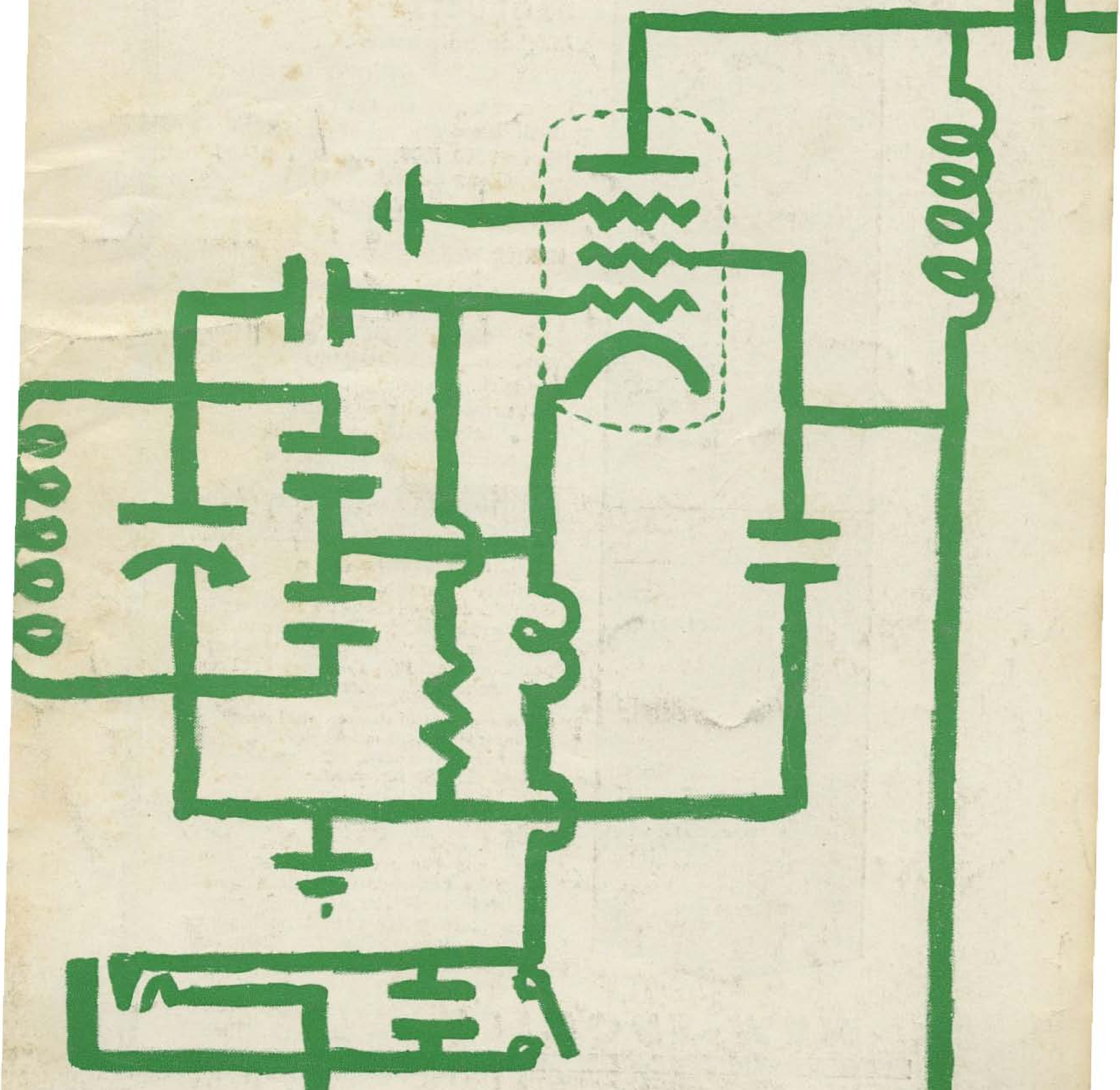
73

October, 1961
37c



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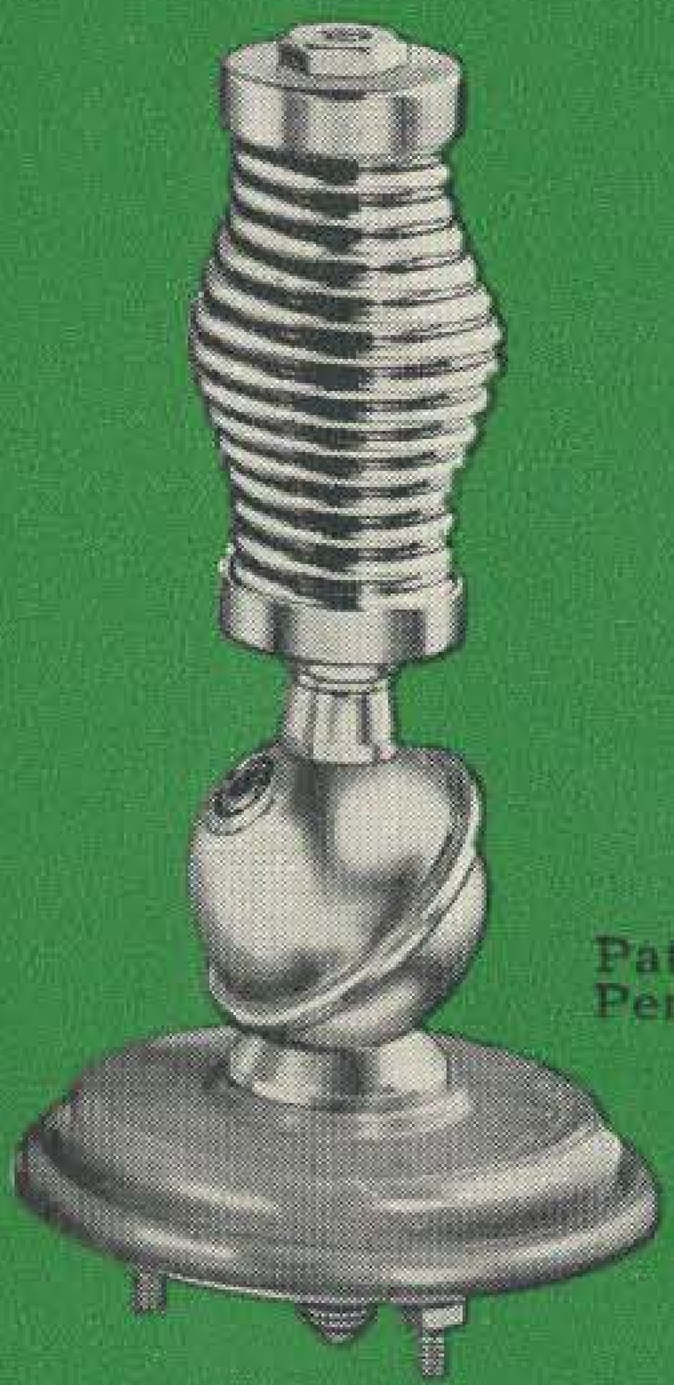

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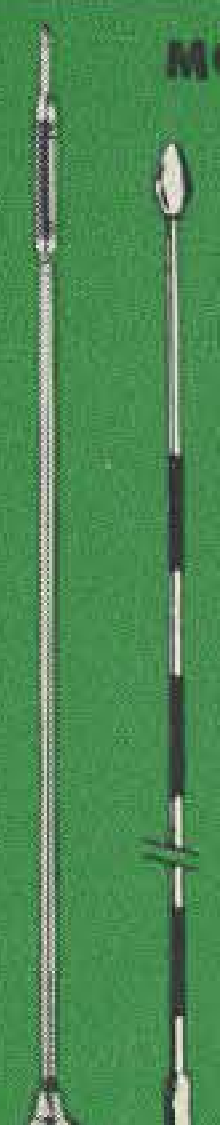

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73 Magazine

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Wayne Green W2NSD—Editor, etcetera October 1961, Volume 1, Number 13

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Cover: Radio Circuit, painted by hand by Wayne Green, age 39.

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. . . de W2NSD

(never say die)

Everything Is a Big Deal

One of the most frequent questions at conventions is, "How many people do you have working on 73?" They are amazed when I tell them that just two of us are doing it all. They would be even more amazed if they had an idea of the work that is involved.

As an example, and rather typical, let's see what we had to go through to get the cover for September. Maybe you remember that mosaic quad design. Step number one is thinking up the design. This occurred to me while I was looking through a catalog from an artist supply house and saw that tiles weren't too expensive. Hmmm, how about doing something in tile for the cover? I sat down with a pad of quad ruled paper and worked out the design, trying to make it something that was typically ham and still make enough of a pattern so it would be artistic. Tiles are rather limiting as a medium.

Once the design was set I counted up the tiles needed and drove over to Manhattan to get them. Virginia did the actual work of pasting them on a large sheet of cardboard with special tile glue. This took hours and hours. When she was done she mixed up groat (a white powder) and wiped it into the cracks between the tiles. Then the finished work had to be taken over to New York for a photograph. That's two trips so far, at two hours each trip. Then one more trip to bring back the tiles and the finished photo. A couple of sections of the photo didn't come out very well so I sat down with a scissors and cut up the two prints and pasted them together to make one good print.

The print was then mailed to the engraver to have the front cover engraving made. When proofs of this came back a few days later I was horrified to find that many of the white lines had dropped out entirely. It looked awful! I drove over to Manhattan again and gave it to Dave Fish, our production man, to heavy up the weaker lines a bit. He had a negative photostat made of it and inked in the lines with a hand pen in black and then sent it back to the engraver again for another cut. This time it came out fine and the cut was finished just in time to rush it by special messenger to the printer's local office in Manhattan so he could send it by special messenger up to the printing plant in Connecticut. Whew!

As I was breathing a sigh of relief I got a call from the printer. The plate had been made two inches too large and wouldn't fit in the presses. After measuring it carefully he found that he could trim off the nice borders I had on it and just get in all the words and the design. With a quivering voice I agreed that there was nothing else he could do.

So that's how we made our September cover. It took at least ten hours of work by Virginia and another ten by me to get it done. This, unfortunately, is not particularly a special case. I've had to do the design on all but our March cover myself. Oh, how I wish someone else would come up with some good ideas. The rules are simple, the cover should be relatively simple, artistic, and as different as possible from anything you might see on any other ham magazine. I like to use only one or two colors due to the costs involved.

Maybe you think the cover was unusually time consuming? Well, let me tell you about what happens to every article that we publish. First of all the article arrives in the mail one day (sometimes I get a letter asking if I am interested in a particular article and have to write back that I am). This then is dated in and goes into a large carton of articles to be read. I read these when I get a chance and it sometimes takes weeks before I have time. Flying trips to conventions are great for this, I get lots done on them.

Once read I either return them immediately with an explanation or else set to work to figure out how many pages the article will run in the magazine. I count up the number of lines of copy, measure the length of each line, and then use a chart I have developed to estimate the number of inches of column space it will take (36 inches of typewriter copy equals one column-inch). Then I add a couple of inches for the title space, size up the diagrams and figure how large they will run, measure the photos and, using another chart, add in this space. This takes a lot of time, but I haven't figured out how to do it any faster.

When the space has been calculated I note on the article folder how much room to allow for it and then write out a check for the number of pages, times $20 per page. Next I have to go through the article again and correct it for spelling, grammatical errors and deviations from our standard style. At the same time I mark it up for the printer to set in

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The photos have to be marked for the engraver so he will know what kind of cut to make, what screen to use, and what size to make it. These are then packed in a special envelope and mailed to the engraver. Diagrams are marked as to the finished size desired and all parts values are written in on the diagram. I much prefer to have as much information on the diagram as possible and keep away from long parts lists. The diagrams are then mailed to our drafting department. The text is mailed to our printer.

About four days later the engravings are delivered to our printer and the proofs come by mail to our office. These are filed in the folder assigned to the article. A week or ten days after that in comes the galley proofs of the text. We send two copies of these proofs to the author with a note asking for him to return one, the remaining copies are filed in the folder. Two weeks after this I get word that the drafting has been completed and is ready to be checked. I drive over to Manhattan and carefully check each diagram, marking all corrections. About a week later I receive engraving proofs of these diagrams in the mail. Now, if the author will get those galley proofs back, we can set the article up in page form.

A few days later in come the proofs. I note with dismay that the author has thought of a whole bunch of things he wishes he'd said originally and has them written in the margins. I cross all that out (it cost a fortune to reset type) and leave only the actual corrections of typographical errors. These are then filed in the article folder.

Each month I sort out from the complete articles those that we want to use and Virginia starts pasting them up. This means cutting out all the proofs of text, diagrams and photos and pasting them into the place that we want the printer to put them for the finished page. It is very tricky to lay out a page so it looks well.

While the pages are being pasted up Virginia has to make sure that she has all of the photographs and diagrams in the right place. She often finds that one is missing and has to hunt it down. It may turn up still on the drafting table, on a shelf at the engravers, or mislaid somewhere at the print shop. She has to make a note on the proofs of all corrections found by her and the author so they can be corrected while the page is being made up. The pasted-up pages are mailed to the printer. A week or so later we get a proof of the completed pages. A copy of this is mailed to the author and the remaining copies filed.

Once the advertising space is fairly definite we can assign page numbers to articles. This

(Turn to page 69)

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An AM Linear for Six

Bert Green W2LPC
and Michael Leis
c/o Amperex Electronic Corporation
Hicksville, New York

HOW would you like to raise the power output of your present 6 meter AM transmitter from 2.5 watts to 90 watts without investing money in a system that will be obsolete in a few years? This would automatically rule out the construction of the conventional Class C Amplifier and accompanying modulator. There is one method of increasing the output of your present low powered AM transmitter and still be able to use this new equipment for Single Sideband in the future years. The answer is an AM Linear Amplifier.

For those not familiar with Linear Amplifiers the following information may be enlightening.

1. The construction and operation of an AM or SSB Linear Amplifier is the same.
2. The efficiency of a Linear Amplifier when used with a SSB signal is about 40 to 50% while with an AM signal the efficiency drops to about 25 to 30%.
3. The efficiency of a Linear Amplifier varies with the amplitude of the input signal. When the input signal is zero there is no output and thus the efficiency is zero. As the input signal is increased the efficiency of the amplifier increases reaching a maximum of about 70%.
4. The peak to average ratio of a 2 tone SSB signal is 2:1 while the peak to average ratio of a 100% sine wave modulated AM signal is 4:1. From this it is obvious that since the average power level of the SSB test signal is twice that of the AM signal therefore the average efficiency should be much higher for the SSB signal.
5. The efficiency of a Linear Amplifier for a 2 tone SSB signal will generally run between 40 to 50%. For a 100% sine wave modulator AM signal the efficiency is about 25 to 30%.
6. A Linear Amplifier with 200 watts of plate dissipation available will be able to produce approximately 180 watts of SSB output or 90 watts of AM output.
7. It should be kept in mind that the 180 watts SSB power represents 360 watts peak power and that the 90 watts of AM also represents 360 watts of peak power. This means that in either case the amplifier will linearily amplify a signal up to 360 watts peak power.

From the above facts the conclusion is reached that if a Linear Amplifier is constructed for our 6 meter AM exciter, this amplifier will still be useful when SSB arrives on the scene in years to come. As most 6 meter exciters produce only a few watts output an amplifier that would increase the output to somewhere near 100 watts would really be worth while.

For our amplifier we decided to use a pair of Amperex 7378's. This tube is a new radiation cooled glass tetrode that was designed for low voltage high current operation as a Class AB, linear amplifier. This tube is so new that ICAS ratings and ratings above 30 megacycles

NEW!

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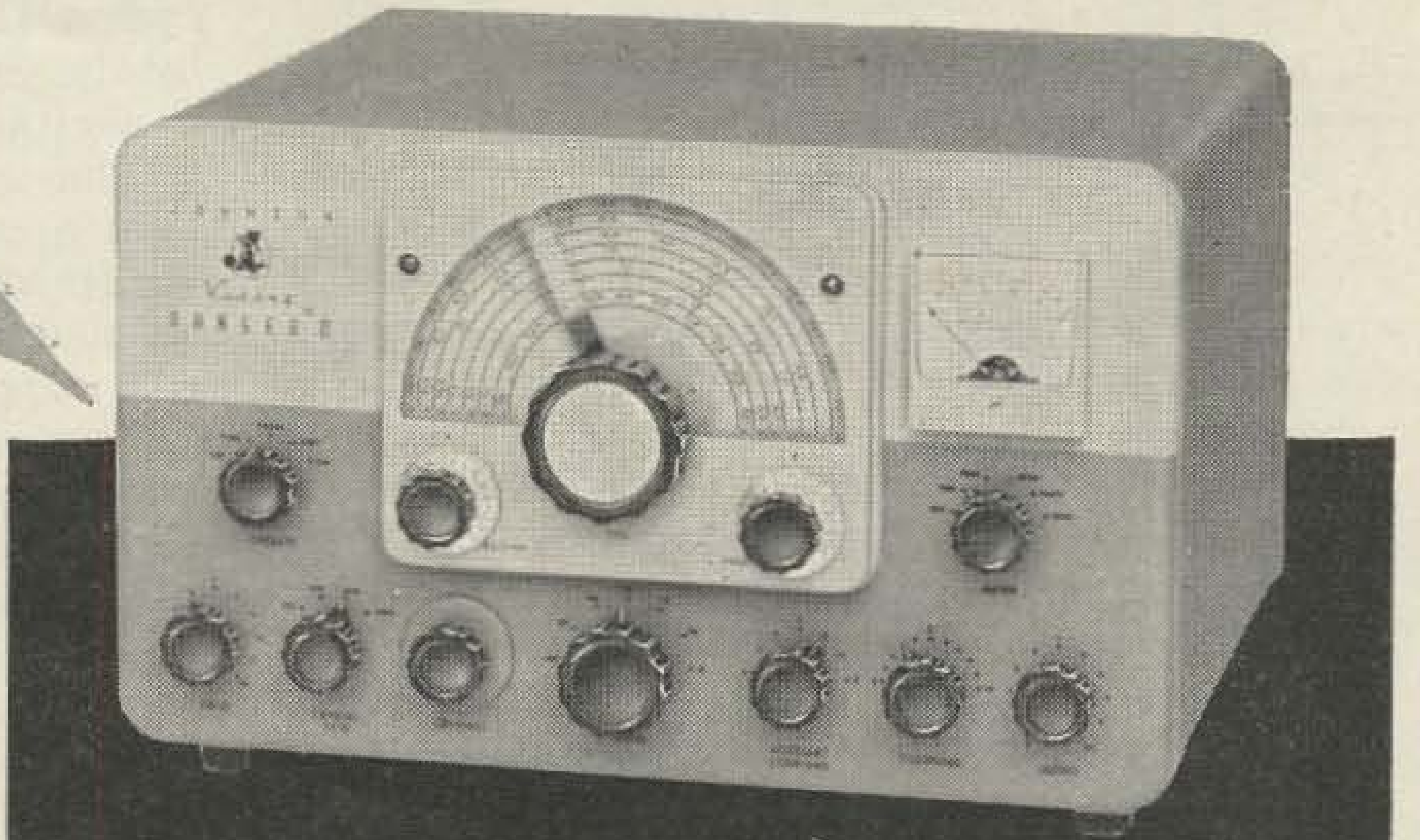
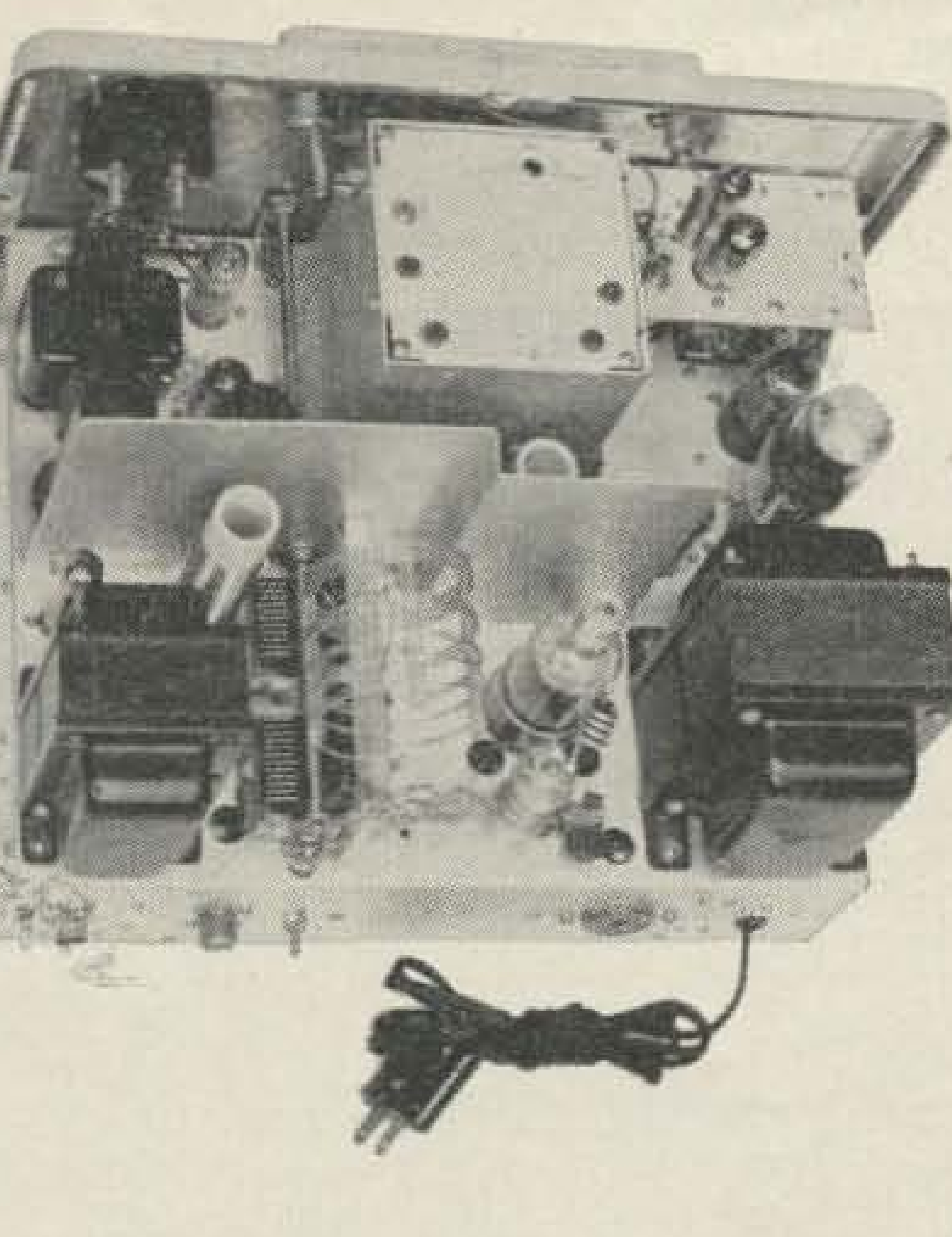
NOW COVERS 6 METERS IN ADDITION TO 160, 80, 40, 20, 15, 10



75 watts CW input . . . 65 watts AM!



Now—a new version of the popular Viking "Ranger" . . . the "Ranger-II" Transmitter/Exciter! Completely self-contained in a handsome re-styled cabinet, the "Ranger II" now covers 6 meters! As a transmitter, the "Ranger II" is a rugged and compact 75 watt CW input or 65 watt phone unit. Pi-network coupling system will match antenna loads from 50 to 500 ohms and will tune out large amounts of reactance. Single-knob bandswitching on six amateur bands: 160, 80, 40, 20, 15, 10 and 6 meters—built-in VFO or crystal control. Timed sequence (grid block) keying provides ideal "make" or "break" on your keyed signal, yet the "break-in" advantages of a keyed VFO are retained.

As an exciter, the "Ranger II" will drive any of the popular kilowatt level tubes, provides a high quality speech driver system for high powered modulators. Control functions for the high powered stage may be handled right at the exciter—no modification required to shift from transmitter to exciter operation. Nine pin receptacle at the rear brings out TVI filtered control and audio leads for exciter operation. This receptacle also permits the "Ranger II" to be used as a filament and plate power source, and also as a modulator for auxiliary equipment such as the Viking "6N2" VHF transmitter. Unit is effectively TVI suppressed . . . extremely stable, temperature compensated built-in VFO gives you exceptional tuning accuracy and velvet smooth control. Complete with tubes, less crystals, key and microphone.

Cat. No. 240-162-1
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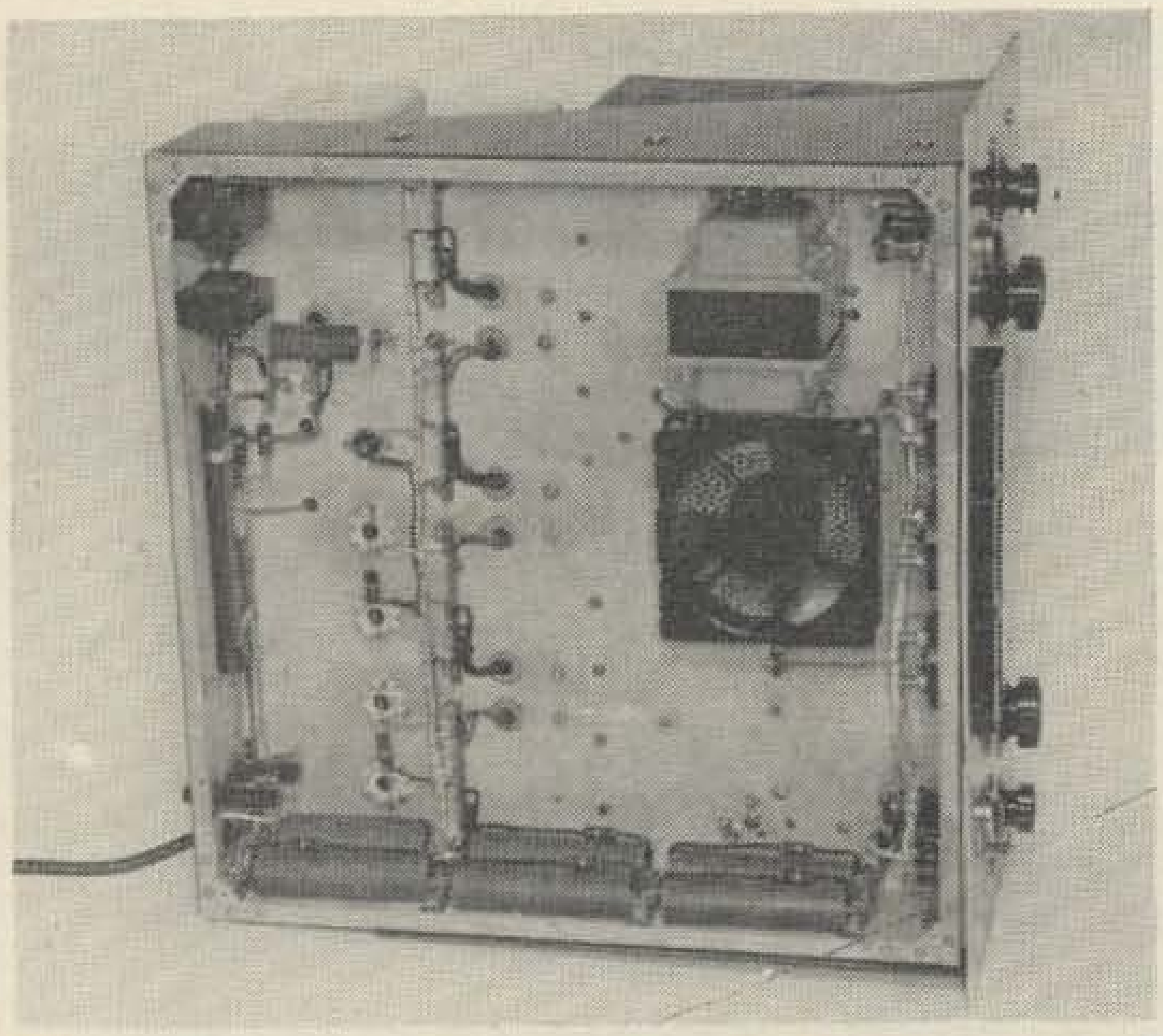


are not as yet published. The CCS ratings show the anode dissipation at 100 watts up to 30 megacycles without any air cooling required. The tube carries a maximum CCS voltage rating of 825 volts and a maximum CCS plate current rating of 400 milliamps.

For 50 megacycles we decided to run the tube under CCS ratings with a small blower supplying air cooling to make up for the increased heating at the higher operating frequency.

Amplifier Circuit

The rf Amplifier Section consists of a standard push-pull circuit using two 7378's (Figure 1).

A 50 ohm input line is coupled to the grid tank via L_1. The input power is adjusted by varying the coupling between L_1 and L_2 and tuning out the reactance of L_1 by means of the series capacitor C_1.

The grid tank capacitor rotor is grounded (C_4). The bias voltage is fed through a 47 ohm decoupling resistor (R_1) to the center tap of the grid coil. Each grid is fed through a parasitic suppressor consisting of a coil in parallel with a resistor (L_4R_2) (L_3R_3) to give a resultant impedance of 18 ohms at 50 megacycles and 23 ohms at 120 megacycles. This was used to suppress a parasite at 120 megacycles, the parasitic input circuit being formed by the cathode lead inductance and the cathode capacitance to the grid and filament.

The cathode is grounded by means of a heavy copper plate, which extents the full width of the tube socket. This low inductance cathode lead keeps the parasitic frequency as far above the operating frequency as possible.

Neutralization is accomplished by series tuning the screen by means of capacitors (C_9, C_{10}, C_{11}, C_{12}) tied back to the cathodes. It is advisable to return the capacitors back to the cathode itself rather than the ground side of the cathode lead so that any rf voltage developed across the external cathode lead does not affect the neutralization. The neutralizing capacitors were paralleled since a physically small capacitor with sufficient capacity was not readily available.

The screen grids are decoupled from the power supply by means of resistors (R_4, R_5). These resistors are shunted with rf chokes (L_5, L_6) to prevent the resistors from impair-

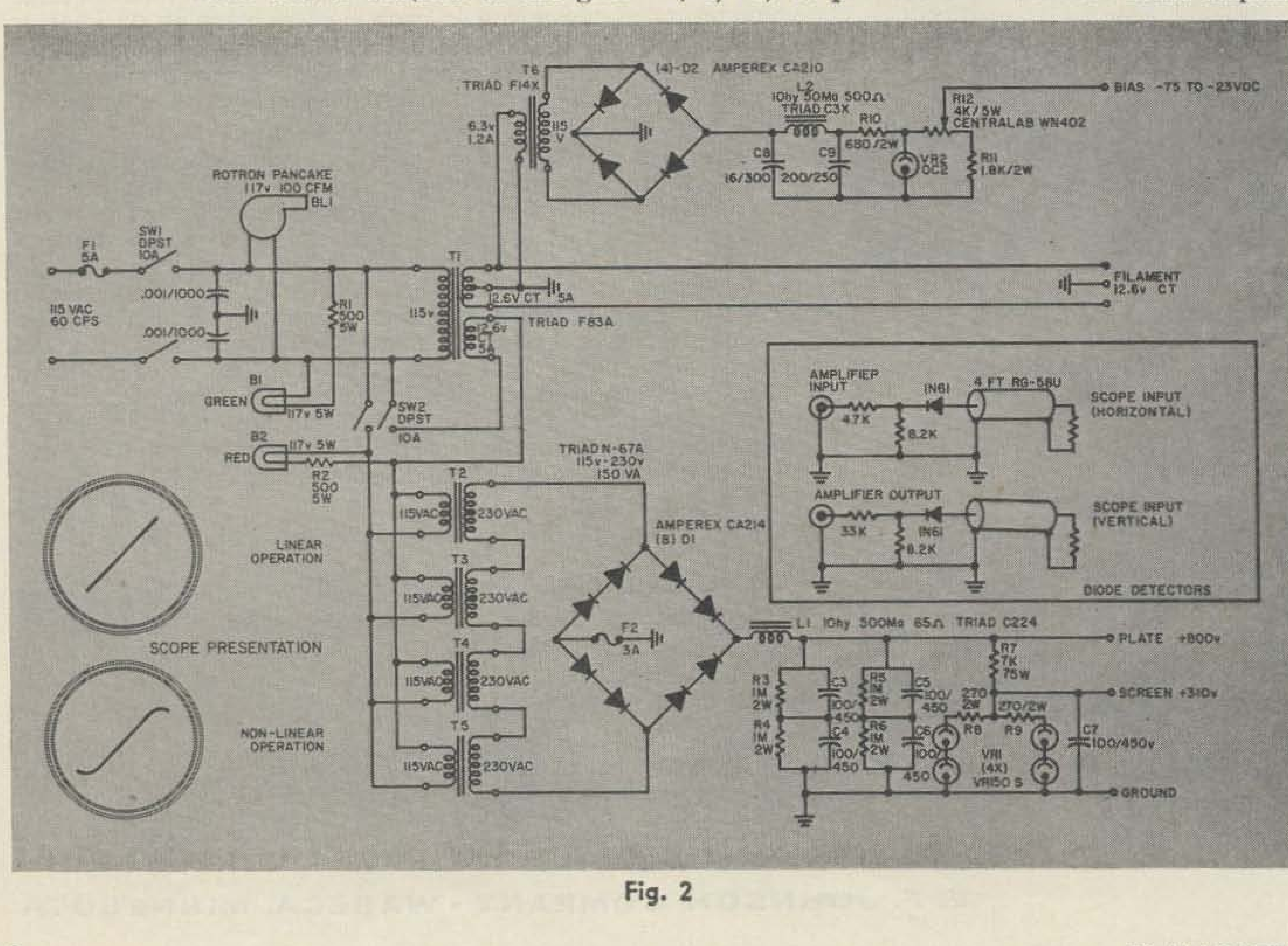


Fig. 2

ing the dc regulation of the screen supply voltage. For linearity the dc screen voltage must be held very constant.

The rotor of the plate tank capacitor (C17) is left floating so as to permit the plate circuit to seek its own balanced ground. For the same reason the tank coil (L_7) is decoupled from the plate supply by means of resistor (R_6). A shunting rf choke (L_9) keeps the dc voltage drop across (R_6) to a minimum thus maintaining constant plate voltage to the tube.

Generally, parallel mode oscillation of a push pull oscillator is prevented by floating the ground of the tank circuit and inserting some impedance in the ground lead as described above. The explanation being that if the tubes tend to oscillate in a parallel mode then the resistor (R_6) and rf choke (L_9) are in series with the tank circuit reducing the Q of the tank circuit to a point which prevents oscillation. For push pull operation no rf currents flow through the resistor (R_6) and rf choke (L_9) thus the Q of the tank is maintained.

Initially, a parasitic oscillation of 180 megacycles was present. This parasite was traced to the series circuit consisting of the plate capacity, plate to tank circuit leads, and the capacity of the tank capacitor (C_{17}). This oscillation occurred only when the tank capacitor (C_{17}) was near its maximum capacity range. However, this portion of the capacity range was not necessary for tuning the 50 to 54 megacycle range. Therefore, 4 rotor and 3 stator plates were removed from each side of the tank capacitor (C_{17}) to remedy the above problem.

The 50 ohm output line is coupled to the plate tank circuit by means of the coil (L_8) which is movable to permit variable loading. The reactance of the coil (L_8) is tuned out by means of the series capacitor (C_{18}).

Power Supply

The power supply schematic is shown in Fig. 1 and the requirements are as follows:

Plate........800 Volts dc @ 400 ma
Screen........310 Volts dc @ 26 ma
Bias...... —25-75 Volts dc @ O ma
Filaments.....6.3 Volts ac @ 8 amps

A plate transformer to fit the above requirements was not commercially available. Therefore four line isolation transformers (T_2T_3 T_4T_5) of the 230v/115v type were used with the 115v windings in parallel as the primary and the 230 volt windings in series as the secondary.

When considering a typical 230v/115v isolation transformer it should be noted that the winding ratio of the transformer is not 2:1 as the published voltage ratio would indicate but rather 2:1.05 to compensate for the drop in the secondary voltage due to loading. If we now use this transformer backwards (115v/230v) then we have a ratio of about 1:1.9. This means that instead of getting 115v to

920v from our transformers we were only able to get approximately 870 volts. In order to attain sufficient secondary voltage it was necessary to use a spare 12.6 volt winding on the filament transformer (T_1) as a line boost transformer in the primary of our plate transformer.

The bias voltage is secured from transformer (T_6) which is a filament transformer hooked up backwards and securing its 6.3 volt primary voltage from one side of the 7378 filament transformer (T_1). Since the primary current requirement of the bias transformer is very low it does not upset the balance of the 7378 filament transformer.

The filament of each 7378 is connected to one half of the 12.6v winding on the filament transformer (T_1) with the transformer center tap leg being common to both filaments. This provides 6.3 volts to each tube filament.

Construction

The power supply is mounted towards the rear of the chassis and the amplifier is in the shielded compartment towards the front. The shielded compartment is constructed of perforated aluminum. The blower is mounted under the chassis just below the 7378's. The plate rf choke (L_9) is mounted in a shield can (open at the top) to aid in keeping the cold end of the choke out of the rf field. The shield can is a 35 mm film container.

Standard components are used for the physical construction. The chassis is aluminum 17"x17"x4". The cabinet is a Premier Prem-O-Rak 18" deep x 12⅞" high. The front panel is aluminum 19"x10½".

Neutralization

The amplifier is neutralized by means of screen grid neutralization. Limited drive is applied to the input of the amplifier so as not to exceed 1 ma on the grid current meter with no voltage on the screen or plates of the tube. A grid dip oscillator, set to diode position so as to act as a sensitive wave meter is held near the plate tank coil. With all the tuned circuits in the amplifier adjusted for maximum reading on the wave meter, the screen neutralizing cendensers (C_9, C_{10}, C_{11}, C_{12}) are adjusted until a minimum output is indicated on the wave meter.

Amplifier Tuning

For maximum power output in conjunction with the greatest degree of linearity the tuning procedure requires in addition to the front panel meters some means of monitoring the degree of distortion. A relatively simple method of distortion monitoring may be accomplished in the following manner. A diode peak detector circuit is connected to the input of the amplifier while a second one is connected to the output of the amplifier. One of the above peak detectors is connected to the horizontal input of a scope while the other detector is connected to the vertical input of the scope. When the amplifier is linear, that is the output signal is exactly the same as the input signal, the trace on the scope will be a straight line. Any distortion in the amplifier will cause the straight line display on the scope to curve at the ends.

Fig. 2 shows the schematic of the diode detector circuits for monitoring the input and output circuits. Fig. 2 also show a typical scope presentation for linear and nonlinear operation of the amplifier.

To adjust the amplifier, using a 100% sine wave modulated signal source, the input capacitor (C_1) and the grid tank capacitor (C_4) should be tuned for maximum plate and screen current while the drive power from the exciter is adjusted to a level just at the point of grid current. The plate tank capacitor (C_{17}) should be adjusted for resonance (maximum power output) and the output link capacitor (C_{18}) should be adjusted for maximum power output. The coupling between the plate tank circuit and the output link (L_8) should be adjusted for greatest power output while still maintaining good linearity. This may be done by watching the scope as described previously. The final object being to achieve the longest straight line scope presentation. During the

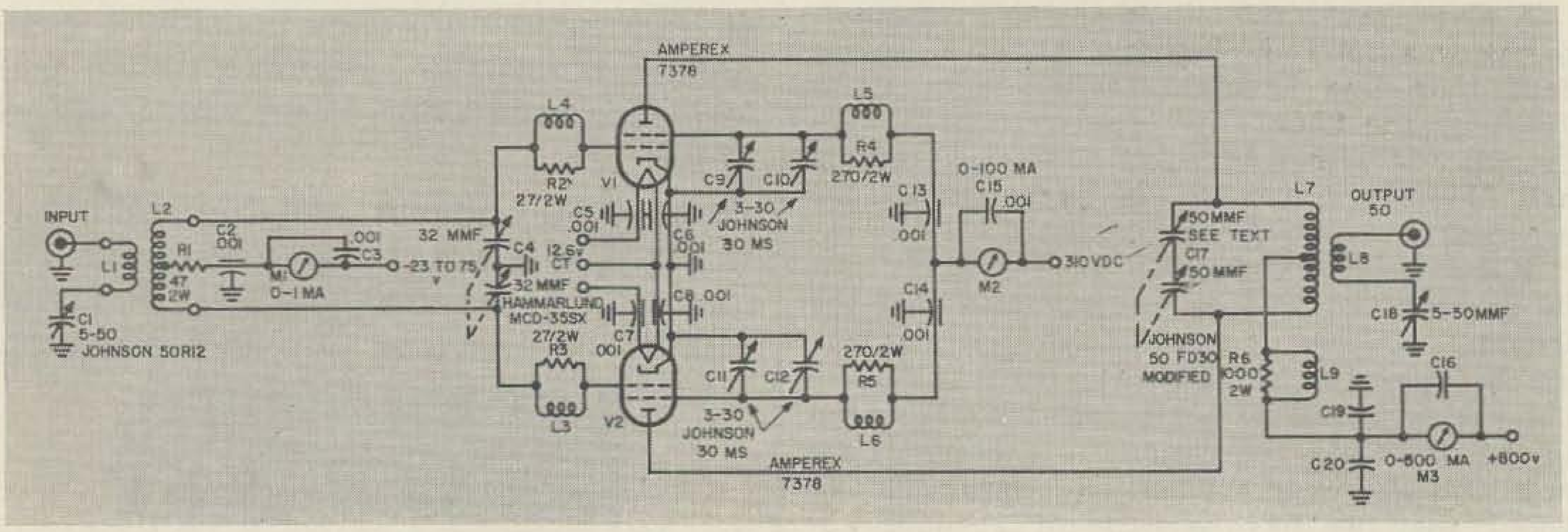


Fig. 1

"Terrific!...Unbelievable... Best rig – ever"!

Here are a few unsolicited comments from owners of Clegg VHF equipment

Clegg Zeus VHF Transmitter FOR 6 AND 2 METERS

A highly efficient, 185 watt AM, high power VHF transmitter for full coverage of the amateur 6 and 2 meter bands and associated Mars frequencies.

Automatic modulation control with up to 18 db of speech clipping provides magnificent audio with "talk power" greater than many kilowatt rigs.

This beautiful unit with its ultra-stable VFO is the ultimate in VHF equipment for amateur and Mars operation.

99'er Transceiver

FOR 6 METERS

This completely new transmitter-receiver is ideal for both fixed station and mobile operation. Small in size, low in cost, and tops in performance, the 99'er offers operating features unequalled in far more costly equipments. The double conversion superhet receiver provides extreme selectivity, sensitivity and freedom from images and cross modulation. The transmitter section employs an ultra-stable crystal oscillator which may also be controlled by external VFO. An efficient, fully modulated 8 watt final works into a flexible Pi network tank circuit. A large S meter also serves for transmitter tune-up procedure.

From Ohio:

". . . I am a quality control supervisor with a leading electrical manufacturer and this Zeus transmitter is to me the finest piece of workmanship that I have ever purchased or inspected . . ."

Richard E. Hayes, K8UXU

From New Hampshire:

". . . We feel that our new Zeus is the best thing that ever happened to us since we have been in ham radio (5 years) . . ."

Hazen & Beatrice Bean, K1JFQ

From Florida:

". . . We are well satisfied with the results of this unit as we have worked forty DX contacts in little more than three hours on May 23, 1961, including six new states which we were unable to work in the past two years with a 120 watt, 6 & 2 transmitter of a different mfg. . . ."

Jack Edlow, K4YIW

From California:

". . . Never before have I been more pleased with a piece of gear than I am with my Zeus. In two days I have worked 24 states with several contacts in each, (phone) on six meters. And the signal reports — yow! For the most part unbelievable . . ."

Jeanne & John Walker, WA6GEE

From Pennsylvania:

"Words cannot express the pleasure and performance of ZEUS. I have worked 5 states 5-9, plus I have given you $1,000,000 advertisement . . ."

Dr. A. Schlecter, K30EC

From Puerto Rico:

". . . I want to inform you of the excellent results obtained with the Zeus Transmitter I bought one month ago. Taking advantage of the band opening, I have been able to work up to the present thirty-eight states, including California . . ."

Pedro Fullana, KP4AAN

From New Jersey:

". . . I would like to tell you I am more than delighted with the operation of the Zeus. Have had nothing but good reports from other Ham's . . ."

Donald E. Gillmore, WA2QCQ

From Georgia:

". . . This set is terrific. I've had terrific results with it. It's the best rig — ever."

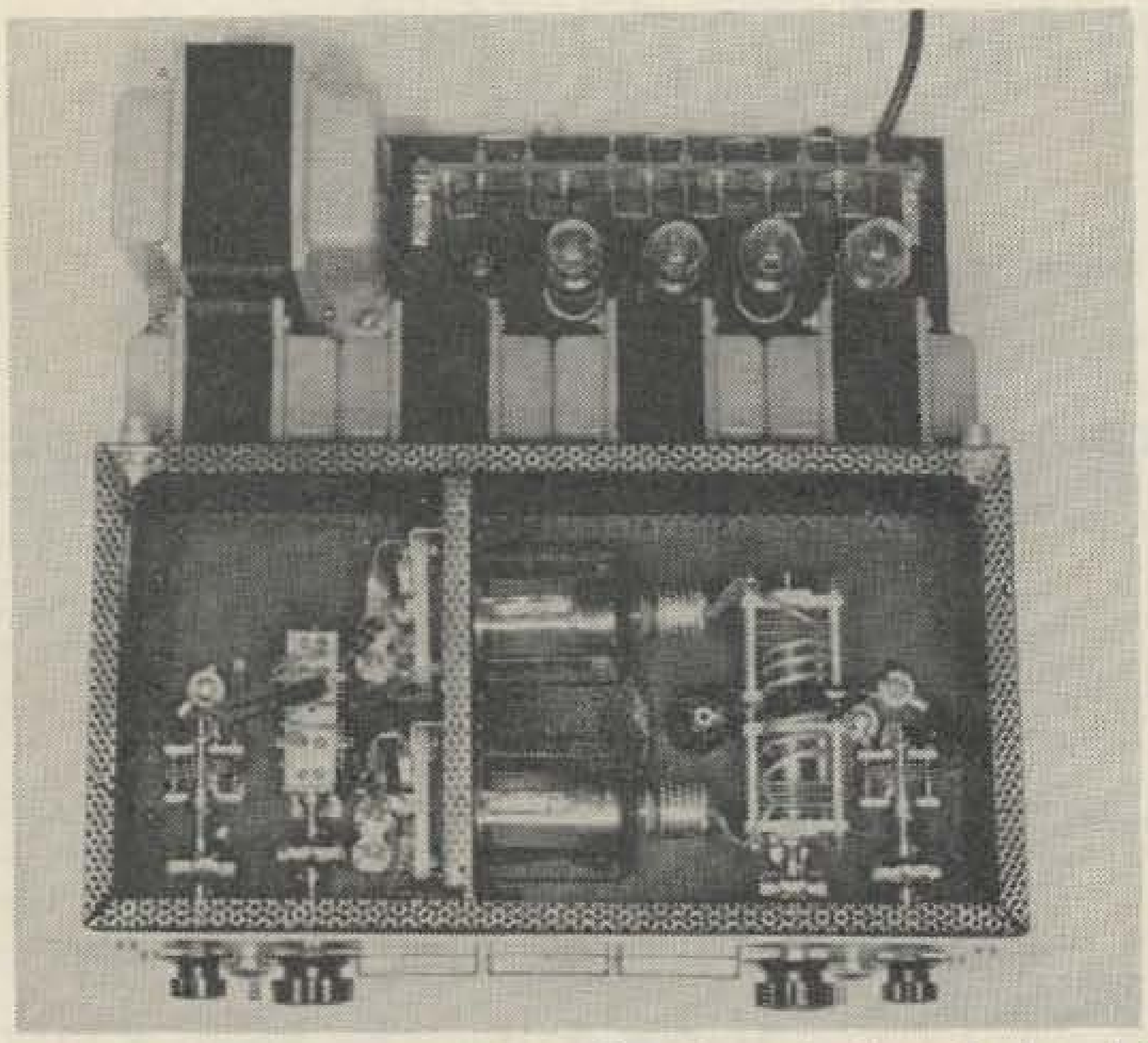
George E. Missback, K4QOE

K8CHE in Ohio tells about 99'er

". . . with the 99'er haywired in from a four element beam, through 100 feet of coax, through a matching network, through a length of 72 ohm twinlead, and then through a length of 300 ohm twinlead to reach the 99'er, we could read the Michigan stations Q5! and back through the above haywire we were able to put 4.4 watts into the antenna as measured by a RF ammeter! . . ."

Ken Phillips, K8CHE

Clegg LABORATORIES



entire tuning operation the input signal should be constantly monitored to keep the grid current just at zero grid current.

Typical operating conditions for maximum power output with good linearity when the amplifier is driven by an exciter that is 100% modulated with a sine wave signal is as follows:

AVG Drive Pwr (100% Sine Wave Modulated)	2.5 watts
AVG Load Power Output	90 watts
Peak Load Power Output	360 watts
Power Gain	15.6 db
I_{c1}	0 ma
I_{c2}	26 ma
I_b	412 ma
I_b zero signal	150 ma

Conclusion

As an AM linear amplifier satisfactory operation in the 50-54 megacycle band was obtained delivering 90 watts output with 2.5 watts of drive.

When used as a linear amplifier for a Gonset Communicator some means of attenuating the 5 watt output of the Gonset to 2.5 watts must be used. A typical attenuator for 3 db would be a resistor T pad with 8.6 ohms in each series arm and 140 ohms in the shunt arm.

(Tests made on a borrowed Gonset Communicator indicated only 70% modulation. If this is true for all Communicators then the figures shown in paragraph above on typical operating conditions would not be as shown when a communicator is used as a driver.)

. . . W2LPC

Coil Data

L1 3 closewound turns #12, ¾" dia.
L2 4 turns #12. ¾" dia. 1⅝" long.
L3 2½ turns #16 on R3.
L4 2½ turns #16 on R2.
L5 Ohmite Z-144 RF Choke
L6 Ohmite Z-144 RF Choke
L7 6 turns (C.T.) #10, 3" long, 1" dia.
L8 3 turns #10 closewound 1" dia.
L9 Ohmite Z-25 RF Choke
9L Ohmite Z-28 RF Choke

Letters

Dear Wayne:

I have just been made forcibly aware of the presence of three frightening members of the amateur radio community—the Know-Nothing KNovice, and his older brothers, the Technically Deficient Tech and the Generally Apathetic General. These birds are usually well-disguised as normal (Hah!) amateurs, but the astute observer can easily see them for what they are. Gradually, it seems, they are taking over ham radio, and turning it into a sort of variable-frequency Citizens Band. Rather than giving a detailed description of the three, I shall describe an encounter with a Novice/Tech of the species who lives in my apartment building. (I shall call him Harvey, because that happens to be his name.)

A few minutes ago, this Video Ranger rang my bell, was admitted (first mistake), and promptly began to fire questions at me. This is typical; I've been trying to answer his questions for many years now, but, in mid-sentence, a thought struck me. "Wait a minute," said I. "Aren't you a Tech?" In answer, he proudly pulled out a genuine Technician's license, neatly encased in plastic. His problem, I should mention at this point, was to decide whether or not he could convert his transmitter (a popular bandswitching Novice kit) to six meters. He had seen in the August—a conversion of another rig, and wondered if he could do what W1 * * * did. Now I fully approve of his spirit and desire to improve his rig, but something was wrong. Shouldn't a ham who has passed the standard theory test know enough about circuitry, reactance, and resonance to recognize two almost-identical pi-networks and compute parts values? I am reasonably sure that he got a high score on the theory test; when I asked him about capacitive reactance he could throw a formula at me, but couldn't explain what it meant. I have nothing against his not knowing, but when he has gotten a license which assumes that he DOES know something, then, as I said, something is wrong. When asked how he passed the Tech test, he said that he had merely "memorized the questions in the license manual." Further investigation revealed that he didn't really care about how his rig worked, didn't know the resistor color code and didn't want to learn it, didn't own ANY books on radio theory or operation, and just wanted me to stop bothering him with questions and show him how to put his rig on six.

How, then, does he differ from a Citizens Bander? Well, he says he has passed a test, and so implies that he knows radio theory and is entitled to look down his nose at CB'ers, little knowing that he is one at heart.

Perhaps the fault lies with him, perhaps his attitude is a product of a world of objective tests, CB'ers, license manuals, anti-intellectuals, and apathy. In any case, something should be done to make our hobby less of a breeding-ground of the Know-Nothings, the Technically Deficient, and the Generally Apathetic.

Daniel Wazcog Gardner WA2COG-WA2SOF

Dear OM:

I just ordered some junk from Columbia Electronics and told 'em I saw their advertisement in a magazine, like you said, but I couldn't remember which magazine. Incidentally, nobody uses expressions like "Bah!" in editorials any more. Let's see more pictures of your wife, I like her.

. . . Ken W7IDF

Now! You can go SSB at a profit!

Right now I can allow you a lot more for your present gear than it is worth–in many cases even more than you paid for it!

These extra-high allowances make a new Gonset GSB-100 a real worth-while investment – one that will pay you big dividends in greater operating pleasure.

Now, everyone can graduate up to SSB, especially with Harrison low terms on the balance! Join the gang having more fun, with SSB. Send the coupon to me today!

73, *Bil Harrison*, W2AVA

LOOK AT THESE GUARANTEED ALLOWANCES*

FOR YOUR GONSET

$440.00–G76, with pack
310.00–G77, with pack
340.00–G77A, with pack
260.00–Communicator I
280.00–Communicator II
330.00–Communicator III
365.00–Communicator IV 2M
355.00–Communicator IV 6M

FOR YOUR JOHNSON

$260.00–Viking I
300.00–Viking II
315.00–Ranger
255.00–Challenger
410.00–Valiant
300.00–Pacemaker
260.00–Navigator
240.00–6N2 Transmitter

FOR YOUR COLLINS

$250.00–32V-1
325.00–32V-2
385.00–32V-3

FOR YOUR CENTRAL

$245.00–10B
300.00–20A

FOR YOUR HEATH

$170.00–DX-35
200.00–DX-40
280.00–DX-100
330.00–TX-1

*For original Factory-wired equipment, delivered here in good operating condition, toward a new GSB-100.

For others, regardless of make, model, and condition, I will still allow you a lot more than it's worth!

GONSET

GSB-100 TRANSMITTER

The GSB-100 is a complete, self-contained SSB transmitter for operation on 80-40-20-15-10 meter bands. This transmitter is rated at 100 watts PEP output, operates on SSB with selectable sidebands, phase modulation, AM and CW.

Output circuit utilizes pi-network. The new GONSET FILTER-PHASING network gives high sideband rejection, uses a quartz crystal band-elimination filter for carrier suppression of more than 60 db. This filter avoids critical carrier balancing.

