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Wayne Green, W2NSD

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de W2NSD/1

On the Air Again

BETWEEN THE seven-day-a-week night and day job of getting 73 going and the restrictions of one of the nastiest landlords I've ever encountered, my hamming has been badly pruned back for several years. Even under the best of conditions it is difficult to make much of a mark while operating from Brooklyn. Antenna space is nil, the cement sops up all the rf, and you have more TVI per square inch than is believable.

This had a lot to do with our leaving the city. One of the important factors in our choice of a new home for 73 was the heighth and the clearness of the shot to the southwest for VHF operation.

Once moved into the new headquarters we set about getting a ham shack in operation. I'm not counting the Clegg 99'er and the halo hung out the attic window for local six meter contacts . . . this was installed and working before we had finished unloading the first truckload. The first installation was the Central 200V driving a Central 600L into a Hy-Gain tribander up on a forty foot Rohn tower. The receiver was a National 303. The results were marvelous! Every DX station I called came back and gave me encouraging reports. I hadn't been able to work out like that since my old ham station up in Troy, New York, at college where I racked up a rather good DX score and won several of the SS and DX contests.

Outside of some difficulty in getting the tribander to the top of the 40 footer, it was a snap getting a good signal onto the 10-15-20 meter bands. Dipoles hung from a couple of our 80' and 90' trees brought in nice reports on 40 and 80 meters. This left us with a lack on the VHF bands. This would never do. . . . I've been a staunch VHF'er ever since I started in ham radio (my first contact was on 2½ meters).

There is a big difference between getting on two meters with a Gonset and a halo and really putting a DX signal on the air. If you are going to do a serious job on two you have to have a minimum of a 16 element beam, two or three hundred watts, and a low noise converter. That beam has to be up in the air a ways, too. I looked over my gear and decided to throw caution to the winds and put up the best we could manage.

The first step was to order sixty feet more of Rohn tower and get the antenna above the 90' trees. The tower came in a few days, complete with erecting tool and guys. Art, VE1EY, arrived at this time with XYL and three harmonics in tow. Art announced that he was a rigger and could swing the tower into place in a couple hours. "Nothing to it." They moved in with us and five days later the tower was in place. I don't think Virginia likes kids any more.

Then, the day before our Open House, Bob Cushman of Cushcraft came over in his TR3 and unloaded a formidable pile of aluminum. He spent the whole day converting this "pick-up-sticks" into a 64 element beam. What a monster! It filled the whole backyard. This left only the small matter of putting the beam up on the tower. Ho, ho.

We needed an expert.

We got one. Pat Harris, W1HIV, son of Sam and Helen Harris, W1FZJ and W1HOY (also W1BU), who tends their forest of one hundred-plus footers, drove up with his safety belt and spent two days on the top of the tower getting the 64 elements in place. I hate to think how long it would take someone who didn't know what he was doing to put up a tower and beam like that.

The results were not quite as great as I expected. I hooked my Tapetone 417A converter through the NC-303 and used the Gonset Communicator with the Gonset linear, running about 50 watts output and worked over a range of about 100 miles. Over the next few days the band opened a little now and then and I managed many contacts with New York and New Jersey and even two with Philadelphia. As the

September ARRL VHF Contest neared I dropped everything and worked furiously to get some higher power on the band.

A trip down to Meshna's in Lynn, one of the larger surplus houses in the Boston area, armed me with a couple of nice power supplies for bias and screens of my 4-125A's. The final amplifier is one I bought years ago for $30 from Herbach & Rademan. . . . I should have bought more. I wired in the high voltage supplies and modulator, complete with remote control between the transmitter in the basement and the radio shack right above. Some one hundred insurmountable problems later I not only had the rig on the air, but had it arranged for both phone and CW.

The 64 element beam didn't seem to be working very well, but it was hard to really tell without something to use for comparison. I sort of expected to put a slamming signal down into Boston, some 60 miles away, in spite of a rather high mountain directly between us. I didn't. Lenny, W1MEL, defying his chronic acrophobia ("I get sick"), quiveringly climbed the tower and hung a pair of the Cushcraft Big Wheels below the 64 element beam. When we found that they worked almost as well as the big beam, we knew that all was not well.

Jud, K2CBA, came over for a visit and looked over the beam. He climbed up the tower and pronounced all the phasing wires connected correctly. He felt, as I suspected, that our use of a light TV line for the feeder might be holding us back a bit. He came back the next weekend with some of the heaviest twinlead he could scrounge and, with the help of Mike, K2LZF, replaced the old line we had originally used. Gadzooks! What a difference. Signals came up about four "S" units on both transmitting and receiving. All of a sudden Connecticut and Long Island were coming in the way Massachusetts had been before. Now, if I can only locate some of that K200 line. . . .

Did someone say something about high power being expensive? Maybe so, but not the way I do it. The rig starts out with an old 522 transmitter, giving about seven watts output. The power supply out of an old TV runs this gadget just fine. From there I swing the rf through an old Gonset Two Meter Linear, bringing it up to about sixty watts . . . which is really enough for most applications. This drives the 4-125A's in the final. The final was surplus and cost $30, as mentioned previously. The bias supply is a $17 regulated job from Meshna, the RA-42. The screen supply, also regulated, came from Meshna for $20. The use

(Turn to page 92)

John Specialny Jr. W3HIX
Philco Corp. Lansdale, Penna.

1296 mc Converter

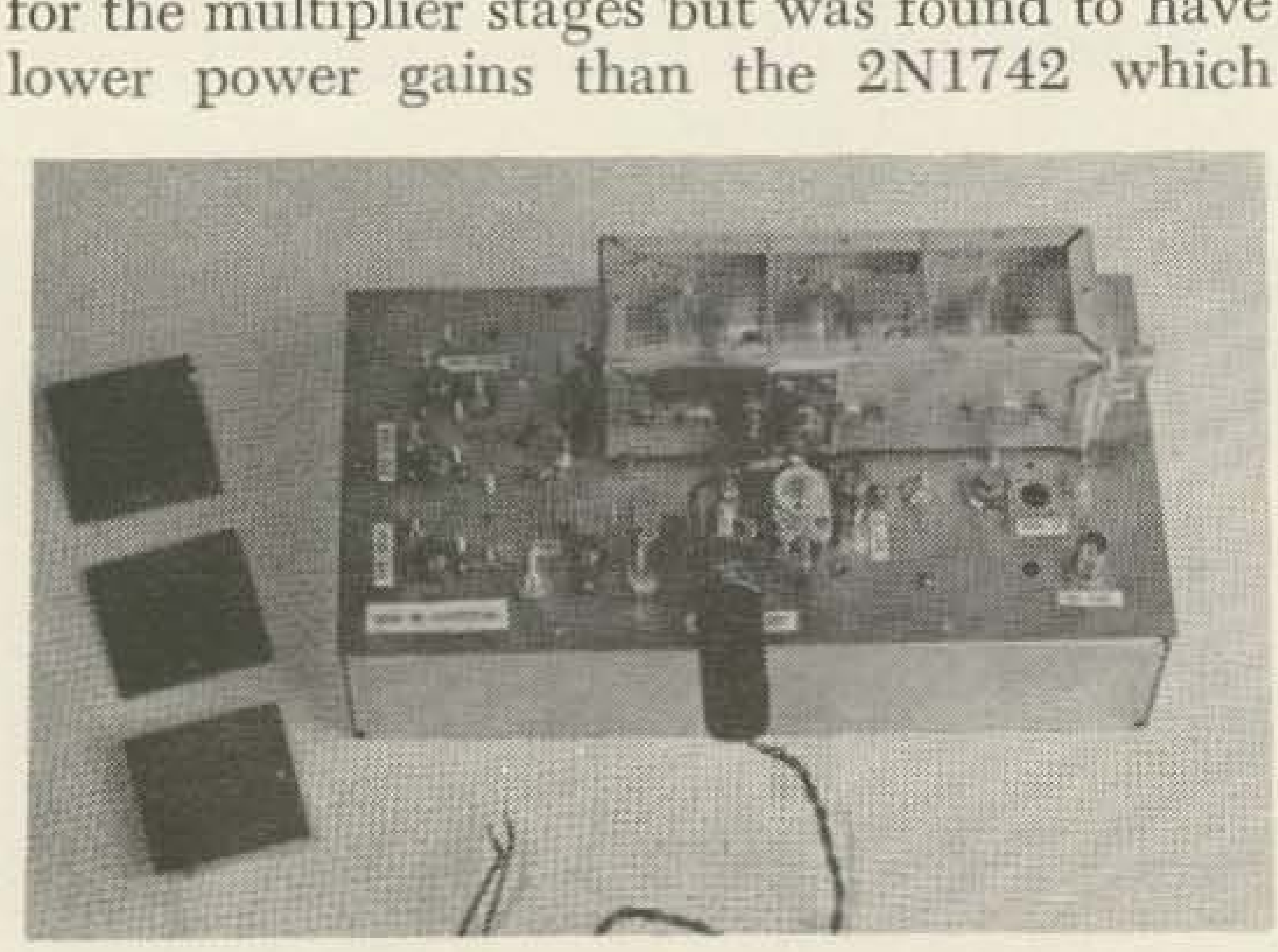
A CONVERTER IS described that operates at a signal frequency of 1296 mc utilizing semiconductors throughout. The converter is intended for ham communications on the 1296 mc band and could easily be adopted for moon bounce operation. An *if* frequency of 30 mc permits the use of any communications receiver capable of tuning this range.

Six transistors are used in functions previously performed by tubes. The use of transistors reduces the amount of heat generated both by the *if* stages and harmonic generators, thereby increasing frequency stability. A diode is used as a frequency tripler in the last stage of the frequency multiplier section. A low noise mixer diode is used in conjunction with a low noise *if* preamplifier (2.7 db) to provide extremely low noise operation. This converter has a measured overall noise figure of 8.5 db with a power gain of better than 50 db. The image response was at least 10 db down from the signal frequency.

Circuit Description

Fig. 1 shows the schematic diagram of the entire converter.

Philco's 2N1742 MADT transistors are utilized in the oscillator and the three frequency doubler circuits. All are operating in the common-base configuration. A 1N147 type mixer diode is used as the diode frequency tripler. The 2N1744 MADT type which is specified for oscillator service was considered for the multiplier stages but was found to have lower power gains than the 2N1742 which due to its higher gains provided more drive to the diode tripler stage.



Top View of 1296 mc Converter.

The 1266 mc heterodyning signal for the 1N263 diode mixer is generated by a 52.75 mc crystal controlled oscillator, three Class "C" frequency doublers and a diode frequency tripler.

In the oscillator output circuit, capacitor C_1 and coil L_1 are tuned to 52.75 mc. The 1.5 to 7.0 mmfd trimmer in the emitter circuit is adjusted for maximum output consistent with stable oscillator operation. With certain crystals it may be necessary to add about 1.0 mmfd of capacitance between the collector and emitter terminals. Winding L_2 couples the output from the oscillator to the input of the first doubler. Capacitor C_3 and coil L_3 tune the output of this stage to 105.5 mc. A tap on coil L_3 couples the 105.5 mc output to the emitter of the second doubler. Capacitor C_4 and coil L_4 tune the output of this stage to 211 mc.

A low impedance tap on coil L_4 couples the 211 mc output to the input of the third doubler. A strip line tank circuit consisting of capacitor C_5 and coil L_5 tune the output to 422 mc. A copper type shield serves as the enclosure for this tank circuit.

Driving of the 1N147 multiplier tripler diode to 1266 mc is through the variable matching capacitor C_6 tapped onto L_5. Inductor L_{15} with the capacitance C_c formed by the tuning screw SC_3 is tuned to 1266 mc.

Inductors L_{13} and L_{15} and capacitors C_A and C_B formed by the tuning screws SC_1 and SC_2 respectively, are preselectors tuned to 1296 mc. Loops L_{11} and L_{12} couple the signal from the antenna through the preselectors to the 1N263 diode mixer.

The 30 mc output of the mixer is amplified in two common-emitter *if* stages. Coupling to the T2364 first *if* amplifier is through a network consisting of coil L_6 and capacitors C_7, C_8 and C_{13}. C_8 and L_6 are adjusted for the lowest noise figure. The *if* system noise figure was measured to be 2.7 db. A T2028 can be used in this stage with a slight deterioration in the noise figure. Capacitor C_{10} and coil L_7 are tuned to 30 mc. Inductive neutralization is provided by the tapped output coil L_7 and capacitor C_9.

Secondary winding L_8 provides the coupling to the 2N1742 second *if* amplifier. Capacitor C_{12} and coil L_9 are tuned to 30 mc. Inductive neutralization is obtained by the tapped output coil L_9 and capacitor C_{11}. The converter output is coupled to the input of the receiver through secondary winding L_{10}.

Application of forward bias to the 1N263

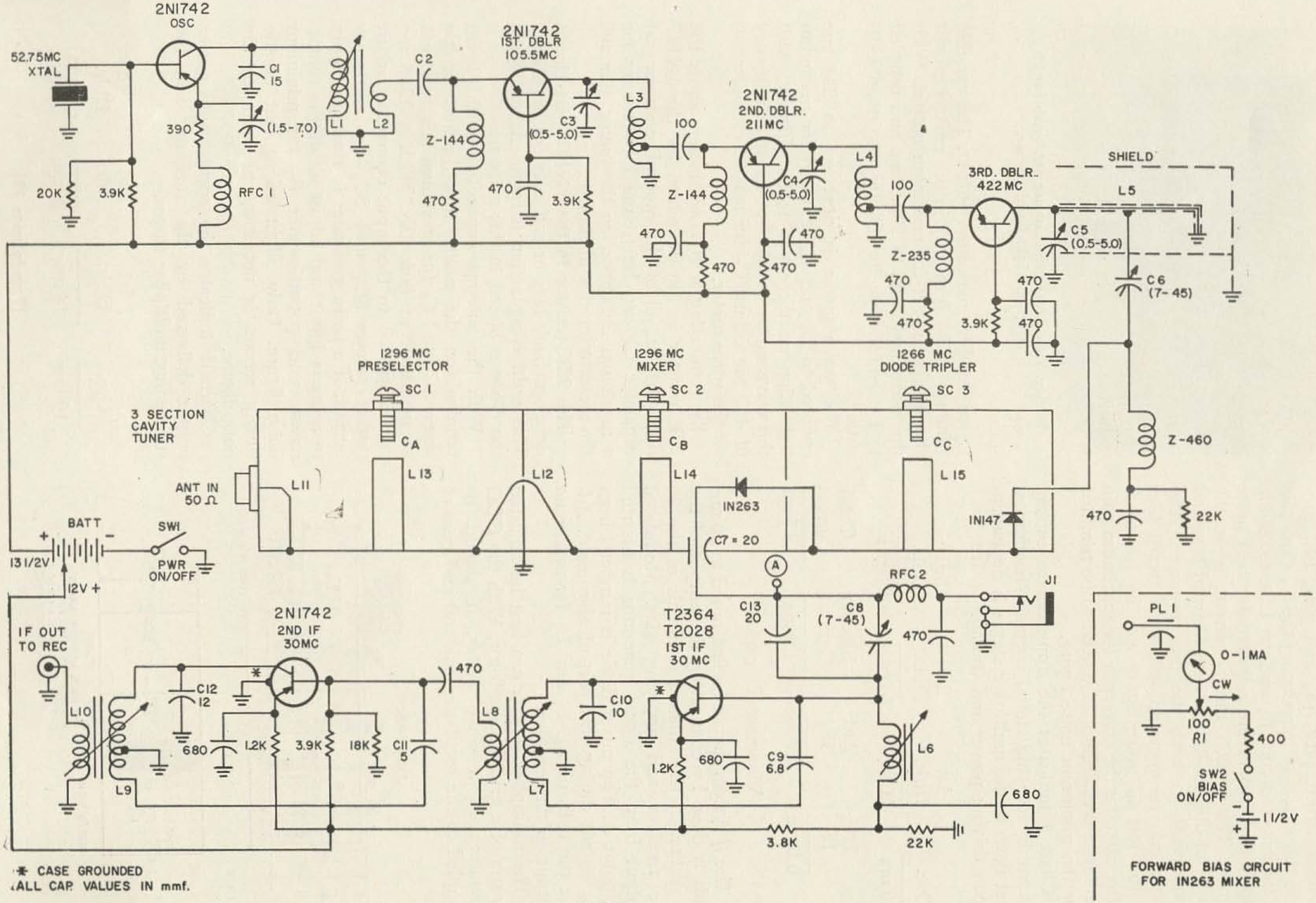

2N1742
OSC
52.75MC
XTAL
C1
15
(1.5-7.0)
390
20K
3.9K
RFC 1
L1
L2
C2
2N1742
IST. DBLR
105.5MC
Z-144
470
470
C3
(0.5-5.0)
3.9K
L3
100
2N1742
2ND. DBLR.
211MC
Z-144
C4
(0.5-5.0)
470
470
470
470
L4
100
3RD. DBLR.
422 MC
SHIELD
L5
C5
(0.5-5.0)
Z-235
470
470
3.9K
470
470
C6
(7-45)
1296 MC
PRESELECTOR
SC 1
1296 MC
MIXER
SC 2
1266 MC
DIODE TRIPLER
SC 3
3 SECTION
CAVITY
TUNER
CA
CB
CC
ANT IN
50 Ω
L11
L13
L12
L14
L15
IN263
IN147
Z-460
470
22K
C7 = 20
BATT
13 1/2V
12V +
SW1
PWR
ON/OFF
A
RFC 2
J1
C13
20
C8
(7-45)
470
IF OUT
TO REC
2N1742
2ND IF
30MC
C12
12
L10
L9
680
1.2K
3.9K
18K
C11
5
470
L8
L7
C10
10
T2364
T2028
IST IF
30 MC
1.2K
680
C9
6.8
L6
680
3.8K
22K
PL 1
0-1 MA
CW
100
R1
400
SW2
BIAS
ON/OFF
1 1/2V
FORWARD BIAS CIRCUIT
FOR IN263 MIXER
* CASE GROUNDED
ALL CAP. VALUES IN mmf.

FIG. 1

diode mixer gives about a 3 db improvement in noise figure. Jack, JK_1 and plug, PL_1 provide the means of introducing the forward bias in the mixer circuit. R_1 and the 1266 mc diode tripler tank circuit are adjusted for best noise figure. The 1N263 mixer current is in the range of 300 to 400 μa with forward bias and about 200 μa with the bias removed. The mixer can be operated without forward bias if the loss in noise figure can be tolerated. After aligning the converter for maximum gain the input preselectors may need to be trimmed for the minimum noise figure.

Chart I indicates the approximate current drawn by the individual stages. The current that flows in the multiplier stages is dependent upon driving power and tuning.

Osc.	1st Dblr.	2nd Dblr.	3rd Dblr.
5.0 ma	3.0 ma	5.0 ma	2.0 ma

1st IF	2nd IF	Bleeder Current	Total Current
0.6 ma	1.7 ma	1.2 ma	18.5 ma

Alignment Procedure

The *if* system should be first tuned to 30 mc. This is done by connecting the output of the *if* section to the antenna terminals of the 30 mc receiver and applying bias. Modulated output from the signal generator is inserted at point A. The mixer diode is removed from the circuit during this part of alignment. Adjust the coils of L_6, L_7 and L_9 for maximum output on the receiver.

The multiplier section can best be adjusted by use of a grid dip oscillator. With the GDO operating as a wave meter, it should be coupled to the oscillator tank coil and core of

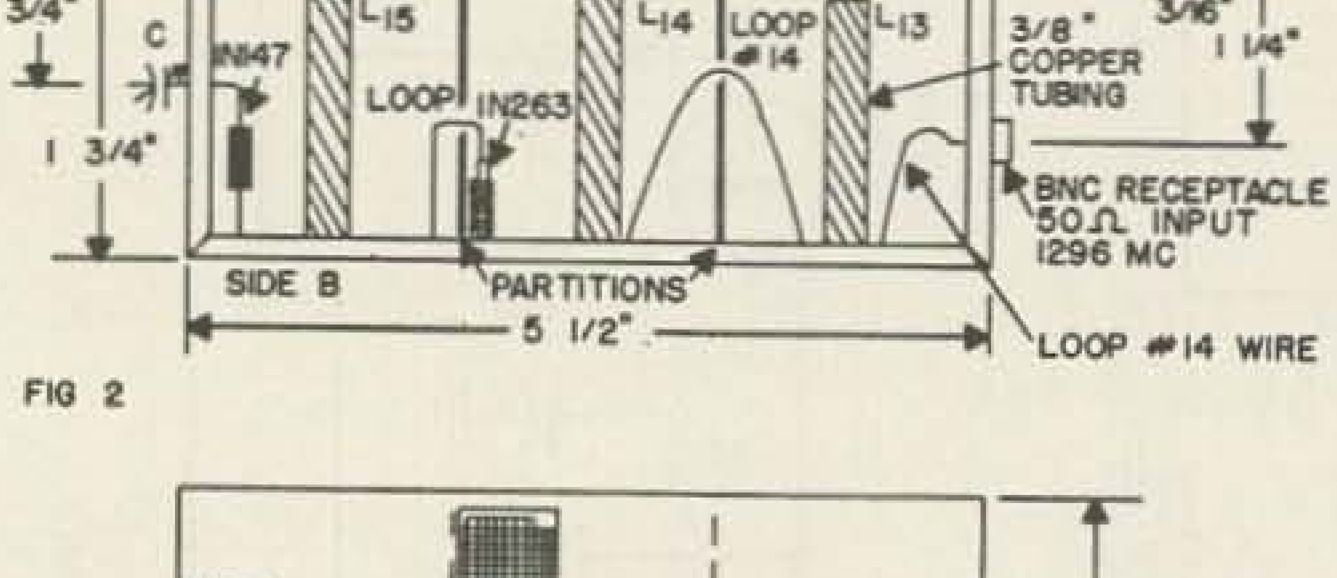


FIG 2

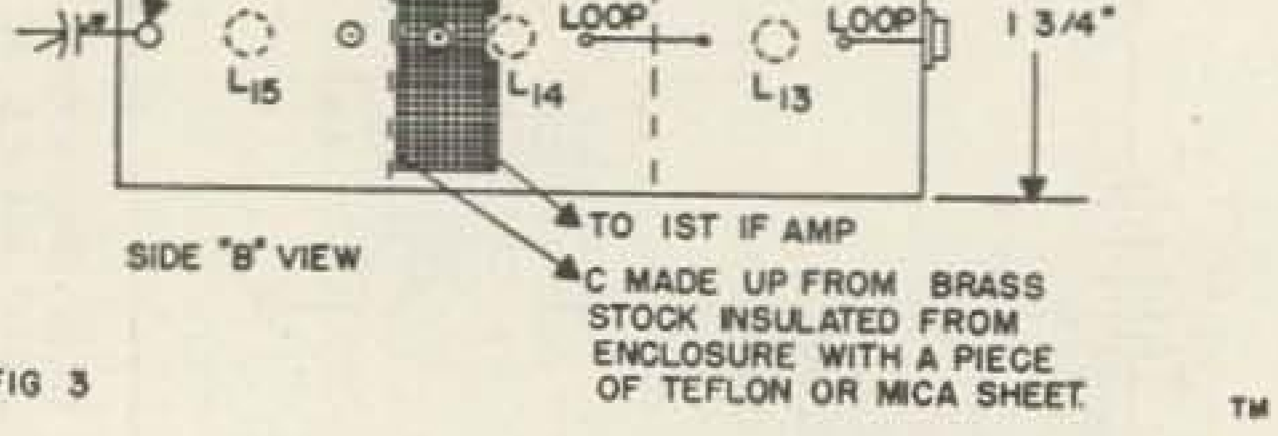
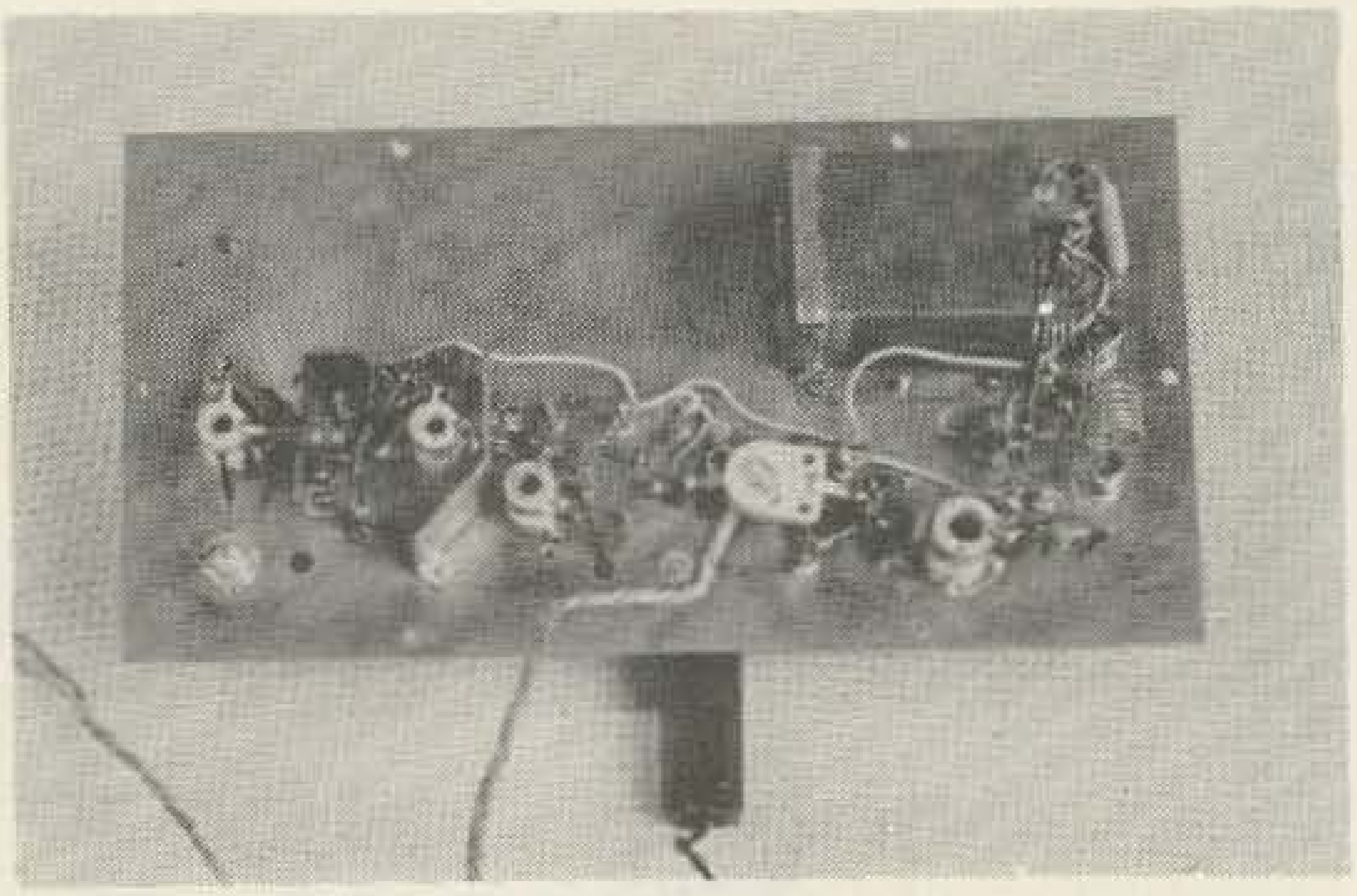


FIG 3

TM



Bottom View—Note the copper enclosure for L5 in upper right hand corner.

L_1 adjusted for maximum output. The variable trimmer (1.5-7.0 mmfd) in the emitter circuit should also be set for maximum output. With the wave meter set to 105.5 mc and coupled to L_3, adjust capacitor C_3 for maximum indication.

The wave meter is next set to 211 mc coupled to L_4 and C_4 adjusted for maximum indication on the wave meter. Finally, with the wave meter coupled to L_5 at a frequency of 422 mc, adjust C_5 for maximum indication on the wave meter.

By connecting a 0-5 ma meter across the 22K resistor in the dc return for the 1N147 diode tripler, all of the multiplier stages and capacitor C_6 can be trimmed by tuning for a maximum indication on the meter. Remove the meter after this alignment.

The 22K resistor in the 1N147 bias circuit develops back bias or self bias for the diode. The multiplying action is more efficient when the diode is biased in this manner.

With the antenna connected to the input terminal on the cavity tuner, adjust tuning screw SC_3 and C_6 for maximum mixer current as measured at Jack JK_1. With a 1296 mc signal applied to the input connector, adjust tuning screws SC_1 and SC_2 for maximum output. If a noise generator is available, apply to antenna input and adjust all of the tuning screws and potentiometer R_1 for minimum noise figure. Only slight adjustment of the tuning screws is necessary to optimize the noise figure.

Chart II indicates the approximate power output delivered by the oscillator and the succeeding multiplier stages.

Osc.	1st Dblr.	2nd Dblr.	3rd Dblr.
10 mw	14 mw	9 mw	6 mw

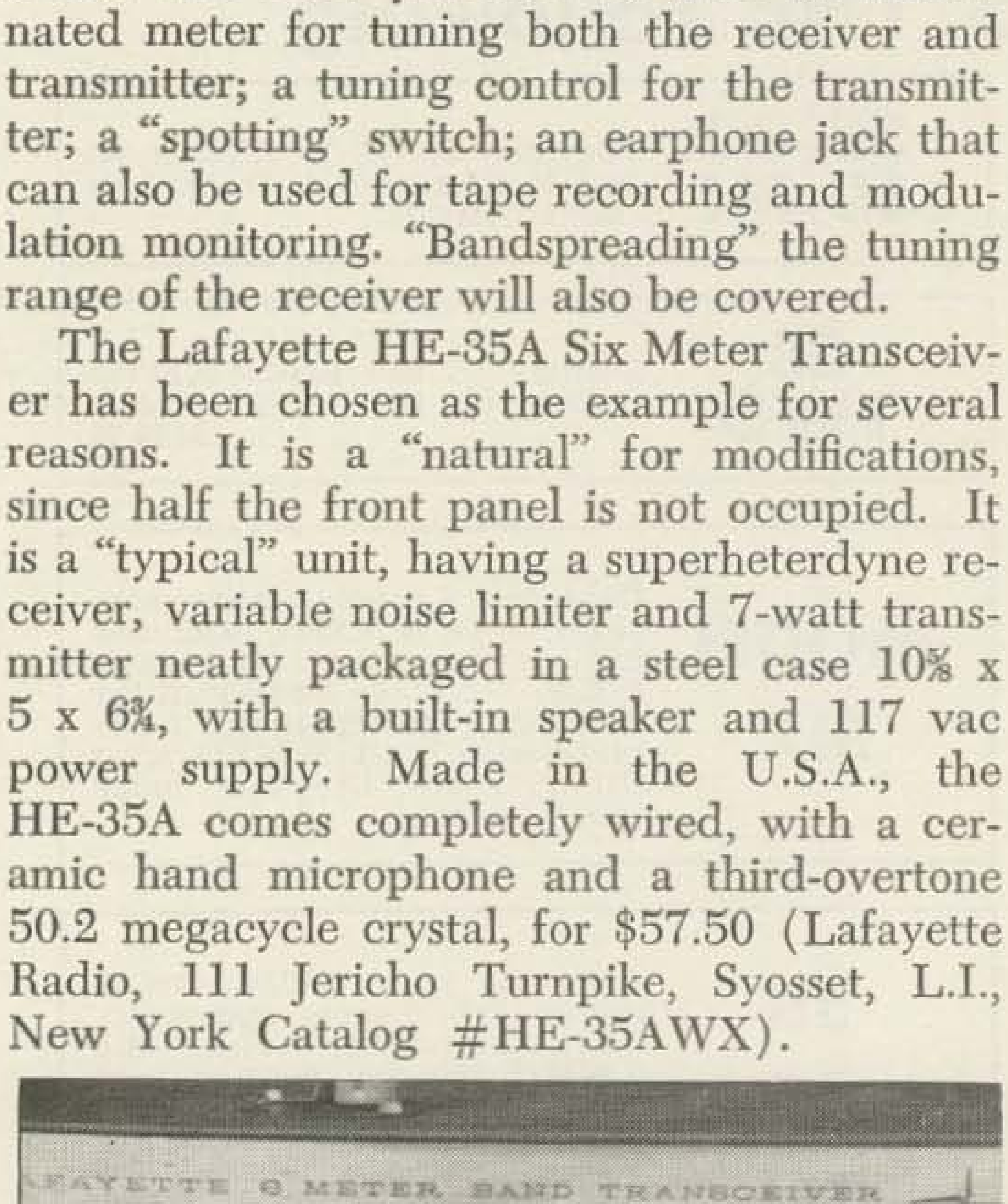
(Turn to page 79)

Deluxe your Transceiver

Fred Blechman K6UGT
23958 Archwood Street
Canoga Park, California

IF you would like to add some "deluxe" features to your inexpensive transceiver, this article will show you how to add: an illuminated meter for tuning both the receiver and transmitter; a tuning control for the transmitter; a "spotting" switch; an earphone jack that can also be used for tape recording and modulation monitoring. "Bandspreading" the tuning range of the receiver will also be covered.

The Lafayette HE-35A Six Meter Transceiver has been chosen as the example for several reasons. It is a "natural" for modifications, since half the front panel is not occupied. It is a "typical" unit, having a superheterdyne receiver, variable noise limiter and 7-watt transmitter neatly packaged in a steel case 10⅝ x 5 x 6¾, with a built-in speaker and 117 vac power supply. Made in the U.S.A., the HE-35A comes completely wired, with a ceramic hand microphone and a third-overtone 50.2 megacycle crystal, for $57.50 (Lafayette Radio, 111 Jericho Turnpike, Syosset, L.I., New York Catalog #HE-35AWX).



G-16—The front panel of the "Deluxe" HE-35A. The small switch under the meter turns on two small bulbs included in the meter case. Note the added "pointer" on the receiver tuning dial.

Two other nationally available transceivers are virtually identical to the HE-35A: The Lincoln 6 Meter Transceiver (Allied Radio, 100 N. Western Ave., Chicago, Illinois. Catalog #78SZ195, $57.50) and the DeWald 6 Meter Transceiver, Model TR-850 (Burstein-Applebee Company, 1012 McGee St., Kansas City 6, Missouri Catalog #35A468, $69.95). Ready-wired power supplies are available for 6 or 12 volt mobile use that plug into the cigarette lighter for connection to the battery, and plug onto the back of the transceiver.

The modifications described are relatively simple, and enough explanation is given to allow their application to similar Amateur and Citizens-Band equipment.

Adding A Meter

Perhaps the most desirable change to any piece of communications equipment, not already having a tuning device, is the addition of a meter. Normally, this is a relatively expensive device, and consumes a lot of panel space. However, with the availability of the Lafayette TM-11 Illuminated "S" Meter, the expense and space problem has been overcome. Only 1⅝ inch square, with a sensitivity of 1 milliampere full-scale, jeweled bearings, plastic front, 3-color dial face with 3 sets of scales, and two built-in grain-of-wheat bulbs for 6 or 12 volt illumination, this meter sells for only $2.95! It is added to the HE-35A front panel as shown in Photo G-16. A single-pole-single-throw (SPST) slide switch (S2) is placed directly below the meter to control the built-in bulbs. A double-pole-double-throw (DPDT) toggle switch (SI) is used to select meter function, and it is placed alongside the meter.

The meter serves three useful purposes when wired as shown in Fig. 1. With the meter selector switch (SI) in the "S-Meter" position, the relative strength of incoming signals is shown, and the receiver can be tuned to the "center" of the received carrier; also, when used with the "spot" switch described further on, it gives definite indication of transmitting crystal activity and frequency on the receiver dial. In the "RF Output" position of

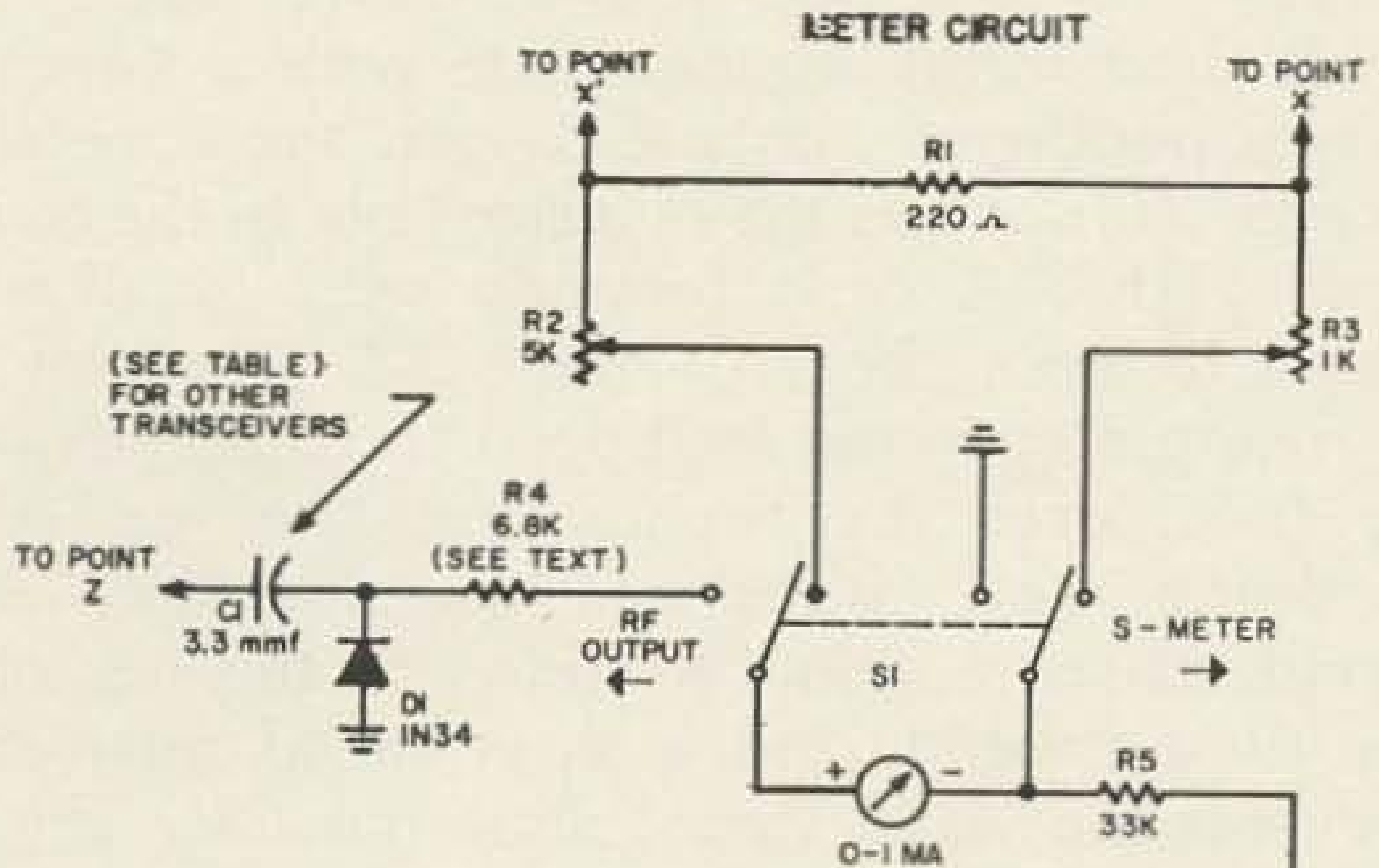


FIG. 1

S1, the transmitter final tuning capacitor may be adjusted for maximum output on the meter.

To add the meter circuit break the connection at "X." This can be located by following the normally-connected lead of the transmit receive switch. This lead goes to a terminal strip under the chassis. Locate the 10K resistor (brown, black, orange) that goes to pin 3 of V2 (via the *if* can), and disconnect this resistor from the terminal strip. Connect this free end of the resistor to an unused lug of the terminal strip. Now wire in the circuit in Fig. 1.

An explanation of the circuit allows its use in almost any transceiver. When SI is in the "S-Meter" position, fixed resistors RI and R5, and variable resistor R3, form three legs of

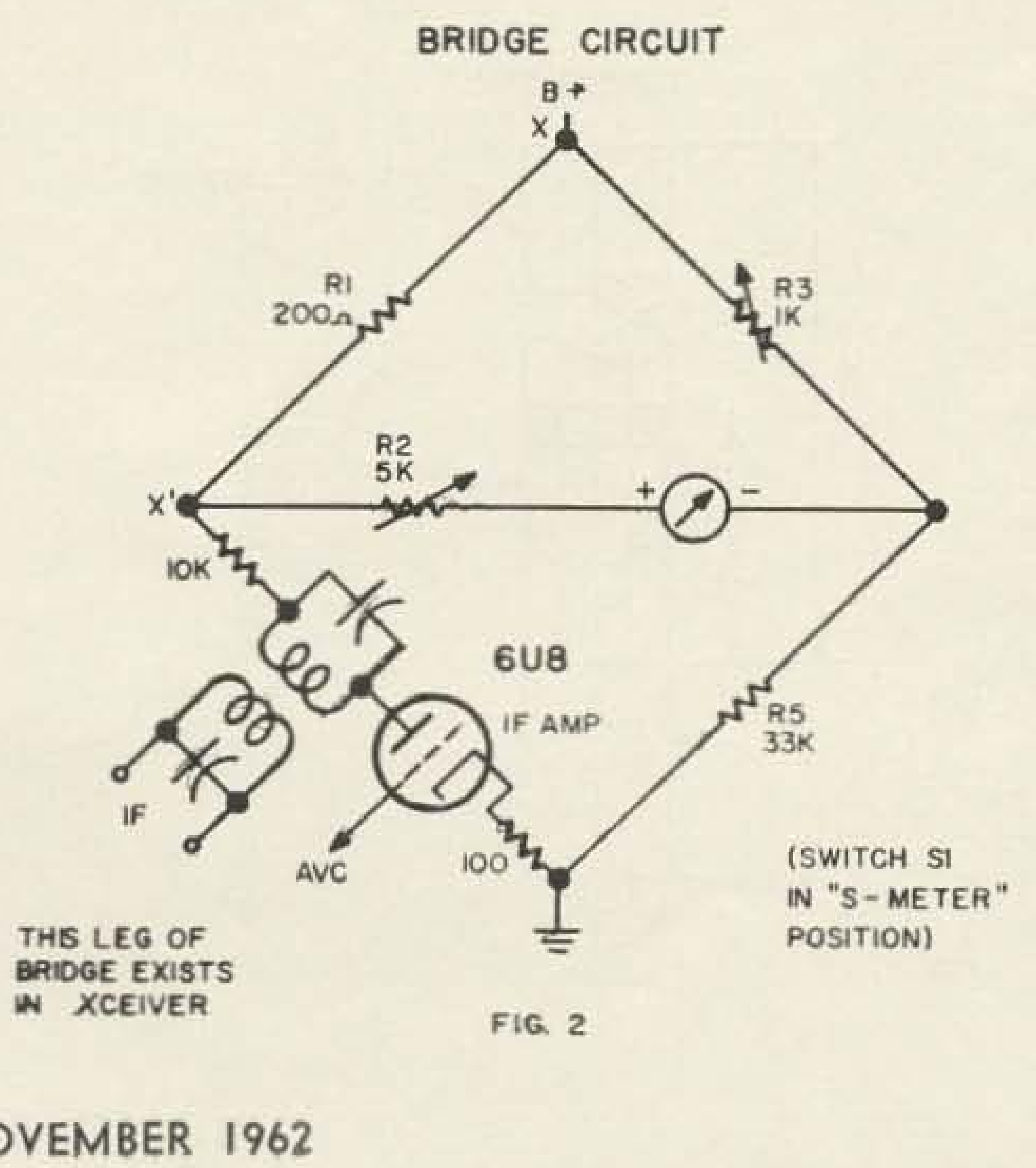


FIG. 2

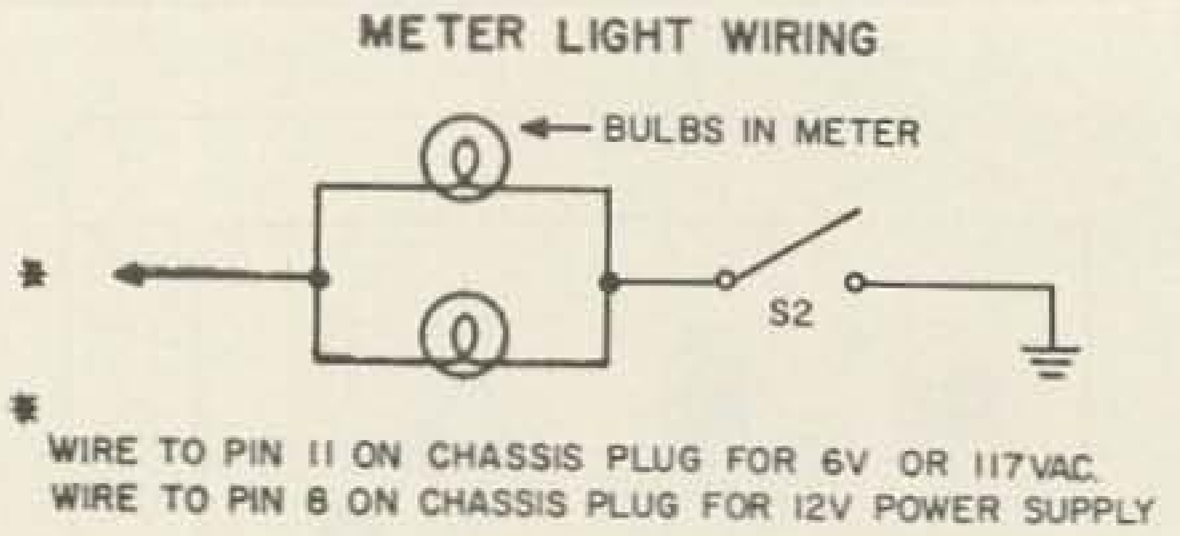


FIG. 3

a Wheatstone Bridge circuit, with the transceiver *if* amplifier circuitry as the fourth leg. See simplified schematic, Fig. 2. The meter is used as a voltmeter across the bridge output, with R2 used to limit meter current. The bridge is powered at point X, and is balanced in a no-signal condition by adjusting R3 for a zero meter reading (about 400 ohms). When a signal is received, the receiver AVC action changes the impedance of the *if* amplifier leg of the bridge, thus throwing the bridge out of balance, and creating a voltage across the series combination of R2 and the meter. R2 is adjusted for a full scale reading (about 1300 ohms) on the strongest local signal. Do not be alarmed if the meter "pins" when the transceiver is turned on; the bridge is severely unbalanced for a few seconds until the *if* tube warms up.

The meter lights should be connected as shown in Fig. 3. If to be used on 6 volts or 117 VAC, connect to chassis plug pin 11. For 12 volts use only, connect to pin 8. Switch S2 is in the circuit to allow the meter illumination to be shut off when not needed, since the bulbs have a limited life (about 50 hours on 12 volts).

When S1 is in the "RF Output" position, radio frequency energy from the antenna connection is coupled thru C1 and rectified by D1, with the resultant dc voltage fed to the meter through R4. The reactance of C1 should be approximately 1000 ohms at the operating frequency, so the rf power drawn by the meter is negligible compared to the much lower antenna impedance of around 50 ohms. Suggested values of C1 for various frequencies are shown in Table I. The value of R4 should be selected to provide near-full-scale reading when the transmitter is tuned to maximum output into the antenna to be used. The meter reading is only to indicate relative output on a given antenna, and will give different maximum readings with different antennae; it is essentially an rf voltmeter, and therefore reads the standing wave voltage on the antenna line at the point to which it is connected.

When changing crystals in the HE-35A, it is usually only necessary to adjust the variable slug-tuned capacitor (C-1) for maximum output on the meter. Slug L-4 and capacitor C-4 can be adjusted to cover a broad range of crystal frequencies, and very little is gained by retuning them each time the crystal is changed. As shown in Fig. 4, a tuning wand to adjust C-1 may be made from ¼ inch diameter polystyrene tubing. A thin metal sliver, or a piece of fine music wire, is heated and inserted through the side of the tubing to form a "key" for the slot in the tuning slug. A small sheet-metal adapter plate with a ¼-inch hole is positioned above C-1 with sheet metal screws. This covers the oversize hole in the top of the HE-35A case, formerly used to allow access to tuning both C-1 and C-4. The polystyrene tuning wand is slipped thru the adapter hole, over the tuning slug, and turned until the "key" drops into the slug slot. A round set-screw knob is added to the top of the tuning wand, and a sheet metal retainer prevents the wand from falling out. See Figure 5. CAUTION: Be sure to remove the wand before attempting to remove the HE-35A from its case.

