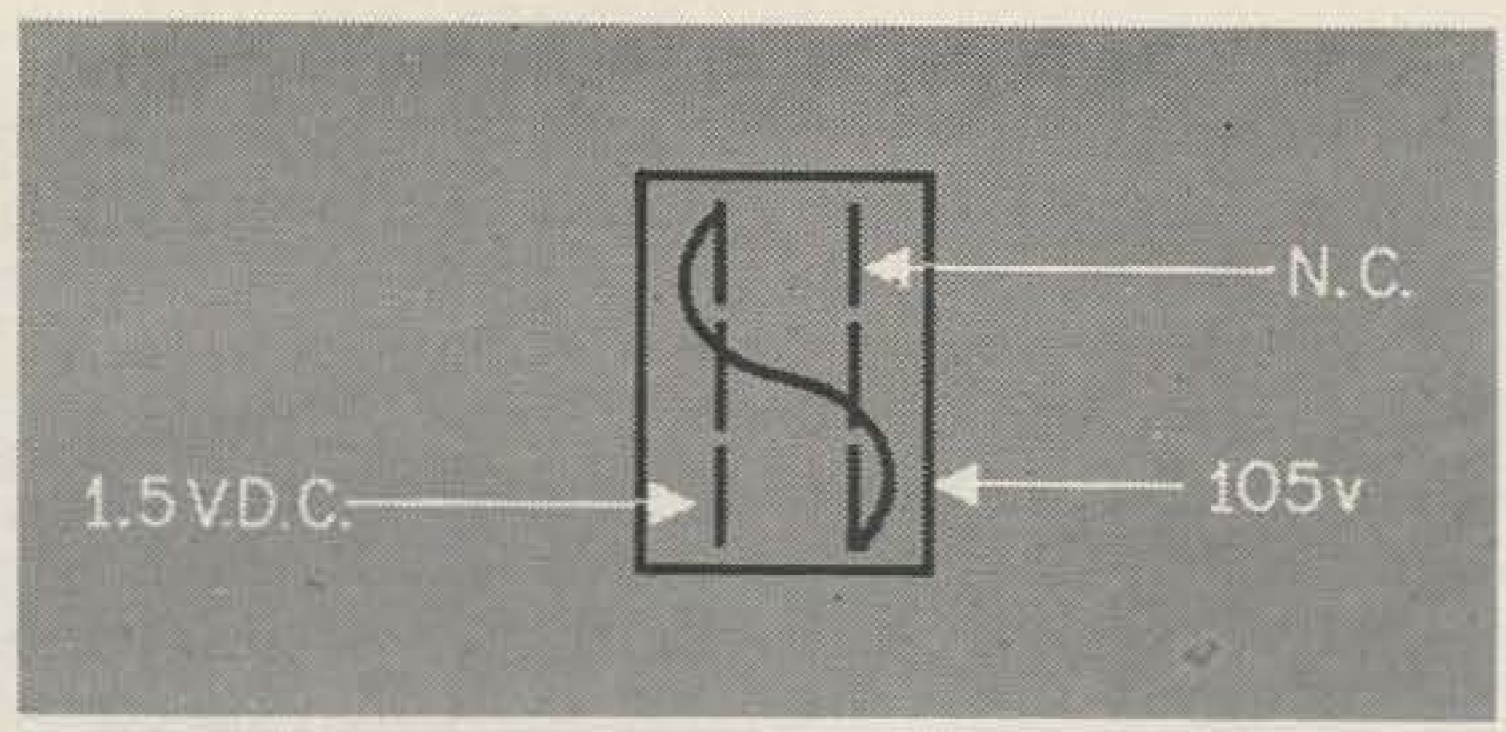
The author has been using this unit for about 5 months now, and the results are gratifying! This unit was also used in the well known 24 hour grind, Field Day, a good test for any piece of gear, and is still going strong! Hope to work you soon