Frequency control is by fixed quartz crystal and built-in VFO. Latter features exceptional stability. Unit gives full 600 kcs within all amateur bands, 80 through 10. Highly effective voice-operated control system (VOX) is provided. Heavy duty 115 VAC power supply is built-in.

Model #3233........$499.50

Bring your problems to the HARRISON-GONSET ✚ WORKSHOP ✚ CLINIC

Free! To help you get more enjoyment from your Gonset equipment. Advice, minor repairs and adjustments, by Factory experts, without charge.

COLUMBUS DAY WEEKEND
Oct. 12, 13, 14. 10 to 5.

HARRISON
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NEW YORK 7, N. Y.
BArclay 7-7922

LONG ISLAND: 144-22 HILLSIDE AVE., JAMAICA–RE 9-4102

RUSH this coupon, today! G
Bil Harrison, W2AVA
"Ham Headquarters, U S A":

Here's my $10 deposit (returnable at any time) to reserve a new Gonset GSB-100, so I won't be disappointed.

☐ I am shipping my ____________ to you for

OR your guaranteed allowance of $________.

☐ What is your extra-high allowance for the gear I describe on the attached sheet?

I (can) (cannot) visit you with it.

I want terms on the balance: ☐ $________ a month. ☐ Charge Account.

Name________________ Call________

Address________________

____

A Simple High Stability VFO

Fred Haines W2RWJ
123 Roberta Drive
Liverpool, New York

FOR several years now, the series-tuned Clapp oscillator, or variations of it, have enjoyed an almost unique position in the lore of Amateur radio. That position is deserved and has been earned through excellent electrical stability. In terms of mechanical stability, however, the Clapp circuit has added materially to the sales of foam rubber pads and shock mounts. Anyone who has constructed one of these "nervous beasties" knows exactly what I mean.

I decided to throw caution to the wind and try an old faithful Colpitts oscillator to see if something could be done about the microphonic problem. The results have been extremely gratifying, and the circuit so stable and free of mechanical shock effects, that I couldn't resist sharing my experience with others.

The circuit consists of an electron-coupled Colpitts oscillator, followed by a class A stagger-tuned buffer stage. The rf output is more than enough to drive the usual crystal oscillator circuit in existing transmitters. A voltage-regulated power supply is included on the chassis and contributes to stability vs. line voltage changes.

The oscillator is designed to cover the entire 80 and 75 meter band, from 3.5 to 4.0 mc. The higher frequency bands do not spread out over the dial, but this is not considered a disadvantage because a secondary frequency standard in the receiver is used to mark band edges and the VFO is not used as a frequency indicator.

The frequency range of oscillator V1 is 1.75 to 2.0 mc which is doubled in the plate circuit. The plate circuit of V1 is broadly resonant in the 80 meter band, L2 with its stray capacitance representing the tank circuit.

Buffer V2 is a class A stage to minimize loading effects on the frequency of the oscillator. The plate tank circuit of V2 (L3-C9) is also broadly tuned in the 80 meter band. When the tuning slugs of L2 and L3 are correctly staggered in frequency, the rf output of the VFO remains essentially constant over the entire 3.5 to 4.0 mc range.

The oscillator plate and screen circuit are supplied regulated B+ from the gas regulator, while the buffer is operated from the full unregulated output of the power supply.

Keying of the oscillator is satisfactory for 80 and 40 meter operation, although an almost imperceptible chirp is present. For more ideal characteristics on the higher frequencies, amplifier or differential keying is recommended. A switch in parallel with the key jack is used to provide a "zero beat" condition for tuning the oscillator to the desired spot in the band without energizing the transmitter.

I use the VFO as a control center for the station. A 117 volt outlet is mounted on the rear of the chassis and supplies ac power to the high voltage plate supply of the transmitter. A switch on the VFO front panel controls the ac to the outlet. Note that an interlock circuit is used so that the transmitter cannot be turned on until the VFO is energized.

Even though the high-C oscillator is much better than others in resistance to microphonics, it is desirable to take some precautions against instability. Accordingly, the VFO is built as shown in the photographs using three standard aluminum chassis as basic building blocks. The main chassis is a 7 x 11 x 2-inch unit equipped with rubber feet in the four corners. Two 5 x 7 x 2-inch chassis, mounted on edge at the front of the main base, serve as a particularly rugged basis for the shielded compartment containing the tuned circuit and other components. The two smaller chassis are fitted with an inverted "U"-shaped cover of aluminum fastened at the sides and top with self-tapping screws.

It is important to note that all heat producing components are mounted outside of the shield enclosure to prevent frequency drift due to heating effects. V1 and V2 are mounted horizontally at the rear of the enclosure so their wiring is inside the box near the turned circuit. Since there was not much room behind the enclosure for the mounting of the power transformer, VR tubes, etc., the filter capacitor can was mounted inside the shield.

The most important thing regarding mechanical stability is the mounting of the tuning capacitor, C1. It is not important what type of capacitor is used as long as it is ruggedly built, preferably with a bearing at each end of its shaft. Any dial mechanism similar to the one illustrated can be used provided it has a

DOES YOUR TRANSMITTER HAVE AN AUDIO CLIPPER?

If not, your signal is lacking the "punch" it should have.

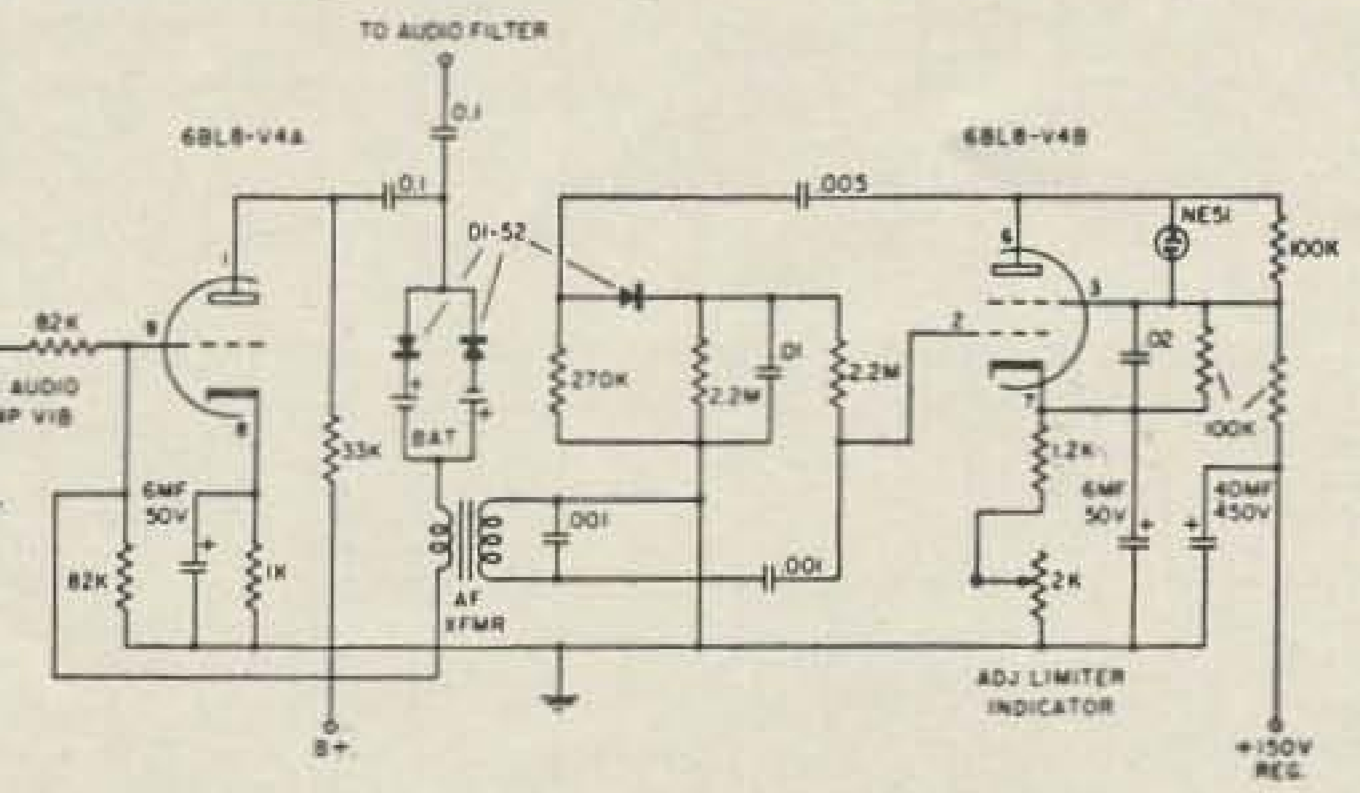
Clipping tends to hold the output at a constant level and brings the weaker high frequency speech components up to the same level as the louder low frequencies. This provides improved intelligibility during interference or weak signal conditions, and is equivalent to raising your power many times.

Conventional AVC systems prevent over-modulation, but will not increase the level of the weaker components of a complex speech wave form.

THE 200V AUDIO LIMITER IS ACTUALLY AN IMPROVED CLIPPER

It employs a triode with biased clipping diodes in its plate circuit. The clipped wave is applied back to the grid as inverse feedback to lower the distortion. A neon indicator begins to flash with 3 db of clipping. Additional clipping can be obtained by advancing the speech level control calibrated in db.

200V TRANSMITTER
AUDIO LIMITER & INDICATOR CIRCUIT



HOW DO YOU ADJUST THE 200V AUDIO LIMITER?

Simply advance the speech level control until the Limiter Indicator flashes on loud syllables. Watch the trapezoid on the built-in linearity monitor scope and adjust the Power Output control until the pattern shows no flat-topping. After this condition is established, shouting into the microphone will not flat-top the outgoing RF wave.

73 *Wes*

Write for a 200V brochure with detailed specifications.

Wes Schum, W9DYV

Central Electronics, Incorporated

A subsidiary of Zenith Radio Corporation 1247 W. BELMONT AVENUE CHICAGO 13, ILLINOIS

73 tests the Central Electronics 200 V

Anyone who has been around ham radio for more than a few weeks has heard of Central Electronics and probably has been looking over the ads for the 200V. Time was when ham radio was split into two factions: CW and phone. Nowadays there aren't many strictly CW ops around. Sideband had a lot to do with coaxing most of the more firmly entrenched CW men into the phone ranks. And Central Electronics, in spite of the growing list of sideband equipment manufacturers, was there first and did the spade work which built the present popularity of SSB.

Ten years ago, when sideband was a hellishly complicated curiosity that we read about in QST, and there were just a few of those strange quack-quack signals on 75 meters, Wes Schum W9DYV emerged from his cellar with the prototype of the 10A exciter. This was the first well-engineered SSB exciter to appear commercially. This unit was so well done that it is as useful today as ever and you will still hear hundreds of them on the bands.

While competitors were busy imitating the 10A, Wes was back in the workshop bringing out the 10B. Next came the 20A, which was a bit more complicated and ran a bit more power . . . and a bit more expensive. Each time Wes came out with a new rig he was literally years ahead of everyone else. When he announced the 100V he scooped everyone by at least five years. Though I don't have all the actual facts, since Wes is one to keep his worries to himself, as I understand it the 100V was the straw that broke the back of Central Electronics.

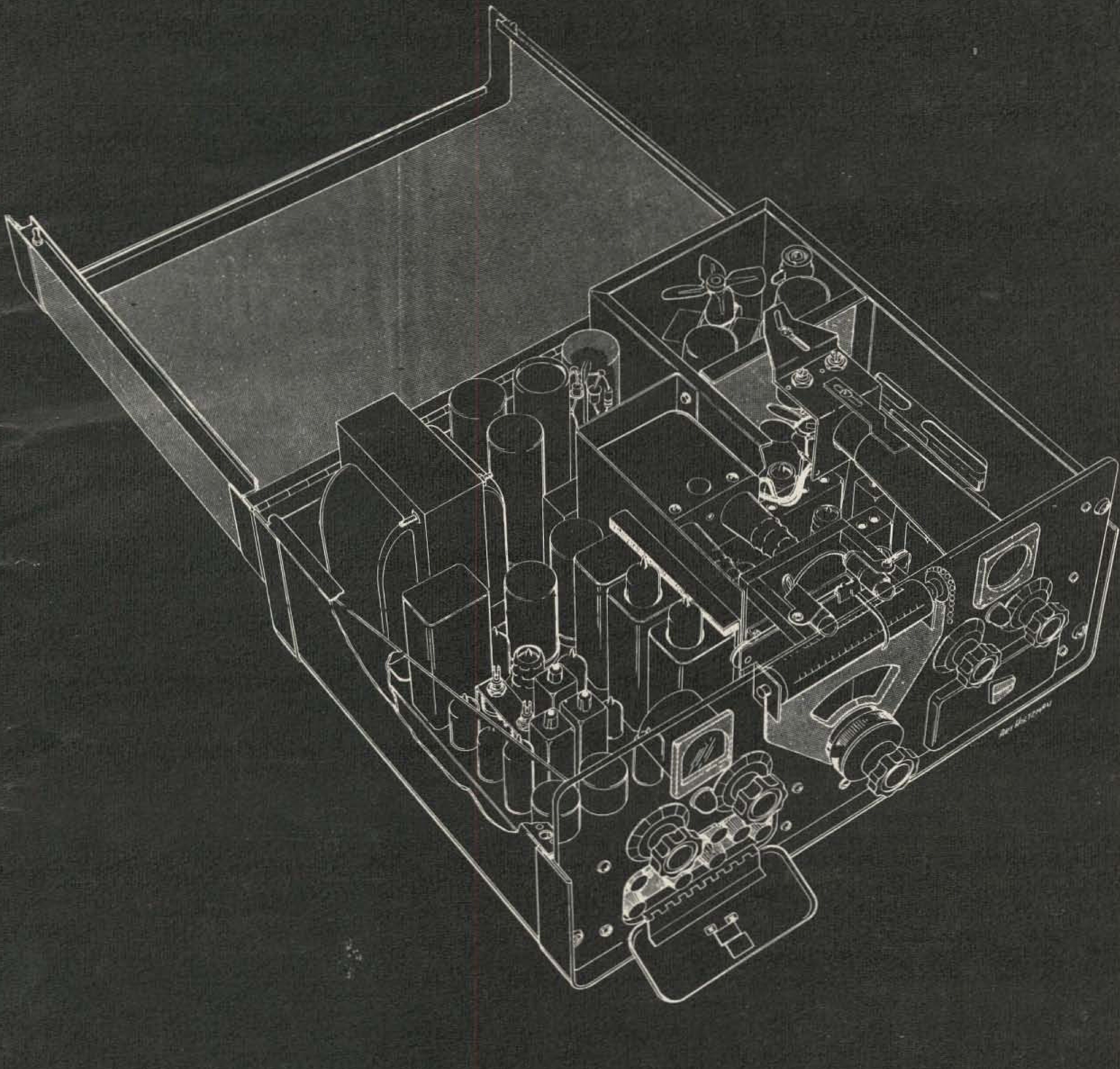
Central had grown slowly from the first cellar operation and through gradual growth had developed a nice plant. Then they designed the 100V, which was to sell for $595, in 1957. Though ads for the 100V didn't appear until about December of '57, the orders were starting to pour in. It wasnt' long until it was obvious to Wes that his plant couldn't possibly meet the demand. Just the cost of filling the orders on hand . . . let's see, 2,000 orders at a cost of about $400 per unit to build comes to about $800,000, was overwhelming. Wes tried everywhere to find some way to fill those orders, but one plan after another ended up in discouragement. The final solution was the changing of Central Electronics to a subsidiary of Zenith. Once this had been accomplished they tooled up to produce the 100V.

The 200V, born of complications due to the new $795 price, an increase in power, and complications arising from the backlog of orders for the 100V, is the latest model and is rapidly becoming as classic as the old 10A and 20A exciters.

History disposed of, let's look at the rig. The 200V is about the present-day ultimate in plug-it-in-and-operate. I made my usual scientific test by hastily throwing up a folded dipole late one night, plugging the receiver, line cord and antenna into the 200V and working every one I could hear . . . and I heard plenty. I really got behind on processing new subscriptions for a few days before the urgency of keeping 73 going overcame my enthusiasm for racking up more DX.

QST did a yeoman job of covering the electronic details of the 200V back in August (while I was too busy playing with it to write it up), so I won't go through all the circuits. A major part of the schematic appeared on our February cover. I selected this circuit because it was the most complicated one I had ever seen for any ham gear. QST spent four and a half pages analyzing it, so you can see how complicated it is. I wont' fuzz you up with a detailed tale of what the electrons do when they reach the pentode section of V11A. From an operating standpoint the 200V is the easiest to use rig ever built. You turn on the ac switch, turn to the band you want to use, set the tuning dial for the frequency and start talking. The oscilloscope on the front panel tells you if you are talking loud enough. All those dozens of knobs you usually find on a transmitter have been consolidated and hidden behind a couple of little doors. These are the set-and-forget controls.

The most important feature of the 200V is the broad-band tuning arrangement which is obviously the way a transmitter ought to be,



but is managed by a patented system which has imitators biting their nails. I remember when Central brought out their 600L linear amplifier with the first broadband coils. They were completely hidden in a cement-like lump which defied opening. One engineer told me about the company he worked for buying a 600L (after trying to buy the coils separately), removing the coil and trying to pry it apart. He ended up with a mangled mess and gave up. I doubt if Central would sell them a new coil either, so there probably is a 600L around somewhere which now has a tuned plate circuit. It is nice not to have to worry about tuning up every time you change frequency.

The more you use the 200V the more excited you get about it. True, it costs $800, but this is pretty reasonable when you consider the incredible amount of stuff they crammed into that 90 pound unit. The dial reads off in kilocycles and can be brought into calibration anywhere along the dial should the unlikely need ever arise.

The unit should hold its value well since all previous Central units still bring a good price. An RF wattmeter indicated more than rated output on all bands. Central should be able to turn these out for years.

. . . Staff

A Simple Antenna Mast

That's me putting the mast up.

THIS is for you! Yes, this is for you if you have ever wanted an antenna mast up twenty or thirty feet with no guys, no braces, and no groundpost. The mast can be moved around with ease to any location. It also has desirable applications for Field Day.

The idea is very simple. You will need one old tire, one or two bags of cement, and a two foot pipe. The amount of cement will depend on how heavy you want your base. The inside diameter of the pipe should be large enough so that the mast you plan to use can be inserted with ease.

Fill the tire with the cement and secure the two foot pipe in the center. Care must be taken to be sure that the pipe is straight.

The base should be heavy enough to support a three element beam twenty or thirty feet up. I am using it at present for a three element ten meter beam. One person can easily walk the mast up or down in seconds to work on the beam. It can also be rolled around to any convenient place in your yard when the XYL stumbles over it taking out the garbage. If the idea catches on we are going to sponsor a contest once a year to see who can get it up and down the fastest. . . . K4GSD

Over she goes. It's so easy with this simple mast.

direct road to earning a successful living in electronics—here it is!

RIDER'S

BASIC RADIO

by M. Tepper

6-Volume 'pictured-text' course makes it easy for you to master radio communications

A BACKGROUND IN RADIO COMMUNICATIONS IS A SPRINGBOARD INTO MANY VITAL AREAS OF ELECTRONICS

Radio communications and the areas that comprise this subject—AC and DC electricity, vacuum tubes, receivers, transistors, and transmitters—is the foundation for many important branches of electronics—FM and AM radio, citizens band, amateur radio, mobile and marine communications, telemetry, radar, television, instrumentation, microwave, facsimile, ultrasonics, telephony, remote control, paging, etc. To know the fundamentals of radio communications is to be prepared for all of these important fields, and BASIC RADIO presents these fundamentals more clearly, more accurately than any text, or any group of texts ever published.

SPECIAL ILLUSTRATIONS MAKE SUBJECT EASILY UNDERSTANDABLE

Not only is the content of the course complete, but it is presented in such a manner that anyone regardless of previous education can grasp it quickly and know the subject thoroughly. The reason—carefully selected language, specially prepared illustrations — specially thought out presentation. These illustrations are not the typical ones found in most books on radio. They are specially conceived and selected for their ability to convey an idea, make complex thoughts simple to understand. You can't miss! There is at least one illustration to every page, one to support every idea—more than 650 illustrations in all in this six-volume course.

COVERS EVERYTHING YOU'LL NEED TO KNOW ABOUT RADIO COMMUNICATIONS TO GET AHEAD

This 6-volume pictured-text course covers the fundamentals and circuitry of radio communications. While it stresses fundamentals, it does not neglect the practical—it puts these fundamental principles to work. You will be able to read schematics—recognize circuits used in radio equipment. You will understand electricity and magnetism. Following the study of electricity, magnetism, circuit components, vacuum tubes, power supplies, oscillators and amplifiers—the various circuits are put to work in simple and elaborate radio receivers—AM and FM, auto and communications receivers including citizens band, mobile communication equipment, etc.

You are made thoroughly familiar with semiconductors and transistors their applications; what they are—how they work and how they are used in radio. Transistor circuits and receivers with parts values are shown.

The last volume provides a thorough coverage of transmitters, antennas and transmission lines You'll understand modulation and transmitter type oscillators, microphones, coupling methods and power supplies and transmitter schematics.

Volume I, DC electricity; Volume II, AC electricity; Volume III, vacuum tubes and vacuum tube circuitry; Volume IV, radio and communication receivers; Volume V, semiconductors, transistors and transistor receivers; Volume VI, transmitters, transmission lines and antennas.

A LOW COST ELECTRONIC EDUCATION 6-VOLUME COURSE ONLY $13.85

This 6-volume course opens the wonderful world of electronics to you. The complete course costs only $13.85 (soft covers). Or, you can select any volume covering the area of radio communications in which you wish to increase your knowledge. Buy this course today at parts distributors, bookstores or order direct using convenient coupon: FREE: Write for free brochure showing samples of pages demonstrating how special illustrations speed your learning.

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A Versatile Automatic Keyer From Surplus

CQ de 73

Roy E. Pafenberg, W4WKM
316 Stratford Avenue
Fairfax, Virginia

NUMEROUS amateur applications exist for an automatic CW keyer that will, on activation, send a predetermined transmission at a preset rate of speed. Just such a device was developed for use aboard military aircraft and was designed to automatically transmit a distress message from the normal aircraft transmitter. The complete equipment is nomenclatured Control Keyer Group, AN/ARA-26, and consists of Keyer, KY-65/ARA-26, and two types of remote switching stations. These units have recently been declared obsolete and have been released through MARS channels. In the normal progression of such matters, they should be available through surplus dealers in the immediate future.*

The keyer is a motor driven, code disk device that is designed to turn on the aircraft transmitter, channel it to the distress frequency and transmit the signals set up on the code disks. As supplied, two metal disks send SOS and bearing dashes and a third disk can be set up in the field to send the aircraft identification number. These blank disks are made of notched plastic and any desired CW message, within the capacity of the disk, may be formed by breaking out notched teeth. Two spare blank disks and a special setup tool are secured inside the cover of the keyer. The photographs show interior and exterior views of the keyer as supplied. The schematic of the unmodified unit is shown in Figure 1.

Several approaches to amateur utilization of this equipment are practical and the one selected will depend on the users requirements. Three conversions are covered in this article and they vary in complexity with their intended application. The first is very simple and

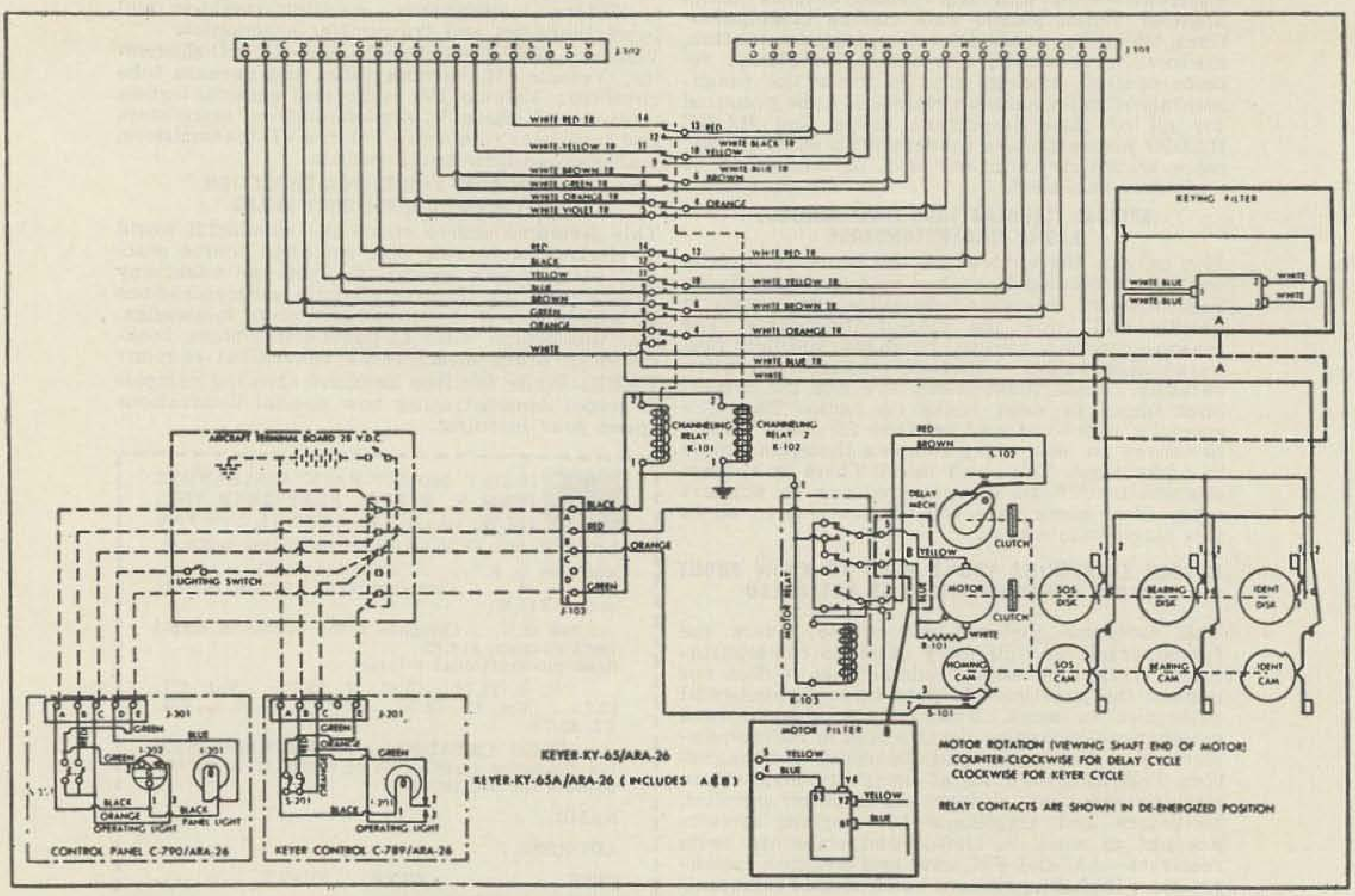

Fig. 1. Schematic diagram of KY-65/ARA-26 Keyer.

be sure

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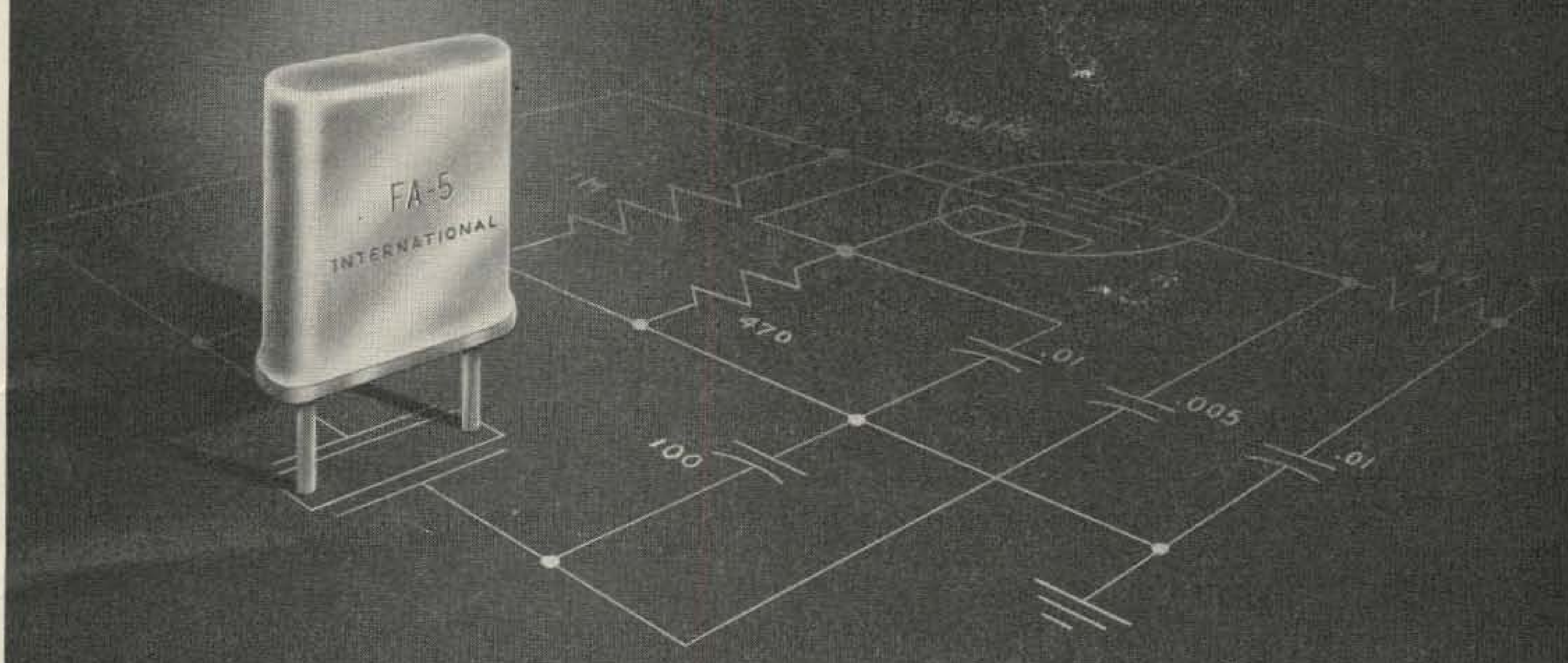

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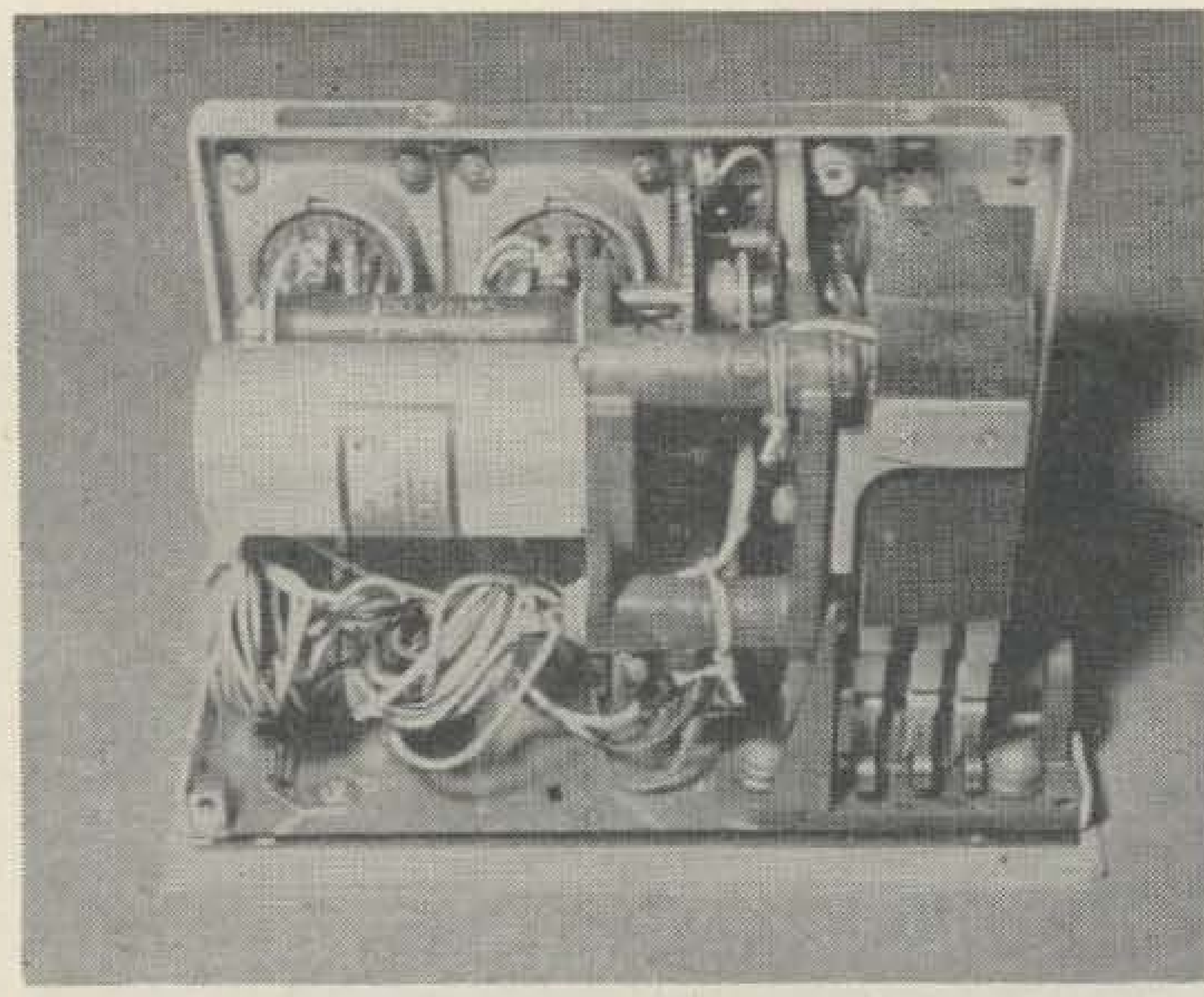


Interior of unmodified ARA-26 keyer.

its primary virtue is that it plugs in the wall and sends CW signals. The second is a deluxe automatic caller and the last is a line break operated keyer to provide automatic transmission of CW identification following radio teletype transmissions.

Each modification consists of both mechanical and electrical work. In common with most airborne equipment, a source of dc is required to operate the PM field motor and the relays. This requirement is met by the use of a slightly unorthodox but very economical, line operated, silicon rectifier supply. The mechanical work consists of replacing the metal code disks with the plastic blanks and, in the two more complex versions, rework of the disk sequencing cams and their associated contacts. This work may be accomplished with ordinary hand tools and is not particularly difficult or time consuming.

The first step is to strip the chassis and clean up the parts which will be used in the conversion. Retain all hardware for assembly of the completed keyer. Loosen the main drive unit by removing the four screws from the bottom of the case and the single screw that secures the assembly to the front panel. Locate the key contact leads and follow them to where they attach to other components. Cut these leads, leaving them as long as possible. Follow the same procedure with the yellow motor lead. Clip the blue motor lead near the housing, slip a piece of sleeving over this lead and tie to the yellow lead. This is a speed governor contact that will not be used. Unsolder the two blue leads from one end of R-101 and clean up this terminal, leaving the resistor in place with the white motor lead attached. Unsolder the leads from the homing switch, S-101, and clean up the terminals. Remove and discard the delay mechanism switch, S-102, along with its actuating lever. At the same time, remove and discard the time delay adjust ratchet spring which is mounted alongside the microswitch lever.

Remove the keying drive assembly and examine carefully. A little time devoted to study of the mechanism will prevent many problems later on. The key disks are driven by a small PM field dc motor through a gear train. Two friction clutches and a time delay mechanism were provided but they can not be utilized in this conversion since the timing gear ratio is not usefully related to that of the keyer drive. Keying is accomplished by three code disks fixed to a common shaft. These disks are made with teeth and spaces around their perimeter and are arranged to actuate the keying assembly. This assembly has three sets of contacts in parallel, each operated by a blade which contacts the association disk at all times. Only one switch operates at any given time, due to cam follower levers which always hold two of the key switch contacts open. The cam levers are operated by a set of sequence cams mounted on a common shaft along with an actuating cam which switches off the drive motor upon completion of each cycle of operation.

The cam shaft is rotated by a geneva star, which is in turn actuated by a pin permanently attached to the SOS disk. Each rotation of the keying disk shaft advances the cam shaft 1/7 of a revolution and, upon completion of one revolution, switches off the drive motor.

Replacement of the metal with plastic keying disks is necessary in each conversion and may be accomplished at this time. Remove the hairpin retaining clip and the knurled nut from the end of the code disk shaft. Loosen the set screw on the outermost disk spacer and remove the complete disk assembly from the shaft. Remove the center disk and discard it.

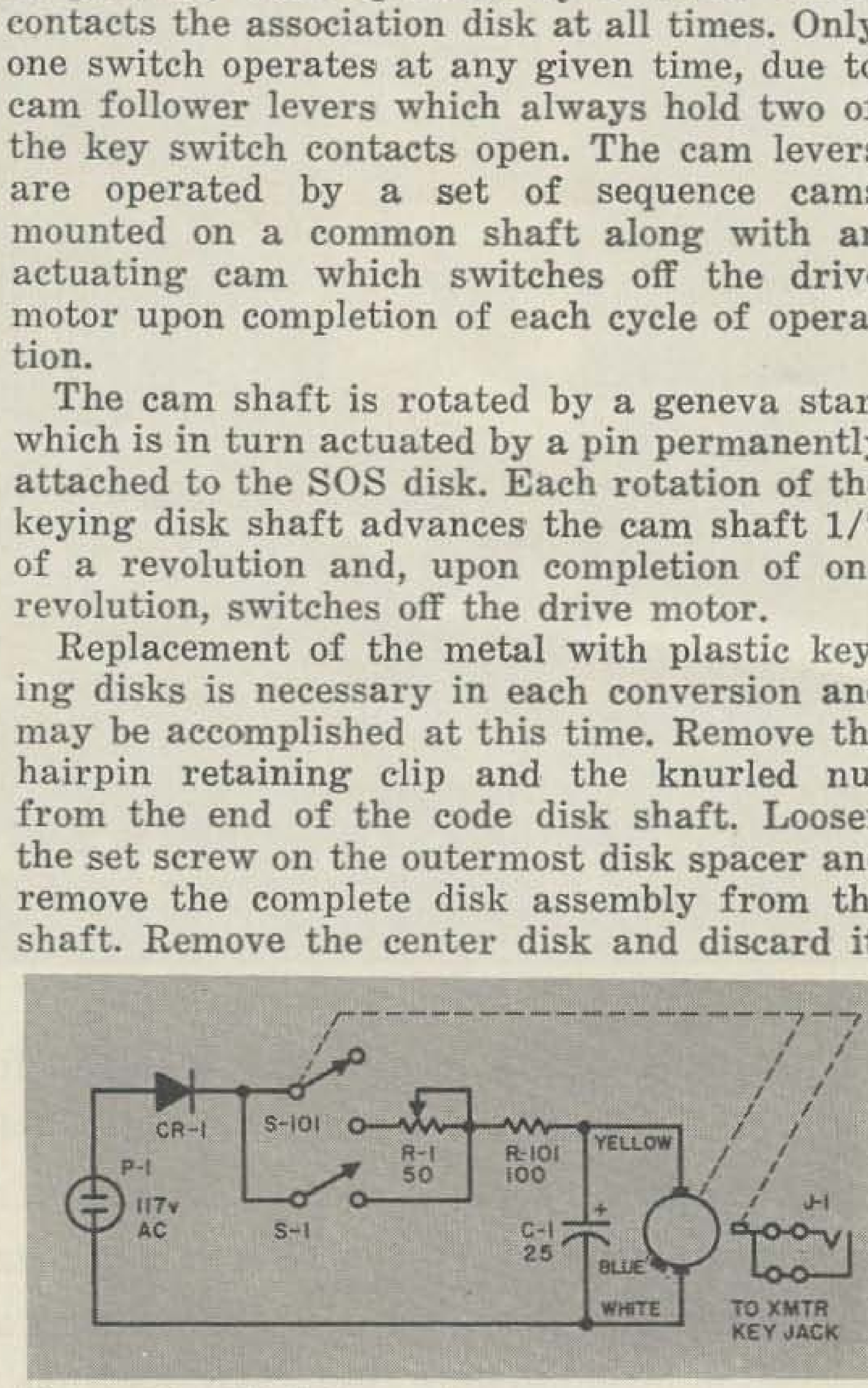
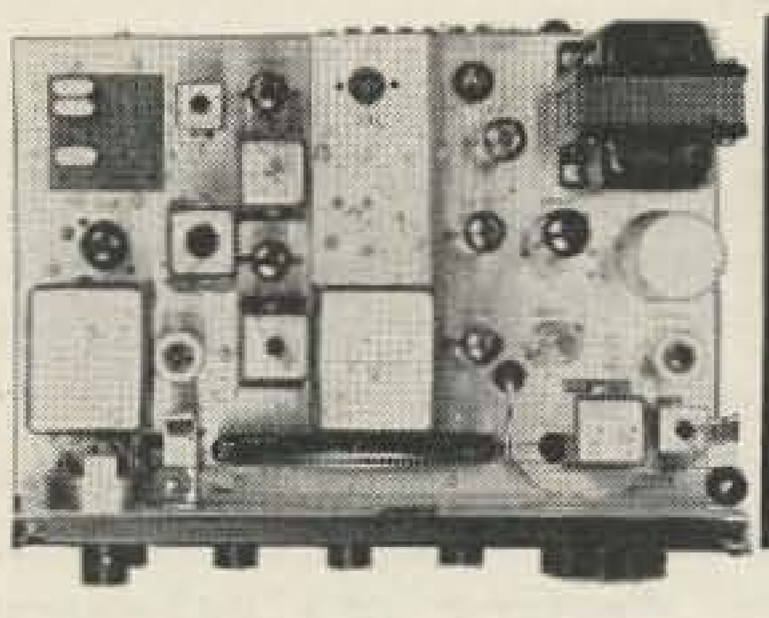


Fig. 2. Simplified Conversion.

C1—25 mfd, 50 wv dc electrolytic cond.
CR1—500 ma silicon rect.. Sarkes-Tarzian M-500 M-500
J1—Standard phone jack. Switchcraft C-11
P1—Replacement ac line cord
R1—50 ohm, 25 w variable wirewound resistor
S1—SPST normally open mom. contact push button switch
Three digit parts numbers are original components

Next, remove the center spacer and the SOS disk. Since the geneva star actuating pin is attached to the SOS disk is must be retained. File the code teeth flush with the inner perimeter of the disk and replace it on the sleeve assembly. Install a plastic disk flush against it. File the center spacer to a thickness of ⅛" and install in its original position. Install another plastic disk and the outermost spacer.



INSIDE THE
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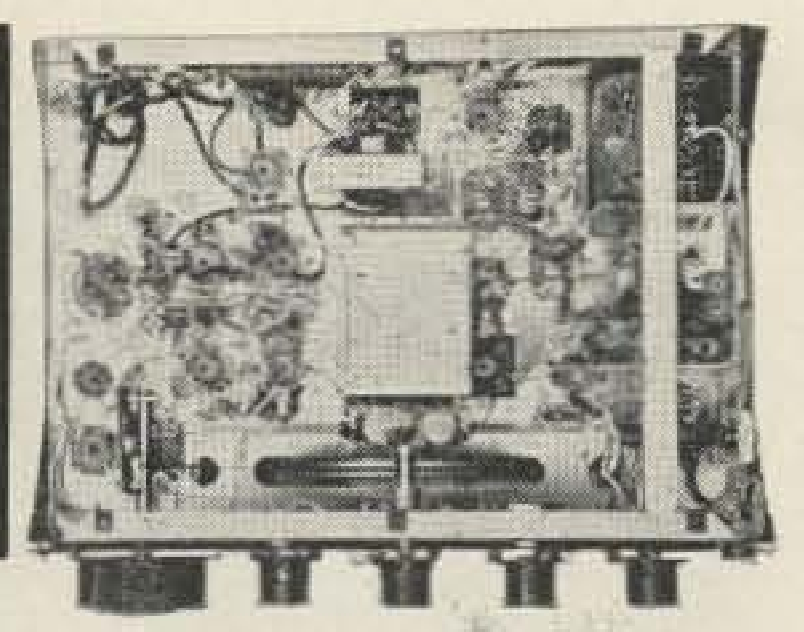

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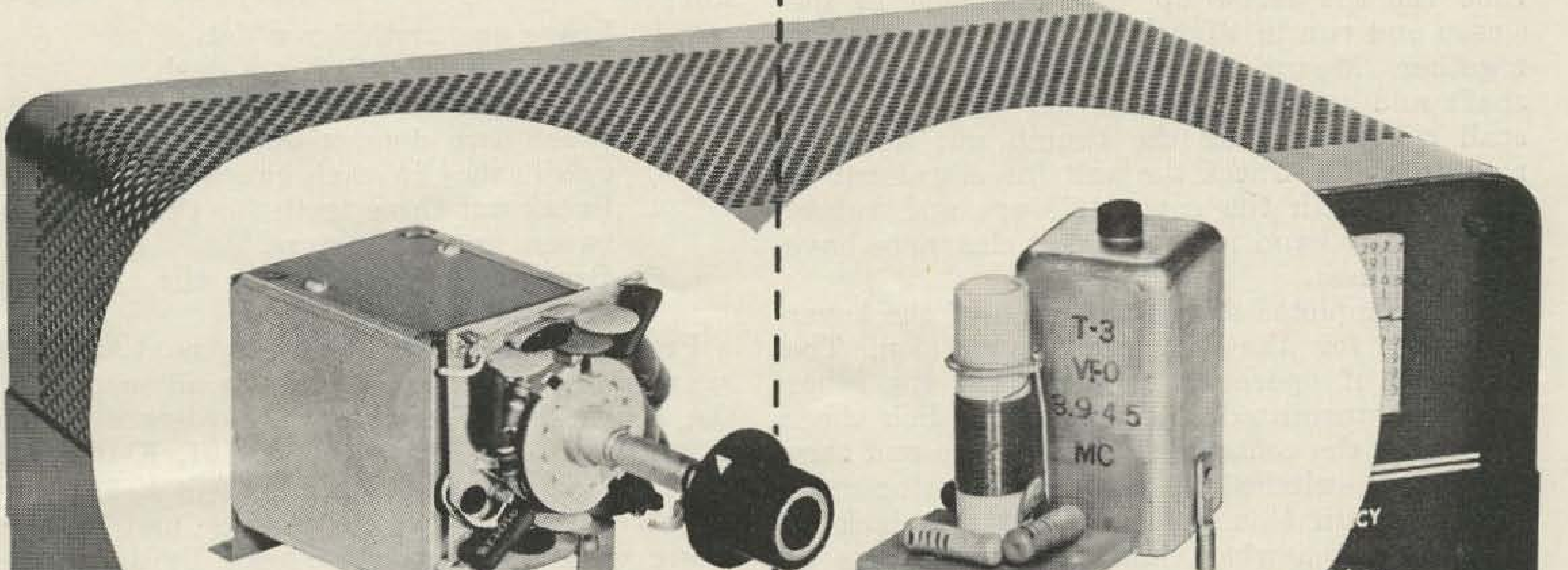

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Before and after.

Line the set screw up with the hole in the sleeve and run in slightly to hold the assembly together. Mount the assembly on the drive shaft and securely tighten the set screw. Install the outer disk the thumb nut and the retaining clip. Check the unit for alignment of the disks with the contact levers and rotate the disks by hand to insure that clearance have been retained.

This completes the modification of the keyer assembly for the simplified conversion. The sequence of operation is such that the inner disk is transmitted once, the outer disk three times and the center disk three times and then the unit is switched off. Any transmission must be set up in this sequence and this lack of flexibility somewhat limits the usefulness of the stripped down version. Full flexibility, at the expense of additional work, is achieved in the other two models.

Setting up the plastic code disks is a simple task. As the photographs show, teeth are broken out of the disks to form CW characters. A tooth broken out results in key open condition and the presence of a tooth results in closure of the keying circuit. A special tool for breaking out the teeth is mounted inside the cover of the keyer. The basic code element is a dot which is represented by a single tooth. Coding is obtained by starting at the space on the disk which is marked with an arrow and continuing in a clockwise direction, breaking out teeth in the disk to obtain dots and dashes. A word of caution is advisable here. Plan your transmission carefully, keeping in mind the sequence of operation. Adhere to the following chart and perfect characters will result:

1. Leave one tooth for a dot.
2. Leave three teeth for a dash.
3. Break out one tooth for the space between two dots, a dot and a dash or two dashes in each character.
4. Break out three teeth for the space between two characters.
5. Break out five teeth for the space between words.

Preparation of the case is next on the agenda and this step applies to all models of the conversion. Remove the hardware which mounts J-101, J-102, J-103, K-101, K-102 and K-103. Clean up and retain relays K-102 and K-103. Discard the connectors and K-101, along with the wiring harness. Drill out the three rivets holding the bottom plate to the case and discard the plate. A coat of flat or semi-gloss spray lacquer will cover the existing panel markings and restore the original black crackle finish to new condition.

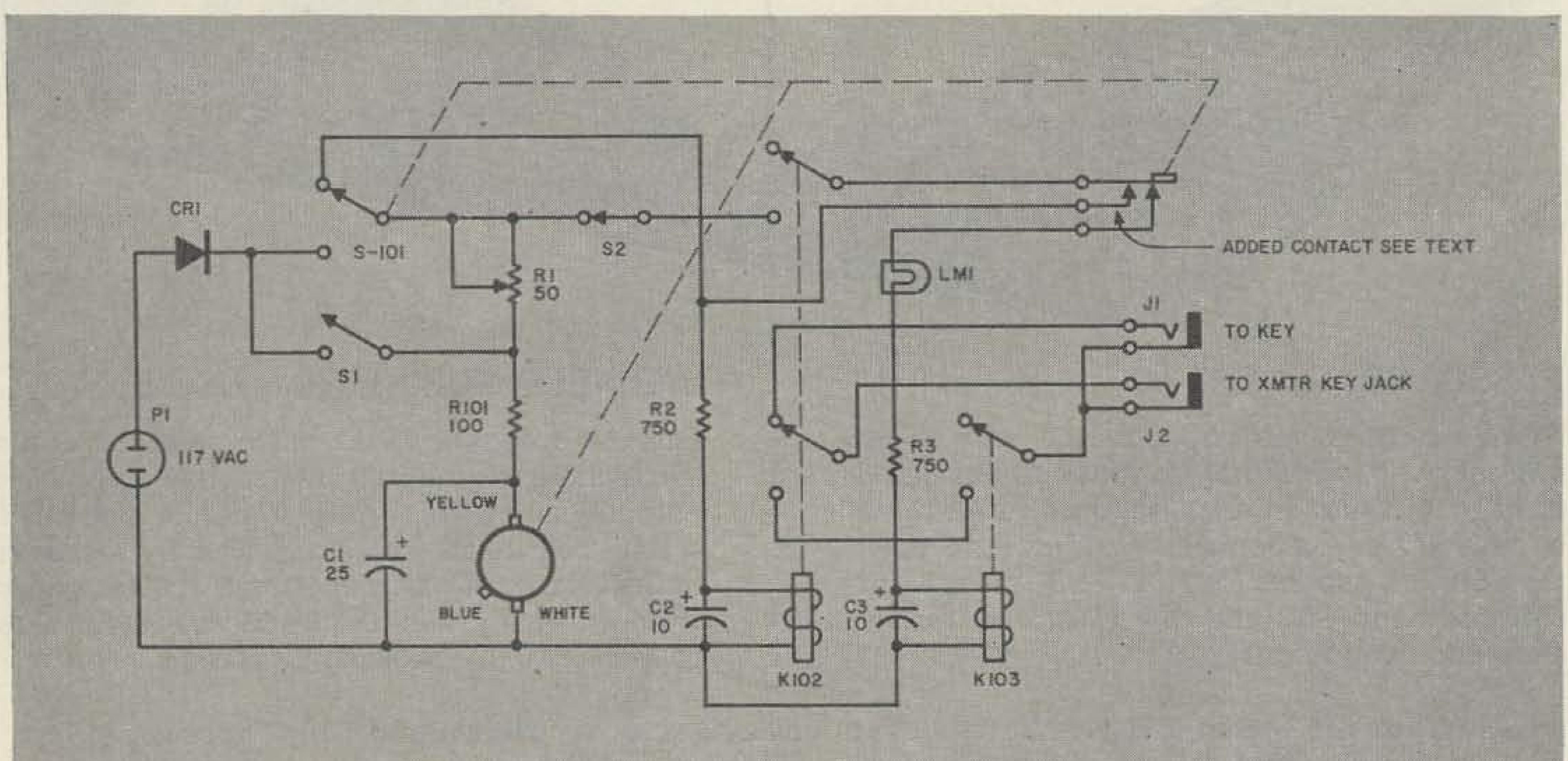
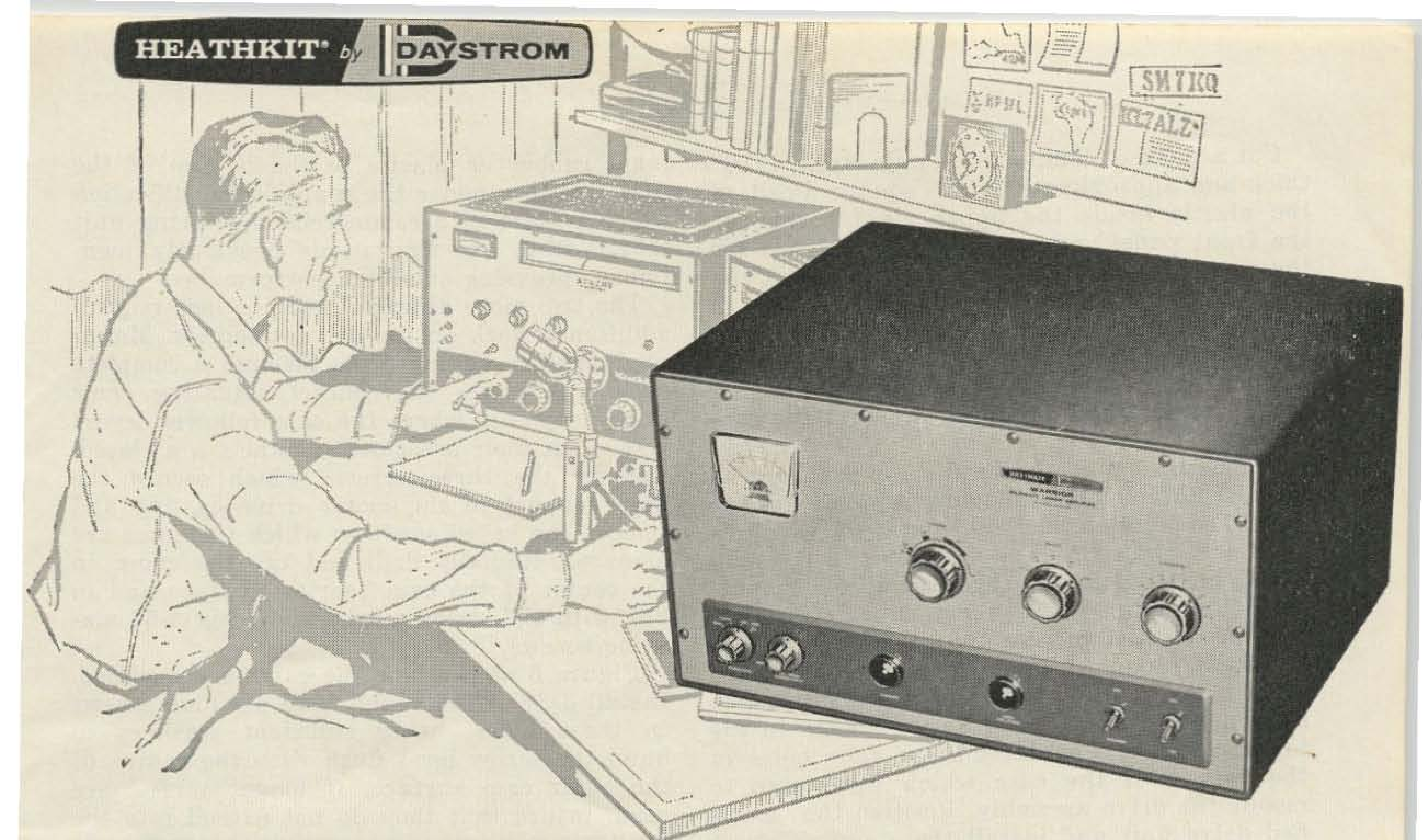


Fig. 3. De Luxe Automatic Caller.