Spotting Switch

The addition of a "spotting switch" to a transceiver allows the operator to locate his own transmitting frequency on the receiver dial. This is useful for receiver calibration purposes and to judge the frequency of an incoming signal. If your transmitter has a variable-frequency oscillator (VFO), a spotting switch allows you to "zero-beat" (match the frequency) of an incoming signal. The addition of a spotting switch is usually a simple wiring job, and the HE-35A is a good example as shown in Figure 6. Break the connection between pins 1 and 6 of the oscillator-amplifier tube (6CX8 V4) and add a SPDT pushbutton

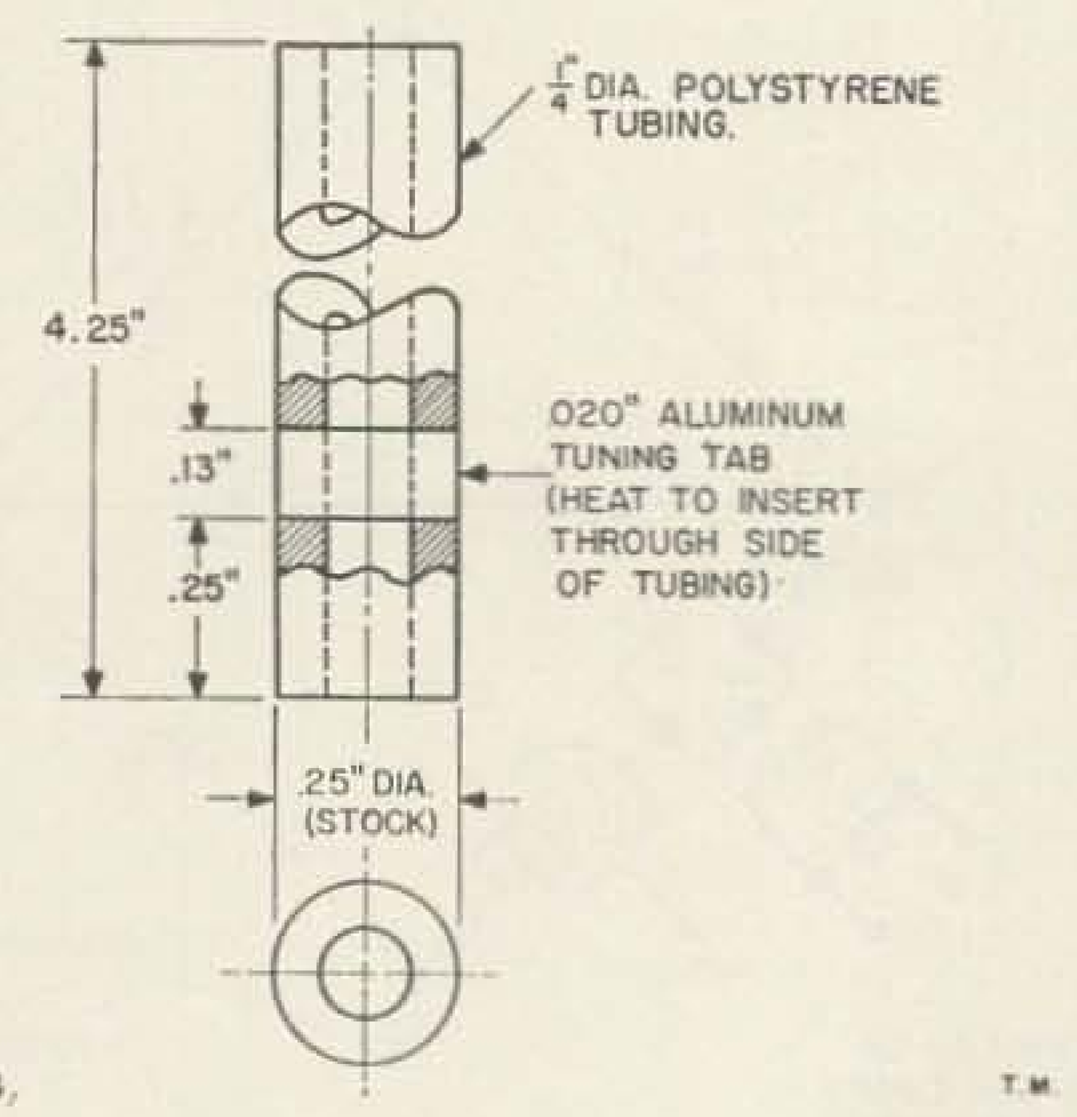
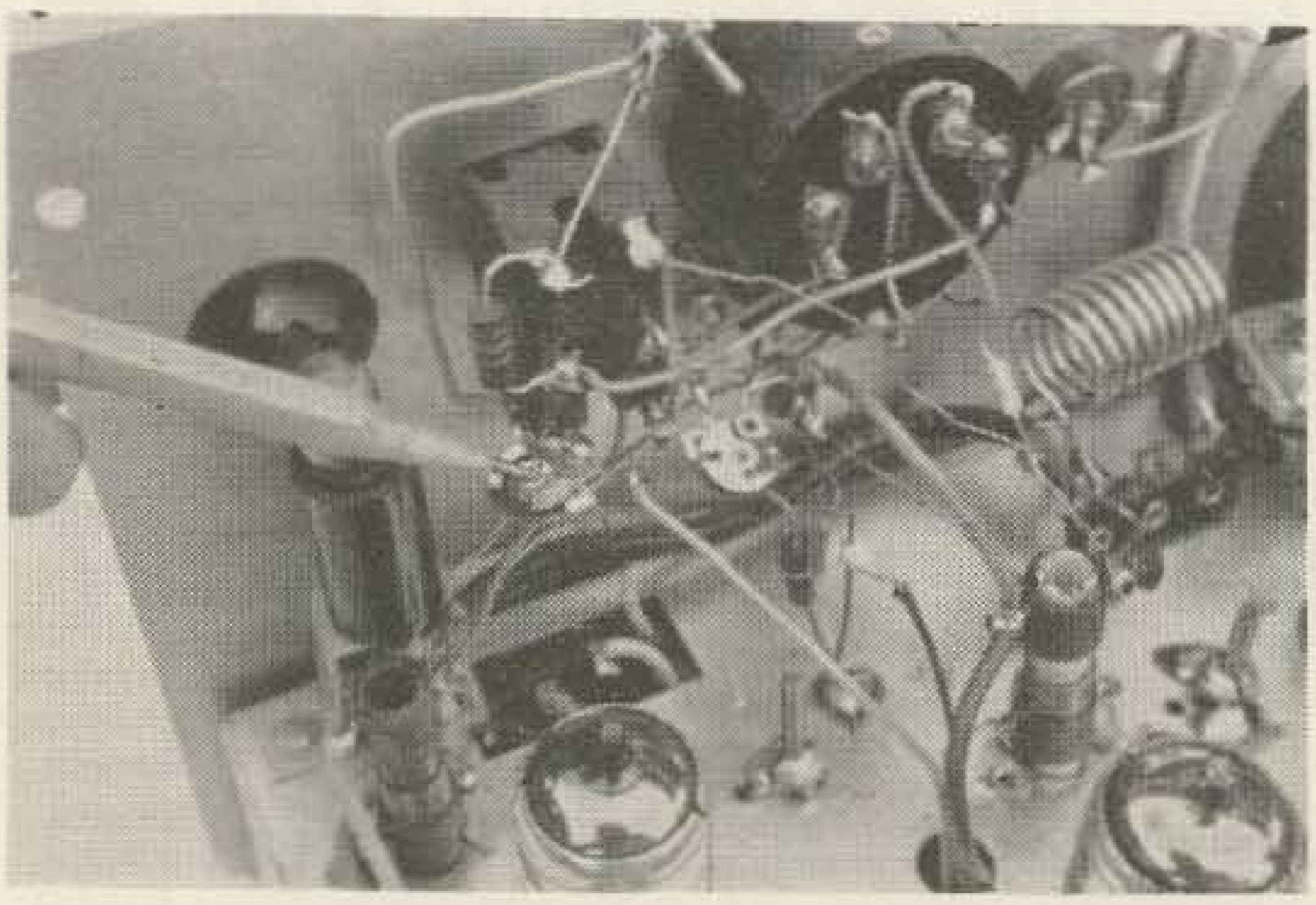


FIG. 4.



H-16—Behind-panel view of the "Deluxe" HE-35A. Point-to-point wiring was used, since the author's unit is not being used mobile. However, tie points or terminal strips should be used for the new wiring junctions if the unit is going to be subjected to rough handling. Note the ultra-miniature variable resistors used to "align" the S-meter circuit.

switch (S3), mounted below S1 on the front panel. When S3 is in its normal position, pins 1 and 6 of V4 are connected to the transmit-receive switch as before. However, when the spotting switch is depressed, only the oscillator cathode of the tube is grounded, while the receiver is operating. This allows the oscillator to generate a relatively low-level rf signal on the crystal frequency which does not "block" the receiver. Using the newly installed S-meter, tune the receiver for maximum, and that's the "spot" on the dial at which you'll be transmitting in normal operation. Various crystals can be used to calibrate the receiver dial in this manner.

Speaker Selector Switch and Jack

It is often desirable to use earphones in place of the speaker to prevent disturbing others. A jack on the front panel can accommodate this need. This jack can also be used

TUNING WAND INSTALLATION

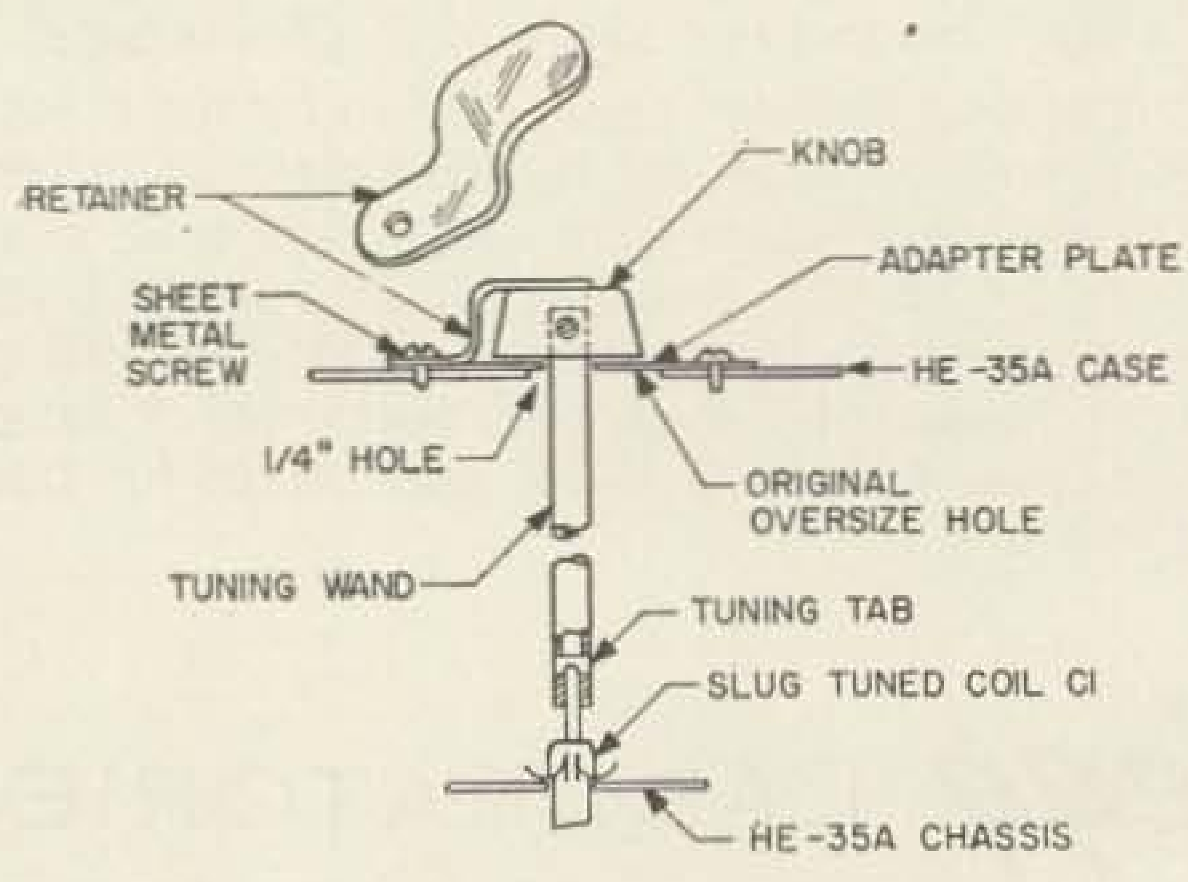


FIG. 5

on those occasions when tape recording from the air is desired, such as when receiving a message or running modulation tests. However, if the jack disables the speaker, you can't hear what's being recorded! Also, sometimes you want to check your own modulation to verify proper operation of the microphone and speech amplifier circuitry. Your choice of the above can be accomplished by adding speaker selector switch (S4) and earphone jack (J1) as shown in Fig. 7.

Note that J1 must be *insulated from the panel* of the HE-35A with the insulating washers called out in the parts list! Connect J1 across loudspeaker voice coil. When the transceiver switch is in the receive position the jack receives the signal from the output transformer.

SPOTTING SWITCH

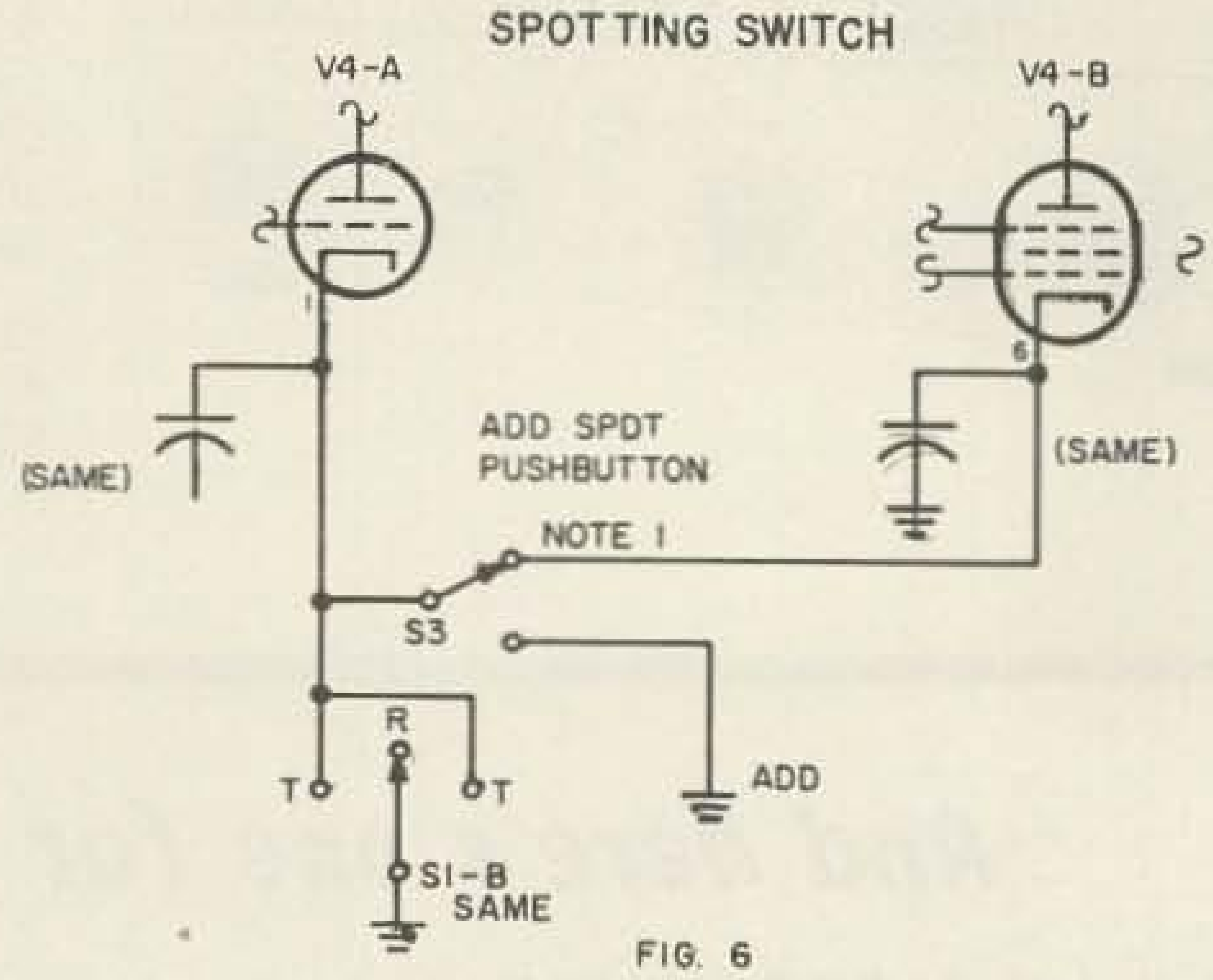


FIG. 6

NOTES:

1. Remove jumper from pin 1 and add Lafayette MS-449 pushbutton switch as shown.
2. Tune for max. on S meter for SPDT.

In operation, S4 is left in the "on" position. When earphones or a tape recorder input plug are inserted in J1, S4 may be left "on" to monitor, or placed in the center "off" position to disable the speaker. When transmitting, if S4 is put in the "monitor" position, the speaker will monitor your modulation. R6 is used to prevent overloading the speaker and reduce acoustic feedback. If howling and

TABLE I

FREQ. (mc)	CI (mmfd)
3.5	47
7	22
14	10
21	6.3
27	5.0
30	5.0
50	3.3
144	1.0

whistling are evident in this mode of operation, increase the value of R6.

Bandspread

Most 6 meter and Citizens-Band receivers cover the entire band, but it may be desired to tune only part of the band. This allows less critical tuning, making it somewhat easier to separate adjacent stations, and to tune quickly without missing a station. On 6 meters only the first two megacycles of the 50-54 megacycle band are active, so the HE-35A was modified to tune only to 50-52 megacycles. This was accomplished by merely changing the 15 mmfd capacitor in series with the tuning capacitor to a 6.8 mmfd NPO (zero drift) unit. Various other values may be tried to "spread" the tuning range the desired amount. The smaller the value of the substitute capacitor, the smaller the portion of the band covered. It will be necessary in each case to reset the receiver oscillator slug (L-3) to bring the desired portion of the band in the tuning range of the receiver.

If your tuning arrangement is not like the HE-35A, bandspread may not be a simple matter. The better superheterodyne receivers have dual-ganged tuning capacitors for improved selectivity and image rejection. The HE-35A has a broad-band RF amplifier, and only the oscillator is tuned by the front panel control for station selection. In most superregenerative receivers, however, the tuning arrangement is similar to the HE-35A and the series capacitor, as shown here, will provide

SPEAKER SELECTOR

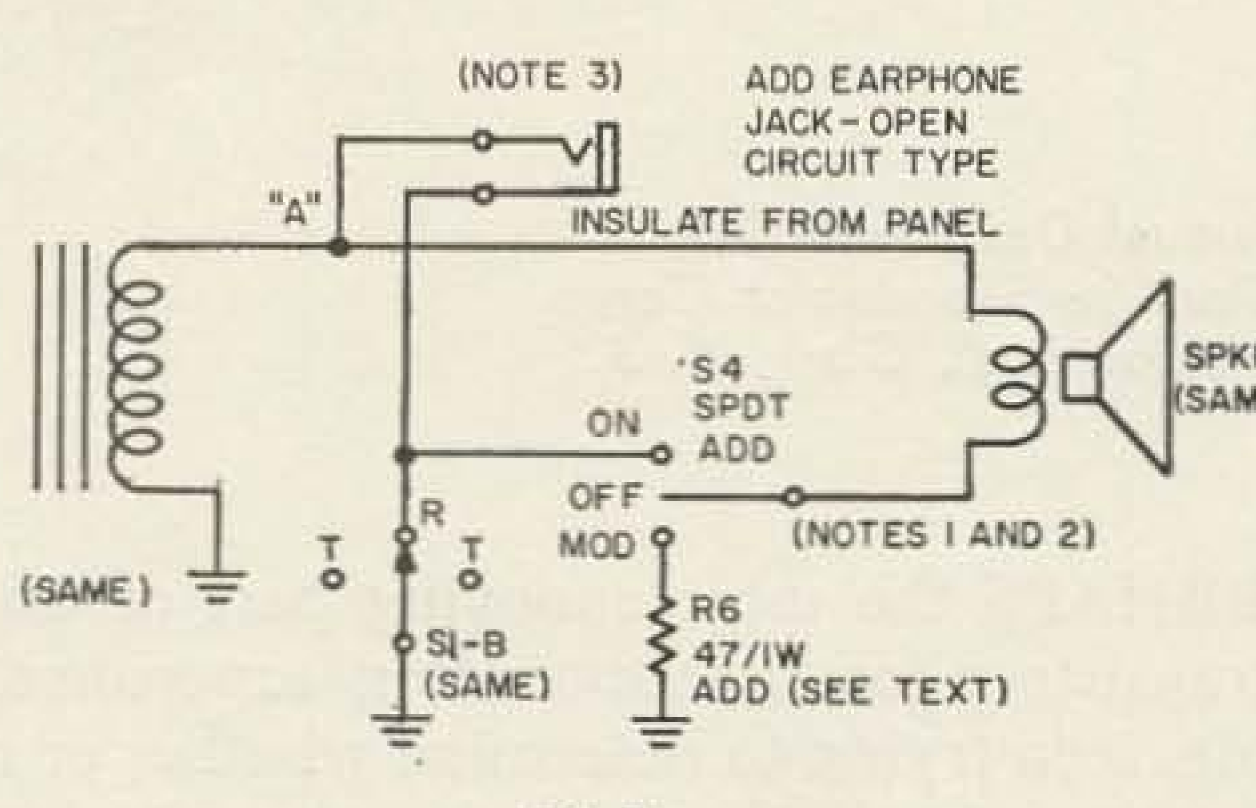
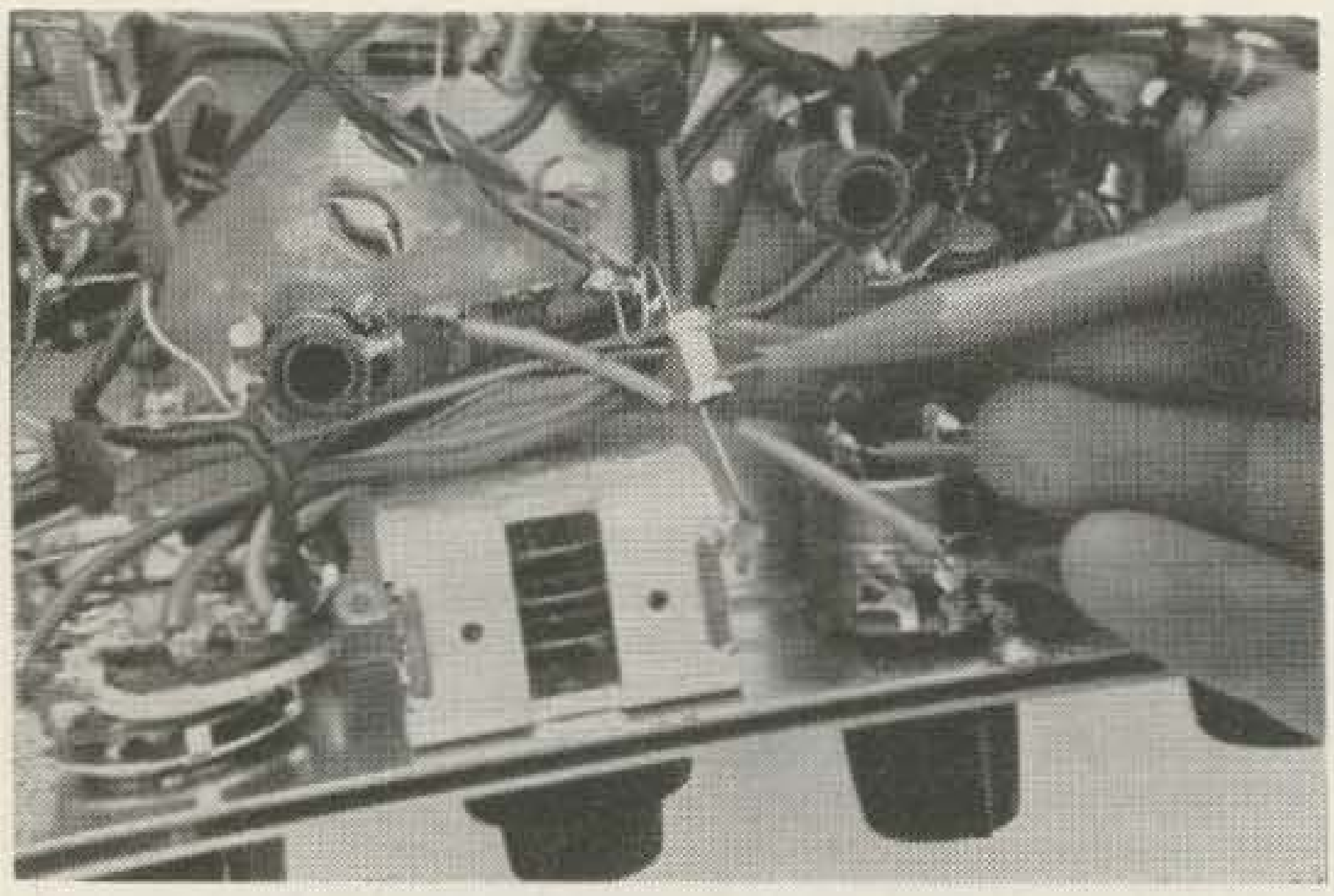


FIG. 7

NOTES:

1. Switch should be SPDT center off.
2. Position 1: Speaker on
   Position 2: Speaker off
   Position 3: Modulation monitor (when transmitting or testing mike)
3. This jack may be used for input to tape recorder. Switch allows monitoring while recording.
4. Earphones: 6-2000 ohms.



H-17—Under the HE-35A chassis. Changing the capacitor indicated (the new one is shown) will "bandspread" the receiver.

bandspread.

Reading the receiver dial of the HE-35A is somewhat of a guess, since the indicator dot on the tuning knob is far from the numbers on the panel, and parallax is extreme. This can be corrected by simply gluing a thin triangular-shaped piece of plastic or celluloid to the bottom of the main tuning knob after scratching a line in the plastic and filling it with white ink to act as a "pointer."

There are many other potential changes to a versatile rig like the HE-35A. Conversion of the oscillator to use cheaper 8 MC. crystals in place of the presently used third overtone crystals, could be done by adding another tube. However, this is not such a simple change, and the harmonics generated could lead to television interference problems. Front-panel tuning of the transmitter output would be nice, but hardly worth all the trouble. Addition of a beat frequency oscillator (BFO) to receive CW code would be useful to only a limited number of operators; transmitting CW would require the addition of a keying jack, and "chirp" would be a problem.

The HE-35A and similar units will look better and be more efficient and convenient to operate if the changes described are incorporated. The effort and cost are small; the result: a deluxe transceiver!

. . . K6UGT

PARTS LIST

R1—220 ohm ½ watt composition resistor.
R2—5000 ohm variable resistor (Lafayette VC-58 29¢)
R3—1000 ohm variable resistor (Lafayette VC-57 29¢)
R4—6.8 K ½ watt composition resistor (see text)
R5—33k ½ watt composition resistor
R6—47 ohm 1 watt composition resistor (see text)
S1—DPDT toggle switch (Lafayette SW-22 32¢)
S2—SPST slide switch (Lafayette SW-14 9¢)
S3—SPDT pushbutton switch (Lafayette MS-449 19¢)
S4—SPDT center off toggle switch (Lafayette SW-27 39¢)
C1—See Table I
C—bandspread—6.8 uufd. NPO (Allied Radio 19L960 29¢) (see text)
M1—0-1 ma. meter (Lafayette TM-11 $2.95)
J1—Open circuit phone jack (Lafayette MS-441 19¢)
Insulating washers for J1: Lafayette P-204 35¢/box of 20
¼ diameter polystyrene tubing (Lafayette P-470 10¢)

Junction Checks

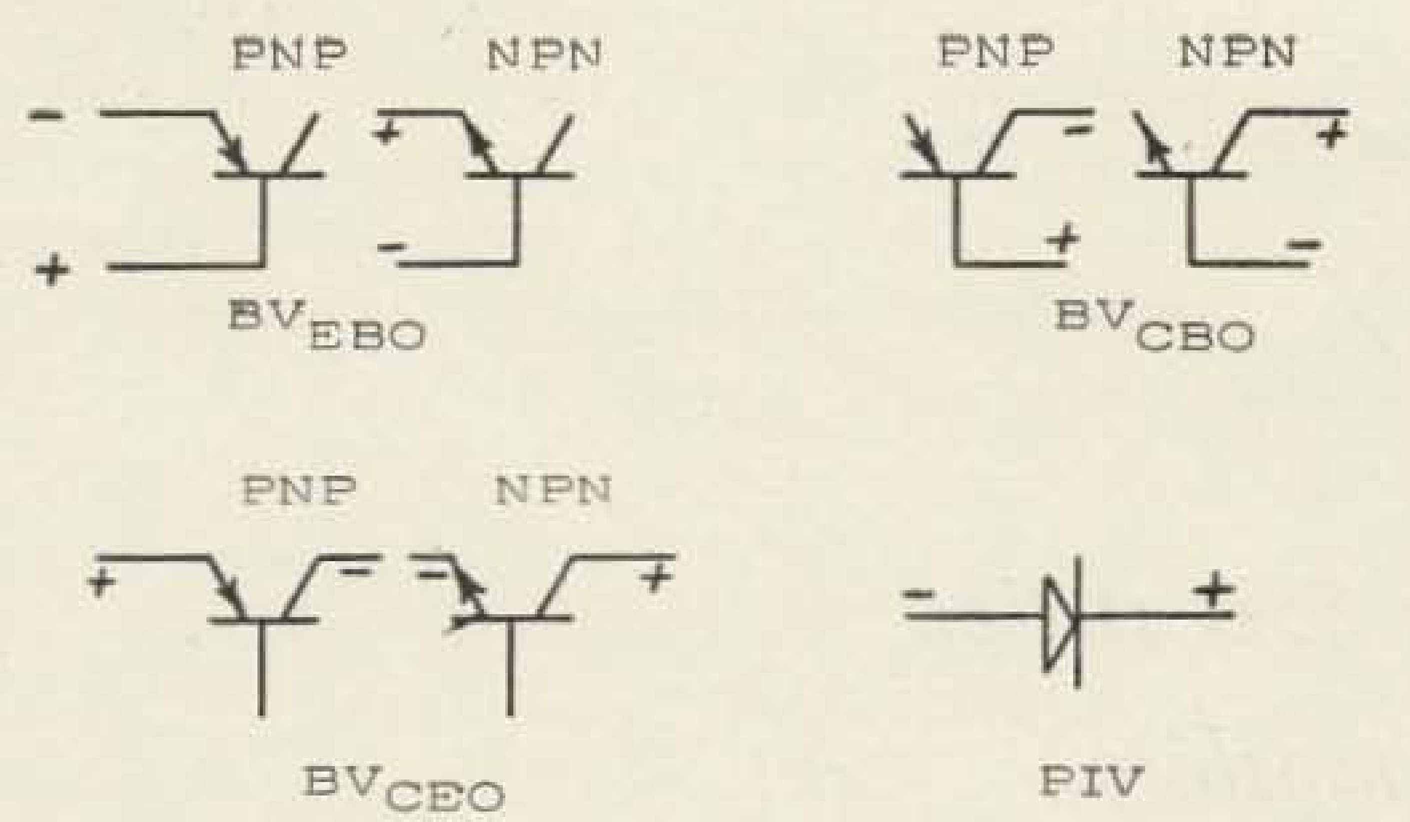
Quick and Dirty

Samuel Daskam K2OPI
Clark Semiconductor Corp.
Walnut Ave., Clark, N. J.

PERHAPS the most annoying part of using transistors for breadboarding experimental circuits is in trying to determine whether or not the junctions are still good after the initial use. There are many types of transistors and rectifiers on the surplus market, some of which have to be bought "as is." Without some kind of measuring instrument to check the collector-to-base and emitter-to-base junctions, it is very difficult to utilize these devices.

A method is described here which utilizes a resistance-capacitance comparator bridge. This instrument is widely used by many experimenters and a new application of existing equipment is always welcome. Although an Eico Model 950B Bridge was used to investigate this application, other makes should work equally well.

The "electrolytic test" position of the bridge is normally used for checking the leakage of electrolytic capacitors as a function of the voltage across the capacitor. As the voltage applied across the electrolytic is increased by turning the front panel control on the bridge, the relative leakage is indicated by the closing of the tuning eye.



Since a semiconductor rectifying junction acts in a manner similar to an electrolytic capacitor in a test such as this, it was only a matter of making a few experiments to determine if the RC Bridge could be used for checking transistors and rectifiers. Fig. 1 gives the hook-ups needed to measure the various breakdown voltages such as BVebo, BVcbo, BVceo, and the peak inverse voltage of rectifiers.

The procedure is simply to connect the transsistor or rectifier leads to the correct terminals of the bridge so that the applied voltage reverse biases the junction. The easiest way to make the connection is to use alligator clip leads. A voltmeter should also be connected across the terminals since loading down the bridge will cause inaccuracies in the voltage dial calibration. Next increase the voltage control and watch the magic eye tuning indicator. When the eye starts to close, the voltage is approaching the breakdown voltage of the junction. No harm will come to most transistors and rectifiers if the breakdown voltage is exceeded during this test, since only 4 or 5 milliamps are required to close the eye. The voltmeter reading will usually only go as far as the breakdown voltage of the junction under test regardless of the voltage setting. This is because loading the power supply in the bridge causes the voltage to be dropped internally. . . . K2OPI

The Continental Six

first six meter SSB station in New Hampshire

Paul Day W1PYM

Strange things are happening on six. In almost any part of the country nowadays, Donald Duck type noises can be heard on the low end of the 'phone band. The success of SSB on the lower bands has inspired not a few VHF men and several manufacturers to think about what it might do for six. With low band SSB exciters in common use, the logical approach seems to be a simple heterodyne converter. Several of these have appeared on the market and one of the neatest is the Continental "Six" designed by K4RLX.

Circuit Description

The Continental "Six" uses a 6U8 as a triode crystal oscillator/pentode buffer amplifier combination to provide a 36 mc local oscillator signal to the grid of a 5763 mixer. Output of a 14 mc exciter is injected through a tuned circuit in the screen of the mixer and the 50 mc sum frequency is selected by the 5763 plate circuit. A 2E26 operates as a straight through final amplifier on 50 mc. The final screen voltage is regulated by two OB2 miniature VR tubes. A 1N34 crystal diode coupled to the pi-section output tank provides relative output power indication on the front panel meter.

Controls and Adjustments

The front panel of the Continental "Six" consists of only two tuning adjustments, two switches, two indicator lamps and the meter. Nothing else is necessary and even these few controls may be left alone after initial adjustment. The 36 mc oscillator and amplifier tuning and the 5763 plate tank are slug tuned coils preset at the factory and normally need not be touched. These are located on the chassis and easily accessible with the case removed. The 2E26 plate tank is the familiar pi-section coupler. Its tuning and loading capacitors are the two controls on the front panel. One setting on these controls is normally all that is required for SSB operation, but they may need readjustment for frequency changes of 250 kc or more away from the original operating frequency. One of the switches on the front panel switches the 2E26 plate voltage off and on. The other selects either 2E26 plate current or relative power output to be read by the meter. A sensitivity adjustment for the power output position is provided inside the cabinet.

Trying it Out

So much for the internal workings. Now let's make it work and see what happens. Making it go is so easy it's hardly worth writing about. Simply plug in the power supply and the drive, connect your 6 meter antenna relay and away we go. A word of caution. The converter only needs 5 watts maximum of 20 meter drive. Most popular exciters provide much more than this and must be padded down. Continental has 3, 6, and 9 db pads available or roll your own, but don't put more than 5 watts in the input pipe. Full instructions for tuning up are provided in the instruction book. Once I had the sample unit tuned up, I never had to touch the controls again. In fact my exciter (a 32S1) required more retuning than the converter.

Results

After the initial tuning up and playing around to get the feel of operation, the first single sideband station on six in New Hampshire was put on the air. As luck would have it, I got going just too late to catch the Summer sporadic E season and had to be satisfied with local contacts. With a 3 element beam hardly off the ground good solid contacts were made all over southern New Hampshire and eastern Massachusetts. The exciter was recognized immediately as an S-Line by most of the regular SSB gang. Contacts were made on CW and AM as well with excellent results. In fact, anything the 32S1 would do on 20, it did on six with enough sock from just the barefoot converter to be heard. All in all the Continental "Six" seems destined to be the flyweight champ on six and should do its part to popularize SSB as a practical VHF mode of operation.

Continental "Six" Specifications

Power rating: 30 watts p.e.p. SSB and CW, reduced ratings on AM
Drive requirements: 1-5 watts from 20 meter source
Drive available at output for next stage: 15 watts minimum
Dimensions: 5 3/16 inches high, 8⅝ inches wide, and 11⅜ inches deep
Power supply required: 400 VDC at 100 ma.
150 VDC regulated at 30 ma.
6.3 VAC at 2 amperes

Price: $99.95

Letter

Dear Wayne:

I wish to compliment you on that portion of your editorial in October 73 which deals with the League. It has always been my feeling that membership in the League is much more than a mere subscription to QST and I encourage all amateurs to subscribe to more than one amateur magazine, but to consider that their League affiliation is their democratic voice in the internal affairs of amateur radio. Your description and explanation of ARRL should do much to put into proper focus the purpose of the League and to encourage all active amateurs to support it.

Do you anticipate any further aims of the Institute of Amateur Radio than that of the proposed ham flight to Europe? If so, I would be most interested in hearing about them with a consideration of charter membership.

Carl L. Smith W⌀BWJ
Director, Rocky Mtn. Division

The Institute will, if our mail is any indication, be involved with the fostering of technical improvements and dissemination of information on special amateur interests such as TV, RTTY, beacons, repeaters, scatter tests, moonbounce, etc.

Build Your Own Mobile Mike

Jim Kyle K5JKX

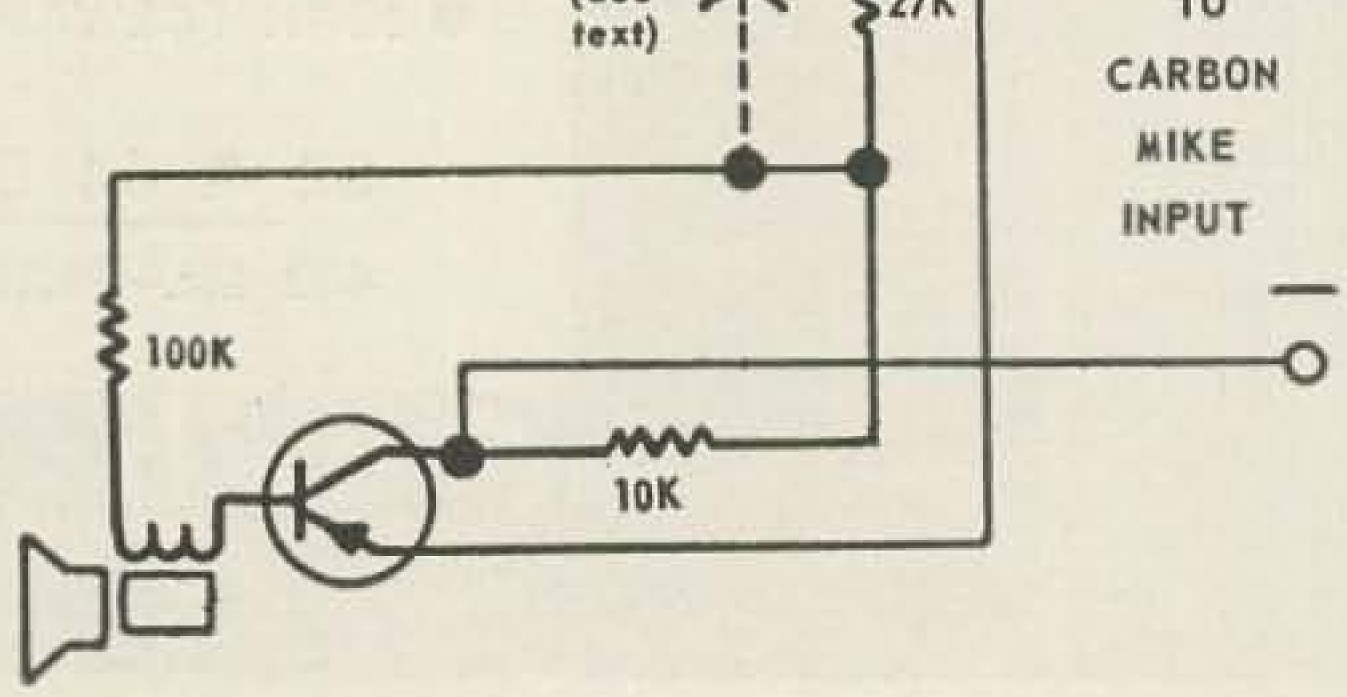
In the early days of transistors, one of the favorite construction projects for ham use was a transistorized microphone for mobile use.

The superb semiconductor is more than 10 years old now, and most of the homebrew-mike projects have long since gone by the boards, but here's one far simpler than any which appeared in print in earlier years—which can still find a place in most any mobile station.

The circuit is an adaptation of a custom mobile mike built by Two-Way Radio Communication Co., of Oklahoma City, for its customers, which in turn was an adaptation of the Shure transistor dynamic mike and the Motorola model of the Shure.

Its main feature is complete elimination of any dc power supply for the transistor. This mike is a plug-in replacement for any carbon microphone; the transistor is powered from the same source originally used to power the carbon button.

If you want to be as fancy as the commercial version, scrounge up an old Shure-type carbon



mike case and buy a Shure VR dynamic mike cartridge for approximately $15. On the other hand, if you're out to save some pennies here and there, use a tiny 2½-inch transistor-radio speaker and contrive a housing from brass, aluminum, or tin-can scraps.

In either event, you can put the circuit together most easily on either a printed-circuit board or a cardboard chassis. In addition to the transistor, all you need is the speaker or VR unit and three ½-watt resistors.

In operation, current through the 27K resistor produces a voltage drop. This voltage powers the single-stage common-emitter amplifier. Bias for the base is fed through the speaker coil. Ac generated by sound striking the cone is superimposed on the dc bias, and the transistor amplifies this up to approximately 1½ volts RMS output for average speech.

Virtually any common PNP transistor will work in the circuit as shown; the 2N107 is ideal and was used often in the commercial version. By simply switching polarity of the power leads, an NPN unit can be substituted.

Note that neither side of the circuit is grounded; this enables the mike to be connected to its plug in such a manner that power polarity is correct without introducing signal-ground problems. Occasionally, shunting the 27K resistor with a 10 mfd capacitor may boost output; however, it's not usually necessary.

The Quaker Electronics Crystal Etching and Grinding Kit

THERE ARE MANY surplus crystals around that fall just outside the ham bands, probably because the hams have already bought up the ones inside the bands. These crystals, almost useless to hams, are available for a ridiculously low price because of the lack of demand. Some hams have tried grinding these crystals to raise the frequency slightly, but the grinding method makes it difficult to make small changes. Small changes should be made by the more controllable method of etching, since with this process it is possible, with some practice, to get a frequency within a few cycles. A new kit, manufactured by Quaker Electronics, Mountain Top, Pa., and selling for only $3.50, makes the process of changing crystal frequencies so easy that you really can't afford not to own one.

The kit contains a package of Ammonium Bifluoride, used for etching the crystals, a package of grinding compound, six assorted crystal blanks, twelve assorted crystals in holders which can be modified for use on the ham bands or for practice, and the necessary tools.

With this kit it is possible to raise the frequency of a crystal from a few cycles to somewhat more than a megacycle. The crystal is ground until the area of the desired frequency is reached, and then etched to the exact frequency. Under some conditions this kit can even restore activity to somewhat inactive crystals.

The instructions are clear and well written, and good results can be obtained by anyone the first time. The instruction sheet has many hints in insure good results, as well as a diagram for a calibration oscillator.

The Ammonium Bifluoride can also be used to etch glass, numbers on tubes, etc. To do this, coat the glass object with paraffin and scratch the wax off where the etching is desired.

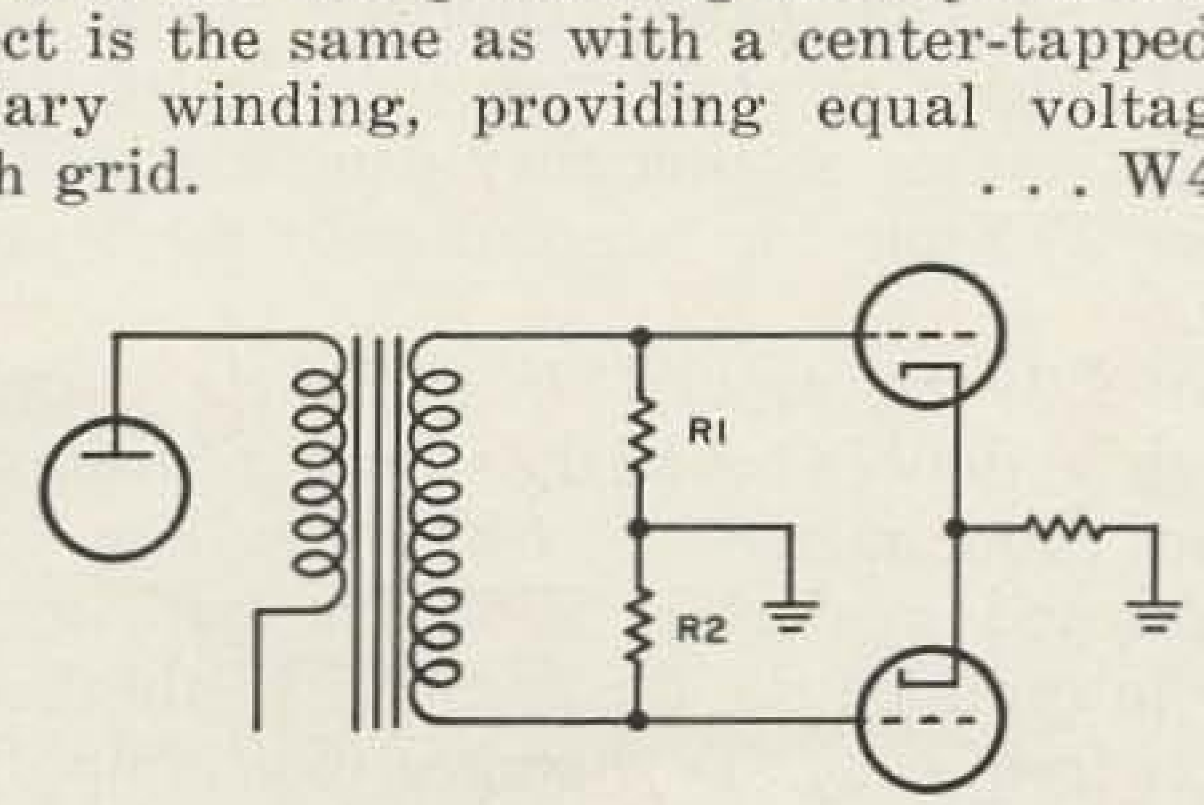
Results from this kit have been good. Several crystals were moved to within a few cycles of a frequency for VHF net operation and more moved from one part of the band to another.

This kit is quite a bargain at $3.50 and can be ordered from Quaker Electronics, Mountain Top, Pa. . . . WA2INM

Push - Pull

Few hams are blessed with a well stocked junk-box or a surplus of cash. The idea presented here is intended to help you make use of what is in your junk-box.

The diagram hereabouts shows how a driver transformer with a single un-tapped secondary may be used to drive tubes in push-pull. Since the voltage across resistors R1 and R2 is equal to the voltage across the secondary of the transformer, the midpoint of the transformer can be grounded effectively by making R1 equal to R2 and grounding their junction. The effect is the same as with a center-tapped secondary winding, providing equal voltage to each grid. . . . W4JKL



Charles Spitz W4API
Associate Editor

73 tests the Gonset Communicator IV-220

GONSET UTILIZED A LOT of engineering skill in producing six and two meter transceivers that were identical in appearance and performance. Now they have come out with a 220 mc Communicator that conforms to this pre-set pattern. In common with other Communicator models, the IV-220 is a transceiver in the functional sense only. It utilizes a separate transmitter and receiver with the only common portion being an audio section. Just like the six and two meter versions, the IV-220 has a directly calibrated and illuminated slide-rule receiver dial, geared by a dual ratio planetary drive for fast or slow tuning. The illuminated meter can be made to read signal strength, a frequency spot, or relative power output. The new model 3357 vfo shown in the photograph may be plugged into one of the six crystal sockets on the rear apron. The vfo dial is directly calibrated for the output frequencies of any of the Communicators, and even has a provision for FM!

