73

October 1964

A Conservative 40c

A HAM IN THE WHITE HOUSE ?

NEW

Cush Craft

SQUALO*

6-10-11-15-20 or 40 METERS

Cush Craft's continuing research produces another first —THE SQUARE HALO. Squalo is a full half wave, horizontally polarized, omnidirectional antenna. Outstanding all around performance is achieved through a 360° pattern with no deep nulls. Full size and compact dimensions provide a low Q for broad band coverage. Direct 52 ohm Reddi Match feed gives an SWR of 1.5-1 or less from 50 to 51 Mc.

The 6 and 11 meter Squalos are packaged complete with rubber suction cups for car top mounting and a horizontal support for mast or tower mounting. The 10-15-20 and 40 meter Squalos are designed for mast or tower mounting where space does not allow for larger antennas. Squalo is ideal for net control, monitoring, or general ham coverage.

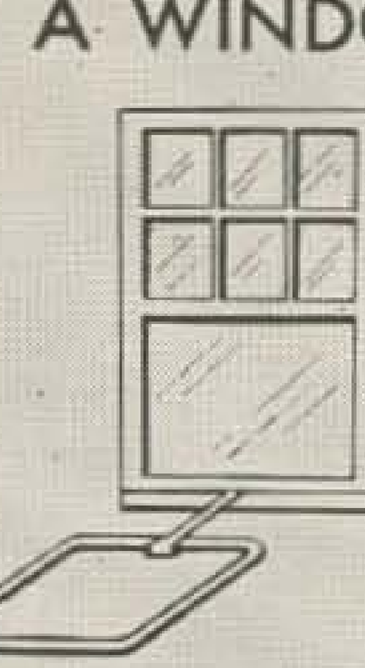
Whether you are a beginner, apartment dweller, or serious DX man the space saver Squalo is for you. You can buy one for each band and build a Squalo Tree!

Model No.	Description	Net Price
ASQ-6	6 meter 30" square	**$12.50**
ASQ-10	10 meter 50" square	**19.50**
CSQ-11	11 meter 50" square	**19.50**
ASQ-15	15 meter 65" square	**23.50**
ASQ-20	20 meter 100" square	**29.50**
ASQ-40	40 meter 192" square	**66.50**

ON YOUR CAR

OUT A WINDOW

ON A MAST



*Pronounced Squaylo

Cush Craft

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MANCHESTER N. H.