C1—25 mfd, 50 wv dc electrolytic cond.
C2, 3—10 mfd, 25wv dc electrolytic cond.
CR1—500 ma silicon rect. S-Tarzian M-500
J1, 2—Standard phone jack. Switchcraft C-11
LM1—28 v pilot lamp. GE #1829
P1—Replacement line cord.
R1—50 ohm, 25 w variable wirewound resistor
R2, 3—750 ohm. 10 w wirewound resistor
S1, 2—SPDT momentary contact push button switch
R101—Original part. 100 ohms.



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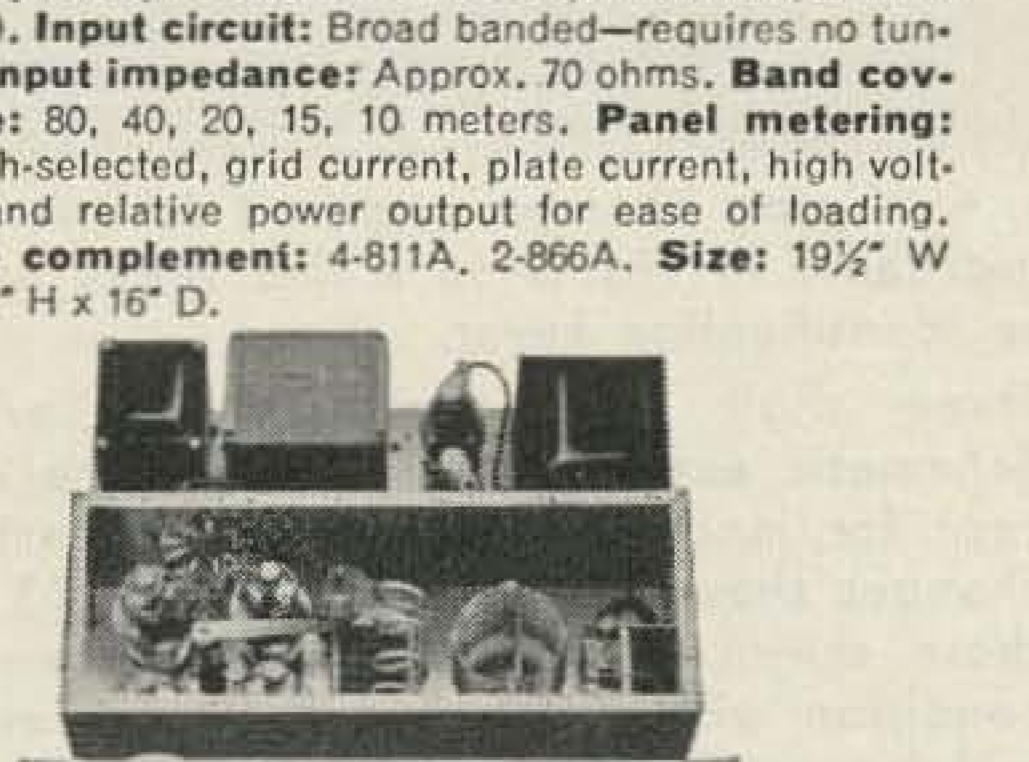

This inside view shows the neat circuit layout and husky components that emphasize quality. Note the internal shielding of plate circuit for maximum protection against TVI.

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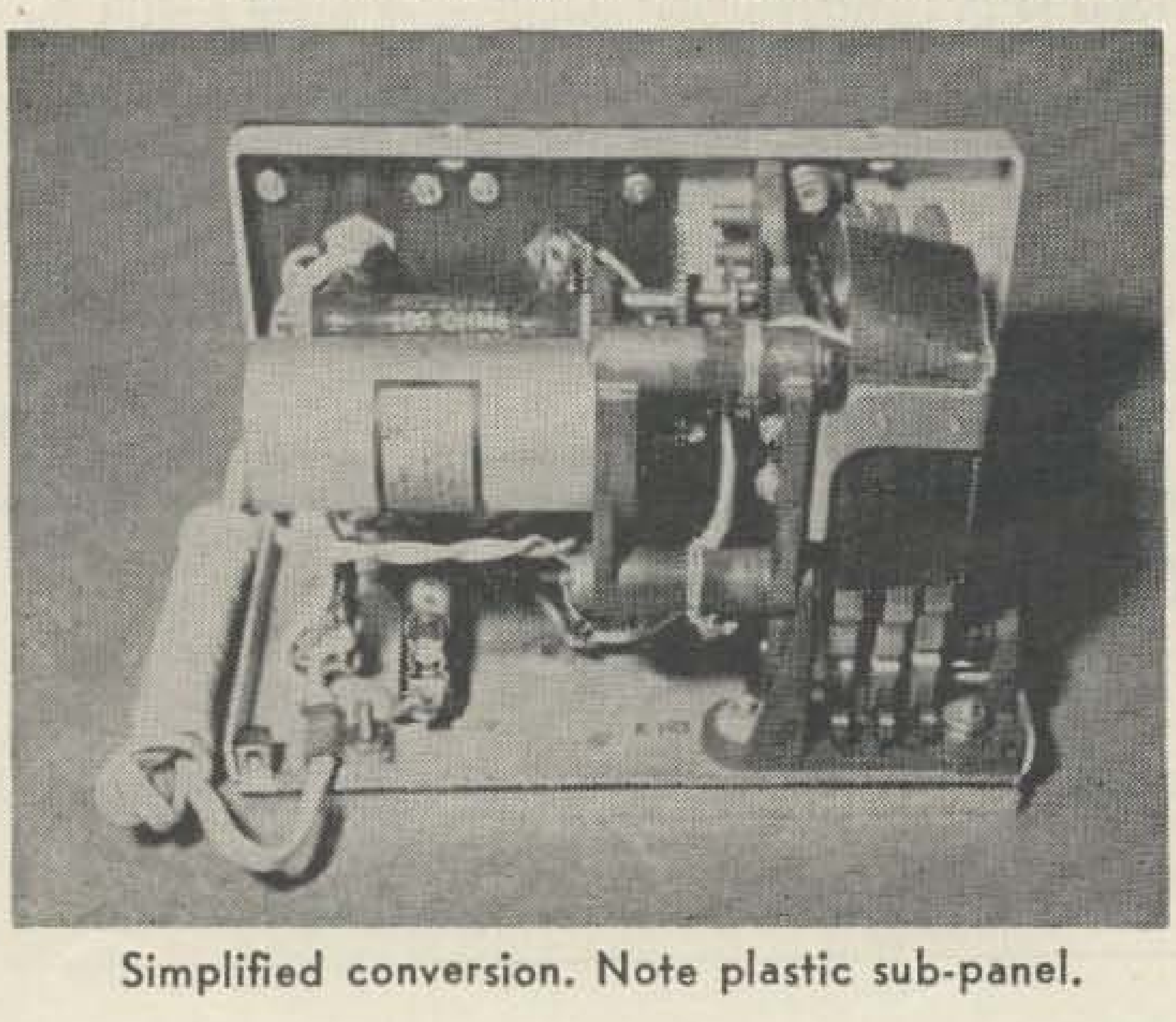
Cut a piece of laminated plastic stock, 1/16" thick and approximately 3½" square. Position the plastic inside the upper right corner of the front panel and cut clearance notches for the captive nuts which are used to mount the cover to the case. Mark the location of the 12 holes that were used to mount the original connectors. Drill matching holes in the plastic and secure the sub-panel in place, using the hardware that was used to mount the connectors.

From this point on, details for each of the models differ. The following applies to the simplified version, the schematic of which is shown in Figure 2. Drill ⅜" holes in the sub-panel, centered in the three connector mounting holes. Mount the 50 ohms, 25 watt resistor, R-1, in the bottom hole and install a knob on the shaft. Mount a standard open circuit phone jack in the top left hole and a normally open momentary contact, push button switch in the top right hole. Countersink the four holes in the bottom of the case which were used to mount the drive assembly. Position the modified drive unit and install these screws along with the front panel screw. Install the silicon rectifier mounting clip, using one of the relay mounting holes. Similarly mount the capacitor, C-1, and tie points to terminate the line cord and as required for wiring convenience. Wire the unit in accordance with Figure 1, insuring that no portion of the circuit is accidently grounded.

If all appears in order, plug the unit in and press the starting switch. The drive should turn freely without binding and the key contacts should close in accordance with the keying information set in the disks. The motor speed should be smoothly adjustable from just short of stall to the point where the keyer walks across the bench.

Drill a hole in the back of the cover and install a rubber grommet to pass the line cord. Remove the name plate from the cover and give the spray lacquer treatment to the cover. Vibration may be reduced to negligible proportions by cementing a rectangular piece of foam rubber or plastic to the bottom of the case. This completes the simplified modification which results in a commercial appearing unit that, within the limitations previously mentioned, provides excellent performance.



Simplified conversion. Note plastic sub-panel.

The two more complex modifications require additional work on the drive assembly. Manually turn the keying disks through a complete cycle and scribe the contact actuating cams at those points where the cam follower levers rest when their associated contacts are closed. Remove the three screws which secure the base support to the motor drive casting and remove the keyed shaft on which the cams are mounted. Radially drill and tap the cams, in the center of the cam bearing surface and in line with the scribe marks, to accept 2-56 machine screws.

Figure 5 shows how the cams are modified. Install 3/16", 2-56 round head machine screws in these holes, using sufficient washers to build the screw head flush with the radius of the outer cam surface. If longer screws are used, insure that they do not extend into the

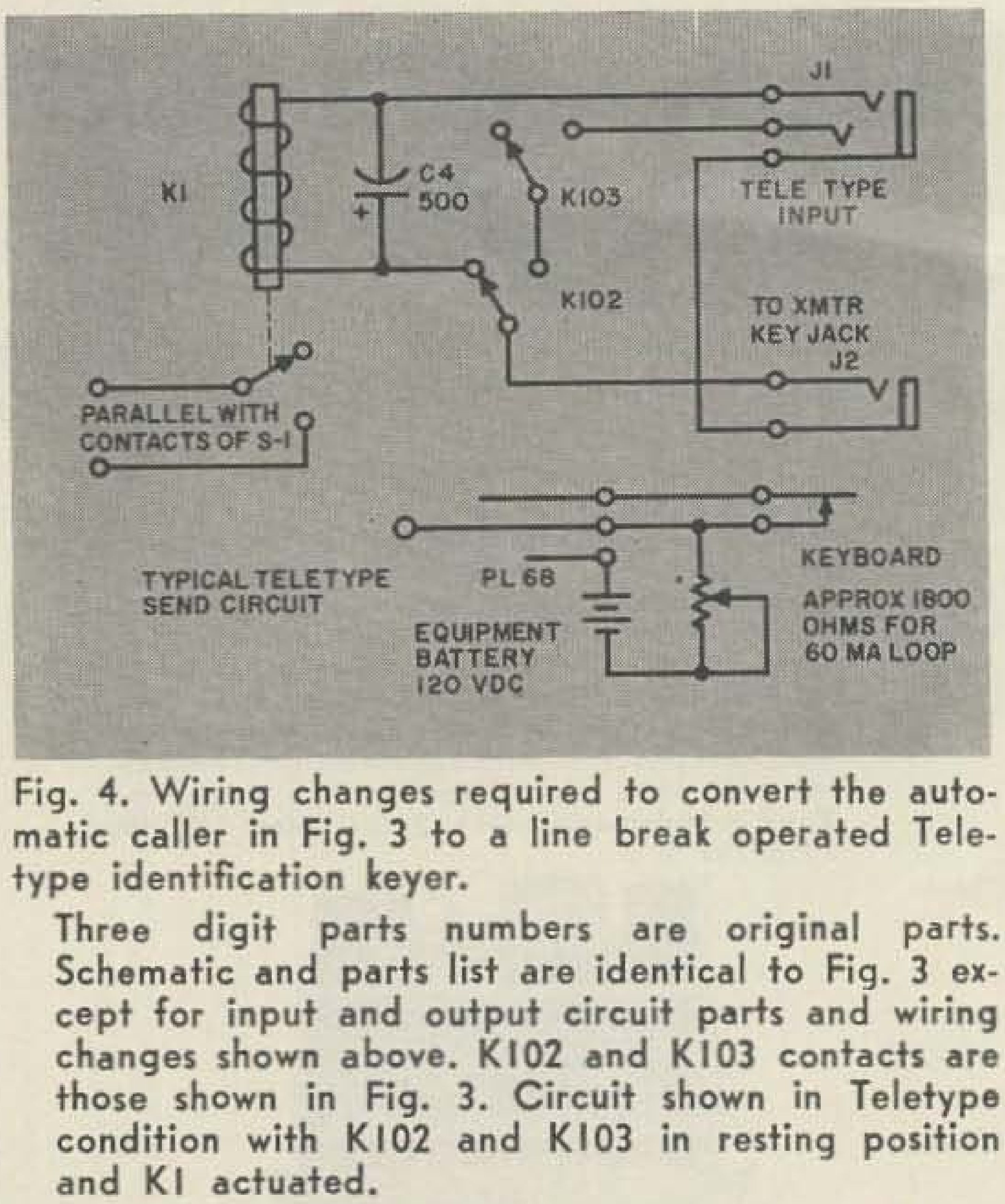


Fig. 4. Wiring changes required to convert the automatic caller in Fig. 3 to a line break operated Teletype identification keyer.

Three digit parts numbers are original parts. Schematic and parts list are identical to Fig. 3 except for input and output circuit parts and wiring changes shown above. K102 and K103 contacts are those shown in Fig. 3. Circuit shown in Teletype condition with K102 and K103 in resting position and K1 actuated.

C4—500 mfd, 25 wv dc electrolytic. C-D type BR5002

J1—Mike jack, Switchcraft type C-12B

K1—Sensitive relay, 200 ohm coil. Sigma 41F-200-S/SIL

shaft hole. File the keys which engage the shaft keyway flush with the radius of the cam shaft holes. Drill and tap a 4-40 hole in the center of the hub of each of the three cams and start a socket head set screw in each hole. Slide the cams on the shaft and reassemble the drive unit.

The cams should now be set for the desired sequence of transmission. Keep in mind that the single detent cam may be used for zero or one revolution while the other two cams

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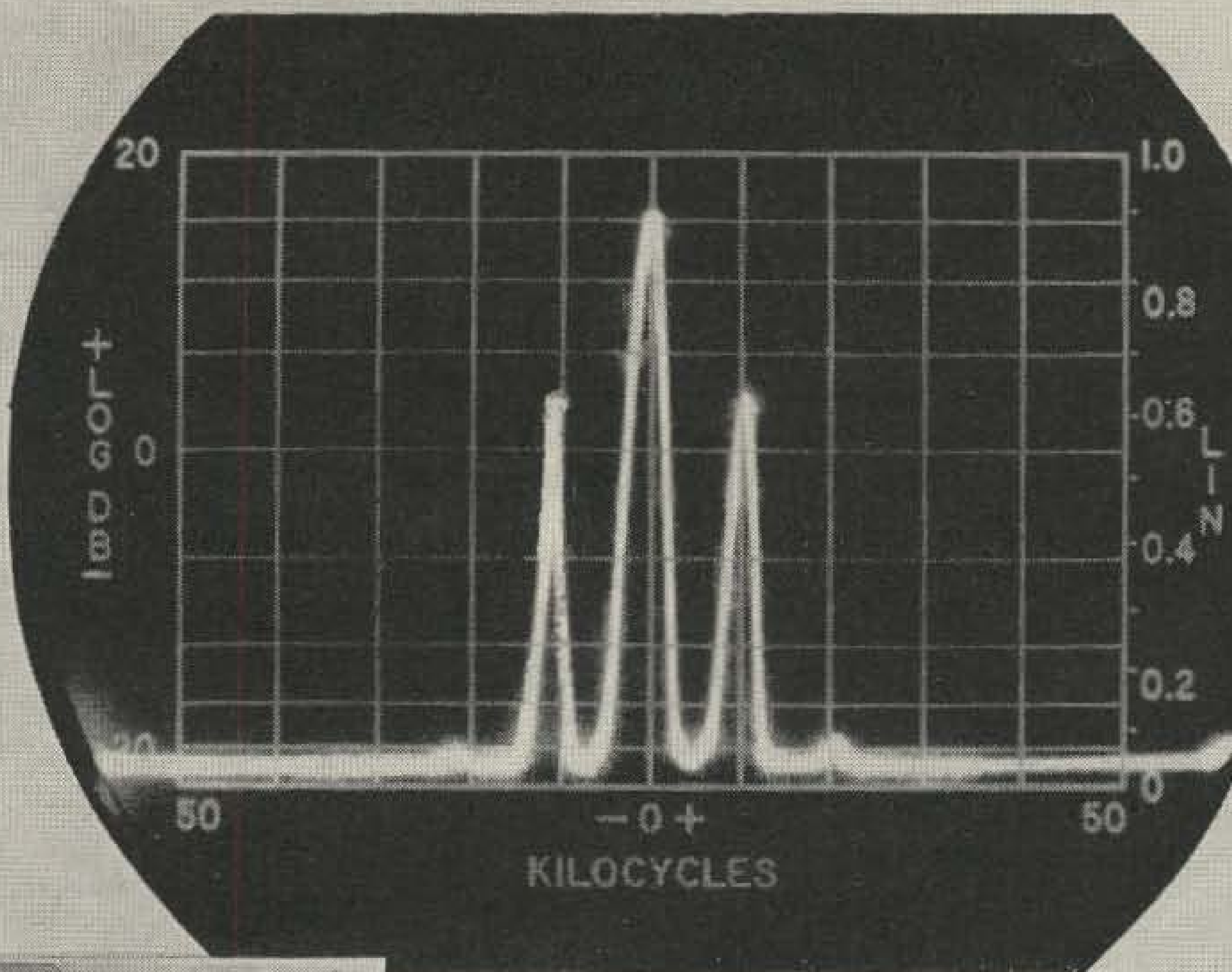

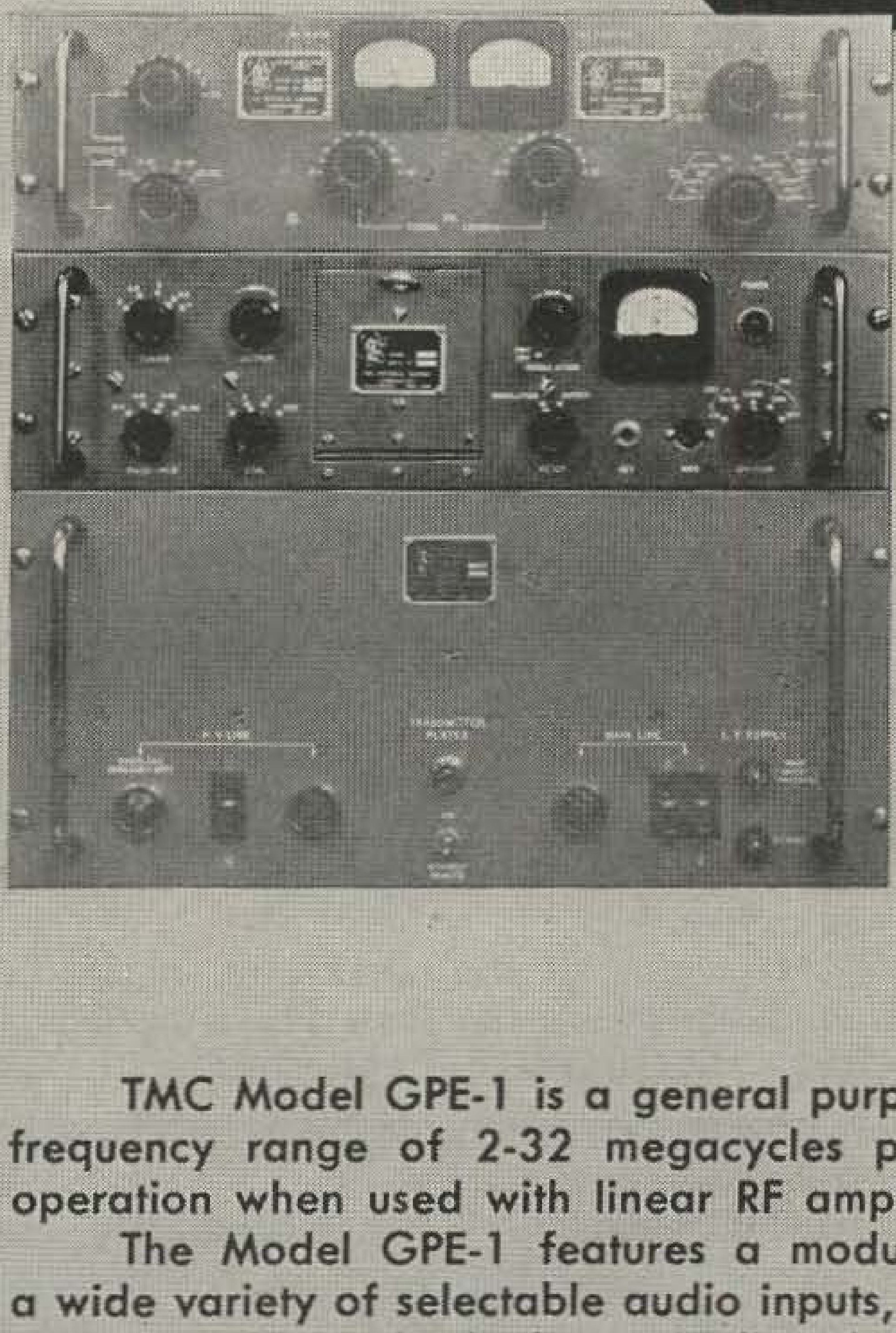

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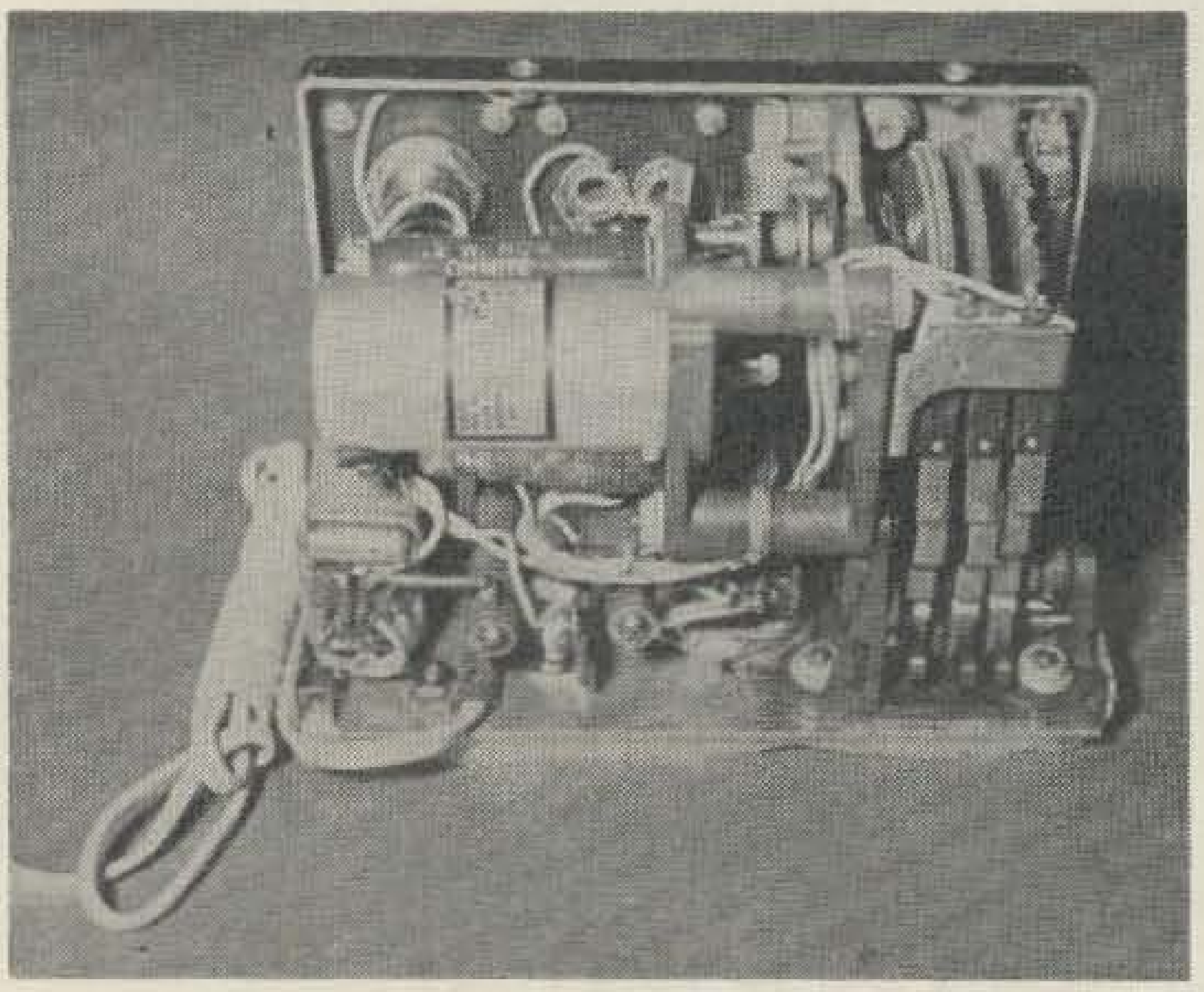
OTTAWA, CANADA • ALEXANDRIA, VIRGINIA • GARLAND, TEXAS may be used for from zero to three revolutions. Rotate the keying head to neutral and advance to the first detent. Rotate the cam which is associated with the disk to be transmitted first in a counterclockwise direction until the first screw is positioned under the cam follower. Tighten the set screw which secures the hub to the shaft and then remove the screw under the cam follower. Working in a clockwise direction, remove as many 2-56 screws as keying revolutions are desired from that disk. Rotate the keyer head this number of detents and do the same for the second and third disks. Rotate the head manually and check that the desired sequence of transmission has been obtained.



De Luxe conversion.

In order to automatically transfer the keying circuit back to the hand key on completion of the desired transmission, it is necessary to add a contact to each of the three keying switches. When the end of the keying is reached, all of the cam followers are actuated and these paralleled contacts will open, transferring the keying circuit back to normal. The keyer drive will continue through the seven revolutions and stop at neutral.

Loosen the two key contact stack screws and separate the contact stack on the inner side of the outer contact. Cut mica scrap to the same shape as the existing insulator and, after slotting the screw holes, insert the insulator without removing the screws. Cut three contacts from brass stock or use very light relay contacts and slide them between the new and existing insulators. Bend and position them in such a fashion as to make with the outer contact in the transmission cycle and to break when the cam follower is actuated. Tighten the screws and rotate the head through a keying cycle to insure that the original contacts key as intended and that, for each disk, the added contacts close during the transmission cycle.

The circuit of the de luxe keyer is shown in Figure 3. Line voltage is rectified by the silicon rectifier, CR-1, and applied to the contacts of S-1 and S-101. When S-1 is momentarily closed, current is applied to the drive motor and through the normally closed contacts of S-101 to the winding of K-102. The latching contacts of K-102 close and the drive motor advances the keyer head, closing the added contacts of the key contact stack and switching S-101. At this point, the current to K-102 is applied through the normally open contacts of S-101, the normally closed contacts of S-2, the latching contacts of K-102, the added contacts of the key contact stack and R-2 to the winding of K-102. The motor drive is operated until S-101 is tripped at the end of the drive cycle and the motor stops.

The keying circuit bypasses the keyer when K-102 is in the resting position. When K-102 is actuated, the extended key is removed and the keyed contacts of K-103 are connected across the output jack, J-2. During the keying cycle, the keyer contacts supply keyed current through the lamp, LM-1, and R-3 to the winding of K-103. The keying cycle is ended by either the "off" switch, S-2, or the added contacts of the keyer head being opened. Capacitors C-1 through C-3 smooth the rectified voltage applied to the drive motor and the relays.

Some modification of the circuit of Figure 3 is required to adapt the keyer to radio Teletype use. A typical Teletype send circuit is shown in Figure 4. The input and output circuits of the keyer are wired to apply the 60 ma loop current to the keyer through the ring and sleeve contacts of J-1, through the winding of K-1 and the normally closed contacts of K-102, to the output jack, J-2. The output is patched to the transmitter where the circuit is completed by the frequency shift keyer. Relay, K-1, is actuated by the loop current and the charge of capacitor C-4 holds the contacts open during normal Teletype keying impulses.

Operation of the break key on the Teletype machine opens the loop for a period of time that allows C-4 to discharge and the contacts

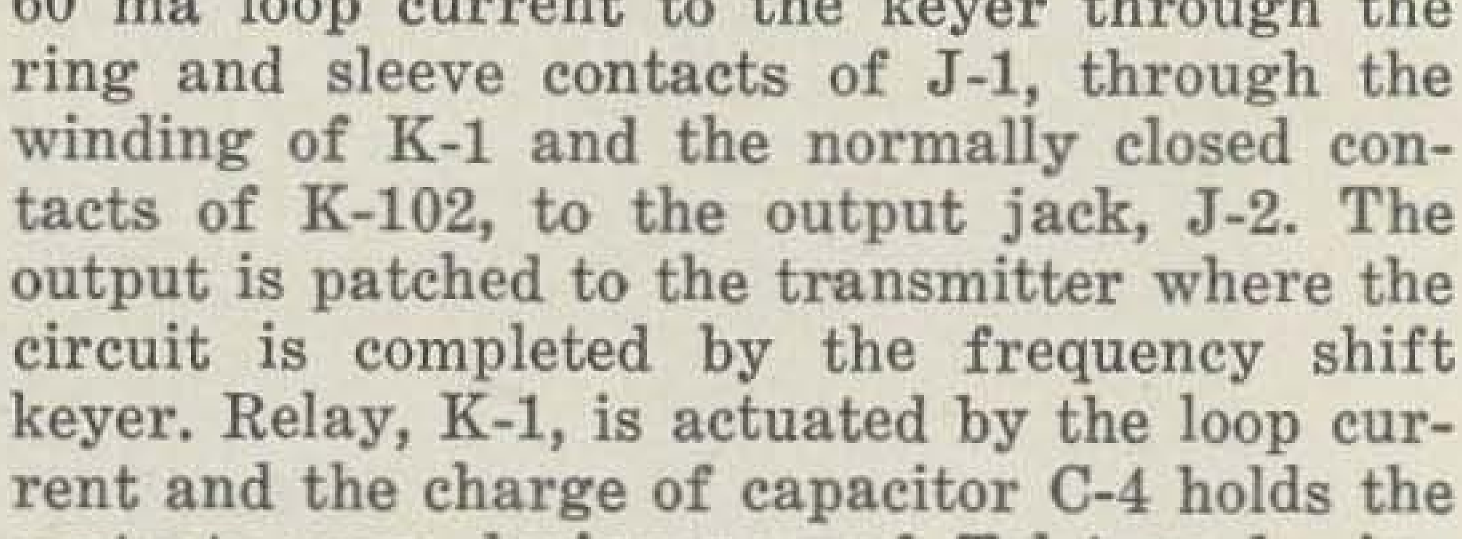


Fig. 5. Key switch cam modification. This change will allow any sequence of transmission from the three code disks. Keying cycle may be set for from one to seven revolutions of the keying head.

(A) Holes drilled and tapped 2-56 in center of cam surface. Text describes method of determining exact location. Round head machine screws are installed, using washers to build the screw head out flush with the outer circumference of the cam surface.

of K-1 to close. This starts the keying cycle and K-102 is actuated. Loop battery is then supplied through the tip contact of J-1, through the CW keyed contacts of K-103, to J-2 and hence to the transmitter. Completion of the keying cycle releases K-102 and the circuit is restored to normal Teletype operation. It is essential that the ac input to the keyer be routed through the loop battery power supply switch. If this is not done, switching the power supply off would cause the keyer to run continuously.

The photographs show construction details of the de luxe versions of the keyer. Mount the variable resistor in the bottom, J-1 and J-2 in the top left and the indicator pilot in the top right connector clearance holes. The relays mount in their original positions and the other components are mounted as they can be squeezed in. Use of miniature transistor circuit capacitors for C-2 and C-3 permits their being mounted on the relay terminals. C-1 may be mounted under the stud which secures R-101 to the motor drive casting.

Wiring is straightforward and the layout of the original harness can serve as a guide for routing. Decals and the finish details described for the simplified version will dress these units up and result in assemblies that are indistinguishable from factory products. Operation of the keyers is trouble free and they, in addition to their novelty attraction in producing contacts, are genuine assets in any operating room.

*Both Columbia Electronics Sales and J. J. Candee Company have plenty of the ARA-26 units in stock. R-W Electronics did have a few but we wiped out their supply stocking up the "73" lab. The following non-advertising (so far) surplus dealers also have indicated that they have them in stock: C&H Sales; Bill Slep Company; Tri-County Electronics.

Junk Box

My cellar and garages are famous all over Brooklyn for the twenty-five year collection of radio debris that has accumulated. Naturally I have occasional visitors whose eyes bug out and who pay re-visits when they need something for some gadget they are building. This does not always work out to their advantage, as Stan WA2BGA found out to his bewilderment the other day. He dropped in to "borrow" some coils for a little receiver he was whipping up. I dug out some oldies, blew the dust off 'em, and said a sorrowful goodbye. I needn't have worried so about it for they were back in a couple hours in the hands of an irate Stan. "Take back your old fashioned coils . . . all I can get with 'em is Little Orphan Annie and Just Plain Bill." . . . NSD

A Like-New Mixer Circuit

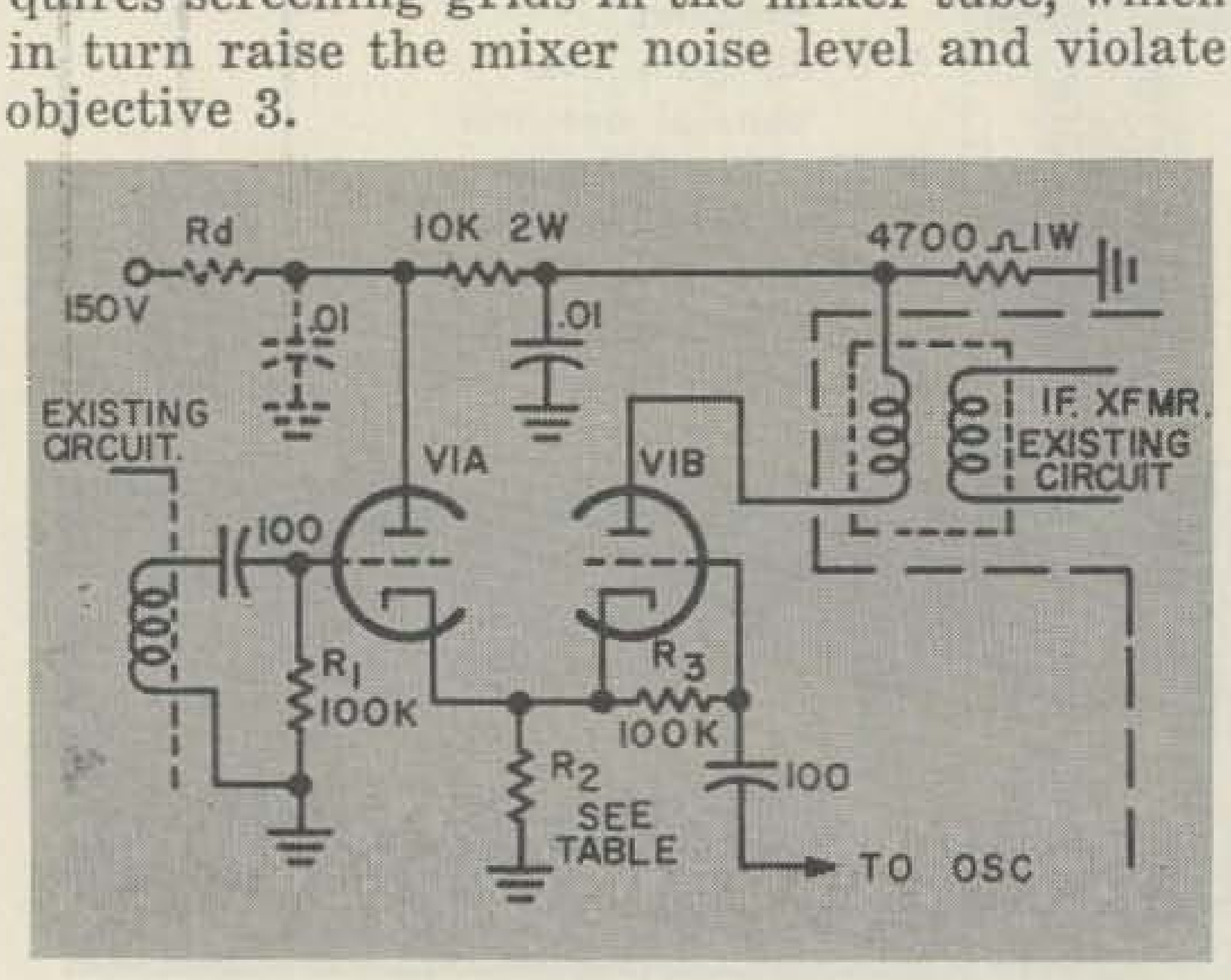
WOULD you like to improve the sensitivity and the stability of your receiver?

If you would, and don't mind delving underneath the chassis a bit, one of the quickest routes is to modify front-end circuitry. The technical article, "Up Front," in our March issue contained a rather complete collection of improved front-end circuits.

However, here's one which escaped attention when the article was prepared—and which has escaped almost everyone's attention since it was first developed. That's why we're calling it a "like-new" circuit; it's been around for a spell but it might as well be new since almost no one knows of its existence.

Before going into this circuit, it might be well to review the characteristics of a good mixer. The ideal mixer in a superhet receiver should (1) produce no spurious frequencies, (2) provide ample gain for the signal, (3) contribute no noise to the signal, (4) provide complete isolation between oscillator and signal to prevent undesired radiation, and (5) present as light a load as possible to the oscillator to preserve frequency stability.

These characteristics, at least to a degree, are mutually incompatible with most conventional circuits. For instance, isolation of the oscillator from the signal circuit usually requires screening grids in the mixer tube, which in turn raise the mixer noise level and violate objective 3.



As pointed out in our aforementioned technical article, the best compromise to date has been the 6AC7 used as a pentode mixer, following the circuit described in Langford-Smith[1]. This circuit provided low noise, adequate gain, little in the way of spurious output, and adequate isolation for most purposes.

However, the particular version of the twin-triode cathode-coupled mixer which we're describing here outdoes the 6AC7 on all counts except gain, and runs it a close race there. On top of this, it can be installed in any set which uses an octal-base, a 9-pin, or a 7-pin mixer tube without changing the socket, since suitable twin triodes are available in all three basings.

The circuit is not original; it was found in K. A. Pullen's book "Conductance Design of Active Circuits," a volume[2] which incidentally should be in the library of every serious ham designer (plug unsolicited; Radio Bookshop please copy), and was field-tested in a vintage BC-779 in comparison with both a 6L7 and a 6AC7.

Results were judged on a purely subjective basis, due to lack of test instruments suitable for adequate and accurate measurements. numerical values mentioned here are calculated figures, but the field tests confirm them as closely as possible.

The full circuit is shown in the schematic, Fig. 1, Table I lists parts values and operating conditions which vary with different tube types or design objectives.

At first glance, you may be led to believe that this is approximately the same circuit as that recommended by Geisler[3] or Lee[4], or may be a version of the Crosby triple-triode product detector[5]. While the general configuration is similar, the circuit operation and its advantages are radically different.

The key point is the low value of plate voltage supplied to V1B. Pullen recommends only that V1B's plate supply be "considerably" lower than that for V1A. The best operation was found with 50- and 150-volt supplies, respectively, and component values shown are for use with these voltages.

By operating the two nominally-identical triode sections with a common cathode resistor but at two different plate-supply voltages, a relatively small change in current in one tube will cause a large change in the gain of the other. This is accomplished without sacrificing average gain in either tube.

In addition, the cathode-follower action of each stage completely isolates the oscillator from the signal circuit. Since the signal sees only a pair of triodes, noise is not increased.

This circuit is a true linear mixer rather than a detector; its output contains only the two original frequencies and the "product" of the original signals (numerically equal to the sum and difference frequencies but without their usual noise content). The chain of spurious frequencies usually found in detection-type mixer circuits is absent.

Those who have tried triode mixers before, even of the cathode-coupled variety, may wonder about gain. Calculations showed that the version first tested should have shown a conversion gain of about 20, as compared to the calculated pentagrid mixer gain of about 5 under the same conditions.

The test signal was a broadcast station with consistent strength. S-meter reading with the pentagrid mixer was recorded and the twin-triode circuit then substituted and mixer alignment readjusted. The S-meter showed just under 2 units improvement.

Considering the free-wheeling calibration of most S-meters, and this one was no exception, this is a remarkable correlation of theory and experiment. Frankly, we disbelieved it and substituted another tube which had a calculated gain of 13. After realignment, the S-meter dropped one unit.

Regardless of such gain figures, which are dependent on many variables not all of which are under control, this version of the twin-triode mixer shows more signal gain than many pentagrid mixers. Its noise figure is so low that mixer noise simply disappears, even with three *if* stages following. The result is almost complete silence between stations, leading one to believe at first that the circuit is a dud. Then, though, a fading long-hop signal will come through, moving almost instantly out of the no-signal region into clear audibility, and the design is vindicated.

Every type of twin-triode tube tested to date works in this circuit, but some give better results than others. As noted in Table I, oscillator injection voltage requirements vary drastically from tube to tube. In a like manner, sensitivity varies.

Among octal-base tubes, the 6SN7 gives greatest gain but requires higher voltages to get there. The 6SL7 develops its gain (just half an S-unit less) with much weaker signals and much less oscillator injection. Therefore,

Table I. Voltage Requirements for Various Tubes and Values of R2 With Typical Conversion Gain

Tube	6SN7 (also 12AX7)			6SL7 (also 12AU7)			12AT7			6J6	
Value of R2	100	500	1000	100	500	1000	100	500	1000	100	1000
Input—Voltage (Signal)	2.1	10.5	21	0.32	1.6	3.2	1.4	7.0	14.0	2.1	21
Input—Voltage (Osc.)	2.5	11.5	22.4	0.42	1.9	3.6	1.6	7.0	13.1	2.3	22
Conversion—Gain if IF Xfmr Impedance Is 50K ohms (For Comparison)	18.5	18.3	18.0	13.9	13.7	13.6	100	150	160	80	130

the 6SL7 is recommended.

Dozens of twin triodes are available on 9-pin bases; among the most popular are the 12AX7, the 12AU7, and the 12AT7.

The 12AX7 is directly comparable with the 6SL7, and the 'AU7 with the 'SN7. However, the 12AT7 is the hottest tube available for this circuit, with a gain of more than 100 and comparatively low injection- and signal-voltage requirements, so it's the only recommended type. If you're willing to change sockets, the 12AT7 is the best for any set regardless of original tube type.

In the 7-pin basing, there's only one choice —the 6J6. Aside from the fact that the 6J6 is the only 7-pin twin triode easily available, it is surpassed only by the 12AT7. Gain is in the neighborhood of 100 (see Table I).

The entire circuit is simplicity itself to install. Remove all old connections from the mixer-tube socket, being careful not to cut short either the grid lead from the tuning coil or the plate lead from the *if* can. Then rewire according to the schematic.

If you don't have +150 vdc available in your receiver (many don't, install resistor R_d and its bypass capacitor (shown on the schematic in dotted lines. Value of R_d must be determined by trial and error. Start with 50K ohms, and work down until you find the resistor which gives 150 volts at point A after everything has warmed up.

With the new mixer installed, you'll have to realign the mixer tuned circuits. The cathode-follower inputs reduce input capacity so drastically as to completely detune the stage, so don't be surprised if nothing comes through at first.

The input capacity change has least effect at the low end of any band, so it's best to reverse normal alignment procedure and start by adjusting the *trimmer capacitors* in the tuning assembly at the *low end*. Simply adjust for maximum signal strength (or higher S-meter reading).

Next, tune to the high end of the band and rock the trimmer slightly to see if the adjustment is optimum. If not, adjust the trimmer again for the best high-end signal strength.

If the high and required adjustment, return to the low end but this time adjust the coil slug for maximum signal. Then return to the high end and readjust the trimmer. You may have to repeat this slug-at-low end-and-trimmer-at-high-end procedure several times to restore tracking, since the change in input capacity usually amounts to about 10 mmfd, which upsets original tracking adjustments. However, with patience the tracking can be made to surpass the original condition.

For the theory-minded, here's how this mixer operates:

First, imagine that the second half of the tube, V1B, is not in the circuit at all. Signal voltage supplied to the grid of V1A varies the tube's plate current, and this variation of current through cathode resistor R2 varies the instantaneous voltage from the cathode end of R2 to ground.

Now add V1B to the circuit, but keep the oscillator turned off. The circuit is now a cathode-coupled amplifier. Since it is biased to operate in a linear region, the only output frequency is the signal frequency, which is bypassed to ground through the *if* transformer. Output is nil.

Remove the signal voltage from V1A, apply the oscillator voltage to V1B, and the situation is reversed. Now V1B is the cathode follower and V1A the grounded-grid amplifier (with no load in the plate circuit). Output is still zero.

With both signal and oscillator voltages applied, the situation changes. V1B is a grounded-grid amplifier for the signal, but its bias is being changed also by the oscillator signal and as a result its gain varies from zero (at cutoff) to maximum (zero bias) at the oscillator frequency.

Thus, at the instant when signal voltage is high and oscillator voltage is low, V1B will have maximum gain and output will be high. If oscillator voltage is high at that instant, output will be low because V1B's gain will be zero.

This can be expressed mathematically too: The gain of two cascaded amplifiers is equal to the product of their individual gains. That is, $K_{total} = K_1 \times K_2$. In this circuit, K_1 is equal to the gain of V1A and K_2 is equal to the gain of V1B.

However, gain is equal to the product of the tube's mutual conductance and the effective load resistance, and the mutual conductance of a tube is determined in part by its grid bias. If this bias is changing at a rapid rate, as it is in this circuit, the gain will be equal to average gain times the rate at which bias changes, or $K_2 = K_{2av} \times F_{osc}$.

Plugging this equasion back into the original total gain equation gives us $K_{total} = K_1 \times K_{2av} \times F_{osc}$.

Since the output signal is, by definition, equal to the input signal times the total gain, we have for an input signal F_{sig} an output of $K_1 \times K_{2av} \times F_{osc} \times F_{sig}$, and since AC signals are *vector* rather than *scalar* quantities the indicated multiplication must be carried out by vector rather than by straight arithmetic methods. The result is that the output consists of the original two frequencies, the numerical sum of the original frequencies, the numerical differences, *and nothing more.*

Getting away from the exotic mathematics, the big difference between this process and detection-type mixing using non-linear devices such as diodes or overdriven tubes is that *only* four output frequencies are present. Harmonics and spurious outputs are not.

In addition, the cathode follower is far more tolerant of overload than is any other basic amplifier circuit, and as a result no clipping or distortion occurs in the mixer.

A common problem with many conventional mixers is cross-modulation, in which two carriers become "intertwined" and an unwanted signal rides in on the one you want.

Even under extreme conditions, such as local injection of a signal strong enough to almost block the *if* strip, cross-modulation could not be induced in this mixer. Apparently this is another by-product of its unusual method of operation.

Although no tests have yet been made, Pullen's analysis of the circuit indicates that it should provide a good high-output product detector for converting SSB and CW to audible signals; simple substitution of an RC coupling network (or an audio transformer) for the *if* transformer is the only circuit change, though you might want to increase the value of resistor R2.

In summary, this overlooked mixer circuit appears to offer extreme advantages over more-conventional circuits in all of the five characteristics of the ideal mixer, with fewer parts than usually required. It works as well in the set as it does "on paper" in the design stage, and can easily be adapted to any receiver. Try it, and let us know how it works for you.

References:

1. Langford-Smith, F., Radiotron Designer's Handbook, Fourth Edition, Radio Corporation of America, Harrison, N. J., 1953, pages 938 and 967.

2. Pullen, K. A., Conductance Design of Active Circuits, John F. Rider Publisher, Inc., New York, 1959.

3. Geisler, Leonard, "Souping The Super-Pro," CQ Magazine, December, 1957, page 30.

4. Lee, Cmdr. Paul, "Save Your Super-Pro For SSB," CQ Magazine, September, 1958, page 52.

5. 73 Staff, "Beat Generation," 73 Magazine, February, 1961, page 28.

Uncited by number. 73 Staff, "Up Front," 73 Magazine, March, 1961, page 32.

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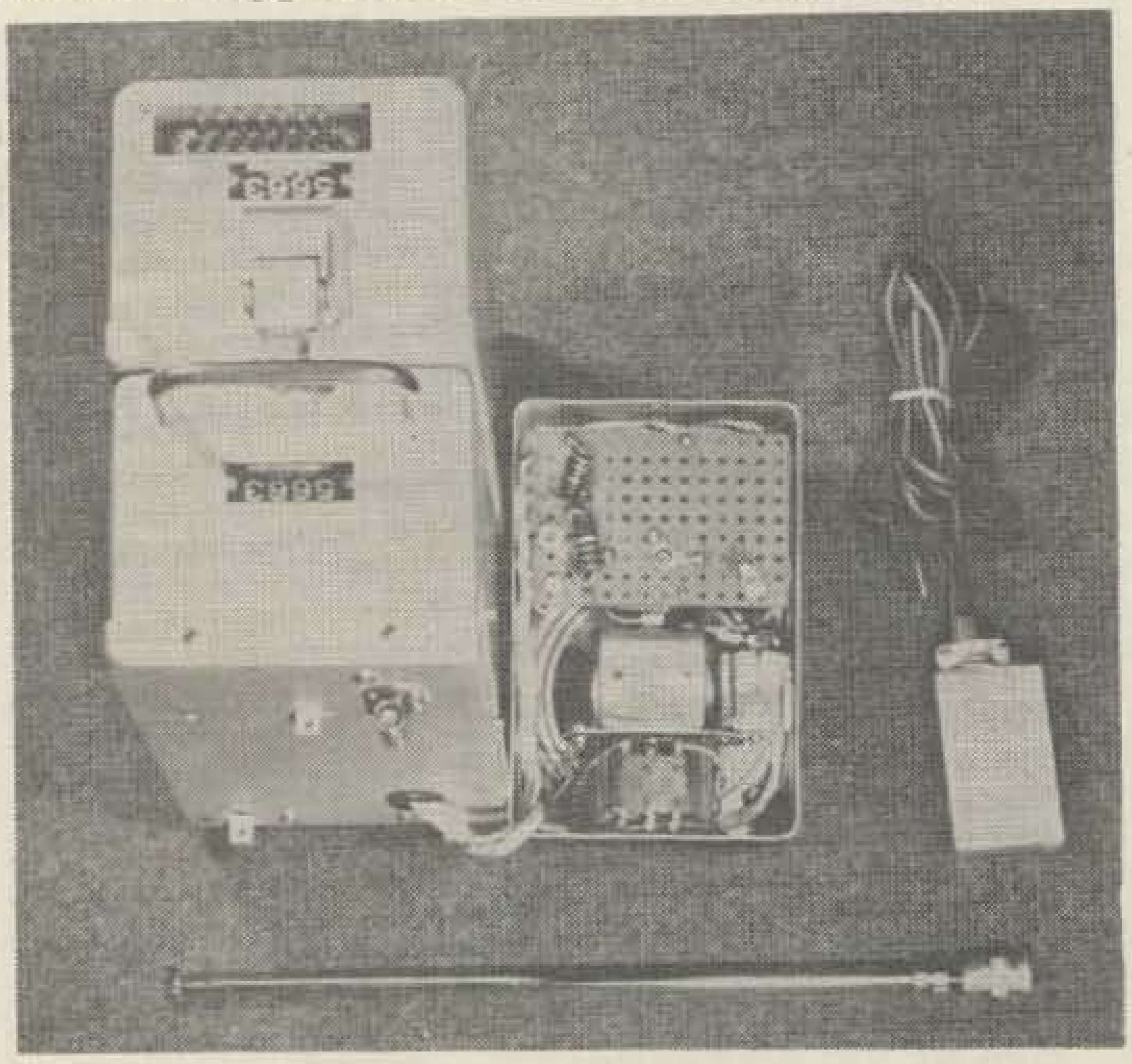
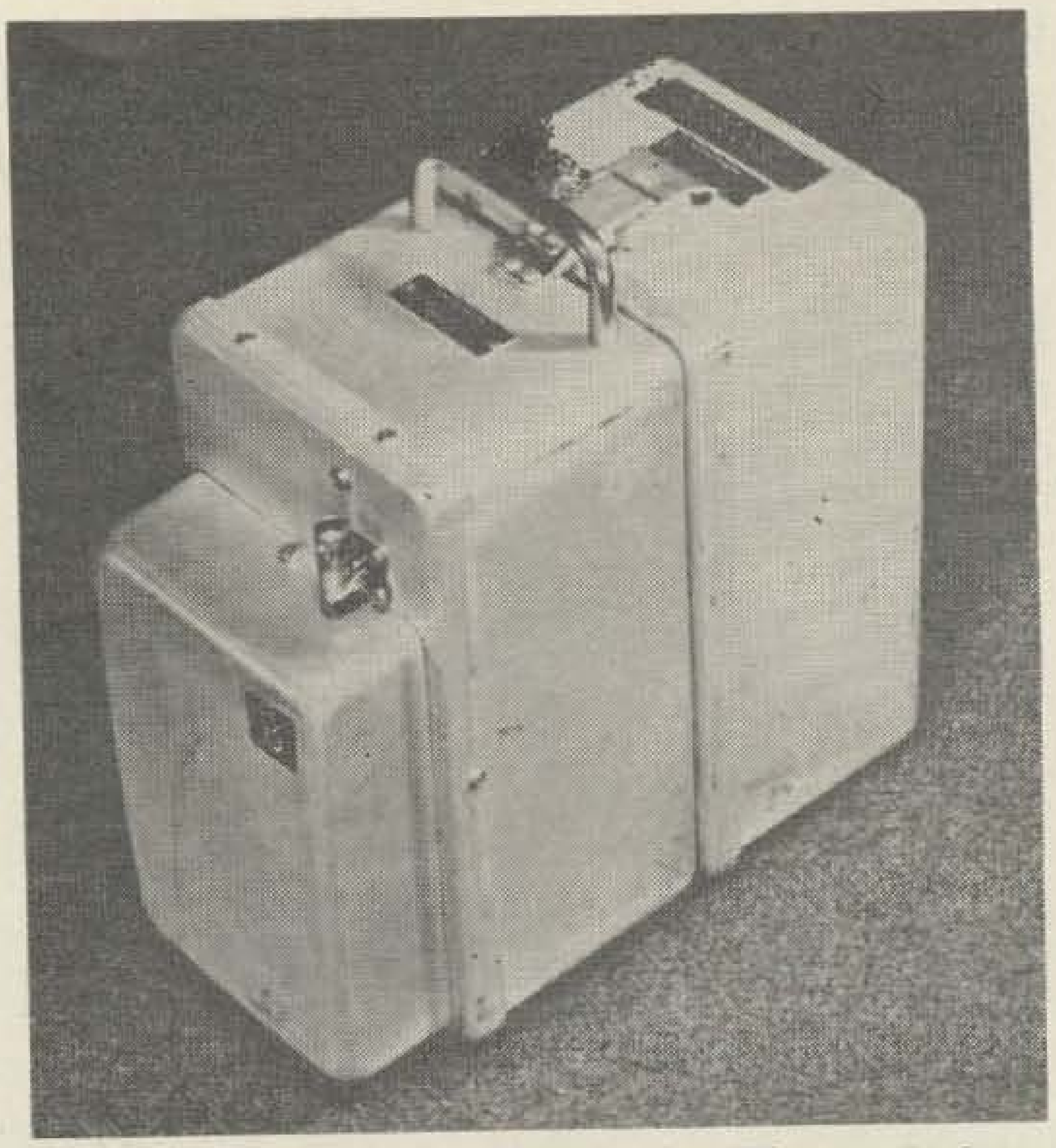
Two Meters the Easy Way

Photo Credit: Morgan S. Gassman, Jr

Today's "best buy" in 2 meter equipment is available on the surplus market as a government agency variation of the famous Bendix MRT-9 Packset. This VHF transceiver is available from Metro Electronics Corporation, 172 Washington Street, New York 7, N. Y., at a cost of $24.95. This is a real bargain by any standards since the wholesale cost of the tubes alone exceeds $65.00. The dual considerations of high performance and low cost, coupled with an easy conversion, make the sky the limit for amateur application of this equipment.