Unfortunately the Gonset Company no longer gives out microphones as standard equipment, and this change has been carried over to the later two meter models. The IV-220 uses a standard three contact PJ-068 jack for the mike connector.

On older Communicators it was necessary to switch meter function between receive and transmit, and be restricted to push-to-talk operation. Not so on the IV-220! Transmitting on manual will automatically change meter function from S readings to power output. A spotting switch in the metering circuit shows not only your transmitting frequency, but the relative merit of your crystal by meter readings.

Receiver Section

There are many ways of arriving at 220 mc from some lower frequency, and the way that Gonset does it is interesting. The receiver portion of the system uses one of the new 6FY5 frame grid tubes as an rf amplifier, which is responsible for the low-noise front end. A 6J6 oscillator with an overtone crystal operating at 65.667 mc multiplies to 197 mc for injection into another 6FY5 which acts as the first mixer. The crystal controlled conversion thus achieved provides for excellent frequency stability. The second oscillator, a 7059 triode section, is tunable over the frequency range of 25.3 to 30.3 mc, and combines with the first *if* frequency of 23 to 28 mc. A 6AV6 is used as a second mixer, and produces a fixed frequency output of 2.3 mc. The pentode half of the 7059 second oscillator is used as another oscillator when crystal controlled fixed frequency operation is desired. These crystals may be selected from 6.9 to 8.566 mc so that they can be tripled to 20.7 or 25.7 mc for injection into the second mixer.

The 2.3 mc second *if* signal is coupled through a double-tuned bandpass transformer to the third mixer (a 6BE6) where it is heterodyned against a 2755 kc oscillator in order to produce the desired 455 kc third conversion frequency. Two stages of *if* amplification are employed at 455 kc. Six tuned circuits in these stages are responsible for the outstanding selectivity. A vacuum diode (one-third of a 6AV6) is used as a detector, while the other portions are used as a rectifier to furnish delayed AVC to the rf amplifier. One-half of a 6AL5 is used as a conventional noise limiter, and the other half is used for squelch operation.

The triode section of the 6AV6 is used as the first audio amplifier. This audio is fed into the triode section of a 7059 in the modulator, and then into one of the 6BQ5 modulators that functions as the audio output amplifier as well. An audio jack is available on the rear apron and may be used for either headphones or external speaker.

Transmitter Section

The transmitter uses the plentiful and low priced 8 mc crystals or a vfo for the frequency source. The crystals connect to the input of a broad-banded 12BY7 that triples to 24 mc. A second 12BY7 triples between 73.332 and 75 mc, and is followed by a 6939 that triples to the 220 mc operating frequency. This signal then gets amplified by a pair of 6360's in push-pull. The Gonset people certainly had simplicity of operation in mind, because the only transmitting controls are plate loading and plate tuning.

The modulator uses the pentode section of a 7059 as a speech amplifier and the triode section as a phase inverter. The 7059 is followed by a pair of 6BQ5's operating in push-pull. This modulator is enough to provide 10 full watts of class AB_1 audio for real high level plate modulation.

The antenna changeover relay is built right in here, so it'll save you the expense of buying one.

Power Supply and Control System

Just as in the six and two meter models, the universal power supply uses two 2N1554 transistors for 12 vdc operation. Regular 117 vac can be used by merely changing the line cords in back of the set. The secondary winding of a two way power transformer feeds a power silicon diode bridge rectifier with a regular capacitor input filter. The push-to-talk relay changes the antenna connections between transmit and receive, as well as B plus from the modulator to the receiver, and ground from transmitter keying to speaker.

Observations

Even though the IV-200 was given its test

runs with a poorly oriented 12 element Yagi, good signals were sent as far as 50 miles. My thanks go to the many hams who unwittingly took part in the tests with their unsolicited observations and constructive criticisms, not realizing the help they were giving.

Many good 5 x 9 contacts were held with Ernie, W3UJG in Maryland, and with other hams through Virginia and the District of Columbia. To give an idea of band possibilities, W3UJG has been working twice a week schedules with W3ARW 120 miles away in Scranton. This has been going on for years . . . and they've never had any QRM.

Scope patterns were clean as on the six and two meter versions. A better than average converter was placed ahead of a 75A4 receiver, and pitted against the IV-220. Every station that was heard on the 75A4 was heard on the IV-220. Frequency readings were within the parallax of the dial configuration; for practical purposes it was as accurate as anyone could desire.

I suppose that if modifications were to be made, a bfo would be one of the first things on the list. It sure would help in locating weak stations and working CW. Many veterans of the band may applaud the fact that there is no gain control, but a screw driver adjust positioned to discourage the over-modulators would have been an aid to my weak voice, provided more gain were available.

All on-the-air reports were very good without having to solicit them. All controls function uncritically in a manner one would expect from low frequency professional equipment. Shorting the antenna terminals on receive did not disclose any self-generated birdies.

It cannot be emphasized too much that there is a lack of activity on the band. The band must see more operation if we are to keep it and we all can help by devoting some time to these higher frequencies of ours. I am sure the availability of the Communicator IV-220 will do much towards that end on 220 mc. Amateurs who have not ventured on the band will find much pleasure, companionship and the thrill of joining the pioneers in this portion of the spectrum. . . . W4API

Specifications

Frequency Range	: 219.7 mc to 225.3 mc
Frequency Control	: Front panel selection of 6 crystals, 8 mc and/or external VFO
Final Power Input	: 20 Watts, DC Plate.
Power Supply	: 12.6 VDC; Receive 7.2 amps, transmit, 10.3 amps. 117 VAC; Receive 87.5 watts, transmit 110 watts.
Modulation	: High Level, 10 watts, amplitude. 100% with high level clipping.
RF spurious and harmonic attenuation	: Down 50 db
Tuning Indicator	: Panel mounted meter for relative RF output or receive S meter.
Receiver Sensitivity	: 1.0 uv for 10db S/ N/N ratio.
Receiver Tuning	: Rear apron switch for one fixed crystal frequency or manual.
Triple Conversion	: 1st Conversion crystal, 2nd manual tuning, 3rd six tuned circuits.
Spurious Rejection	: Main image down 48db.
Noise and Hum	: Down 40db
Squelch Sensitivity	: 0.1 uv to 50 uv
Audio Output	: 2 watts nominal
Dimensions & Weight	: 5" high, 12½" wide, by 11" deep. 21.8 lbs
Power Supply	: 2-way 117 VAC/12 VDC built-in, solid state.
Microphone	: High impedance push to talk
Price	: Model 3351 Transmitter-Receiver $394.50
	: Model 3365 Universal Mounting Kit 3.95
	: Model 3152 Telescoping Antenna 3.95
	: Model 3363 Carrying Bag 12.00
	: Model 3250 Ceramic Microphone 9.95
	Model 3357 VFO 69.50
Manufacturer	: Gonset Divison, Young Spring & Wire Corp., 801 South Main St., Burbank, California.

In Defense of the Operator

Douglas G. Hedin KφOFB/2
219 Blanchard Blvd.
Syracuse 9, New York

"The amateur that does not build his own equipment does not deserve to have a license!" These sentiments echo mockingly through the hallowed halls of the best (and worst) radio amateur circles. Unfortunately, though they are uttered with deepest conviction, they are based more on misguided sentiment than on considered judgement. A thoughtful glance at the past, as well as the present, will bear this out.

In the beginning, there was static, bits of galena, slop jars, and pencil-lead resistors. The only way to get an amateur rig on the air was to build it yourself, and more than likely you made most of the components too. Contradictory ideas were a dime a dozen.

For a while, as the pulse of technology quickened with new-found adventure, amateurs kept pace with it, building their own equipment and contributing as much to the fledgling science as they benefited from it. But as new rungs were added to the ladder of knowledge, the amateur soon found that he had neither the time to spend studying nor the money to spend on components in order to keep up with the Jack-and-the-beanstalk growth of electronics. At the same time, many of the amateurs at first drawn to amateur radio by the thrill of building equipment with which to communicate discovered even deeper satisfaction in the communications themselves. True, they came to build, but they stayed to talk!

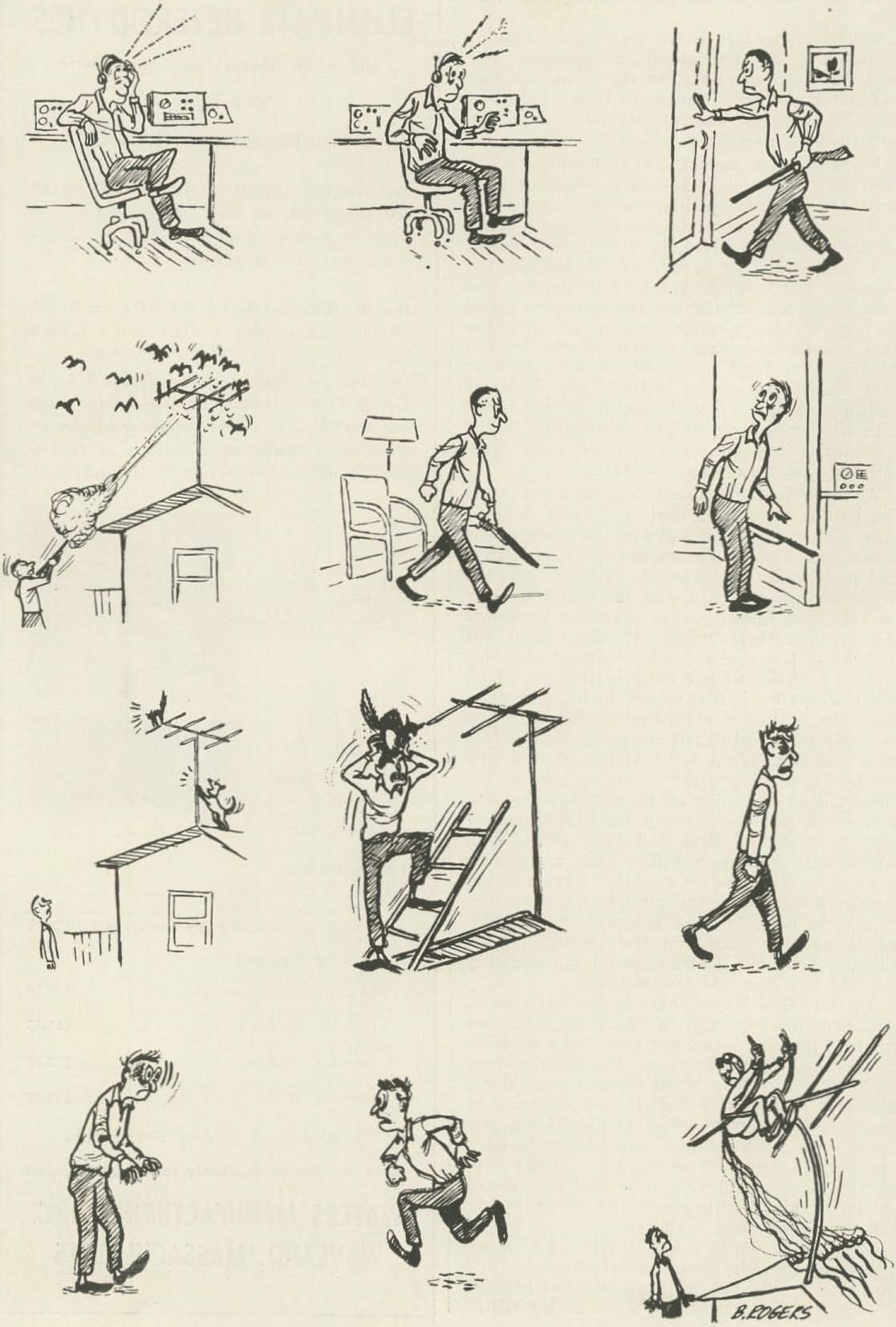
As more amateurs shouldered their way onto the bands, equipment that was more dependable, stable, selective, and easy to operate was demanded. Also, the amateurs found that they had to consider the demands of their jobs, the needs of their families, and the limits of their pocketbooks. Against these they had to equate the love of their hobby. If they could not both build and operate, which should they do?

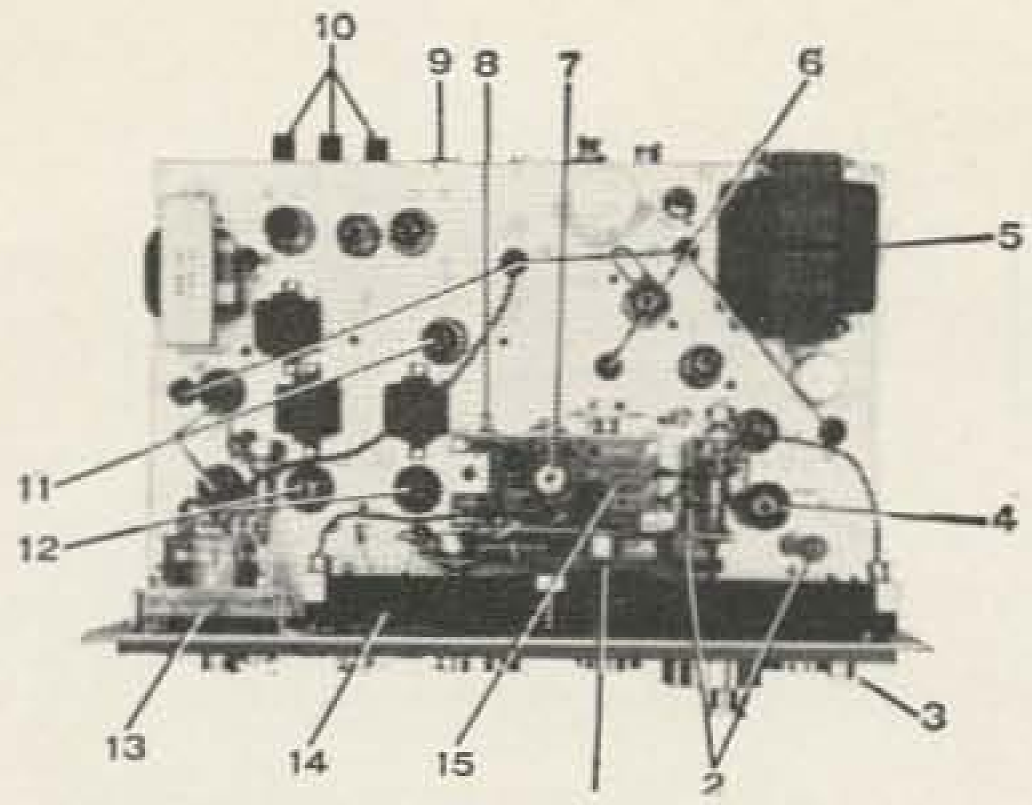
Such a choice undoubtedly is difficult. Those of us who once had the time to build remember with nostalgia absent-mindedly munching on a piece of insulation; watching the surface of a newly-soldered joint slowly shrink and change from shiny silver to mossey grey as the metal cooled; snipping off the excess wire from a new component; blowing the old solder off an "old faithful" that had been used again and again; drilling a jillion little holes in a circle or square because we didn't have a socket punch; or flipping the switch when it was finally finished, keeping one eye on the filaments and the other on the rectifier plates (hoping that the former would glow cherry red and that the latter would not).

On the other hand, there is the promise of that first hissing rush of electrons when the receiver is turned on; the cacophony of little sounds as the rig warms up; the beam, sweeping the horizon like a great electronic spyglass; the thrill of a new contact in another state or country; the warm voice of an old friend, perhaps never seen but as real and close as a brother; the walls and ceiling a patchwork quilt of 3 x 5-inch memories; and the pile of old logs stained with sweat and other liquids, and growing dumpy with age.

Yes, the choice is hard. But it must be remembered that the choice is ours to make, and we make it only because we must, not because we want to! . . . KϕOFB/2

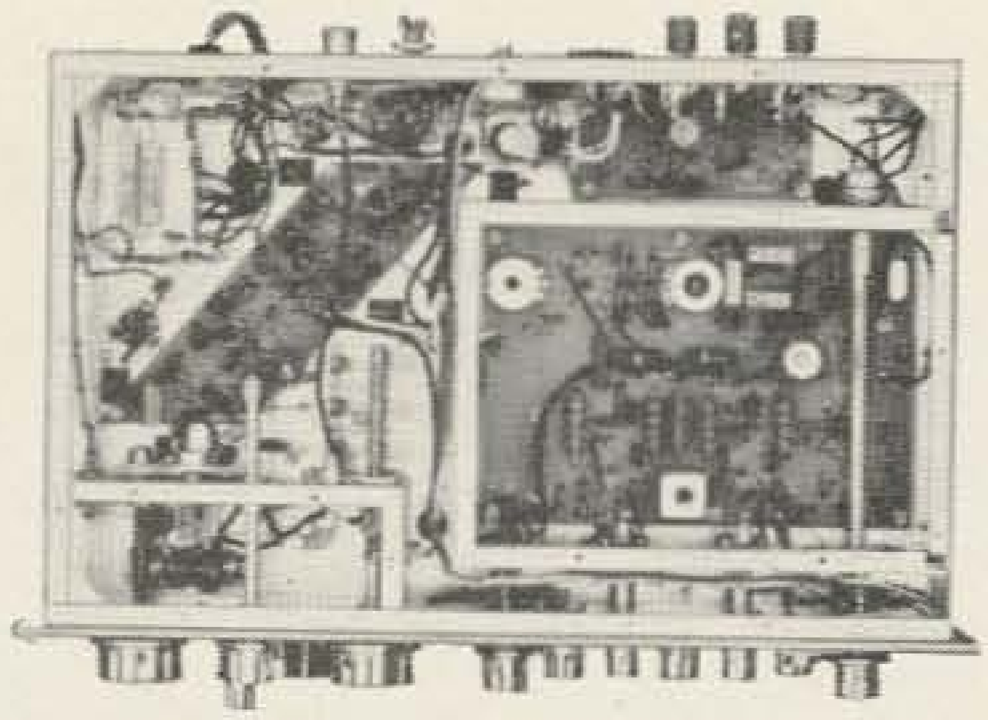
Catch All





HEATHKIT HX-30
SIX METER SSB TRANSMITTER

1. Anti-backlash helical gear for smooth VFO tuning. **2.** Adjustable final amp. coupling and loading. **3.** Meter control with push-button over-ride to check carrier null. **4.** 6360 final amplifier for 20 watt PEP RF input. **5.** Regulated power supply. **6.** Five test-point jacks for easy alignment using panel meter. **7.** Low frequency heterodyne VFO electronics on circuit board. **8.** VFO frequency determining components mounted on "heat-sink" plate in enclosure. **9.** Accessory socket for control functions. **10.** Built-in VOX & anti-trip circuitry. **11.** Three audio stages with speech filter. **12.** Phasing type SSB generator heterodyned to output frequency. **13.** Meter indicates relative power output. **14.** Lighted slide-rule dial with 9" per megacycle of bandspread. **15.** Two crystal sockets for net or MARS operation (provides frequency coverage down to 49.8 mc).



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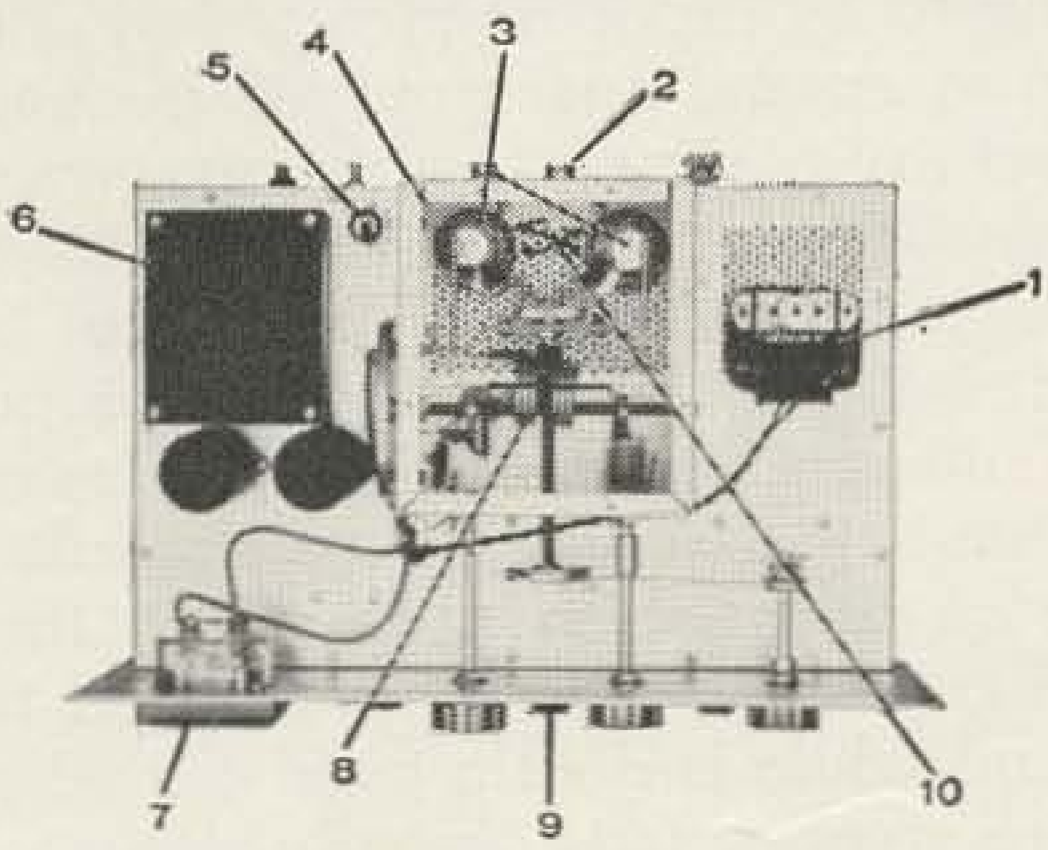

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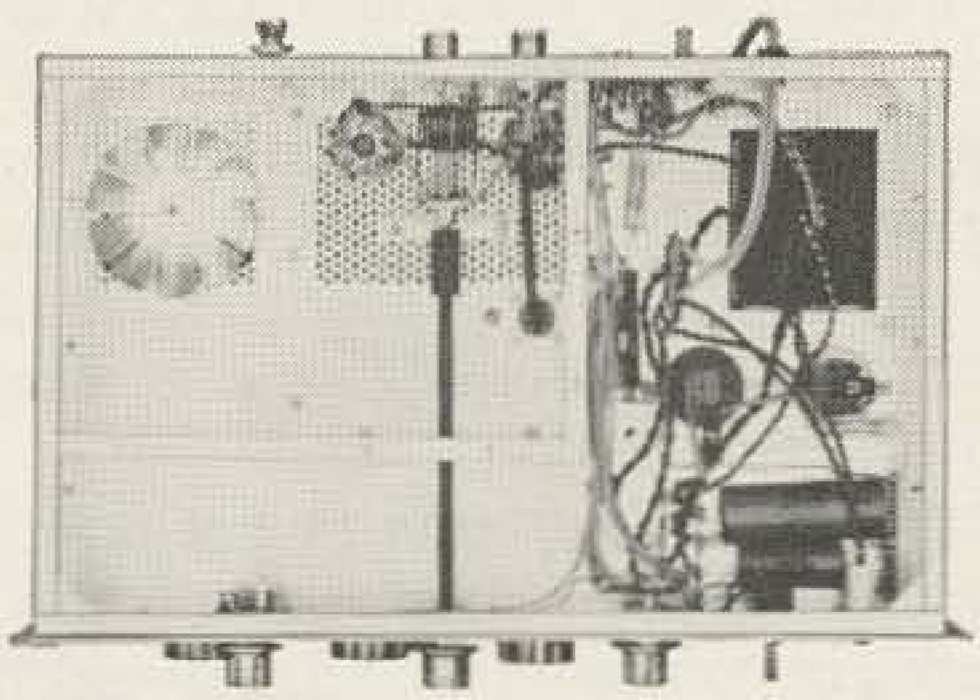

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Of RTTY – and Filters

Frank VanBrunt W3TUZ

Teleprinter operation by amateurs usually consists of the transmission of two frequencies, one separated from the other by 850 cycles. One frequency represents the mark signal and the other the space signal. With frequency shift keying (FSK) normal practice is to have the lower of the two frequencies as the space signal and the higher frequency the mark signal. The problem in reception is, briefly stated, to use specialized receiving equipment which, when the frequency representing the mark signal is received, provides current to the selector magnet of the machine and when the space signal is received cuts off the flow of current to this magnet. A filter (or a discriminator, which is basically a specialized form of a filter) must be used for separating this information. Our objective here will be to give some indication of the considerations that go into the choice of filter, and some help in getting a reasonably adequate filter operating.

One of the simplest systems to get operating is a system which uses only one of the two signals. Briefly, if you have an FSK signal being received by a receiver with either a 500 cycle mechanical filter or a good crystal filter you can tune the receiver so as to pass only one of the two signals. If you then rectify and filter the audio tone coming from the receiver you will have a dc signal that switches on and off depending on whether a mark or a space is being transmitted. This can then be amplified (by relays, tubes, transistors, or magamps) and used to control the printer. It has the virtue of simplicity, but unfortunately it also has the accompanying defects. It is quite sensitive to noise and to interference. It also discards half of the information being transmitted, a luxury we can seldom afford with the present level of ham band occupancy. Quite obviously the transmitting station could save power by merely transmitting either the mark or space only—this is sometimes done and is known as make and break keying (m.a.b.). Some countries do not permit amateur FSK operations and the hams are forced to this less efficient system.

Another relatively simple type of filter that is sometimes used is a cycle counter. This circuit, which is used in simple frequency meters, gives a dc voltage output which is proportional to the frequnecy of the input signal. This voltage output is fed to circuits which give a current *on* condition for a voltage output below a certain level and a current *off* condition for a voltage above a certain level. This level is adjustable and is normally set at an output voltage level corresponding to an input frequency half way between the mark and space output frequencies. The circuitry is simple, consisting only of resistors, capacitors, and tubes or transistors. No complex adjustment procedures are involved and it is quite tolerant of varying input frequencies and receiver drift. The very tolerance and simplicity which are so appealing are also the qualities which make it less than adequate. It is very sensitive to noise and interference, and while is does a good job when conditions are good, it fails dismally when the going gets rough. Somehow it seems the going always gets rough for me!

By far the most widely used filter systems are those which employ what is basically a discriminator. The simplest forms are those operating at the intermediate frequency of the receiver and having a peak to peak separation of about 1000 cycles. The circuits are substantially the same as conventional FM receivers and, unlike the two systems previously described, have the noise cancellation characteristics of FM discriminators. They can also tolerate a modest amount of drift and will work for signals ranging from relatively short shifts (short shift is the term usually applied to shifts of less than the usual 850 cycles) up to those with shifts of the order of 1000 cycles. This has considerable merit for even the most casual of checks will indicate that while 850 cycles is generally accepted as the standard by the amateur fraternity, some of the gang only have a very foggy notion of what constitutes 850 cycles.

Receiving short shifts is a distinct advantage —you can copy some of the commercial stations using 425 cycle shift, and you can experiment with even smaller shifts. However, if your primary concern is with short shift signals, it would be far better to have a discriminator with a peak to peak separation of only 10% more than the desired shift. With this circuit the output voltage is proportional to the frequency shift from the center frequency, thus with a 1000 cycle discriminator being used on a 170 cycle shift signal, an interfering signal of equal strength but 500 cycles away from the center frequency will give far greater output voltage than the desired signal.

This technique has another disadvantage however—it won't work conveniently on an AFSK signal. You can, by careful tuning and continuous watching make it play, but in the process you lose the freedom from drift problem that make AFSK operation on VHF such a pleasant change.

The most widely used system is the audio discriminator type which uses one resonant circuit for the mark channel and another resonant circuit for the space channel. With relatively low Q resonant circuits this is substantially the same as the *af* discriminator (See Fig. 1). However, it does have the added advantage of being equally useful for both FSK and AFSK. With higher Q inductors you sacrifice the ability to operate with short shifts but you improve the interference rejection capabilities of the system, and at the same time decrease the effective bandwidth with a resulting increase in the signal to noise ratio. (See Fig. 1). The problem for the amateur RTTY operator has been twofold, first obtaining inductances with reasonably high Q, and secondly, actually tuning up the unit once suitable inductors had been procured.

As for inductors, some of the earliest units which were described used conventional chokes or transformers with laminations removed or

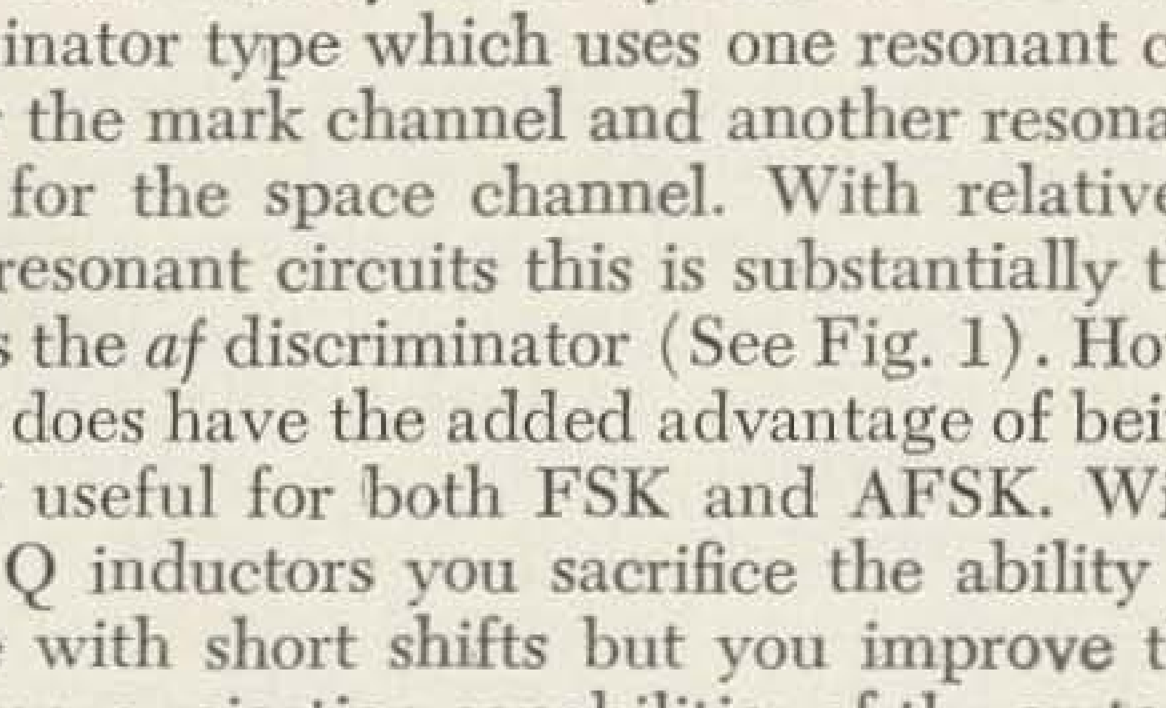


FIG. 1

Discriminator response curves:
a. Simple if type discriminator
b. Single toroid in each section
c. Double toroid in each section

otherwise modified. These were very low Q units and while some of them used multiple resonant circuits to improve the performance they were still relatively poor filters. A number of subsequent units used slug tuned inductors which were designed for television sets. While the Q of these inductances was reasonably good at higher frequencies, their Q and thus their resulting performance at 2125 and 2975 cycles was poor. The best Q and the best performance are to be had from molybdenum permalloy toroids. There are a number of possible sources for these toroids. If you are more affluent than the average ham you can go out and buy them with precisely the inductance you desire for a price between $5 and $10 each. A second alternative is to buy the cores for about $1 each and wind them yourself. It is not particularly difficult and you can get precisely the values you want. A third alternative is to find some surplus filters which have usable toroids in them and disassemble the filters. This technique provided about 300 excellent toroids for the local gang at a cost of less than 25¢ a doughnut. This I might add was the result of a trip down radio row buying a sample of every likely looking filter, then taking them home and unpotting them to find what was inside. The last and most common source of these toroids is the 88 mhy loading coils that are used by telephone companies in large quantities. These are widely advertised and in small quantities cost on the order of $1 each. If you are alert and find a junkyard with large sealed cans of these the costs can be cut significantly—you will end up doing a considerable amount of labor and have an awful lot of toroids on hand.

So much for supply problems, back to performance. The 88 mhy units used in a single resonant circuit for each of the two frequencies have a number of drawbacks. The response is more sharply peaked than is desirable for general use. Ideally this could be improved by using larger inductances which would result in a higher L/C ratio—inductances of 500 mhy or so are better in single tuned circuits. Another drawback is the fact that using the same value of inductance in each resonant circuit results in a L/C that is significantly different in the two circuits (by a factor of about 2/1). An added source of variation is the change in Q of the inductors as a function of frequency.

Ideally one not only wants the peak output of each of the two response curves to be equal in value (and this condition is readily achieved by adjusting the inputs of the two circuits), but you also want the area under the two curves to be equal. The latter requirement will result in optimum noise cancellation in the output of the discriminator. This assumes, of course, that by noise you are referring to an input which is stochastically distributed within the relevant frequency limits.

The next step toward this ideal and toward improved performance is to use a more complex filter. The most common is a simple filter using two toroids in each channel with capacitive coupling between the two resonant circuits. This is just two resonant circuits in which the over coupling is adjusted to broaden the response curves so that the bandpass in both the mark and space channels are the same. This type of filter has been widely used and was discussed in detail some years back by Bob Breitbach (WφNRM) in an article in RTTY News. The basic filter with the appropriate values is shown in Fig. 2. The values given are

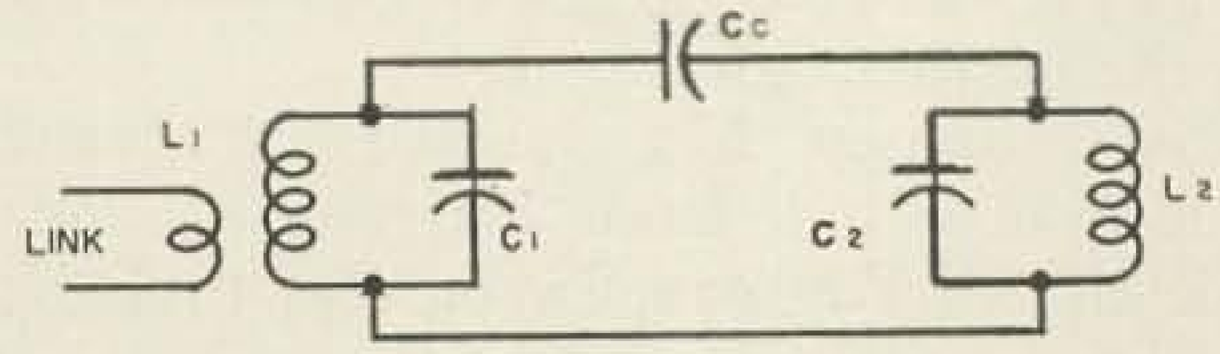


FIG. 2

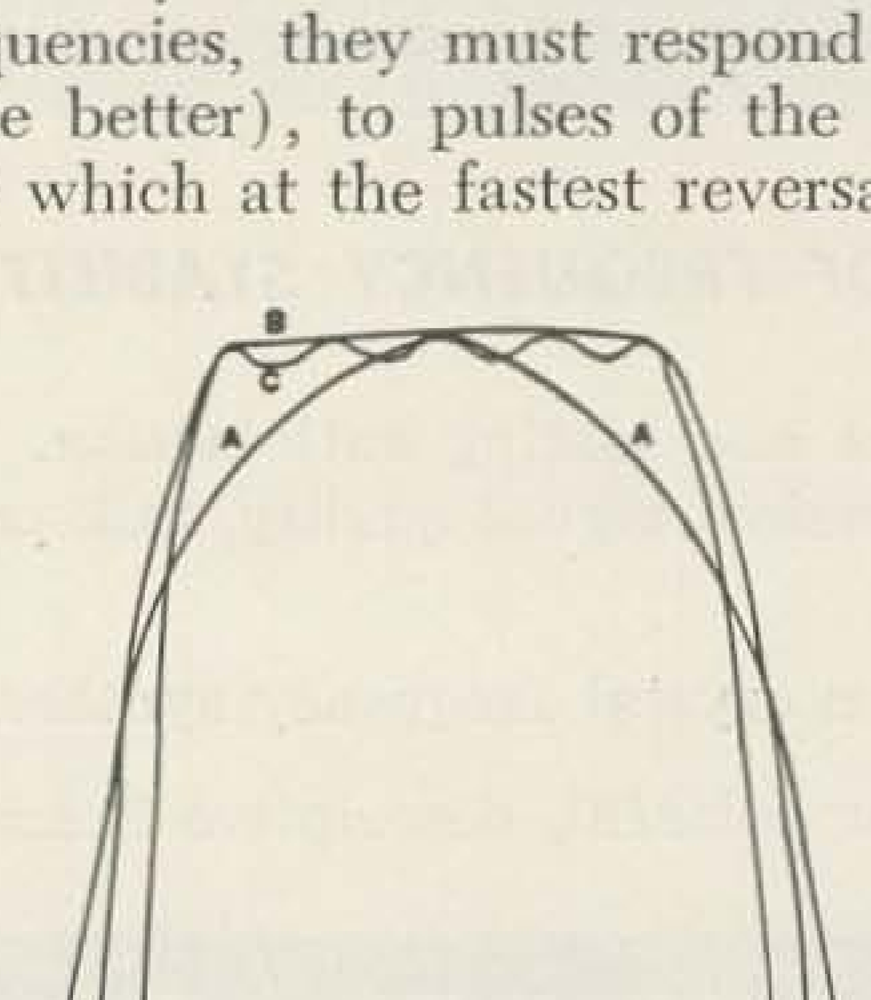
	L_1 & L_2	C_1 & C_2	C_c	Link
2125 cps	88 mhy.	.06	.0059	9 turns
2975 cps	88 mhy.	.03	.0022	5 turns

for a bandwidth of 200 cycles. This bandwidth is recommended for general operation, and represents a compromise between a desire for a better signal to noise ratio and better rejection of interfering signals that results from a narrower bandwidth—and the ease of tuning, tolerance of moderate drift, and ability to accept inaccurate shifts that result from wider bandwidths. If you have a good stable receiver and don't mind retuning now and then you can use a narrower bandpass.

The question often arises as to how narrow a bandpass can be used, and considerable controversy, information, and misinformation have been published on the subject. This will in fact depend on the signal to noise ratio, the printer speed (baud rate), the characteristics of the filter you use, the number of errors you are willing to tolerate, and the signal processing after the filter. For the average ham the only two factors he can control in his terminal unit are the filter characteristics and the signal processing after the filter. There are commercial equipments on the market which transmit information at baud rates which are greater than the bandwidth (in cycles) of the circuit, and there are many equipments where this ratio is almost 1:1. Thus it should be feasible (since amateur operation is at 60 wpm or about 45 bauds) to use filters which are considerably sharper than the 200 cycle figure suggested for general use. The error rate a ham can tolerate

(or for that matter be quite pleased with), is far higher than would be considered acceptable in normal commercial practice. Luckily languages have a relatively large order of redundancy and an error in one letter of a word now and then does not normally destroy the meaning of a sentence.

When one starts considering sharp filters another factor becomes important: these filters do not merely have to discriminate between two frequencies, they must respond (and the faster the better), to pulses of the given frequencies which at the fastest reversal rate are



Filter response curves:
a. Maximally linear phase design
b. Butterworth (maximally flat amplitude)
c. Chebyshev

22 milliseconds in length. If the risetime of the filter is too long relative to the pulse length, you will have poor performance regardless of the fine shape of the steady state frequency response curve. You can design three basic types of filters, the most common being the Butterworth or maximally flat amplitude response type. These have a flat response across the top and relatively steep skirts. A second type is the Chebyshev*, which is becoming increasingly popular. Briefly put, if you are willing to tolerate some ripple across the pass band of the filter, you can achieve better skirt selectivity characteristics; and the more ripple you can tolerate the steeper you can make the skirts. The third class of filters are those designed for maximally linear phase variation across the passband of the filter. This type does not have as steep skirts as either of the other types, and it does not have a flat amplitude response across the passband—it is in fact peaked in the center of the passband and falls off gradually toward the edges of the passband. It does have a significant advantage, it has a faster risetime than the other types of filters and hence is more appropriate for use with pulse inputs. It is also less subject to ringing

*The spelling varies considerably, depending on how you transliterate the Russian.

which often becomes a significant problem with sharp, steep sided filters. If you want to try better filters than the simple two section variety described earlier, by all means use the maximally linear phase characteristic. Detailed design procedures would be much too lengthy to go into at this time but an excellent summary and the necessary tables can be found in "Reference Data for Radio Engineers" *Fourth Edition*, published by I.T.&T. The information is *not* in the third edition.

A number of articles on filters have asserted that, since the objective was to recover from the two tones information in the form of 22 millisecond pulses, and since in the fastest possible case—successive mark space signals (reversals) this was in fact a square wave of about 23 cps.—and that you had to recover the third order products in order to reasonably reconstitute this square wave which was being transmitted. The argument then continued that since this involved both sidebands on each side of the center tone frequency, that the bandwidth of the filter had to be at least twice the third harmonic of 23 cps and that therefore the minimum bandwidth that could be used was of the order of 135 or 140 cycles. This argument is only valid if you have no provision for pulse reshaping following the discriminator.

Each audio tone may be considered as consisting of a carrier on the particular center frequency (2125 or 2975) which is modulated by a square wave. At the fastest reversal rate you have 22 millisecond pulses or a square wave of approximately 23 cycles, this is approximately what you have when RYRYRY . . . is being transmitted. The average modulation rate is lower than this, but this represents the maximum requirement of the system. This square wave produces the usual Fourrier series of sidebands, thus you have the 2125 cycle carrier, the first order sidebands at 2125±23 cycles, the third order sidebands at 2125±3x23 cycles, and all the rest of the odd order sidebands. The major portion of the energy is in the carrier and the first order sidebands, with decreasing amounts of energy in the higher order sidebands.

We can separate the input to the filter into three basic components: the tone carrier, noise (by which we mean stochastically distributed inputs), and interference (by which we mean signals with a coherent frequency distribution which may appear within the passband of the filter). When we narrow the bandpass of the filter we are affecting all three inputs: 1. We are discarding higher order sidebands of the desired signal; 2. We are decreasing the noise, and 3. We are decreasing the probability of receiving an interfering signal. The first mentioned effect is the price we pay for the advantages of the last two. When we go from a filter that passes the fifth order sidebands to one that passes only the third order sidebands we find we have decreased the noise to 60% of the former value and the probability of interference by the same amount, and since the loss in information in the fifth order sidebands is not this large we increase the signal to noise ratio and the efficiency of the system. Now if we decrease the filter from a bandwidth that passes the third order sidebands to that which passes only the first order sidebands we have decreased the noise by a factor of three, the probability of interference by the same amount, and the information we have lost is substantially less than this amount. Don't try to take it any further or you start losing ground. Note that the modulation rate is not normally the 23 cycle square wave, it actually varies from nearly zero to this figure, and with quite a number of ifs thrown in this represents the limit of a function. This is not to imply that you can't go further—there is a theorem in information theory that says you can transmit an infinite amount of information in an infinitely small bandwidth if you have an infinitely high signal to noise ratio. The last is what you don't have. Even to go to the limit indicated of a 46 cps bandpass which recovers only the first order sidebands would require perfect stability, excellent filters, and the best in signal reprocessing techniques.

Any terminal unit of reasonable design will,

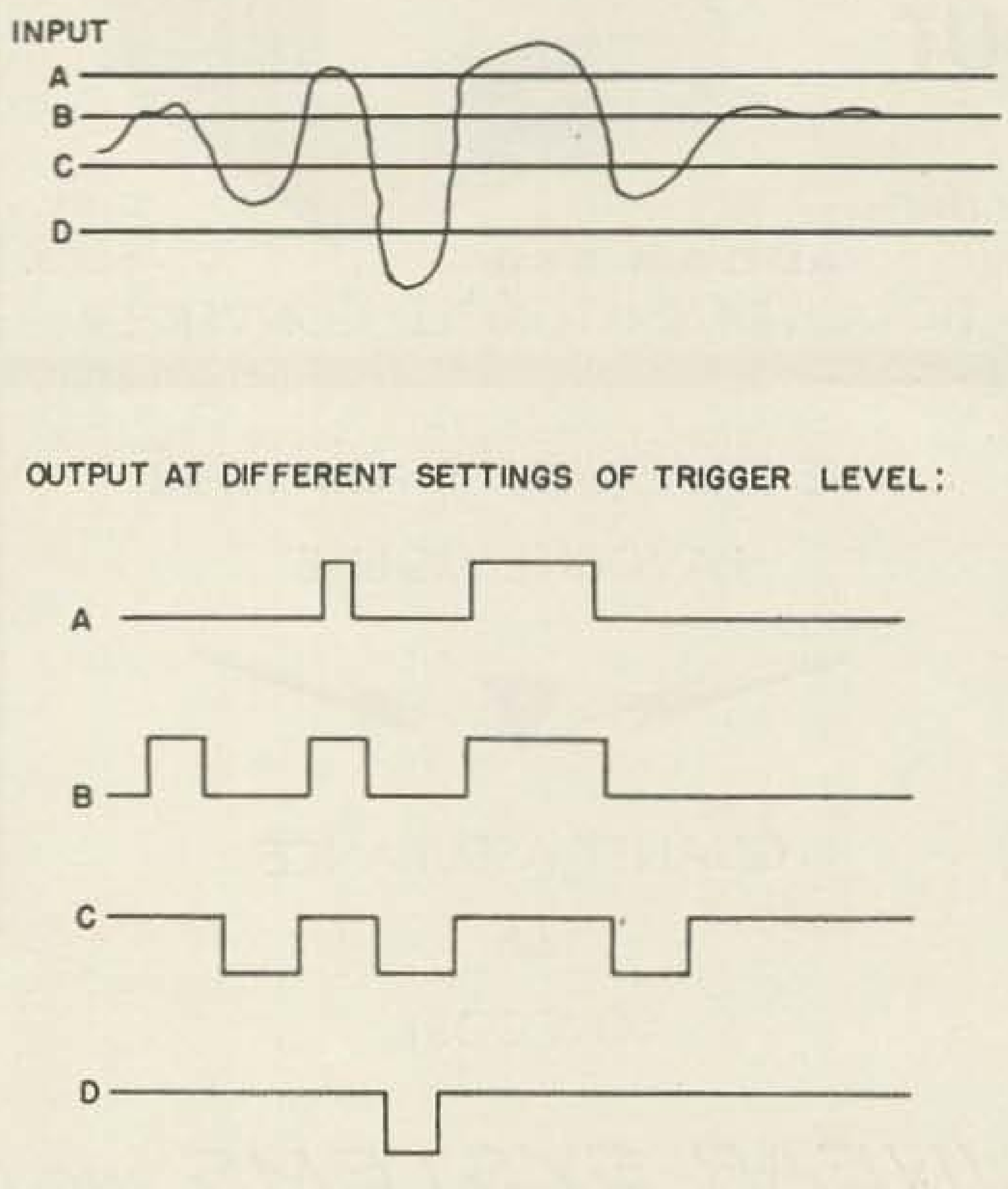
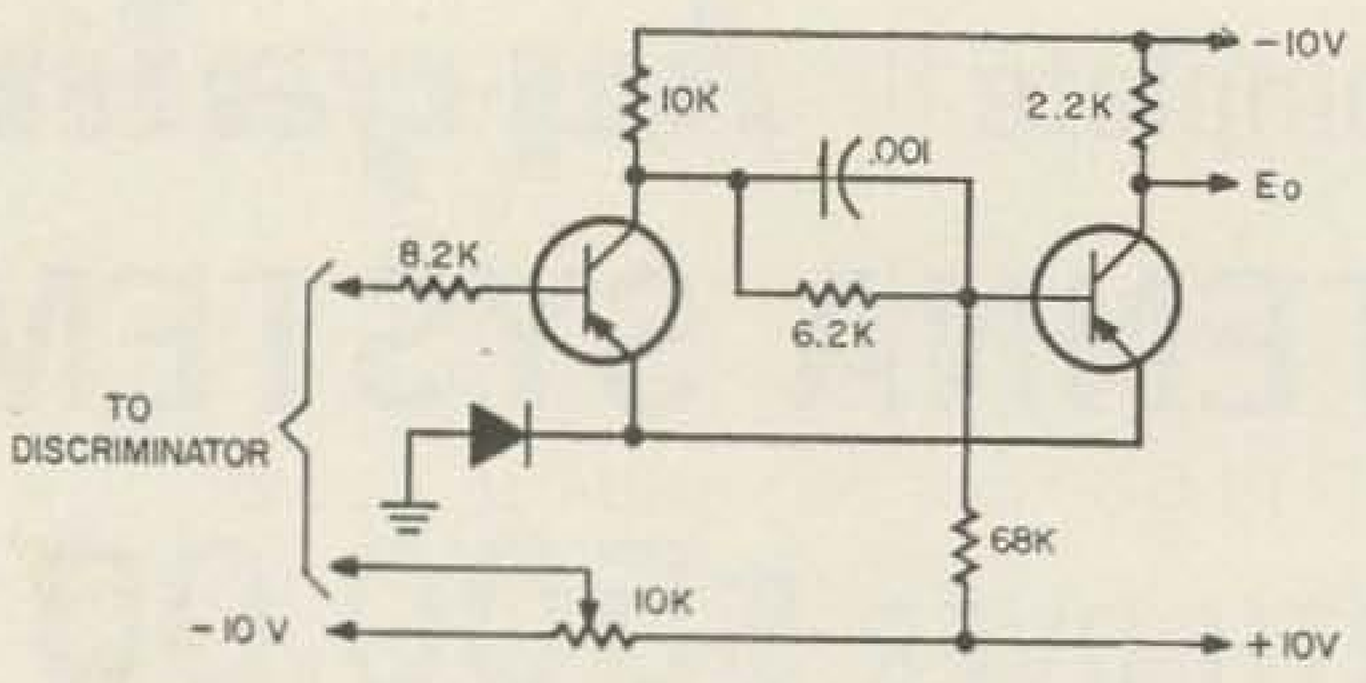


FIG. 3

in fact, incorporate some facility for pulse reshaping—perhaps the most common and elementary device is a relay. With inputs above a certain level this will be on and at inputs below a certain level it will be off, and if you feed low frequency sine wave input to it you will get a square wave out of it. There is in fact no requirement for a reasonably square wave input. It has the obvious disadvantage that the hysterisis or difference between pull in and drop out levels is too great and that the adjustments of the characteristics are usually mechanical and extremely difficult. Because it is a mechanical conversion device the speed at which it reacts is limited. Further it tends to stray from optimum adjustment over time and has contacts which generate a species of noise which is very difficult to eliminate.