with your new Tubeless Electronic Key. 73

(SURPLUS from page 21)

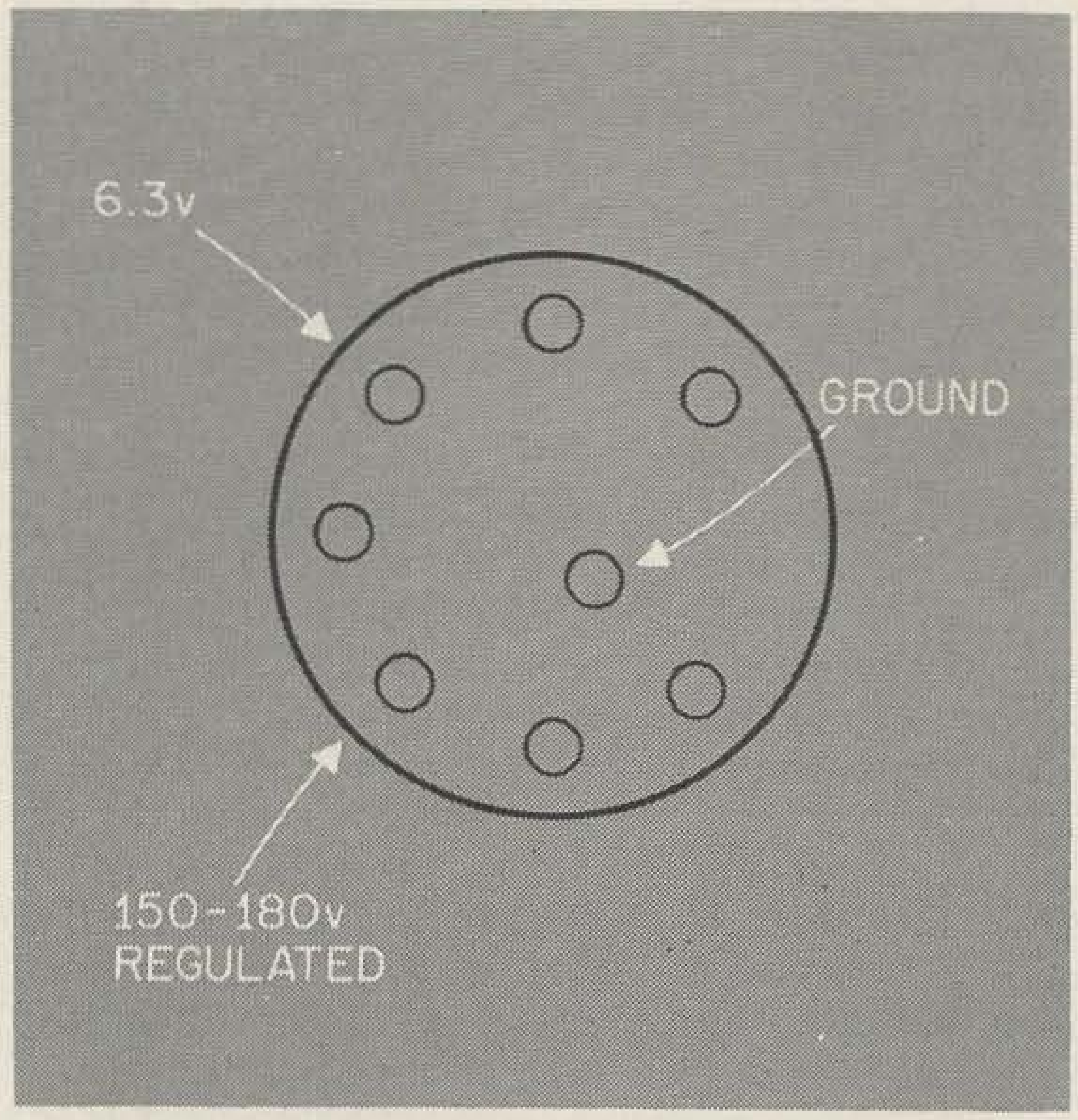
Interested in UHF? Here is a beauty. ASB-5 or CPR-46ACJ. Originally a radar receiver, and following the conversion in Oct. 1956 CQ you will have a gem of a receiver on 420 mc.