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73 Magazine

Wayne Green W2NSD/1
Editor, etcetera

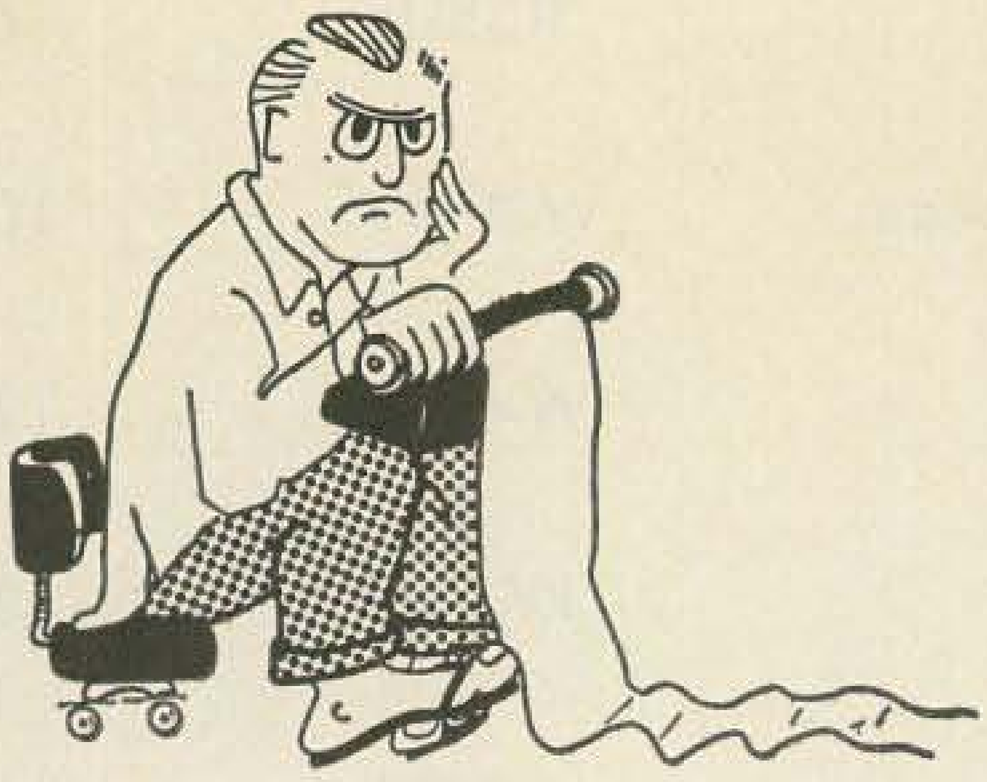
October, 1964

Vol. XXIIII, No. 1

Cover:
Wayne Pierce, K3SUK

73 Magazine is published monthly by 73, Inc., Peterborough, N. H. The phone number is 603-924-3873. Subscription rates $4.00 per year, $7.00 for two years, $10 for three years world wide. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in the US.A.

Postmaster: please send form 3579 to 73 Magazine, Peterborough New Hampshire. Twenty interesting articles, and here you are reading this stuff. Come *on!*



de W2NSD

never say die

432

432 is a real comer. I hope you'll note that a good deal of this issue is devoted to trying to arouse your interest in giving 432 a try. Everywhere I go I am finding that fellows are getting on 432. Some are doing it the hard way, with lathes and coaxial tanks, others are snipping circuit-board a-la Hoisington.

Most of us will live to see the day when 432 is our biggest DX band, if we can beat off the commercial interests who realize what this band is worth and are working on getting it away from us. Many of the fellows working on the communications satellites are hams and one of them recently came up with an estimate of what we might have to spend to build a set of three 432 mc repeaters for fixed orbit use, a placement which would permit us to contact any place on earth on this band. While I can't speak for future elected directors of the Institute of Amateur Radio, the present Interim Directors feel that this is an extremely worthwhile project to be underwritten by the Institute. The costs are estimated at about $200,000.

This is a big order, but just contemplate the probable results. Relatively QRM-free contacts will be possible between any two or more amateurs anywhere in the world using fairly inexpensive and simple equipment. Our 30 mc wide band would accomodate 10,000 simultaneous round tables (using SSB). That should hold us for a while.

Self Appointment

The fellows used to laugh at "Richie" because he would come running to the control room every time we dove to make sure that everything was alright. They teased him about "carrying the boat on his shoulders." However there was something very reassuring about having this man always standing there ready for an emergency . . . a man who knew every one of those thundreds of control valves intimately. A submarine is a ticklish proposition at best and we breathed a little easier when Richie went flying past, day or night, on his sixty yard dash from the maneuvering room or after torpedo room up to control.

I guess I'm in about the same position today with respect to amateur radio. I'm trying to carry ham radio on my shoulders. Some of you kid me about it. Some of you hate me for it. Some appreciate it. While the appreciation feels good and the hate hurts, neither change me any more than ridicule or cheers changed Richie. It is a question of accepting responsibility for something.

Sure, I know, nobody asked me to take the responsibility. But isn't responsibility always a purely voluntary thing unless you have a threat to back up irresponsibility?

So, here I am, sitting at a battered old $5 desk up in the mountains of New Hampshire . . . wondering if I should continue on or maybe just throw in the towel.

My mind goes back over the past few years, trying to discover how I got in this situation.

One of the first turning points was back in 1948 when I first heard the "jingle bells" on the high end of two meters and became interested in radioteletype. The second turning point was in 1951 when I got a television directing job out in Cleveland and the station had a mimeograph machine. Thus began my ham writing career as I printed volume one number one of the Amateur Radioteletype Bulletin. In 1952 I began my column on RTTY in CQ. I was in the big time.