Since few details are available on the government application of the transceiver, the equipment is best presented by describing the commercial prototype and then outlining the specific charges found in the surplus version. The Bendix MRT-9 Packset was a very compact, high performance FM transceiver, operating in the 152-174 megacycle band and designed to meet all FCC requirements for this service. The equipment used 19 subminiature tubes and was powered by dry batteries or by a 2 volt, vibrator power supply. Figure 1 shows a block diagram of the prototype equipment and the performance more than justifies the complexity of the circuit. Power output of the transmitter was 1 watt and the receiver sensitivity exceeded .5 microvolt.



The surplus version of the transceiver was modified in production for a telemetering application and is shown in the photograph. While the circuit changes are not too extensive, the mode of operation and the control circuitry are changed considerably. Specific differences are as follows.

1. The second operating channel is deleted and V202 is wired as an audio oscillator.
2. The squelch circuit is deleted and V112 is changed to a 1AH4 and wired as a 1st audio amplifier for the receiver section.
3. A receive audio tone filter has been installed in an enclosure secured to the front panel of the equipment.
4. Crystals for operation on 138.06 megacycles are supplied and the tuned circuits are padded for operation on this frequency. This provides for operation on 2 meters with no further change of the tuned circuits.
5. A 6 volt vibrator power supply is housed in the former battery compartment.

The transceiver shown in the photograph is modified for AM operation in the 2 meter band. This conversion is relatively simple and should be easily duplicated. AGC voltage is obtained from the DC component developed across the 1st limiter grid resistor. The audio component developed across the 2nd limiter grid resistor provides AM detection. A power transistor audio stage is installed in the ex-filter compartment along with a PM speaker and the combination audio output-modulation transformer. Also included in the compartment are the send and receive audio gain controls, the carbon mike input circuit and a send-receive relay. The power supply is used as is and requires no modification for 6 volt DC operation.

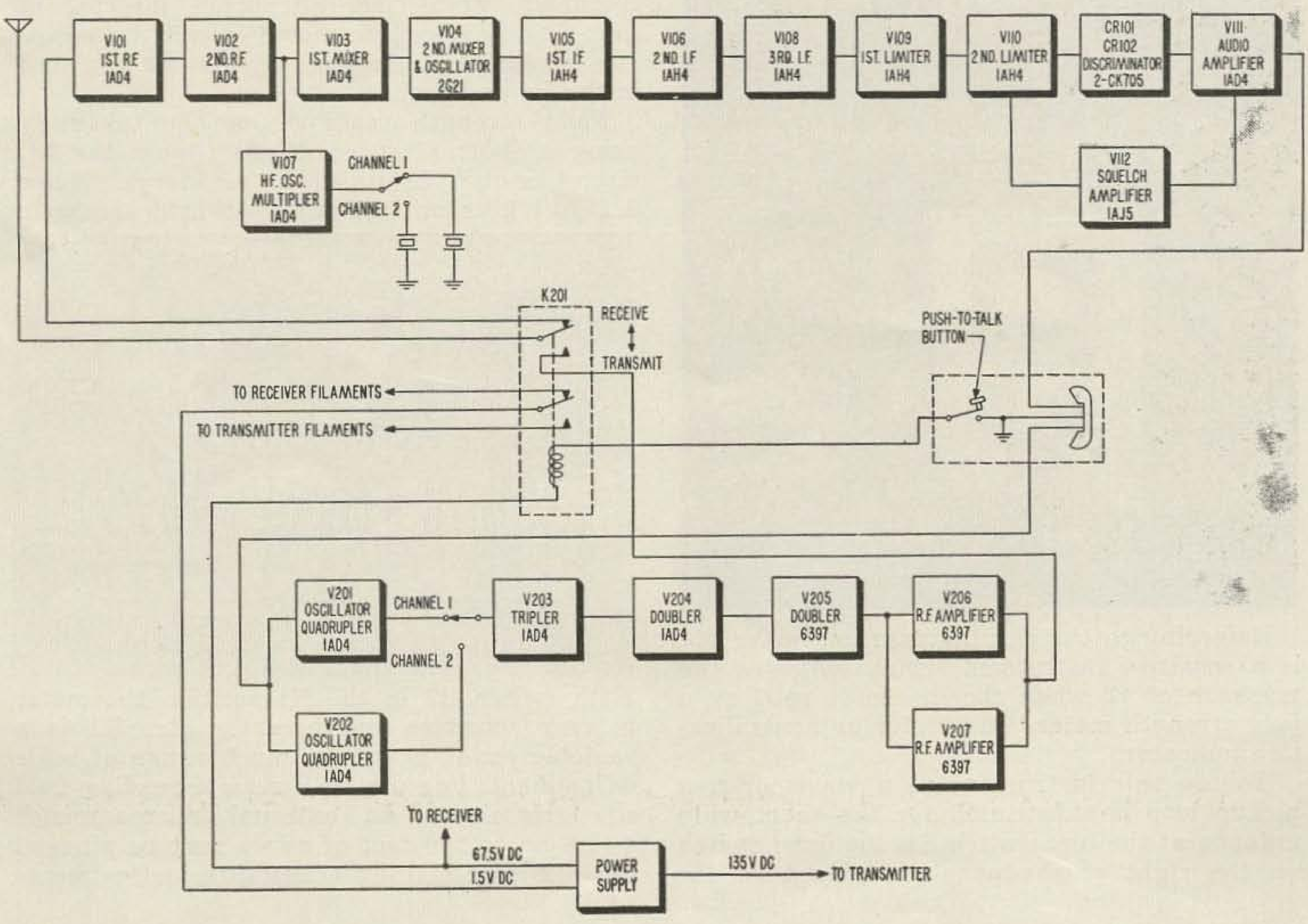
Crystals for the converted equipment pose no problem. International Crystal Manufacturing Company has correlation data on hand for this equipment and can provide one day service on small orders. Cost is reasonable, $5.75 for the transmit and $6.50 for the receive crystal units.

Since technical data on the surplus transceiver is simply not available, it was necessary, in writing up this conversion, to describe the equipment in much greater detail than would otherwise be required. A detailed description of the project, including schematics, layout drawings, conversion instructions, crystal data and alignment instructions, was prepared in the form of an article for publication in 73 Magazine. However, space limitations, particulary for presentation of the large schematics, make it impossible to print the article in a regular issue.

In view of the heavy demand for detailed information on this surplus transceiver, the editor has decided to print the full article in a separate booklet and make it available through 73 Magazine. Cost per copy of this special printing is $.50 and, as Wayne says, "If we can break even on the deal, we will be happy."

This little transceiver is, at its price, one of the most attractive buys on the surplus market. Modified as described, it will meet the individual amateurs requirements for a fixed frequency, battery powered transceiver and for emergency or club net operation it is ideal.

. . . W4WXM



A Useful Accessory for the Ham Shack

Rex Morris W2WXH/6
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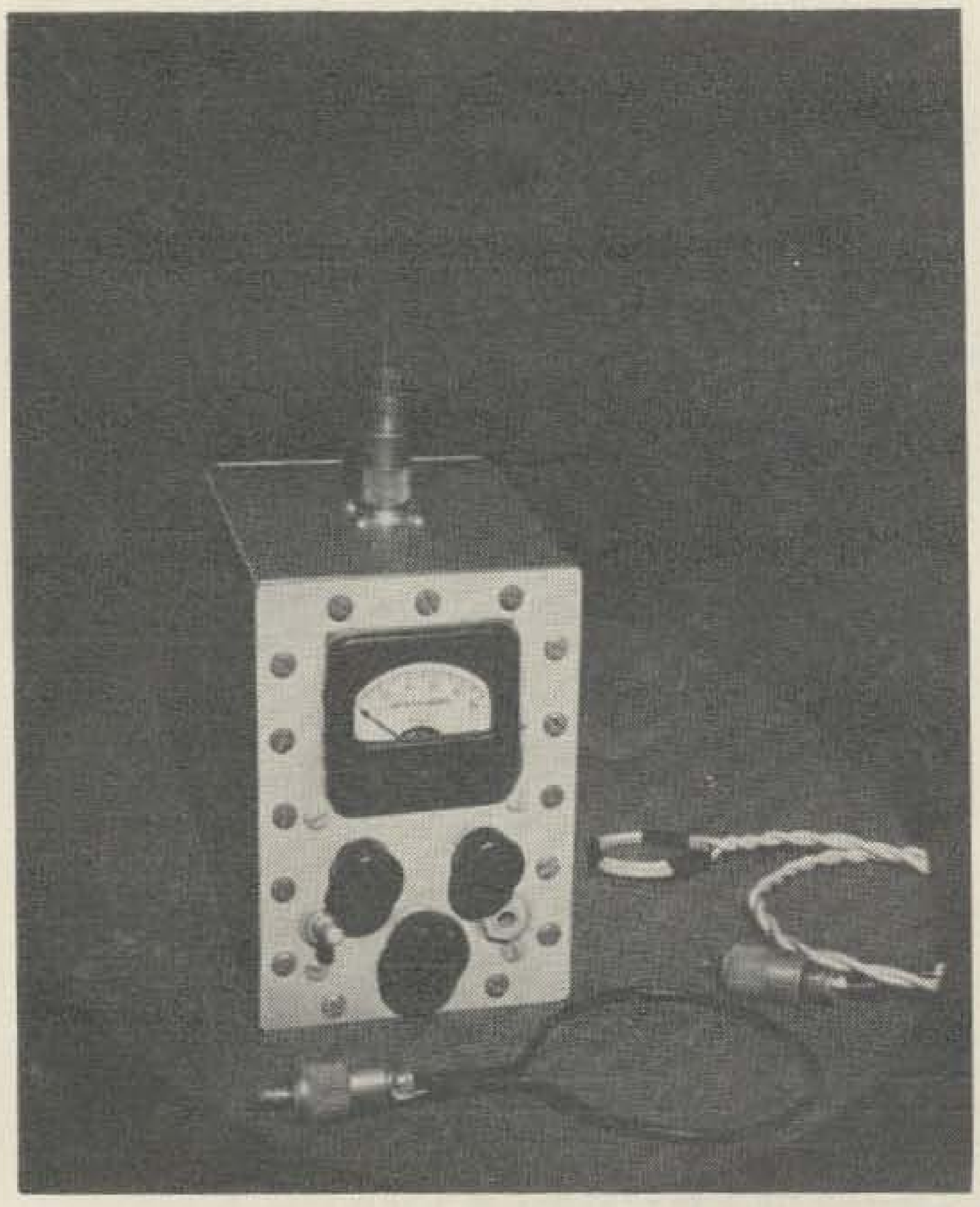
San Diego 9, Calif.

BECAUSE we are dealing with something we cannot see, namely electrons and electromagnetic radiation (we only see their effects), we must acquire the ability to use test equipment, in order to understand and find our way in this invisible realm.

The piece of test equipment about to be described is one of the more useful instruments that the amateur should have in the shack. While this instrument serves primarily as a field strength meter, it will also serve as a phone monitor, neutralization indicator and a sensitive wavemeter.

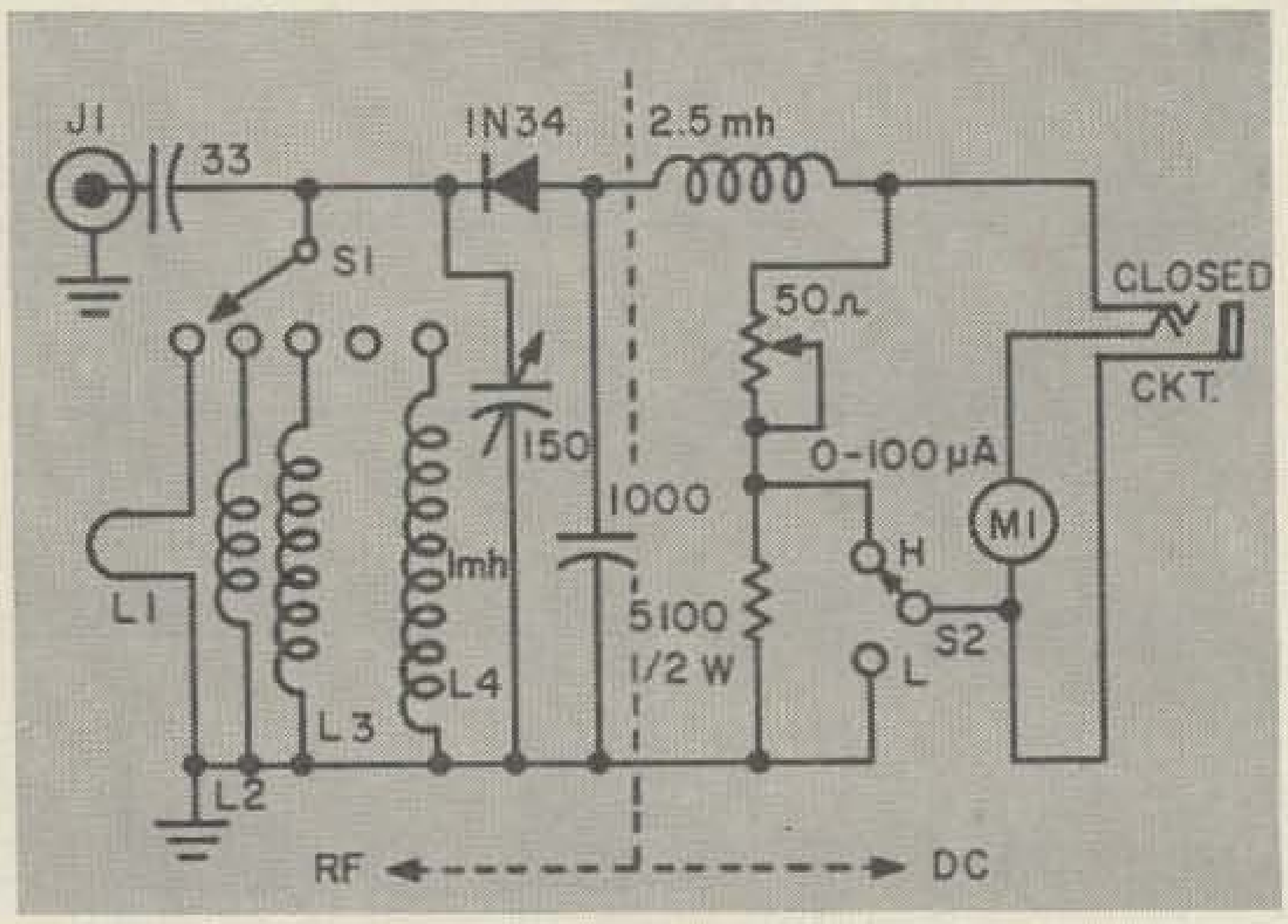


Referring to the circuit diagram, meter M1 is a sensitive instrument which indicates the pressure of rf when the device is used as a field strength meter, wavemeter or neutralization indicator.

To use this instrument as a wavemeter, a pickup loop is substituted for the short whip antenna at the top. Switch S1, the band switch on the right of the panel, is placed on the proper position. Coil L1 tunes the vhf range of approximately 90 mc to 170 mc (2 meters). L2 tunes 28 mc to 100 mc (10 meter and six meter bands). L3 tunes to 7 mc to 30 mc (40, 20, 15 and 10 meter bands). L4 tunes from 2 mc to 7 mc (80 and 40 meter bands). With switch S1 on the proper tap, condenser C2, on left of panel, is used to peak the reading on meter M1. Using a calibrated dial, frequency may be read directly. Toggle switch S2 is a high-low range switch for meter M1, providing a means of keeping the meter on scale and protecting it against burn-out. Potentiometer R1 (center of panel) is a vernier shunt control, also for keeping the meter on scale.

For use as a phone monitor, rf should be fed into the input jack with a link or pick-up wire. Once again the LC circuit is resonated to the frequency we desire. Earphones inserted in jack J2 will open the meter circuit and allow you to monitor the signal. Switch S2 is placed in the Hi position.

Field strength readings can be taken by using a short pickup antenna. Again the LC circuit should be tuned to resonance. Meter M1 will give an indication of field strength.



With switch S2 in the Hi position the meter is very sensitive and potentiometer R1 is a variable shunt providing much range of scale adjustment. For use as a remote reading field strength meter an external microammeter (with up to 200 feet of wire) may be plugged into J2. For making transmitter adjustments this is a very desirable feature.

Now notice that one position on the bandswitch S1 is vacant, this vacant position provides a very broad band—low sensitivity position for those extremely high rf fields where even R1 and S2 cannot provide enough attenuation.

Neutralization measurements are made by coupling the instrument through a pick-up link to the tank coil involved, with S2 in the Lo position. When the instrument is tuned to resonance it becomes a very sensitive rf indicator. It is so sensitive that it will readily be seen that complete neutralization exists in theory only.

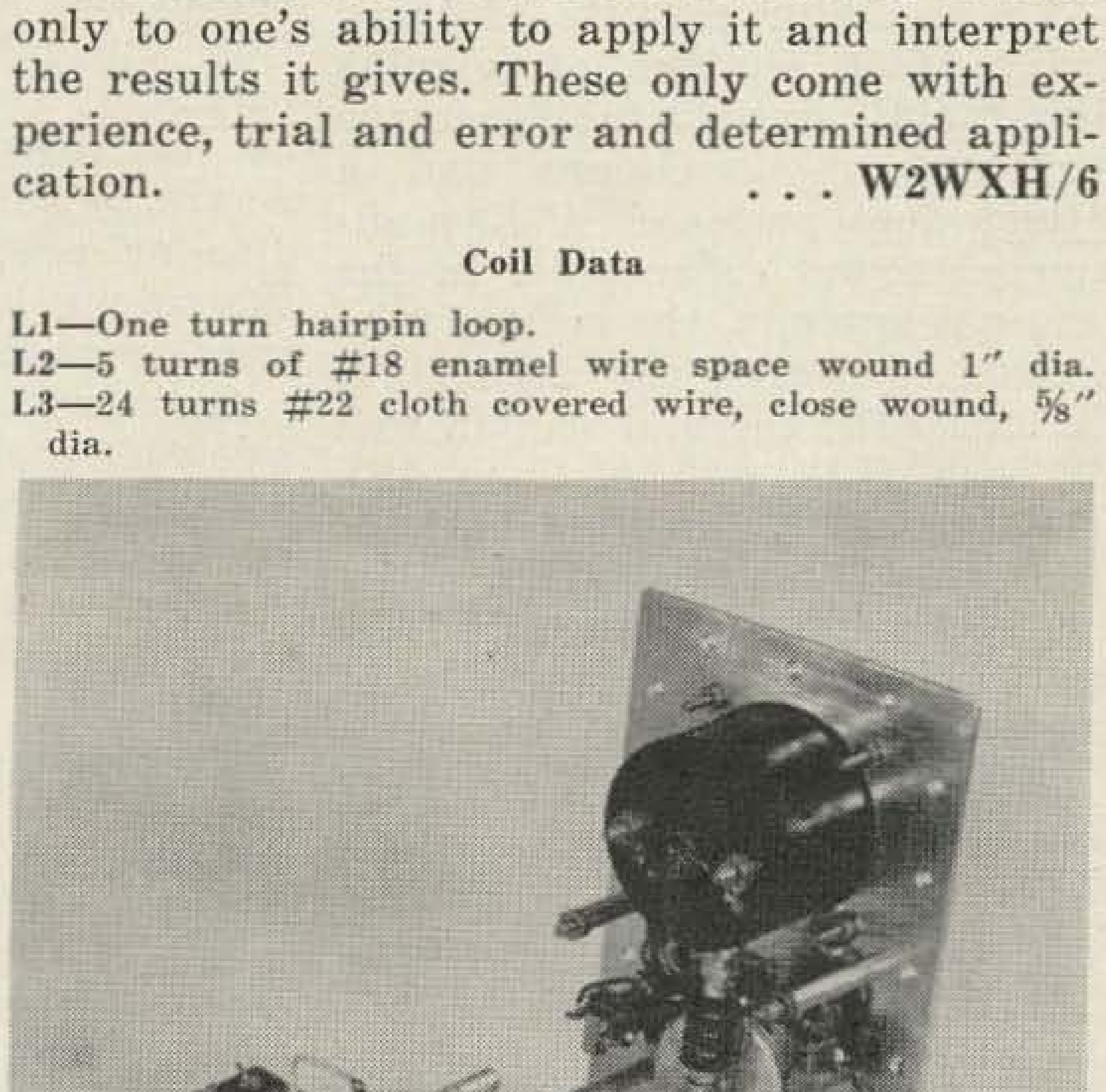
As in all simple gadgets there are a few simple construction techniques which make the difference between gadget and instrument. In this case the important thing to keep in mind is that from the antenna to the crystal is the rf portion, and from the crystal to the jack J2 is the dc portion (with audio superimposed). With this in mind, construction is such that the two parts are separated, thereby giving some measure of protection from rf energy to the very sensitive microammeter M1. Also note the extensive use of sheet metal screws on the aluminum case. The only rf we want to enter the case is the rf we are attempting to measure via the antenna jack. Note again, we have here an instrument for detecting electromagnetic radiation, from approximately 170 mc to 2 mc. We now have an instrument for visualizing what cannot be seen.

The usefulness of this instrument is limited only to one's ability to apply it and interpret the results it gives. These only come with experience, trial and error and determined application.

. . . **W2WXH/6**

Coil Data

L1—One turn hairpin loop.
L2—5 turns of #18 enamel wire space wound 1" dia.
L3—24 turns #22 cloth covered wire, close wound, 5/8" dia.



An Inexpensive Vertical

Ken Johnson W6NKE
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THIS antenna was born of the lack of space and money and a desire for simplicity. It not only satisfied these requirements but proved to be one of the best DX getters that I have ever built in more than twenty-five years of hamming. It requires no radials and feeding and loading are accomplished at ground level. It can be mounted on the side of a house (Fig. 1) and is so designed that the top half is self-supporting. The majority of the materials are aircraft surplus and the total cost of the system is around fifteen dollars.

The radiator consists of three twelve foot sections of surplus aluminum aircraft tubing, three aircraft tubing clamps and a fifteen foot piece of ¾ inch diameter round cedar pole. In the original antenna, the bottom tube section measured one inch O.D., ⅞ inch I.D.; the mid section was ⅞ inch O.D. and ¾ inch I.D. The top section had an O.D. of ¾ inch. These diameters allow the sections to be telescoped together in the final assembly of the radiator.

Slot one end of the bottom and mid sections of tubing for a distance of one inch. This can be easily done with a hack saw.

Loosely install one of the tubing clamps on the slotted end of the mid section and insert one and one-half feet of the top section into it. Tighten the clamp until a good mechanical and electrical joint is produced. Care should be taken to remove any protective coating, such as anodize, from the area of the joint. This can be done by cleaning the contact point on the top section and an inch or two of the interior of the mid section with emery cloth.

Next, insert the cedar pole into the opposite end of the mid section and run it through the tubing until it butts against the end of the top section. Drive four small finishing nails through the wall of the mid section and into the pole near the lower end. This will hold the stiffener pole in its proper place.

Loosely install another tubing clamp on the slotted end of the bottom section of tubing. Insert the protruding end of the pole and the mid section tube into this end of the bottom section. Adjust this slip joint until the overall length of the radiator measures 33 feet, then tighten the clamp. Again, be sure to remove any anodize or protective coating from the tubing to insure a good electrical connection.

Clean an inch or two of the outside of the lower end of the bottom section, install the third clamp and tighten. This will later serve as a feed connection when the antenna is raised to a vertical position.

The next step is to install the ground pipe but before this can be done, the exact location of the antenna must be determined. As it was previously stated, the antenna was designed to mount on the side of a house. The peak of a roof is ideal for the top mounting insulator and another one should be located approximately three feet below it.

Assuming you are going to use the peak of the roof, install a standoff insulator at that point. Tie a length of string with a weight or plumb bob at the end of it to the insulator and mark

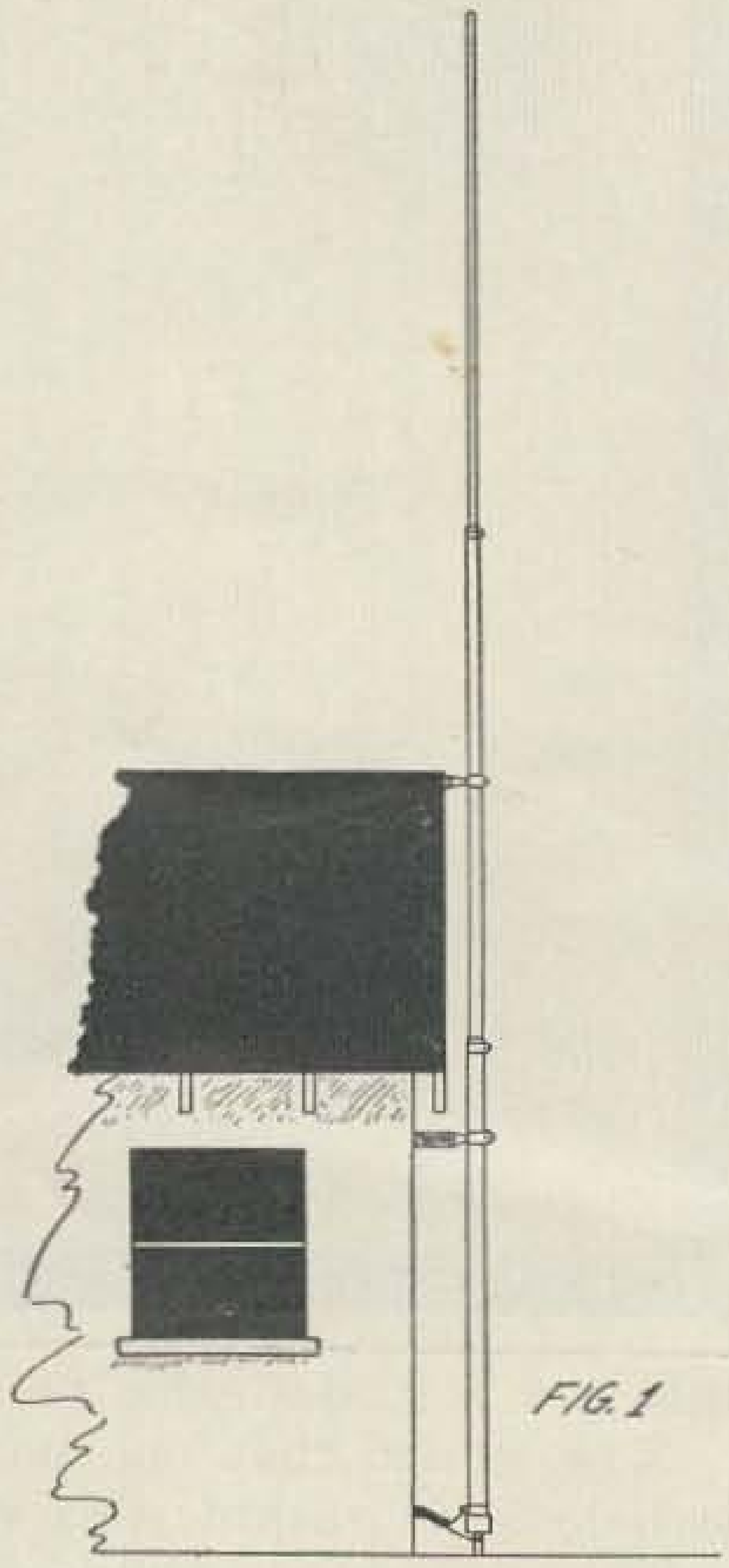
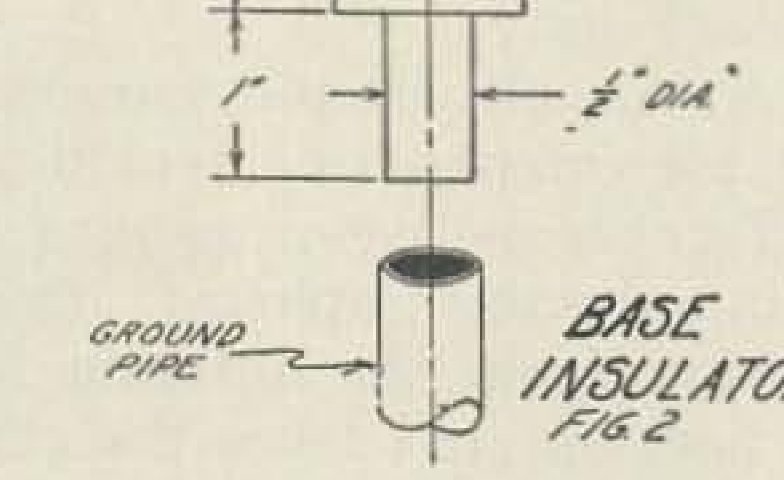
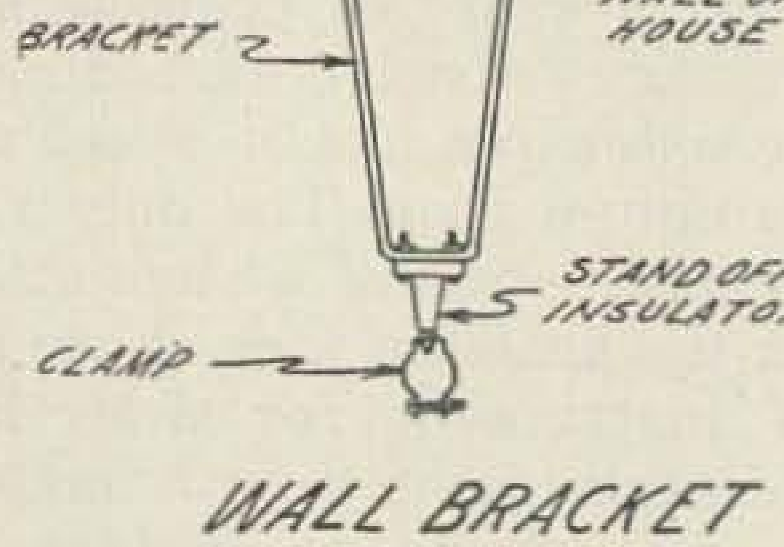


FIG. 1



BASE INSULATOR
FIG. 2



WALL BRACKET
FIG. 3

the spot where the weight touches the ground. This is the spot for the installation of your ground pipe.

Thread one end of a piece of one-half inch galvanized pipe twelve feet long and install a pipe to garden hose adapter. File the opposite end of the pipe until it is somewhat sharp. Attach the garden hose and have a friend on top of a step ladder help you hold the pipe vertical with its sharpened end on the spot indicated by the plumb line.

At this point, a word of warning is appropriate. The first foot of the next operation is extremely wet and muddy, so be sure and wear your oldest clothes.

Have someone turn the water pressure on full. keep your mouth closed and wash the pipe down into the ground. If you should strike rocks, work the pipe gently up and down until enough earth is washed away to allow the rock to move and the pipe to pass. Continue this process until approximately eight inches of pipe are still above the ground.

The usual procedure at this point is to turn off the hose and head for the shower.

The next job is to fabricate some kind of separating insulator. The original one was a piece of micarta filed to a point on either end. The present one is machined from a piece of plastic round stock (Fig. 2).

With the plumb line still in place, measure the distance from the wall of the house to the line. From this dimension, figure the size of the wall mounting bracket necessary to compensate for the overhang of the roof as shown in Fig. 3. This bracket can be made of one-eighth inch by one-inch strap iron and can be bent to the proper shape in a vise.

Mount the bracket to the wall of the house with lag or toggle bolts approximately three feet below the top insulator at the peak of the roof.

Two large size fuse clamps were used to clamp the radiator to the standoff insulators. These can be purchased at any electrical supply house.

At this point, you are ready to erect the radiator. Install the base insulator on the ground pipe and raise the radiator to a vertical position. Snap it into the fuse clamps on the standoff insulators and place the bottom end over the top of the base insulator. Insert the screws through the ears of the fuse clamps and tighten them, locking your vertical in place.

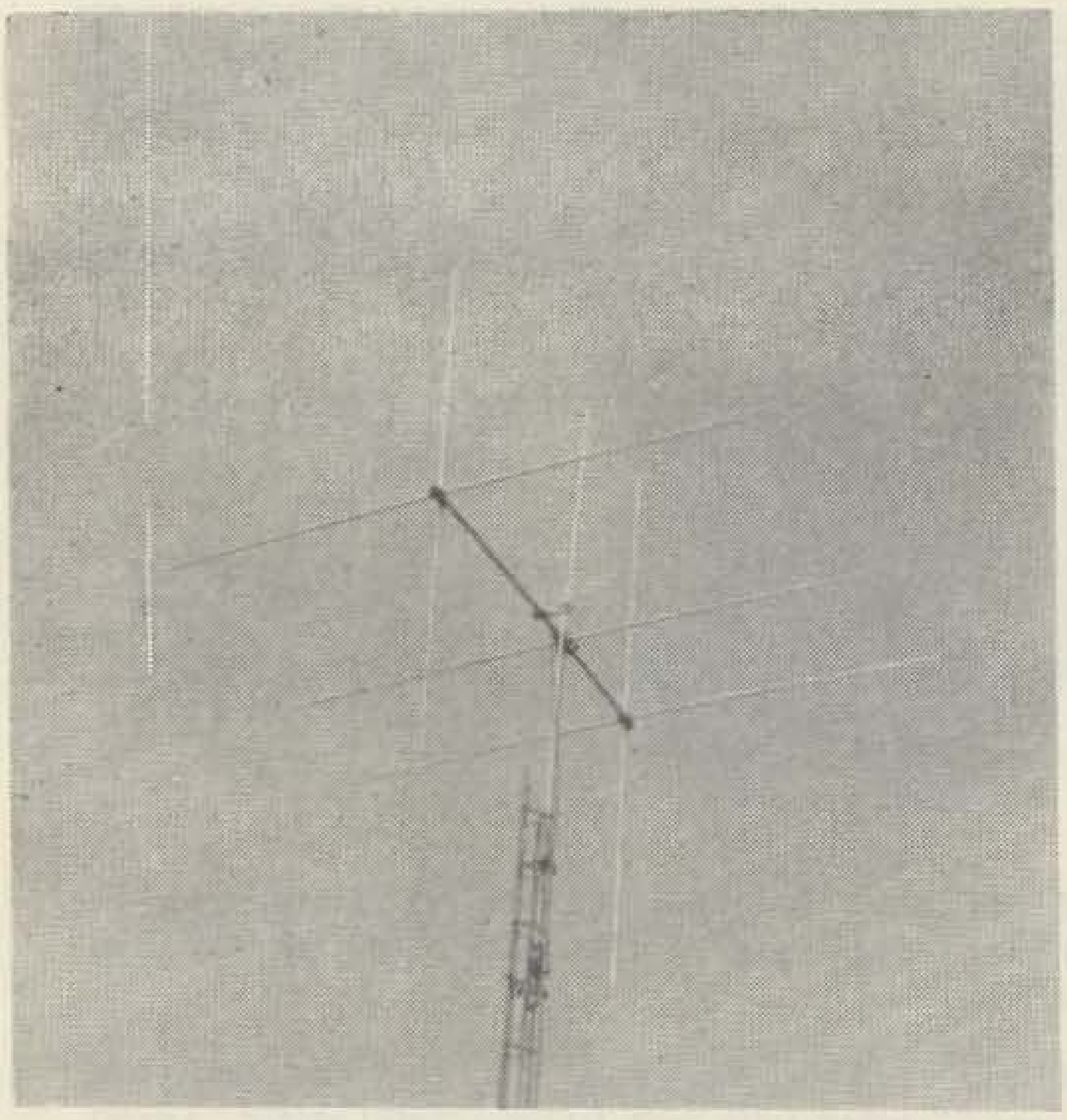
This antenna is fed with 52 ohm, RG58U or RG8U coax cable. For operation on 40 and 15 meters, the center lead is connected to the radiator by installing an alligator clip to its end which, in turn, is snipped on to the clamp at its base. The coax shield is connected to the ground pipe by means of a ground clamp.

For operation on 80 meters, an air wound loading coil of 15 turns of #14 wire, three inches in diameter, is used. The top of this coil is connected to the base of the vertical with a small battery clamp. The alligator clip on the center lead of the coax is then snipped on to the coil at approximately the twelfth turn.

The SWR on the original antenna was below 2:1 on all three bands.

With 75 watts and this antenna, the writer worked Europe, Asia, Oceania and South America on 15 meter CW. Numerous other dx contacts were made on 40 and 80 meter CW.

With patience and favorable conditions, you, too, will find that this antenna will get the job done. When you get your General Class license, you will find that it will do well on the phone bands too. It's an all around good antenna for an all around good ham. . . . **W6NKE**



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A New Antenna Design

Part II

Dual Diversity Beam

IN the September issue of "73" I described the design concept and the performance of the cross-polarized beam. This article will describe the antenna itself and the factors that influenced the design details.

Essentially, it is two Gamma-match fed Yagis on a single boom, one of them in the horizontal plane and the other vertical. No single part of the physical arrangement is new. Parasitic elements originated with Yagi, crossed dipoles from the Brown Turnstile, Gamma matches are standard and phasing lines occur in many different designs. The only new thing that is involved is the combining of all these into a new physical arrangement to achieve diversity reception and transmission.

The basic objective is to develop a forward beam pattern as close as possible to a circle. In the Brown Turnstile both dipoles are mounted in the horizontal plane and produce a horizontal radiation pattern that is almost circular. That pattern, viewed from above, is shown in Fig. 1. The question was whether a Turnstile could be turned on its side and have the horizontal radiation pattern become the frontal aperture of a beam. If this could be done, then such a beam could function equally well in the horizontal and vertical planes, and provide improved performance in oblique planes.

The beam was built and the element lengths and the spacing between elements adjusted for best performance. Two field strength meters were used to make these adjustments, one with a horizontal pickup antenna and the other vertical. In this manner simultaneous readings in both planes were made. After adjusting the beam for maximum forward gain performance, the field strength meters were rotated to test the signal pattern at various angles. The plot of the observations approximated the horizontal pattern of the Turnstile. The slight sag from a circular pattern (marked by the shaded area in Fig. 2) turned out to be a drop of about 5 db.

The design was discussed with a number of amateurs and engineers and the opinion was often expressed that such a configuration would result in a loss of one-half the power in each plane because the available power was being divided between two driven elements. Though tests have not borne out these predictions, I have no idea as yet of why. I'll let you know if further tests shed some light on this.

Feeders

The feeding and phasing system are, as far as I know, original features in the design. All of the Turnstile antennas that I read about used open wire phasing and feeding systems. Using coax cable for this purpose seemed to me to be a simpler system both electrically and mechanically.

The matching and phasing system is shown in Fig. 3. Any transmission line you may have on hand may be used. The chart in Fig. 4 gives

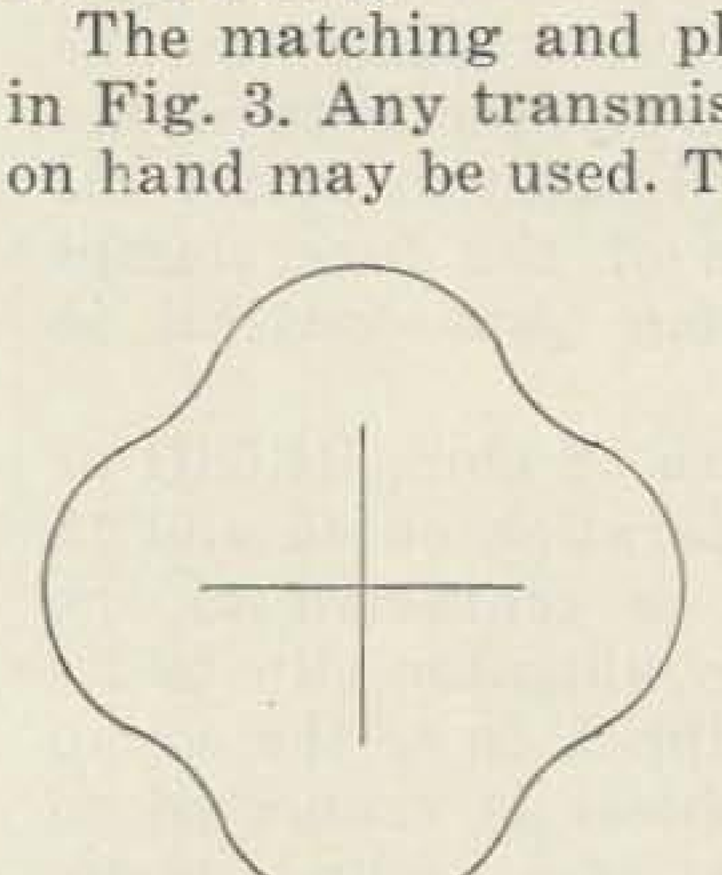

Figure 1: Horizontal field strength pattern of the Turnstile antenna.

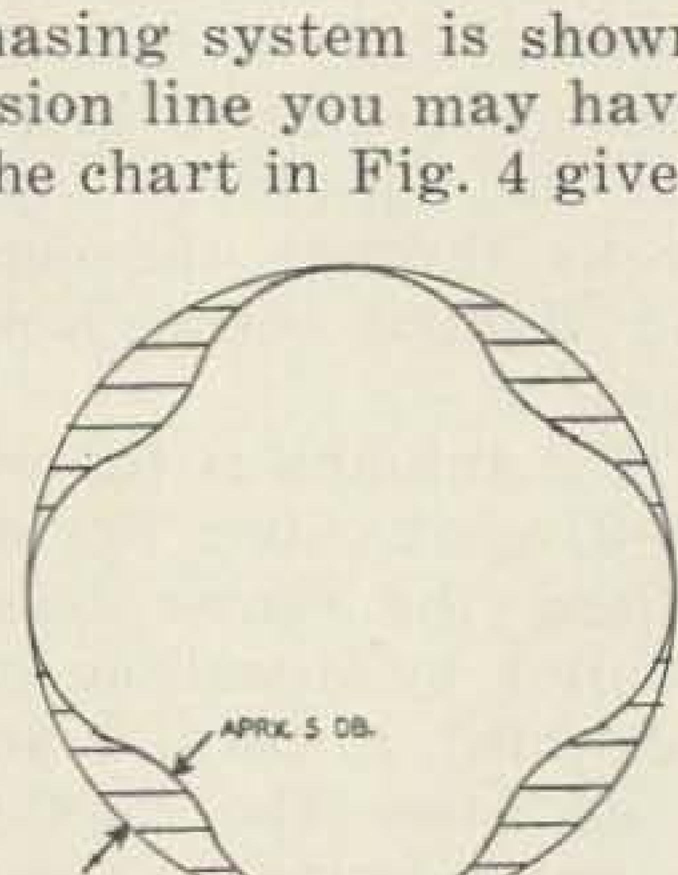

Figure 2: Approximate forward aperture pattern of the beam.

the dimensions for the gamma match for different impedance lines. I used RG58/U because it matched my low-pass filter and RG63 for the phasing line because it made for a shorter gamma match. I did notice, in trying other lines, that the gamma adjustment was not very critical.

Going into the design philosophy just a bit, it will be obvious to those of you with an acquaintance with antenna and feedline theory that Zgb should equal Zpl . . . the feedline impedance should match the antenna. Thus at point X you have the phasing line and feed line, both with fixed impedances, in parallel with the variable impedance of gamma rod A, or Zga. Using the formula for parallel impedances this can be calculated for various types of line and the numbers in Fig. 4 developed.

Only one mechanical problem is involved. The antenna must have the boom high enough above the top guys to the tower (if guyed) so the vertical driven element will not run afoul of the guys when the antenna is rotated.

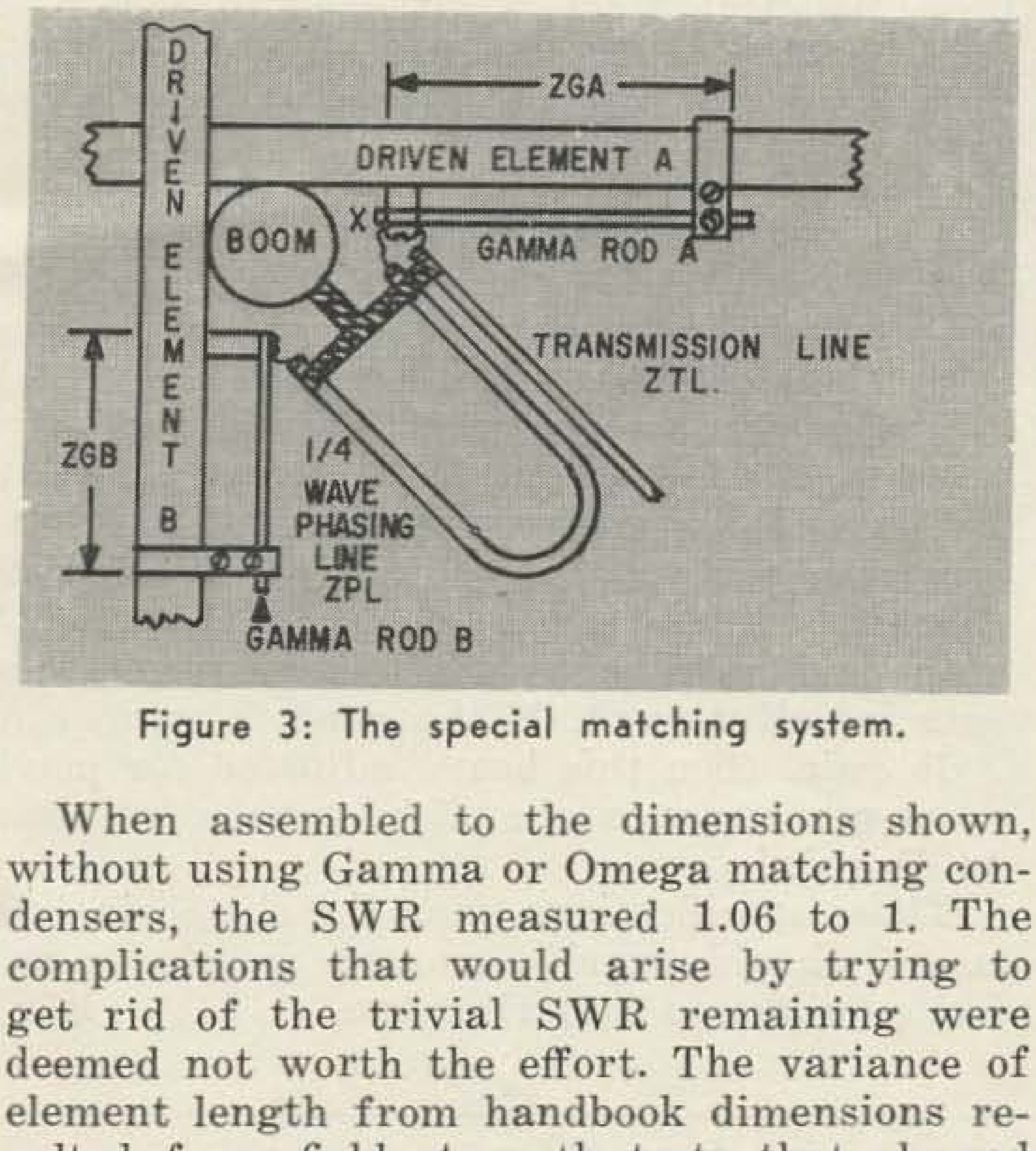

Figure 3: The special matching system.

When assembled to the dimensions shown, without using Gamma or Omega matching condensers, the SWR measured 1.06 to 1. The complications that would arise by trying to get rid of the trivial SWR remaining were deemed not worth the effort. The variance of element length from handbook dimensions resulted from field strength tests that showed the lengths given as providing the best overall performance.

Transmission Line Type	Z_{tl}	Phasing Line Type	Z_{pl} & Z_{gb}	Necessary Z_{ga} to match
RG8/U	52	RG62/U	93	118
		RG63/U	125	89.4
		RG11/U	75	169.5
		RG59/U	73	180.7
RG11/U	75	RG62/U	93	387.5
		RG63/U	125	187.5
RG58/U	53½	RG62/U	93	125.9
		RG63/U	.125	93.5
		RG11/U	75	186.6
		RG59/U	73	200.2
RG59/U	73	RG62/U	93	339.4
		RG63/U	125	175.4

Fig. 4

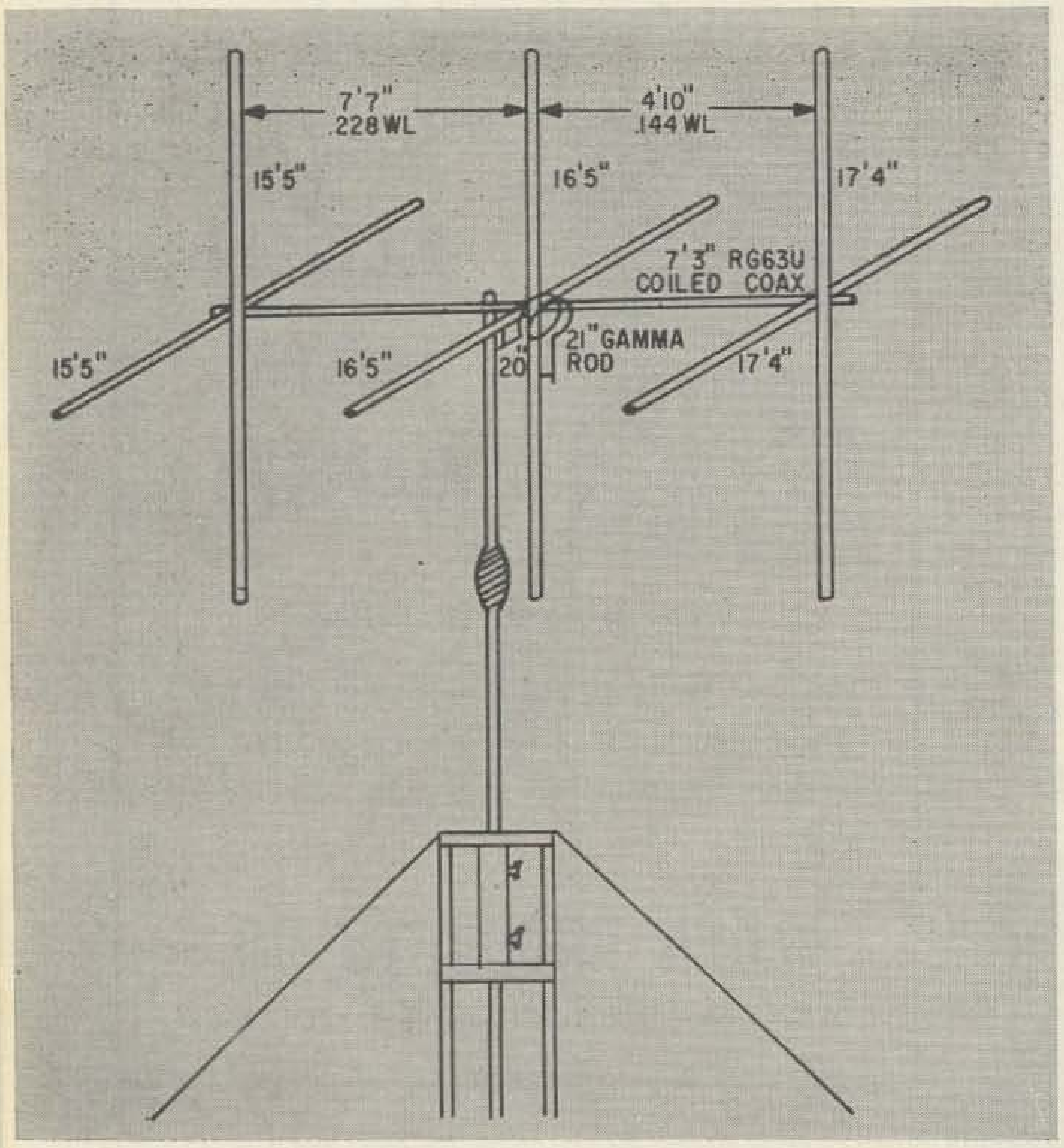

Figure 5

Transmission line connects at junction of horizontal Gamma rod and 1/4 wave phasing line. Mast is attached to the center of gravity of the antenna, which keeps the vertical driven element about 14" from the mast. Spacing between the Gamma rods and driven elements is 4". Ground all coax shield ends together and to mast. Raise antenna above the guy wires so there won't be any interference with the rotation.