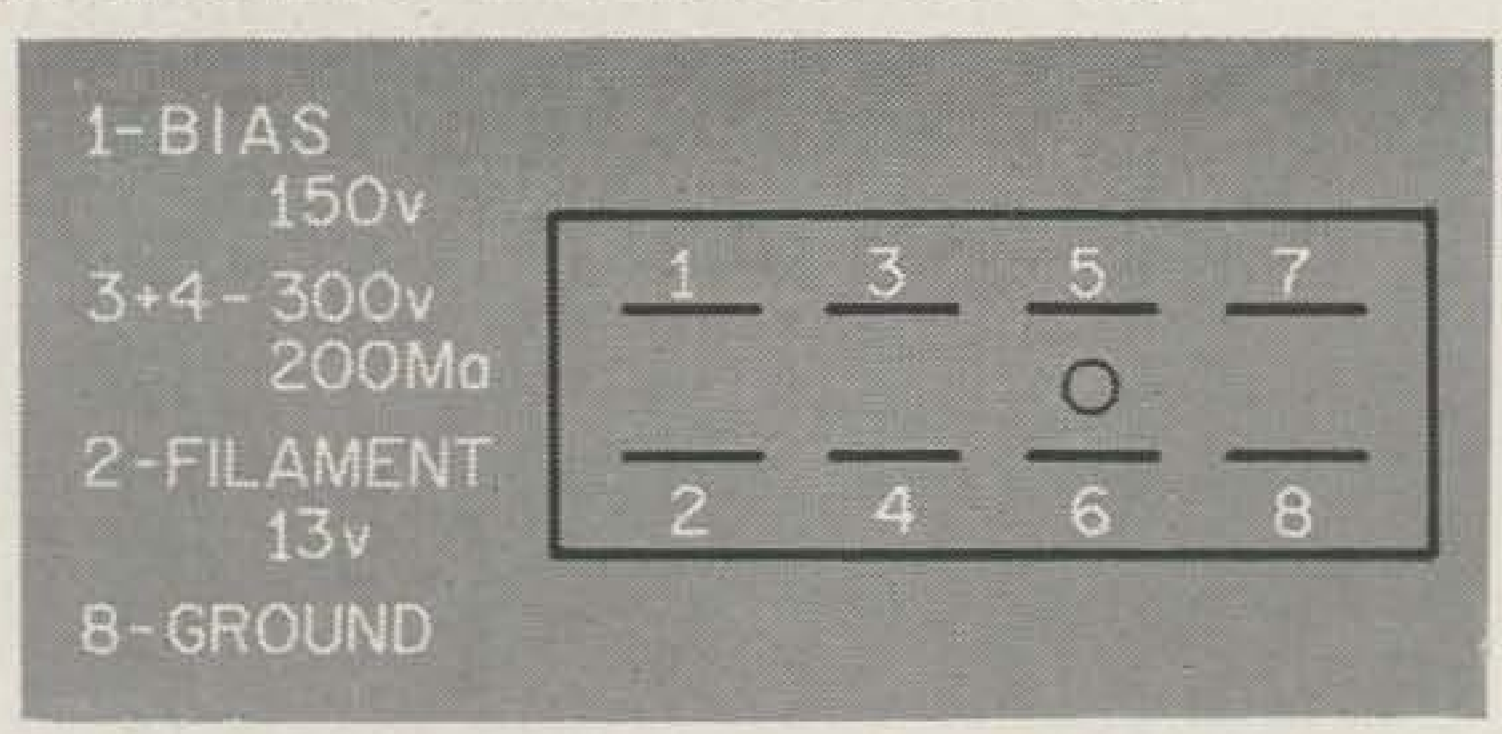
In case anyone is interested in using only the receiver section separated from the complete unit, here are the receiver rear deck connections. Use a Jones plug here.