Being rather close to CQ, I knew that the editor was having great troubles with Cowan and was anxious to leave. In December 1954 he left to become editor of popular Electronics, leaving CQ editorless. Somehow, in spite of the fact that I was running a successful hi-fi manufacturing business, I let myself be talked into editing CQ on a part time basis. The magazine was, I understood, losing money and was being supported by Cowan's only other publication, Radio Television Service Dealer.

In view of this financial problem I agreed to start in at a low salary as long as I would have a share in any success I might bring to the magazine. I made a great mistake in just

NOW

DIRECT CRYSTAL CONTROL TO 160 mc
With AOC Plug-In Transistor Oscillators

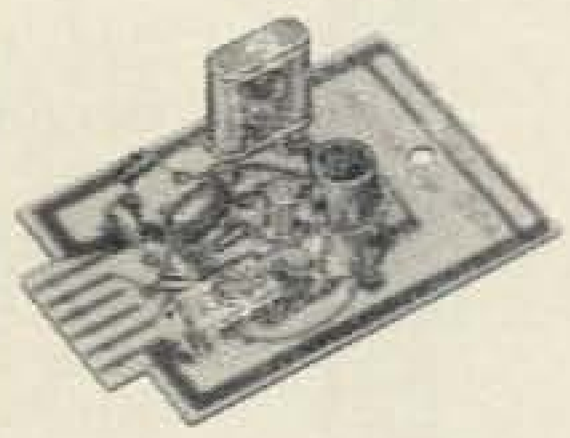
• Portable Signal Standards • Signal Generators For Receiver Alignment • Band Edge Markers
• Frequency Markers For Oscilloscopes • Quick-Change Plug-In Oscillators • Accessory Cases

HIGH FREQUENCY (20 mc – 160 mc)

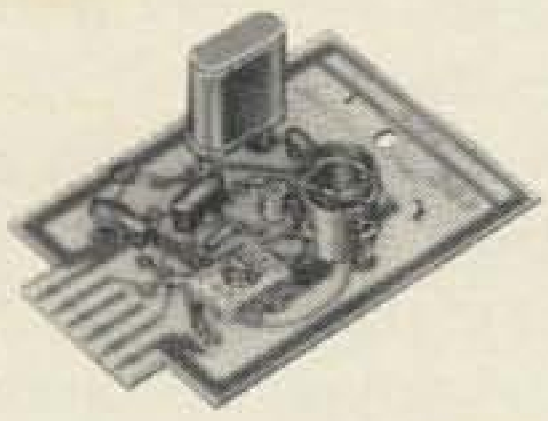
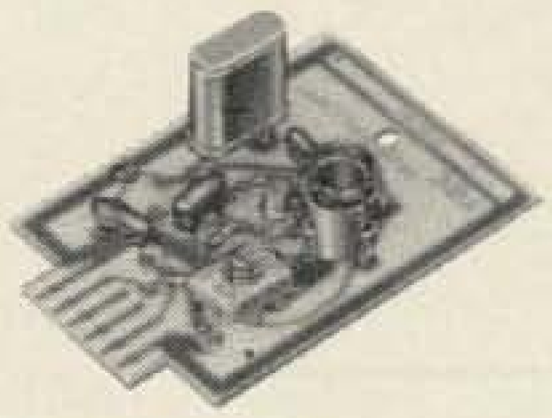
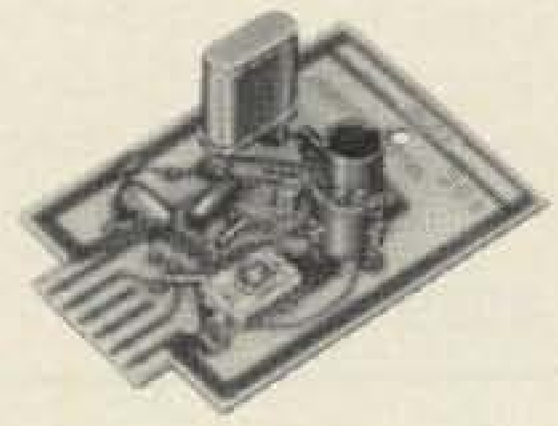
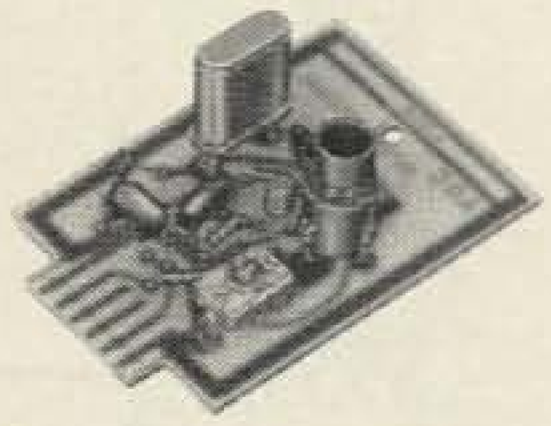
Five transistor oscillators covering 20 mc - 160 mc. Standard 77°F calibration tolerance ±.0025%. The frequency tolerance is ±.0035%. Oscillator output is .2 volts (min) across 51 ohms. Power requirement: 9 vdc @ 10 ma. max.