The same object can be accomplished electronically, and it can be done in a fashion so that the action can be readily adjusted and the noise of mechanical contacts eliminated. Probably the simplest electronic means of reconstituting a square wave is to overdrive an amplifier that is fed by the degraded waveform. This technique has been widely used and while it gives relatively good square wave output it lacks flexibility, and it is possible with certain settings to get intermediate outputs which are neither on nor off. A better technique—which can be easily adjusted over a wide range and gives only on and off outputs—is the Schmitt trigger. These can be readily built with either tubes or transistors (although with this circuit the transistor version is simpler and easier to work with).

Fig. 3 gives an excellent illustration of the action of a Schmitt trigger when the trigger level is varied over the operating range. Here the positive direction corresponds to a mark signal and the negative direction to a space. Levels A, B, and D give misprints, while setting C gives a practically perfect letter F. I confess that when one draws illustrations one tends to stack the cards—but its function in actual practice is equally impressive. Note here that regardless of the input voltage wave shape that the output from the trigger is a perfect square wave. The filters do not have to deliver a reasonably square output—they merely have to separate the input signal into two channels and deliver the resulting outputs to the discriminator. The Schmitt trigger then electronically makes the decision as to whether a mark or a space is being transmitted. This decision is based on the relative amplitudes of the outputs of the two channels. The bias level setting compensates for continuous unwanted signals in either channel, or in the case of AFSK for variations in the levels of mark and space tones



NOTE:
1. DIODE: HOFFMAN HB-1
2. TRANSISTORS 2N2374 (HIGH BETA PNP)

FIG. 4

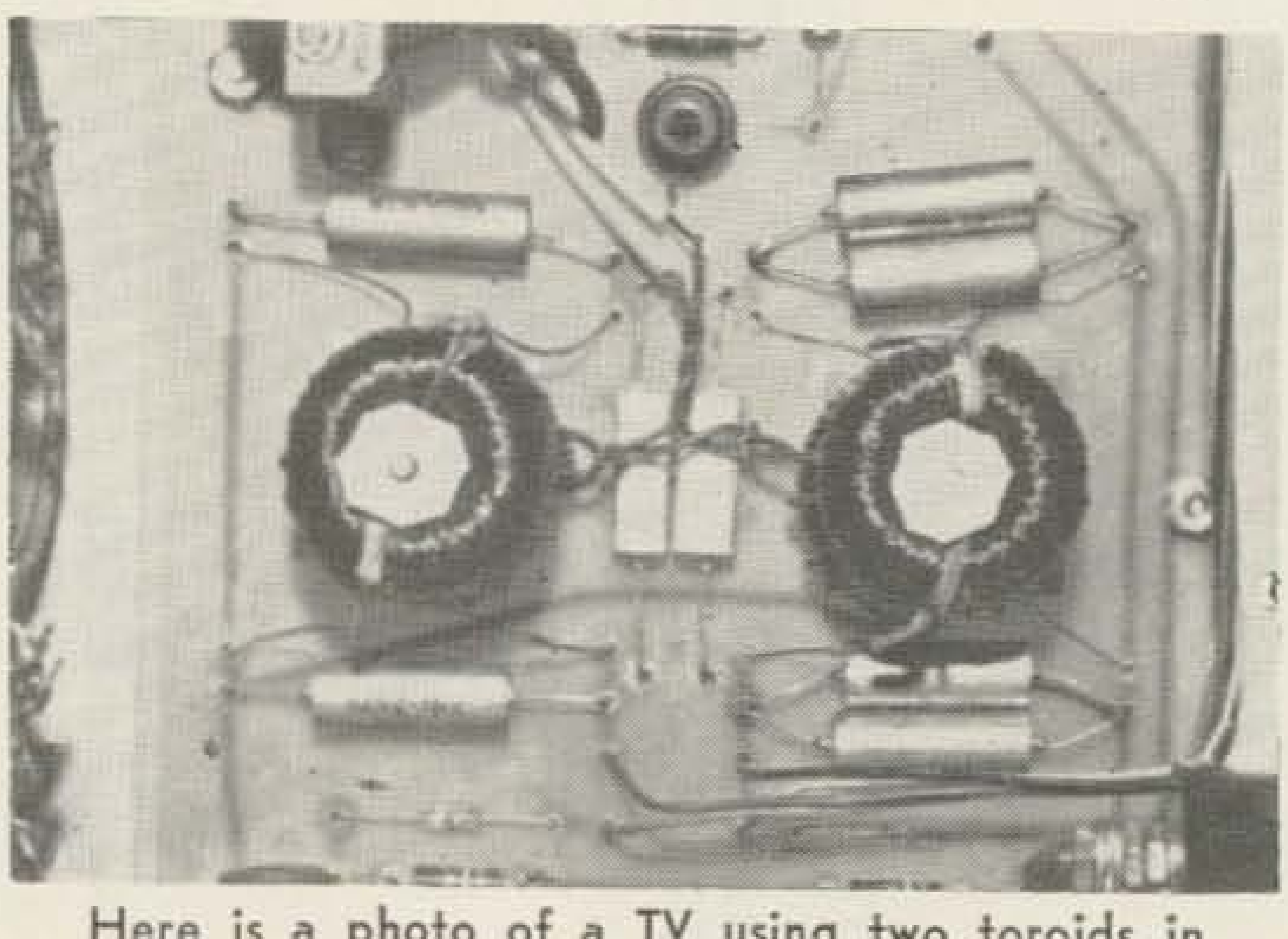
being transmitted. (This varies more widely than you would suspect, having these within 25% is better than par for the course.)

Fig. 4 gives the circuit of a typical transistor Schmitt trigger. The trigger level without the bias potentiometer is about –.8 volts, but with the variable bias this point may be varied over a ±10 volt range. Provision should be made in the terminal unit to insure that the discriminator output voltage range does not exceed this 20 volt peak to peak range. In actual practice there is a small amount of hysterisis in the circuit, the output flips to the on condition when the input exceeds –.83 volts and turns off when the input falls below –.80 volts. This difference of .03 volts is of no import when compared with the 20 volt range of the input from the discriminator. Compare this with the typical relay which has a 2:1 range between pull in and fall out.

It should be noted that even if no explicit restoration technique is used in the terminal unit, you will get it in the printer as a result of the action of the armature of the selector magnet of the machine. This is the poorest of all techniques, adjustment will be critical, and the range of the machine will be very narrow. This function should be provided in the terminal unit, should have minimum hysterisis, and should have as wide a range of adjustment as possible.

The next step, once you decide on the filter you want, would logically be to tune up the filter. But for those of you who don't have counters available it might be best to turn your attention to some sort of frequency standard. If tuning up the filter is going to be a one shot affair the most reasonable procedure is to use the standard audio tones broadcast by WWV or one of the other standard frequency stations, along with an oscilloscope to give you the appropriate Lissajou patterns and after your audio signal generator has warmed up completely calibrate it as accurately as possible in the 2000-2250 and 2850-3100 cycle regions. For those who desire greater precision than this or plan to do an appreciable amount of work, either borrow from one of the local gang or build a standard for the common RTTY frequencies. There are two types of standards in use, both of which do an admirable job. The first and most common—although not the easiest to build is the tuning fork standard. This uses a tuning fork as a resonant element and normally operates on a frequency of 425 cycles. These are made with standard 435 cycle tuning forks which have been lowered to 425 cycles either by loading the ends of the tynes with solder or by filing the crotch of the fork. There have been a number of articles published on building these and they serve admirably for tuning up filters and checking RTTY equipment. With an oscilloscope they give you 5:1 and 7:1 Lissajou patterns with the standard 2125 and 2975 frequencies. They are also handy for setting the 850 cycle shift in FSK operation. The alternative approach is to build a crystal oscillator for 446.25 kc (there are standard surplus FT-241 crystal units that are approxiamtely this frequency and they may be easily brought to precise frequency by edge grinding the crystal). The oscillator is followed by two successive multivibrator dividers—the first dividing by 6 and the second dividing by 5. The end result is a standard frequency of 14,875 cycles. This, too, gives the 5:1 and 7:1 Lissajou patterns with the standard frequencies. If you intend to do much RTTY work, they are handy gadgets to have about the shack.

The next requirement is a voltage indicator, if you are using a counter or a well calibrated audio signal generator a good ac VTVM is all that is needed. If you are using one of the frequency standards an oscilloscope is highly desirable since you can check amplitude and frequency at the same time. The basic set up is to feed the output of the audio signal generator through an isolating resistor to the circuit under test, and in turn, through another isolating re-



Here is a photo of a TV using two toroids in each section.

sistor feed the Y axis of the oscilloscope. (See Fig. 5). The two resistors should be 1 megohm or higher. The standard signal generator should be fed to the X axis of the scope to permit observation of the Lissajou patterns for calibration purposes. With this set up you tune the circuit for resonance (which is indicated by maximum amplitude) at the proper frequency (which is indicated by the Lissajour patterns).

Tuning the circuits to resonance is naturally the basic process of varying L or C. With the usual 88 mhy toroids there is usually not much variation from one unit to the next—they seem to be wound to relatively tight tolerances. The easiest method by far is to have a large number of capacitors of approximately the correct value and just keep trying different ones until you find the right value. The typical spread on capacitors is fairly wide and the selection process is fairly simple. A similar technique which requires fewer capacitors is to use two capacitors to get a given value—the .06 mfd that is needed to tune up the 2125 cycle unit may be obtained from an .01 and an .06 in parallel, and resonance can be achieved from a relatively modest supply of each by successively trying various combinations of the two. Of course, if a given capacitor falls slightly below the desired capacitance a small capacitor can be added for precise resonance. If your stock of capacitors is small, the easiest adjustment is in the number of turns on the toroid. It is easy to add a few turns or peel off a few to tune the circuit to resonance.

A simple two toroid filter and approximate values were given in Fig. 2. There are two basic ways to attack this problem. The first, and most elegant, is to tune both L_1C_1 and L_2C_2 to a frequency of 100 cycles (i.e., half the desired bandwidth of the filter) higher than the desired center frequency. In this case the frequencies would be 2225 cycles for the pair intended for the mark filter and 3075 cycles for the pair intended for the space filter. If you have a 425 fork standard you will find it quite convenient to use a 21:4 Lissajou pattern, which gives you a frequency 425/4 or 106 cycles high. On the space filter use a 29:4 Lissajou. Then assemble the filter and try successive values of coupling capacitors—the correct value will extend the passband of the filter to the desired limit on the lower side of the center frequency. The larger the value of coupling capacitor the wider the bandpass of the filter. For narrower filters, the pairs are initially tuned to frequencies closer to the center frequency and the coupling capacitors are not as large. An excellent approximation of the coupling capacitor can be obtained by shunting a single LC circuit with the coupling capacitor—the circuit should then tune to the center frequency.

The other method is to select the value of the coupling capacitor (C_c in the table) and tune each pair individually to the center frequency. Thus you will first resonate $L_1(C_1+C_c)$ to 2125 cycles, then remove C_c from this circuit and resonate $L_2(C_1+C_c)$ to 2125 cycles, and finally assemble the filter in the final circuit configuration. This is easier than the first method and only requires the use of the 2125 cycle reference frequency rather than shuttling back and forth between the two sides of the center frequency. This procedure should best be followed with the filter in place or at least with the operating load circuit connected since when it is actually installed there will normally be added capacitance across at least the last of the two toroids. Merely shorting out the toroid not being tuned will place the coupling capacitor across the appropriate resonant circuit.

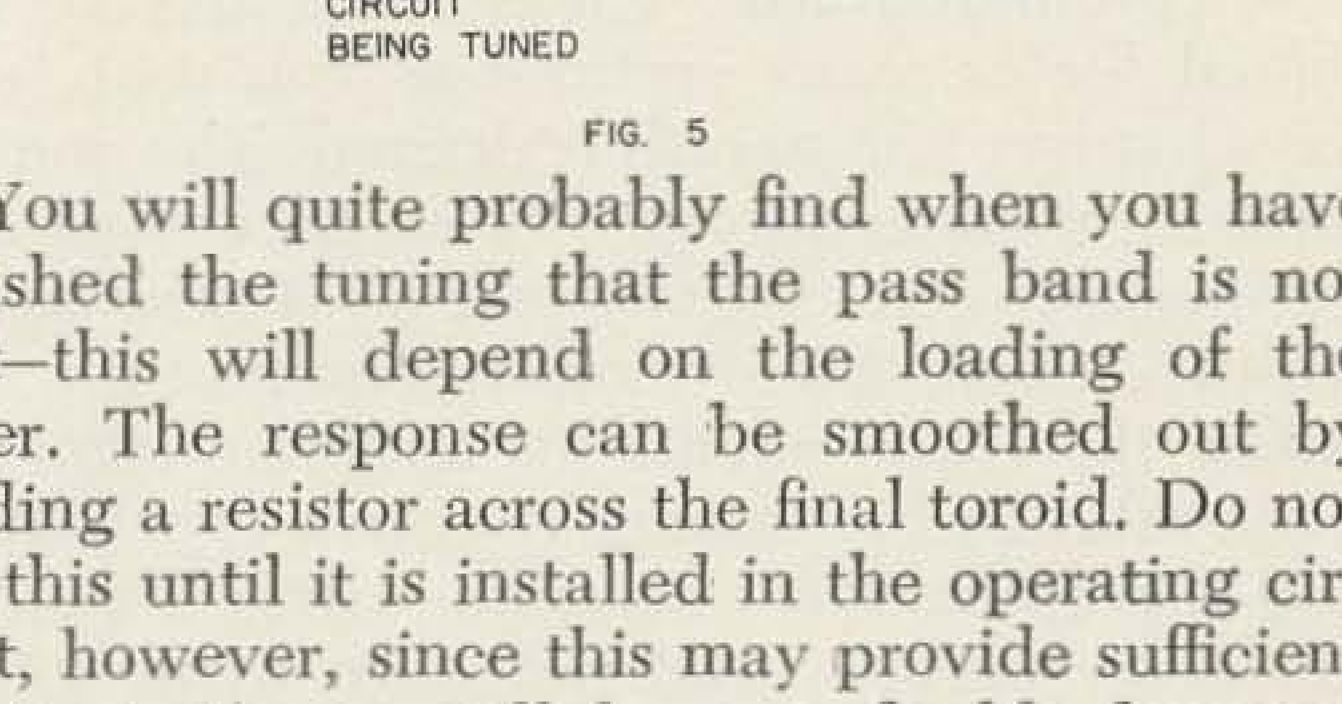


FIG. 5

You will quite probably find when you have finished the tuning that the pass band is not flat—this will depend on the loading of the filter. The response can be smoothed out by adding a resistor across the final toroid. Do not do this until it is installed in the operating circuit, however, since this may provide sufficient loading. If you still have a double humped response add a resistance of whatever value is required to smooth out the response. This value of resistance will not be the same for both the mark and the space filters, since the loads will be approximately the same for the two while their impedances vary by a factor of about 2:1.

The values given are for the standard 88 mhy units but if you have other toroids you can merely adjust the capacitance values by the appropriate ratios and use the same tuning procedures. If you have different inductance toroids you should use the larger inductances in the 2125 cycle filter and the smaller inductances in the 2975 cycle filter.

The input to the filter is easily accomplished by winding turns on the toroids. The output section preceding the filter should use a plate to voice coil or collector to voice coil transformer—the voice coil winding provides matching to the links wound on the toroids. The number of turns on the links are adjusted to give equal output from each of the two filters. This adjustment, while not difficult, is important since the outputs of the two filters are so arranged that when there is an interfering signal or noise with equal amplitude in both channels the resultant outputs cancel. We found 9 turns on the 2125 filter and 5 turns on the 2975 filter gave these desired results, but you should check the performance before you consider the job complete.

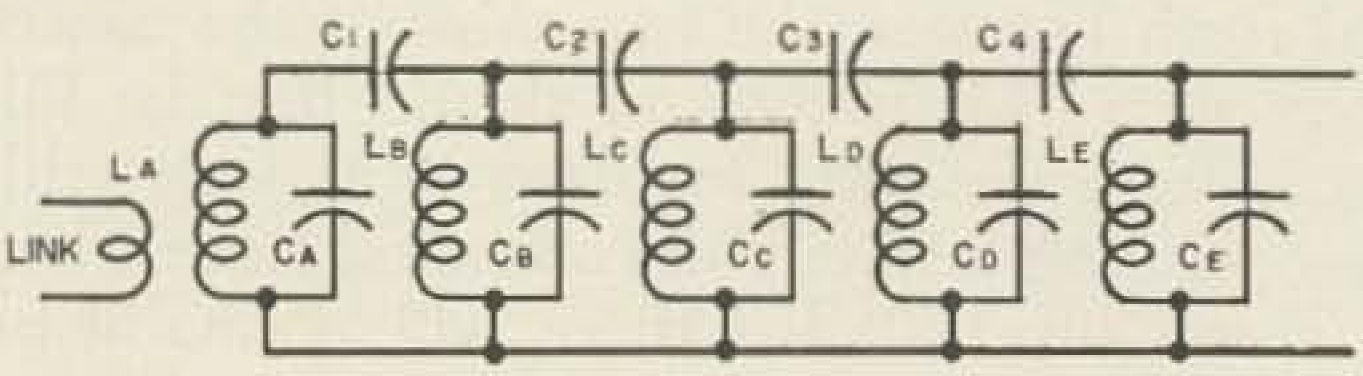


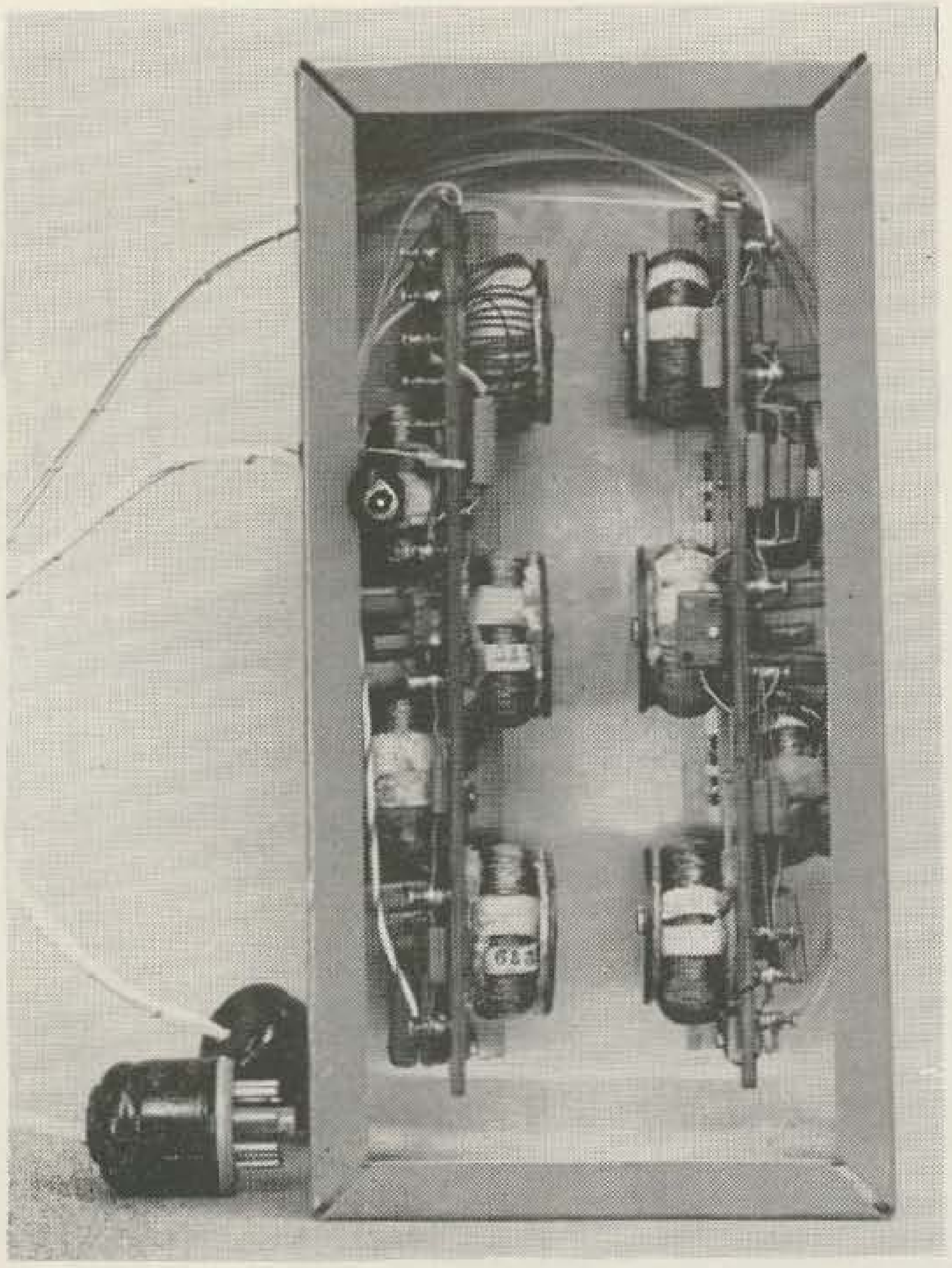
FIG. 6

freq.	C_1	C_2	C_3	C_4	(Approx.) C_{a-e}
2125	.0074	.0037	.0026	.002	.06
2975	.0025	.00125	.0009	.0007	.03

Values for 85 cycle bandwidth, maximally linear phase response, using 88 mhy toroids

The next step in order of effectiveness, and of complexity too, is the use of multisection, maximally lienear phase filters. I might comment though that getting set up to tune filters is the major chore, and the actual tuning is a relatively straight forward and not particularly time consuming task. These filters may be designed for as many sections as you wish, and for whatever bandwidth is desired. The one we built up used five toroids in each channel and the basic circuit is given in Fig. 6. The bandwidth chosen, 85 cycles, is compromise between the requirements for optimum signal to noise ratio and interfence rejection capabilities, and the necessity of accommodating a moderate order of drift and not have hypercritical tuning requirements. The performance is excellent, particularly when the going gets rough. The skirt selectivity is impressive indeed and in practice the tuning is not particularly difficult. The tune up procedure is the same as that outlined in the latter part of the discussion of the procedure for two section filters. The values of C_1, C_2, C_3, C_4 are not critical and are either ordinary 10% tolerance units or combinations of them. Mount and wire up the filter with the toroids and coupling capacitors in place. For a convenient mounting, ordinary terminal boards serve nicely with the terminal points providing mountings for the capacitors and the toroids mounted on alternate sides of the board. One note of caution on mounting toroids in general—don't have them completely surrounded by metal—it is equivalent to a shorted turn and the performance (if you can discern any!) is very poor. To tune up the first section, short the second section and tune the first using the same set up described before—either by varying the capacitance or adjusting the turns on the toroid. When this is completed remove the short from the second section, short the first and the third section and proceed to tune up the second section. The successive sections are then tuned up in precisely the same manner, always making sure that the short has been removed from the section you are tuning and that the two adjacent sections are shorted. For the final section, which when the filter is operating will be connected to additional load—it is best to tune this after the unit is connected to the terminal unit. The coupling is accomplished in precisely the same way as before—in fact, you can try the same number of turns suggested before as a starting point. Although the values given here are for 88 mhy toroids, other values can be used by making the proportional changes in capacitance. This assumes that the Q of the toroids you use is not too far off from those of the 88 mhy units; the design of the linear phase shift filters is based on the Q of the toroids as well as the frequency and bandwidth of the filters.

A further point to note is implicit in the tune up procedure. C_a has C_1 in parallel for resonance, C_b has C_1 and C_2 in parallel, and so on—hence the values of capacitance will not be the same for C_a through C_e. The actual values may readily be computed since you need .064 mfd to resonate 88 mhy at 2125 cps and .033 mfd to resonate 88 mhy at 2975 cps. Thus the actual values will run under the approximate values given. This has the merit of using different values for each capacitor—the probability of your having a quantity of identical value capacitors is relatively small. Some mention should also be made for those few of you who will actually consult the references given on these filters. The standard design lists a resistor across L_a to degrade the Q of this section for optimum phase performance. In actual practice the loading by the input circuit takes care



A five section maximally linear phase filter. This does not use 88 mhy toroids but the techniques are identical and the L/C ratios are appropriately scaled.

of this problem handily, but if there is any doubt as to whether you have enough turns on the input link—by all means err on the side of overcoupling.

The filters were made on the terminal boards mentioned before, and after the filters were tuned they were both mounted beneath a 5x10x3 chassis with 4 leads 10 inches long coming from each filter to an octal plug. By removing the regular two section filters (which were mounted in Vector C-12 cans with octal bases) and plugging in the two octal plugs we are able to convert from the broad to the sharp filters in a matter of seconds. Since our terminal unit is built on a 5x10x3 chassis also, we merely place the t.u. on top of the filter and have a very compact unit. (See Photo).

You will find the performance of this filter decidedly better than the simple two toroid filter. The passband is adequate for good performance and the unit has high selectivity without the attendant ringing of other designs. If you use the conventional scope tuning indicator with the output of the mark channel to the horizontal plates of the scope, and the space channel to the vertical plates of the scope, you will note that the lines are considerably sharper with this filter. In addition, since the passband is not flat but is slightly peaked in the center (the 85 cycle bandwidth figure here specifies the width to the −3 db points) the tuning is actually easier in some respects since there is no ambiguity in the setting. However, don't throw away your old filters, there will be times when you need them—particularly when the other station is using only a rough approximation of 850 cycle shift. The ideal arrangement would be one in which you could merely switch from the two section to the five section filter—however, in actual practice we have found the plug-in technique quite adequate.

We have mentioned short shift a number of times and you might wonder why—if you can in any case build filters with bandwidths on mark and space, respectively, equal in width to those used on short shift signals—there should be any advantage in using short shift. The most significant advantage in short shift is a result of the propagation characteristics of electromagnetic waves; the closer two frequencies are to one another, the smaller the probability of selective fading. Since the basic method of detecting the RTTY information is to make a decision based on the relative signal in the two channels, it is desirable to have a minimum amount of selective fading. Another advantage for many is the possibility of supplementing the selectivity of the terminal unit with the more selective *if* filters which are found in the better ham receivers. A further advantage is the possibility, with the more compact signal that results, of avoiding certain types of interference.

An advantage of the plug-in technique used for the filters we have mentioned is that you can build up one extra section for short shifts. If you have filters for 2125 and 2975 and are interested in short shift, say 170 cps, you have only to build a unit for 2295 cps and use it in conjunction with the 2125 cps unit for this short shift work. In addition you may also want to build a unit for 425 cps shift for copying a number of the commercial stations using that shift.

The first filter is the hard one—once you've gone through the procedure the rest are easy and the returns in terms of actual on-the-air performance are impressive. If more attention is turned to putting together a satisfactory terminal unit with adequate filters you will get much more effective and much more enjoyable RTTY operation.

For the adventurous—and for those who don't like graphs, mathematics, and such, I have included Figs. 7, 8 and 9. These give design data for 3, 4 and 5 section maximally linear phase shift filters, with a choice of bandwidths which you can use according to your receiver stability and personal tastes and inclinations.

I suspect it will save a number of inquiries and make life a little easier for those who want to strike off on their own. I might comment that one of the reasons both the maximally linear phase shift filters and the Chebyshev filters were not more widely used before was the mathematics involved. More recently tables have been complied which make the procedures far easier and in addition, the advent of electronic computers that make formerly impossible tasks merely the subject of a modest amount of machine time have changed these from the realm of interesting theoretical possibilities or the objects of arduous cut and try procedures into relatively common everyday items.

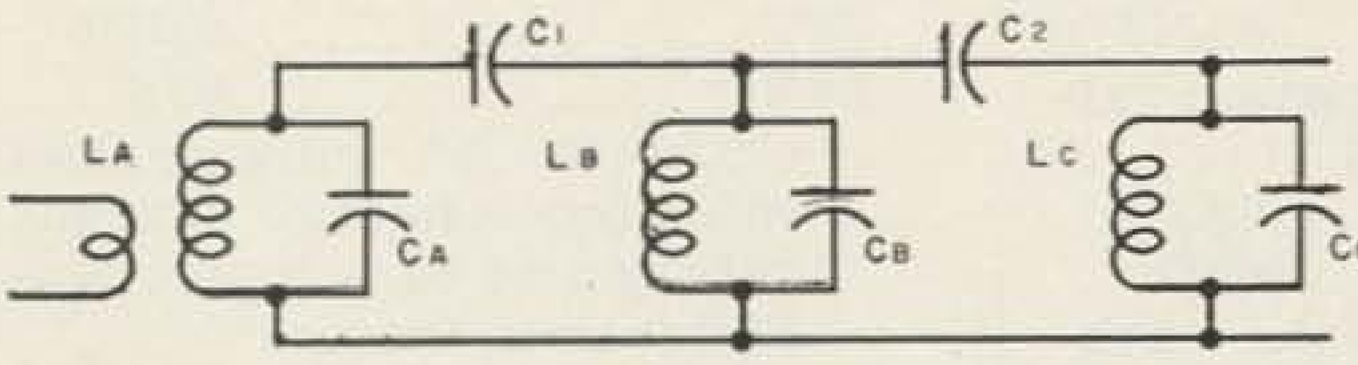


FIG. 7

Width	Freq.	C_1	C_2	C_{a-c}
60	2125	.0027	.0014	.06
60	2975	.00082	.00048	.03
85	2125	.0043	.0021	.06
85	2975	.0014	.0008	.03
120	2125	.0062	.003	.06
120	2975	.0021	.0011	.03

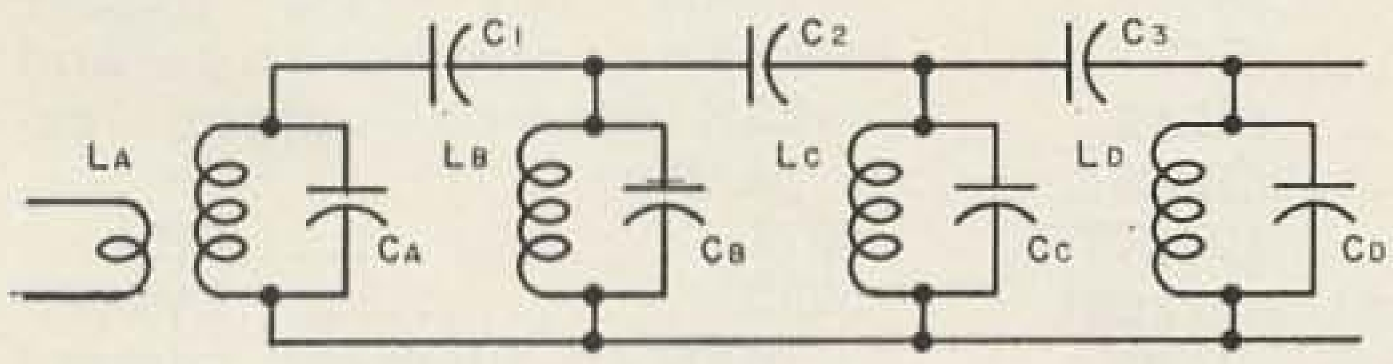


FIG. • 8

Width	Freq.	C_1	C_2	C_3	C_{a-d}
60	2125	.0038	.0020	.0014	.06
60	2975	.0011	.00064	.0005	.03
85	2125	.0058	.0029	.0020	.06
85	2975	.00195	.0010	.0007	.03
120	2125	.0087	.0042	.0029	.06
120	2975	.0029	.0015	.00105	.03

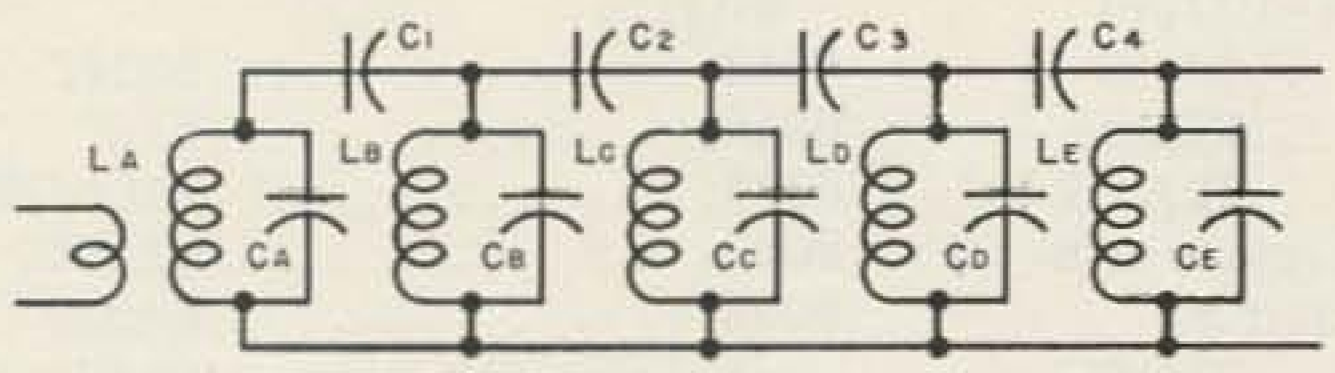


FIG. 9

Width	Freq.	C_1	C_2	C_3	C_4	C_{a-e}
60	2125	.0049	.0024	.0018	.0014	.06
60	2975	.0015	.0008	.0006	.0005	.03
85	2125	.0074	.0037	.0026	.002	.06
85	2975	.0025	.00125	.0009	.0007	.03
120	2125	.0113	.0055	.0038	.0029	.06
120	2975	.0039	.0019	.0014	.0010	.03

. . . W3TUZ

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Premium Tube Replacement Guide

Roy Pafenberg W4WKM

THERE is a seemingly endless series of "four digit" tube types designed as "premium," "reliable-ized" and "rugged-ized" replacements for the more common types. The listing presented here is compiled from many sources and is designed for the amateur. That is, it is a "one way" list showing which of the more common tubes will plug into those "four digit" holes in surplus equipment and pointing out the more obvious uses for the "four digit" tubes that are flooding the surplus market.

Although care has been taken in the preparation of this listing, much of the source material could not be verified from available references. Also, caution must be exercised in using the list. Minor differences, both electrical and mechanical, exist between many of the types listed. Therefore, in critical applications, any substitution should be made on a "try and see" basis.

Premium Tube — *Prototype*

1201................7E5
1221................6C6
1267................OA4G
1291................3B7
1293................1LE3
1294................1R4
1299................3D6
1603................6C6
1609................6J7
1612................6L7
1613................6F6
1614................6L6
1620................6L7
1621................6F6
1622................6L6
1629................6E5
(1629 is 12.6 volt filament version of 6E5)
1631................6L6
(1631 is 12.6 volt filament version of 6L6)
1632................12L6GT
1634................12SC7
1635................6N7
(6N7 filament current is 33% higher and plate load resistance is 33% lower)
1644................12L8GT
1852................6AC7
1853................6AB7
5591................6AK5
(6AK5 filament current is 16.6% higher)
5602................12AT7
5608................6AK5
5651................OA3
5654................6AK5
5659................12A6
5660................12C8
(12C8 transconductance and screen voltage rating are 25% higher)
5661................12SK7
5670................2C51
(2C51 filament current rating is 14% lower)
5679................7A6
(5679 has added filament center tap)
5691................6SL7
(5691 has .6 A heater and plate dissipation rating is slightly less)
5692................6SN7
(5692 plate dissipation rating is 30% less)
5693................6SJ7
5694................6N7
(5694 has separate cathode connections) &
5719................6AD4
(6AD4 transconductance is 17% higher and grid to plate capacitance is 12% lower)
5721................6AU6
5725................6AS6
5726................6AL5
5727................2D21
5731................955
5732................6K7
5749................6BA6
5750................6BE6
5751................12AX7
(12AX7 filament current rating is 14% lower, transconductance is 33% higher and amplification factor is 43% higher)
5755................6SU7
5764................2C37
5765................2C37
(Electrode rings differ)
5766................2C37
(Electrode rings differ)
5767................2C37
(Electrode rings differ)
5784................6AS6
5812................2E30
5814................12AU7
(5814 has 16% higher filament current rating)
5824................25B6G
5838................6X5GT
5844................6J6
(5844 has 33% lower filament current rating, 26% lower amplification factor and 30% lower transconductance)
5852................6X5GT
5871................6V6GT
5873................12AU7
5881................6L6WGB
5910................1T4
(1T4 plate and screen ratings are 18% lower)
5915................6BE6
5920................6J6
(5920 is 3/8" longer, has 10% lower heater current rating and 34% lower amplification factor)
5930................2A3
(5930 has .3" greater base diameter)
5931................5U4G
5932................6L6GA
5933................807
(5933 has .3" greater base diameter)
5961................6SA7
5964................6J6
(5964 has 14% higher transconductance and 20% lower output capacity)
5977................6K4
5992................6V6GT
(6V6GT filament current rating is 25% lower)
5993................6X4
6005................6AQ5
6006................6SG7
6021................6BF7
(6BF7 is 1/8" longer and has lower transconductance)
6028................6AK5
(20 volt heater version of 6AK5)
6042................6SN7
6045................6J6
6046................25L6GT
6057................12AX7
6058................6AL5
(6058 is 3/8" longer and has 27% higher voltage ratings)
6059................6BR7
6060................12AT7
(12AT7 interelectrode capacitance is higher)
6061................6BW6
6063................6X4
6064................6AM6
6065................6BH6
(6065 has 33% greater heater current rating and half the Gm of 6BH6)
6066................6AT6

(Maximum rating of 6AT6 is 22% lower)
6067................12AU7
6072................12AY7
(12AY7 heater current is 14% lower and interelectrode capacitance is 6% lower)
6073................OA2
6074................OB2
6080................6AS7G
6082................6AS7G
(6082 is 26.5 volt heater version of 6AS7G)
6085................12AU7
(6085 has 100% higher heater current, 80% higher transconductance and 77% higher amplification factor)
6087................5Y3GT
6094................6AQ5
6095................6AQ5
6096................6AK5
6097................6AL5
6098................6AR6
6099................6J6
(6099 has balanced plate currents)
6100................6C4
(6100 is ⅜" higher and has 25% higher interelectrode capacitance)
6101................6J6
6106................5Y3GT
6113................6SL7GT
6118................6Q7
6132................6CH6
6134................6AC7
6135................6C4
(6135 has higher heater current)
6136................6AU6
6137................6SK7
6145................7AD7
(7AD7 plate voltage rating is 100% higher and transconductance is 5% lower)
6169................7F8
6180................6SN7
6185................2C51
6186................6AG5
6187................6AS6
6188................6SU7
6189................12AU7
6197................6CL6
6201................12AT7
(6201 amplification factor is 10% higher)
6202................6X4
(6X4 has 40% higher output rating)
6215................1B3GT
6265................6BH6
(6BH6 heater current is 14% lower and plate resistance is 40% higher)
6268................4C35
6277................3B28
6279................5C22
6288................816
6336................6AS7G
(6336 has 230% greater plate dissipation and 160% greater Gm)
6355................6AF6
6384................6AR6
6385................2C51
6485................6AH6
6626................OA2
6627................OB2
6660................6BA6
(6660 is ¼" longer)
6661................6BH6
6662................6BJ6
6663................6AL5
6667................6CL6
6669................6AQ5
6678................6U8
6679................12AT7
(6679 has 10% greater amplification factor)
6680................12AU7
6681................12AX7
6830................OA2
6831................OB2
6922................6BQ7
6BK7
(Reliable substitute but not directly interchangeable)
7000................6J7
7184................6V6
7193................2C22
7700................6C6
7752................6AS6
7755................6AJ5
7758................6AR6
8016................1B3GT

. . . W4WKM

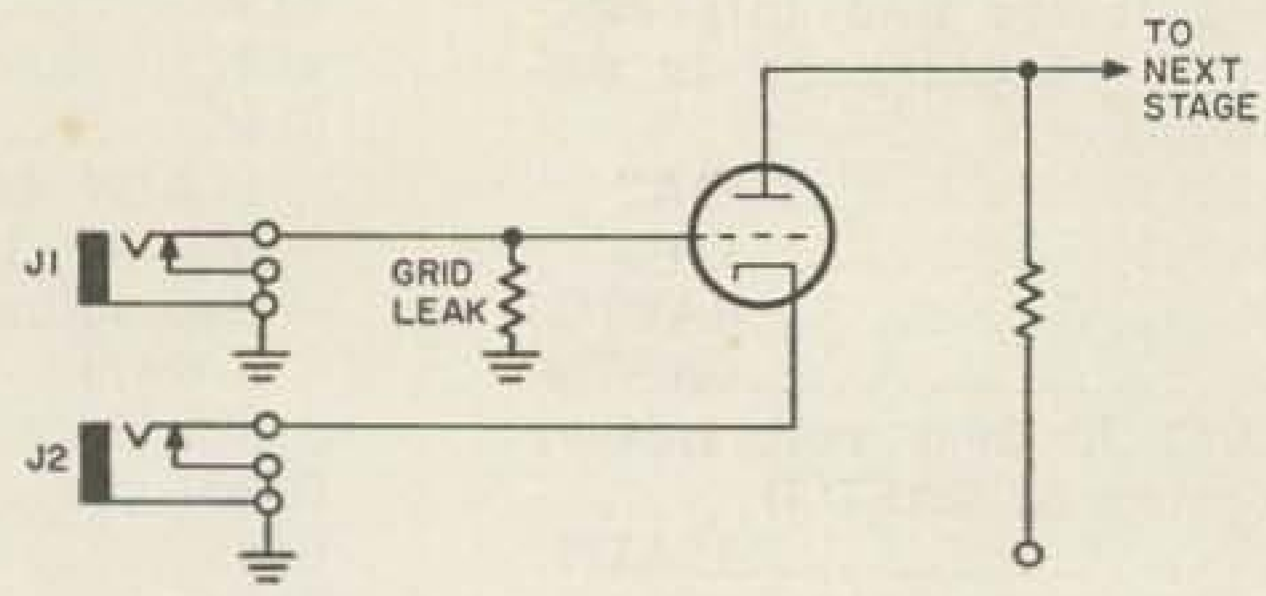
Mike Versatility

Would you like to be able to use either a carbon or a crystal mike in the same speech amplifier? This might come in very handy in equipment used in both mobile and fixed service. The secret of this versatile operation lies in the cathode follower configuration. For carbon mike service the control grid is grounded and the mike lies between cathode and ground. In crystal mike operation the cathode is grounded and the grind is operated in the standard manner.

There are several methods of accomplishing the switching required to bring about this small miracle, the simplest of which is shown in Fig. 1. This circuit employs two closed circuit phone jacks, one in the cathode and one in the grid. For operation, either a carbon mike is plugged in the cathode jack, or a crystal mike in the grid jack. This circuit is most useful in homebrew equipment where there is no shortage of panel space. Fig. 2 is slightly more sophisticated; here a single three circuit jack is used, with switching done in the plug. This circuit is of advantage where space is at a premium.

Both circuits have been used in assorted speech amplifiers with a great deal of success.

. . . WA2AKT



J1, J2 - NORMALLY CLOSED PHONE JACKS CIRCUIT

FIG. 1

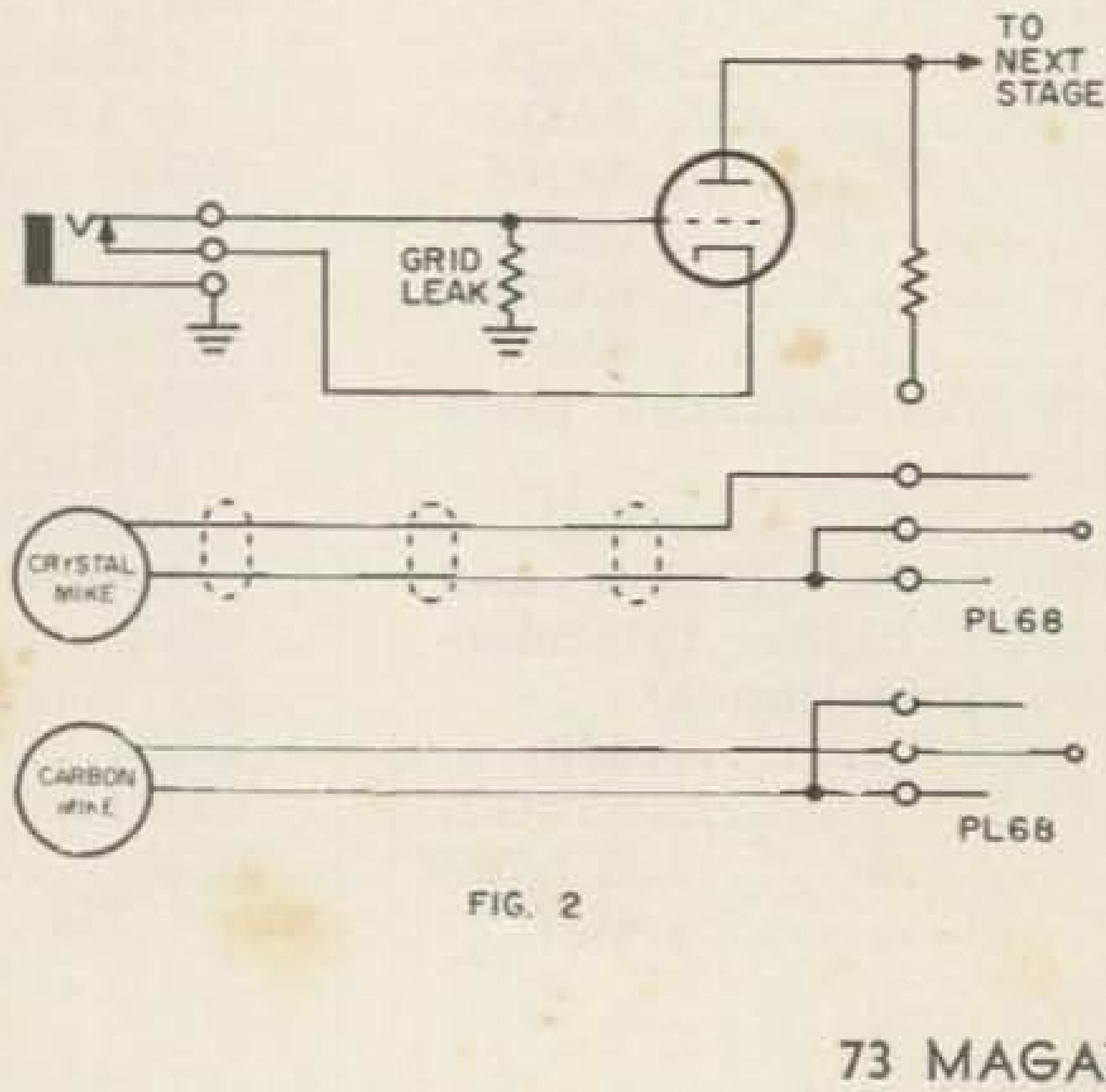


FIG. 2

73 Tests the Lafayette KT-390 Starflite

and likes it

Leonard Tamulonis W1MEL

EIGHTY DOLLARS, ninety watts, phone and CW. Those are the things that make the new Lafayette Starflite KT-390 transmitter a really desirable piece of gear for the hamshack. While looking over the specifications, I wondered how Lafayette could get so much into such a small package for such a small price. Well, this transmitter comes as a kit, so *you* supply most of the labor, and cut most of the cost. The whole thing measures only 13 x 12 x 6¼ inches, and is very attractive in its two-tone steel cabinet. Size, cost, and performance make it even more attractive for the beginning ham who has to watch his cabbage.