The beam, which has been in use for one year so far, is constructed as follows:

Boom: 13 feet long—2 inch outside diameter, aluminum alloy.

Elements: 3 pieces per element—center piece 12 feet long—1¼" diameter, aluminum alloy. Two outer pieces, telescoping into center piece, 6 feet long, 1 inch diameter, aluminum alloy.
For frequency 28.65 mc — element lengths: Reflectors—17' 4"; Driven elements 16' 5"; Directors 15' 5".

Gamma Rods: 5/16" Aluminum tubing, 24" long. Adjustable strap set as follows: Vertical Gamma strap, for 125 ohms—21"; Horizontal strap, for 93 ohms—20".
¼ Wave Phasing Coax—7' 3" of RG63-U.
SWR at design frequency: 1.06:1.

Spacing between Gamma rods and driven elements, 4". At antenna end, all coax shields connected together and to mast.
Balance: Mast is attached to center of gravity of the antenna at the boom. This keeps the vertical driven element about 14" from the mast.

Clearance: Mast is clamped to boom on opposite side from vertical elements which keeps mast out of the immediate plane of the vertical elements.

The beam was compared with a quad two wavelengths away and at the same height. The new beam showed a superiority of 3 to 5 db over the quad. Further experiments with element spacing and length show that 2 to 3 db more is possible by exact measurement and care in adjustment. If the quad is capable of 7 db gain, then this beam, adjusted for maximum performance, should be capable of about 14 db gain!

These specifications, plus the sketch in Figure 5 should provide enough detail for any home builder to copy the beam. . . . K6CT

Silicon Replacements for Tube Rectifiers

There are numerous advantages in the use of silicon rectifiers over tube rectifiers. Unfortunately, some equipment was built before silicon rectifiers were available at prices that compared with vacuum tubes. There are applications where tubes are superior, but these are usually in circuits requiring a high PIV. In such circuits, the high cost of silicons when the number required to make up the PIV required, or the use of special silicons, make it more practical to use tubes. Where the voltages are lower, the silicons are superior to vacuum tubes because of their smaller size, increased efficiency, cooler operation and the fact that they don't require heater voltage. While on the topic of heater requirements, it is usually overlooked that the heaters or filaments of rectifiers require tremendous (comparatively) amounts of filament power. An example of this is the 5U4, one of the most common rectifiers used, which has a heater input of 15 watts; the 5Y3 which requires 10 watts; or the 5AU4 which requires 22½ watts. Compared to amplifier tubes, the power used is tremendous. A small tube like the 6C4 requires less than a watt while the larger power tubes like the 807s use about 5½ watts of heater power. In some circuits, the heater power of the rectifier is larger than the entire plate power used. To me, waste like that seems ridiculous, as eliminating the heater power of the rectifier would almost halve the AC power required. Another disadvantage of vacuum tubes is the large amounts of heat that they generate. In compact equipment, it makes the area around the power supply extremely hot which leads to failure of parts prematurely as well as the requirement for increased ventilation. About half of the failures in filter condensers which are placed near the rest of the power supply can be traced to excess heat from the rectifier tubes. The problem is multiplied by the use of a can type filter placed almost next to the rectifier tube. Silicons are also more efficient since they have a lower voltage drop across them.

In some equipment, the change to silicons is simple as all that is required is to solder two of them in place and add a protective resistor. In other equipment, the rectifier socket is almost inaccessible. The obvious solution is a plug-in assembly to replace the tube rectifier. This can be made by removing the base from an old rectifier tube, and soldering the rectifiers to the correct pins in the base, along with the protective resistor. It should then be possible to plug it into any equipment which uses the tubes, as long as the ratings on the rectifiers aren't exceeded.

The rating that usually has to be watched is the PIV. When a rectifier is used in a full-wave circuit, the PIV is the *full* voltage between the ends of the plate winding X 1.41 plus a safety factor. For example, if a full wave power supply is to deliver 100 volts output, the PIV of the rectifiers should be 200 X 1.41 or 282 volts. With a safety factor, the PIV of the rectifiers should be 300 to 350 volts. When figuring output voltage allow for the drops across the rectifiers, protective resistors, transformers, chokes, etc. The protective resistor is necessary to protect the rectifiers from surges of current when the unit is first turned on. A discharge filter will appear as a dead short to the rectifier and can draw several amps of current until it is charged, especially if voltage is applied on the voltage peak of the cycle. The resistor limits this current to a safe value.

The uses for this plug-in are almost limitless, and it is usually worth while to have several around. . . .WA2INM

VFO Circuits

Staff

LAST month, we explored the field of crystal oscillators in some detail, and promised you a similar study of VFO circuits in a later article. This is it.

Almost every ham who graduates from the Novice license looks forward to the day when he is allowed to use a VFO to control the frequency of his transmitter, rather than being rockbound at a few selected spots within the bands.

But after a little experience with the VFO, the ham who is a perfectionist rapidly learns that the word "variable" in the name "variable frequency oscillator" frequently means exactly what it says: unpredictable, movable within wide limits, not stably fixed. In other words, there's a world of difference between the rock-like frequency stability of a crystal oscillator and the performance of many VFOs.

Much of the difference is inherent in the physical distinctions between the frequency-controlling elements, since it's hardly possible to get an LC circuit's Q up to 25,000, while this figure of quality factor is common in quartz crystals. But the popularity of sideband and VHF interest have combined to focus attention on high-stability oscillators, and the result is that—on the lower bands, at least—it's possible to build a VFO whose performance can't be distinguished from that of a crystal oscillator.

One key point of VFO technology can't be overemphasized, though you've undoubtedly heard it many times. That is the fact that frequency stability is determined more by mechanical considerations than by the individual circuits involved. While it's true that some circuits have inherently greater stability than others, even the least stable basic circuit can give excellent results if its construction is mechanically sound. On the other hand, no matter how stable the circuit *should* be, it will show drastic instability if components are free to move, subjected to extreme temperature changes, or if construction is otherwise sloppy.

Another point less frequently emphasized is that almost any oscillator is stable when it's operating without a load. The only way to check out a VFO and get accurate results is to test it in action, connected to the transmitter just as it will be when in use. Naturally, all such tests should be run into a dummy load, not into the antenna, to keep in good favor with your fellow hams and with the FCC.

From here on out, we're going to assume that good construction practice has been followed when comparing performance of various VFO circuits. A few tips on mechanically solid VFO construction are gathered at the end of the article.

Before we delve into the intricacies of individual VFO circuits, let's look at the basics of vacuum tube oscillators.

In general, oscillators can be divided into either of two major pairs of classifications. One grouping breaks them into relaxation and sinusoidal oscillators, but that's useless for us because we're only interested in sinusoidal oscillators. Square waves, sawteeth, pulse trains, and the like have their places, but not as transmitter VFOs. So we'll use the other pair of classifications: feedback oscillators, and negative-resistance types.

One interpretation lumps these all into one group, on the basis that the feedback provided by a tube circuit introduces effective negative resistance. However, it's easier to understand circuit action by considering them as separate groupings.

Only three types of negative-resistance oscillators are in anything like general use these days: the transitron, the point-contact transistor circuit, and the tunnel-diode circuits. Of these, we'll look only at the transitron circuit (semiconductor circuits are of sufficient importance to warrant another article all to themselves) and the discussion of negative-resistance oscillators will be deferred until we reach that circuit.

All the other oscillators in use are of the feedback type, in which a portion of an amplifier's output is fed back to the input. When just enough signal is fed back to provide a steady input, the closed-loop system formed is self-sustaining and requires no external signal to keep going. The first major differences in oscillator circuits evolved from different methods of obtaining and applying the feedback.

A more complete analysis of the general feedback oscillator shows that it consists of four separate and distinct functions. These are (1) an amplifier, (2) a limiter to maintain feedback value at the proper point, (3) a resonator to determine frequency, and (4) a load. In practice, some of these functions are combined in a single circuit element. For instance, in most VFOs the tube acts as both amplifier and limiter, and the tank circuit may

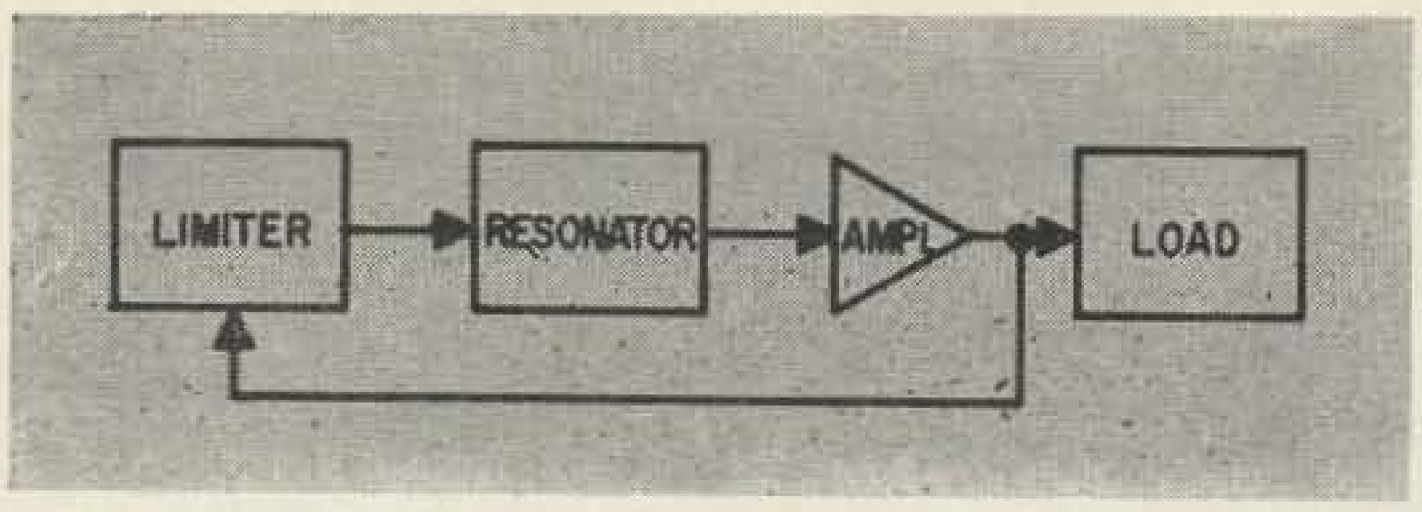

Fig. 1

serve as both resonator and load.

A block diagram of this breakdown is shown in Fig. 1. To examine it more closely, let's start with the amplifier.

The amplifier is actually the heart of the oscillator, for without it, the circuit could not function. However, it is just a conventional amplifier circuit, regardless of the overall circuit complications. Only two design choices are possible so far as the amplifier is concerned; it may be operated in Class A for maximum frequency stability due to minimum harmonic output, or it may be operated Class C for simplicity of the circuit.

Most common VFO circuits use the amplifier in Class C so that the limiter may be combined with it (more about this a little later) and accept the loss in frequency stability.

The limiter's purpose is to keep the amplifier's input signal constant. If input signal were not kept constant, the output would increase with time until it reached infinity—which is obviously an impossible situation. If no limiter is provided as such in a circuit, then the physical properties of tubes themselves will provide one, because at some point you discover that the tube is putting out all it can, and increased input causes no change in output.

Most VFOs do it in just this way, too. The tube is biased well below cutoff by a grid leak resistor, and acts as a Class C amplifier. Large pulses of feedback drive the tube to saturation, producing large pulses of plate current, and it's up to the resonator to smooth these pulses into sine waves.

Addition of a limiter circuit and the accompanying switch of the amplifier from Class C to Class A can improve stability of the oscillator, but it's not usually worth trying until all other improvement methods have been exhausted.

The most critical component of the oscillator is the resonator, because it determines the frequency. In a crystal oscillator, the crystal itself is the resonator. In microwave work, the resonator is frequently a cavity in the tube itself. But in most ham VFOs, the resonator is composed of an LC circuit which resonates at the desired frequency.

The ideal resonator would discriminate sharply between currents at its resonant frequency and all other currents, passing one and rejecting the other. Such a resonator has not been and probably never will be built, because

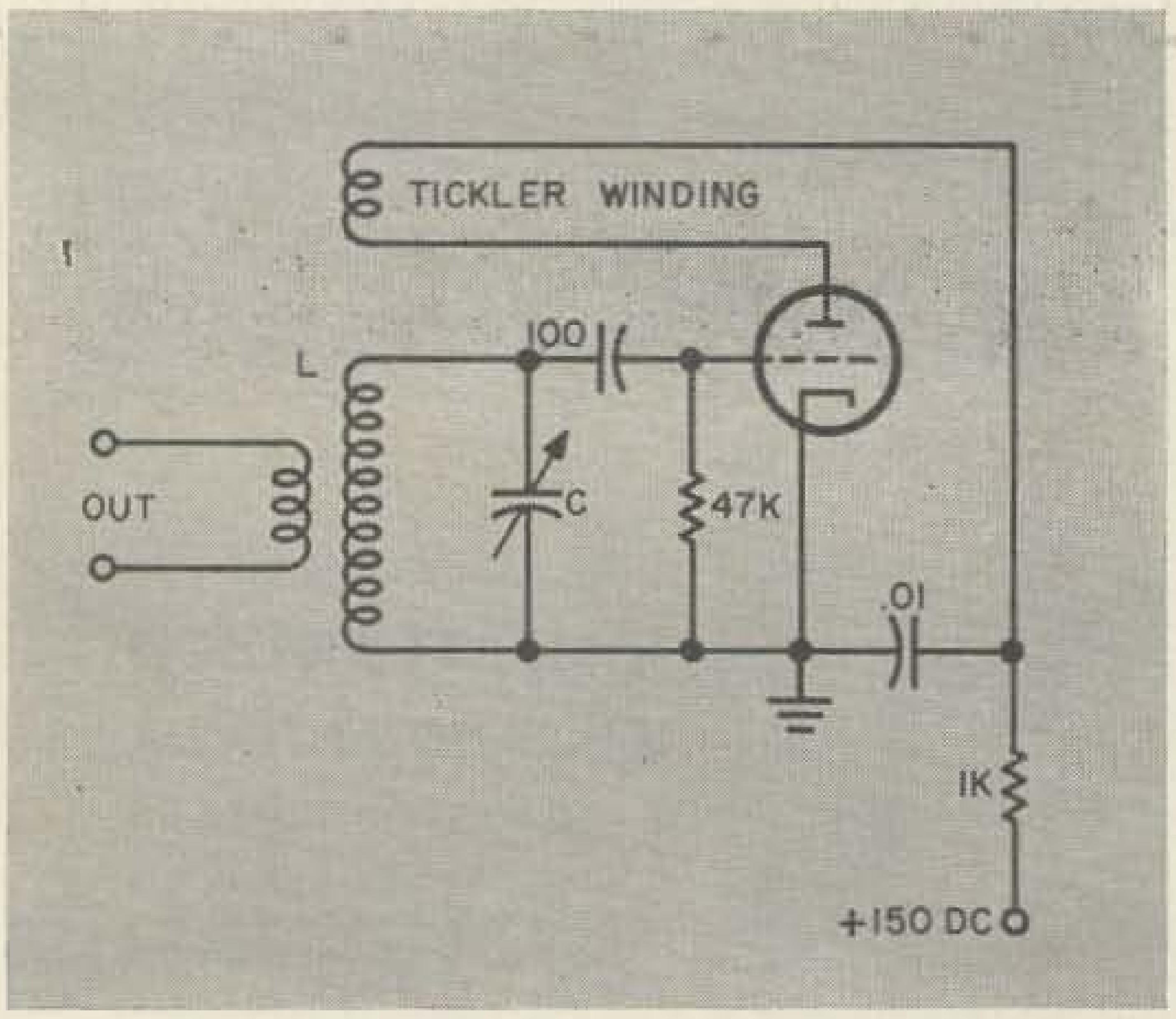

Fig. 2

it's a physical impossibility at the current state of the art.

Characteristics of the best available resonators include these: extremely high Q; suitable impedance level for the circuits; resonant frequency which is not affected by time, temperature, or other uncontrollable variables; and lack of undesired resonances.

Since everything connected to the resonator becomes, in effect, part of the resonator also, we must keep the resonator as isolated as possible from the rest of the circuit. This means that coupling between the resonator and the other components must be extremely light.

Little needs to be said about the load except that it should be completely isolated from the resonator. For good frequency stability, it's best to run the oscillator with extremely light loading, separate it from the power amplifiers with an isolating buffer amplifier, and build up the power in later stages.

With the sole exception of the Transitron circuit which we mentioned earlier, all the VFO circuits described here operate in the manner we've just described. Individual differences in the detailed operation of the various circuits, though, make some better than others for specific uses.

For each circuit, we'll go into the detailed theory of operation, identify the elements which perform the four basic functions, tag critical components, and finally, we'll compare the circuits on the basis of frequency stability, efficiency, and power output as well as pointing out any unique advantages or disadvantages.

With the great variety of VFO circuits available, it's difficult to classify them in any meaningful pattern. One way to do it is merely to take them in historical precedence—and that's what we did. One caution—frequently a single circuit is known by several names, and the name under which it's listed here may not be the one you're most familiar with. However, we have attempted to include all VFO circuits available in the literature as well as a few which aren't too widely known. If your favorite isn't included, let us know — the chances are great that it's one of the relative unknowns which the rest of us would like to hear about.

The progenitor of all vacuum-tube oscillator circuits was that invented in 1914 by young Edwin Howard Armstrong, which bears his name. It's listed here for historical interest only; later circuits achieve better performance with fewer parts.

In the Armstrong circuit (Fig. 2), the output of the amplifier tube is inductively coupled to the grid tank by the feedback winding. The grid tank acts as resonator, and limiting is achieved by saturation of the amplifier. The load is usually coupled to the resonator by a separate winding, but may be placed in series with the feedback winding if desired.

Since feedback is determined only by the coupling between "tickler" and grid coils, this oscillator gives strong output with almost any tube regardless of gain. However, its stability is not so great as later circuits because grid, plate, and load circuits are all coupled closely to the resonator. Its only widespread use now is as the local oscillator in many inexpensive BC receivers, where dependability is the chief desired characteristic.

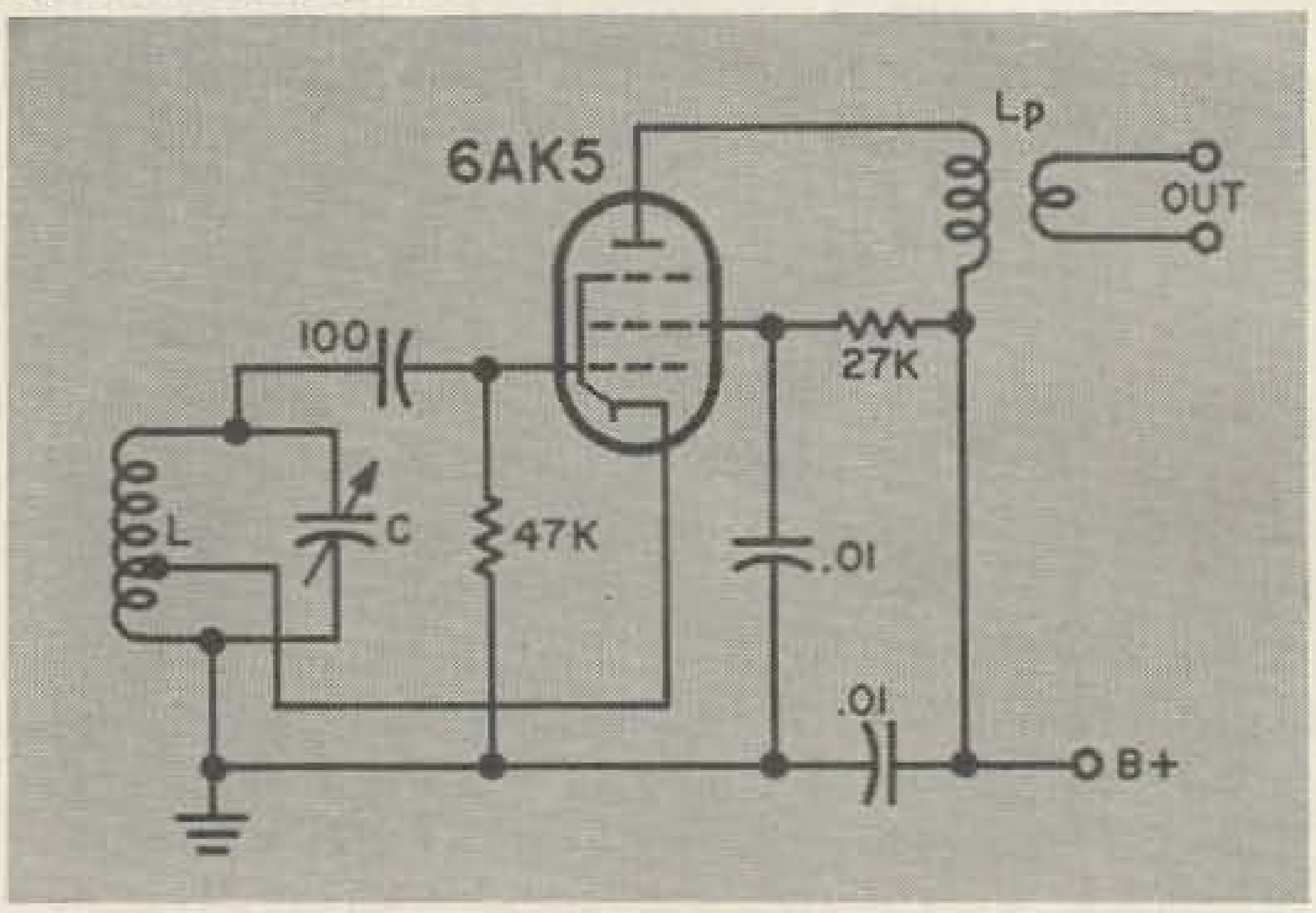

Fig. 3

By joining the "tickler" and grid coils into one winding, then moving the rf ground point from the cathode to the plate, Hartley developed the oscillator (Fig. 3) which bears his name. The tube continues to serve the dual purpose of amplifier and limiter, and the grid tank is still the resonator, but now the load may be taken by electron coupling if we use the screen of a pentode as the plate of the oscillator as shown in the schematic. This isolates the load from the resonator to a much greater degree, thus improving frequency stability.

The Hartley oscillator is widely used as the local oscillator in communications receivers, and for many years was the standard VFO circuit for hams. More recent circuits have tended to put it in the shade for transmitter use, but with proper design a Hartley can still hold its own. A little farther on we'll look at

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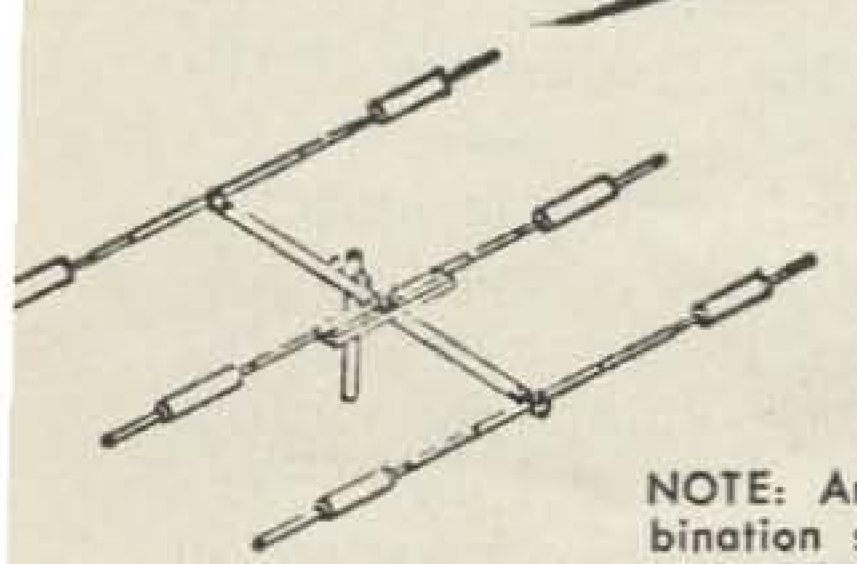

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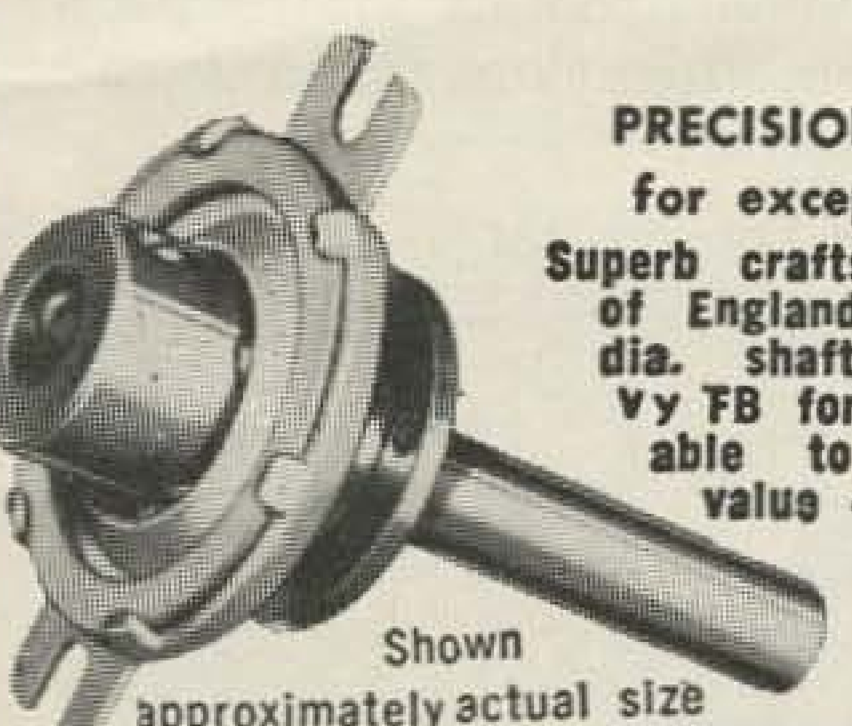

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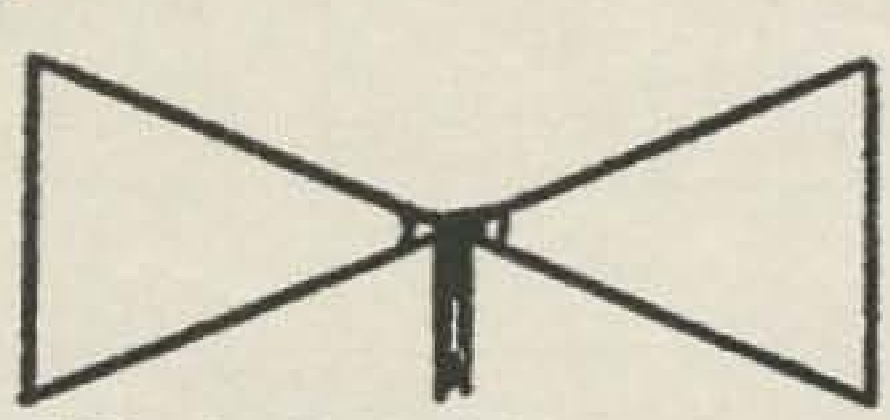

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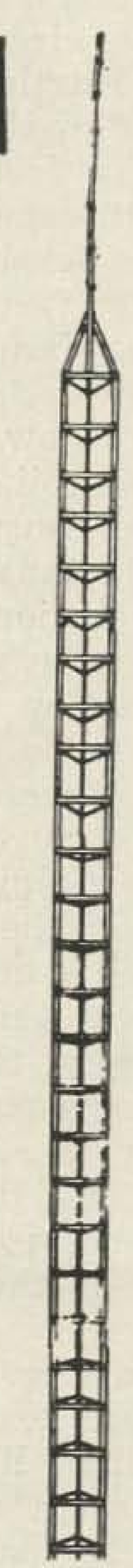

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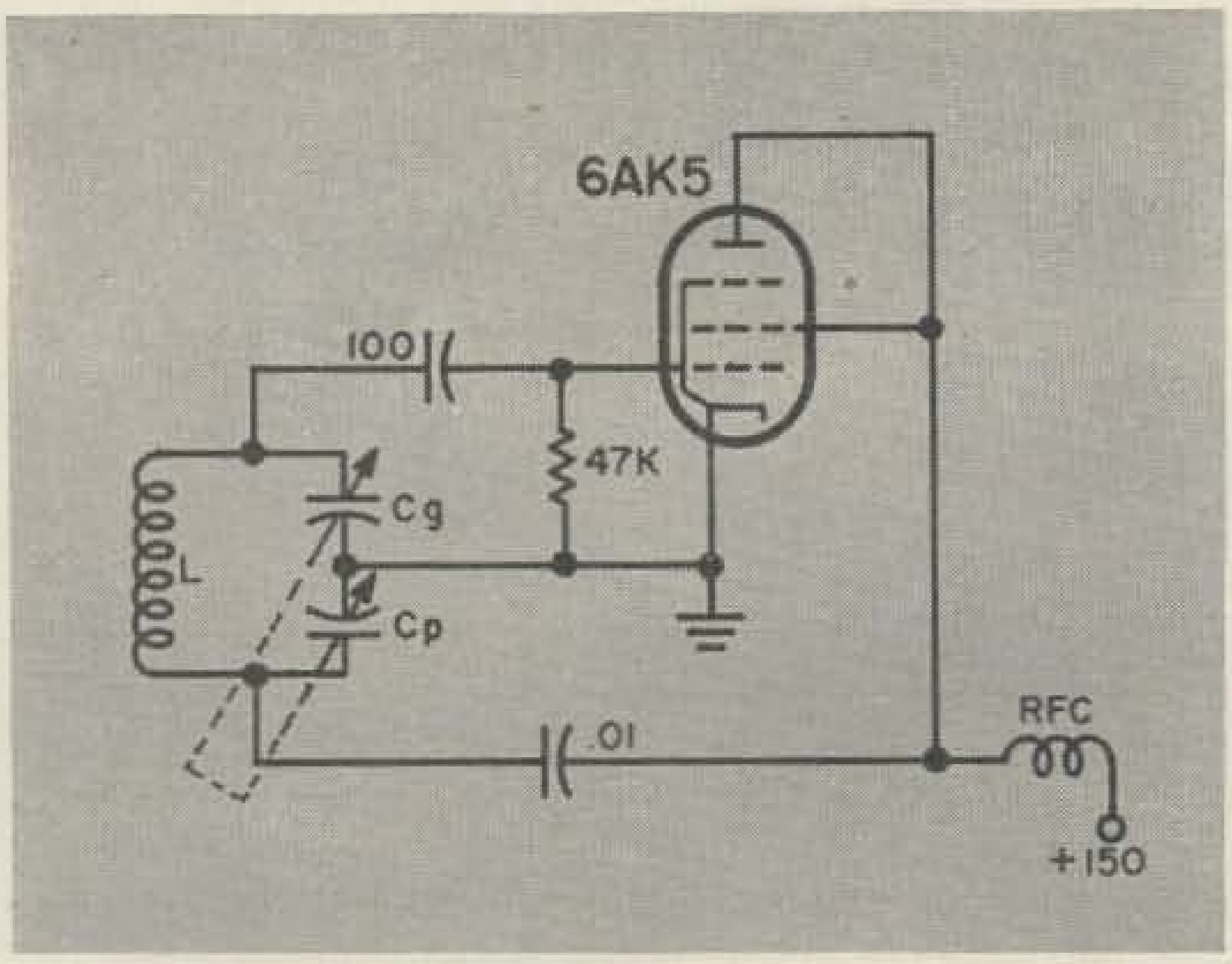

Fig. 4

some updated versions of the older circuits.

The greatest weakness of the Hartley circuit is that the load current must flow through a part of the resonator to return from the cathode to ground. This introduces some coupling between load and resonator despite the electron coupling, and also degrades frequency stability if harmonics are present (and they always are).

Even if harmonics are at very low level, the dc flow through part of the tank coil causes local heating of the wire, with consequent physical expansion, change of inductance, and change of frequency during operation (described as short-term drift). The only way to avoid this drawback with the Hartley circuit is to move the ground to the cathode, which then eliminates the possibility of efficient electron coupling to the load.

This difficulty is avoided in the Colpitts oscillator (Fig. 4), a close relative of the Hartley circuit. In the Colpitts, feedback is achieved by current flow through a part of the resonator capacitance (Cp). Electrically, there is no difference in the circuits, since the "tapped" capacitor made up of Cp and Cg in series is equivalent to the tapped coil of the Hartley. Mechanically, though, the difference is great, since dc flow through any part of the resonator is eliminated.

In its basic form as shown in Fig. 4, the Colpitts is hardly used any more except at UHF. In fact, one authority (Pullen) has concluded that it's impossible to design a good Colpitts oscillator for use below 10 mc. However, modified versions are now finding wide acceptance, and we'll come back to it later.

Considerably different from these oscillators is the next circuit, the Franklin (Fig. 5). Developed many years ago but almost neglected until recently, the Franklin oscillator has been claimed by some to be equal to many quartz crystal circuits in frequency stability.

Despite its unusual appearance, the Franklin operates in the same general manner as all other feedback oscillators. The amplifier of the Franklin is a two-stage affair instead of just one; both tubes are used in a closed-loop RC circuit. Limiting is achieved by saturation of the amplifiers, and the resonator is a conventional LC circuit coupled loosely to the circuit between the two stages.

In the absence of the resonator, the circuit would operate as a multivibrator, generating square waves in the audio range. However, the resonator offers a low-impedance path to ground for all signals except those at its resonant frequency; for those signals, it is a high impedance.

This means that the amplifier is loaded down at all frequencies except that to which the resonator is tuned, but has a high-impedance load at that single frequency. Therefore, oscillation is confined to the frequency of the resonator.

The secret of the circuit's extreme stability is that the resonator is almost completely isolated from everything else. It is coupled to the amplifier loop only by the small capacitors, which effectively keep all external influences away from the tank. The load is connected on the other side of the loop for additional isolation.

The advantage of the Franklin oscillator is, of course, its stability. Its disadvantage is extremely low output, measured in tenths of a volt and requiring amplification for any use at all, even in a receiver.

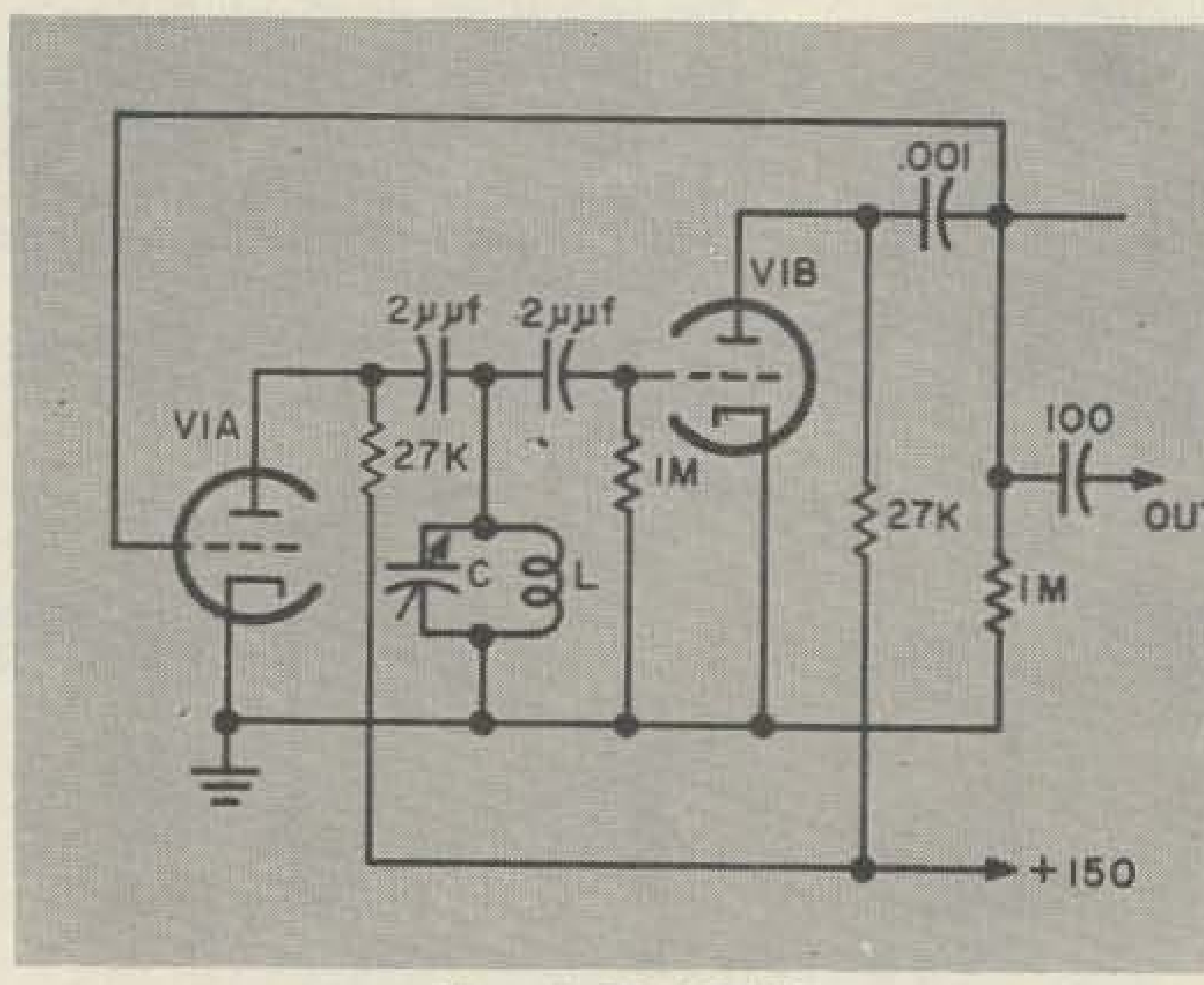

Fig. 5 V1-12AT7

Offering even higher stability at low frequencies is the Meacham bridge oscillator, shown in Fig. 6. This circuit, developed at the National Bureau of Standards and used also by Bell Telephone Labs and the British Government Post Office for frequency standards (but with a crystal instead of an adjustable tank), can achieve stability on the order of one part in 109. That's one cycle variation at 1,000 mc! As a VFO, naturally, stability won't be that good, but by virtue of its special features of operation it will give much higher stability than any other circuit with the same resonator.

The Meacham bridge, like the Franklin, is a two-stage circuit. Both stages together make

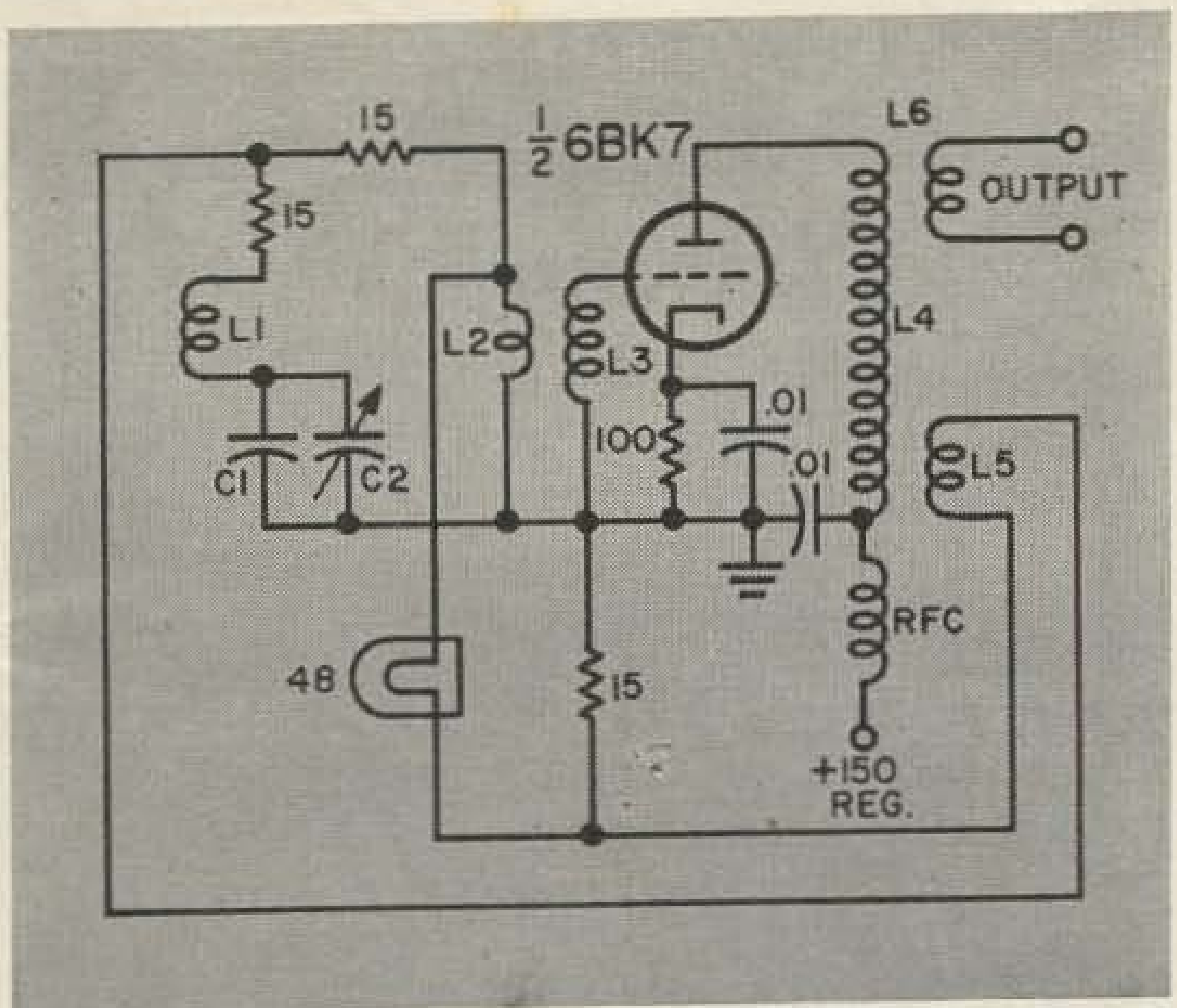

Figure 6. Meacham Bridge VFO, Experimental Circuit Diagram.

C1—35 mmf double-spaced variable
C2—100 mmf air trimmer
L1—17.5 michrhenry Q = 200 (Miller 43A155CBI or equivalent)
L2—5 turns #20 bifilar-wound with LO3
L3—335 turns #24 on small toriod form
L4—260 turns #24 on small toriod form
L5—10 turns #20 bifilar wound at B+ end of L4
L6—30 turns #24 bifilar wound at plate end of L4

NOTE—If circuit refuses to oscillate reverse connections to L5. Effective Q of circuit should be greater than 15,000.

up the amplifier, and the resonator is located in the feedback loop. However, unlike all the other circuits we've examined, the Meacham uses a separate limiter. This allows the amplifier to operate in Class A, providing exceptional stability and purity of the frequency in itself.

The special feature of the Meacham circuit, though, is the manner in which the resonator is connected. As you can see from the schematic, feedback is achieved through a bridge circuit. The resonator is located in one leg of this bridge. When the bridge is balanced, no feedback can get through and the circuit cannot operate. When the bridge is slightly unbalanced, a small amount of feedback gets through.

The circuit is designed to operate almost at balance. The lamp, also connected in the bridge, is the limiter. Its resistance varies with the voltage across it, and by proper choice of the values in the resistance legs of the bridge the circuit can be made to balance in the most sensitive portion of the lamp's variable-resistance range.

Since three legs of the bridge are pure resistances, the bridge can be balanced only if the resonator acts as a pure resistance also. This condition is achieved only at series or parallel resonance. Since values of the other three legs are all low, the bridge will balance only at series resonance.

However, we said earlier that, at balance, no feedback gets through and the circuit stops working. Here's where the interplay between the limiter and the resonator starts to work. If the circuit stops, there is no output. With no output, no voltage is applied to the lamp. With no voltage, resistance drops from the balance value and the bridge is unbalanced. With the bridge unbalanced, feedback is re-established and oscillation resumes. It builds up until the bridge is balanced. With the bridge balanced . . . and off we go again.

That's the picture theoretically. In practice, the thermal time constant of the lamp filament is long enough that operation settles down within a couple of rf cycles to the just-off-balance point at which the circuit is designed to operate.

This is all very well, but what does it have to do with stability? Let's look at the bridge again. If frequency tends to shift slightly from the series-resonant point, the resonator is no longer a pure resistance. With reactance present, the bridge is unbalanced. More feedback gets through, and oscillator output increases. This output is shifted in phase by the pass through the resonator, and the phase shift is in such a direction as to tend to drive the frequency instantaneously back towards the resonance point. This continues until the output is back at the resonant frequency and the bridge is back almost in balance.

You can see that the bridge connection of the resonator acts to multiply its phase-shifting abilities, which is the same thing as saying to multiply its Q. The numerical amount of this Q-multiplication is equal to the reciprocal of the operating unbalance figure; with the circuit shown, it's about 200. This will increase the normal Q-of-100 value found in a well-constructed VFO tank circuit to 20,000 — a figure comparable to that of a crystal!

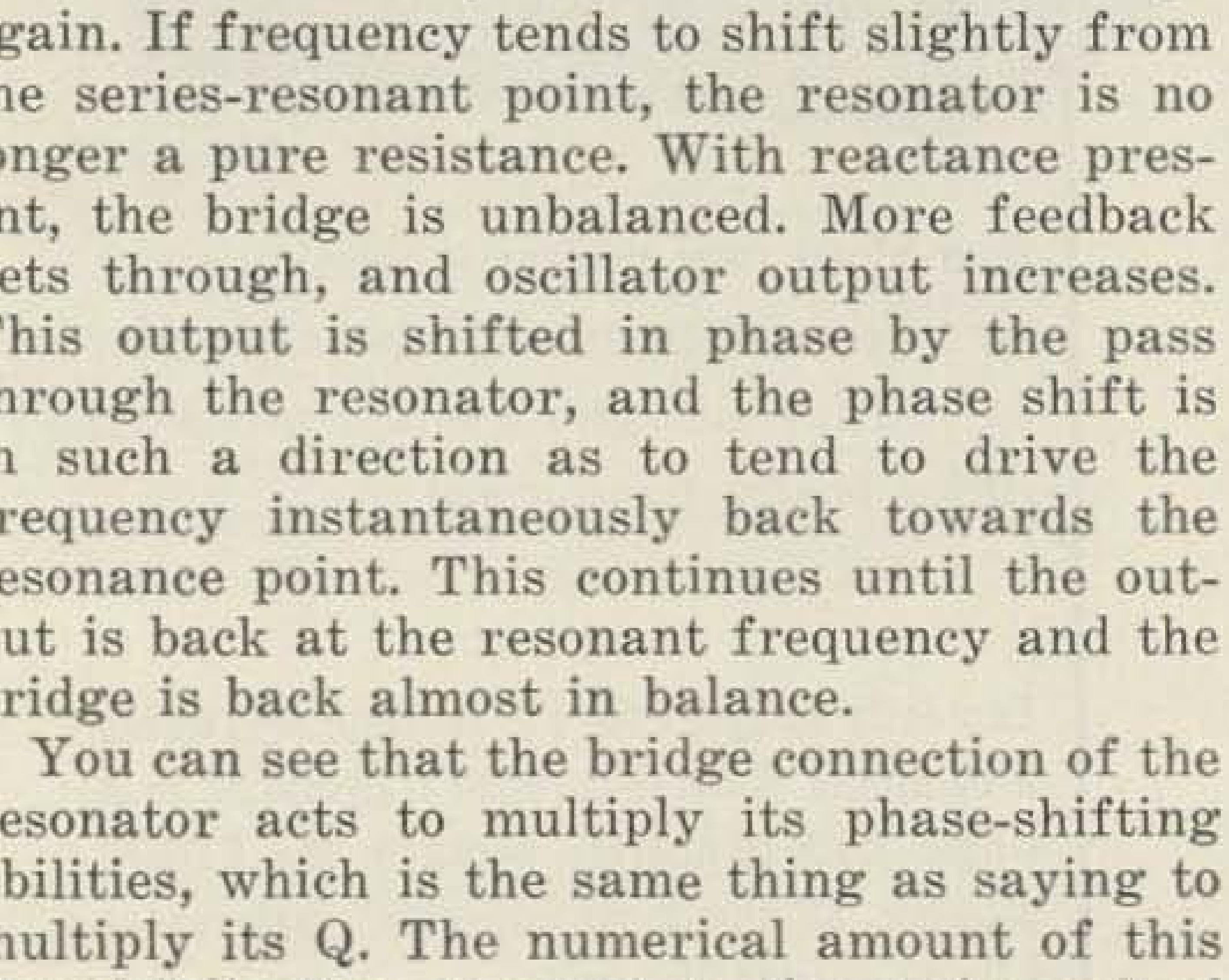

Fig. 7

The Meacham circuit is best suited to use at frequencies below 500 kc, because stray feedback becomes a problem at higher frequencies and the entire operation of the circuit depends upon critical balance of the bridge, which can be upset by stray feedback. However, no tests have been run to determine the upper frequency limit; the circuit shown in Fig. 6 is theoretical and untested but should work properly with parts values as shown.

The next circuit we'll examine is the Transitron, so named because it makes use of the transit time of electrons between screen and suppressor grids in a pentode tube to provide an effective negative resistance. The circuit is shown in Fig. 7.

In most pentode tubes, if the screen is operated at a voltage higher than the plate voltage you'll find a region where Ohm's Law seems to work in reverse. That is, as plate voltage goes up plate current comes down. Mathematically, this is the same thing as a negative resistance.

The reason for the strange behavior is simple. In the region below the knee of the characteristic curve, screen current increases with an increase of either plate voltage or screen voltage. With fixed grid bias, the total current leaving the cathode is also fixed. Thus, when an increase in plate voltage causes an increase in screen current, the only place from which the extra screen current can come is by a diversion of electrons which would otherwise have gone to the plate.

We said that mathematically this is the same thing as a negative resistance. Strangely, mathematics holds pretty true in most areas of electronics, and this is no exception.

Jumping away from the main subject for a moment, you'll recall that the only thing that keeps an LC tank circuit from oscillating indefinitely is the internal resistance of the circuit itself, which eventually damps out the oscillation by dissipating the energy.

Now, from a mathematical point of view, the internal resistance of the tank can be eliminated by adding a suitable amount of negative resistance to make the total resistance zero.

Physically, we do this in the transitron oscillator by connecting the coil between screen grid and plate. This couples the negative resistance of the plate circuit into the tank, and oscillation results.

The Transitron and other two-terminal oscillators have several distinct advantanges over feedback circuits: Since the resonators require no feedback provisions, changing resonators becomes an easy job. Bandswitching is convenient in a VFO, and as a bench test oscillator only two leads are necessary. In addition, these circuits will operate from the audio range up to several hundred megacycles without change, making them especially versatile as bench test units.

Authorities differ concerning the comparative stability of the Transitron oscillator. Some claim it has frequency stability classed with the best feedback circuits, while others denounce it as unstable and unreliable. It appears that the circuit's operation is dependent on many factors, not all of which are as fully understood as they might be, and all of which influence stability.

Another popular two-terminal circuit has

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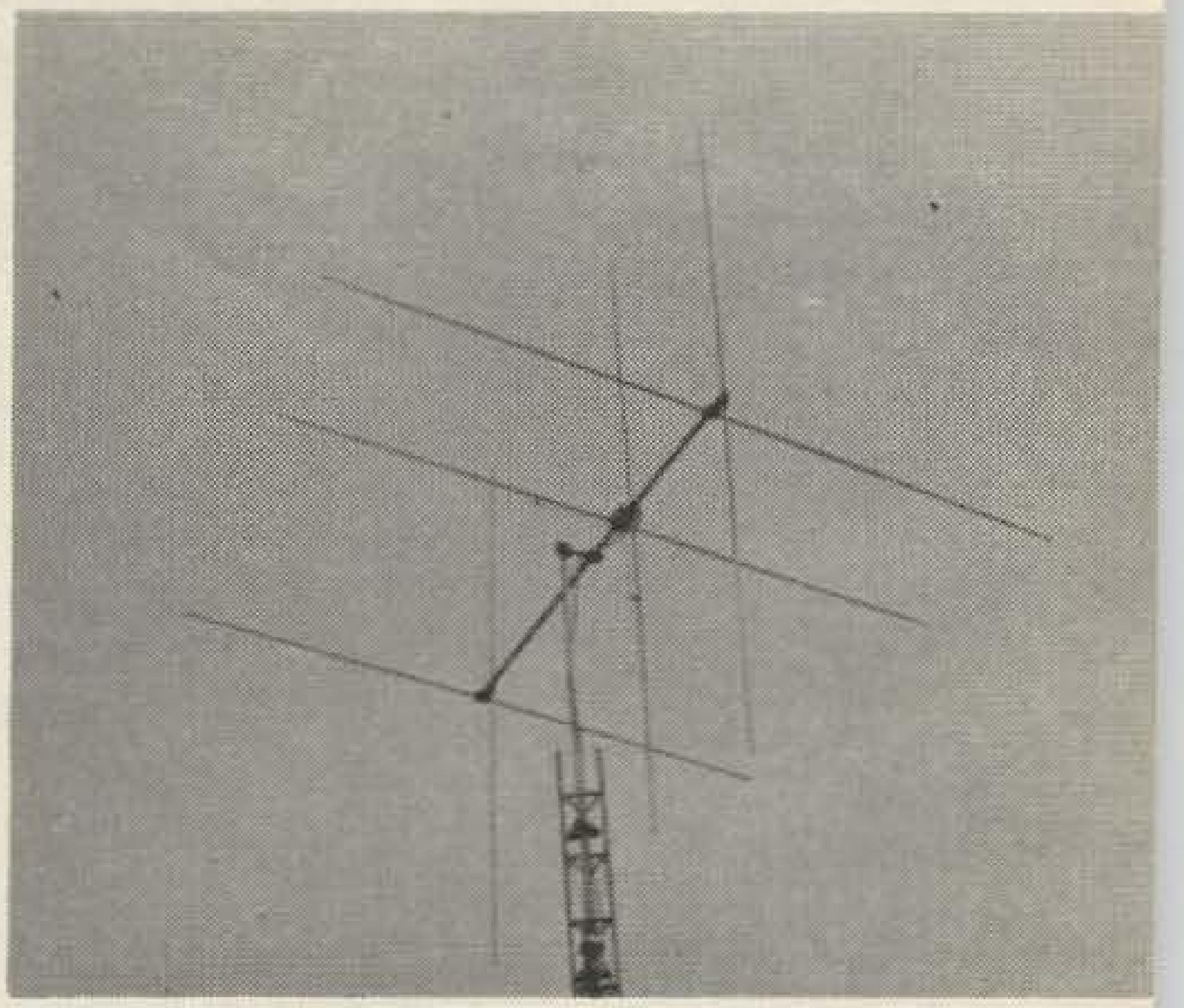

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10 METER BAND

Model	Specifications	Amateur Net	Weight
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15 METER BAND

Model	Specifications	Amateur Net	Weight
B-15-6	K6CT Polarized Diversity Beam, 6 element. 1¼" O.D. Center Sections; 1" O.D. & ¾" O.D. adjustable end sections. Boom: 2" O.D. 15' long. .125 .19 Spacing. Forward gain 12 D.B. Front/Back ratio; 44 D.B.	$90.00	38 lbs.