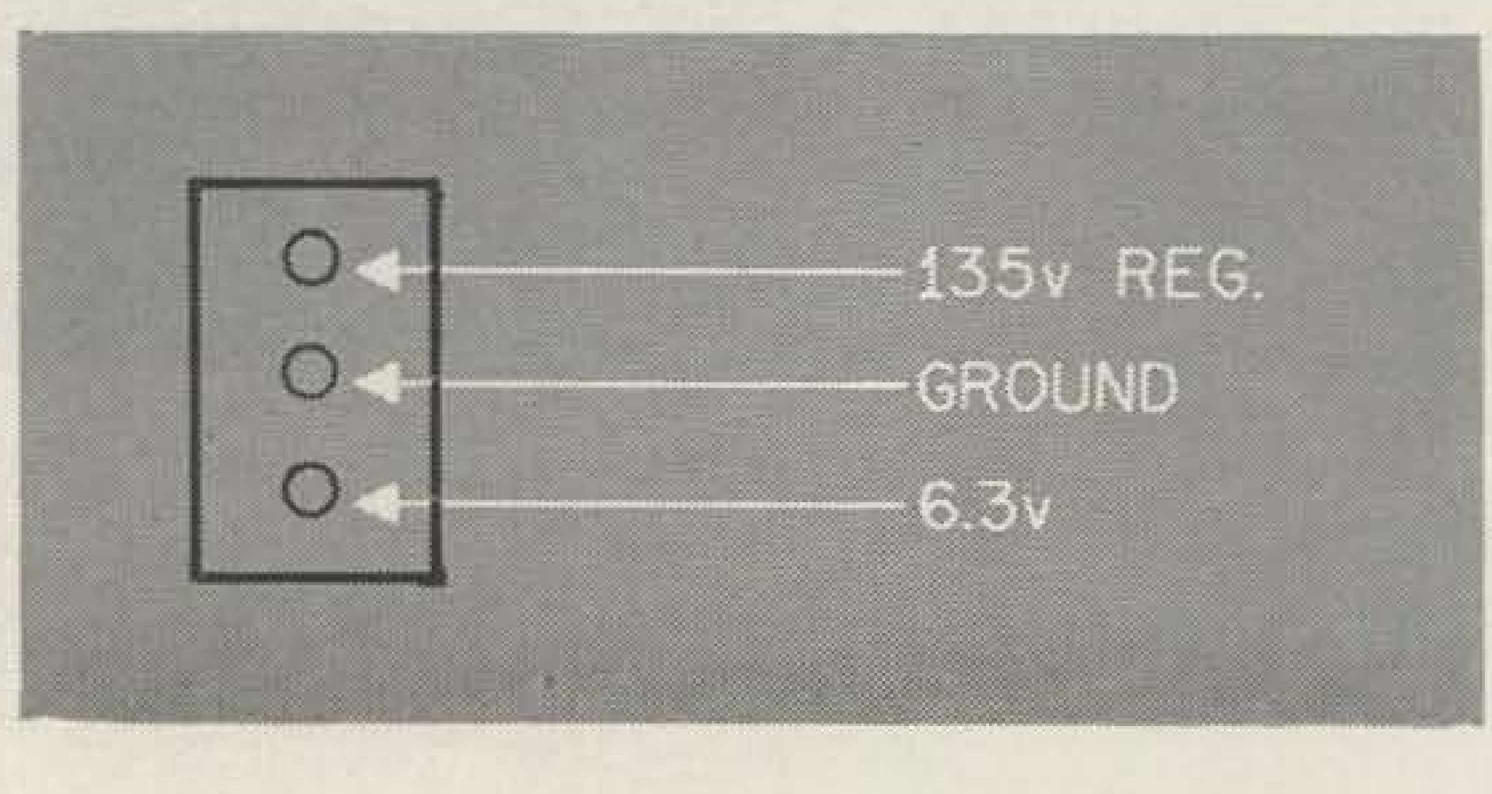
Another UHF band? The R-1/ARR-1 when converted will turn out to be a 220 mc converter with a 50 mc I.F. Complete conversion for this unit can be found back in January 1949 Radio and Television News.