There are 266 steps to final assembly, and since the instruction manual is liberally salted with diagrams, the job is foolproof (almost).

The circuit is simple enough for what it does. It consists of an oscillator that acts as a buffer stage with vfo operation, a driver, a modulator, and a 6146 final. A low-pass filter is built into the back of the cabinet, and the shielding of the entire rig is pretty thorough. This should help out the ham who lives in a forest of TV antennas (and who doesn't nowadays?).

A schematic of the Starflite is shown in Fig. 1. The 6CL6 (V1) functions as a modified Pierce oscillator with crystal control. When vfo operation is desired, the vfo is plugged into the appropriate jack, and the 6CL6 then functions as a buffer stage between vfo and driver.

The driver tube (V2, another 6CL6) operates as a class C amplifier. The plate circuit of this stage is tuned by the "DRIVE-TUNE" variable capacitor, and the coil L_3 (or sections of the coil that are selected by the band switch). The entire stage operates straight through on 80 and 40 meters, functions as a doubler on 20, a tripler on 15, and as a quadrupler on 10. The drive level control (pot R5) controls the screen voltage of the driver, and therefore controls the output that is fed to the grid of the final.

A 6146, complete with parasitic suppressor, is used in the final, and operates straight through on all bands as a shunt-fed, neutralized amplifier. The tank circuit is made up of C20 (the final tuning capacitor), L_6 (or sections of it that are selected by the band switch), and variable capacitor C22 (final loading). This final loading capacitor consists of three 450 mmfd capacitors in parallel, so that there is no need to switch fixed capacities in and out when band changing. A 69 mmfd disk ceramic was added to the tank coil to maintain a good L-C ratio on 80 meters. The whole thing is a pi network output, so any of the regular dipoles and antennas having 50 to 75 ohm impedance should work out well.

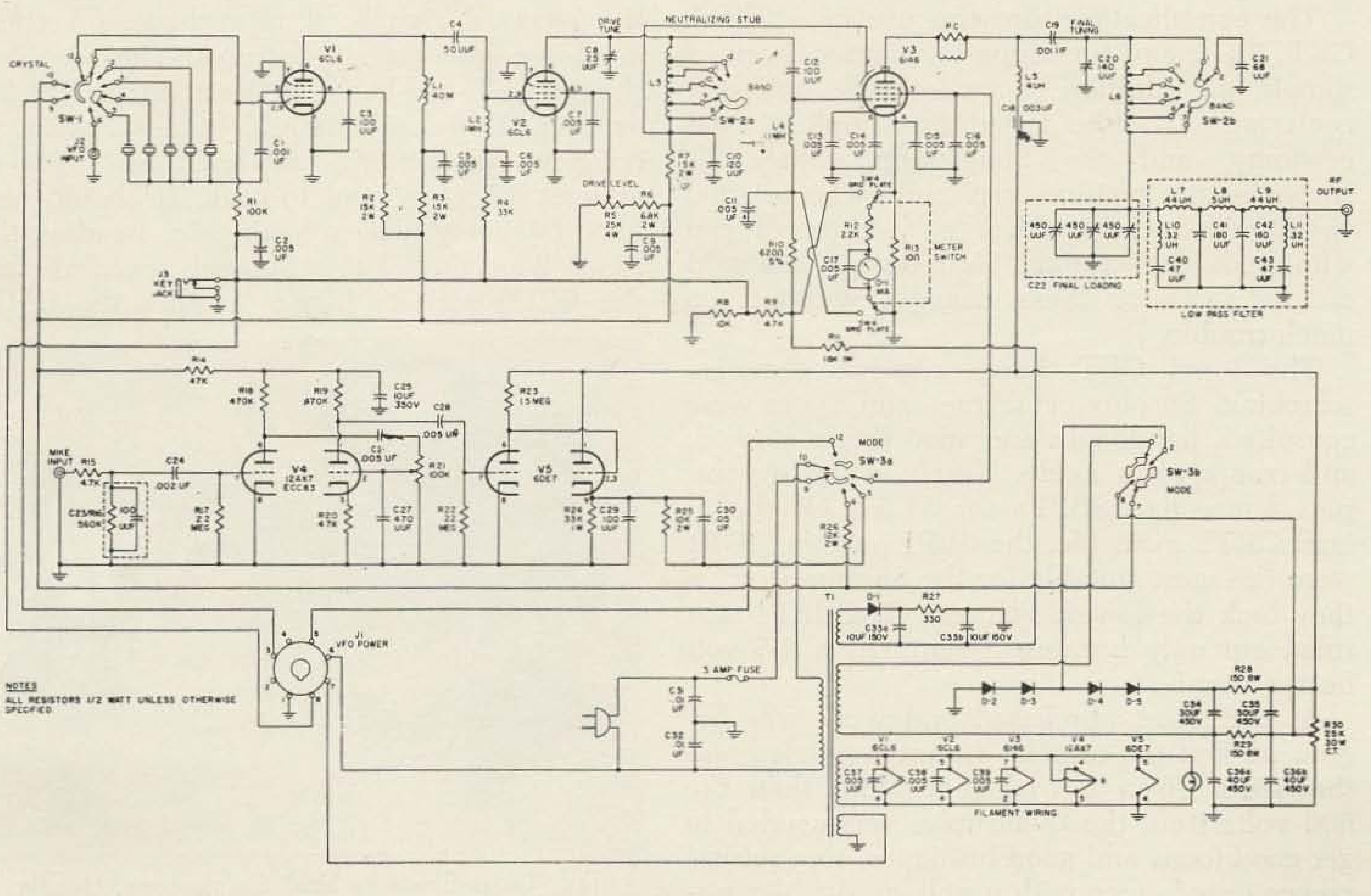
A metering switch is located just below the modern horizontal meter on the front panel. In the "GRID" position, the meter reads the voltage developed across a 620 ohm resistor in the final, and in effect measures the current passing through the resistor. In the "PLATE" position, the meter reads voltage that's developed across R13 on the cathode of the 6146, and as before, the effect of measuring current is achieved. Although cathode current is actually a combination of grid, screen and plate current, the readings may be taken as actual plate current. The error caused by the addition of grid and screen current is very small, and on the legal side.

The Starflite uses carrier-controlled modulation, and judging by some on-the-air-reports that I've gotten, there seems to be a lot of misunderstanding about this sort of modulation in general. The 2 triode sections of a 12AX7 (V4) act as a regular resistance coupled audio amplifier. The output of the second triode section is coupled to the first half of the modulator tube through C28. The modulator tube is a 6DE7 (V5) that contains two dissimilar triodes, one with a power rating of 1.5 watts, and the other with a rating of 7 watts. The output of the low power triode is directly coupled to the grid of the higher powered triode which actually functions as the modulator. Bias voltage on the 6DE7 is arranged so that conduction is low when there's no audio input signal. This lowers the screen voltage of the 6146, and naturally when the screen voltage goes down, so does the plate voltage and output. An audio input signal that's caused when someone speaks into the mike reduces resistance in the modulator section, and raises the screen voltage of the final. Naturally, this jacks up your plate current and output, giving you carrier-controlled modulation.

Grid block keying is used in the Starflite, and a good thing too! This method of keying gives the least trouble as far as clicks and things like that go. Grid block keying in the Starflite is accomplished like this: with an open key, a high bias voltage is fed into the grids of tubes V1, V2, and V3. This high bias voltage cuts off these tubes and eliminates any output. In the key down position, R8 is shorted, and this cuts out the high bias to V1, and V2. It leaves a small amount of bias on the final (V3) to protect it in case the drive is suddenly removed. The values of R8 and C2 were chosen by the Lafayette people to give the most desirable CW waveform.

Lafayette is using a unique power supply for this transmitter in that it uses four silicon diodes in a voltage doubler circuit. These diodes are more efficient than their tube counterparts because they use no filament power, and voltage drop is much less. Filtering is accomplished through a capacitor input filter that is made up of R28, R29, and C34, 35, and 36. Of course there is an accessory socket that provides the necessary voltages for convenience in operating vfo, CW monitor, etc.

On the air tests proved this little transmitter to be extremely satisfactory (satisfactory



SCHEMATIC DIAGRAM

enough so that the writer had a short fist-fight with the editor when the latter decreed that the Starflight had to be sent back to Lafayette after testing). Operation on 80, 40, 20, and 15 meters was good, but a little critical tuning on 10 was necessary to keep a good quality signal going out.

All in all, this rig turned out to be quite a surprise, and just a hair short of fantastic for the price tag. It makes a sweet rig for the Novice who will get his general class license and won't be able to afford a new rig. It makes a swell rig for the ham who'll want to keep it around as a standby rig, or who'll use it portable on Field Day or vacation.

. . . W1MEL

Complicating the Simplescope

Harvey Pierce WØOPA
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THE "Simplescope"* was conceived as the simplest form of an oscilloscope that would give adequate service as a phone monitor. But it was too simple for some ambitious builders who wanted to complicate it by adding various features they felt a scope should have. Of all the ideas for improvement, a few had merit. Here is how you can "Complicate the Simplescope" to get the "LARGE Economy Size."

The complications are the use of a 3-inch CRT, the use of the scope to monitor received signals, the addition of a pilot light, and spot centering. All were tested for simplicity and economy, and the Simplescope Mark II, shown in the pictures was built. The original circuit was merely added to, so those of you who built the original Simplescope can add one or more of these changes without too much trouble.

The 3-inch CRT change required some researching. Surplus catalogues and flyers were consulted, handbooks and spec sheets studied, and comparisons made. Nearly every big surplus house had 3BP1's for $1.95. Of the 3-inch CRT's available, the 3BP1 and the 3GP1 were the most suitable for the Simplescope, as they took the lowest voltages. The 3AP1 was ruled out only because it required a 2.5 volt heater supply.

A 3BP1 was purchased and work was begun. At first the original circuit was tried and the 3BP1 given a trial run. More than the 600 volts from the quadrupler was needed to get good focus and good brilliance, so a second power transformer with a voltage doubler circuit was added and connected in series. With about 900 volts pushing the electrons, the 3BP1 worked fine. Focus was good, brilliance good, and deflection sensitivity good. 'Scope design is a compromise between brilliance and sharp focus on one hand and deflection sensitivity on the other. This one is no exception. The 2AP1 and 3AP1 should have at least 500 volts, the 3BP1 and 3GP1 at least 850.

If the Simplescope is to be used to monitor the received signals, it must have a vertical amplifier with certain features. The amplifier should be broad-band, at least up to 500 kc, or even 2 mc, so it could be used with all common receiver *if's*, and have an output of at least 75 volts peak-to-peak. It should also have relatively high voltage gain. Reading the RCA Receiving Tube Manual revealed that the 6CL6 and its bigger brother the 6AG7

The "Large Economy Size" Simplescope. Handle is mounted toward the rear for proper balance. Note NE2 pilot light below knobs on front.

*See the Sept., 1961, 73 Magazine.

were both capable of 130 volts output in a broadband video amplifier up to 4 mc. The voltage gain was a shade over 40, so that a bit over 1 volt would be enough input for a good clear pattern on the 'scope.

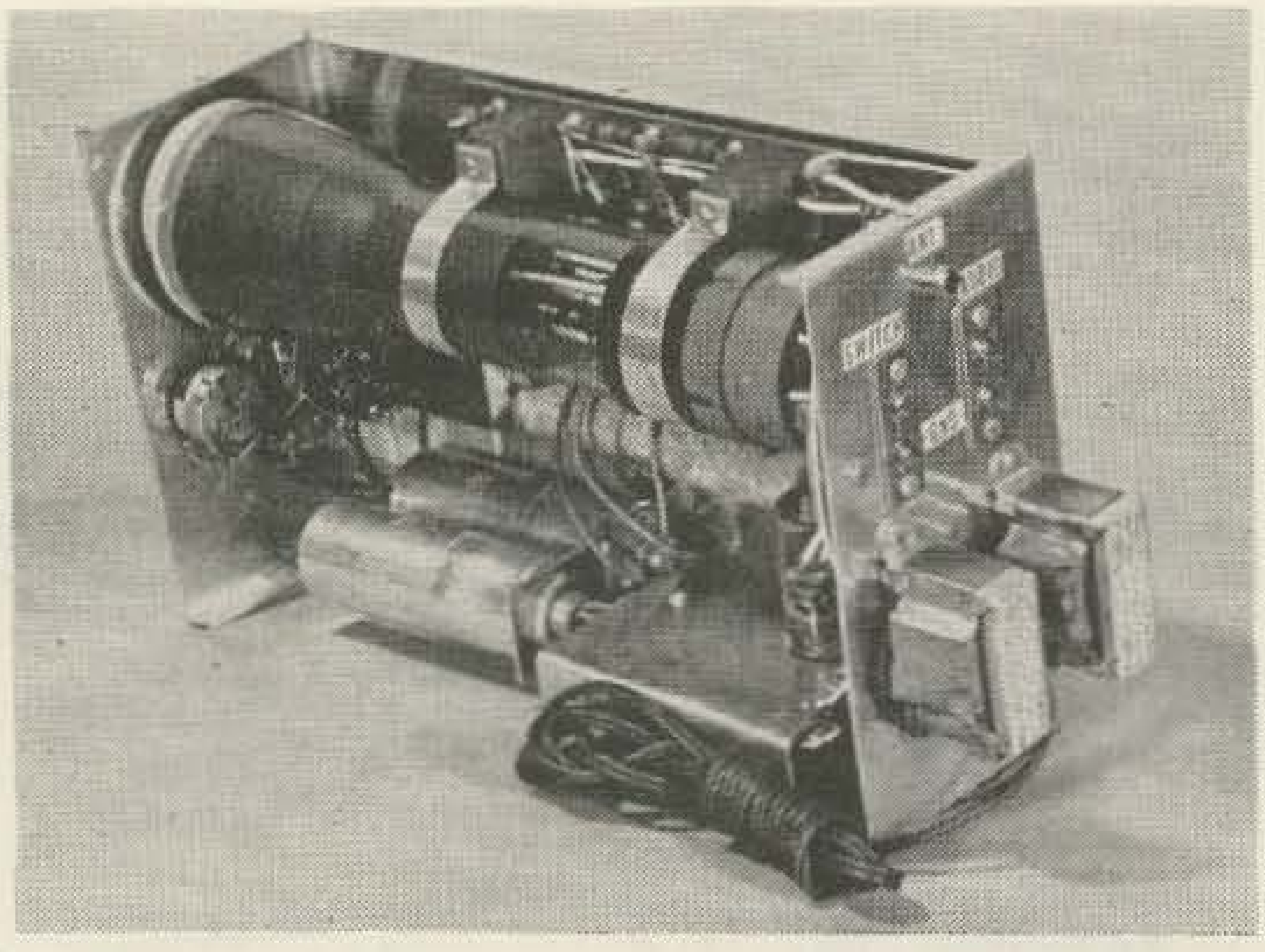
Heater and plate ratings for these tubes were a trifle high for the additional power transformer added to the original Simplescope power supply circuit to build up the voltage to 900 volts for the 3BP1 CRT, but no trouble was experienced in using this transformer to supply the amplifier. The amplifier and added power supply circuit are shown in Fig. 1 added to the original Simplescope circuit of my previous article. Points of attachment are marked with an "X," and other added parts marked by a °.

Switching is now done by a 4-pole, 4-position switch to give an added position to turn on the amplifier and the high voltage for monitoring received signals. From long experience in using 'scopes, I felt there was no need for continuous receiver monitoring, so this provision was made for turning the amplifier off. The life of the CRT phosphor is extended this way, and the overload on the added transformer reduced.

Switching of the vertical deflection plate from the transmitter to the amplifier was avoided by coupling it to the "ANT" jack by a 22 mmfd mica capacitor. This value gives adequate coupling at 4 mc, yet a minimum of bypassing at a 455 kc *if* frequency from the amplifier. Switching would be better, but complicated, as the switch would have to be at the rear, otherwise the long leads to a front panel switch would bypass more rf than the 22 mmfd capacitor does. As an added bonus, this circuit will monitor *both* transmitted and received signals during a QSO without added relays or switching when the "USE" switch is in the "RCV" position.

The amplifier can be built as a separate unit if you wish, to use with an already constructed Simplescope. With its own power supply it can be permanently connected to your receiver and its output plugged into the rf jack of the Simplescope as needed. The original Simplescope circuit must be changed for use with this amplifier by the addition of a 15 K ½-watt resistor between the rf choke and ground at the rf jack. This will not change the original operation of the 'scope in any way.

The addition of a pilot proved easy and cheap. It can be added to any Simplescope. A rubber grommet, an NE2 neon bulb and a 180 K ¼-watt resistor are all the parts needed. The grommet should have a hole that fits the NE2 snugly, and is mounted on the front panel

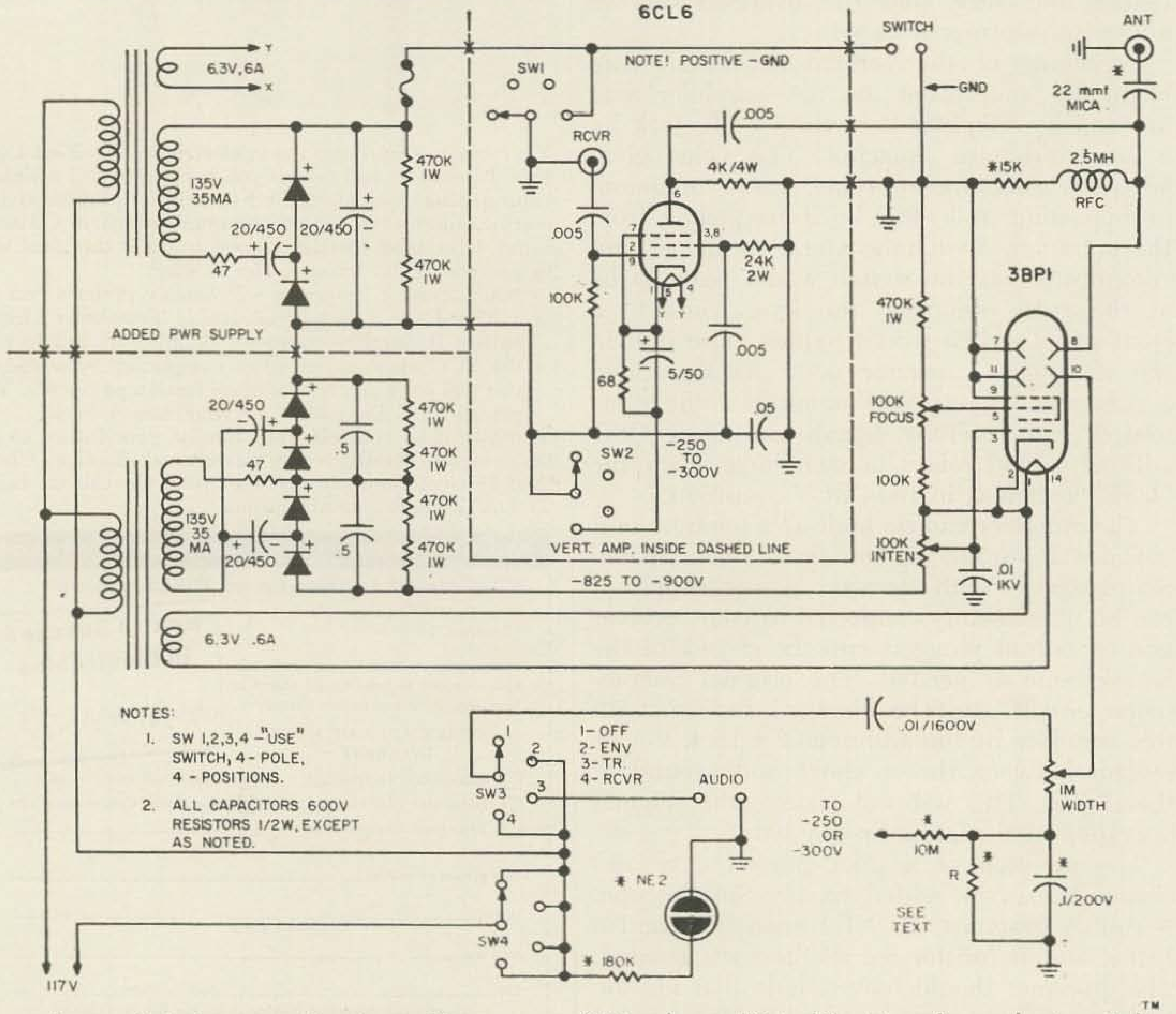


Rear terminals and transformer mounting. The "RCVR" phono jack is at center, bottom, hidden by the transformer, for short lead to the amplifier.

as convenient. The NE2 is pushed half way thru, wire leads inside. Ground one of the wires to the case. Connect one lead of the 180 K resistor to the lug of the "USE" switch that goes to the power transformer. The other resistor lead connects to the unused lead of the NE2. Use insulating sleeving to avoid shorts.

Connected this way, the neon light shows three things. If everything is hooked up right to the 'scope, it acts as a pilot light, indicating if the power is off or on. If the 'scope is not grounded it will not light at all, or very dimly. Lastly, if the ac cord is plugged in wrong it will light when the switch is off.

The spot centering problem seemed to be due to the magnetic field of the earth, and the spot was always left of center, no matter which way the tube was rotated. With the deflection plates connected in Fig. 1, and the locating guide slot of the socket on the bottom, two resistors and a bypass capacitor added to the circuit will pull the spot over near the center. The bottom or ground end of the width control is bypassed to ground by a .1 mfd capacitor, and connected to the −300 volt tap on the power supply thru a 10 megohm ½-watt resistor. Various resistors of up to 1½ megohms are tried in parallel with the .1 mfd capacitor until one is found that centers the spot, and then this resistor is



Corrections: eliminate connection to position one on SW4—change "X to Y" at transformer heater winding.

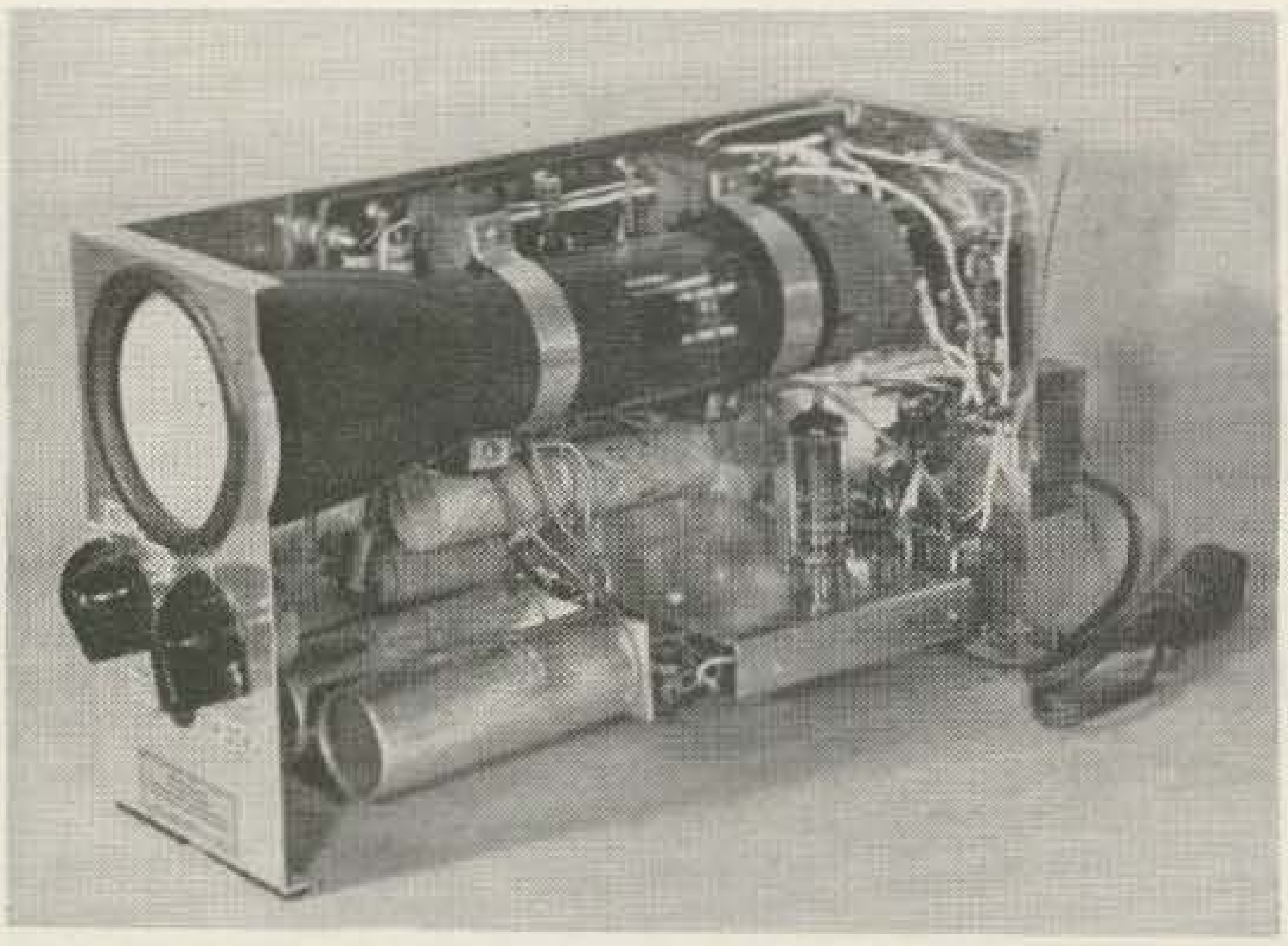
soldered in place. This is much cheaper and simpler than putting in a control.

No vertical centering was attempted because the vertical position of the spot was not far enough from center to matter.

The pictures show the general construction of the "Large Economy Size Simplescope." The vertical amplifier is mounted on a 4 x 4 inch subchassis, and uses two 8.2 K 2-watt resistors in parallel to make up the required 3.9 K 4-watt plate resistor called for by RCA. Also, the screen resistor is two 47 K 1-watt resistors in parallel to get the 24 K 2-watt value required. Power transformers are mounted on the outside rear to prevent distortion of the spot by their ac magnetic field. Rf leads are as direct and short as possible, and away from the chassis to avoid losses. No other precautions (outside of the usual care in insulating high voltage leads) are necessary.

The Large Economy Size Simplescope was built in a Premier Minibox, 12 x 7 x 4 inch size, and cost me, (except for bolts, nuts, wire, handle, and knobs, which came from my junk box) just $13.85. Many items came from kits and only the Minibox was purchased at what might be called the standard price, and was the most expensive item, at $3.17. The two power transformers are $1.35 each (Cat. #T-173 from Olson Electronics). The silicon diodes costs 36¢ each (#T200, from TAB, New York). The three potentiometers used should be linear taper if you must be particular, but it really isn't too important. The rubber tubing used as a grommet around the CRT opening is a section of an old Stethescope tube donated by a doctor friend.

Installation of this version is the same as for the earlier Simplescope, except for a connection to your receiver. Enough rf from the transmitter is fed into the "ANT" jack to produce a satisfactory pattern and enough audio from the modulator is fed into the "AUDIO" connectors to give a good Trape-



Interior view, showing method of mounting the 3BP1. 'Saddles' are wood, straps of thin (.015") aluminum. Insulation board holds saddles, quadrupler supply, and "Focus" and "Brilliance" controls, is mounted 3/8" away from metal case.

zoid. The best method of getting rf from the transmitter is by coupling thru a small capacitor to the coax output connector. The size of this capacitor depends on several factors, and cannot be specified. Start at a couple of mmfd and increase as needed. If you have really wild SWR's on your antennas, it may have to be a variable.

The audio *must* come from the actual modulated voltage, regardless of the type of modulation used. It should be at least 25 v rms, or 80 v peak-to-peak for a good pattern. In AM rigs, add one, 1-megohm, 1-watt resistor in series (inside the transmitter) with the audio lead for every 250 volts of modulated voltage over 250 v. In some SSB and DSB rigs the available audio may be insufficient. If so, a hi-fi audio transformer may be tried to step up the voltage, but there is a possibility that phase shifts might distort the pattern.

Connecting to the receiver is more complicated. First locate the plate terminal of the last *if* amplifier (the one that feeds the detector) and the lead from it to the last *if* transformer. The connection is made to the transformer plate terminal if it has one, otherwise the tube socket plate terminal is used. The 'scope is coupled to this terminal thru a small capacitor. The size of this capacitor cannot be predicted precisely, but should not need to be over 75 mmfd to give a good pattern with an S9 signal. Start with a few mmfd and increase the value until you get a readable pattern from a moderately strong signal.

Use low-capacity shielded wire inside the receiver for this connection to prevent possible *if* feedback and oscillation. Keep all leads short, and *don't forget* there is *plate voltage* on that *if* tube! Every time the coupling capacitor is changed peak up *only* the input (plate) side of the detector *if* transformer for maximum pattern height on the 'scope, using a steady signal or a signal generator. The wire to the 'scope should have as little capacity to ground as possible. Be sure the 'scope is grounded to both transmitter and receiver.

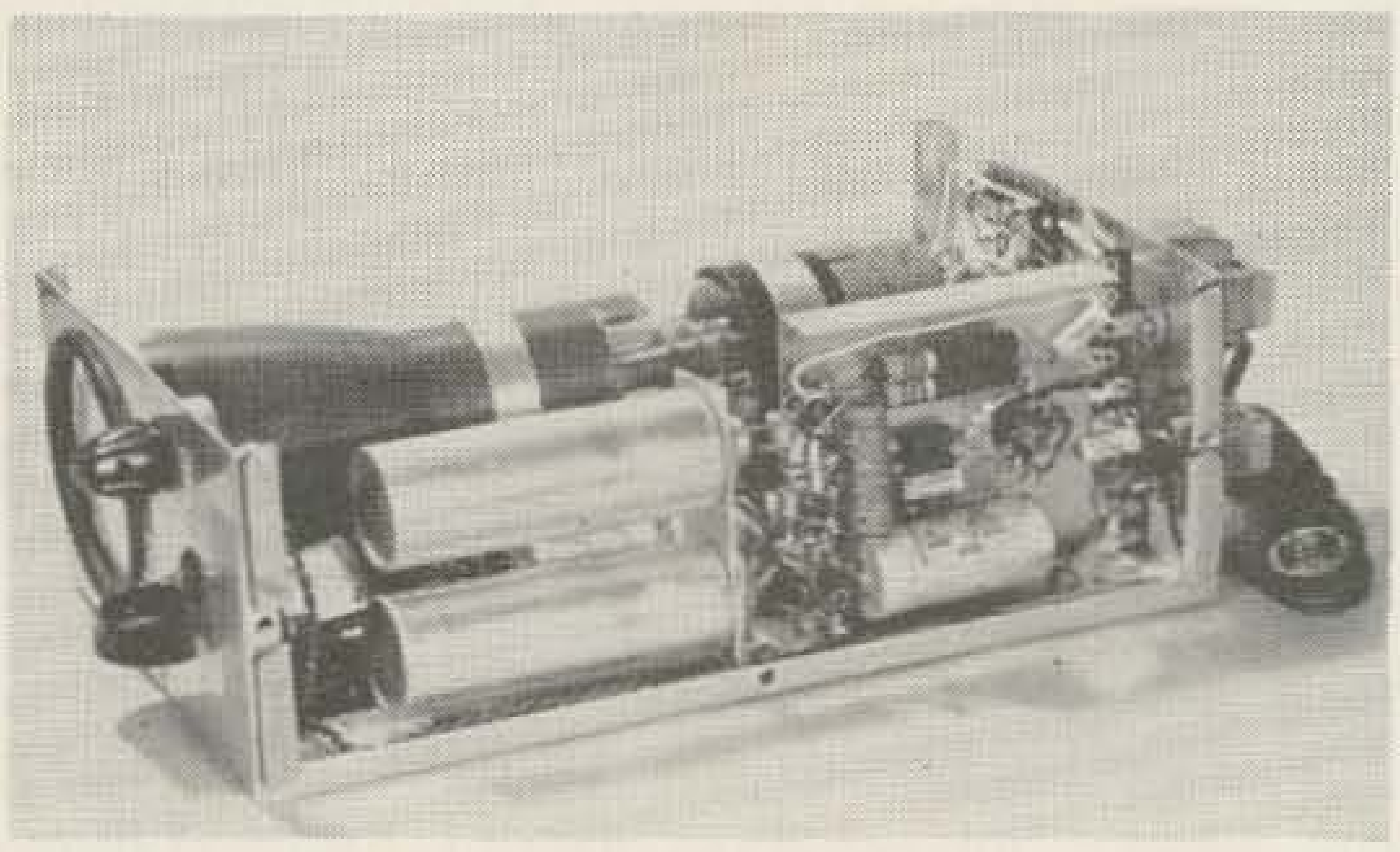
The 6CL6 amplifier needs about 2 volts of rf on its grid for the maximum, and ½ volt for the minimum, useable pattern.

Remember, the oscilloscope is very susceptible to stray magnetic fields, so for the cleanest patterns do not place it near any magnetic devices such as transformers, relays, clocks, motors, or even solder guns! For practical purposes all transformers should be at least 6 inches away, relays, clocks, and motors a foot or more.

The "SWITCH" terminals should be connected to switch or relay contacts that close when the transmitter goes on the air. While these terminals are shorted when the use switch is in the "RCV" position, spot switching is required in the other two positions to avoid "burning" the CRT phosphor.

There is little need for a vertical gain control. The weaker received signals have so much "grass" on them from QRN and QRM that more gain wouldn't help, and the strong signals can always be reduced by the receiver's rf/*if* gain control. The transmitter always puts out the same power and about the same rf voltage into any reasonably "flat" coax line.

With the "USE" switch turned to the "ENV" position, the 'scope is turned on, and shows the envelope type pattern on transmitting. The "TR" position gives a trapezoid pattern on AM when transmitting, or a bow-tie pattern on SSB. The "RCV" position turns on the vertical amplifier, and the 'scope shows



Underneath view, showing amplifier layout. Tie point strip (center) holds voltage-doubler supply connections and parts. Each electrolytic can contains two 20mfd 450 volt electrolytics, with separate positive and negative leads. Upper can is used for the doubler circuit.

the envelope type pattern on both transmitted signal and the received signal, without further switching.

The first two positions are necessary to monitor your transmitted phone signals properly and monitoring by 'scope of received signals is not needed 95% of the time. Once you have checked a guy's modulation and told him about it, and perhaps checked again as he adjusted his gain, there's not much use in watching any more. So switch back to "TR" or "ENV" so you can keep your own modulation right up there and conserve the CRT phosphor while receiving.

The envelope pattern of the received signal is not always a true presentation of the transmitted signal due to the limitations of the receiver and the propagation path. The receiver bandwidth affects the apparent modulation of the higher frequency sidebands, and the truest pattern is shown with the greatest bandwidth. Yet even with an 8 kc bandwidth it could be possible for the signal to be overmodulated by a 10 kc parasitic the receiver wouldn't show! Fading on the lower frequencies is often selective enough to remove either carrier or sidebands, giving wide variations in apparent modulation. Such a signal must be watched for some time and averaged to get the approximate modulation percentage.

Despite these limitations, monitoring received signals by 'scope is a rewarding experience. Certain makes and models of transmitters can be identified by their patterns! Good, clean, well-modulated signals look as good as they sound. Surprisingly, over-modulation is NOT the prime cause of severe splatter! Broad signals are often apparently undermodulated, while the definitely overmodulated ones are often surprisingly narrow.

There are so many variations of power supplies possible for the high voltage that it would only be confusing to even list a few. You're welcome to try any and all varieties of rectifiers and multiplication circuits that you want. The one shown in Fig. 1 is OK and inexpensive, but is just one of many possibilities. What is needed is 900 volts at 2 ma, −250 volts at 40 ma, and two 6.3 heater windings at .6 amp or more each.

WARNING! Ordinary insulation does a pretty good job below 1,000 volts but is risky above that, so don't get any ideas about using 1,250 or 1,500 volts in these Simplescopes. It isn't worth the trouble. And don't get careless with the 800 to 900 volts in this 'scope! It bites real hard! Be sure all insulation is clean and unbroken.

The complications added to the original Simplescope circuit as described in this article are about as far as it is advisable to go in an instrument of this type. Anything further would bring it into a class with kit and commercial type scopes. The 3-inch Simplescope with vertical amplifier does a very adequate job of monitoring at a very reasonable price, without complicated circuitry, requires no special parts, and should not prove to be a difficult building job.

I want to thank Dick St. Amant WøGZQ, for his thorough testing of the model shown at his station under typical conditions. I almost didn't get it back, he liked it so well! And again my thanks go to my friend Bob Rode WøBRE, for the excellent photographs.

. . . WøOPA

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The Heath IM-30 Transistor Checker

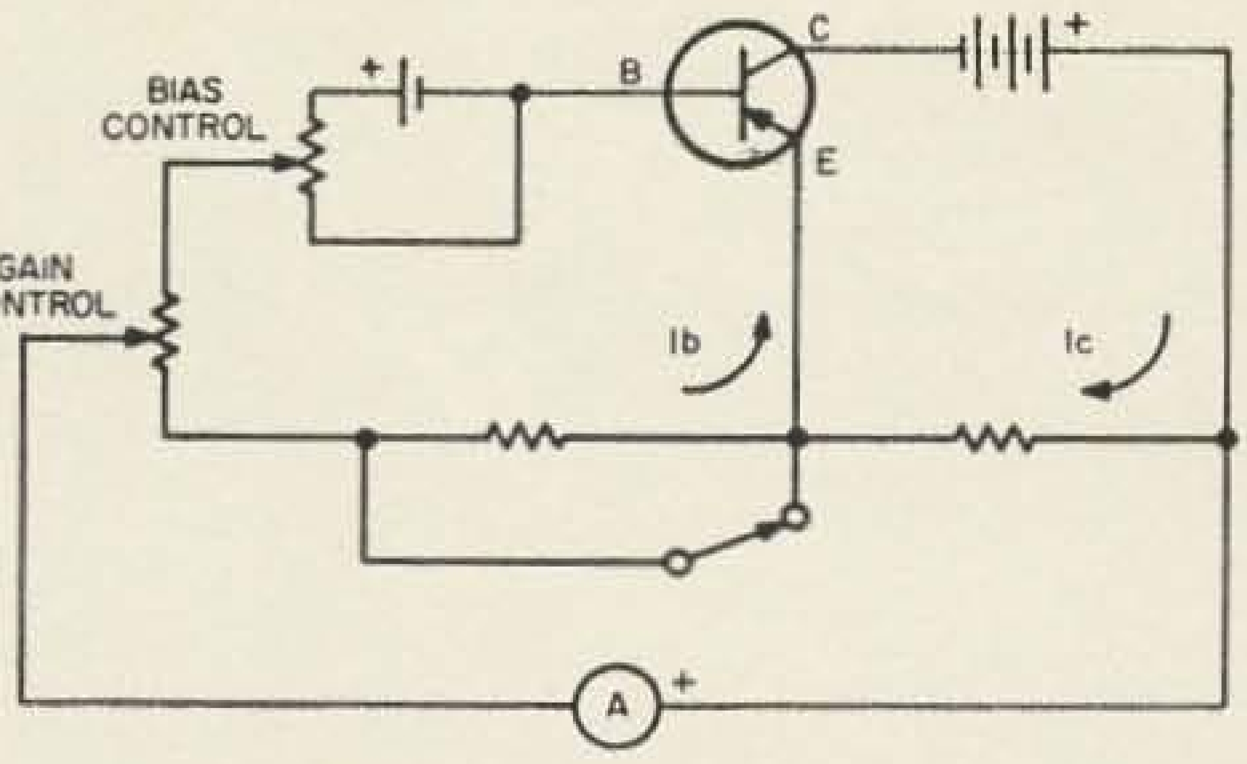
Here is a piece of test equipment that has been misnamed. Instead of a transistor tester it should have been named the transistor analyzer. This is exactly what it does. It measures 5½x10¼x10¾. The tester tests transistors and diodes under conditions that correspond to actual dc operating conditions. Since the author has specialized in transistors for the past 7 years this equipment is right up his alley.

The kit is complete and the instructions are thorough. Only precision components were used in this kit. It was constructed and tested by the author in approximately 20 working hours.

With transistors coming into the amateur field more each day this piece of test equipment fills the bill. It would almost be impossible to cover all the parameters this tester covers in this article.

Just about everyone who even has a slight interest in transistors wonders what the gain is of a particular transistor. This is a good way to find similar transistors when using 2 PNP in conventional push pull amplifiers or PNP and NPN in complementary symmetry amplifier for receivers or modulators.

Let's cover the gain test (dc beta-dc alpha). Readings are taken off af a calibrated direct gain dial after the 10-0-10 micro-amp 100K/volt meter has been nulled. The following is the gain circuit:



GAIN TEST (DC ALPHA) (DC BETA)

The following additional information may be obtained direct:

Base current (Ib)
Collector voltage (Ec)
Collector current (Ic)
Collector to emitter leakage (Iceo)

Collector to base leakage (Icbo)
Leak voltage
Short test
Diode Test

With some of the above information and an external voltmeter used in several instances the following information may be obtained:

AC current gain $\dfrac{Ic_1 - Ic_2}{Ib_1 - Ib_2}$

AC Transconductance $\dfrac{Ic_1 - Ic_2}{E_{b1} - E_{b2}}$

AC Base resistance $\dfrac{E_{b1} - E_{b2}}{I_{b1} - I_{b2}}$

AC Collector resistance $\dfrac{E_{c1} - E_{c2}}{I_{c1} - I_{c2}}$

DC Transconductance $\dfrac{I_c}{E_b}$

DC Base resistance $\dfrac{E_b}{I_b}$

DC Collector resist. $\dfrac{E_c}{I_c}$

What difference is used in the formulas two different bias or voltage points have to be taken.

The author selected a bargain basement transistor audio *if* type which costs less than a dollar and made several checks with some surprising results. It was a PNP with a gain of 90 which is excellent. A transistor has good gain if it has a gain of 70. The base *ac* resistance was 750 ohms and the collector *ac* resistance was 1500 ohms.

The base and collector resistances become important when a transistor is to be used in a circuit. This allows the builder to properly match the input and output. The checker in itself is an education in transistors. It takes a little practice and usage to master it. Remember it is a piece of laboratory test equipment. Instructions with the tester are very clear to follow. . . . W5JSN

Simple Squelch

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THERE is one basic circuit missing from most receivers currently available to the modern amateur—squelch control. Essential for VHF operation, squelch can also provide a tremendous increase in operator enjoyment on the lower bands or wherever QRM and background noise levels are high. The lack of such a circuit becomes extremely obvious whenever one of our present communication receivers is used as a tunable *if* for VHF converters. Fortunately the problem is easily solved, as a squelch circuit may be incorporated in most receivers with minimum effort and without disfiguring the equipment. A simple, proven circuit for this purpose is outlined below.

First, however, for those who have never used a receiver with squelch, it will be worth while to back up and define exactly what this circuit does. Stated simply, the squelch circuit is an active circuit which effectively silences the receiver in the absence of signals stronger than a certain preset threshold. The word active should be noted, for it is what separates a true squelch circuit from judicious adjustment of the various receiver gain controls. Squelch circuits are normally tied, either directly or indirectly, to the receiver AVC bus and obtain their controlling voltage therefrom. Squelch circuit operation is based on the fact that most noise and QRM, while of high audio content, actually represent little signal strength and therefore cannot develop significant AVC voltages.

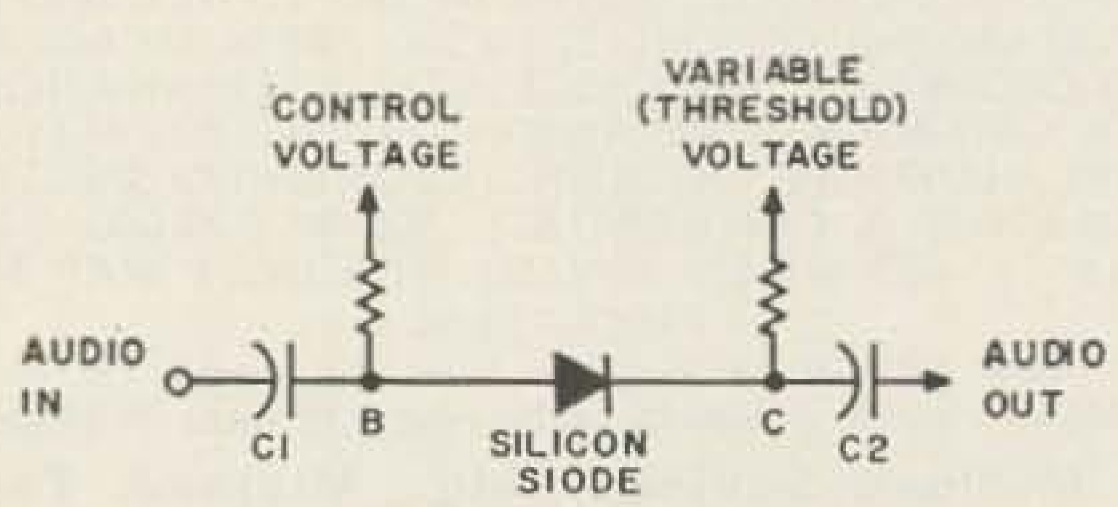


FIG 1

There are three basic requirements that must be met by any squelch circuit before it can be considered acceptable for inclusion in a typical communications receiver. These are:

1) The circuit may be installed without making any mechanical alterations to the receiver.
2) The squelch threshold must be a front panel control.
3) The squelch must operate reliably on the weakest signal that may be discerned above the background noise level.

The requirements of item one are obvious as most of us are unwilling to compromise the resale value of an expensive receiver. Thanks to TV (there must be something good about TV!) requirement two is easily satisfied. Squelch threshold can be made a front panel control by substituting a dual potentiometer with concentric shafts for the original receiver audio gain control. One section remains a volume control, the other is used for squelch threshold. These dual pots mount in the same size hole as the original volume control and are readily available from any parts house. The last requirement is operational in nature and based on a rather fundamental premise—none of us like to miss the weak ones as this is where the DX usually hides!

A simple circuit which fulfills the above requirements is shown in basic form in Fig. 1. Its operation is based upon the unique characteristics of a silicon diode. Such a diode, when forward biased, represents a very low impedance. When back biased the same diode has an effective impedance of ten or more megohms. Germanium diodes, because of their low back resistance, will not work. The best silicon diodes available are the high back resistance types. The Hughes 1N457 used here is typical (and also inexpensive). When it is connected as shown in Fig. 1, squelch action is obtained in the following manner. The variable voltage lead is connected to a potentiometer which allows this voltage to be set as desired. This is the squelch threshold control. The other side of the diode is connected to what will be called the control voltage and must be one which varies depending on the strength of the signal being received. Audio is applied to the circuit through dc blocking capacitors C1 and C2. As can now be seen, in the absence of signal it is possible to set the variable voltage (threshold) to where the diode is just slightly back biased, blocking the audio. Any increase in the control voltage will cause the diode to conduct. The diode then represents a very low impedance and allows the audio to pass. The control and variable voltages are both applied through isolating resistors whose combined parallel resistance must be greater than ten times the typical audio impedance of the circuit wherein the diode is placed in order to avoid bypassing a significant portion of the audio voltage.

The first source to be considered for a control voltage is the AVC bus itself. Unfortunately this bus normally operates at an extremely high dc impedance and will not tolerate the degree of loading the squelch circuit would impose upon it. A much better point to obtain the control voltage is the series fed screen grid on the last AVC controlled *if* amplifier. This screen grid's current (and therefore voltage) varies in accordance with variations of the dc bias applied to the control grid of the tube. As the control grid obtains its dc bias from the AVC bus it can be seen that the screen grid voltage will shift significantly for even the smallest of AVC bus fluctuations. The screen grid therefore provides an excellent source of control voltage, one that has both convenient magnitude and low dc impedance.