20 METER BAND

Model	Specifications	Amateur Net	Weight
B-20-6	K6CT Polarized Diversity Beam, 6 element. 1¼" O.D. Center Sections; 1" O.D. & ¾" O.D. adjustable end sections. Boom: 2" O.D. 24' long. .125 .19 Spacing. Forward gain 12 D.B. Front/Back ratio; 44 D.B.	$114.50	44 lbs.

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been published in at least three different versions. They're shown as circuits A, B, and C in Fig. 8. While this circuit is definitely a two-terminal affair and so might be classed as a negative-resistance oscillator, it can also be analyzed as a feedback circuit. Feedback is obtained through C1, and is effective at all frequencies. However, the circuit provides gain only at the parallel-resonant frequency of the tank circuit or resonator, and thus can oscillate only at this one frequency.

The advantages and disadvantages of this circuit are practically the same as those of the Transitron. However, the twin-triode oscillator has fewer parts which might prove critical.

Getting back to the more-conventional oscillator circuits, we're just now getting to the one which for the past 12 years has been almost the standard circuit for ham-use VFOs —so much so that many newcomers may not be aware that any other circuit exists. This is the Clapp oscillator, first announced in 1948.

Some authorities have "proved" that the Clapp circuit has inherently greater frequency stability than any other design, while others of equal eminence have "disproved" this assertion.

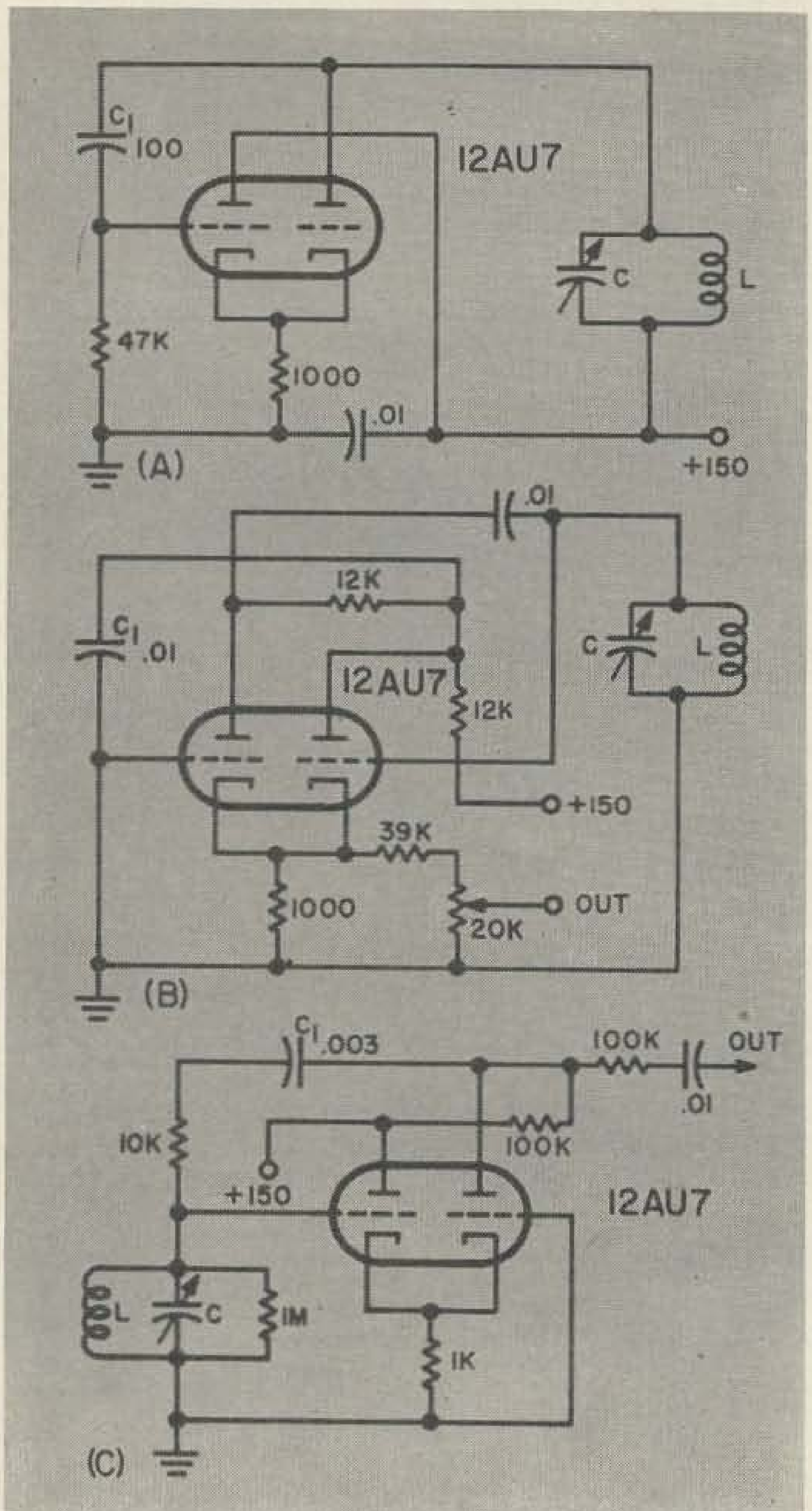

Fig. 8

Actually, the Clapp circuit does provide greater stability *with respect to tube variations* than any other circuit, if we confine our analysis to designs using practical component values. However, recent developments in tubes have brought other circuits to almost-equal stability at less expenditure of time in construction.

The Clapp oscillator, shown in Fig. 9, differs from most other circuits in that its resonator is series- rather than parallel-tuned. Use of series tuning enables high values of parallel capacitance to be employed while still retaining wide tuning range. However, it also makes mandatory the use of a large, extra-high-Q coil, which in turn raises problems of mechanical stability.

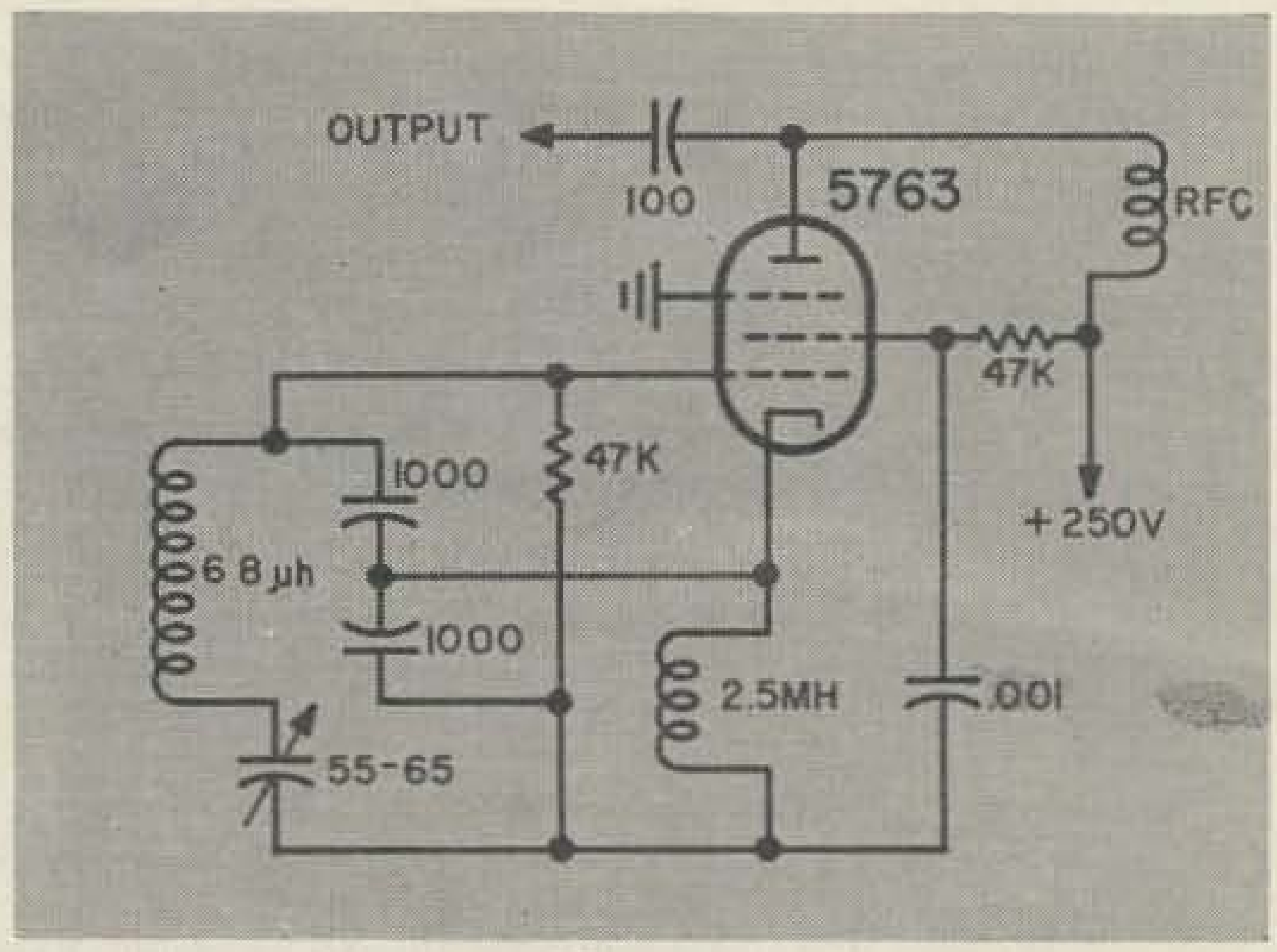

Fig. 9

Actual operation of the Clapp circuit is similar to the Colpitts, and the only electrical differences are the method of tuning and the large-value parallel capacitors.

The frequency stability is directly due to the large-valued parallel capacitors, which effectively swamp any changes of tube characteristics. This stability, incidentally, is *only* with respect to tube variations. Mechanical flaws of feedback to the VFO circuit from later stages can still play hob with your signal. In practice, the tank circuit of a Clapp oscillator is usually placed in a completely shielded compartment and tied down solidly to prevent any motion of the coil or other components.

The attention given the Clapp circuit has also been focused on its ancestor, the Colpitts, with the result that a number of Colpitts oscillators producing equivalent preformance have been described.

One of the earliest was the Vackar (1955), shown in Fig. 10. The Vackar oscillator shows its similarity to the Clapp in the high value of parallel capacitors and the isolation from the tank to the grid achieved by capacitative voltage-divider action. However, the feedback is taken from plate to grid rather than from the cathode, the resonator is parallel- rather than series-tuned, and both the cathode and one side of the tuning capacitor are grounded.

The only circuit in print which employs the Vackar oscillator shows a drift figure of only 3⅓ cycles per minute under best conditions. Under these conditions, a SSB signal wouldn't drift far enough to sound unnatural in 15 minutes.

Another version was described by Robert J. Ropes in early 1957. He called it the "Class A Colpitts." This design (Fig. 11) doesn't use quite so much capacity to isolate the tube, but makes interesting use of high-value cathode resistors to maintain grid bias high enough to prevent any grid current flow. No provision for limiting is made in the circuit; it appears to be automatic as a result of the high cathode bias.

Ropes claims that the circuit would hover "within a few cycles per second" of WWV for "hours at a time," but does not mention whether this test was made under load. Apparently this circuit has not been employed in any ham transmitter design which has been published; however, it appears attractive as a simple and reliable oscillator.

The most persuasive argument for abandonment of the Clapp circuit and a return to the High-C Colpitts design was made by W. B. Bernard, ex-W4ELZ, in late 1957. He pointed out the disadvantages of the series-tuned circuit and the advantages of a similar parallel-tuned arrangement.

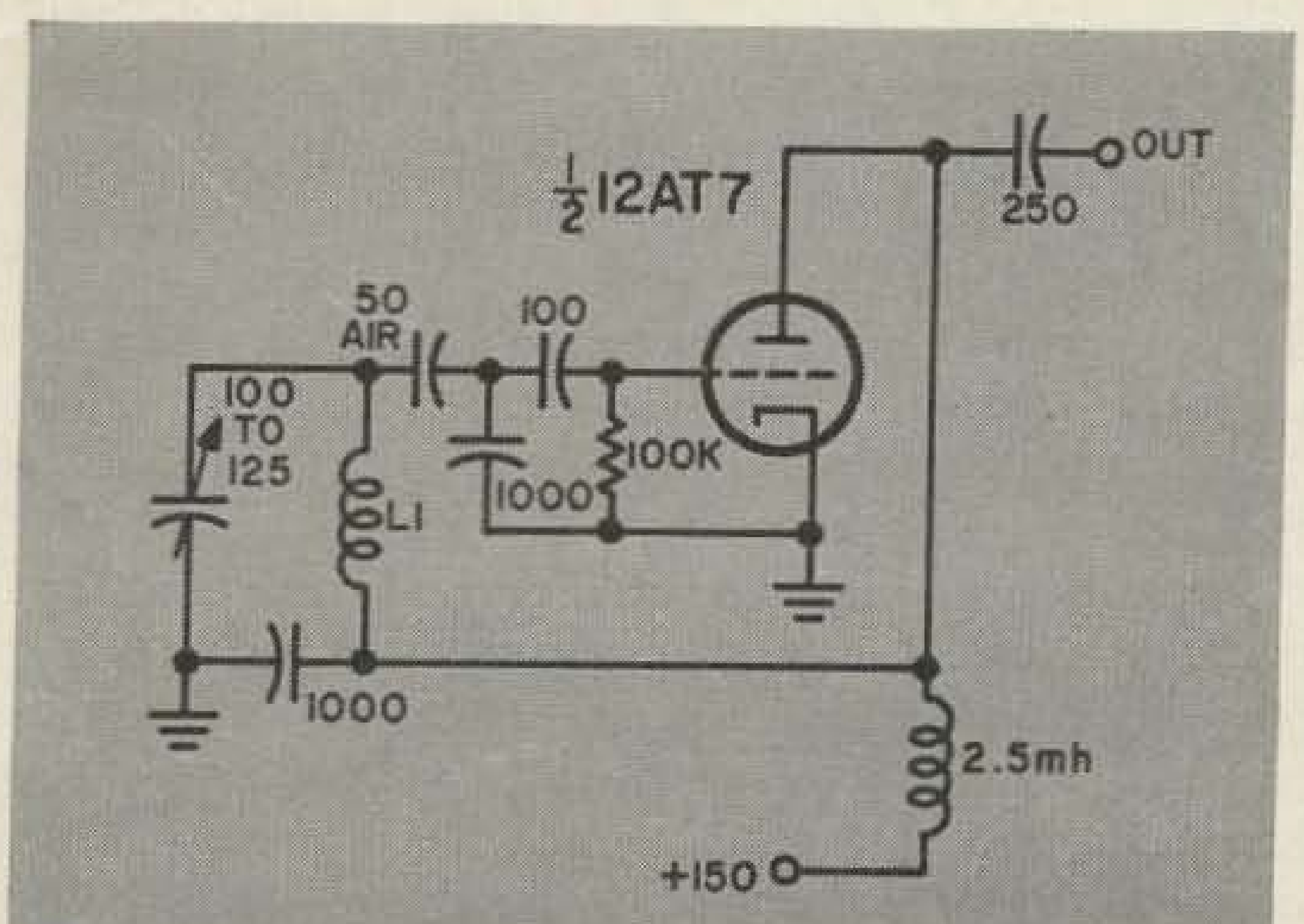

Fig. 10

Bernard's version of the High-C Colpitts utilized a grounded-cathode oscillator tube with separate buffer amplifier. He also listed a series of design equations for calculating your own High-C Colpitts to fit your individual needs (see bibliography). The circuit shown in Fig. 12 is based on his design procedure but has been modified from his original circuit to take advantage of more recent tubes which have high gm and allow proportionately increased stability.

Before leaving the Colpitts circuit and its variations, mention must be made of General Electric's "Lighthouse Larry," who helped pioneer the rebirth of the High-C Colpitts by using it as the VFO in his popular 150-watt single-band contest transmitter. Since the GE circuit is similar to the three discussed here, we haven't shown it separately.

We said earlier that mechanical stability is a more important characteristic of a VFO than any of the electronic parameters of the individual circuit. The only way to achieve this mechanical stability is through careful attention to the geometry of not only the electronic components in the circuit, but the mechanical items such as the chassis, cabinet, and capacitor-driving mechanism as well. Many a good VFO circuit has been built on a standard aluminum chassis, and the builder has been left wondering why he can't eliminate that last trace of frequency wobble. Had he taken a tip from the people who build hi-fi loudspeaker enclosures, and used *heavy* material for the supporting structure, he probably would have discovered he had a rock-stable oscillator!

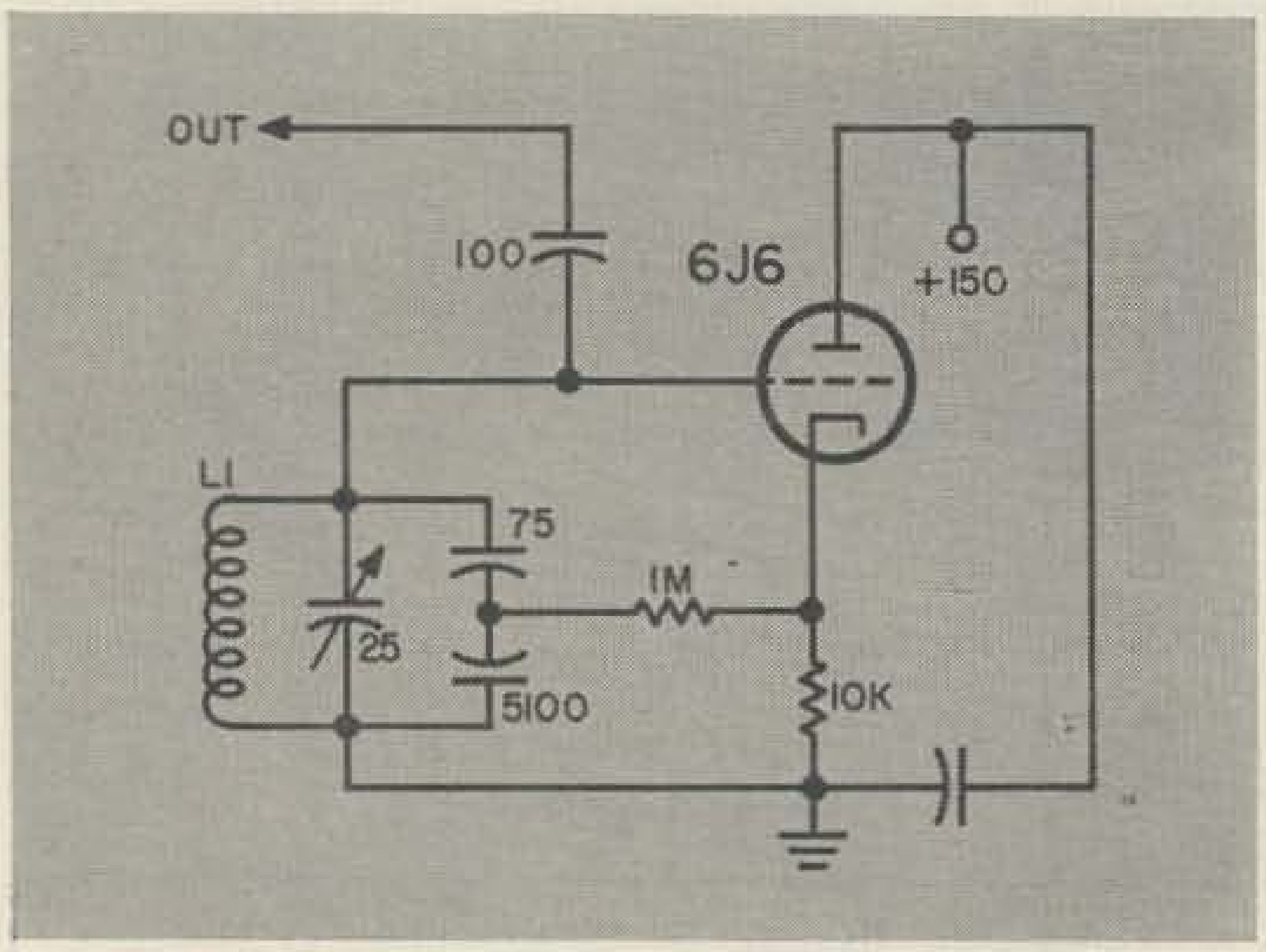

Fig. 11

A good VFO chassis can be obtained by using a chunk of ⅛-inch thick aluminum carved from a standard relay-rack panel, bending it over only at the front edge to attach to the cabinet, and mounting all components firmly in place (using tie points and standoff insulators liberally). An even better chassis can be put together with medium-hard 1/16-inch stock bent at the front and the two sides, and bolted (not soldered or welded—heat introduces stresses) at the front joints to achieve a sort of triangular bracing of the structure.

In either event, the cabinet should be only for decorative and dust-catching purposes. An inner shield (*firmly* attached to the solid chassis) should isolate the circuitry from any electrostatic coupling to the cabinet. Dial drive mechanisms should be precise in their action, and should *float* so far as the cabinet is concerned, being mounted firmly to the chassis only.

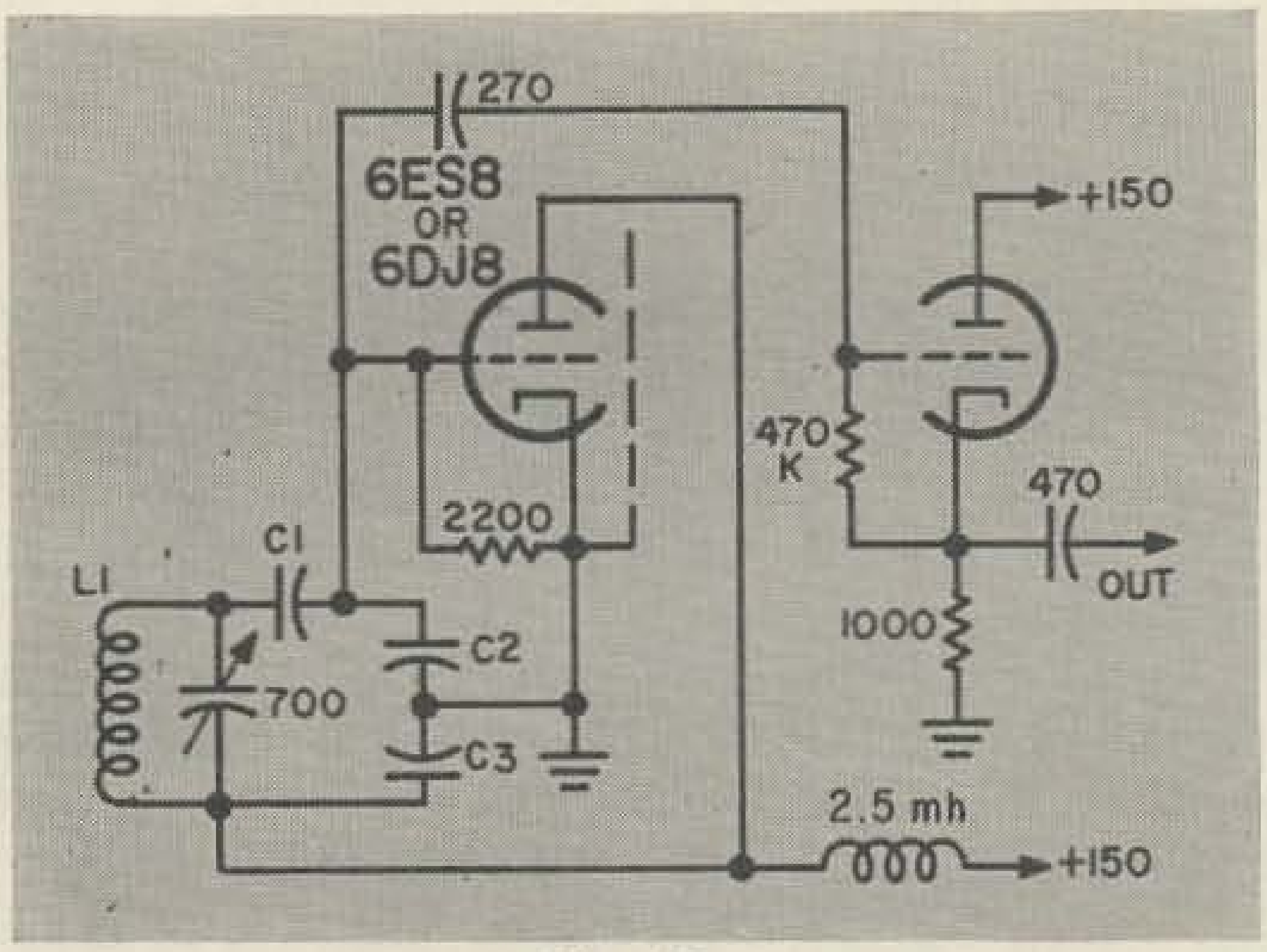

Fig. 12

Incidentally, heat is one of the biggest enemies of VFO stability. The perforated Reynolds do-it-yourself aluminum stock provides a perfect answer to the heat problem. Simply make the shielding from this perforated stock, and your ventilation problems are over. Cooling fans are *not* recommended; their vibration, however small, will put a wobble on your signal.

Heat can be avoided in an electrical way, too. A vacuum tube produces heat in two ways. First, of course, is the heater, and you can't do too much about that. One answer is to go to small battery tubes such as the 1R5 triode-connected or the 3S4, and this approach has been used with excellent results by W2ZGU. The second way in which heat is produced is by plate dissipation. Less than half the power fed to an oscillator tube shows up in the output; the rest is converted to heat and radiated from the plate. Since little power is needed from the VFO, you don't have to feed much to the tube. Cutting tube input down to half will reduce the output by half, but it will also reduce the heat by half at the same time. The output can be restored in later stages. The frequency stability can't. The circuits shown here will work at plate voltages as low as 30 volts—try them and see.

One of the biggest mechanical bugaboos in construction of a high-accuracy VFO is in the tuning mechanism. Using the conventional fixed-coil-variable-capacitor combination, you have to lay out much cash to get good accuracy (such as the $30 National HRO-type unit or the $80 Cardwell precision capacitor). However, you can swipe a trick from the Collins people and build a permeability-tuned circuit with accuracy comparable to the best, for almost peanuts. One such circuit is described by W5HZB (see references) and others are also in print.

The difference, of course, is that the permeability-tuned circuit uses a variable-inductance coil rather than a variable capacitor. By proper choice of coil winding pitch, the calibration can be made completely linear over any desired range, or can be spread in places and compressed elsewhere as desired. Since

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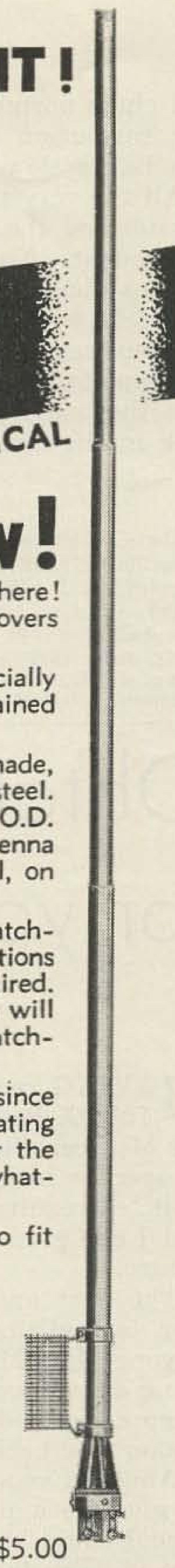

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coil slugs normally move only about 1/32-inch per revolution of the shaft, the tuning rate can be as slow as you like.

All the way through this article, we've been considering the VFO strictly as a transmitter component. Naturally, it is also used in receivers—but there it's called the local oscillator. If you're looking for increased stability in your receiver, or considering homebrewing a complete hearing aid, these circuits can give you the same stability in reception that you seek in the transmitter.

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Obtaining that License for your DX-Pedition

Gus Browning W4BPD
144 Broughton S.W.
Orangeburg, South Carolina

HAVING recently returned from a successful DX-Pedition, I have been asked a number of times, "Gus, how did you get permission to operate from all those places?" Each place I visited required a slightly different approach, and I can give only a general view of the procedure.

The first and probably the most important step is realizing that you are no better than anyone else. Make it a point to have people think of you as a friend when you leave them. Keep a big smile on your face, be a good hand shaker and back slapper.

Andorra was the only country that refused to give me a permit and I feel if I had more time I could have gotten a permit there. Rule two is "Try to have plenty of time when you reach the rare spots so you will have time to work on the proper official." I did not attempt to obtain permission to work from the more well known spots in Europe, as I had no desire to operate from them.

The usual procedure in securing my permits went like this: When I arrived in my prospective operating area, I left my KWM-2 at the airport customs office, telling them I would return for it. I would then find the proper official and, putting a big smile on my face, walk into his office. The conversation was usually, "Hello Mr. ...., my name is Gus Browning, I am an American, and I have come all the way from America to visit your wonderful country. I want to meet as many of your wonderful people as I can while I am here. I am certain that those I have met are the finest people in the world and I want to congratulate you on having such fine people and such a fine country. People here are just like my friends back home. They have made me feel really welcome here. I hope some day to have some of them come to America so that I can have a chance to return their hospitality. Maybe you can someday come to America too, I would like to show you around and let you meet my friends. We seem to have so much in common I am sure you would feel right at home. I want to give you my home address so you can look me up when you come over. Be sure to drop me a letter now and then to let me know how you and your family are getting along. This is just a social visit Mr. .... Before I leave let me order a cup of coffee for us to drink. (By this time we usually have ordered coffee and are drinking it.) When I leave he has asked me to return and visit him again and possibly I have an invitation to visit his home.

When you return you follow the same line and, as an afterthought, "Mr. ...., I wonder if you will do me a *small* favor? He will say certainly, if it's within his power. Explain that maybe someday you can do him a favor in America. Then say "I have a small radio outfit at your customs station (I never did use the phrase "radio receiving/transmitting station") and the entire purpose of the trip is for talking to as many of my friends all over the world as possible. I am sure my low power station will not put out a strong enough signal to be heard back in America, but I would like to at least give it a trial while I am here. It will only be for a few days and would you please give me a temporary permit to just test it." All you want is a temporary *permit*, don't mention the word license. The permits are usually for thirty days. "I want to come to your country in a few years and bring my wife with me. If, however, you cannot give me a permit I will have to leave tomorrow, since this is a radio testing holiday. I would like to stay longer to get to know both you and your country better, but the entire purpose of the trip will have been defeated and I will have to go to a neighboring country to test it out." If you have been diplomatic he cannot refuse the permit. After you have the permit you are ready to get the KWM-2 through customs. At most of my stops the official who gave me the permit wrote a note to customs requesting them to let me have the rig, saying that he had given me a permit and it was all right to let the KWM-2 into the country. One took me to customs in his own car to help me get the rig.

If it's possible to make some official contacts with the proper man in some of these countries before you arrive it will help a lot. A letter of introduction will go a long way to open the door for you. A ham living there will usually do all he can to help. (M1B helped in San Marino, VQ3HV in Zanzibar, Rundy in the MP4 spots, Wayne Green, by knowing the French consulate in New York City, for Djibouti).

My final word is to fly by the seat of your pants, be everybody's friend, keep smiling, and always ask for "just a temporary permit" for your small low powered outfit.

W4ECI and I are now in the process of planning another DXpedition the early part of next year, either Jan. or Feb., this one lasting about one year and taking me to (I hope) 100 countries, some of them easy to work and many of them brand new Virgin spots.

A great deal of details to attend to, but I am getting lined up with some fine connections in many of them, and expect more connections before I leave.

W4ECI will be the man back home attending to QSL chores, etc. This time at least 50% will be SSB. Will also use 40 and 80 this time, so gang get your low frequency antennas in good shape. I will keep the DX chasers busy for a year the way it looks at this time.

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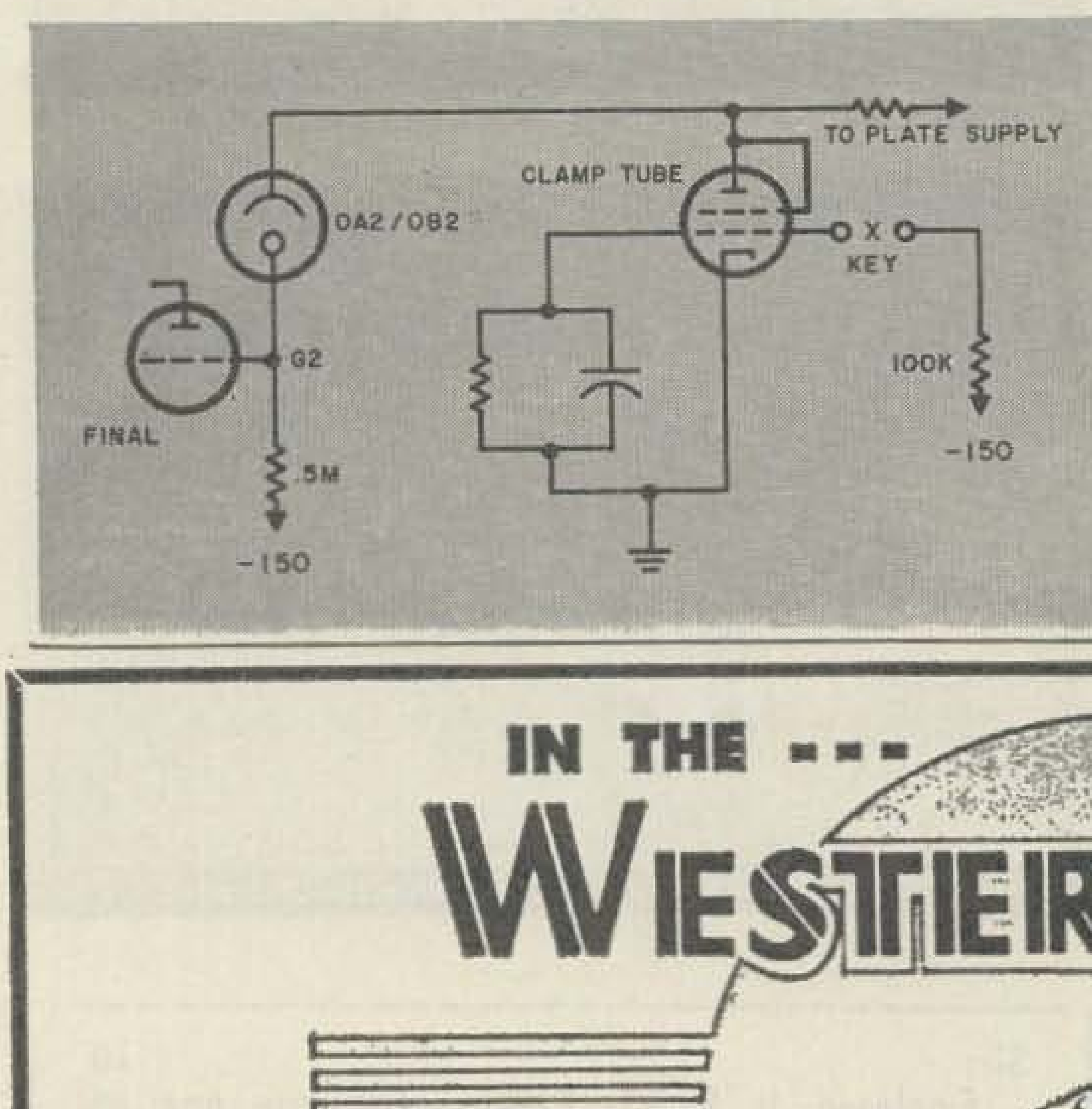
A Sequential Switch

Pat Miller KV4CI
P.O. Box 1853
St. Thomas, Virgin Islands

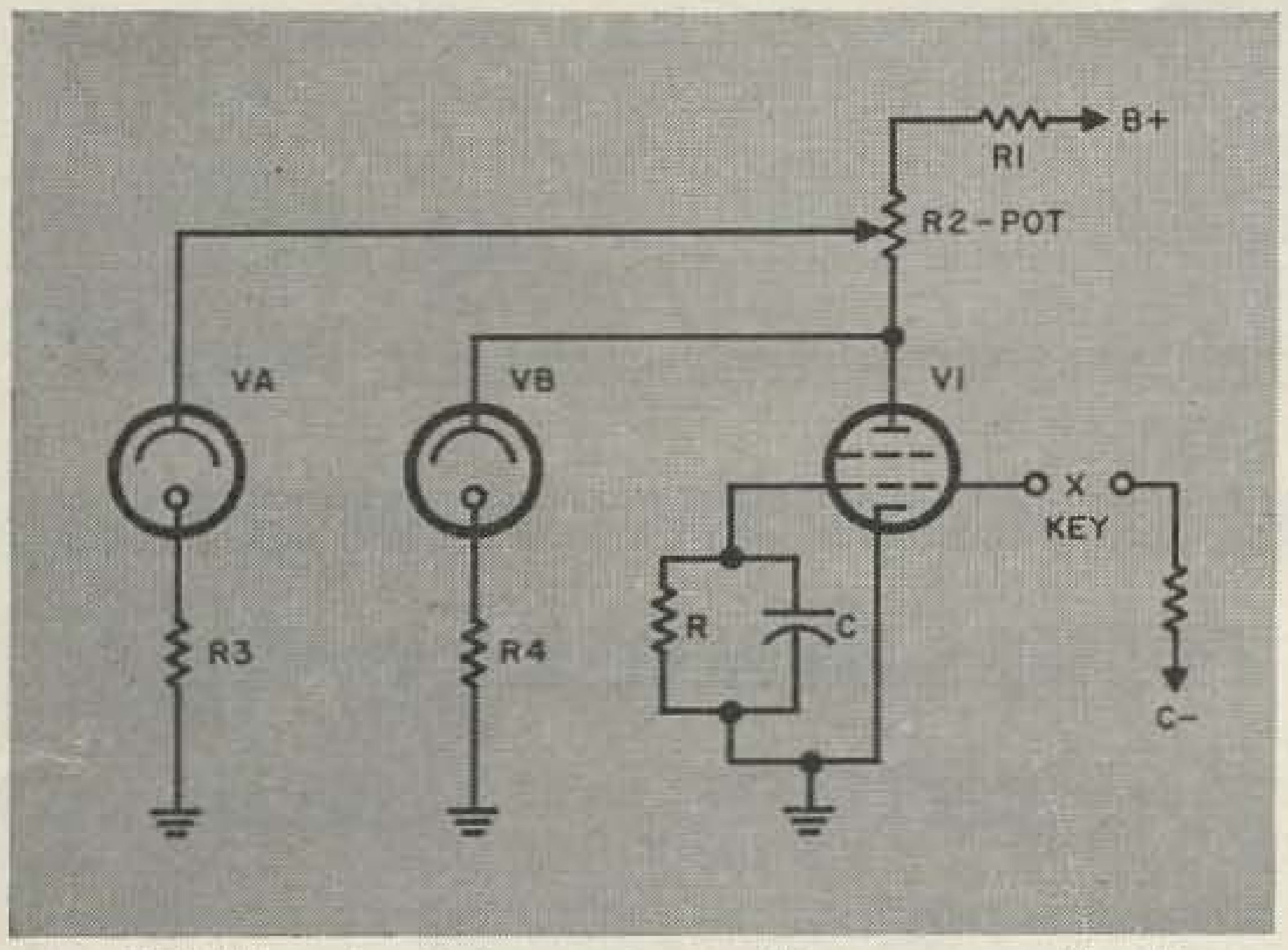
A popular method of clickless, spark-free keying using a combination of clamp tube and VR tube is shown in Fig. 1. By going a step further and using an additional VR tube and a potentiometer one can obtain a simple differential keyer as shown in Fig. 2.

The principle of operation of the circuit in Fig. 2 is as follows. When the key is up there is no bias on V1 causing it to draw heavy current through R1-R2. This high current causes the voltage drop across R1-R2 to be so high that there is insufficient voltage appearing at either Va or Vb and they thus remain extinguished. When the key is down a bias is impinged on the grid of V1 causing the current to drop along R1-R2 with a consequent voltage rise along same. Depending on the values of R and C the voltage will continue rising with Va first firing and conducting current through R3 and then followed by Vb firing and conducting current through R4. Reopening the key removes the source of bias, with the bias remaining on the grid of V1 decaying at a rate determined by R and C. The current through V1 once again starts rising causing the voltage to drop along R1-R2. As the voltage drops Vb is the first tube to extinguish as the voltage at any given moment is always lower at Vb than it is at Va. Shortly after Vb extinguishes it is followed by Va. From this sequence you can see that you have first an "On A" followed by an "On B" followed by an "Off B" and "Off A" as used in most differential keying systems. The circuit as described in Fig. 2 could be used to key the screen of the oscillator with Va and the screen of the amplifier with Vb.



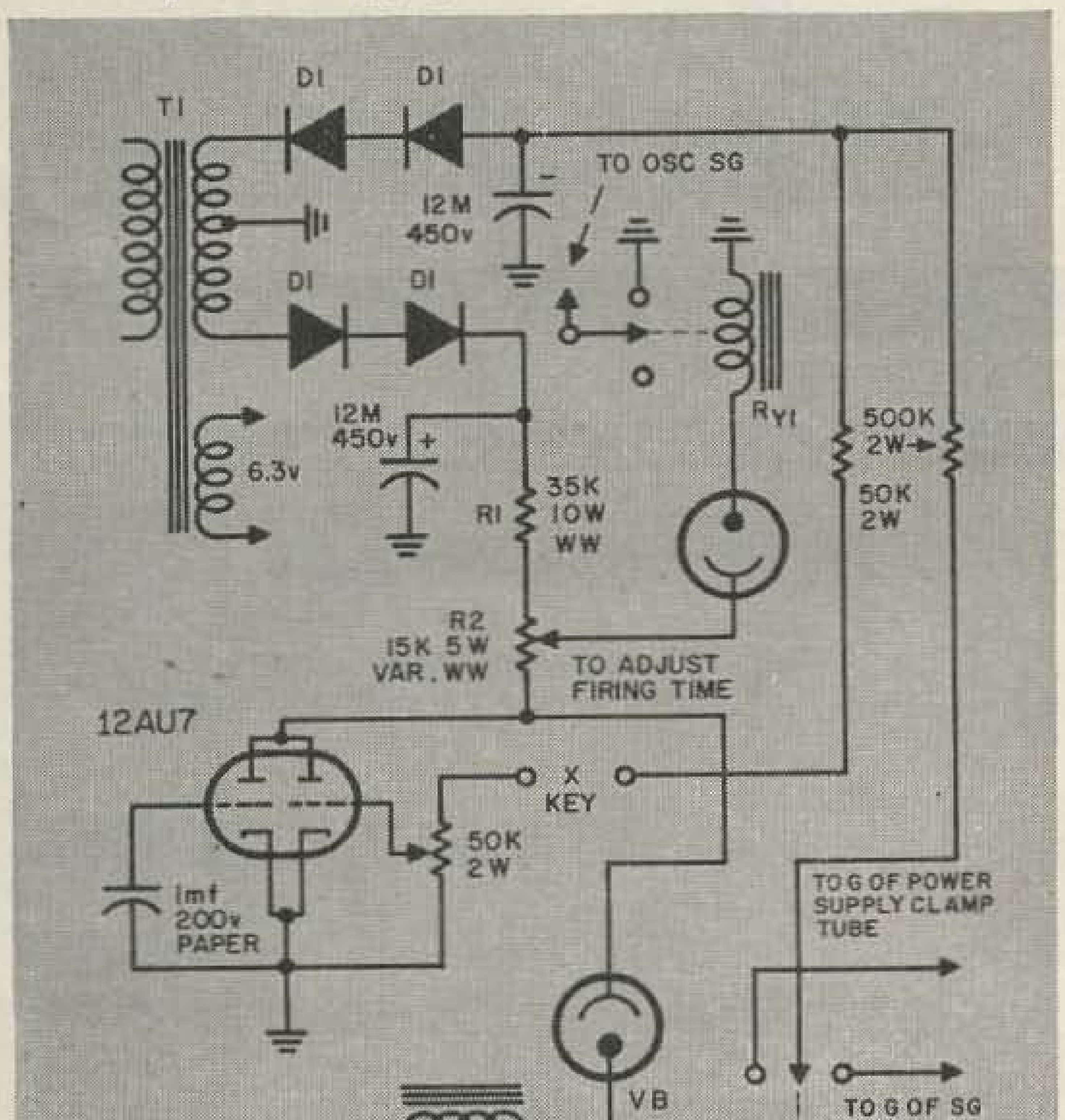
At KV4CI the system used in Fig. 2 is the heart of a slightly more elaborate system as shown in Fig. 3. High impedance plate relays substitute as loads for Va and Vb, thus allowing me to throw a bias voltage from one circuit function to another while maintaining a sequential keying action. RLY1 and RLY2 are SPDT types. Under key up conditions RLY1 grounds the screen of the VFO while RLY2 maintains a bias on the grid of a tube that vacuum tube keys the screen of my 4-125A final. With the key down RLY1 ungrounds the VFO screen grid voltage, allowing it to oscillate. RLY2 switches bias off the grid of the SG keyer tube allowing it to conduct and puts this same bias on the grid of a power supply bleeder clamp tube. (See Jan 61 73 Page 56.) The time sequence of keying is controlled by the settings of the potentiometer R2 and the values of R and C as used in the grid of V1. The system has a great deal of flexibility. Here at KV4CI I am able to vary the keying time from zero to about 120 milliseconds. One warning however in regard to gaseous type tubes. They are temperature sensitive and if you live in a climate where the temperature in the shack varies a great deal you may find it necessary to reset R2 from time to time to obtain your desired sequence time.

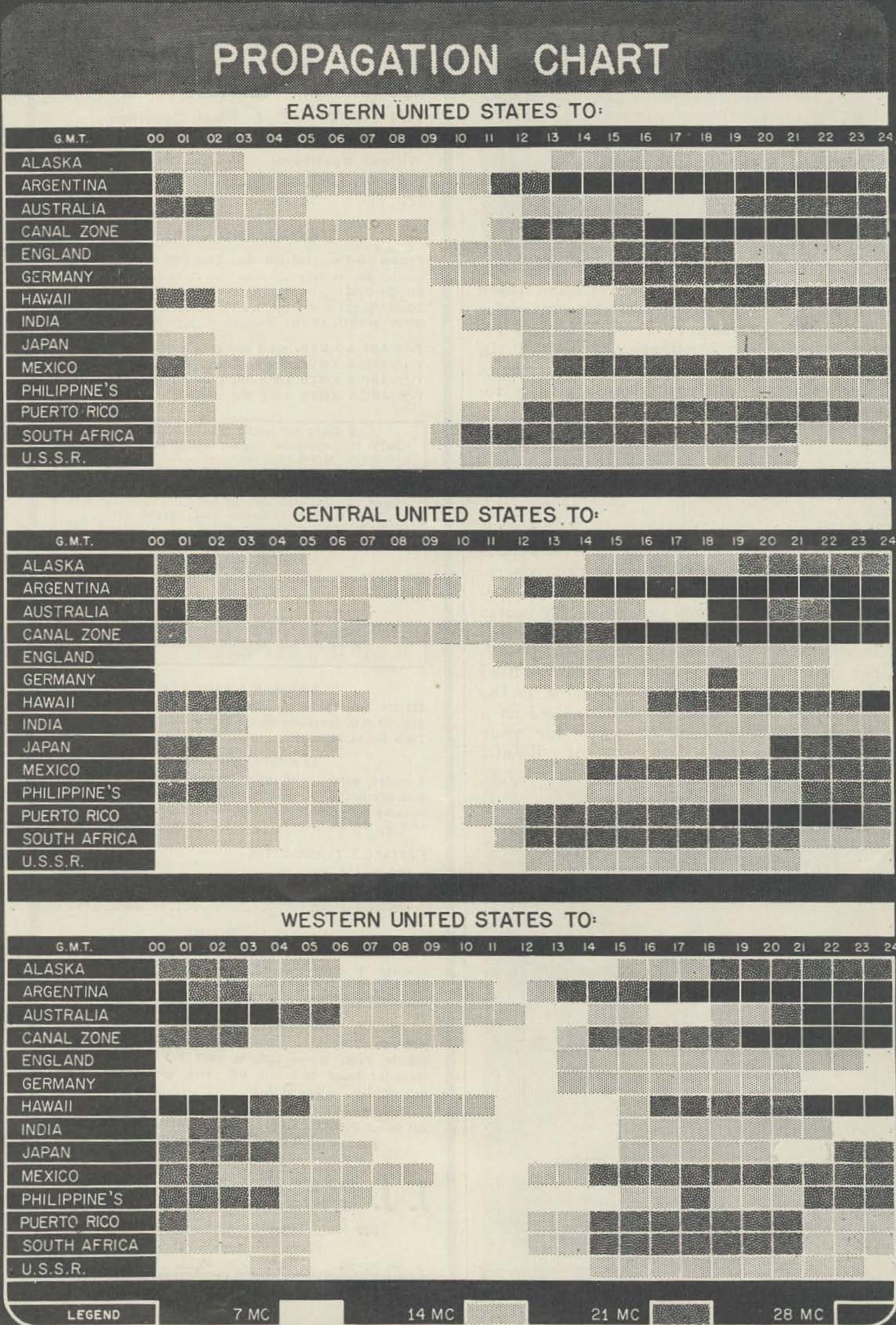
The reader with a sharp eye can see other



possibilities in this system. For example there is nothing to stop one from using a series of VR tubes attached to a multi tapped resistor in place of the potentiometer at R2. In doing so one could turn on a series of circuits in one sequence and extinguish them in reverse sequence.