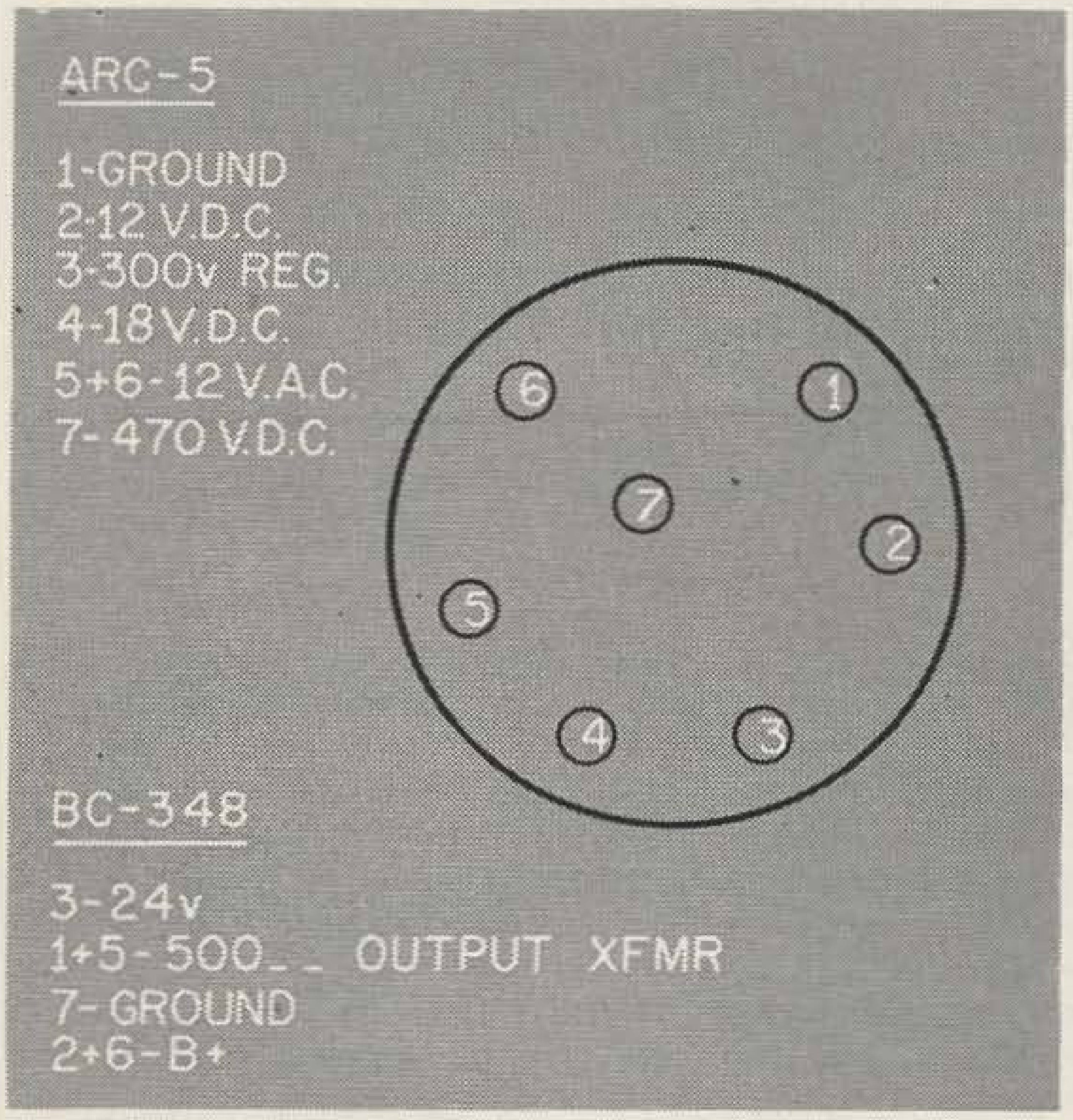
Here is the ever-popular BC-625A (SCR-522). The complete conversion is in July 1947 CQ and information on how to put it on 220 mc is covered in November 1953 CQ.