There are some cases, such as in the ARC-5 series of surplus receivers, where all the screens are fed from a common stiff medium voltage source. If this is the case on your receiver, the particular screen grid should be disconnected from the common line and the circuit shown in Fig. 2 substituted. The screen dropping resistor is chosen to provide the same screen voltage as was originally present. The value of 100 K shown on the diagram is typical and may be considered a good starting point to experiment from. The screen grid dropping resistor can also be optimized to provide the greatest voltage swing for small changes in the AVC bus voltage. This value is best determined by trial and error. So long as the screen grid voltage that results remains within 20% of the original value operation of

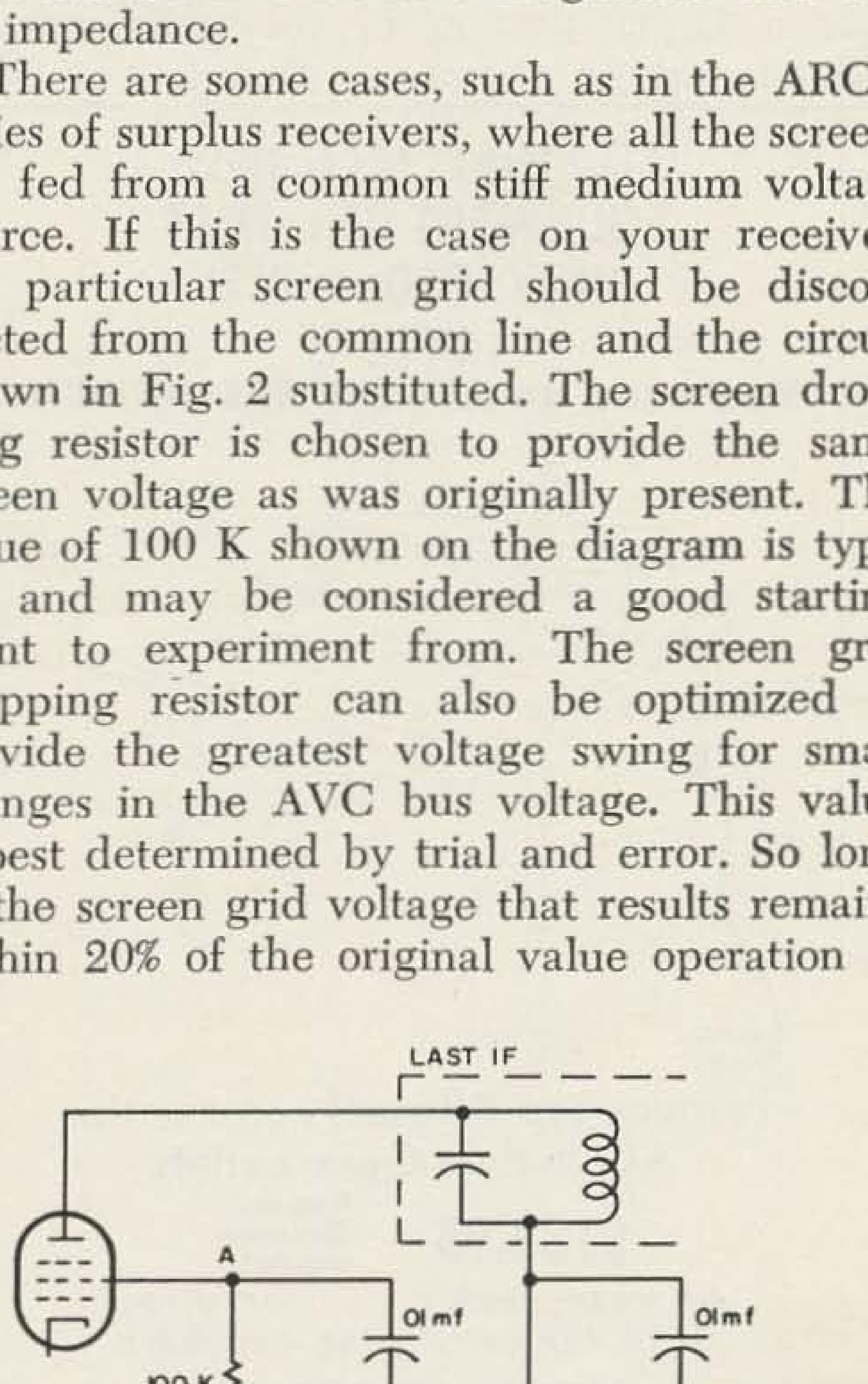


FIG 2

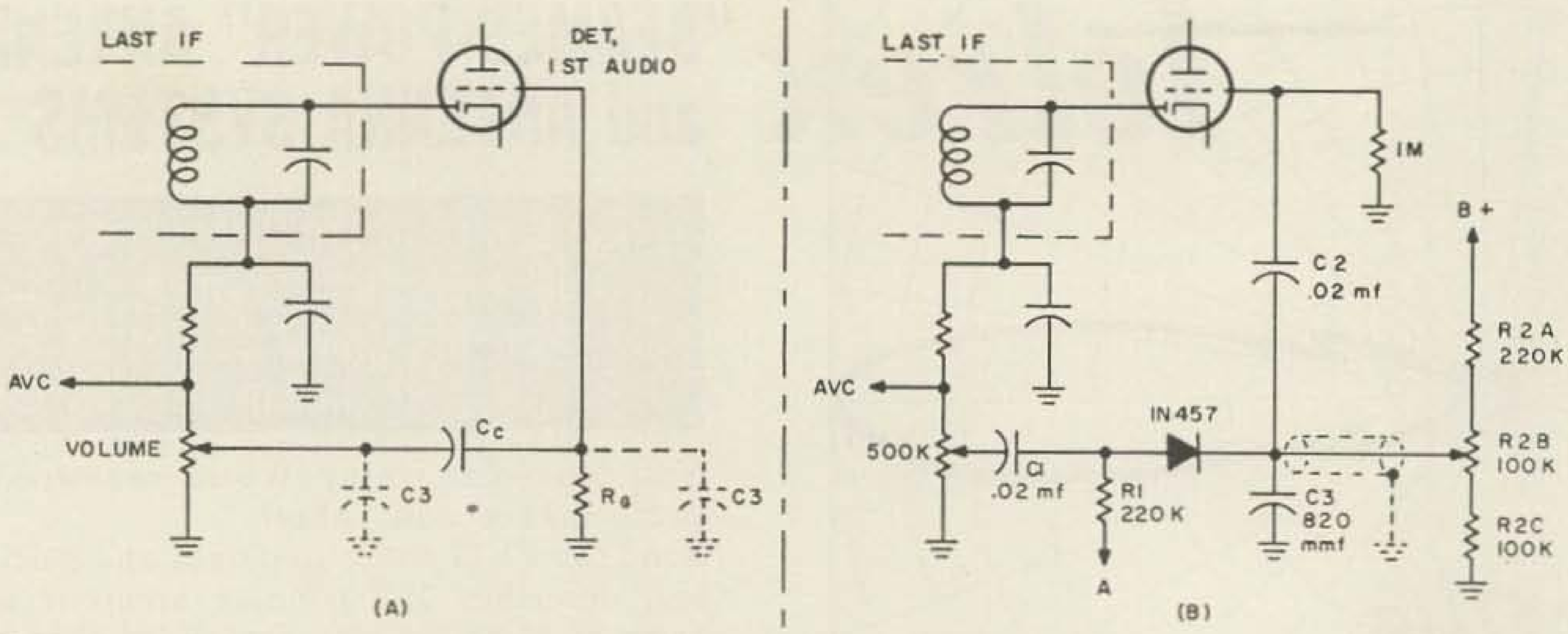


FIG 3

the last *if* stage will not be materially altered.

The best point in a typical communications receiver to apply this squelch is between the audio gain control and grid of the first audio amplifier. This stage, in its typical form, is shown in Fig. 3A. Fig. 3B shows a practical installation of the squelch circuit. Coupling capacitors C1 and C2 have been chosen so as to represent, in series, the same impedance as the original coupling capacitor. Resistor R2 has been split into three components so that the actual squelch threshold may be spread over a larger portion of the pot's rotation. R2B should be chosen so that it can swing the variable voltage over a greater range than will be present under any conditions at point A on Fig. 2. R2A through C can all be part of the same potentiometer, but this is not recommended. For the circuit to work in a positive manner, resistors R1 and R2A-C should be made the lowest possible values consistent with satisfactory performance. Their combined minimum value may be determined in the following manner. Before the squelch is installed, bypass the centertap of the volume control to ground through various resistors. (During this test the volume should be set at a comfortable listening level.) The smallest resistor which can be so inserted without degrading either the audio volume or quality will constitute the minimum ac resistance that the squelch circuit should be allowed to represent between the audio grid and ground. Examination of Fig. 3B will show that in the squelch circuit the equivalent to this resistance is actually composed of three separate parallel components. (For purposes of calculation consider the squelch to be at the high voltage end of R2B.) These are R1, R2A, and the total of R2B and R2C. The three resistances should be essentially equal in value. Their total parallel resistance should approximate the minimum value determined above. The values shown in Fig. 3B may be considered typical.

Capacitor 3C has been neglected so far in order to avoid confusing the basic fundamentals. It may be present in original equipment at either of the locations shown in Fig. 3A. When so placed its presence serves either or both of two purposes. The first is to remove any trace of *if* frequency components from the audio. The second is to provide a degree of tone control. C3 serves both of these functions in the squelch circuit plus one more. When the diode is back biased, there is still a very small amount of audio leakage. If this is allowed to go directly to the first audio amplifier grid an audible output will be present at the receiver speaker. Placing C3 as shown in Fig. 3B shunts this small audio component to ground, allowing the squelch to achieve 100% quieting. The optimum value of 3C is best determined experimentally by substitution. The larger the value of 3C the better, the limiting factor being how much capacity can be inserted before the receiver's high frequency audio response is reduced to an unacceptable point. Some attenuation of highs will normally be beneficial in communications work, as will be noticed when experimenting with 3C. Typical values are 820 or 1000 mmfd.

A brief examination of the impedances involved in the complete squelch circuit is now possible and will help to explain the operation of the circuit. When the squelch is closed (diode conducting) the diode represents an impedance of several thousand ohms. Since the audio impedance of the circuit between the volume control and first audio amplifier grid is typically 100 K–500 K, the additional series resistance of the conducting diode reduces the available audio voltage only a few percent, an effect that is not noticeable. The combined shunt impedances of R1 and R2A-C decrease the available audio 1-3 db, depending on the values chosen. This is not a serious loss either as most receivers can provide considerably more audio than is ever needed. The impedance of 3C is also parallel to these resistors but varies according to frequency. (If it is chosen as outlined above, its presence, rather than detracting from, will probably enhance the audio characteristics of the receiver.) When the squelch is open (diode non-conducting) the diode represents a minimum impedance of 10 to 100 megohms. It, together with C3, may be considered an ac voltage divider. As C3 now represents a relatively low impedance (approximately 100 K at audio frequencies) compared to the non-conducting diode, it can be seen that negligible audio voltage will be present at their junction, or therefore at the first audio amplifier grid. This effectively silences the receiver.

Physical installation is extremely simple. The original volume control is replaced with a dual potentiometer, one section of which has the value of the original audio gain control, and the other section that of R2B. Most of the additional components may be mounted between the volume and squelch control terminals. An additional multilug terminal strip can usually be mounted somewhere near the volume control to provide convenient tie points for the remainder of the circuit. Long leads should be avoided if they are part of the first audio amplifier grid circuit. Where this is not possible, such leads should be shielded to avoid hum pickup.

This circuit has been installed in several receivers by the author, providing satisfactory results in all cases. The actual performance of this squelch appears to be more effective and reliable than many of the circuits commonly used in commercial communications equipment. It is certainly simpler! Effective squelch action, from fully silenced to fully open, is consistently obtained from signals 3-6 db above the background noise level. This corresponds to AVC bus variations of less than .05 volts. The advantages of adding such a squelch circuit are many and worthwhile. Once you have used a receiver so equipped, you too will probably consider squelch an essential control.

. . . K4UWX

Good old Charlie Queen

Ralph Morris W1QUE

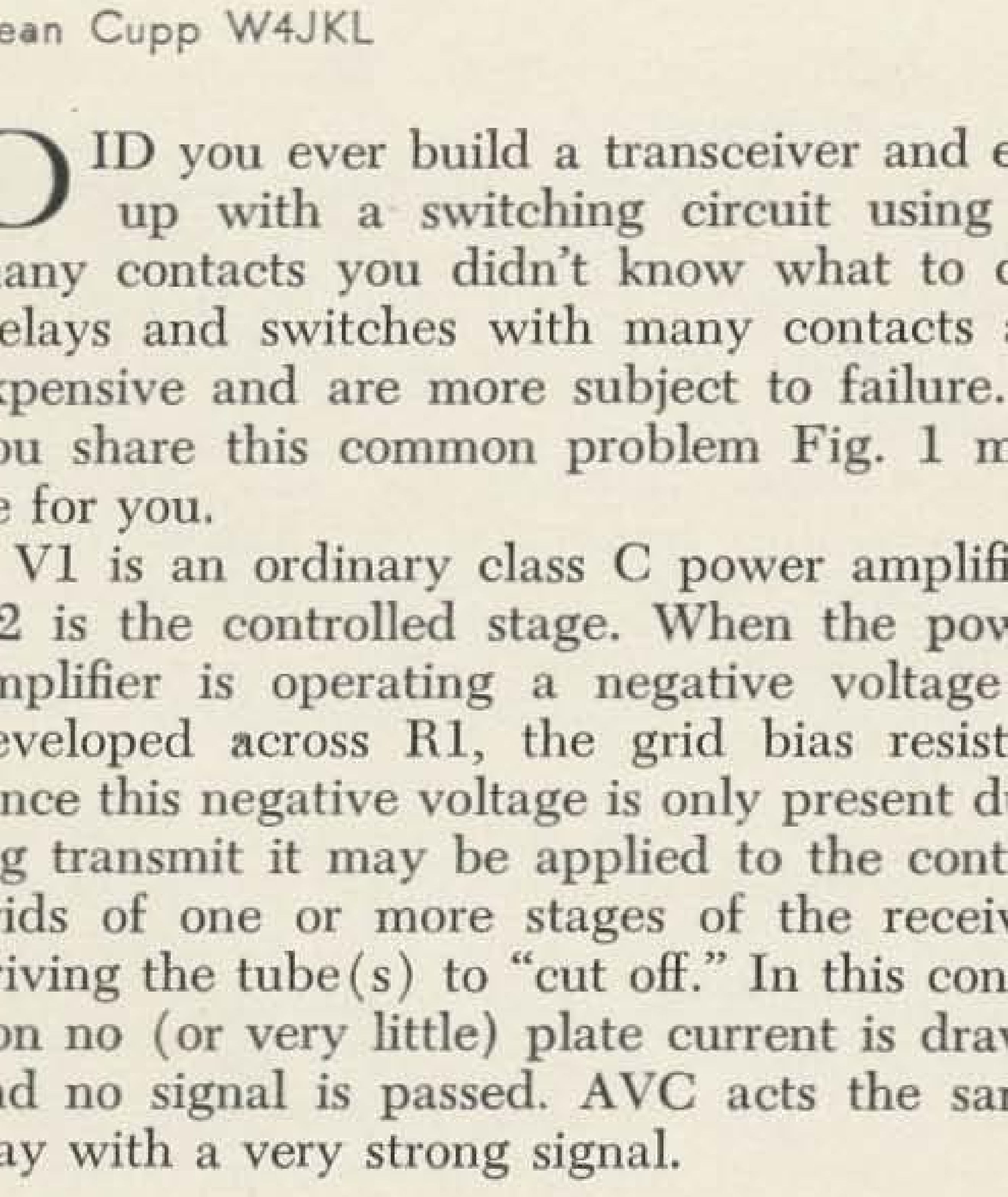
The other night when all the shows in Tennessee Valley had the odor of our local Clark's Cove mud flats at low tide, I placed a pair of cans on my dit happy head. After shooting the 60 cycles to my cabinet of used tubes, my hearing aid came to life. It was then that I heard a Space Jockey calling a Charlie Queen. Not being the type of fellow that drinks and shoots electrons into space at the same time, I put my glass of milk back into the ice-box and slapped the AC to the 55½ pounds of #12 that I got from an old battery charger. As soon as my 1A2's got red on the plates, the neighbors buzzed my land line and I knew for sure that I was on the air. As the XYL answered the twisted pair, giving the names of our local TVI committee to the Video Ranger that called, I gave the Space Jockey calling Charlie Queen a long shout. My signal must have punched a large hole in the QRM, because this Space Jockey started to pump my call letter down the coax and into my hearing aid. At once I knew that I had snagged a DX station. This RF Jockey lives a good five city blocks away from my QTH! He at once thanked me for shouting at him and gave me 10 Dog Biscuits. This made Duke, the canine member of our little family very happy. He also reads the mail. My contact then told me that he had his rig mounted on a bread board. Knowing that most bread comes already sliced, there must be plenty of these boards on the surplus market. He did however put a good signal into my bucket of tubes, in fact enough to make my cans rattle. At this point I switched to my Pretty Mary Squacker, and gave this Space Jockey an RST report of 5 square. I could not give him a true reading from my S meter, as it is one that I picked up at a surplus store and only reads "The Flow Of Fuel Per Hour." He told me that he could not have a long winded Rag Chew at this time as his favorite gun-slinger would soon appear on the one-eyed monster. He thanked me for the shout and the QSO which he said was Real Arm Chair Copy all the way. He asked me to send him some wall-paper for his shack. I told him that I would send his wall-paper by the next Pony Express. I thanked him for the chew as I sent him 73. Then I slung it back at him to tie the ribbons on it saying that I would see him down the log. After that I pulled the Main and slapped his name along with his XYL's handle on the log. I must finish this now, for some Joaker in a white coat is standing in back of me with a big net,—"Must be a TVI Complaint!"

Transceiving

Dean Cupp W4JKL

DID you ever build a transceiver and end up with a switching circuit using so many contacts you didn't know what to do? Relays and switches with many contacts are expensive and are more subject to failure. If you share this common problem Fig. 1 may be for you.

V1 is an ordinary class C power amplifier, V2 is the controlled stage. When the power amplifier is operating a negative voltage is developed across R1, the grid bias resistor. Since this negative voltage is only present during transmit it may be applied to the control grids of one or more stages of the receiver driving the tube(s) to "cut off." In this condition no (or very little) plate current is drawn and no signal is passed. AVC acts the same way with a very strong signal.



RFC, C1, and C2 are to prevent robbing V1 of drive or interfering with the operation of the controlled stage, and should be values appropriate to the frequencies used. (C2 will probably be larger than C1.) C1 and C2 are in parallel, as the lead could pick up a signal causing interference to the circuit at the end un-bypassed. Check to see that you have enough negative voltage across R1, or in the case of a higher powered transmitter, R1 could be made a voltage divider. It is recommended that the mixer and audio stages be controlled. Happy soldering and 73.

. . . W4JKL

Spotting Simplified

George Thurston W4MLE
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Tallahassee, Florida

THE Heath Apache and other transmitters are equipped with shiny bright red "spotting" buttons which, according to the manufacturers, are supposed to let you find your own signal in the receiver without putting a signal on the air.

But in practice, it often takes two left hands or an assistant operator to do the job in less time than it takes to tune up the rig on a new band.

These "spotting buttons" generally do nothing but turn on the VFO (and all subsequent stages) without actuating the antenna change-over relay or receiver muting device.

In phone operation this is usually OK, except that the signal is often so strong you can't zero a weak signal accurately because you just can't hear the beat note.

CW operation goes something like this:

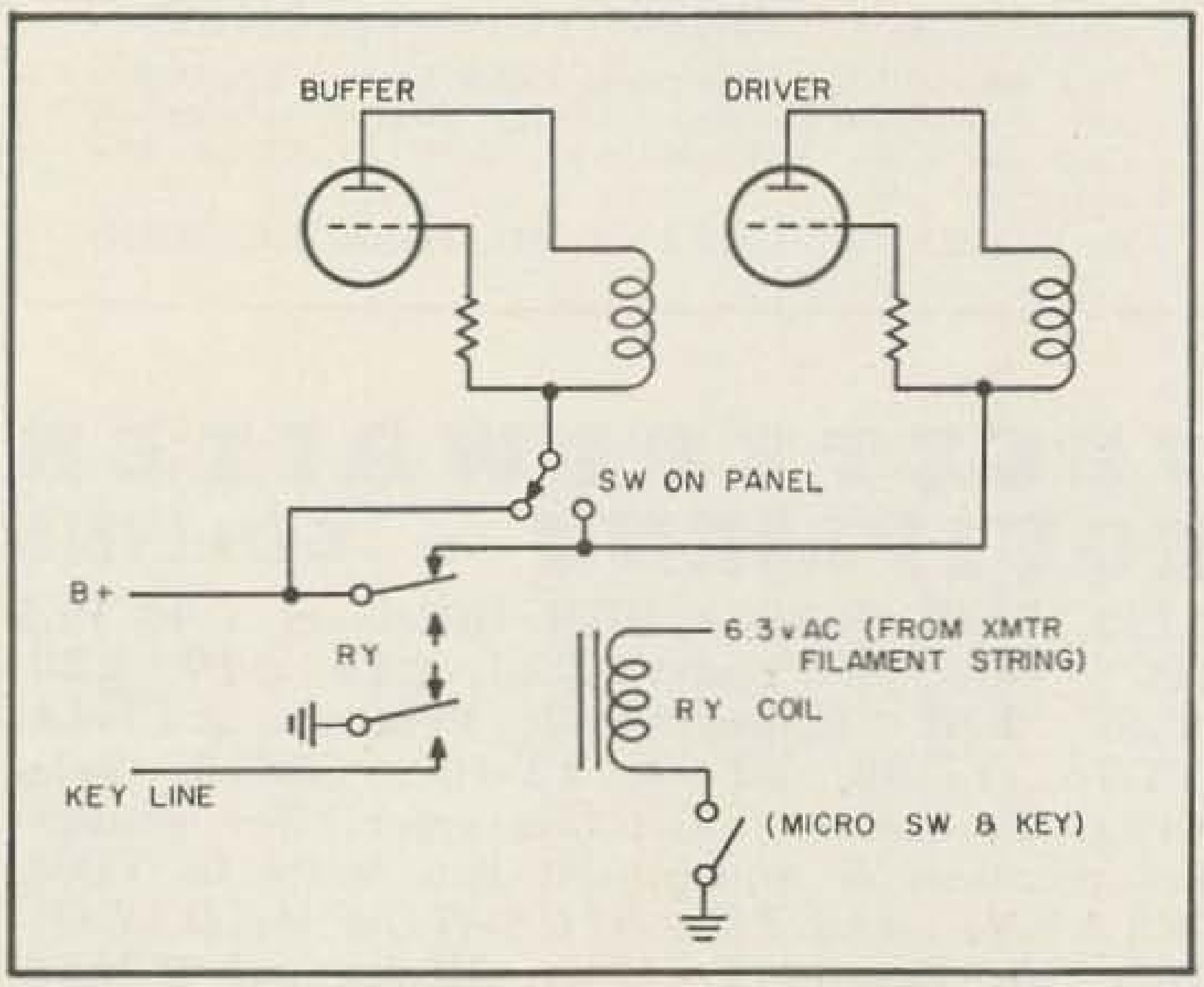
(1) You find an S-5 DX signal down the band calling CQ

(2) Turn off B-plus to the final

(3) Hold the "spotting button" down with one left hand

(4) Turn the VFO knob with the other left hand

(5) Reduce the receiver RF gain with the right hand to avoid arcing between your ear drums as the "spotting" signal screeches into place.



(6) Restore B-plus to the final and restore Rx gain to normal.

Failure to kill B-plus, of course, defeats the purpose of the spotting switch. Since the switch in effect simply closes the key, you'd put a carrier on the air if the final B-plus stayed on.

The solution—in the Apache, DX-100, or almost any other transmitter of whatever make—is a simple DPDT relay with a 6.3v AC coil.

The relay is connected so that one pair of contacts will close the key line when the relay pulls in.

The other pair of contacts disconnects the plate voltage from the buffer and/or driver stages following the VFO. This automatically keeps the spotting signal off the air.

The former "spotting" button on the front panel may now be used to close the circuit to the relay coil. A still better system, however, is the one I've installed in my Apache.

The switch lead for the relay coil is brought out through the accessory plug and connected to a micro-switch mounted next to the key. Thus, simply by moving my forefinger from key to switch toggle, I can actuate the relay, leaving my (only) left hand free to twist the VFO knob.

With only the driver stage disabled by the relay, I found the spotting signal still too strong for comfortable CW work. So I rigged it to cut off plate voltage to both the buffer and driver. This worked fine for CW but gave too weak a signal to use on strong phone signals.

The solution was a two-position rotary switch mounted on the front panel in the place formerly used by the "spotting" pushbutton. In one position, this switch causes the relay to kill only the driver. In the other position, the relay kills both the driver and buffer.

Spotting with this arrangement is absurdly simple.

(1) Hit the spotting switch at the key

(2) Twist the VFO knob

(3) Release the spring-return spotting switch.

Coax vs Open Line

Bill Roberts W9HOV
Gain, Inc.

Sometimes progress does more harm than good. World War II brought us the coax cable. Almost every amateur has used it in or around the shack. Up to the point when cable became available for amateur use, everyone used a variation of open wire feed.

We feel that we should make a box score on this old feed style and let you decide which is best. Score it honestly and let the chips fall where they may:

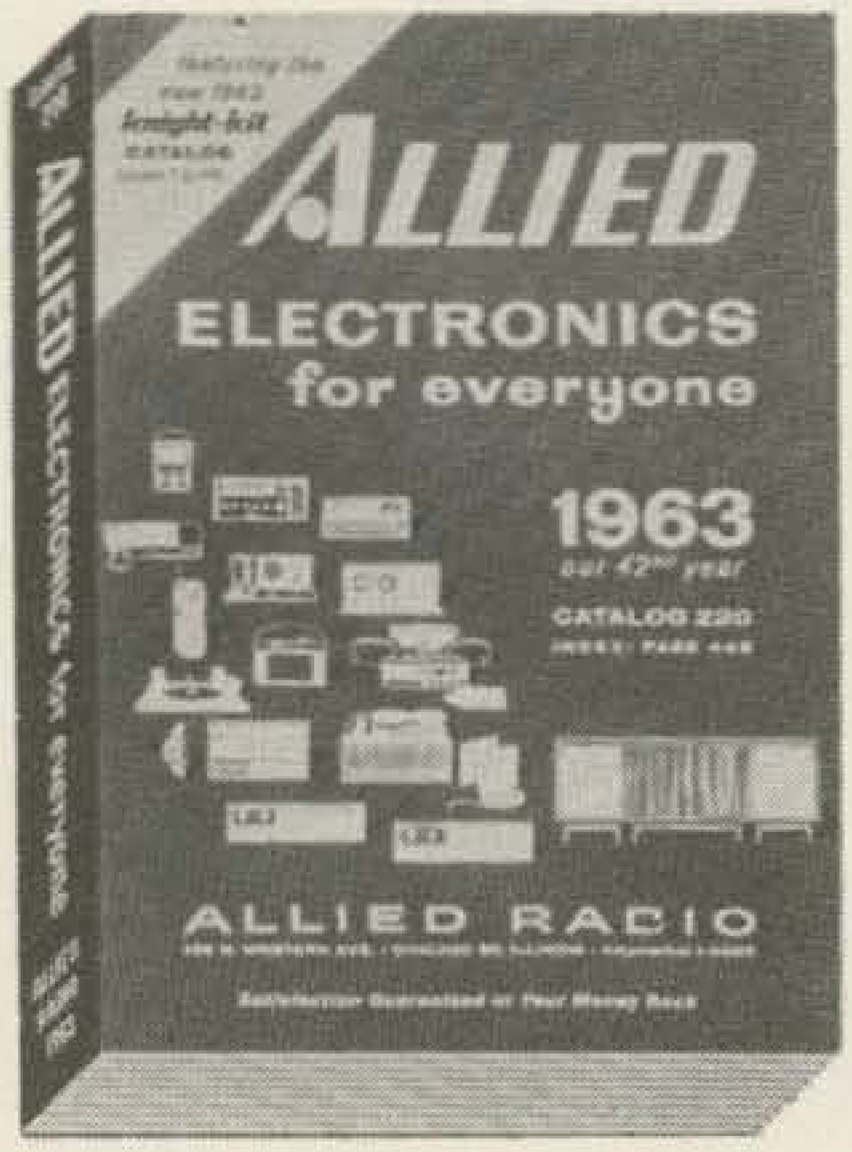
	Open Wire	*Coax*
Weight	*Light*	*Heavy*
Losses mount heavily with High SWR	No	Yes
Will excessive losses render Line Inoperable	No	Yes
Will insulation burn through	No	Yes
Losses at 220 mc (100 feet) Pwr pct.	6 per cent	80 per cent
(using 144 mc	4.8 per cent	70 per cent
RG58U as 50 mc	2 per cent	46 per cent
com.) 14 mc	1 per cent	14 per cent
Cost	Cheap	Expensive
Deterioration with age	Negligable	Noticeable
Capitance in mmfd	O (virtually)	28. 5
When used as untuned line	Good	Questionable
Precautions for water on the line	None	Must be sealed
Effected by nearby objects	Some	Very Little

Now that I have given the pros and cons, it would seem that the score is 10 to 1 in favor of open line.

Let's assume we have a 2 meter antenna 100 feet in the air. Using coax all the way could result in the loss of 70 per cent of the power. Using open wire cuts this to a 4.8 per cent loss (1/14). After reaching the shack it should be converted (balun) to coax. This takes a little matching but maybe the saving of 65 odd percentage points of power makes it well worth the "trouble?."

We are not asking you to go to open line, we are just asking if you can afford not to.

New, New



The Biggest

Allied Radio is not only a good 73 supporter, but they also have an interesting line of ham gear and test equipment that they turn out. The Allied catalog has for years been considered the most complete parts and equipment catalog available. The 1963 issue is now out and if you haven't already received one you would do well to let them know of your interest with a postcard. Mention 73.

Coax Switch

Bay Roy Electronics, well known for their coax relays, now has a cute little DPDT coax switch which will work at frequencies up to 3000 mc. The switch will handle 100 watts and has BNC connectors. Drop a line to Bay Roy for prices. 16608 Madison Avenue, Cleveland 7 Ohio.

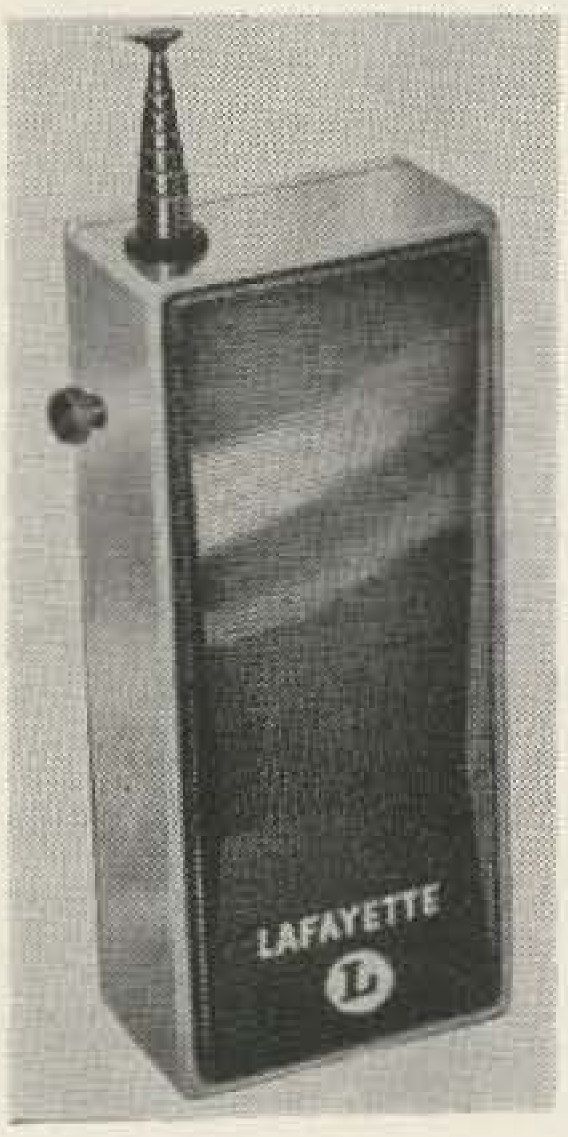
HE-45

HE-50

Lafayette Radio is coming out with new ham gear so fast that it is difficult to keep up with them. Their newest releases are a pair of six and ten meter transceivers. The HE-50 is the ten meter model, runs twelve watts to a 2E26 final and uses the popular 7 mc crystals. The built-in dual 117 vac/ 12 vdc power supply allows the unit to be used either at home or in the car without changes or separate power supplies. Comes complete with push-to-talk mike for $109.50, all set to go. The HE-45 six meter model is similar, using the 8 mc crystals and sells for the same remarkable price. The receivers are superhets with a 1650 kc *if* and an rf stage for good sensitivity and rejection of images. Both are 15 pounds, great for portability. Write Lafayette, 111 Jericho, Syossett, N. Y. or just buy one from this writeup or their ad on page 3.

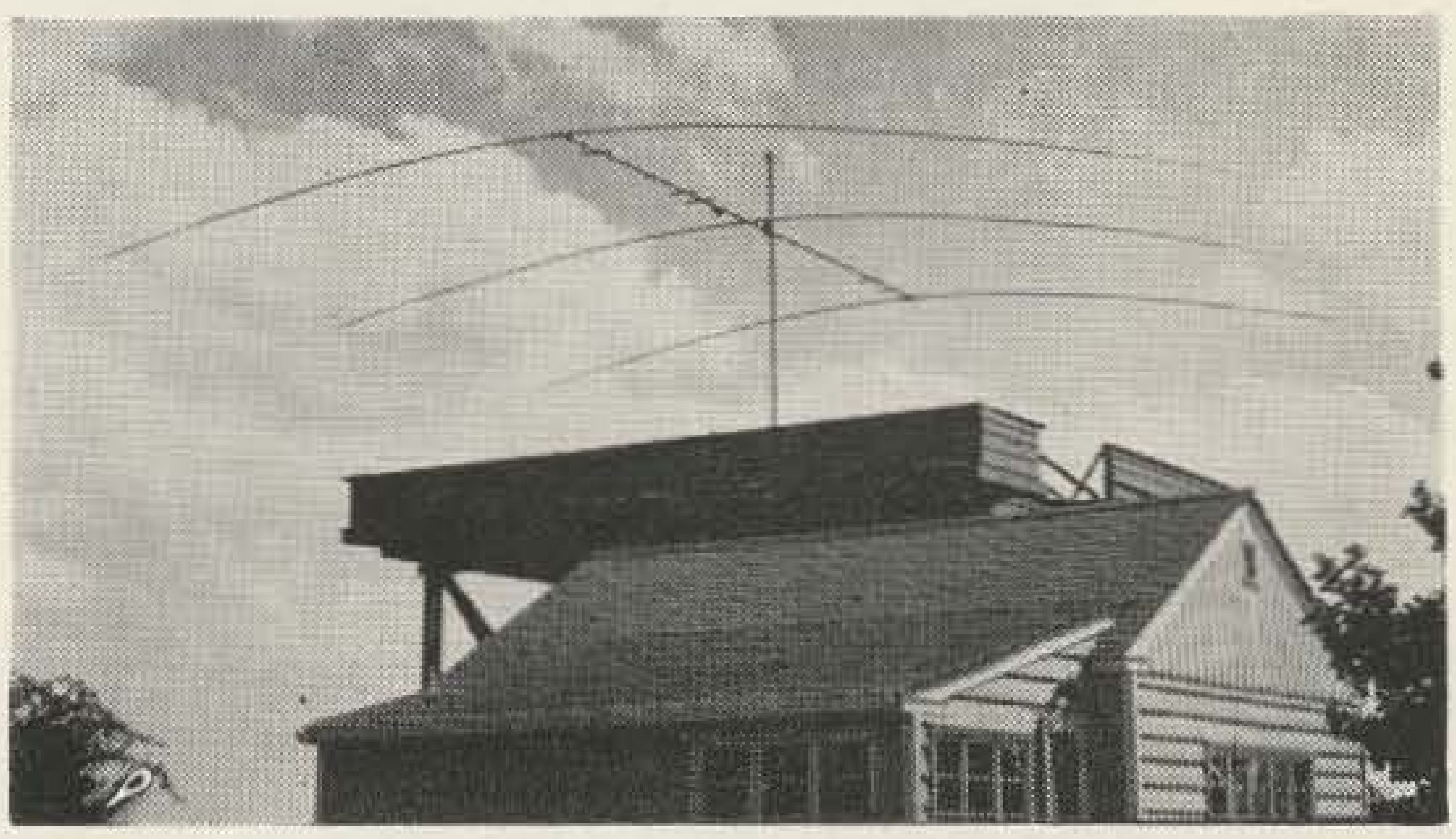
Heath Catalog

The Heath Company is getting out a larger and larger catalog every year. Now it's beginning to look more the size of a Sears catalog. If you can read the latest catalog without eating your heart out for all that ham gear then you're suffering from a lack of imagination. Boy, if I had money could I tear into an order blank! Heath has more ham gear than any other classification, too! Write to Heath for their new 100 page catalog. Benton Harbor, Michigan.



CB Walkie-Talkie

While we don't ordinarily pay much attention to the new CB gear that is announced, this one looks worth a mention. Lafayette's HE-66L CB Walkie-Talkie sells for $19.95 each and uses crystal control for both receive and transmit, plus a superhet circuit in the receiver! Four transistors and a diode are used. Complete with leather carrying case, antenna, crystals and batteries. 85 mw power so you don't even have to have a CB license to use it. A pair of these ($38.95) are mighty handy around any ham shack. Lafayette Radio, Syosset, L. I., N. Y.



Bigger Than a House

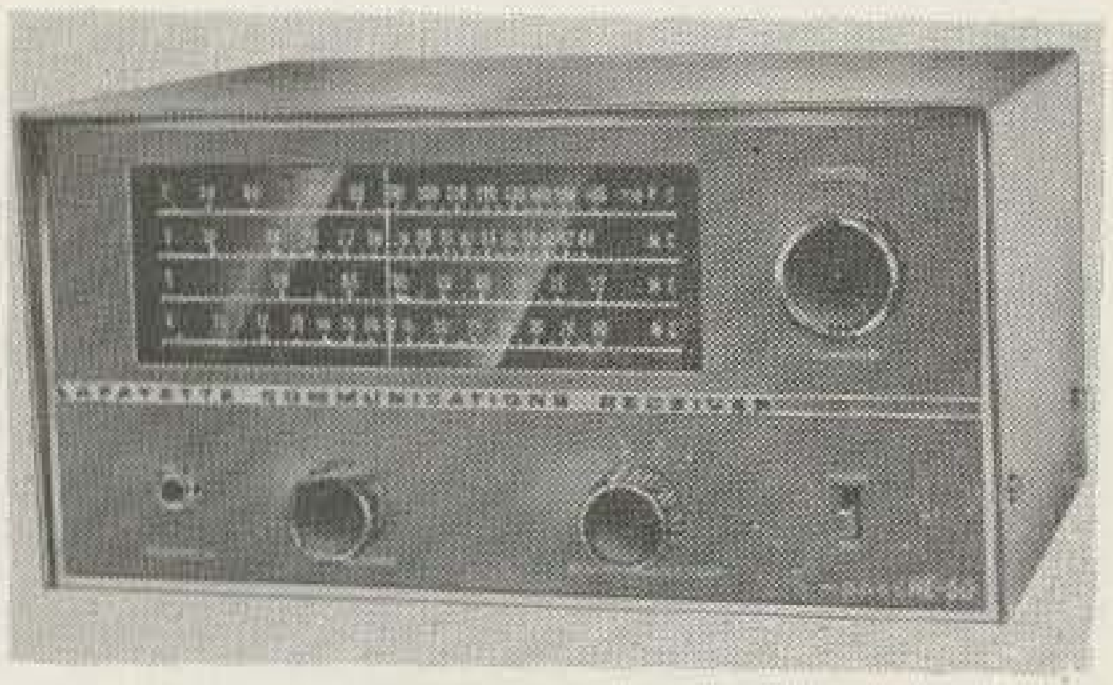
The Telrex full size 40 meter beam, complete with 46′ boom! Price? $725.00 without the cottage.

Books

Radio Frequency Systems is the first volume of the **Modern Communications Course** written by Mr. Edward M. Noll, W3FQJ, and published by Howard W. Sams and Co., Inc., of Indianapolis, Indiana. It is designed to fit with others in the course to give a practical and comprehensive coverage of radio communcations. The reader is assumed to have a basic understanding of radio receiver operation and some fundamental knowledge of electronics. However, basic theory and modern design concepts are included in each volume.

Radio Frequency Systems contain comprehensive coverage of Radio Fundamentals, Class C Amplifiers, Oscillators, Exciters and Frequency Multipliers, Power Amplifiers, Antennas and Lines, Antenna Matching and Tuning Systems, and Transistor R.F. Circuits. Although the course is primarily intended for use as a classroom text, the style of writing is so explicit that it is readily usable for home study. This should prove a worthwhile addition to your library. Price: $4.95. H.P.

Having Fun With Transistors is another Howard W. Sams Photofact publication by Ken Buckwalter. If you have any old oatmeal boxes laying around, this is the book for you. There are thirteen simple transistor circuits that you can amaze and mystify your friends with. Sample chapters: Home Broadcaster, The Speaker Mike, "Boris" the Talking Skull, and the Musical Oatmeal Box. Aside from a brief chapter on construction hints, there is nothing specifically for the ham. L.T.



General Coverage Receiver

The Lafayette HE-60 covers from 550 kc to 30 mc in four bands and is priced at only $39.95. Three tubes plus diode for five tube performance. Built-in speaker. Superhet circuit, bfo, etc.

SWR Bridge

Lafayette has come out with a power meter and SWR Bridge. This is designed for CB use primarily, but is quite useful for ham applications up to 50 mc and up to 15 watts, which covers a lot of territory. The SWR function will handle up to 1 kw, but the power meter is limited by the 15 watt dummy load built in. Model TM-58 ($27.95). Lafayette Radio, Syosset, L. I., N. Y.

The Inverted Vee-Beam

Paddy Labato W8DLU

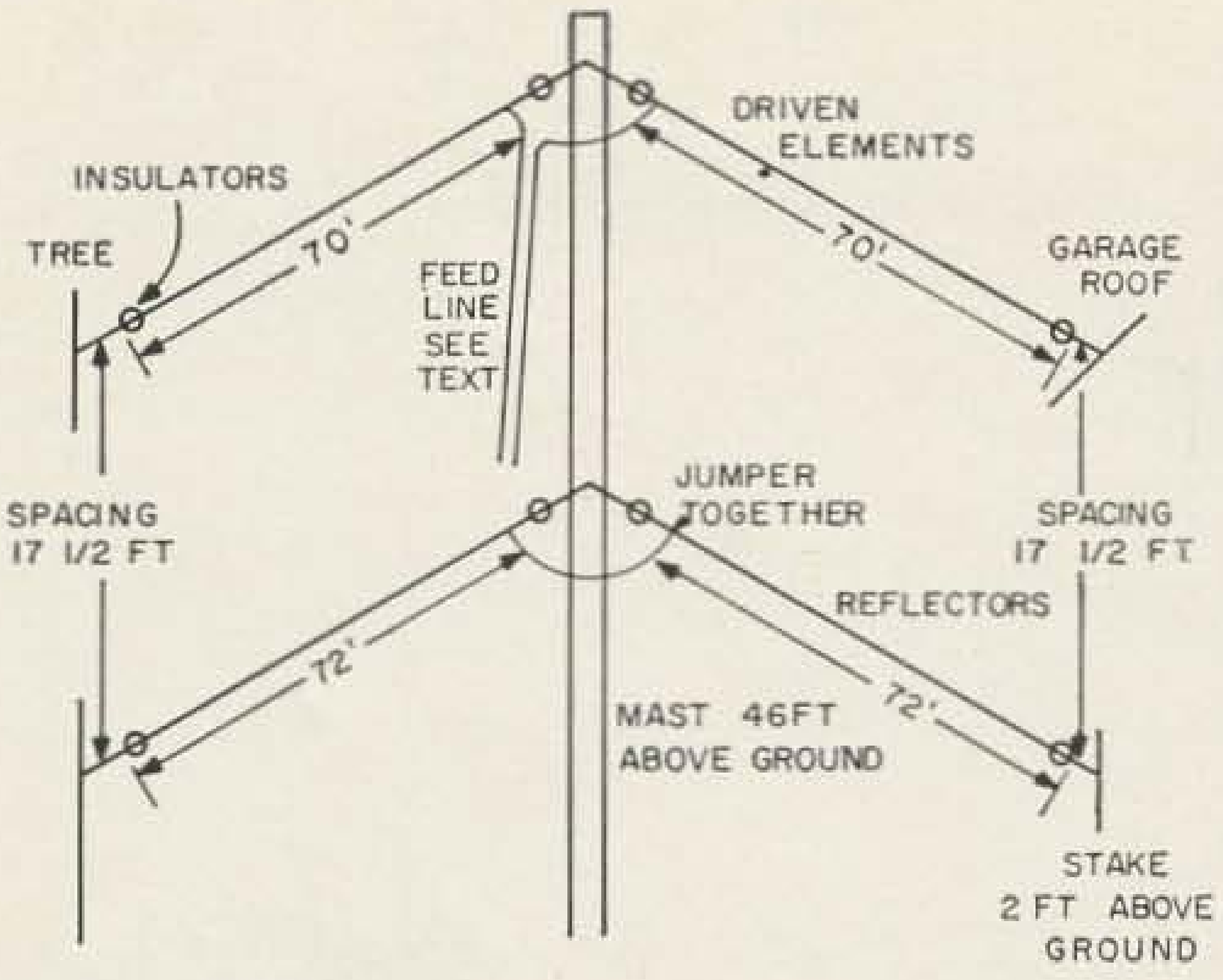
YOURS Truly—may or may not have been the inventor of the Inverted Vee antenna, however in 1926 I discovered that by slanting two wires earth-ward I began getting better reports from my one tube CW transmitter than with a horizontal Vee and long wire antenna that I previously had been using.

Through the years since that time I have tried every conceivable type of antenna from the bed spring to the super rhombic, etc., but for all-around performance, simplicity of construction, ease of feeding and pruning I give the Inverted Vee top honors.

During the past year I have been using a modified form of the vee which I call The Inverted Vee-Beam. And I have found results most gratifying. From W8DLU running 150 to 250 watts I have proof of WAC with QSL's from most all of Europe, S. Africa, S. America, Pacific Islands and Japan, all on 80 meter CW, and Europe, S. America and Pacific on 75 meter AM fone.

As many readers know, the Vee can be hung from house top, tree, window ledge, borrowed utility pole etc. I have selected to use a 25 foot mast above the house top with pulley hung thereto for raising or lowering antenna at will. The reflectors as shown here may or may not be used but I have found that besides providing extra gain they also serve as extra guy wires.

Due to slight rise in resonant frequency when slanting wires toward ground, the Inverted Vee will require slightly longer legs than the standard dipole requirements. Coax cable of most any type may be used for feeding if builder intends to work within 50 to 100 kilocycles of desired portion of given band. However, for covering an entire band such as 80, 75 and 40 meters with one antenna, it is suggested that open wire feeders with a suitable antenna coupler be used. In making checks with other hams in this area I have found that 300 ohm TV twin lead and/or the com-



mon 1 inch spaced open wire line that is used in some TV installations also make suitable feeders for the Inverted Vee. The coupler used at W8DLU is on the order of one described in March 1959 QST (McCOY). If open wire or twin lead is used it is desirable to cut feeders ¼ or ½ wavelength long. However if slightly shorter or longer line is necessary the antenna coupler will tune out enough reactance for desirable operation. Coax feedline may be of any length.

Dimensions as shown here are for 80 meter antenna and may be cut in half for a 40 meter antenna and so on for 20 meters. However keep feed point as high as possible. You will note through checking with grid dipper or SWR bridge that these measurements may not hold true for you. This is due to ground conductivity, surrounding objects, etc. The simplest way is to add or cut antenna length for the lowest SWR reading.

Some readers may ask, how can reflectors directly beneath the antenna act as reflectors? Will they reflect skyward or what? As far as I can determine, the Inverted Vee is a semi vertical-semi horizontal antenna. While making field strength checks we have found strongest lobes off the upper portions of the antenna and those lobes increased further along the antenna legs with the use of reflectors. Signal reports especially from DX were stronger when reflectors were used. . . . W8DLU

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Choke Evaluator

Ronald Ives
2075 Harvard Street
Palo Alto, California

IT is customary and traditional in electrical and electronic work to evaluate large inductances by use of an impedance bridge, an instrument so costly that few amateurs and experimenters can afford it. Impedance bridges range in price from a kit (Heath IB-2A), costing \$69.95 plus several evenings of work, to beautiful laboratory instruments costing about as much as a new car. Unless the bridge is to be used many times a day, or in work where precision is of great importance, its purchase is not usually justified.