The circuit in Fig. 3 is more elaborate than need be. The power supply shown was used as it was compact and available. Any bias supply giving 150 volts or so at a few mills along with a source of 250 volts positive at 30 or 40 mills will more than do the job for you. You will note that type 5651 voltage reference tubes were used to operate the high impedance relays. This was done because the relays operated best around 2.5 ma, just about the center of the current handling range of the 5651. However, lower impedance relays along with either OB2 or OA2 type VR tubes can be used with equal success. Come to think of it the circuit as shown in Fig. 3 could be used as a "see-saw bleeder-differential keyer for your driver power supply! . . . KV4CI




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

Propagation Charts

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

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

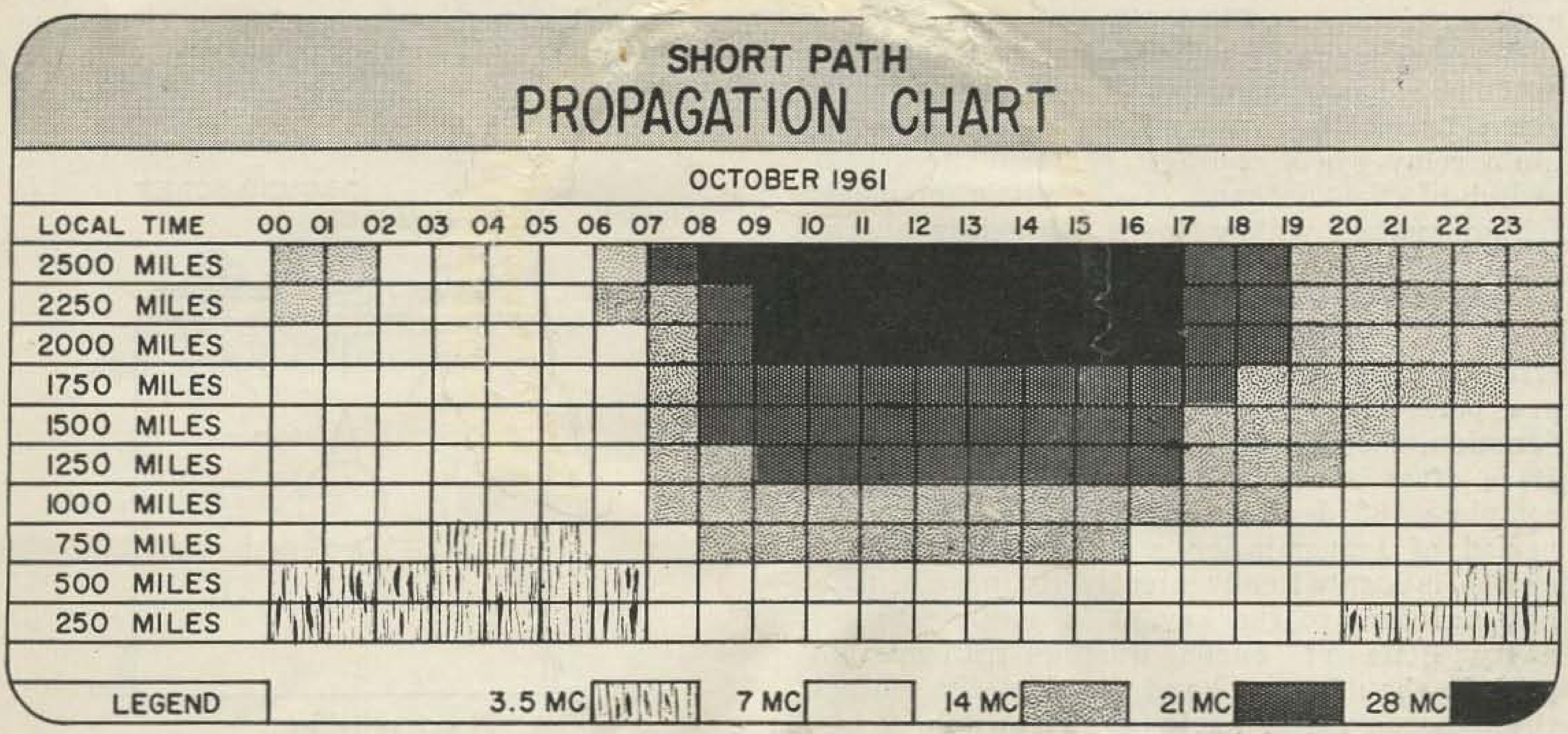
Advanced Forecast, October 1961

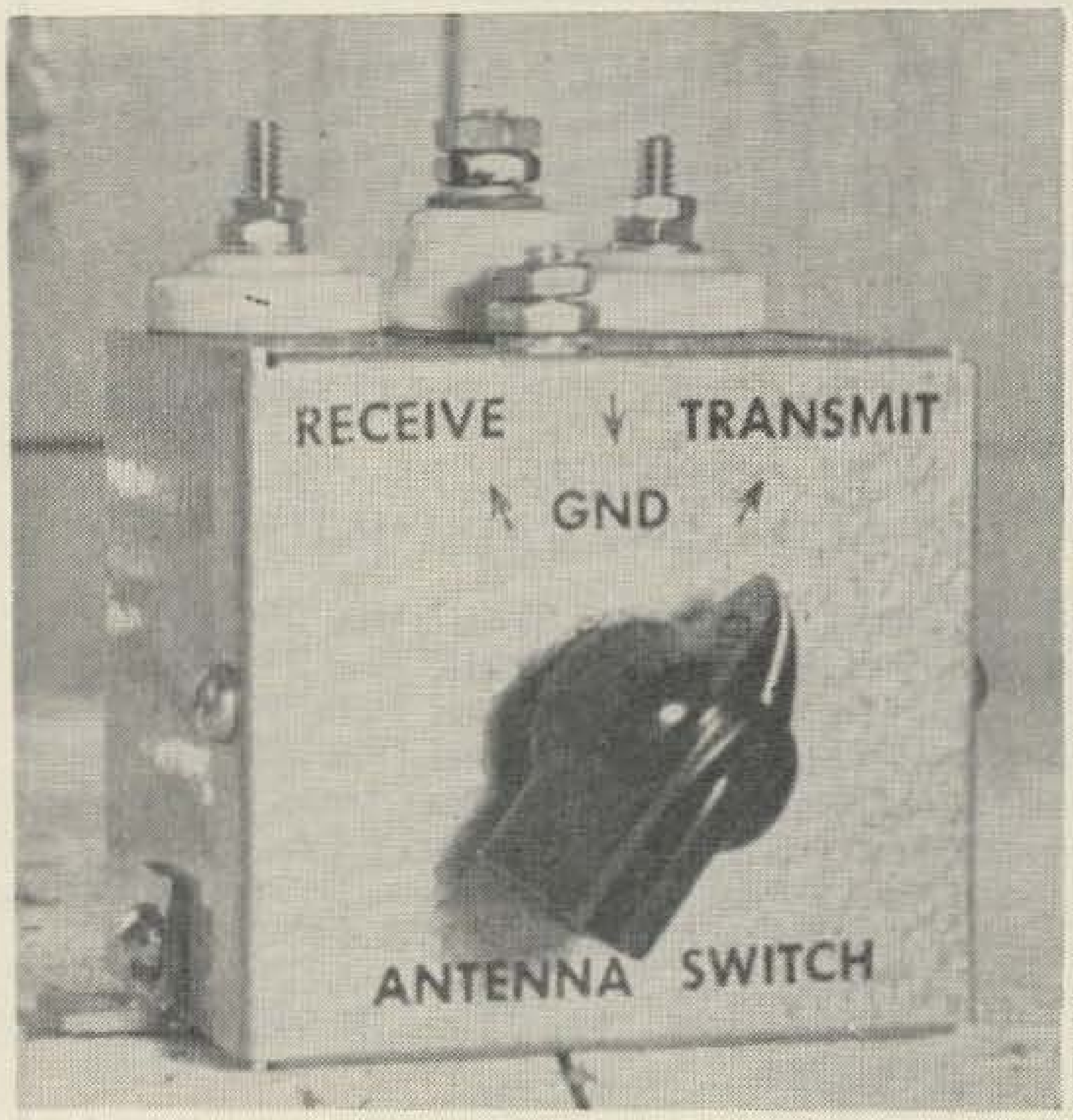
Good: 3, 5-21, 24, 25, 28-30

Fair: 1, 2, 4, 22, 23, 26, 27, 31

Bad: none.

The Short Path propagation chart has been set up to show what HBF to use for coverage between the 48 states. Alaska and Hawaii are covered in the DX chart. The use of this chart is somewhat different than the DX chart. First, the time is the local time centered on the mid-point of the path. Second, the distance given in miles is the Great Circle path distance because of the Earth's curvature. Here are a couple of examples of how to use the chart. A.) To work the path Boston to Miami (1250 miles), the local time centered on the mid-point of the path is the same in Boston as in Miami. Looking up the HGF's next to the 1250 mile listings will give the HBF to use and the time periods given will be the same at each end of the circuit. B.) To work the path New York to San Francisco (2,600 miles), the local time centered on the mid-point of the path will be 1½ hours later than at San Francisco and 1½ hours earlier than in New York (the time difference between New York and San Francisco is 3 hours). Looking up the HBF's next to the 2,500 mile listings will give the HBF to use. In San Francisco subtract 1½ hours from the time periods listed for local time and in New York add 1½ hours [illegible] the time periods listed for local time.





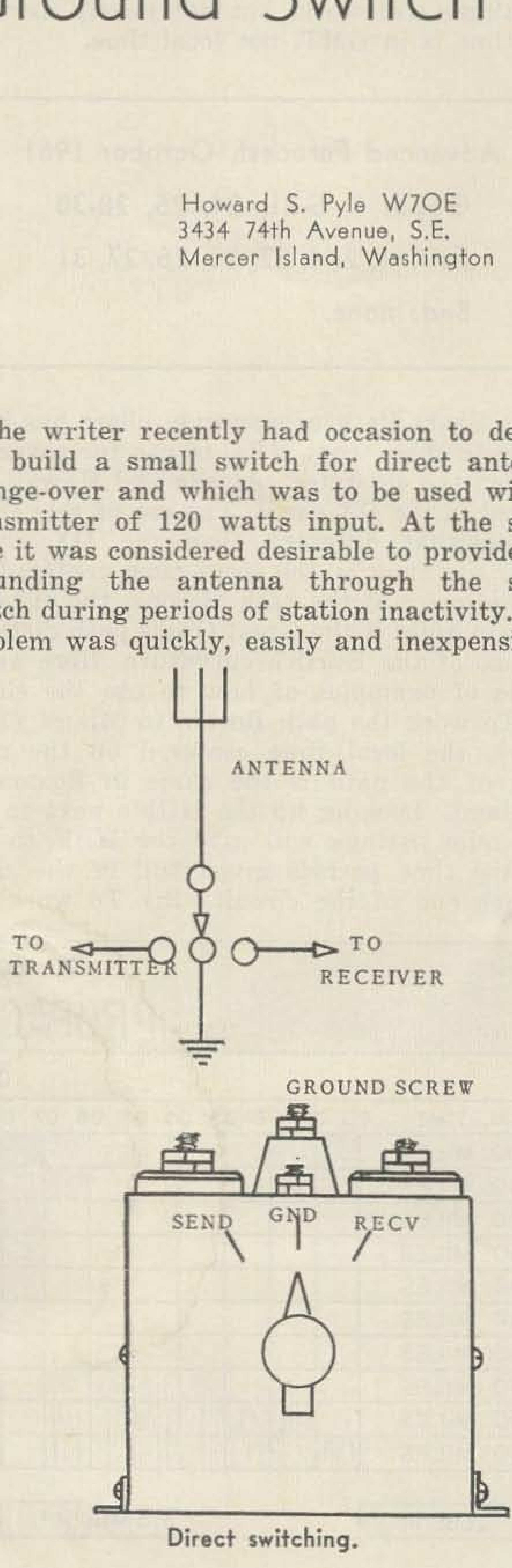
Simple Send-Receive Ground Switch

Howard S. Pyle W7OE
3434 74th Avenue, S.E.
Mercer Island, Washington

A large number of hams prefer to use the same antenna for both transmission and reception. In the more advanced ham stations, such change-over is accomplished either by means of a relay of some magnetic type, often co-axial and of late, an 'electronic' type, vacuum tube operated. In the magnetic type of relays, many go so far as to key the relay coil if they don't object to the clatter of the relay as it follows the keying. For phone operation (usually with 'push-to-talk' switching), relay clatter is of course, no problem. With either the electronic or the keyed-coil magnetic types, break-in operation is possible. So-called 'voice operated relays' also provide some advantages to phone operators but are somewhat more complex and a bit beyond the scope of this article.

Whether a simple switch, serving to shift the antenna from transmitter to receiver and vice versa, or whether such switch is used to actuate a relay whose contacts perform the actual switch-of the antenna, is of little moment. Either method will *not* permit break-in operation. Customarily the Novice amateur prefers to start with a simple single pole, double throw switch, frequently of the knife type with either a ceramic or bakelite base. While these are perfectly satisfactory in their electrical function, they do present some disadvantages. It is often somewhat awkward to make the complete 180 degree throw for each alternate period of transmission and reception. If the switch is located conveniently to operate, usually adjacent to the key, it is possible to get nasty little rf burns during transmission periods should your hand accidentally contact the exposed metal parts of the switch.

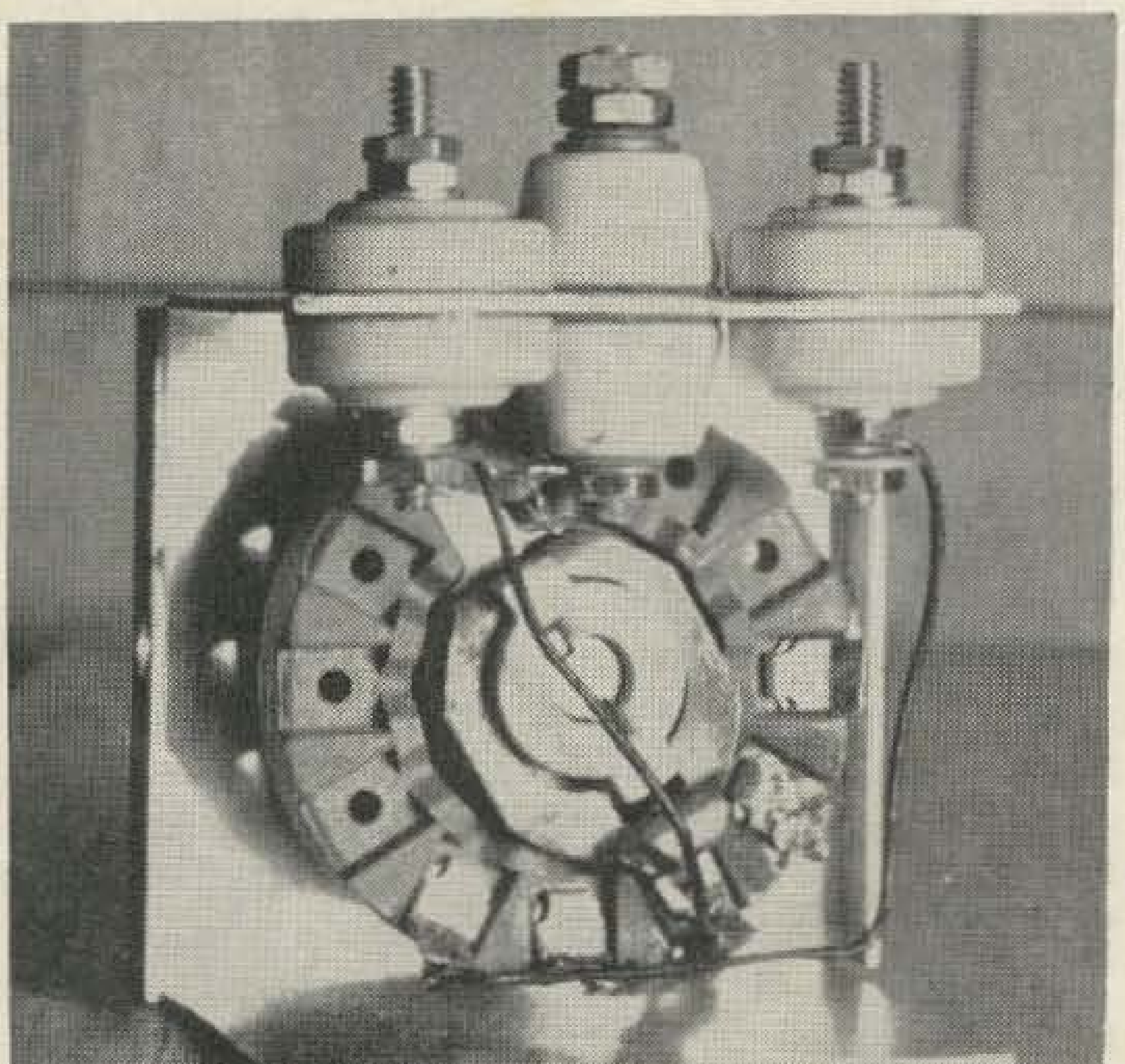
The writer recently had occasion to design and build a small switch for direct antenna change-over and which was to be used with a transmitter of 120 watts input. At the same time it was considered desirable to provide for grounding the antenna through the same switch during periods of station inactivity. The problem was quickly, easily and inexpensively



Direct switching.

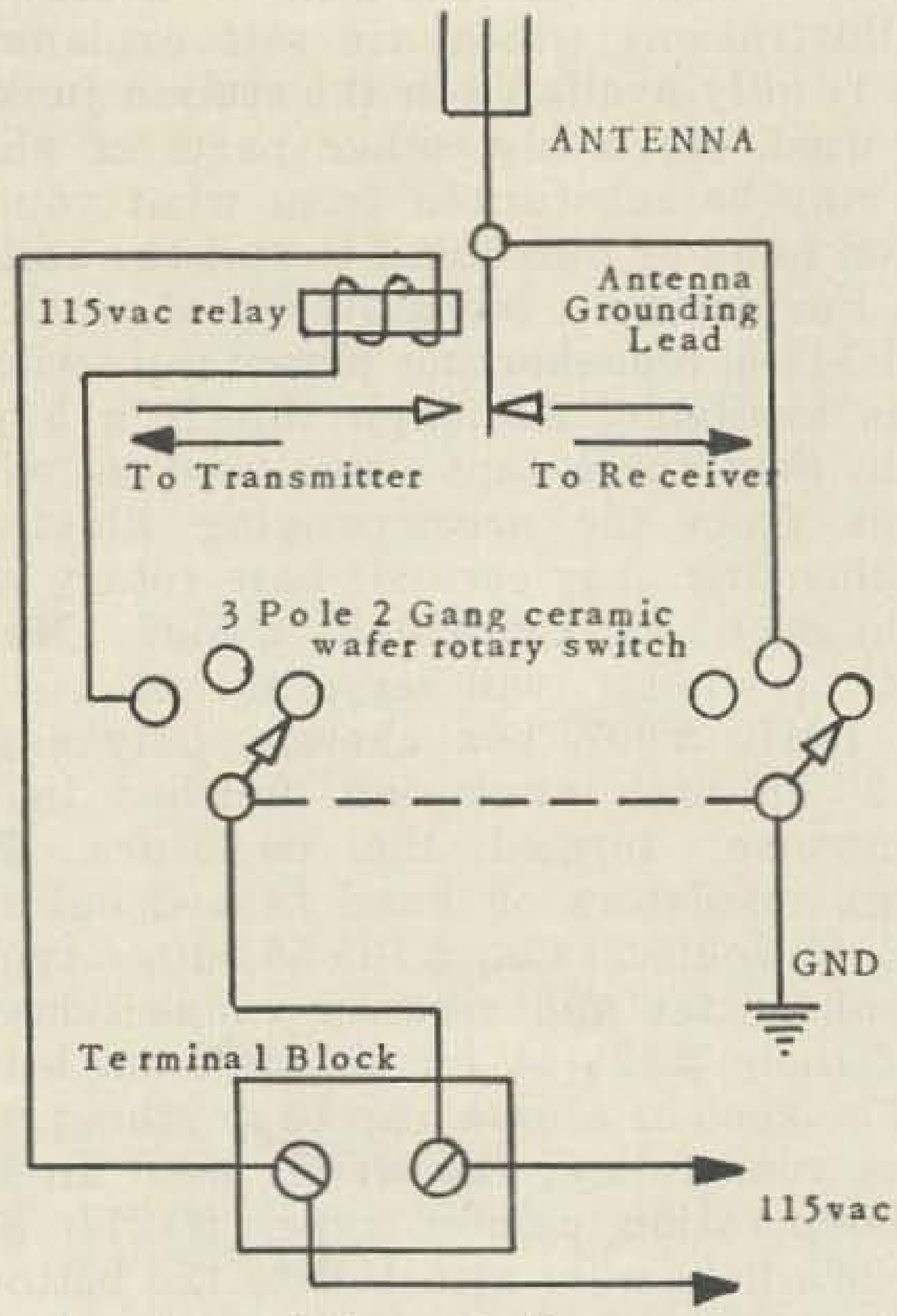
solved in the manner shown in the accompanying illustrations which are self explanatory. Parts readily available in the station junk box were used. Obviously, other parts of similar style may be substituted from what you may have on hand or purchased to suit the builder's taste. For example, the writer used an Ohmite Model 111-5, non-shorting power tap switch as it was available. Although this is a 5 point switch, only three taps were used as will be obvious from the accompanying illustration and schematic. Any ceramic base rotary wafer switch such as Centralab #2507, Mallory #174C or similar, will serve as well.

An LMB #00Z box chassis, only slightly over 2" in each dimension, finished in grey hammartone, formed the enclosure. Feed-through insulators on hand turned out to be two E. F. Johnson Co., #135-55 button type for the transmitter and receiver connections and one of their #135-44 for the antenna lead itself. The knob of course, can be anything which pleases your fancy; the writer used an Insuline Corporation pointer type, #1274. Small angle brackets were attached to the bottom of the two sides of the cabinet with which to secure it in position on the operating table. The 'professional touch' was added by applying small decalcomania transfers (any ham radio store) to identify switch positions and terminal connections.



As shown in the schematic, with the switch connected as indicated, you need merely throw it to the left to transmit, to the right to receive (reverse this if you like). Placing the switch lever in the center position connects your antenna directly to ground, automatically removing it from *both* transmitter and receiver.

The same type of switch can be made up using co-axial connectors if that is what you prefer. Follow the same general idea but provide a somewhat larger cabinet, such as the LMB Chassis box #000, and substitute female co-ax connectors for the feed-through insula-



Relay switching.

tors shown.

Again, should you wish to use such a switch to actuate an antenna relay and yet retain the grounding feature, use a *two* deck, 3 pole rotary type; this need not be ceramic as it will handle no rf. You may have to get a *four* position switch however, as three pole are somewhat uncommon. At any rate you'll use but *one* position on each switch (electrically). This is necessary however to accompish the desired functions. You'll find a large choice in these switches at any ham store or in the mail order catalogs.

You may wish to mount your relay right in the switch cabinet making a compact assembly; if so, provide a two-point terminal block somewhere within the cabinet and feed it with ac through a grommetted hole in the back. If you plan to use an *external* relay, install a *four*-point terminal block. The additional two terminals will provide a handy method of terminating the coil leads of the relay and leading them to their terminations within the cabinet.

Remember too, that if you expect to use a *two* deck switch to control the relay as previously described, you will need a somewhat larger cabinet to accommodate it. The LMB #000 or its equivalent will handle this; very possibly the same box will leave room for the relay as well if you plan to enclose it, unless your relay is somewhat oversize. If so, shop around for a box to fit; they come in a wide variety of sizes and finishes.

One last point; if you mount the relay *externally*, you'll need only *one* feed-through insulator (or co-ax connector as you prefer) in the cabinet, through which to bring the antenna grounding lead (Fig. 2), to the proper switch point. That does it; happy changeovers! . . . **W7OE**

(W2NSD from page 4)

means sending the page proofs back to the printer with all remaining corrections and the page numbers on them. These come back in a day or so for one more final check.

The procedure on ads isn't quite as complicated, but we have to have many of them set in type and go through just about the same thing. When you multiply all this by the fifteen to twenty articles per issue plus the ten or fifteen ads we have to have set you can see where a large hunk of time and energy is invested every month. Somehow, in the remaining time, we process all subscriptions and renewals, answer about half of our mail, bug advertisers for ads, clip out the readers service cards and send 'em to advertisers, count up the votes for articles, write editorials like this, bill advertisers for the ads, bill distributors for the copies we send each month (half our circulation is via radio parts distributors, some 800 of 'em), keep the books on all 800 distributors and 60 or so advertisers, put the monthly checks from all those advertisers and distributors in the bank, fill out voluminous forms for the post office to let them know each month just exactly how many copies we are sending to each postal zone in the country and how much this weighs (to the millionth of a pound), talk to visiting hams who drop in or phone, hunt high and low for stencils for subscribers that have missed a copy, change about ten to twenty addresses a day, pull out expiring stencils and send warnings, make up the mailing strip of all subscribers each month plus labels for all the distributors, and about two thousand other problems. Oh, yes, I musn't forget going to Conventions and hamfests.

(Turn to page 70)

(W2NSD from page 69)

Impedance Bridge Diagrams

The diagrams for the construction of the Impedance Bridge in the August issue were printed in microscopic size for two reasons. First of all we had to fit the article onto eight pages since we had to print it three months before we used it and then insert the eight page section later. Secondly something went wrong with our art department and the drawings were marked up for much too small a cut. By the time I had found out what happened and had gotten over my hysteria it was too late and we owned a couple hundred dollars worth of miniature cuts. Rats! What do you do then? You shudder at the reaction of the readers and vow that this wont' happen again.

Those of you who are interested in getting full scale (mostly) plans for the bridge can get them by sending in one dollar to cover the cost of handling, mailing, printing, etc. We have them ready for you now.

Reciprocal Licensing

Those of you who have followed my editorial meanderings down through the years know how dear this subject is to my heart. Well, it is finally getting somewhere. Someday I'm going to sit down and chronicle what I've gone through on this. This will lead to a lot of emotion though for there have been some important heel draggers, guess I'd better not. We'll write it up some day and have it published posthumously . . . like my chronicle of the "Operation Worldwide" which I've never dared let myself even mention in print.

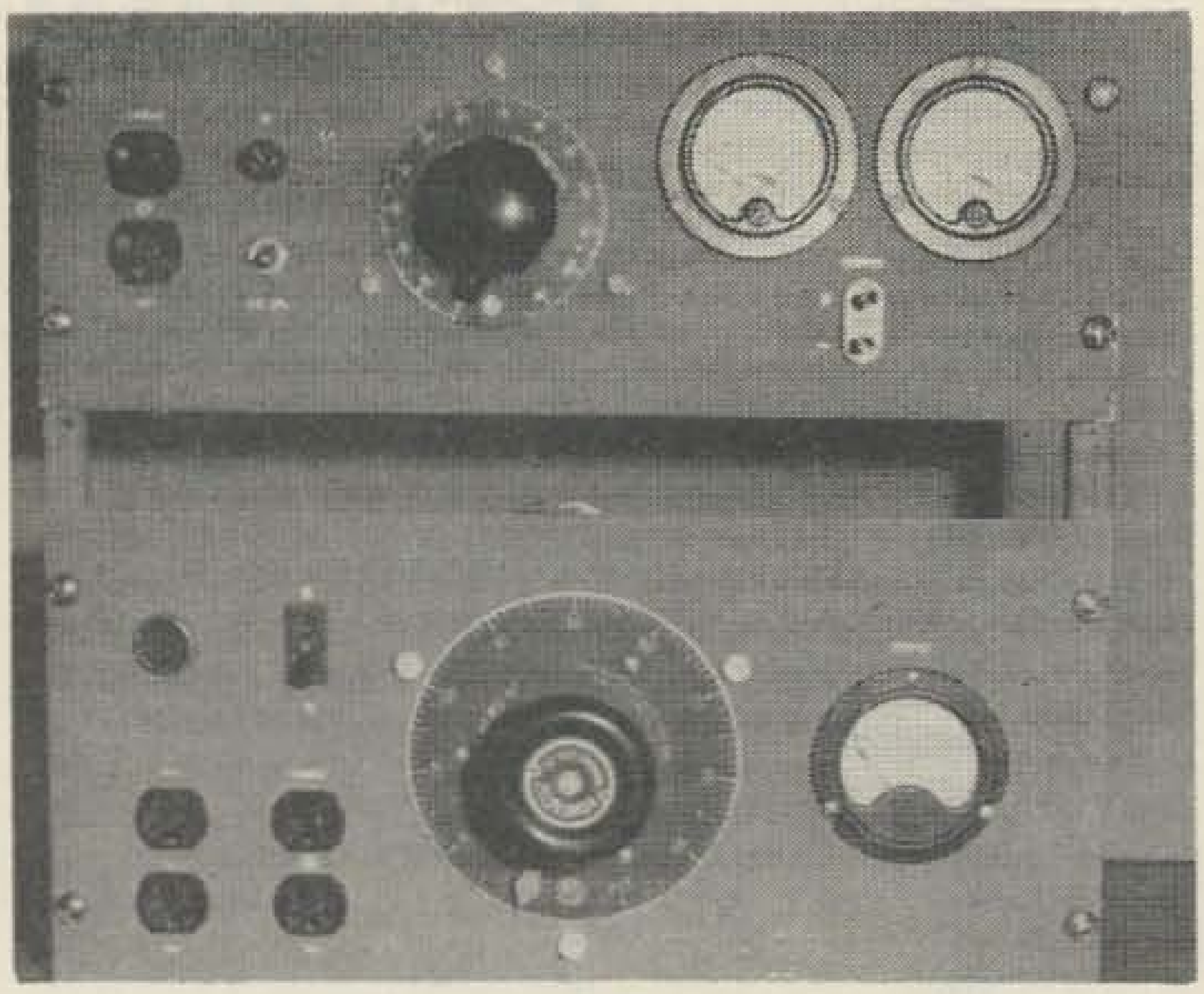
Senator Barry Goldwater has introduced a bill to permit reciprocal licensing of foreign amateurs who are residents of nations who extend similar privileges to American hams. The bill was introduced August first and referred to the Committee on Commerce. This means that it is now entirely up to you to put the pressure on to get this bill through that committee. You do this by writing to your congressman and telling him you are interested in its passage and asking him to help expedite it. If you have a Congressman from your state on the Committee you can write directly to him and this will have an even greater effect.

Senate Bill S.2361 proposes to amend sections 303 and 310 of the Communications Act of 1934. The amendments would permit the FCC to license foreign hams for up to three years in the U.S. if they are convinced that it would not endanger our security.

Why all the fuss? Why should you bother to write? Why should make it your business to see that everyone in your club writes, that your family writes, and that every ham you contact on the air writes? 1) The next Geneva Conference is coming up in a couple of years and we are being no less than foolhardy to do less than we can to get every foreign ham to support the U.S. position for amateur band allocations. Right now there is a lot of bitterness overseas about the strict U.S. policy of NO FOREIGN HAMS operating in the U.S. I have visited these countries, talked to amateurs in a position to know, and interviewed many of their representatives at the last international conference at Geneva. 2) Permission to operate will no doubt lure many DX hams to visit the States and will allow them to really get to know us when they do visit. This will implement the Presidents' plan for having more foreigners vacation in the U.S. and will make for a lot better understanding between the U.S. and nationals of other countries. How many times have we read what some returning foreigner has had to say about his visit to the U.S. and wished that we could have done something to make him know our country better. 3) Once we are able to license foreign amateurs coming to the States our amateurs will in turn be able to get licenses in most foreign countries. This will greatly encourage foreign travel and will enable our amateurs to meet and talk to local foreign hams during their travels. I have visited many foreign cities and wished that there was some way to get acquainted with the local hams, hams that we can only infrequently contact from over here. 4) The prohibition against aliens being licensed that is now part of the Communications Act of 1934 was originally put in to prevent commercial companies from hiring much lower wage Mexicans to operate wireless stations. They had not even thought of this being applied to ham radio, which was almost unknown at that time and certainly was not portable. This minor oversight has grown with the increasing popularity of ham radio to be a major thorn. It is about time that it be corrected. It can be corrected if you take it upon yourself to see that it is. We have a lot of amateurs that are going to resist writing through sheer inertia and it is up to you to keep pushing them until they move to help our hobby in spite of themselves. Here is your golden opportunity to do something positive to keep ham radio going in 1964.

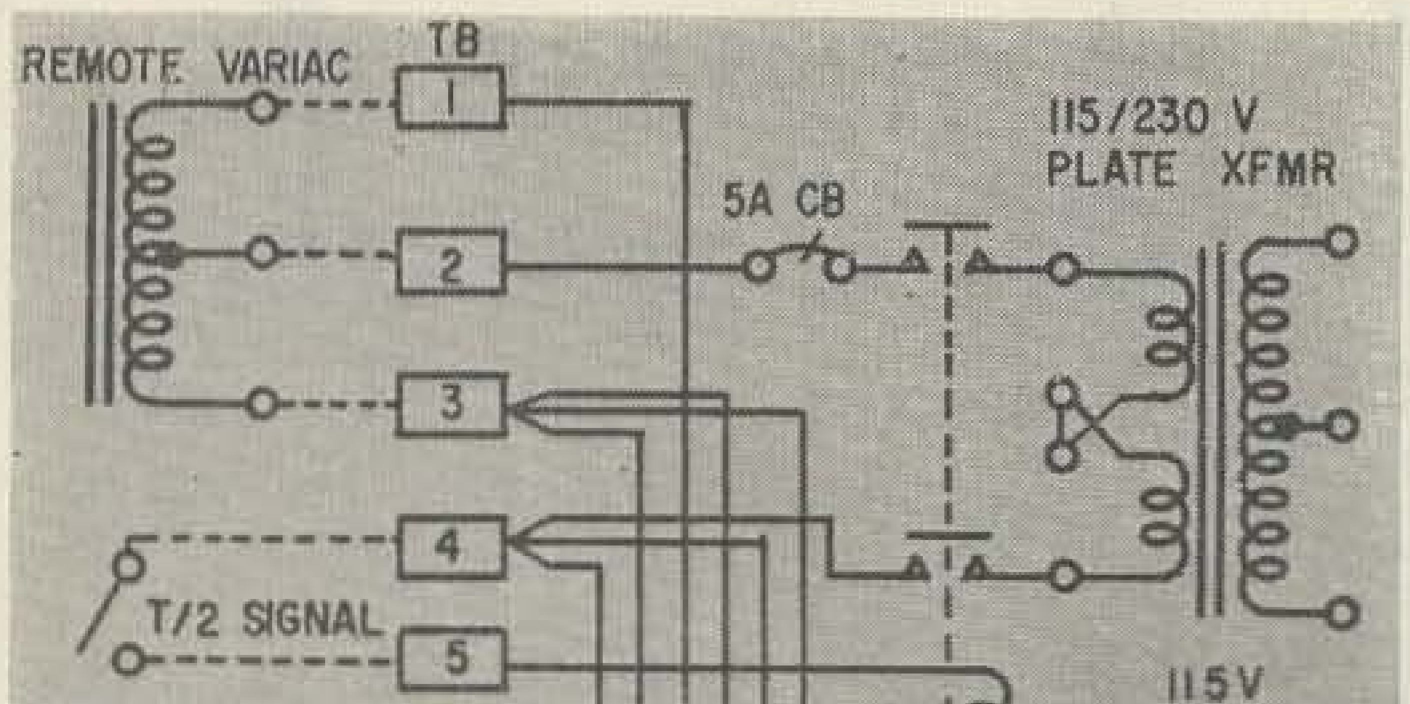
The members of the Interstate and Foreign Commerce Committee are: Warren G. Magnuson (Washington); John O. Pastore (Rhode Island); A. S. Mike Monroney (Oklahoma); George A. Smathers (Florida); Strom Thurmond (South Carolina); Frank J. Lausche (Ohio); Ralph W. Yarborough (Texas); Clair Engle (California); E. L. Bob Bartlett (Alaska); Vince Hartke (Indiana); Gale W. McGee (Wyoming); Andrew F. Schoeppel (Kansas); John Marshall Butler (Maryland); Norris Colton (New Hampshire); Clifford P. Case (New Jersey); Thurston B. Morton (Kentucky); Hugh Scott (Pennsylvania).

(Turn to page 74)



Maximum Utilization from Variacs

Tom Snyder W4CAG
Route 1, Box 286N
Titusville, Florida



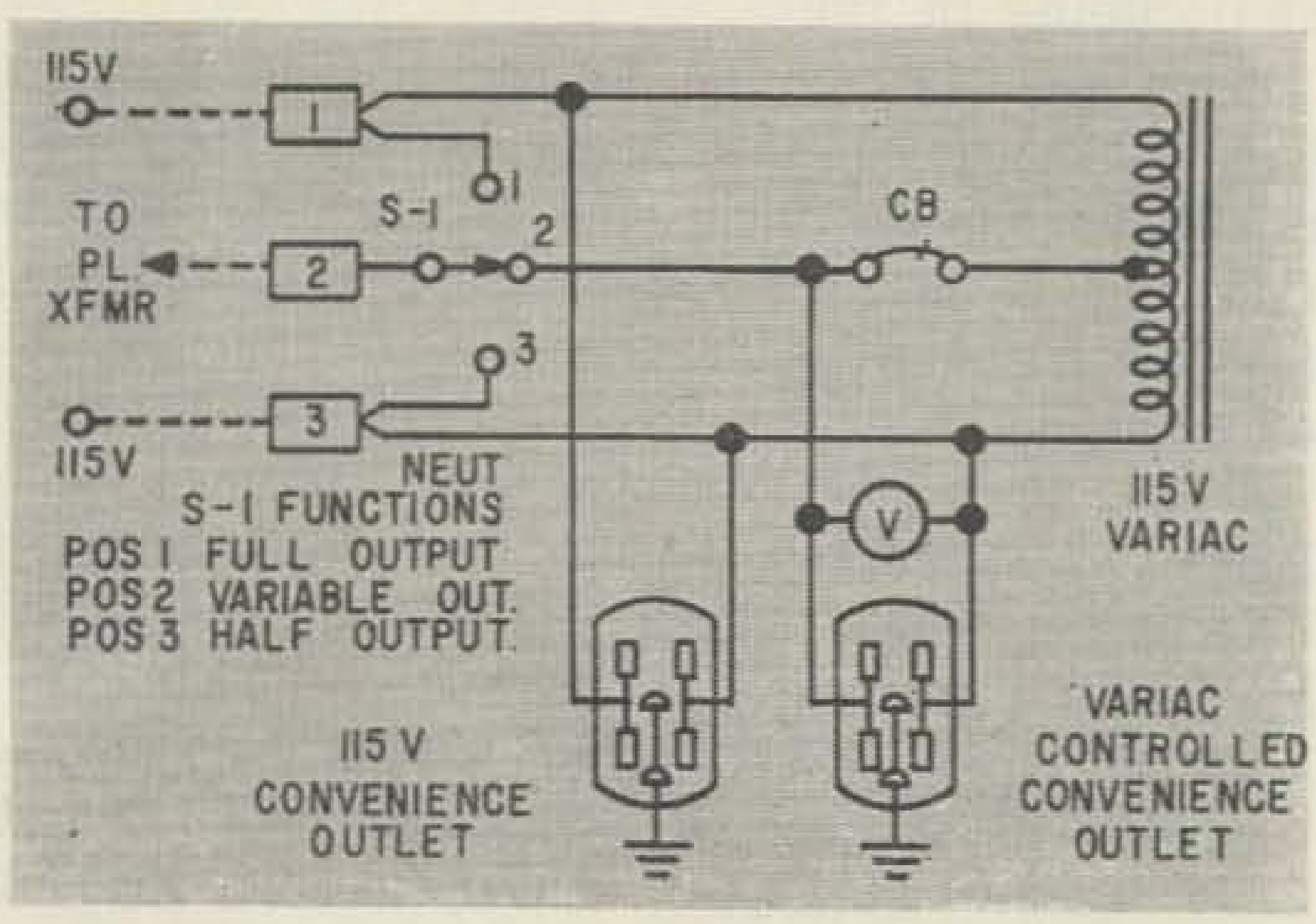
When a Ham finally takes billfold in hand and goes out to acquire his first adjustable line-voltage transformer, the event represents a significant milestone in his progress along the road of amateur experience and proficiency. This article proposes to show some ideas on how a Variac may be most effectively and flexibly used. In particular, it is a simple matter to get your Variac off the bench by building it into apparatus which requires a source of variable line voltage, but still to retain its capability of controlling soldering iron heat, testing unknown transformers, etc. Also, for many amateur applications, a 115-volt, 1 kv-a Variac may be used to control a 230-volt, 2 kv-a load.

Figure 1 shows how a 115-volt, 5-ampere Variac may be used to control a 1-kw rectifier. In the usual case, it is not necessary that the voltage be adjustable all the way to zero. Here, the Variac is connected across half of the 230-volt line, with the 230-volt primary of the plate transformer connected between the output of the Variac and the *other* side of the 230-volt line. It is necessary that no neutral connection be made to the center tap, if any, of the transformer primary.

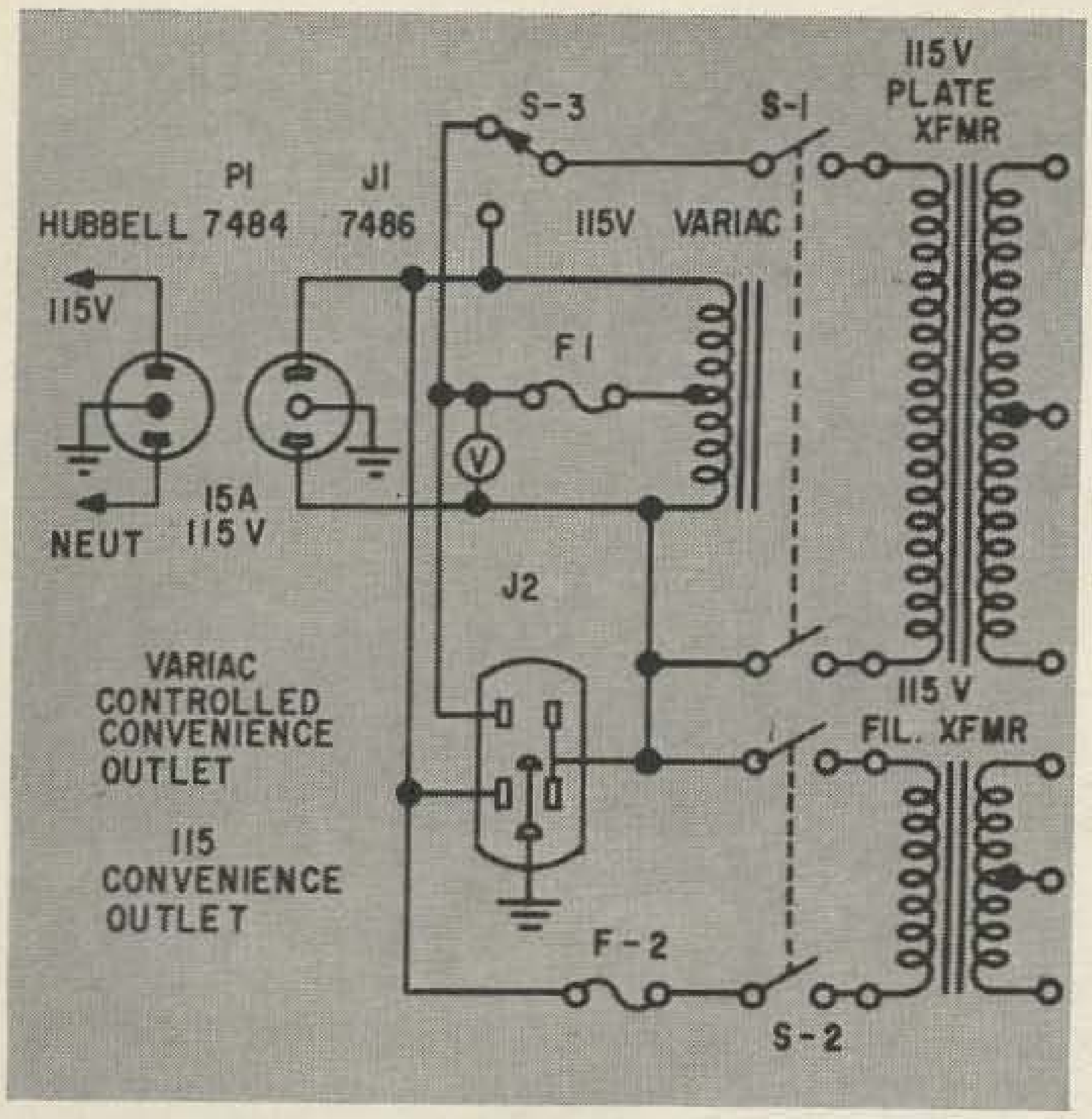
Rather than being built into this rectifier, the Variac is located remotely and connected into the circuit *via* a terminal board, to which the necessary power line connections are brought. With the Variac connection shown, the output of the rectifier may be varied from 50- to 100-percent of the rated output of the transformer. With the usual 30% over-voltage connection of the Variac, the output is adjustable from 50- to 115-percent of rated.

Figure 2 shows how the remote Variac, appearing in Fig. 1, may be mounted on its own panel, together with convenience outlets and an ac voltmeter, plus a switch, so that the Variac may be used to control the remote load, the convenience outlets, or both, as circumstances may require. Separate fuses, or circuit breakers, as shown in the figures, are desirable, since the rectifier and the Variac are each protected for all configurations. The convenience outlets shown are the new NEMA 3-wire grounding receptacles, which will accept either the older two-wire parallel blade ac plugs or the newer, more desirable grounding plugs. Most power tools are now coming equipped with grounding plugs which provide a third wire for earthground connection of the appliance frame.

Figure 3 shows how a Variac may be mounted within the apparatus which it is primarily intended to serve, but still power a convenience outlet, either separately from, or in conjunction with, the main load.



If S1 is shorting type, breaker must be open before changing switch position. If not it will open itself, but contacts on S1 will be burned.



In case panel space does not permit *two* convenience outlets, as are used in the circuit of Fig. 2, but it is still desired to provide one outlet at full line voltage plus another controlled by the Variac, some models of the dual outlets contain a removable link which will permit the isolation of the two circuits. The neutral and ground remains common to the two sections of the dual outlet.

The photograph shows a couple of pieces of equipment that I have built and which employ circuits described above. The upper unit is a low-voltage high-current supply, in which the primary function of the Variac is to adjust the input voltage to the rectifier transformer. However, this rectifier is used only for battery charging or occasional experiments with direct-current, and to avoid unnecessarily tieing up this 5-amp Variac, I added the convenience outlets shown. The lower panel mounts a 115-volt 20-ampere Variac whose primary function is controlling the output of a plate power supply for a 4-400A rig, but which is also made available for odd jobs. . . . W4CAG

Meter Shunt Winding

Trouble making shunts for meters? One big problem is in anchoring the end of the wire. Solderless lugs are the answer here. Clamp one end of the wire in a solderless lug and attach it to one terminal of the meter. Slide another lug on the wire and attach it to the other terminal. You can set up your meter and slide the shunt wire through the lug until you get the right reading and then clamp down the lug.

. . . K8BYO

X-sistor Symbols

In a previous issue of 73, transistor symbols were given. One important thing to add for newcomers to transistors who get mixed up on polarity and ruin a unit or two is to remember this. The middle letter, i.e., NPN or PNP will tell you the polarity that goes to the collector, neg. or pos. . . . KøVQY

W2NSD from page 71

August Votes

Enough readers sent in votes for us to get a fairly vague idea of which article was held in least disdain. The Nuvistor converter article won, just as Nuvistor articles almost invariably win. Good grief, we must be selling a lot of those little thimbles for RCA. I sure wish one of *our* advertisers would come out with a competing product. Hey G.E., how about a Gnuvistor? K6YCX's article on the Drake receiver ranked second and possibly gave a bit of a boost to the Drake advertisement which ran away with the votes for the most interesting ad of the month. Anytime an editor of a ham magazine starts to wonder about whether he should run articles about new equipment he should note our August issue and the over 1500 votes for the Drake article. You fellows who grumble about these articles just repeating the advertising literature had better do something to popularize your position.

The September voting started off light, with Silicon Rectifiers by W100P and the Staff Crystal Cscillators almost even and the Simplescope close behind. Get those cards in quickly if you haven't sent them yet. The Central Electronics ad is already so far out ahead that there is no possible question about who won that little contest.

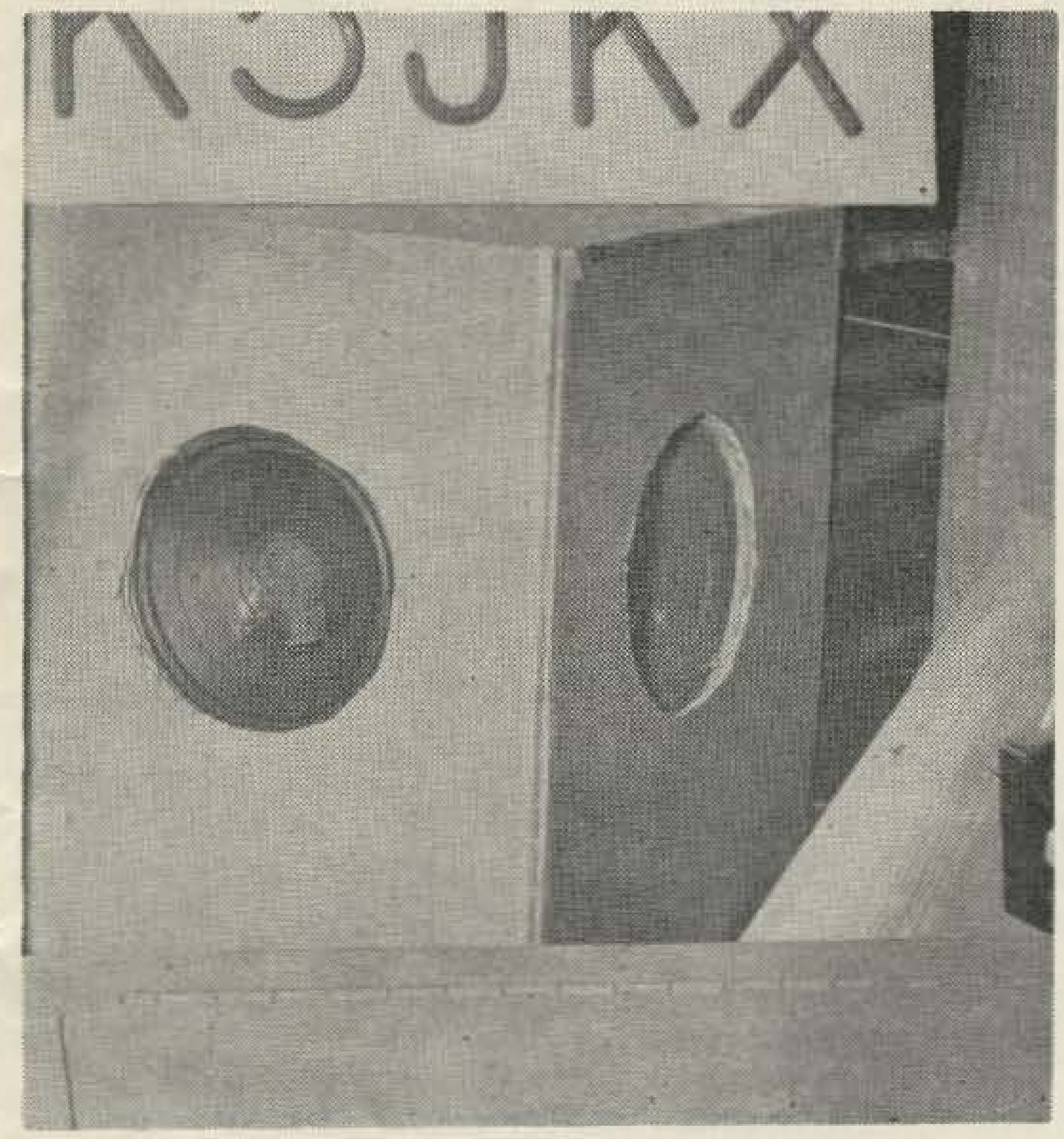
Tear the card out of this issue and get it in right away. Don't (sob!) forget to fill in all those advertiser squares too. Ahem.

Salvaging Surplus Speakers

ONE of the most common faults of the garden-variety small PM loudspeaker is a punctured cone. Since cost of reconing such a speaker is almost as high as that of replacing the entire unit, service-shop junkboxes are usually fairly full of these units.

If used normally, they produce strange and annoying rattles and squeaks. However, these speakers *can* be salvaged. Here's how:

If two or more speakers are mounted in the same enclosure, in fairly close proximity to each other, they will act as if they were actually just one large speaker. Audio power applied to them will be divided equally among the various speakers, and the power applied to each individual unit for a given amount of sound will be correspondingly reduced.



At the lower power levels thus made possible, the rattles and squeaks caused by the punctured cones don't show up. These effects are noticeable only when the speaker is operating near maximum rated power.

As an example, both the speakers shown in the photo have suffered cone damage. A mending-tape patch on one cone is obvious in the picture. However, with both in a single box, they can absorb the full 10-watt output of the modified Super-Pro without a single squawk. Either speaker, alone, begins to rattle at about the two-watt level.

The trick isn't limited to just two speakers; any number can be connected together. Voice coils can be connected in series, in parallel, or in a series-parallel arrangement to obtain whatever impedance level you desire.

. . . K5JKX/6

Subscriptions

As announced a few months ago, clubs may send in group subscriptions at the rate of $2.50 per one year subscription in groups of five or more subscriptions. These subs must start with the next published issue and be for just one year. Orders for back issues should be sent in separately. By simplifying the procedure we can offer this reduced rate.

The regular subscription rate is $3 per year; $5 for two years; $4 per year for DX operators outside North America. All back issues are 50¢ each. Send your name, call and address to 73 magazine, 1379 E. 15th St., Brooklyn 30, New York. Include money.

Jim Kyle K5JKX/6

Construction

IN case you haven't noticed, we're strongly in favor of homebrew equipment. We firmly believe that if more hams built more equipment, not only the individual amateur but our hobby as a whole (and indirectly, the nation and the world) would be better off.

However, being realists as well, we fully understand that many (we might say a majority) of the amateur population, 1961 model, have never built anything more complex than the simplest of code-oscillator kits.

This is no indictment of the poor hams—until now, there's been little emphasis on the fun of do-it-yourself equipment construction. And for a number of reasons, nearly all construction articles have taken for granted the reader's experience in the fine points of homebrewing.

This combination of events makes it a bit rough to get started on the homebrewing trail; either you have to follow only the simplest directions in the "for-Novices-only" departments of other magazines, or you have to take your chances on some inexperienced guesses if you tackle equipment more to your liking.

There's no need to let the situation get the best of you, though. After all, even the most experienced designers and homebrew artists were beginners at this business once. With a simple guidebook of do's and don'ts, to help you avoid the not-so-obvious pitfalls, you should do excellently on your first try—and giving you that guidebook is the purpose of this article.

Rather than giving a concise collection of "Thou Shalt Not"s in the manner of certain other publications which shall remain nameless, we're going to try to break this art down in a systematic manner and present the reasoning behind each hint. This, we hope, will help you reason out that infinite number of cases which we can't cover here (because we can't foresee exactly where you'll have troubles on any specific project).

A good starting point, for any project, is in the choosing of a chassis. The purpose of a chassis is primarily to hold the other components of the equipment in a fixed position; frequently, it also serves as a partial shield.

At the supply houses, chassis come in two basic materials, with two types of finishes for each. You can get steel or aluminum, either painted or unpainted.

In addition, you can build your own from sheet "tin" (really tin-plated iron), aluminum, copper, or even heavy cardboard (November issue.)

Do's and Don't's

Each of these materials has its own set of advantages and drawbacks; which you choose will be determined by the nature of your project.

In general, you want to choose a material strong enough to hold the weight of all the parts that will be mounted on it, workable enough to be easy to handle, and having the proper electrical qualities to best serve on a particular project.

For heavy transformers and the like, steel is almost a necessity. For most equipment, if you're using a store-boughten chassis, aluminum is adequate and much more easily worked. For small transistor projects, cardboard is ideal.

Those electrical properties mentioned a while back have to do primarily with shielding. In audio work you want to steer clear of steel and iron because they carry magnetic fields and can introduce much mysterious hum. Either copper or aluminum is fine. Naturally, if the chassis must provide shielding, it must be of metal.

We haven't said much about building your own chassis. If you do, copper is an excellent material, as is brass. Both of these take solder readily, while aluminum is rather difficult to make a good solder joint to even with the new aluminum solders.

With a chassis chosen, one of the next items to consider is the choice of tube socket types. The choice is wide: You have bakelite, low-loss mica-filled, phenolic wafers, ceramic, teflon, and a host of others. Which should you use?

Surprisingly enough, for all except high-power transmitters the simple phenolic wafer socket is one of the best. With this socket, you can make direct ground connections by folding down the metal tab and bonding it to the chassis. The improvement in performance gained through elimination of inadequate grounding more than makes up for any losses introduced by the cheap socket.

At higher power levels, ceramic is the material to use. It's virtually the only one that won't be harmed by excessive heat, and high-power stages can generate several hundred degrees in the socket areas.

For dc and audio circuits, and to a lesser degree for rf stages, turret sockets such as those built by Eby and Vector are excellent. They allow each stage to be assembled as a unit on the bench, before being installed in final position. The exact point in the frequency spectrum where the losses exceed the advantages differs from project to project, but it's safest to use conventional sockets anywhere above about 7 mc.

Your choice of transformers will probably be determined mainly by design requirements. However, transformer placement is sometimes critical and sometimes not. It's critical whenever you're dealing with low-level audio or with cathode-ray tubes (including sheet-beam and magic-eye types), since stray magnetic fields introduce all sorts of troubles into these circuits. The rest of the time, simply put 'em where they'll fit and forget them.

In critical circuits, it's best to breadboard the circuit in as close to final form as you can, before mounting the transformers. Then, with the unit operating (DANGER—HIGH VOLTAGE!) position the transformer for minimum effect on the rest of the equipment. Mark the position, turn the gear off, and tie the chunk of iron down in place.