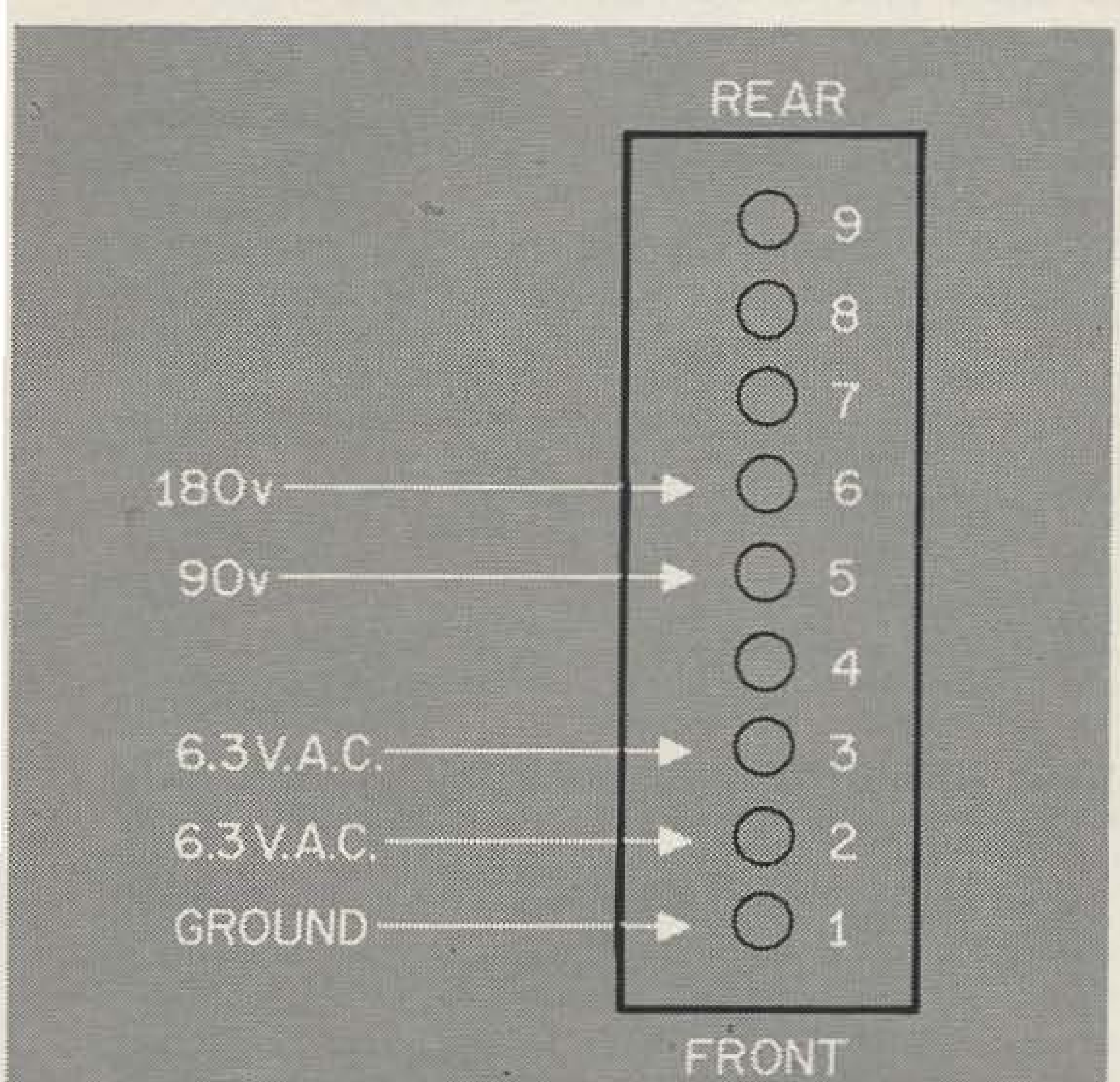
And the well-known BC-221 frequency meter.



Now, the ARC-5 transmitter series. Readily available and capable of fifty watts on cw, a nice unit for the new general. These will operate on 80 and 40, can be converted to work on 20 and one model can be changed to a two or six meter vfo. A wealth of information on the ARC-5 can be found in the CQ publication "Command Sets".



And finally, the RAK-7 receiver. This is a low-frequency TRF receiver and has been issued to Army MARS members. You didn't get the manual either, did you?



So, now you have the easy way to do it. The author is not an expert on war surplus, but he has had the units mentioned in operating condition. If you are a newcomer, if you like to experiment and if you like to operate ham radio, investigate the surplus field, it is a lot of fun.