More than a decade ago, when the grid-dip oscillator became a standard laboratory instrument, it was found that small inductances could be evaluated by shunting them with a known capacitance, and then determining the resonant frequency of the circuit. From this, the inductance was computed. This method works very well indeed for radio and *if* frequencies, but is impractical for large inductances, because few grid-dip oscillators will go low enough in frequency, and the Q of large choke coils is so low that a nonambiguous resonance point is hard to find.

There should be some method of evaluating large chokes by use of ordinarily-available shop instruments. There is! Requisites are a voltage source of known frequency, a low drain multimeter or ac VTVM, a resistor of known value, and some brains.

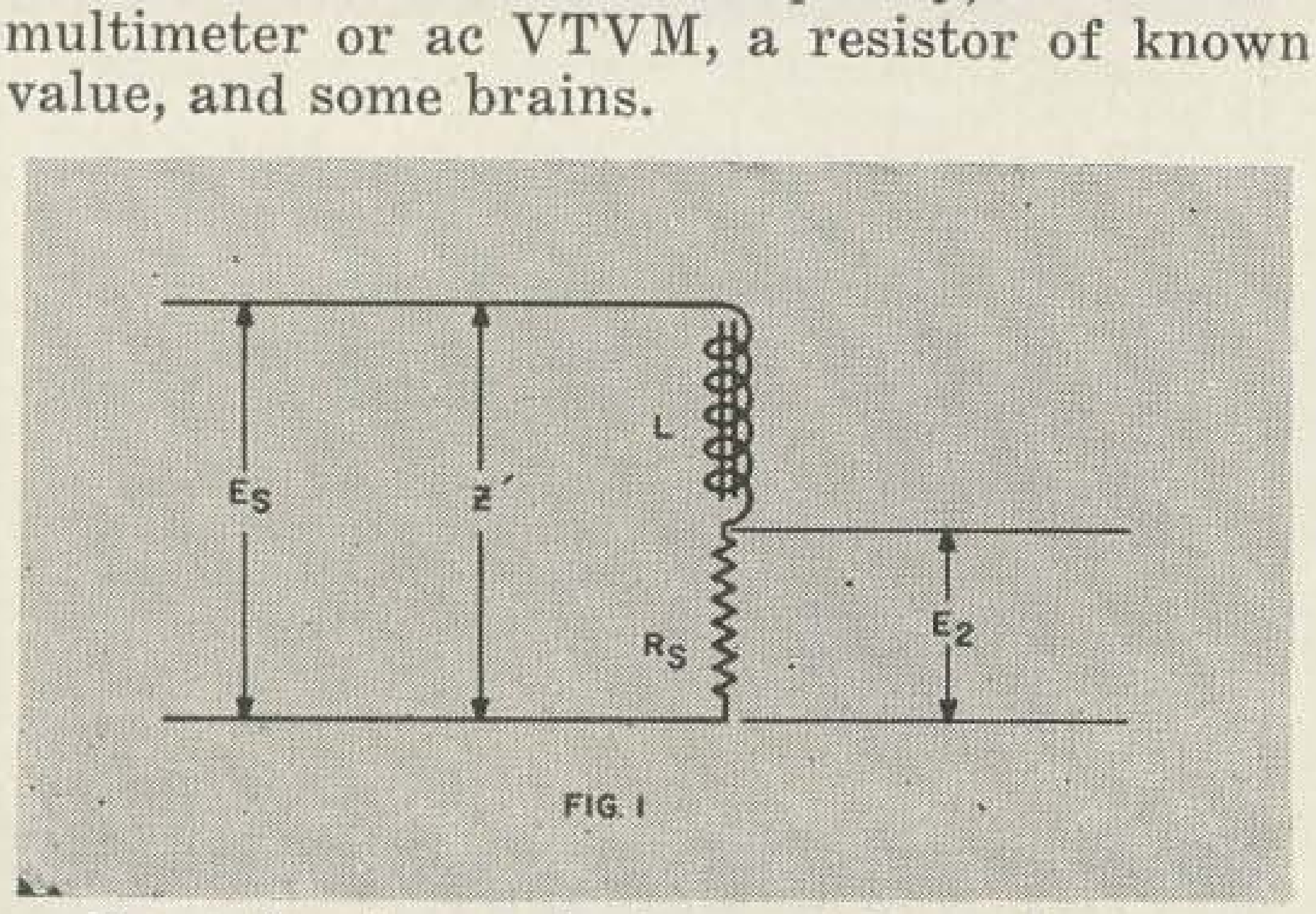

Fig. 1 Simple ac circuit containing inductance and resistance.

In any ac circuit, such as that of Fig. 1, containing both inductance and resistance, the impedance can be found from the ac adaptation of Ohm's law:—

$$1)\quad Z = \frac{Es}{I}$$

In which:—

Z = impedance of circuit (ohms)
I = current through circuit (amperes)
Es = supply voltage (volts)

Quite obviously, Es can be measured directly by use of the multimeter or ac VTVM. Current through the circuit, I, seems to be a problem at first, as few amateurs or experimenters have access to an ac milliammeter. However, known the value of Rs (we can measure it with the multimeter if necessary), and the voltage drop across it (measure it with the multimeter or ac VTVM), E_2, we can compute the current through the circuit from:—

$$2)\quad I = \frac{E_2}{Rs}$$

Substituting these obtained values in (1) gives us the impedance of the circuit of Fig. 1. Computation is simplified if we combine the formulae, by substitution, obtaining:—

$$3)\quad Z = \frac{Es\,Rs}{E_2}$$

Even though we know the impedance of the entire circuit, we still cannot compute the inductance of the choke by any reasonable method, as most chokes have a finite internal resistance, which must also be taken into consideration. Actual circuit, in the configuration of Fig. 1, taking into account the internal resistance of the choke, Ri, comprises Fig. 2. Impedance of this circuit, already found experimentally from (3), is also given by:—

$$4)\quad Z = \sqrt{(Rs + Ri)^2 + (X_l)^2}$$

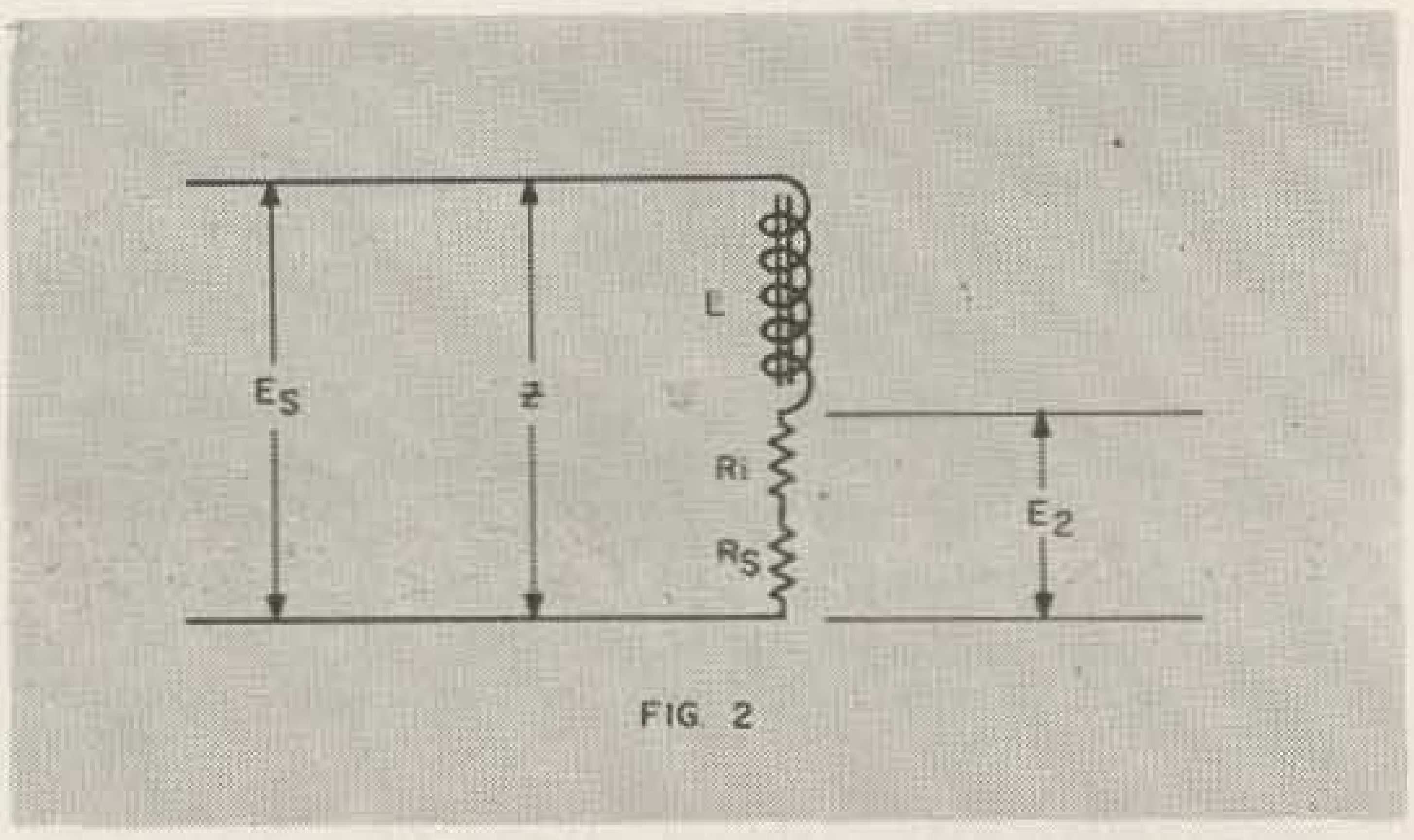

Fig. 2 Series L-R circuit including internal resistance of choke.

and, because things equal to the same thing are equal to each other, we can combine (3) and (4), obtaining:—

$$5)\quad \frac{E_sR_s}{E_2} = \sqrt{(R_s + R_i)^2 + (X_l)^2}$$

from which we can evaluate the inductive reactance. This can be simplified by standard algebraic methods to:—

$$6)\quad X_l = \sqrt{\left(\frac{E_sR_s}{E_2}\right)^2 - (R_s + R_i)^2}$$

and, as $X_l = 2\pi fL$ (f is frequency in cycles per second), the inductance can be computed directly from:—

$$7)\quad L = \frac{\sqrt{\left(\frac{E_sR_s}{E_2}\right)^2 - (R_s + R_i)^2}}{2\pi f}$$

The value of the inductance, L, is in henries.

At first glance, this appears to be a pretty complicated and difficult formula. Actually, as all values to the right of the equality sign are simple constants, each group of terms can be evaluated individually, and the actual computation takes only a couple of minutes. When a 60 cycle voltage source is used, the denominator, $2\pi f$, computes out to 376.9920, which becomes 380 for purposes of practical computation.

To evaluate a choke by this method, we must measure internal resistance of choke, Ri; value of added resistor, Rs; supply voltage, Es; and drop across added resistor, E_2. To illustrate with a practical example, measurements made with a specific choke are:—

Ri = 910 ohms
Rs = 1000 ohms
Es = 25 volts (60 cycles)
E_2 = 2.4 volts

Substituting in formula (7), we find that the value of the choke is 27 henries. Nameplate value of the choke (a Stancor C-1515) is 20 henries at 15 ma dc, and nameplate resistance is 900 ohms. Computations were carried to three significant figures only, as the multimeter used was dependable only to one percent.

Subsequent checking of a number of in-

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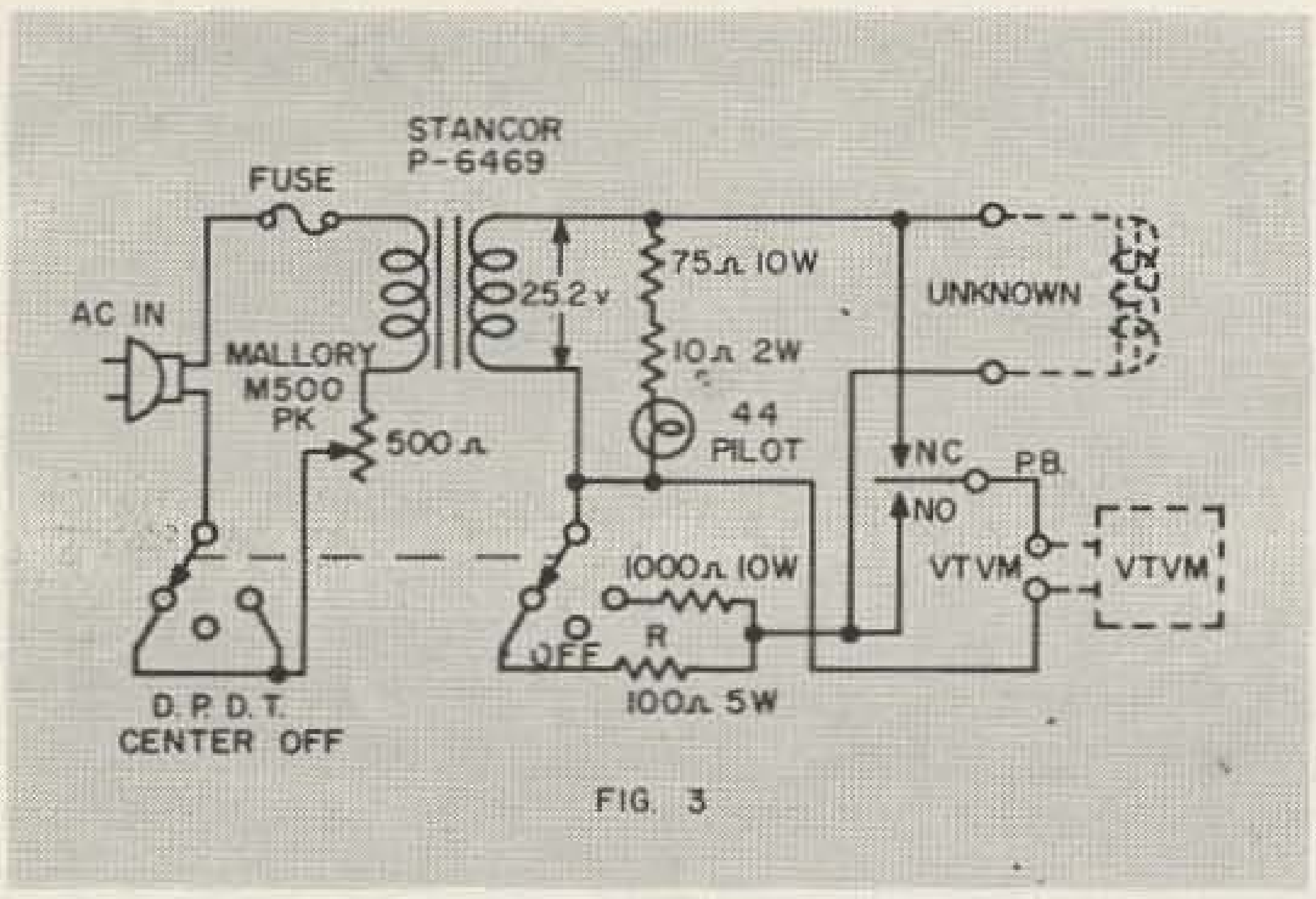


Fig. 3 Circuit of choke evaluator.

ductances, both by this method and by use of a high-grade laboratory bridge, showed that the difference between the two methods seldom exceeded two percent, which is surprisingly good when it is noted that this simplified method minimizes the effects of distributed capacity in the choke by use of low frequency (60 cycles), whereas the laboratory bridge, by a series of somewhat involved measurements and computations, is supposed to eliminate its effects entirely.

These tests also showed that the actual measurement time, including computation, was shorter with the evaluator here described than with the more complicated bridge; but the setup time—i.e. finding and connecting the instruments and components—was about half an hour. To stop this waste of time, which adds up to a considerable figure over a period of months, the essential parts of this choke evaluator were assembled in a bakelite utility box, using the circuit of Fig. 3, and made a permanent addition to the laboratory instrument stock. Parts actually used are noted on the diagram, but electrically equivalent parts of other manuacture will work just as well. Construction is extremely simple and noncritical, there being no high frequencies, high powers, or high resistances involved. Ordinary good workmanship will give entirely satisfactory operation.

Fig. 4 Panel layout of choke evaluator.

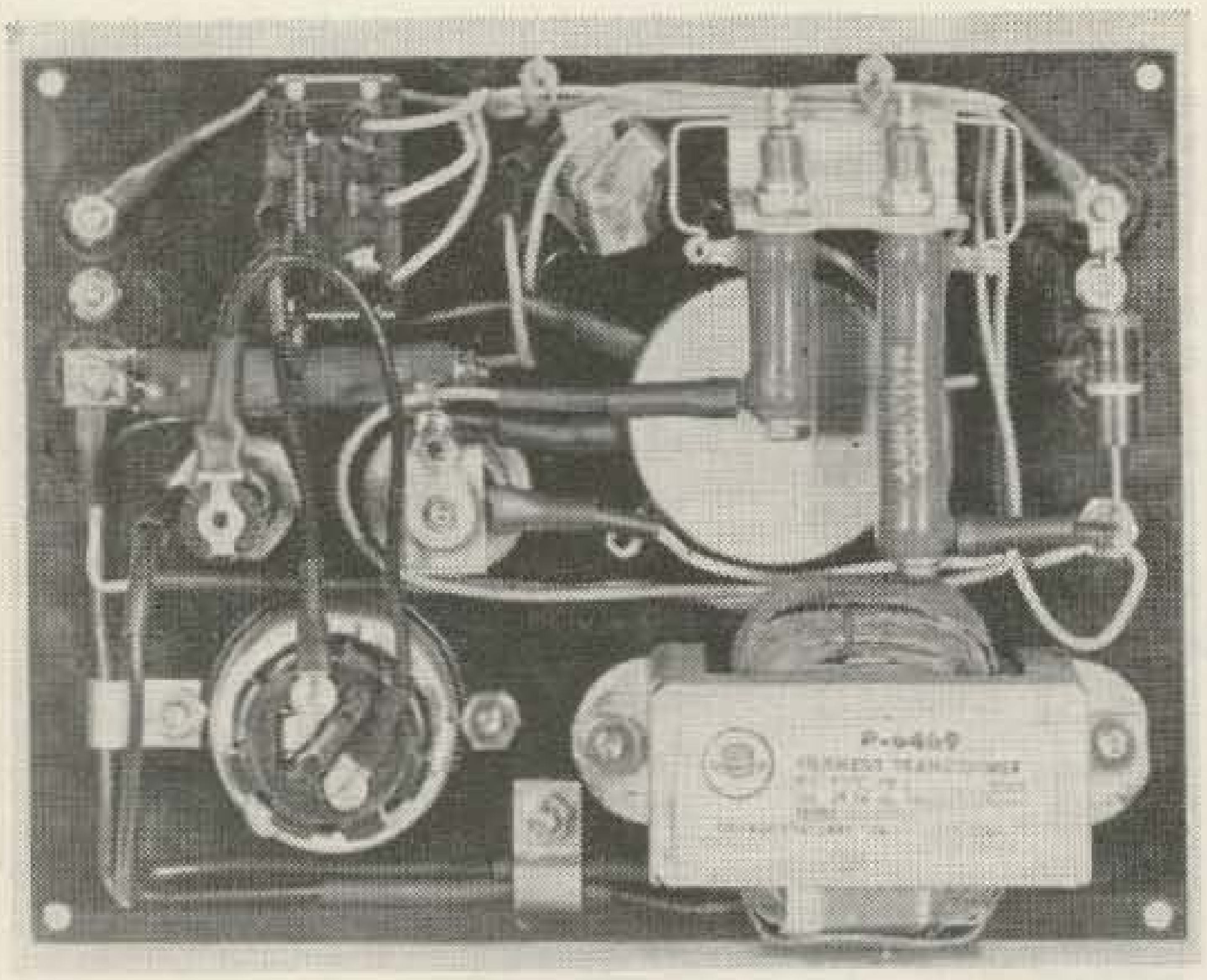


Fig. 5 Interior of choke evaluator.

Panel layout, shown in Fig. 4 is functional, and is designed for a right-handed operator. To simplify construction, and to eliminate long internal leads, all parts are mounted on the lid of the bakelite utility box (Smith #2257). Two series resistors, selectable by means of a double-pole double-throw center-off power switch, are provided, giving an effective measuring range in excess of from 0.1 henries to 100 henries. Panel labels are made on Metalphoto, by the Kohler techniques[1].

Interior of the choke evaluator is shown in Fig. 5. Construction here is perhaps more rugged than is actually necessary, but it is much easier to make things a little stronger while building than to patch and fix at a later date.

Using this device, it is possible to answer the question "How many henries" in a little less than ten minutes. Obtained answers have been found entirely satisfactory in the frequency range from 60 cycles to about 3,000 cycles. As the frequency increases, the readings become less accurate and less consistent, due to distributed capacitance and core characteristics. Because of these extraneous factors, few cored coils have the same inductance at all frequencies.

Because of these limitations, this method of choke evaluation should be limited to selecting components for power and voice frequency filters only. Components for use in ultra-high-fidelity equipment, or for supersonic frequencies, should be evaluated either by use of an inductance bridge, or by use of an evaluator built on this general plan, but having a supply frequency nearer that at which the components will be used. . . . Ives

[1]Kohler, George M. **Prototype Labels,** Electronics, Vol. 33, No. 1, Jan. 1, 1960, p. 100 et seq.

Letters

Dear Wayne:

Just a short word of sincere thanks to you for the great pleasure I have each month in reading "73." The magazine is a work of art. In particular your own column is a veritable jewel and I wouldn't miss it for a mint.

As a Porsche aficionado and ex-newspaper editor I can well understand and appreciate everything that you muse about from the joy of driving a Porsche to the relentless pressures of producing a publication. And this is not to neglect the fine technical articles you feature in each edition. All in all, "73" is far and away at the top of the ham publications list.

I hope that you have found your new quarters in that lovely, huge New England mansion to be all that you had anticipated. Your description of the move was wonderful.

Best of luck on everything!

Mark McCormack K3LOVEA

Dear Wayne:

I was aghast to note your no smokee, no drinkee stand taken in your Sept. editorial. Heavens! Don't you realize, with a clean-lifer approach like that, you are ruining your chances of appearing in Camel cigarette ads (in full color) when you're rich and famous??

The above, plus your constant humor and slightly right-of-center stand, insidiously compels me to kick in another $3.50 to see what happens next!

At the rate you are going, I can only conclude that you honestly enjoy giving Brand x and OLD MEN fits! This cannot go unrewarded! Please renew me with the Oct. issue.

Terry F. Staudt WφWUZ

Dear Wayne:

You have reached me. Here is a check to help pay the wolf before he slips on the coming ice.

From past record this is for my economic protection. Every time I go to the store for the latest 73, I end up with too many ham type goodies and a torn up copy of the word. I figure the back issues have cost me about 700 dollars.

Hope you continue the fine work in the new QTH.

George A. Howland W4AIY

Dear Wayne:

I am just back from the convention at Disneyland. WOW!!!

What's all the talk about a staff of two for 73? I went up to the "73" booth to say "Hello" to you and Virginia. First thing I know this smiling YL is twisting my arm and crooning in my ear. "So what if you do already subscribe to '73'. You can extend your subscription at these terrific convention rates." She says.

OK, Says I—"So I'll extend" Maybe even pick up a couple of back issues for some friends who are not charter subscribers."

"Back issues" she says—"Sure but don't be cheap.

Get a binder to keep them in." "OK"—I said—as the arm starts to turn blue.

Just then up comes good old Jim WA6EUX—"How you doing—? Gracie." He says. "Fine" she says, still smiling—just fine." "Now how about a binder for your own copies" she says, applying a little more pressure.

"O.K., O.K.," I plead, shoving a $20.00 into her eagerly waiting hand.

Please, Wayne, How many of these Green Sales Amazons have you turned loose on us? Do they all train by carrying 65 lb. packages of "73". Do they all look cute and feminine? Are they all married? Is Gracie Jim's XYL? and please can you tell me What will my 95 year old grandmother do with a life subscription to "73".???

I am very much against anonymous letters but if I sign my name I may find Gracie selling me two more maps and a forever subscription.

Dear Friend Wayne:

Nice contact the other day—sounded real FB from that new location. Also talked to one of your boys over your station a few days later in the week.

I have just been awarded the first and only Empire DX Certificate on Two Way SSB by the Radio Society of Great Britain. The award has been in existance for about 25 years and quite a few amateurs have won it on CW and AM phone, but I am the first amateur to qualify on SSB. This award took me five years to get the proper two way contacts.

Chas. W. Boegel, Jr. WφCVU

Good work Chuck.

Dear Wayne:

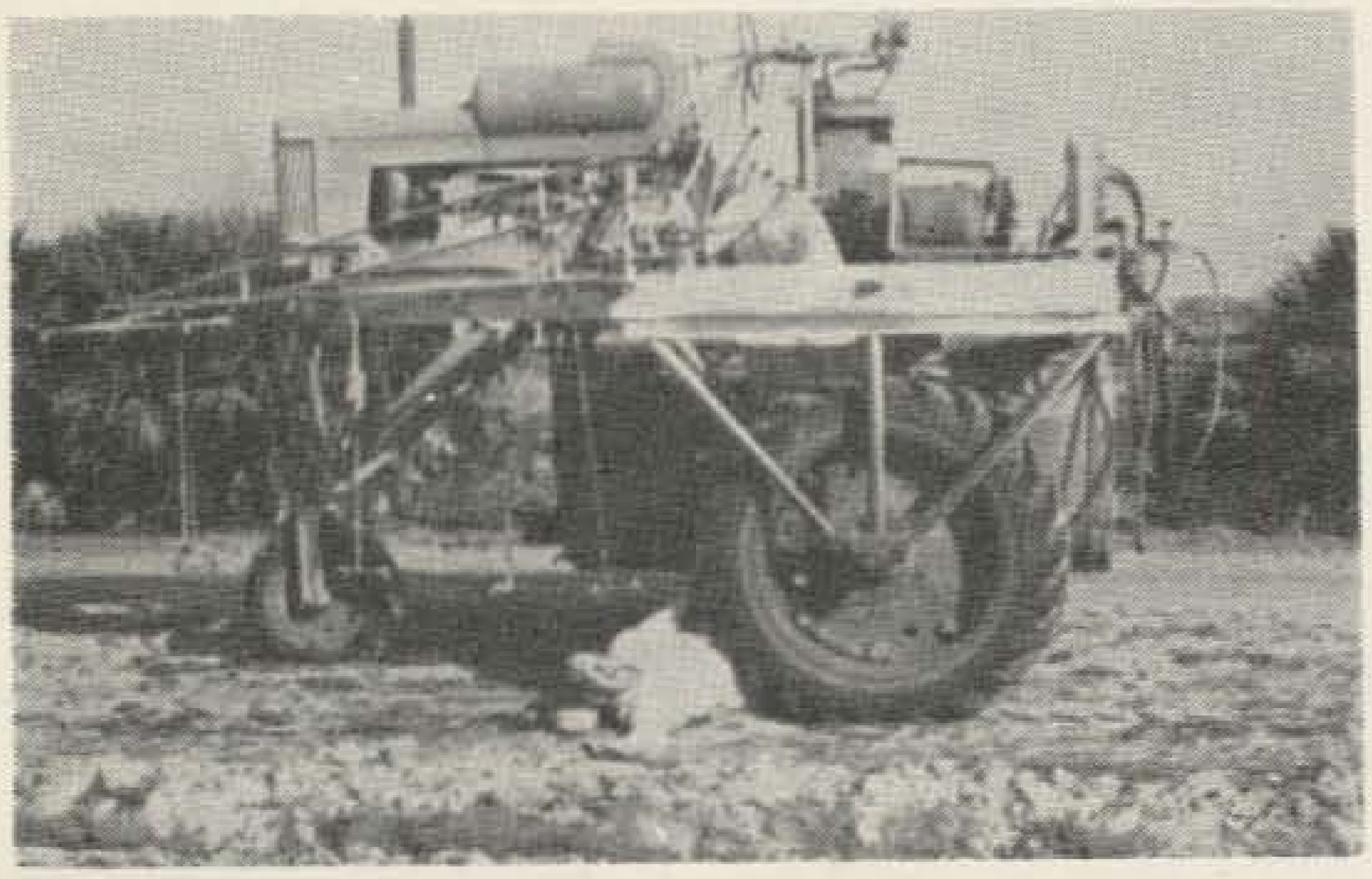
Why didn't you ask your readers to make donations to YOUR Building Fund? **Andy W3NL**

I'd rather not.

Dear Sir:

Here is a stunt I have used . . . a selenium rectifier across a key or relay stops the inductive kick that sometimes can be heard in the receiver. Both Federal and International are making units for this purpose.

H. F. Watson W3ALY



Dear Wayne:

I have, as you can see, been quite careful after subscribing to 73 for Life.

Vance V. Vogel W4OVE

Looks promising Vance. And thanks a megohm for the beautiful box of deadly nightshade fruit that you sent . . . it was delicious. Please send antidote.

Dear Wayne:

Thought you might like to see the vehicle in which your peripatetic Western Representative, Jim Morrisett, WA6EXU, mobiles about his territory. It must be seen to be believed, and even then it rather boggles the imagination.

Jim stopped by to see me one recent afternoon, but my camera wasn't handy at the time. Next morning, on my way to the office, there was Jim's Volkswagen bus, parked about 150 feet from the ocean. Had my camera along that time, and the enclosed photo resulted.

I'm not quite sure what kind of radiation pattern Jim must get from any of the antennas, but apparently they all work. The outer antennas are a stacked pair of six element two-meter yagis, and the center device is a two-meter "Dual Diversity" beam. I asked him what he did when he was mobilling along and wanted to work stations on either side of the highway. "I use the J," he said, and, sure enough, amongst that mass of aluminum tubing there lurks a J (right above the door, on the driver's side). Both Heath and Clegg VHF gear are installed in the bus.

I shuddered at the thought of high winds while traveling and their effect on this rather top-heavy arrangement, and the havoc low-hanging tree limbs could cause, but these have not—at least not yet—been problems to Jim.

And where was Jim when the picture was taken? Well, he was still sacked out in the bus (it is his mobile home-away-from-home) and if you look closely you may be able to see a big toe sticking up back there somewhere.

Richard F. Van Wickle, W6TKA
Santa Barbara, California

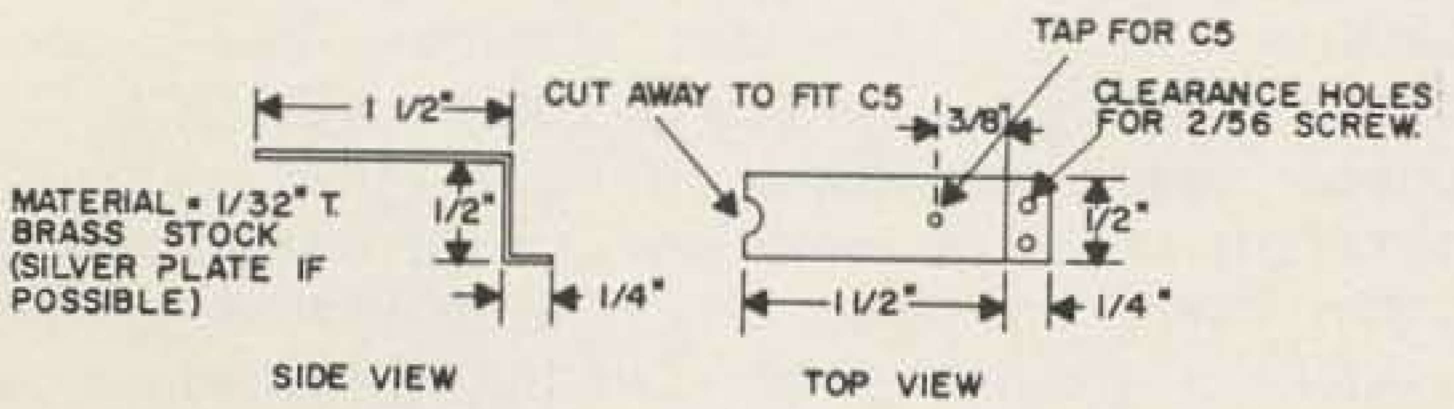
(1296 from page 8)

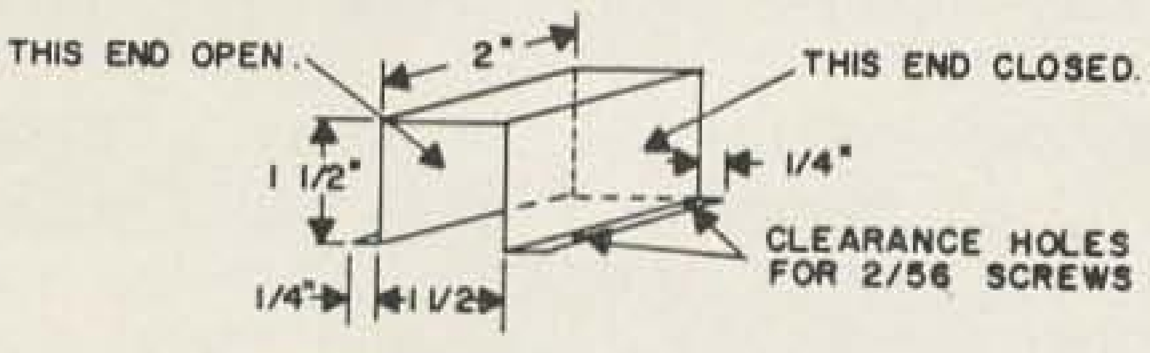
Construction Data

The entire converter was constructed on a 9½" by 5" brass plate 1/16" thick. Figs. 2 and 3 show the details of the cavity tuner. Silver plating of the cavity tuner is advisable but not essential. . . . W3HIX

Coil Data

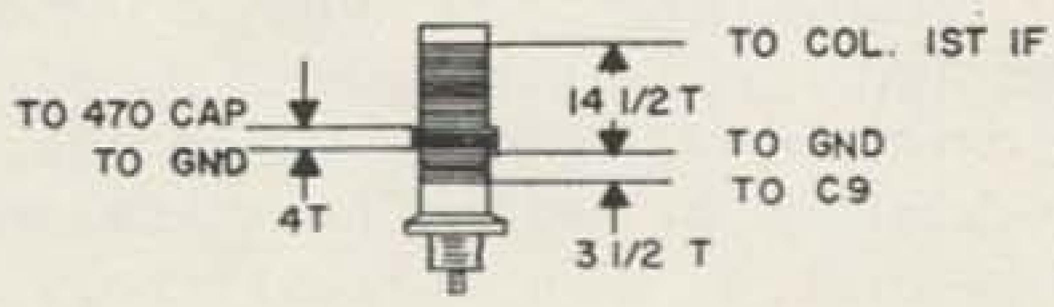
L1—7 turns #28 enam. coper wire space wound to occupy 5/16" on ⅜" dia. from slug tuned with powdered iron core.
L2—4 turns #28 enam. copper wire interwound with low potential end of L1.
L3—5¾ turns #18 tinned copper wire ½" I.D. air wound to occupy ½" output tap ½ turn from ground end.
L4—5⅛ turns #18 tinned copper wire ¼" I.D. air wound to occupy 7/16".
L6—13 turns #30 enam. copper wire spaced to occupy ½" winding area on ¼" form with powdered iron core (VHF Grade).
L7—18 turns #30 enam. copper wire close wound on ¼" form with powdered iron core, ground tap 14½ turns from collecter end.
L8—4 turns #30 enam. over low potential end of L7.
L9—18 turns #30 enam. closewound on ¼" form with powdered iron core (VHF Grade) ground tap 14½ turns from collecter end.
L10—3 turns #28 enam. wound over low potential end of L9.
L13, L14, L15—1 7/16" long ⅜" dia. copper tubing tuning screws SC1, SC2, SC3 enter the hollow copper tubing to form tuning capacitors as noted below.

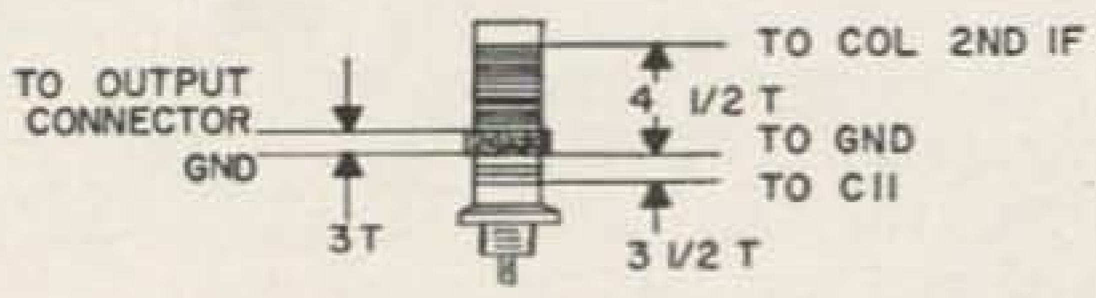




COPPER SHIELDED ENCLOSURE FOR L5

TM





RFC 1 = 50 MC CHOKE
RFC 2 = 30 MC CHOKE

Those Different Diodes

Staff

AT A HAM convention not too long ago, one of the speakers described the updating of a mobile receiver. Among the improvements added, he said, was a Zener diode to regulate oscillator filament voltage. At the conclusion of his talk, when he asked "Any questions?", half the hams in the room raised their hands with the same query:

"What's a Zener diode?"

The situation is a general one today; with many hams employed in the military electronics field where the phrase "state-of-the-art" is a watchword, and others in far different vocations, we're developing a technological split in our ranks. Many of today's construction articles call for strange and exotic devices which are totally unknown to those of us not working on the thresholds of the particular field involved.

In a small effort to remedy this situation, we've collected definitions, explanations, and some workable circuit information for three of the latest diode-type devices. Naturally, by the time you read this, a new crop of gadgets will have appeared — but this may at least take some of the mystery out of those *different* diodes.

Since Zener diodes touched off the whole idea, let's start with them. First, what are they? Second, what do they do?

The answer to the first question makes more sense if the second is answered beforehand: The Zener diode is the semiconductor version of the old familiar VR tube. It is used in the identical manner, current-limiting resistor and all, for the same purpose. However, it requires less room, doesn't break, and is available in a wide variety of voltages and power ratings.

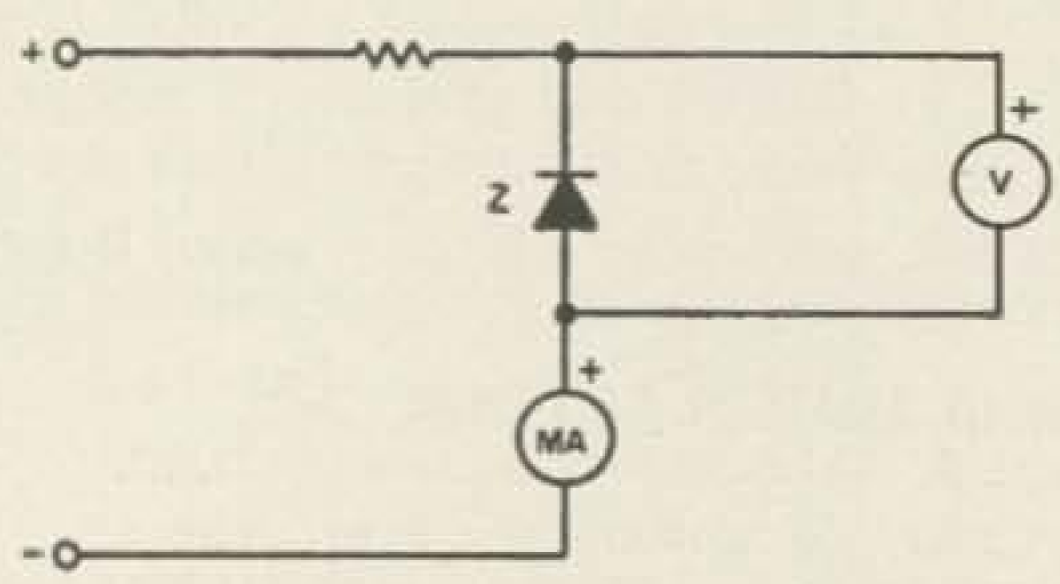


FIG. 1

Now, what is it? Basically, the Zener diode is just a conventional *silicon junction* power rectifier. All silicon junction rectifier diodes have a rated "peak inverse voltage" at which they break down and conduct in the reverse direction. If the diode is specially processed during manufacture, the voltage value at which it breaks down can be kept constant over a wide range of reverse current flow—and you have a Zener diode!

Since special processing is required, the cost of most Zener diodes is rather high. However, ordinary silicon junction rectifiers can sometimes be used as Zeners if you're willing to do some experimenting, and if the current through them is kept low (high current will burn them out instantly). For instance, the rectifiers produced by Diodes, Inc., show a particularly sharp "Zener break" just above their rated PIV.

To use a conventional diode as a Zener, hook it up as shown in Fig. 1. Start with a high value of series resistance. Note the voltage reading across the diode, and the current through it; multiply these two values to get the power going into the diode. So long as this power is less than ½ watt (for the conventional 750 ma power rectifier) the diode is safe; you can reduce the resistance by small steps, recomputing the power after each change, until you reach about two-thirds of the ½-watt level (some margin must be left for regulating action). The diode will then regulate over a wide current range, at the value you read on the voltmeter.

Note that the diode is hooked up *in reverse*, with the cathode to positive and the anode to negative. This is necessary with all Zeners, since it's *reverse* current flow that provides the regulation. Hooked up in the forward direction, they're just like any other diode except that they cost more.

Average cost (as this is written) for the least expensive low-voltage Zener diodes is around $4 each (although Hoffman produces a line of them for about 75 cents per diode); these units won't handle much more current drain than a conventional VR tube, but are available in a wide range of voltages from 3.9 volts up.

For higher current, you have a choice. You can use a bigger diode, at rapidly skyrocketing cost, or you can use the little Zener as a reference element in a transistorized regulator such as that shown in Fig. 2. Here, a small current flow through the Zener can regulate up to 3 amps through the transistor —and bigger transistors can be substituted for higher current still.

Of course, if you want to use the Zener without the transistor, you can use the circuit of Fig. 1 omitting the meters and putting the load where the voltmeter is shown.

These two basic circuits take care of nearly all voltage-regulation applications, but the Zener diode has more uses than that. Unlike the VR tube, the Zener requires no "firing-voltage" margin; it's more of a "built-in battery" as one text describes it. What's more, this battery never wears out.

Thus, you can eliminate the fixed-bias supply for a class B modulator by putting a

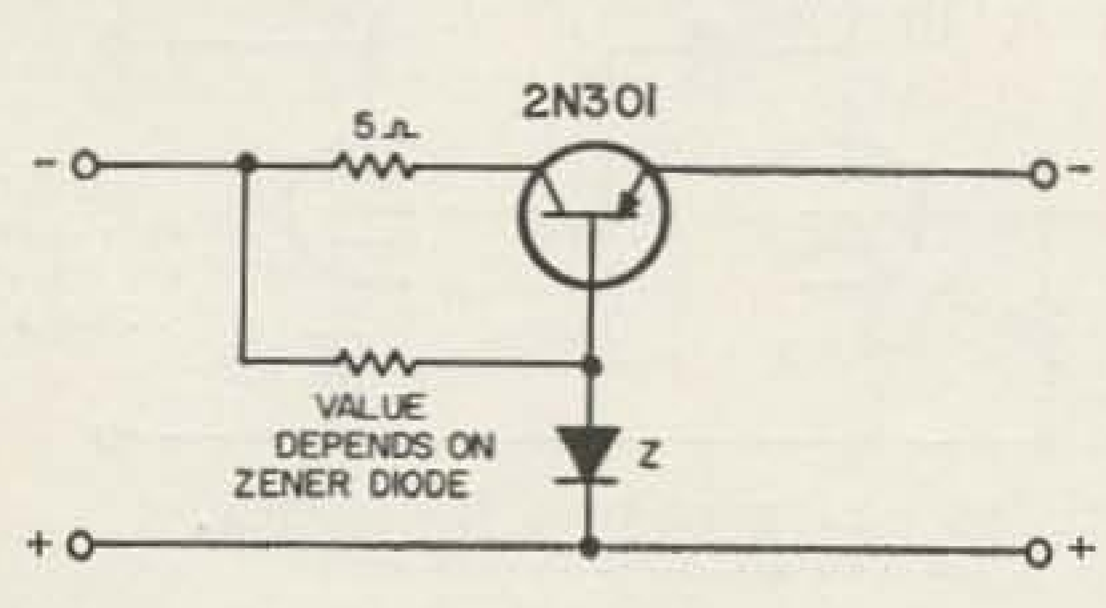


FIG 2

IoAR

Though I have noticed a not unpredictable chill from down Connecticut way, the response to my announcement of the formation of the Institute of Amateur Radio was quite well received. The Institute has been launched and we have a lot of interesting plans afoot for it. Charter Membership, which will have some decided advantages later on, will be open only until the end of this year, but will be good for the entire year of 1963.

Charter memberships are piling in and Charter Membership cards are being sent out. Many members have good suggestions about further organization and possible activities of the IoAR . . . I think we are going to have some fun. One member suggested that we ask age on our application forms, but I have known too many 52 year old children and 18 year old adults to feel that this should be a factor.

. . . Wayne

Application for Charter Membership in the Institute of Amateur Radio
(Valid only if postmarked before January 1, 1963)

Name . . . . Call: . . . .(must be licensed)

Address . . . .

City . . . . Zone. . . . . . State. . . . . County. . . . .

Class of license: Novice Technician General Advanced Extra Conditional

Year first licensed . . . . Old calls . . . .

Charter membership fee of $1.00 must accompany this application. This will pay dues in full until December 31, 1963.

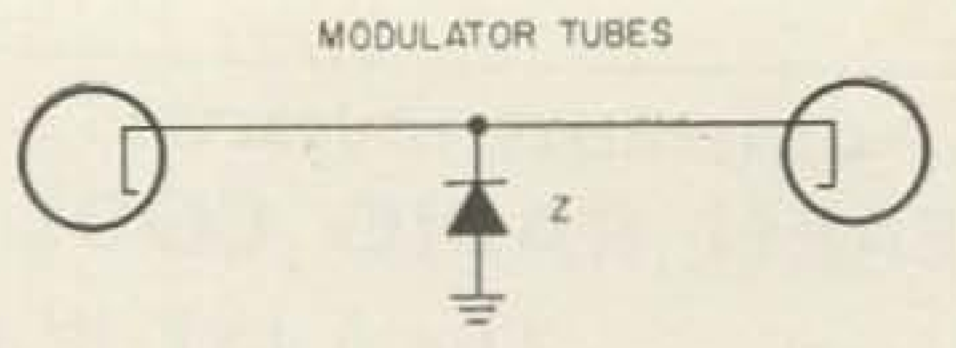


FIG 3

Zener diode (of the right value to provide proper bias) in the common cathode circuit as shown in Fig. 3. Where a conventional cathode resistor will give you a bias which varies with current drain through the tube, the Zener's voltage drop is constant so long as you don't fall below its minimum current or go above its upper current limit; most class B modulators fill both these requirements.

The same trick can be used to put fixed bias on any amplifier stage, either audio or rf. In addition, the Zener diode doesn't require any bypass capacitor, since its ac impedance is almost zero (and at any rate is far below that of most bypass capacitors).

The voltage-limiting property of this diode can also be used to build a most simple audio speech limiter for addition to any modulator, as shown in Fig. 4. Here, two Zeners must be used back-to-back; otherwise, half the audio cycle would be shorted out to ground. As in all clipper-limiter circuits, a low-pass audio filter would follow this to remove the harmonics generated by clipping.

One of the most sophisticated uses of the Zener diode is in the construction of direct-coupled amplifiers. If the Zener is put in series with a dc voltage, it will effectively subtract its own voltage drop from that voltage and pass on the rest.

Thus, if the resting plate voltage of an amplifier tube were 150, and if a 120-volt Zener were connected from the plate of that tube to the grid of the next stage (in place of the usual coupling capacitor) the voltage at the next grid would be 30.

This doesn't sound so good, but now we place a 33-volt Zener in the cathode circuit of the second tube to give a fixed 33-volt bias, and the net voltage from grid to cathode becomes —3. This is more like conventional amplifier operation — except that the circuit will respond all the way down to dc.

While such circuits aren't too useful in most ham equipment, they're occasionally essential in special test equipment. A complete circuit giving a 100-volt output swing for 0.025 volts peak-to-peak input is shown in Fig. 5.