About that verb "breadboard" we used: it's a carryover from the earliest days of radio, when most chassis actually did start life as bread boards of the kitchen variety. As used now, it means anything from making a bench lash-up of a trial circuit to a semi-final version of finished equipment. The distinguishing thing about a breadboard circuit is that it's not meant for performance but to find out how it'll work. As we used it, it means a semi-final version of the equipment, needing only the mounting of the transformers to be complete and final.

Going down our list, we come to wiring. This seems simple, but it hides many pitfalls—such as the time one of the editors shielded the grid leads of his final amplifier and discovered the rf had went!

Basically, wire comes in several sets of categories: bare and insulated, solid and stranded, shielded and unshielded, etc., etc. The problem is: which type do I use where?

In the interests of TVI-proofing, it's best to wire all power-carrying circuits with shielded wire. This means filament lines, B+ leads, bias lines, and the like.

Signal-carrying leads, though, take different treatment. If the signal is dc, you can use shielding. If it's low-level AF *insulated* shielding is a must. High-level ac in the audio range can be shielded or not as you like, while all rf leads should be bare wire if possible.

Incidentally, if you like neatness you can lace your wiring into a harness; however, rf wiring should *never* be cabled. Any lead carrying rf should go directly to its destination and should be kept as far as possible from all other wires. This gets difficult in a crowded chassis, but it's one of the key rules for avoiding instability.

Incidentally, again, when you mount tube sockets you can prevent many later troubles by simply making certain that the pins are so oriented that no signal-carrying leads cross each other, and that all signal leads can go straight to their destinations. Failure to observe this point can result in many hours of searching for troubles that seemingly can't possibly exist—but do!

By now, we're up to the major components: coils, capacitors, and resistors. Since each of these is available in many different styles, the choice of which type to use is frequently perplexing.

Let's look at resistors first (they're simplest). Here, we have only two major types available: composition, and wire-wound. Less widely available and higher in price are deposited-carbon types.

A good rule to follow in choosing resistors is to use the composition type at all times, except in power circuits where the wattage rating needed is available only in wire-wound.

The reason for this is that wire-wound resistors have inductance as well as resistance, and in any rf circuits this makes them unpredictable. If you standardize on composition units, you won't have troubles with wire-wound units somehow sneaking into your projects.

One exception to this rule is that occasionally, a project calls for wire-wound resistors. Whenever this happens, the text will explain why—usually, it's to take advantage of their two-in-one quality. But in general, it's safest to stick with composition resistors at all times unless a project specifically directs otherwise.

Now to coils—the next simplest. Here, we have several choices. We can use air-wound coils such as Air-Dux or Miniductors (or similar home-built items), air-core coils wound on tubing forms, or slug-tuned types. In the slug-tuned category, we have the choice of brass or ferrite core slugs.

At this point, we're treading on the edge of some very thin ice, since variations in characteristicss of coils can make a great effect in performance of the finished item. By far the safest course is to follow the recommendation of the designer—but what if *you* happen to be the designer?

These are the basic characteristics of the various types of coils: Air-wound—low rf loss, fixed inductance value, poor thermal stability. Air-core wound on forms—higher rf loss than air-core, fixed inductance, good thermal stability if properly designed. Slug-tuned—highest rf loss, variable inductance, fair to good thermal stability. In addition, the Q of a slug-tuned coil with the proper core is much higher than that of an air-core inductor.

In the category of slug-tuned coils, the choice is between brass and ferrite cores. Brass cores lower the inductance as the core is inserted into the winding, while the ferrites raise the inductance. Exact choice of a core is best made by checking manufacturer's literature, looking particularly at the recommended frequency range. Brass is usable at almost any frequency, but the ferrites work best only over a narrow band which varies from core to core.

Be sure to keep coils away from metal objects including the chassis and any shielding, or if you can't do this then allow for the effects of the metal. This usually lowers the inductance and increases the distributed capacity; it's safest to dip the coil to frequency after it's in the circuit—this takes care of all the uncalculatable variables which change coil characteristics.

Finally, by a process of elimination, we come to capacitors (frequently called condensers, an obsolete term). These come in many kinds, and confusion is rampant even among experienced builders as to where and when to use which.

The major types include paper, mica, ceramic, silver-mica, electrolytic, vacuum, and glass capacitors. Trimmers are available in mica, ceramic, and glass-piston varieties.

Electrolytic capacitors are limited to medium- and low-voltage power supply circuits, since they have high losses. The other types, however, are more or less interchangeable—more frequently less than more.

Paper capacitors are most suitable for audio use, where they are employed for bypassing power leads and for signal coupling.

Mica capacitors formerly were the standard for rf work. They have been largely supplanted by ceramic types, but with the ceramics you have to watch your step. Most of them have a wider tolerance spread than most other capacitors (many are only GMV, which means the value marked on them is the minimum but the maximum is unknown). The type NPO ceramic capacitor, however, is available in 5 percent tolerance and can be substituted for any mica unit.

Silver-mica capacitors are specially processed, and if they are called for no substitutions should be made. They have excellent rf properties, and hold their value under conditions which would destroy most other types.

However, glass capacitors can be used in place of silver micas. Since glass units are considerably more expensive, there's no reason to make the substitution.

For general rf bypassing, the tiny disc ceramic has no equal up to about 150 mc. Its flat-plate construction holds inductance to a minimum; a paper unit of similar rating will be almost completely ineffective at frequencies above about 3 mc. In addition, because of its tiny size, the ceramic can fit into almost any space. If possible, it should be positioned across a tube socket to help shield input from output connections.

Above 150 mc, the button-type ceramic capacitor comes into play. With no external leads, it has almost no inductance at all, allowing it to perform effectively up to about 500 mc.

In trimmer capacitors, the ceramic type is recommended because mica trimmers tend to change capacity with changes in the weather (glass-piston types are nice but expensive and limited in maximum value). The NPO variety holds its setting regardless of temperature or humidity; temperature compensating types are also available but should be used with caution.

So far, we've examined capacitors, inductors, resistors, wiring, tube sockets, transformers, and the chassis itself. About all that we haven't discussed is the choice of tubes or transistors.

In case you're wondering, that's something we're not going to discuss at this time. The reason is simple—it's worth an entire article in itself. If you can't wait, though, here's a hint: invest in a good tube manual and pick out tube types which are as close as possible to the ones originally called for in such characteristics as input and output capacity, voltages, transconductance, and amplification. If it's a match in everything but the socket connections, the substitution will probably work. . . .

We hope this listing helps you get started on your own homebrewing project. Undoubtedly, you have many more questions that we have provided answers for. If you can't figure them out from the hints given here, drop us a line —and if the question is of wide enough interest, and enough of you have such queries, we'll undoubtedly run a sequel. In any event, you'll get a direct answer.

. . . K5JKX/6

Instant Band Change

MANY types of amateur operation, especially contest work, put a premium on being able to change bands with a minimum loss of time. One approach to this problem is a multiple-transmitter and -receiver installation, which is quite expensive. Another approach is to build transmitter with band-pass exciters, broad-band tuning, etc. This, still, requires a little more work to build than a conventional transmitter.

But all is not lost! Here is a simple idea that can be applied to any transmitter, homebrew or commercial, DX-20 to Thunderbolt. Model airplane dope may be purchased in a variety of colors. Some model shops carry assortments of eight colors plus thinner and brush for about 75¢. Simply take one color for each band and color-code the tuning controls. If you are careful, and do a neat job, it adds a nice touch of color to your front panel without looking gaudy.

Start out by tuning up on your normal operating frequency in one band (any band will do). Using one color of dope, put a small colored dot on each control, including the bandswitch, to indicate the proper setting. Then do the same thing for each band, using a different color dope for each band.

After this is done, to hop to another band, you simply set the bandswitch in the correct position, note the color for that band and set the controls on the matching color. Of course, the tuning may shift slightly due to aging of components, changing antenna load, etc., but with such a system you are able to set the controls to the approximate setting so it is a simple matter to touch them up to bring tuning right on the button.

If you need to change any of the dots later, such as would be required for a new antenna, the dots may be removed with dope thinner or fingernail polish remover, then replaced in the new position.

An advantage of this system is that visiting hams are able to tune your rig with no danger of burning out the fragile screens in those expensive little 6146 finals, or tuning up on a wrong harmonic.

If you want to use a system such as this with temporary, easily-removed markings, use different color grease pencils. Grease pencils may be bought in enough different colors to color-code the usual 160 through ten meter transmitter, and may be removed by rubbing them off with a soft cloth.

. . . Al Brogdon K3KMO/W4UWA

Equipment Refinishing

Although most quality communications equipment is finished to withstand long periods of use, the time comes when the equipment racks and cabinets should be repainted. Spot painting will prevent exposed metal from rusting although attempts at spot painting and touch-up may actually harm the appearance of the equipment.

At this juncture, it is wise to turn to the experts. Your local auto-body shop is fully equipped to perform just about any metal refinishing job. The mechanics are experts in restoring mangled metal to its original shape, matching colors and applying a finish, either lacquer or enamel, that is indistinguishable from the original. Give it a try. The cost is reasonable and a hard, durable finish is always obtained. . . . W4WKM

Writers Needed

No Talent

Necessary

We will be publishing the 1962 Almanac-Yearbook-Ham Buyer's Guide about midway between the November and December issues of 73. This book will be sent to all subscribers and will be available at radio parts distributors.

We will have listings of the postage rates to all countries of the world, QSL Bureaus, call prefixes, and just about anything else we can think of that is frequently needed. If you'll remember back to various things that you looked up recently you'll probably be able to send in a chart, list, table, etc., that others would find of value. This would get you a by-line in the BG and maybe a small gratuity, depending on how much work went into it.

If your club is planning an event for the coming year we'd sure like to list it. Maybe it is a picnic, hamfest, convention, contest, etc. Let us know the details and the date.

Prospective advertisers will find this BG the best advertising media yet invented. The cost is a mere $150 per page (every 4th page free) and we expect close to 100,000 copies to be distributed. Send for rates and details.

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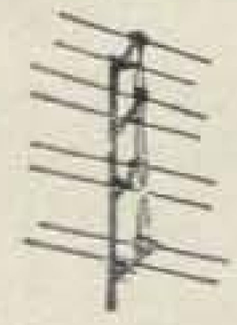


Junk Box

Tips

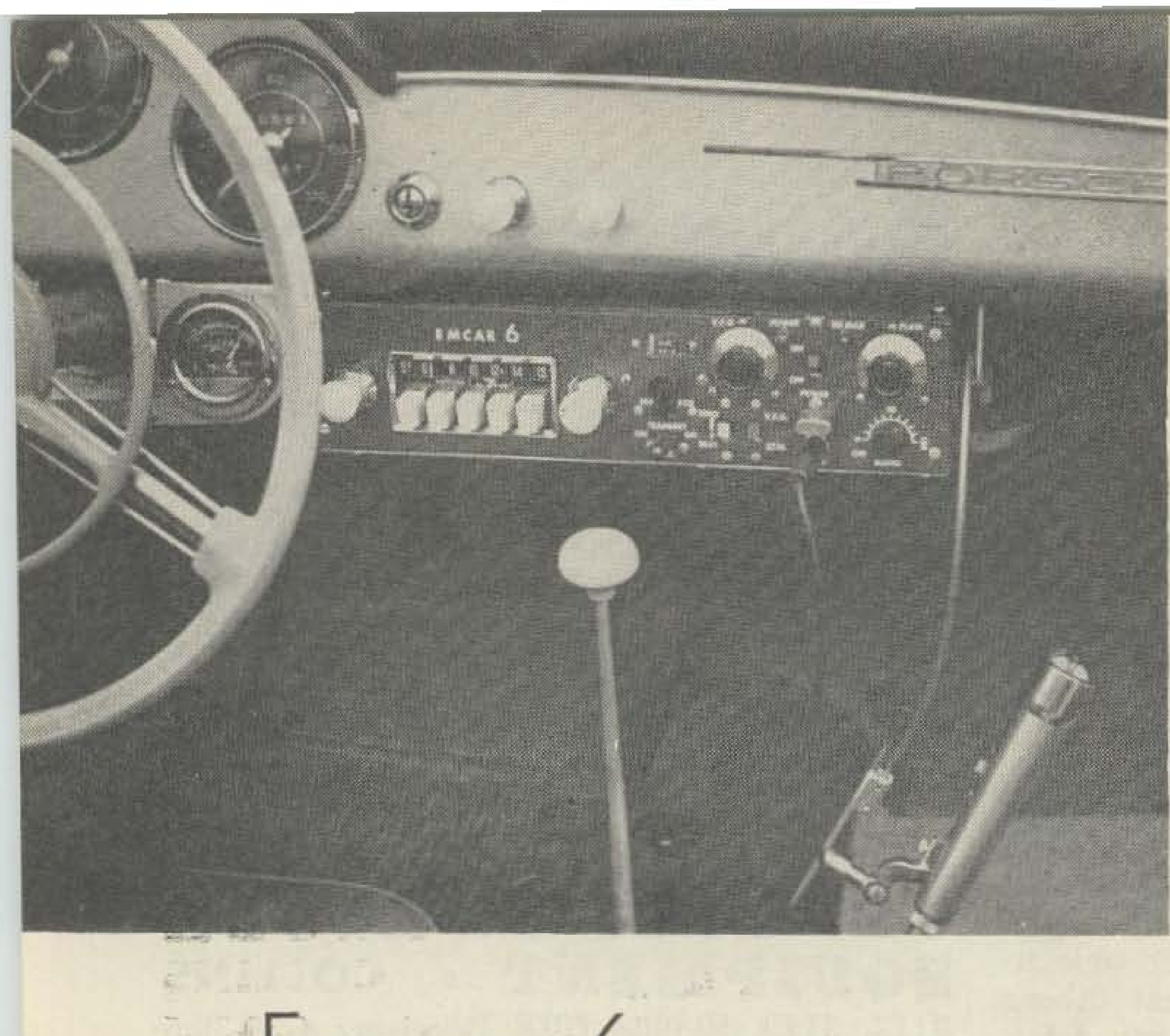
To those who possess coax relays from an ARC 5 (28 volt DC) and plan to use it on a small xmitter whose modulator is push pull 6AQ5's, 6V6's and etc. or a single 6L6, use the winding as the cathode 'resistor' of the modulator tubes. If your B— is broken in rec. position, then in transmit the mod. throws the relay.

This has been in operation on a 2 meter xmitter for 2½ years and still works.

. . . **KøVQY**

Save those transformers from old rotor control units. You'll find uses for them. One is a transistor power supply. With a bridge rectifier, you can get 30 volts plus at more than 30 ma. plus. . . . **KøVQY**

UHF TV is gone for a lot of areas. There are UHF converters (and probably) old TV boosters also. A majority of these contain a transformer that delivers 6.3 volts and 125 volts at 30 ma., that is isolated from the line. Preamps, bias supplies, small set supply and a load of test gear you can dream up can be built around this. . . . **KøVQY**



Emil Carp W3JXT
Montgomeryville, Pennsylvania

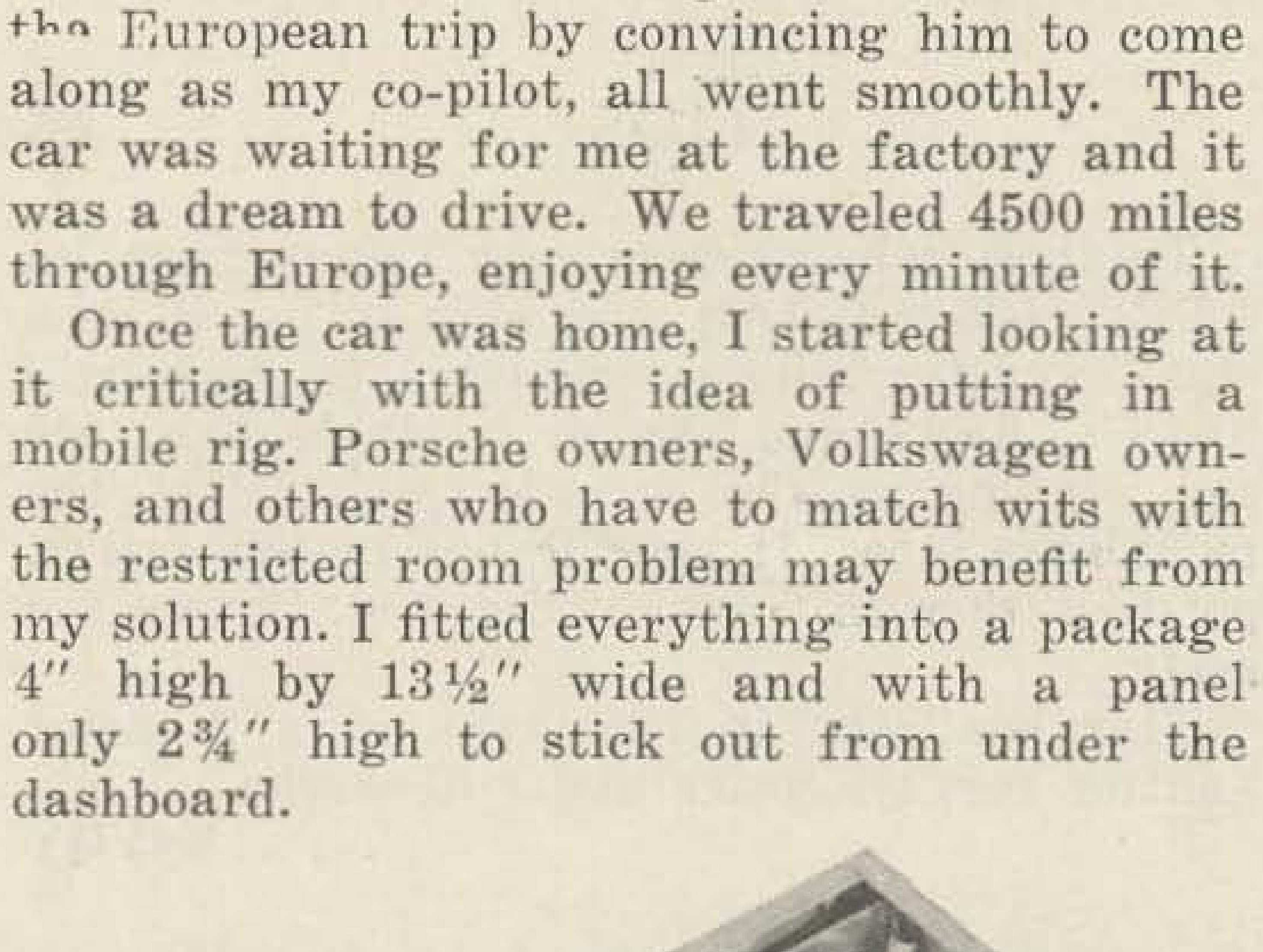
Emcar 6

(for a Porsche)

A couple of years ago I was intrigued by the description of how to buy a Porsche in Germany which appeared in an editorial by Wayne Green. The story influenced me to do the same.

After surmounting the minor obstacle of a boss who didn't want to give me time off for the European trip by convincing him to come along as my co-pilot, all went smoothly. The car was waiting for me at the factory and it was a dream to drive. We traveled 4500 miles through Europe, enjoying every minute of it.

Once the car was home, I started looking at it critically with the idea of putting in a mobile rig. Porsche owners, Volkswagen owners, and others who have to match wits with the restricted room problem may benefit from my solution. I fitted everything into a package 4" high by 13½" wide and with a panel only 2¾" high to stick out from under the dashboard.

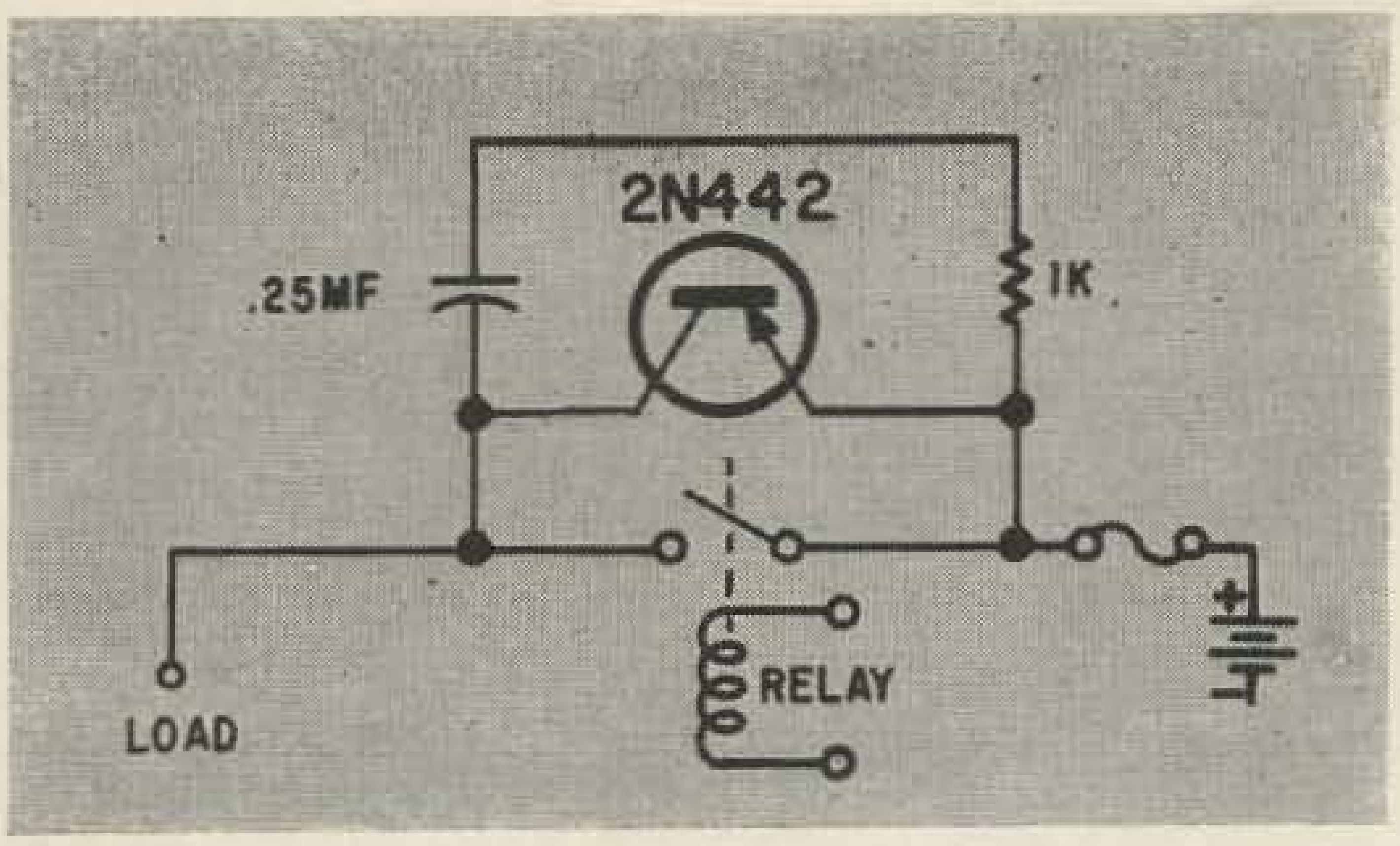


The receiver used was a Bendix all-transistor broadcast set made especially for Volkswagens. I had a Transcon six meter unit which was easily modified to fit in the new package, giving me a crystal controlled converter and transmitter combination. I had to lower all of the Transcon tuning controls and change the plate coil to a horizontal position to get it into the flat case. The vibrator power supply was mounted up front in the luggage compartment and relay controlled. I installed the transistor-condenser combination shown in Fig. 1 to suppress any arcs across the contact points. Perhaps I'm a worry-wart, but I get nervous when gas stations spill gas into the luggage compartment while trying to get it into the six inch wide racing spout on the gas tank.

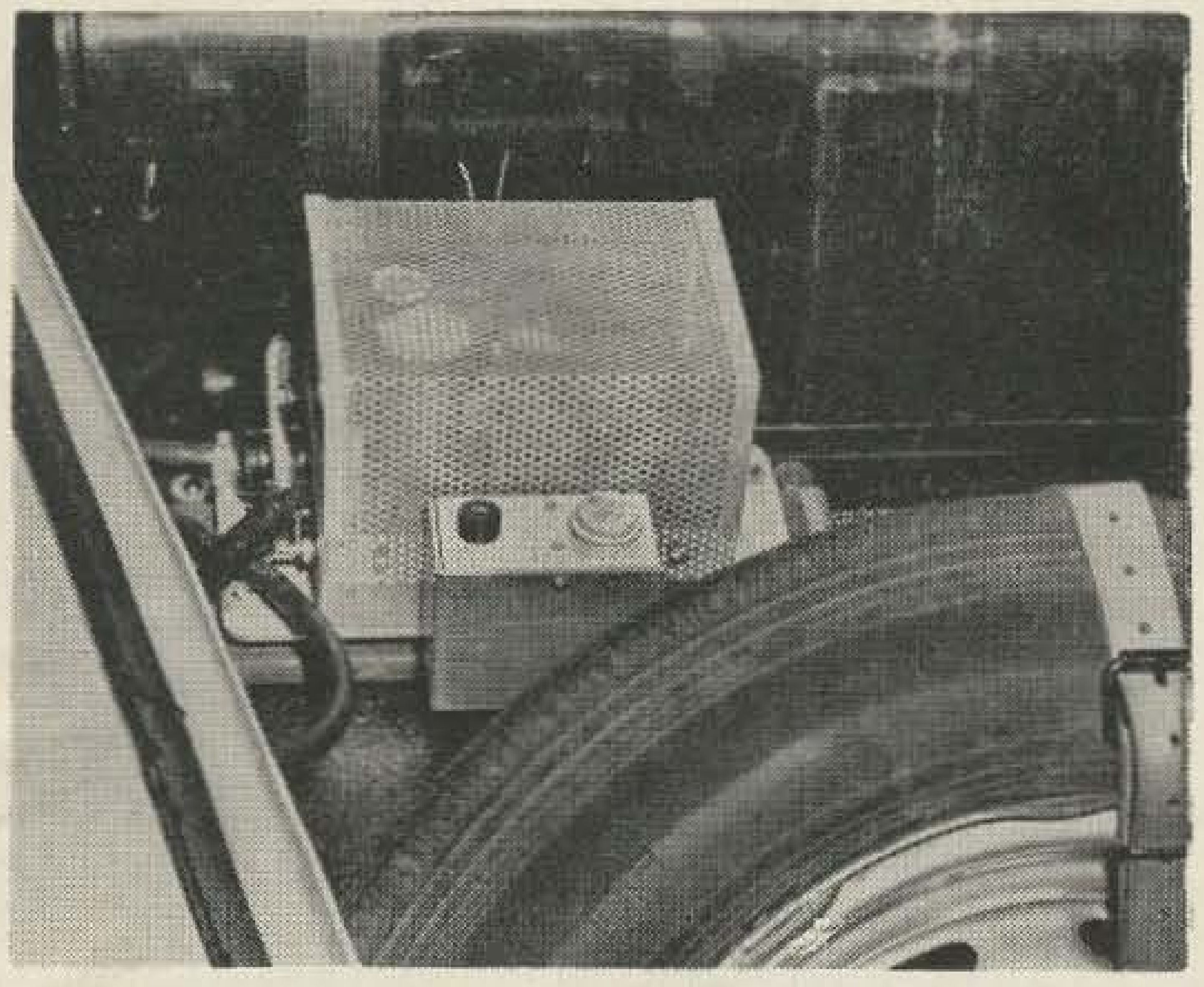
An SWR unit was incorporated using a Lafayette AM tuning meter TM12. The plastic case was carefully opened and the resistor removed, leaving me with a 50 ua movement. I built the rest of it using the Heath SWR for a model.

I used 1/16th inch aluminum for the cabinet, bending each side and using sheet metal screws to fasten all the sections together. With the addition of flat bottom and top plates I had a rigid case. Holes in the plates provide ventilation.

The set mounted in the car easily. A small angle bracket on each end fastened to the bottom of the dash and a quarter inch bolt secured the back end to a bracket attached to the car. I used power plugs on the cables so I could take the rig out whenever I wanted with just a couple minutes work.



This is no place to go into ecstasy over the joys of mobile hamming, so suffice it to say the rig works fine and I wouldn't be without it. The Porsche is fabulous and I pity all you poor chaps who haven't had a chance to try the breed. . . . W3JXT



New Product

Battery Eliminator

Apparently EICO is trying to outdo everyone else in battery eliminator design. This new one has everything you can imagine. It is filtered with 5000 mfd for use with transistor radios and will handle the currents necessary to charge six or twelve volt batteries. It has two ranges, 0-8 vdc and 0-16 vdc, and the meters switch as you select the range desired. $43.95 in kit form and $52.95 ready to go. Load: 10 amps continuous and 20 amps intermittent on low range, 6 amps continuous and 10 amps intermittent on high. EICO will respond with full particulars on this or any other EICO product if you but let them know of your interest. EICO, 33-00 Northern Blvd., L. I. C. I, N. Y.

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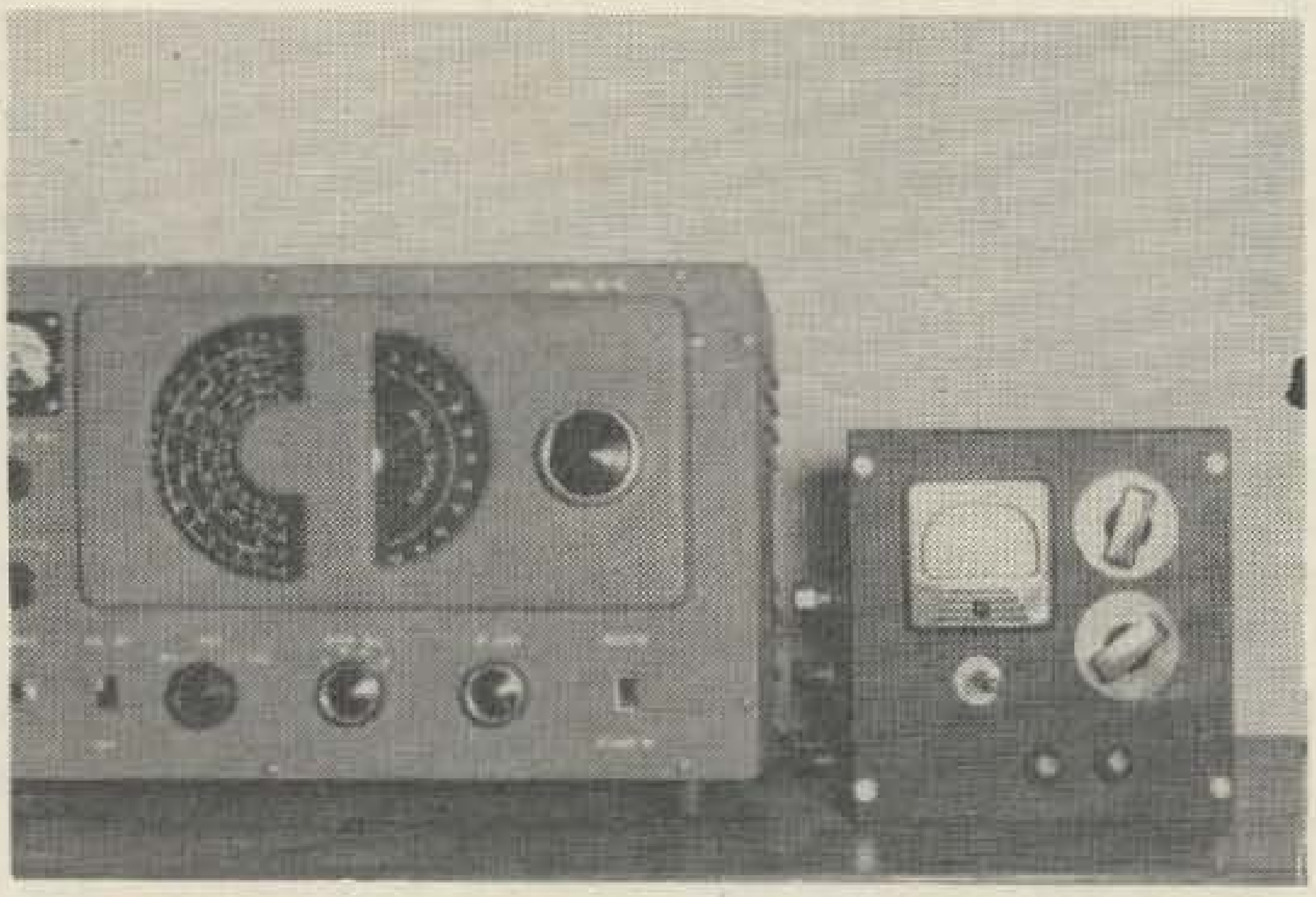
Chalfont, Pennsylvania

The Little Thief



A little rig comes in handy now and then. It may be used to let the fellows know what happened to you when the smoke started pouring out of the big rig, or it may be just for having a little fun down in the Novice bands. This Little Thief steals its power from your receiver, thereby reducing its cost and weight to a minimum.

Your receiver probably has a socket on the back for powering a calibrator, converter, Q-multiplier, etc., so why not plug in a small one-tube transmitter? This won't overload the receiver because the transmitter doesn't draw any more power than the receiver and is only used when the receiver is on standby.

Step one is to get out the manual on your receiver and see how they have the accessory socket wired. All receivers have at least the filament, ground and B-plus available here. You will need some method of switching the B-plus from receiver to transmitter. If your receiver does not have a double-throw switch built in, which it probably has not, you have a choice of either substituting one for the present standby switch or else mounting a suitable switch on the transmitter and letting it perform the duty. This is probably the best bet . . . and simplest.

Many receivers have the B-plus go through a jumper on the accessory plug. If you have one like this then your problems are few. All you have to do is remove the jumper and run the wires to the new switch and use that instead of the one on the receiver. If the manufacturer has been remiss you will have to do the work and break the B-plus lead as it comes from the standby switch in the receiver and run it to two empty terminals on the socket.

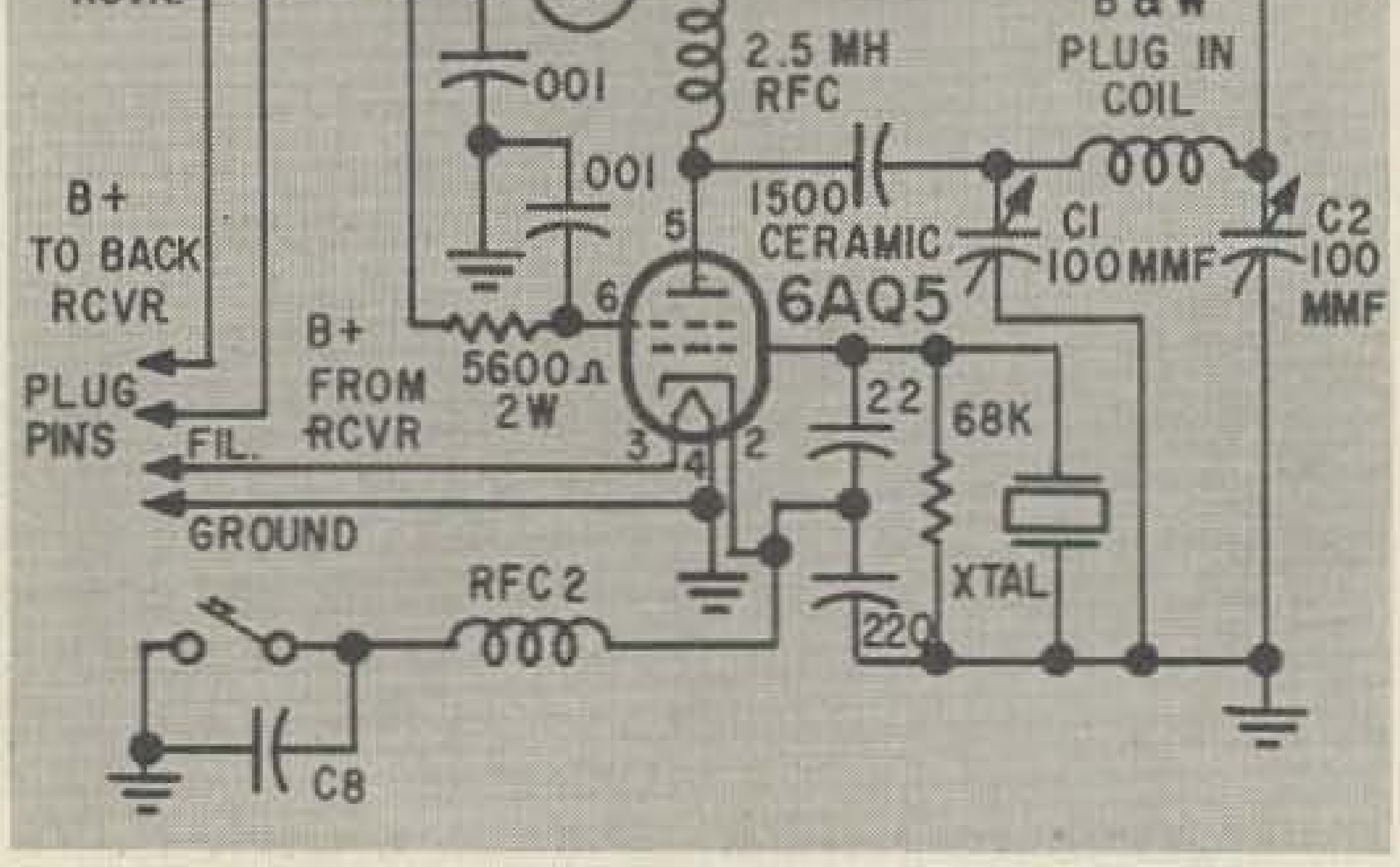
The Transmitter

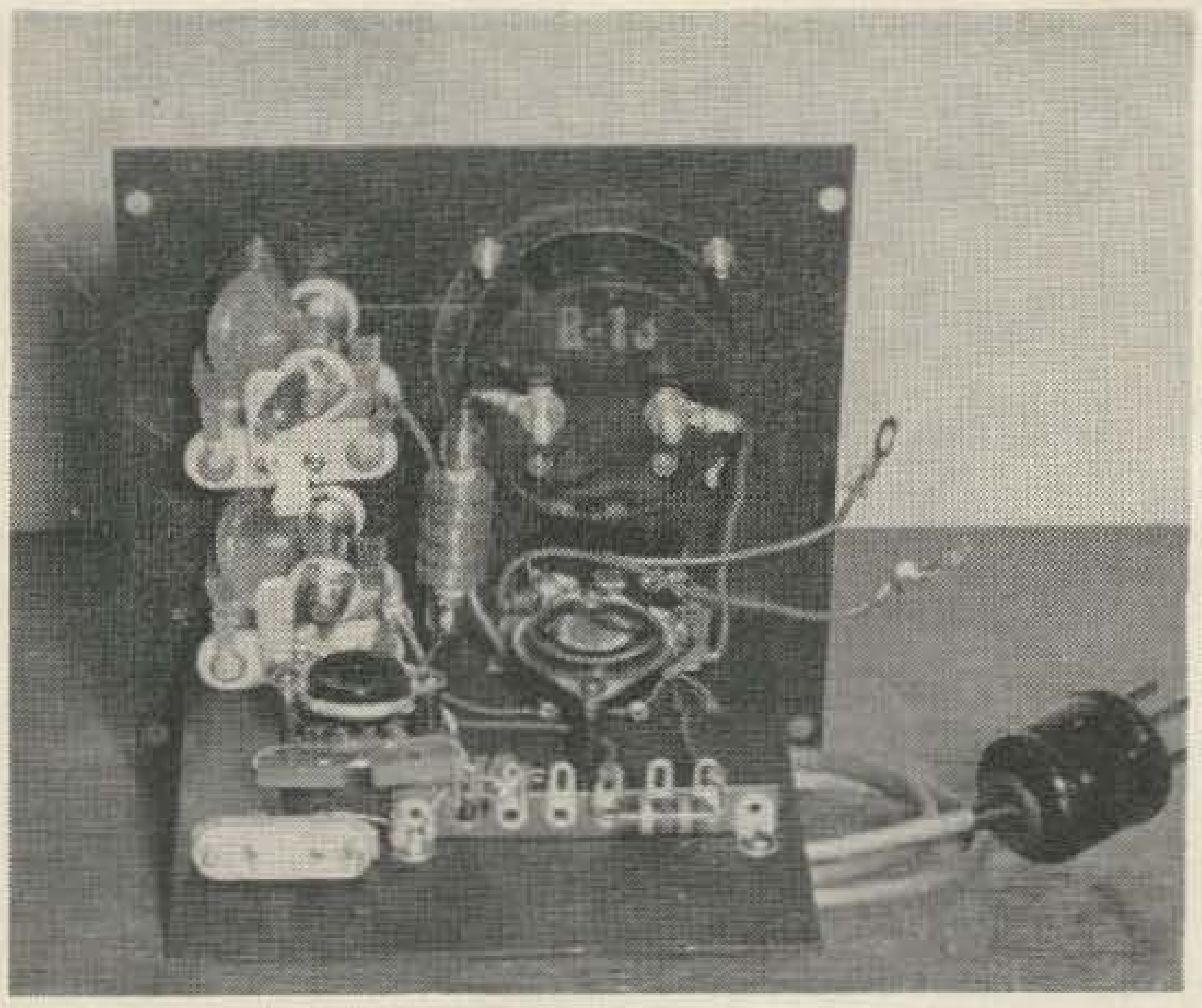
A single crystal oscillator stage is used with a pi-network tank circuit. This will match into random length antennas and give you good harmonic rejection. Both crystal and coil can be changed easily for band changes. A double-pole double-throw switch is used for transmit-receive so you can switch both the B-plus and antenna circuits simultaneously. This gives you one switch operation and you don't have to use any antenna relays.

A small pilot lamp could be used in place of the meter for tuning, but with the low price on meters this doesn't make much sense . . . and besides a meter is a lot easier to read. If you don't have a meter of the right range it is simple to wind up a small shunt and use any meter of lesser range.

Tuning

C1 tunes the tank, C2 determines the loading. Tune C1 for a resonant dip on the meter and





then tune C2 for best loading. I find that a small field strength meter is very handy for getting the best loading. With experience you will see how the plate meter responds to loading and be able to tune by it alone. C2 will affect the tuning of C1 a bit, as you will see. On 40 meter C2 has a greater effect on tuning and you may have to try several different settings to determine the best output. For best stability of the keyed note you should back off the maximum dip just a bit with C1. Experience is a fine teacher and this little rig will be quite an experience.

With a 65 foot antenna and proper loading on both 40 and 80 meters I found that 12 ma plate current gave me the best results.

. . . W3FQJ

Coil Forms

For you newcomers, save the IF's from old TV sets, these make good coil forms for your next converter. . . . KøVQY

1625's

A very versatile tube is the 1625, or 12 volt version of the 807. It can be used in many applications to replace 807s in finals, or most of the common modulator tubes in the medium power class. The tubes sell for approximately 25¢ surplus and have a large number of practical uses. One of them would be to replace 6L6s and tubes of a similar type in modulators. The 6L6s list for about $4.00 and the difference between a pair of these and a pair of 1625s will more than pay for a filament transformer with plenty left over. The difference is even greater when replacing them. It should be noted that although the 1625s will replace 6L6s, they are also good for considerably more power. A pair of them in class B will give about 120 watts of audio. When planning a rig, it might pay to consider the use of these tubes. . . . WA2INM

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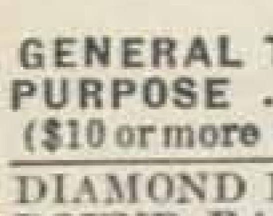

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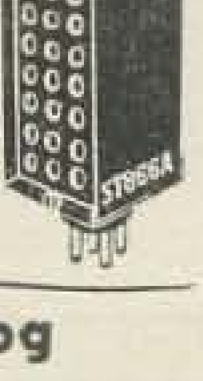

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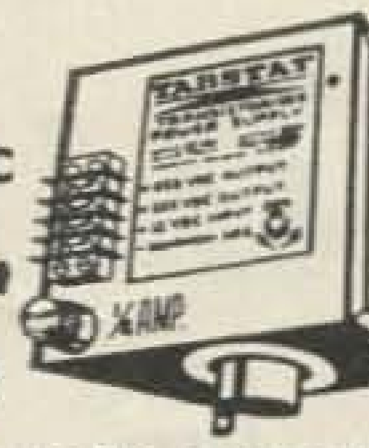

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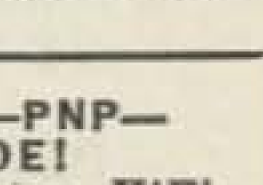

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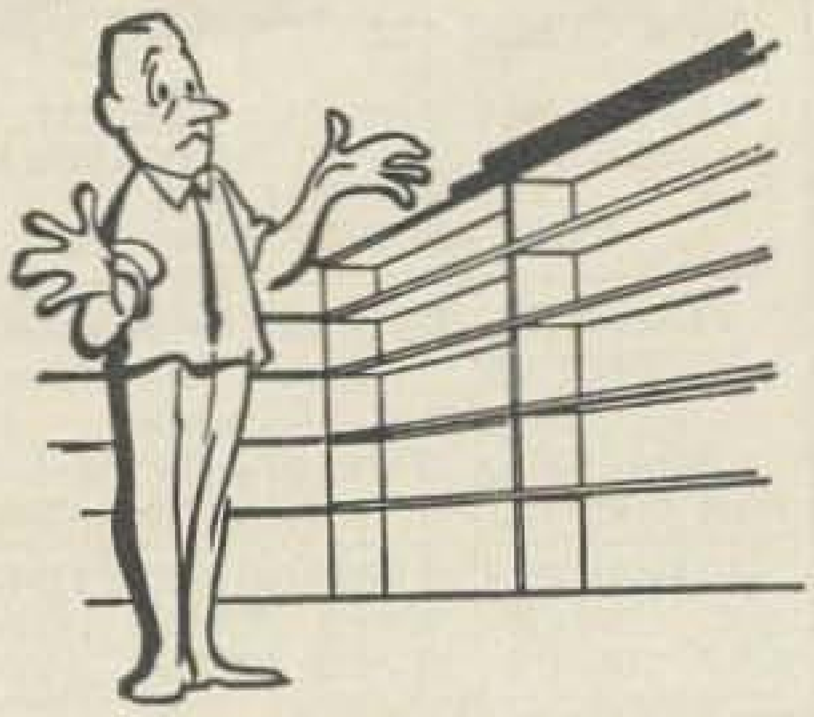

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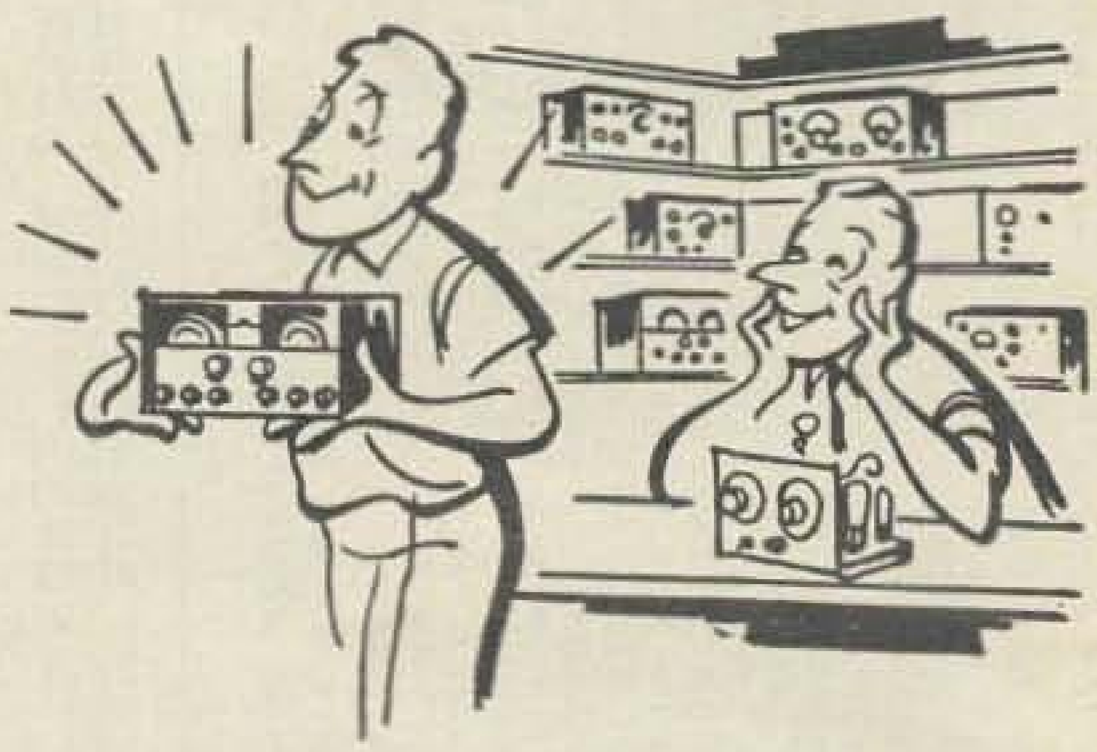
Allied Ham Manager



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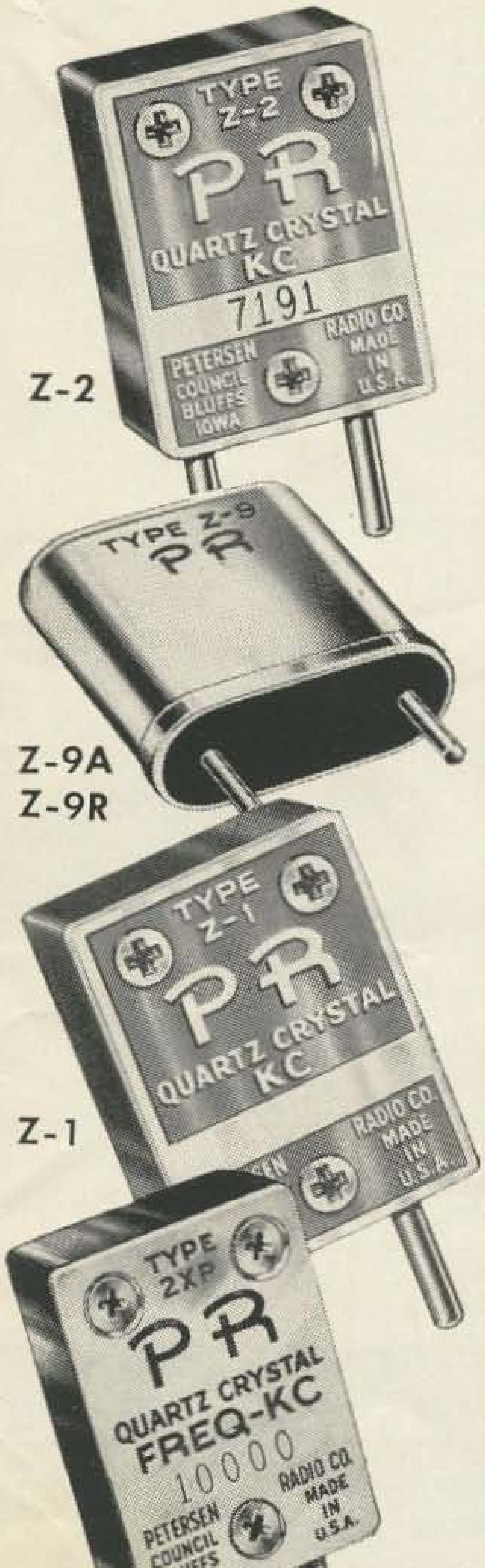

Z-2

Z-9A
Z-9R

Z-1

2XP

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To determine band edge. To keep the VFO and receiver properly calibrated.
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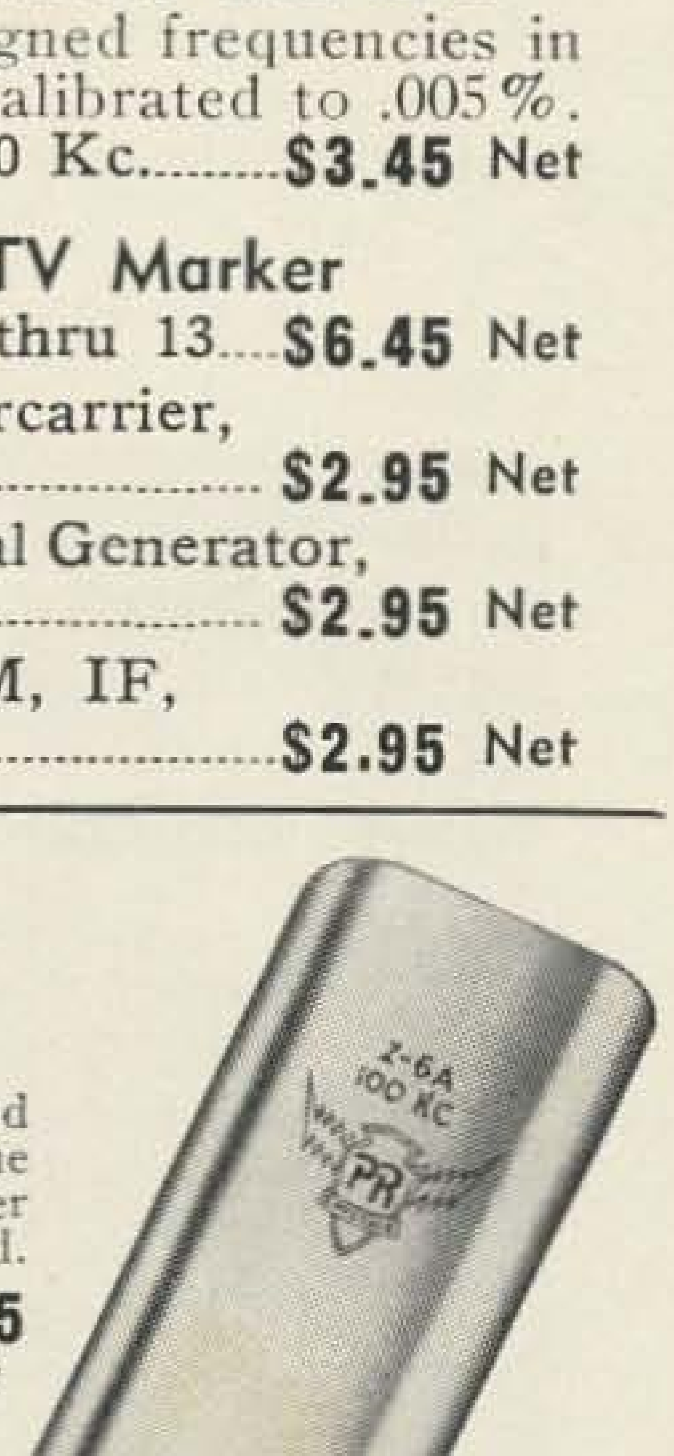

Z-6A

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