Another new diode you've undoubtedly heard

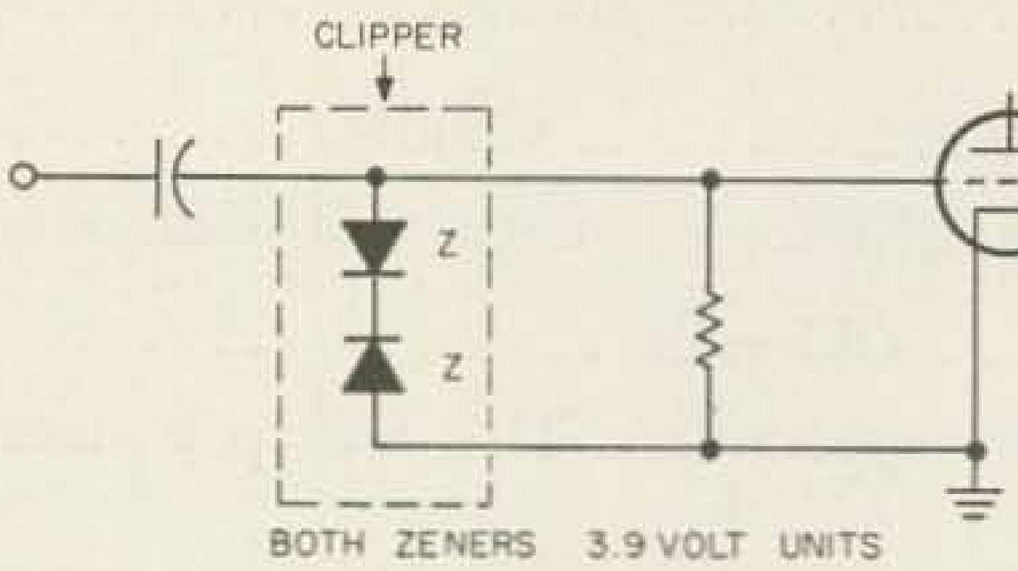


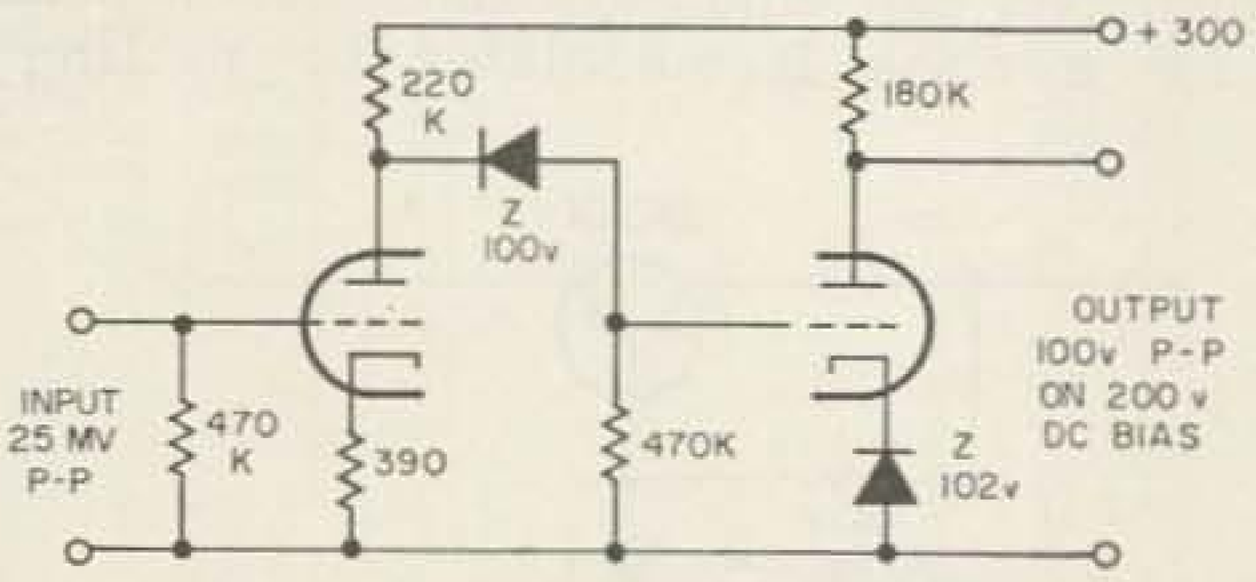
FIG. 4

something about is the Esaki, or "tunnel," diode.

These little varmints can drive you crazy if you let them. Let's try to stay sane while going through the same study of them that we did for the Zeners. First, what are they? Second, what do they do?

The tunnel diode is, again, a specially-treated semiconductor junction diode. The main characteristic keeping it in the spotlight at the moment is its negative resistance under certain conditions—heretofore, negative resistance has been a tricky thing to obtain.

What does it do? Well, if you could cancel out all the resistance in a tuned circuit you would have an ultra-stable oscillator. If you cancelled out most but not all the resistance, you would have a high-gain low-noise amplifier —which would also work in both directions. The possibilities are (theoretically at any rate) limited only by your imagination.



NOTE NO 102v ZENER DIODE IS MARKETED. USE TWO 51v UNITS IN SERIES

FIG 5

The trouble with the tunnel diode is that it works too well. One of the biggest problems with them is that of keeping them from oscillating at any number of frequencies simultaneously. They can amplify af, oscillate at a dozen places in the rf spectrum, and mix all the various signals together—all at the same time, without batting an atom. What's more, if you give them the slightest opportunity, they'll do it!

Fig. 6 shows a typical *theoretical* tunnel-diode circuit you can find in any textbook new enough to talk about them. If the inductance and capacitance of the tank circuit are the only reactances present in the circuit, this gadget will act as either an amplifier or an oscillator at the resonant frequency of the tank circuit. The choice of amplification or oscillation depends on the impedance of the circuit; if the impedance is lower than the tunnel diode's negative resistance value, the circuit amplifies. Otherwise, it oscillates.

The trouble, of course, is that the inductance and capacitance aren't confined to just the tank circuit where you want them. The inter-

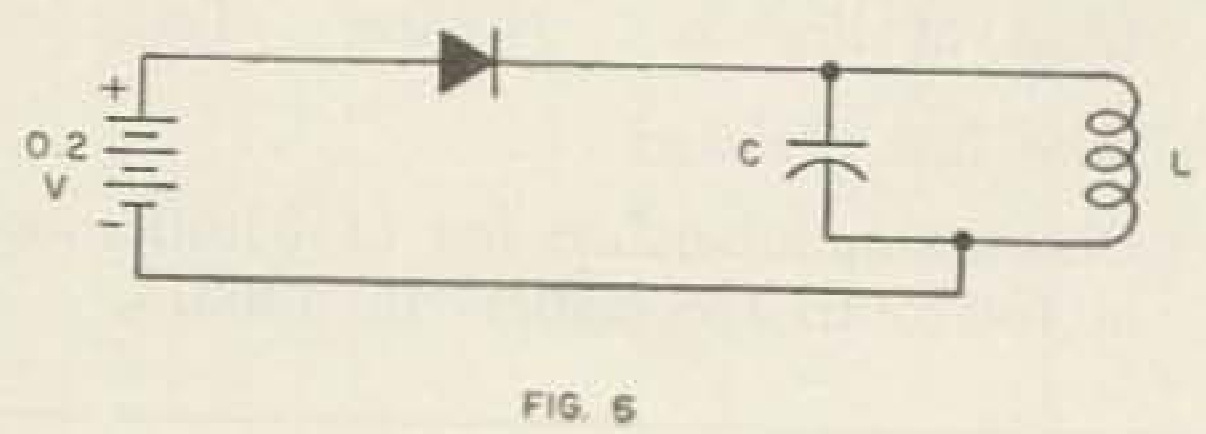


FIG. 6

connecting wires have both self-inductance and capacitance both to ground and to each other. The diode itself has some inductance and capacitance. So does the power supply. And every possible resonant circuit with an impedance greater than the diode's negative resistance produces oscillations!

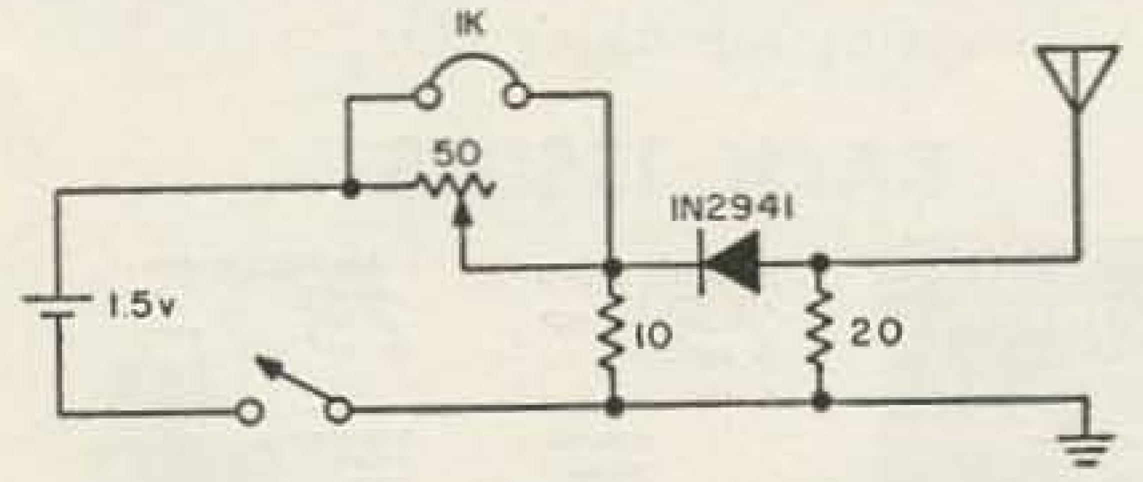
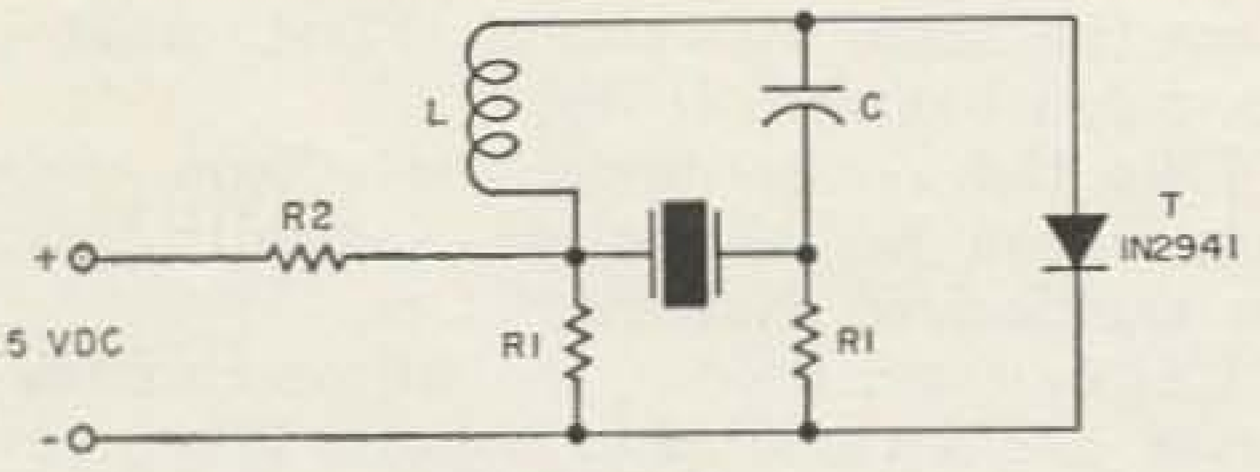


FIG. 7

One way of getting around this problem, by brute force, is that shown in Fig. 7. This circuit may be familiar; it's from "Lost In a Tunnel" in our January, 1961, issue. Here, the 10-ohm resistor in the power supply swamps out any possible oscillations there, while the 20-ohm resistor swamps out the undesired oscillations in the rest of the circuit. Somewhere around 50 mc, the inductance of the 20-ohm carbon resistor and its own capacitance to ground form a resonant circuit with impedance great enough to force oscillations, and the result is a 50-mc-or-so sine wave with nearly 1-volt peak-to-peak amplitude. The headphone is used as a mike to modulate the rf.



L AND C RESONANT AT CRYSTAL FREQ

$R_1 = \frac{0.06 \times L}{C}$ FOR IN2941

$R_2 = 5\ 1/2 \times R_1$

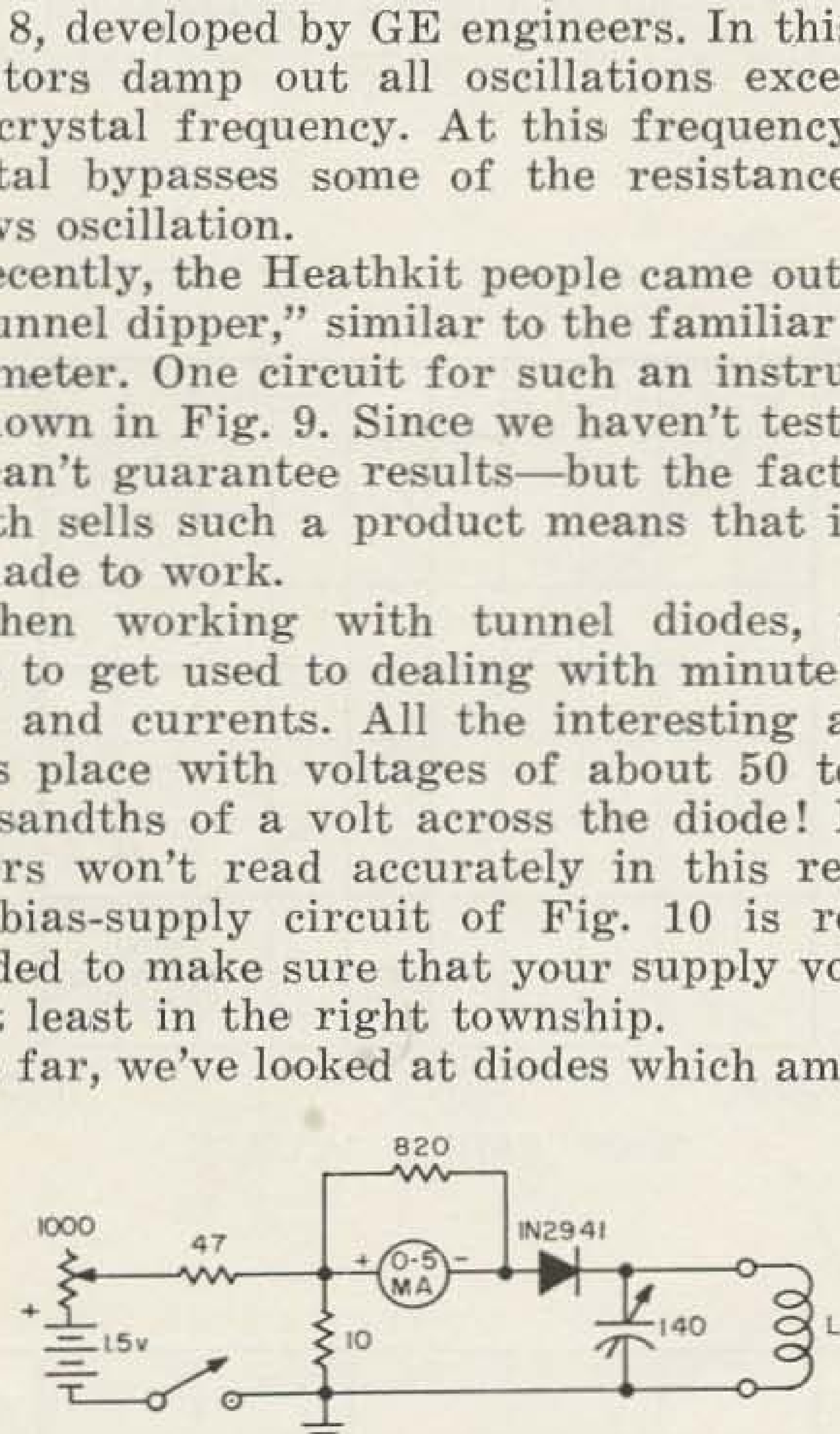
FIG. 8

This circuit is an interesting laboratory curiosity, but isn't too useful. More quickly adaptable to our uses is the crystal oscillator of Fig. 8, developed by GE engineers. In this one, resistors damp out all oscillations except at the crystal frequency. At this frequency, the crystal bypasses some of the resistance and allows oscillation.

Recently, the Heathkit people came out with a "tunnel dipper," similar to the familiar grid-dip meter. One circuit for such an instrument is shown in Fig. 9. Since we haven't tested it, we can't guarantee results—but the fact that Heath sells such a product means that it can be made to work.

When working with tunnel diodes, you'll have to get used to dealing with minute voltages and currents. All the interesting action takes place with voltages of about 50 to 300 thousandths of a volt across the diode! Many meters won't read accurately in this region; the bias-supply circuit of Fig. 10 is recommended to make sure that your supply voltage is at least in the right township.

So far, we've looked at diodes which amplify,

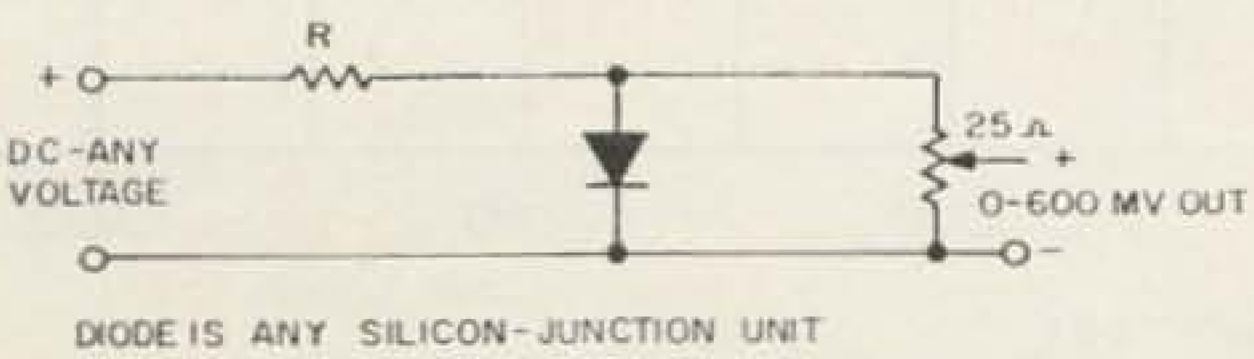


L PLUG-IN COIL TO RESONATE WITH TUNING CAPACITOR AT DESIRED FREQUENCY

FIG 9

5-18mc	40 turns #20, 1/2" dia, 1 1/4" long (B & W 3004 or Air Dux 432T)
12-45mc	16 turns #20, 1/2" dia, 1" long (B & W 3003 or Air Dux 416T)
43-160mc	3 turns on #20, 1/2" dia, 3/16" long (B & W 3003 or Air Dux 416T)

Start with 1K pot at max. resistance, decrease its setting slowly. Meter reading will increase, then decrease. Set for approx 3 ma reading in decreasing portion. Pot need be adjusted only when battery ages or is replaced.



DIODE IS ANY SILICON-JUNCTION UNIT
VALUE OF R IN OHMS = 20 X INPUT VOLTAGE

FIG. 10

diodes which oscillate, and diodes which behave like batteries. How about the diode which acts like a variable capacitor?

These are known by many trade names. Pacific Semiconductors Inc. calls their version "Varicaps," International Rectifier calls them "Semicaps," and Amperex uses a string of words: "Silicon Variable Capacitance Diode." Hughes shortens this to "Silicon Capacitor," but they're all talking about the same kind of a diode.

In many ways, the "silicon capacitor" is like a Zener diode; it is effective only when reverse-biased, and it requires special processing. However, unlike the Zener, the silicon capacitor is never used in the breakdown region, so it never carries any current. Let's approach it from the same viewpoints: First, what is it? Second, what does it do?

Like the Zener diode, the silicon capacitor is a silicon *junction* diode, specially processed for the desired characteristics.

Unlike other diodes, the silicon capacitor behaves like a variable capacitor. When reverse-biased, it has a certain capacitance. Just how much capacitance depends on the voltage across the diode.

As you probably know, a reverse-biased diode looks like an open circuit; now, the definition of a capacitor is also that of an open circuit: two conductors separated by an insulator. The amount of capacitance depends on how far the conductors are separated.

In the silicon capacitor, the insulator is

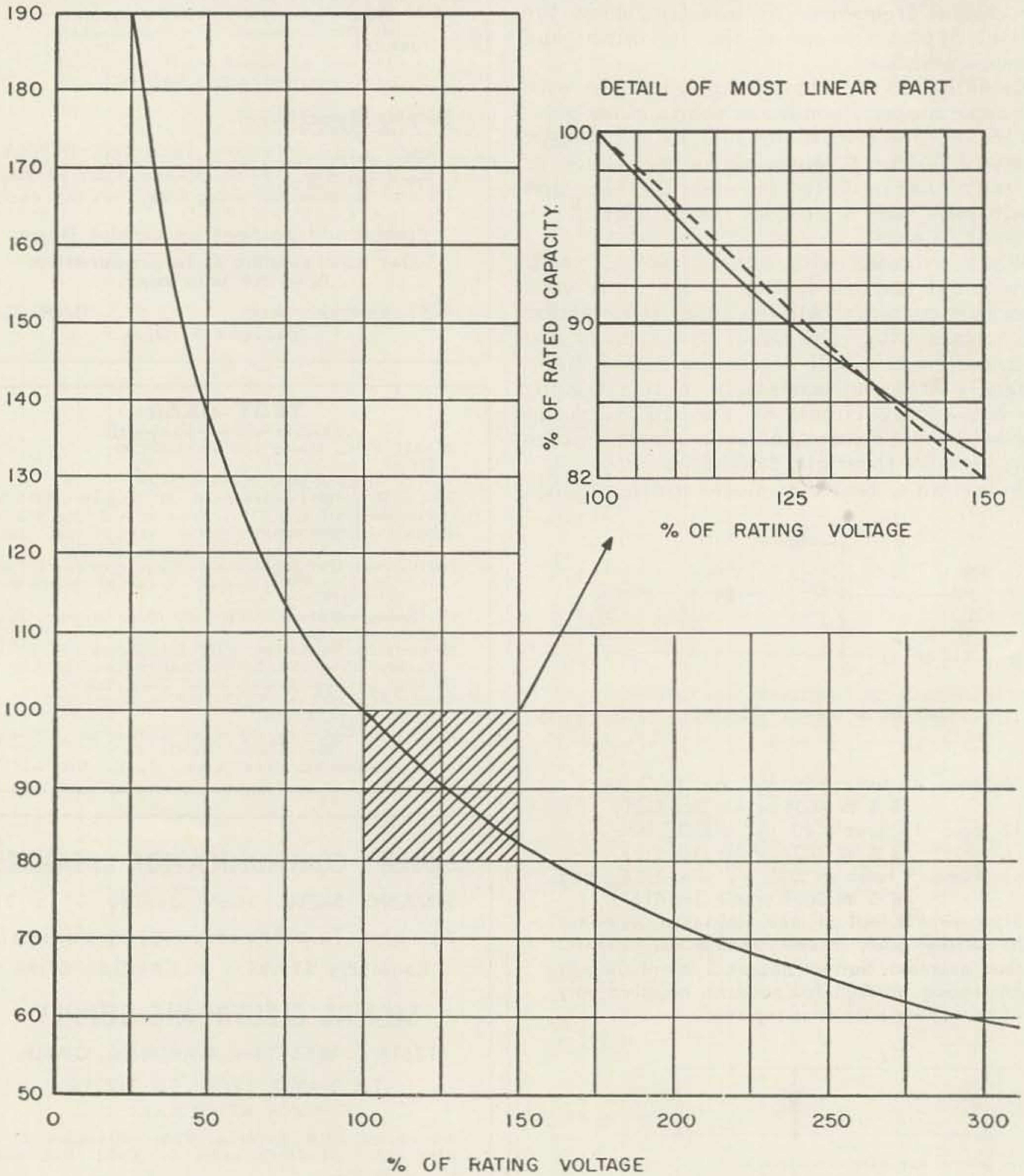


FIG II

furnished by what physicists call "the depletion layer" at the junction. The thickness of this "depletion layer" depends on many things; among these factors are the way in which the diode was processed during manufacture, and the voltage across the junction.

Note those last five words: the voltage across the junction controls the thickness of the insulating layer, or in other words, the distance between conductors—and thus, the capacitance. It works something like the familiar mica compression trimmer, except that voltage controls the capacitance.

If the preceding three paragraphs suggest to you that any silicon junction diode can be used as a silicon capacitor, you're right. However, the specially-processed units often have a greater range of capacitance, and in addition, can be obtained in known values.

The actual amount of change in capacitance with change in voltage follows a rather complicated set of equations; the graph in Fig. 11 shows this change in "normalized" values. If you know the capacity of the diode at any one voltage, you can find the percent change in capacity with percent change in voltage from the graph. Thus, a diode with 22 mmfd capacitance at 7 volts bias will have 14.3 mmfd at 250 percent of 7 or 17.5 volts, and will show 33 mmfd at 2.8 volts (40 percent of 7). This chart is accurate for all diodes, even though various manufacturers rate their units at different bias voltages.

The circuit for using a silicon capacitor is shown in Fig. 12; the silicon capacitor is the symbol which looks something like a diode and something like a trimmer. You can see that the only difference between this and a conventional tank circuit is the dc-blocking capacitor in series with the silicon capacitor. If this blocking capacitor is very large in comparison to the silicon capacitor (10 times or larger), it will have no noticeable effect on the capacitance in the circuit.

Going back to Fig. 11 for a moment, you can see that the change in capacitance is almost exactly proportional to changes in voltage over any very small range. The most linear part of the curve has been expanded for the region from rated voltage to 150 percent of rated voltage; over this spread, the departure from true linearity is no greater than 0.5 percent, which immediately suggests the use of these capacitors for tuning oscillators and receivers.

As a matter of fact, the new Hallicrafters FPM-200 is tuned in just this way, and several articles on use of the silicon capacitor for automatic frequency control have been published as well.

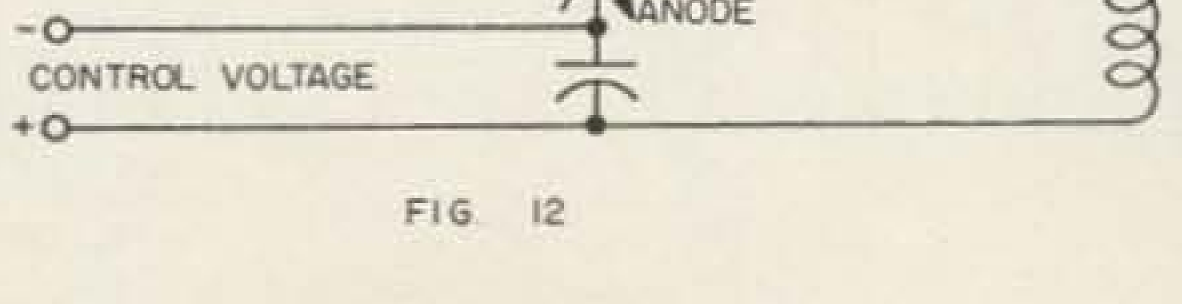


FIG 12

A bit of thought will remind us, though, that the frequency of an oscillator is *not* directly proportional to the capacitance in the tuned circuits; for very small changes, it is, but for large changes, the calibration is far from linear.

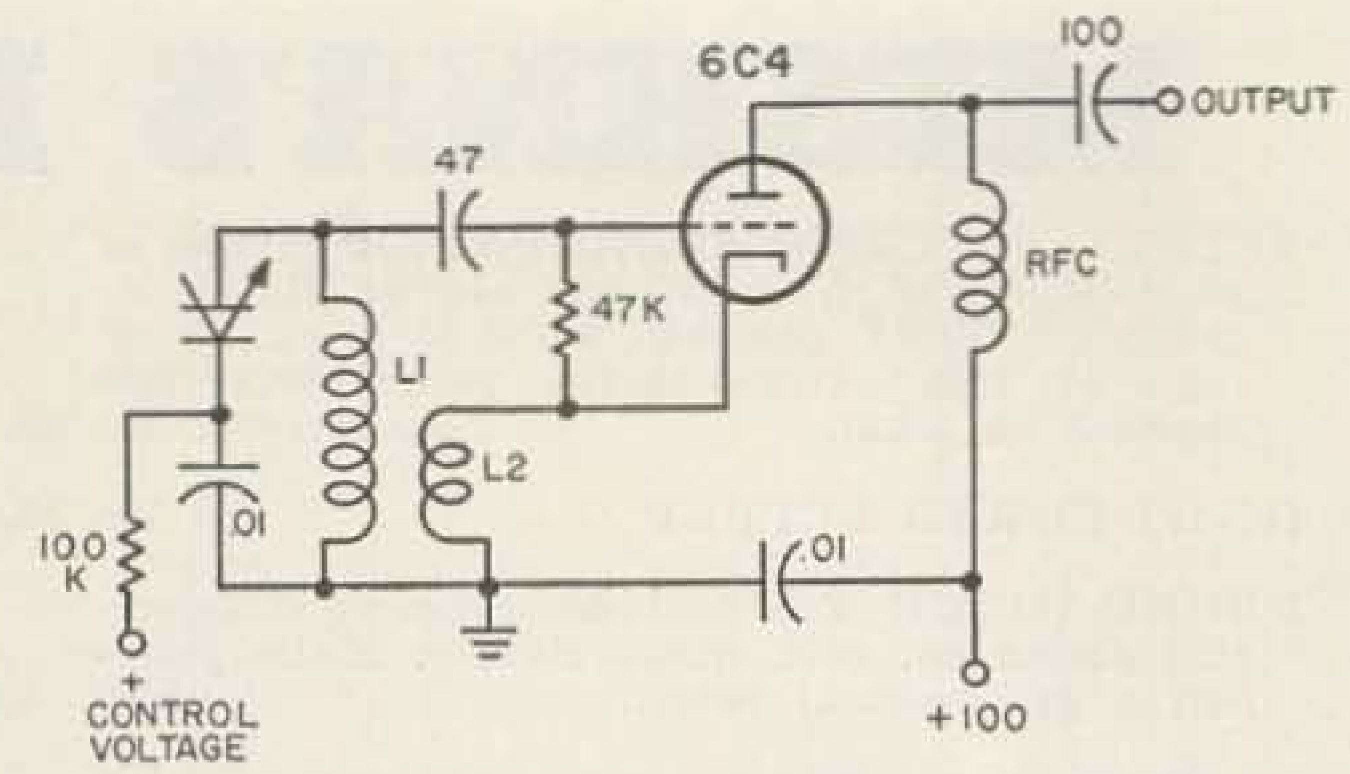
Fortunately, if a silicon capacitor is used in an oscillator tuning circuit, some of the non-linearities cancel each other out. Fig. 13 is a graph of frequency versus voltage for the circuit of Fig. 14; the dotted line is a true linear calibration while the solid line is the actual calibration curve. You can see that the departure from linearity is a very small part of the actual tuning frequency.

Like Fig. 11, Fig. 13 is "normalized" to starting conditions. Thus, if the circuit tunes to one frequency at a given voltage (say, 7 mc at 5 volts) it will tune to 105 percent of that frequency (in the example, 7.35 mc) at 123.5 percent of that voltage (or 6.7 volts).

The linear region of the curve isn't quite long enough to cover the entire 80-meter band at one setting, but is more than adequate to cover all our other bands; you can set your frequency with a voltmeter.

The advantage of such a hookup is primarily that you can now put the rf-carrying leads right where you want them; the tuning is done with dc, which can (and should) be decoupled with high-value resistors, allowing you to put the tuning controls wherever you like.

A word of caution: all these characteristics hold *only* when the diode is reverse-biased. If the rf voltage swing across the capacitor is greater than the dc bias, anything can happen. This can be prevented by tapping the diode down on the coil, or by using circuits which do not put a high rf voltage across the diode-capacitor.



L1 - VALUE DEPENDS ON FREQUENCY DESIRED; SLUG-TUNED COIL IS SUGGESTED.

L2 - 1/4 AS MANY TURNS AS L1, WOUND OVER COLD END OF L1 IN SAME DIRECTION; ADJUST NUMBER OF TURNS AS NECESSARY FOR STABLE OPERATION

FIG. 14

In addition, voltage must be closely controlled. In our example above, it took only 1.7 volts change to swing the frequency clear across the 40-meter band; a 0.17-volt change would move you 35 kc, and just 17 millivolts would swing the frequency 3½ kilocycles—outside the bandpass of many receivers. This effect can be put to use to get FM the simple way (see the references) but is quite a headache when it happens unexpectedly.

In a single issue of this magazine, there's not room to do more than scratch the surface

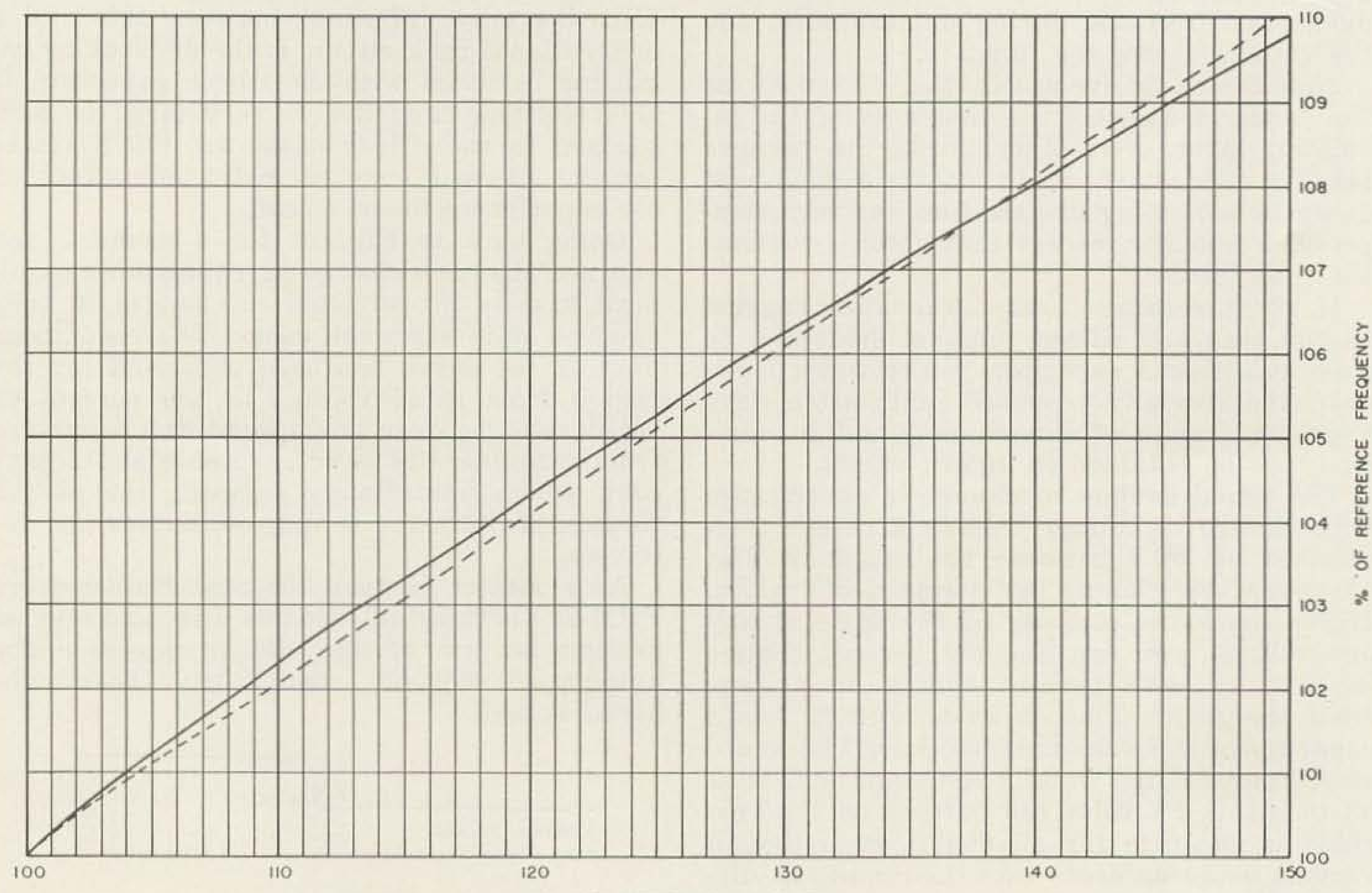


FIG 13

of the strange world of semiconductors. A number of other exotic semiconductor devices have been announced in the past few months: the thyristor, the binistor, the unijunction transistor, the four-layer diode, the silicon-controlled-rectifier, to name but a few. The only way to keep up with them all is to read the dozen or more high-level engineering publications, including three devoted to semiconductors exclusively—but at least, this may have taken some of the mystery from these three *different* diodes.

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". . . then it's all arranged. You'll win all the DX contests for the next seven years, at which time I'll . . ."

A Good Five Cent QSO

George Thurston W4MLE
3407 Prock Drive
Tallahassee, Florida

WHAT this hobby needs is a good five-cent QSO.

We have plenty of the 50 cent variety—the kind we're all familiar with, which last a minimum of 15 to 20 minutes and consist entirely of an exchange of signal report, name, QTH, a description of the rig (in greater or less detail), a run down on the local weather. And the final five minutes is an exchange of totally banal fond farewell, as though you might mortally insult the guy at the other end by just signing off with him.

"Well OM, guess I better QRT pretty soon. The Jr OP just fell out of the tree and seems to have broken his leg. So thanks a lot for the QSO. Hope to see you again before too long. Sure has been pleasant. Oh oh. XYL just called chow so 73 *DX. Good luck.* 73 *now Tom OB SK K4XXX DE W4MLE* 73 *GN GL DX SK GE DIT."*

We need a procedure signal meaning "I don't want to make RCC. I just want to swap sig reports and scram." Some one has suggested "QCQ" for this purpose. Perhaps you could call CQQ CQQ CQQ DE— and in answering another station's CQ, you might try "W4MLE DE W4XYZ QCQ."'

This style of operating—similar in some ways to contest style used in Sweepstakes, CD parties and DX contests—offers many advantages both on phone and CW.

One of my favorite sports is to pick a relatively clear spot (if I can find one) on 40 or 80 CW and call CQ using complete break-in (QSK):

CQ CQ CQ DE W4MLE BK CQ CQ CQ DE W4MLE BK CQ CQ CQ DE W4MLE BK and so on until someone answers. The reply to his call goes "W7YYY DE W4MLE GE UR 579 TALLAHASSEE FLA NAME GEORGE BK"

And W7YYY almost alawys will reply in

kind, often dropping a word about rig, weather or a comment on a new antenna, a question about conditions, DX, traffic or something else.

The QSO usually lasts 3 to 5 minutes because unless it shows promise right away, I "73" the other op on my second transmission. SK is immediately followed by QRZ? And it is surprising how often this will bring an immediate call from some operator who has been reading the mail. Otherwise, the CQ BK is resumed.

Occasionally this has produced eight or ten QSOs or more in an hour of operating but more often the third or fourth—and sometimes the first—of such a series strikes a spark and some really collossal QSOs result.

The third of one such series raised VE3AWE one night and the QSO lasted 56 minutes. Another series produced K2UKQ and Kay and I have had many pleasant QSOs since then.

The first CQ BK not long ago produced W4IEI and the resulting QSO lasted more than two hours and a half and was repeated in similar length the following night and a shorter one (only two hours) two nights later.

Far from being "anti-social," the quick QSO is a fine way to add many new friends. They come around more often for second QSOs if they weren't bored to death the first time.

A K3 called me one evening and got the stock "UR 579 TALLAHASSEE FLA NAME GEORGE BK" and reproached me with "are you in a contest or something? I try to make friends in my QSOs, not just fill my log with numbers."

Before telling him I had just finished a 75-minute QSO with a perfect stranger I asked my K3 friend whether he considered brevity unfriendly.

Is it more friendly to say "UR 579 TALLAHASSEE FLA NAME GEORGE BK?" Or to say "R R R R R GE OM TNX FER FB CALL UR SIGS HR 579 579 579 HR IN TALLAHASSEE FLA THE CAPITAL CITY OF THE SUNSHINE STATE? TALLAHASSEE FLA? TALLAHASSEE FLA BT THE HANDLE HR IS GEORGE? GEORGE? GEORGE BT SO HWS THE WX THERE IN K3 LAND OM? AR K3XXX DE W4MLE?"

They both convey exactly the same information. So why is the five minute variety "friendlier" than the ten second variety?

Certainly the latter approach is more time consuming if the object is sheer length in QSOs.

But I'm inclined to like the briefer and friendlier ones. . . . W4MLE

(W2NSD from page 4)

of a screen dropping resistor, self biasing and a clamp tube would even eliminate the need for the two surplus supplies. The 2000 volts (modulated) come from an old National 600 transmitter, vintage 1937. The power supplies from Meshna replaced a couple of bread-board supplies that I whipped up the last time I ran the final back in Brooklyn in 1956-7-8. It makes it neater. By judicious surplus scavenging and a careful eyeballing of the ham ads you should be able to duplicate my feat quite reasonably.

Once you are on two meters with higher power you will find an entirely different operating world from the Twoer-Halo type of operating. When the band begins to open up you can be in there working the weak ones. When aurora starts you can get answers to your calls. It may be fun to sit there calling station after station, only to hear them come back to someone else, but it doesn't in any way match the fun when they come back almost every time you call. It is worth the effort necessary. Like all other things in this life, you get fun out of ham radio in proportion to the effort you put in.

FM

Our article on the Friendly Frequency in the June 1962 issue of 73 has resulted in a lot of mail and considerable interest. We are preparing a booklet on the conversion of the AN/VRC to six meter FM, which should get a few more fellows interested. In case you are fuzzy on this, there are several hundred fellows set up on 52.525 mc wide-band FM around the country. Most of them are using converted Motorola gear and surplus gear. The idea is to have a completely separate station with sqelch set up on the calling channel so that anyone calling in will have someone or group to talk to. It sure helps tie clubs together and adds a new dimension to mobile operating in cities. Jack Cunkelman W3JKE has published a listing of the FM nets all over the country and the individual stations active in these nets. He also lists the phone number and type of equipment used by each station. It is quite a list and should be in your car if you travel and are set up for 52.525 mc. Copies may be obtained for 25¢ each from Jack.

Anthem

The anti-communists are still in there pitching, trying valiently to sacrifice ham radio for a few moments of their own personal glory. What ever happened to the Old West where they went to lynchings instead of drive-ins? Come on, California, clean up those nuts.

It is heartening to see that the FCC is clamping down on the broadcasting of political nonsense from these guys. I hope they scuttle that incredible request to allow us to play the National Anthem twice a day which has been sent as a petition to the FCC. I can just hear 20 meters now with 100,000 amateur radio stations playing the Anthem twice a day, seven days a week . . . you wouldn't hear much else. With a market like that you can bet that some record company would come out with a long-play rendition of the Anthem that would run 45 minutes.

Ham radio is a fine hobby . . . let's not ruin it with nationalism. We know we have a great country and this comes through every time we talk to a DX station. Let's sell ourselves that way. Let's not try to sell politics, religion and other relatively unsalable items over the air. If you have an urge to sell, dissipate it by selling all comers on the advantages of subscribing to 73.

Mobile Monitor Scope

A reader advises that the 2BP1 or 2BP1A are better alternatives for the obsolete 913 specified in the article in the August '62 issue of 73 than the suggested 2AP1, which requires a higher anode voltage.

Flagging Interest

There were several interesting things in the July issue of CQ (no fooling!). #1 was the USA-CA column by K6BX. This column started out with two waving American flags and reached a crescendo with a huge full page reproduction of the actual USA-CA award certificate, which features not only a large American flag a waving, but all fifty of the State flags. In this day and age where we are used to seeing the American flag being waved more by charlitans and subversives of the far left and far right, it is nice to see someone with honesty and purity in his heart using the American flag as a rallying point.

Further along in this column Cliff has a flash announcement that we are coming out with some sort of award which will do away with all other awards. Good for us.

There are several questions which the column did not resolve for me though. (1) Who originated the idea of an award for working counties? (2) Did Charlie Vogelsong W3BQA send the idea for this award to K6BX together with the rather complete set of proposed rules which were later published as K6BX's? (3) Did this award pave the way for K6BX to get a position on the CQ staff? (4) Did K6BX offer W3BQA USA-CA Certificate Number One in return for his not revealing the situation leading up to the announcement of the new award? (5) Was Charlie foolish to turn down this great honor and thereby miss out on being the feature attraction at the Dayton Hamfest dinner? (6) Are the USA-CA awards all legitimate? (7) What will happen next? (8) Did you know that there is a fine wall-sized map of the US showing all counties available from the Gov't Printing Office and put out by the Dept. of Commerce?

Advertisers

It is encouraging to note that several advertisers have had such good success with 73 that they have decided to run all further ads in 73. Each month there are a few new advertisers who are testing the ability of 73 to sell their products for them. Since it is these advertisers who are buying your magazine for you (the newsstand and subscription price doesn't begin to cover printing costs) it sort of behooves you to take more than a casual look at the ads and to talk up 73 with any advertisers that interest you. Just a few more ads and we will be able to expand the magazine and bring you more pages of articles each month. I call your attention particularly to our Surplus section of the magazine. We have the largest collection of surplus ads of any radio magazine and it will stay that way if you keep after them. Barry, Meshna, Rex, TAB, Goodheart, Verns, Hi-Way, Fair, US #1, Space, Columbia, Candee, JJ Glass, Signal, Jefftronics, all have some great buys. Don't miss the catalogs they put out and stop in to see them if you can. I visited Meshna recently and really loaded up the car . . . what a collection he had. The new Barry catalog eats your heart out. Fair has a terrific selection, ditto Columbia and Candee.

73 TESTS

Perspicacious readers may notice that we have more than the usual sprinkling of tests of new gear this month. There are obvious reasons for the spate at this time. 1) The increased sales which these test reports might bring on will undoubtedly result in a much merrier Christmas for the manufacturers involved . . . and this may just result in a merrier New Year for us when the new ad contracts come in. 2) The test reports are very handy for you to use as a sort of shopping list for the XYL and harmonics for Christmas Buy them one each of the products tested and watch their surprised expression on Christmas morning.

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NCX-3 SPECIFICATIONS

Frequency Range: 3.5, 7.0, 14.0 Mc. amateur bands • **Types of Emission:** SSB (LSB 80 and 40 meters, USB 20 meters), AM (SSB with carrier inserted), CW • **R. F. Power Input:** 200 watts SSB PEP, 180 watts CW, 100 watts AM • **R. F. Power Output:** 120 watts SSB PEP, 108 watts CW, 30 watts AM • **Output Impedance Matching Range:** 40-60 ohms • **SSB Generation:** 5200 Kc crystal filter; bandwidth 2.5 Kc at 6 db • **Frequency Stability:** 400 cyles long-term after warm-up • **Suppression:** carrier —50 db; unwanted sideband —40 db • **Operating Facilities:** all modes —full AGC and S-Meter on receive; SSB-VOX or PTT transmit, product detector on receive; AM—VOX or PTT transmit, separate diode detector on receive; CW — grid block break-in transmit, product detector on receive • **Audio Input:** High impedance, low level • **Controls:** Front panel — Main Tuning, Band Selector, Audio Gain, R. F. Gain, Microphone Gain, Mode (off, SSB, AM, CW, tune), Carrier Balance, Driver Tune, PA Tune, PA Load; Rear panel — Vox Sensitivity, Anti-Vox, Vox Delay, Bias Adjust, Vox Input, PTT Input, Key, Phones, Ext. relay • **Metering:** PA cathode current on transmit; S-Meter on receive • **Receiver Sensitivity:** 1.0 μV. for 10 db S/N ratio • **Receiver Selectivity:** 2.5 Kc at 6 db • **Receiver Audio Output:** Better than 2 watts; 3.2 ohms • **Size:** 6" H., 13⅜" W., 11⅝" D. • **Shipping Weight:** 20 pounds • **Power Requirements:** 700 V.D.C. @ 300 ma., 280 V.D.C. @ 100 ma., —80 V.D.C. @ 10 ma., 12.6 V. @ 5A. • **Tube Complement:** 17 tubes, 4 diodes; parallel 6GJ5's in final amplifier. **Mechanical:** ⅛" solid extruded aluminum front panel; perforated steel enclosure; cadmium plated steel chassis; chromium plated steel mobile mounting bracket. • **Main Tuning Ratio:** 45:1, employing planetary and split gear drive. • **Finish:** Front panel — Hydro-etch off-white matte with brushed aluminum trim; Knobs — Mil-Spec, matte black; Enclosure — gray-blue wrinkle enamel. • **Accessories:** NCXA 115 V.A.C. power supply/speaker console; NCXD 12 V.D.C. power supply

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