OSCILLATOR TYPE	OSCILLATOR RANGE	CRYSTAL TYPE	TEMPERATURE TOL. —40°F to 150°F	OSCILLATOR (LESS CRYSTAL) PRICE
OT-24	20-40 mc	CY-7T	±.0035%	$ 9.10
OT-46	40-60 mc	CY-7T	±.0035%	9.10
OT-61	60-100 mc	CY-7T	±.0035%	15.00
OT-140	100-140 mc	CY-7T	±.0035%	15.00
OT-160	110-160 mc	CY-7T	±.0035%	15.00

CRYSTAL FREQUENCY	CRYSTAL PRICE
20-60 mc	$ 6.90
60-100 mc	12.00
101-140 mc	15.00
141-160 mc	18.00



Order direct from International Crystal Mfg. Co.

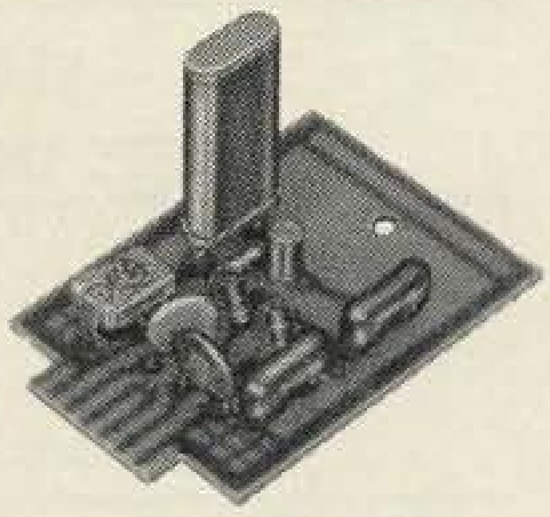





LOW FREQUENCY (70 kc – 20,000 kc)

Four transistor oscillators covering 70 kc - 20,000 kc. Trimmer capacitor for zeroing crystal. When oscillator is ordered with crystal the standard will be ± .0025%. Oscillator output is 1 volt (min) across 470 ohms. Power requirement: 9 vdc @ 10 ma. max.

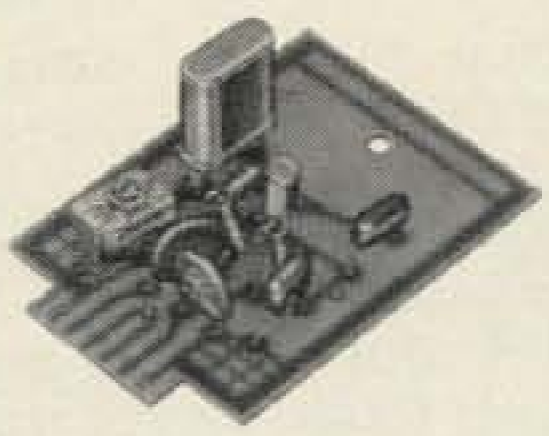
OSCILLATOR TYPE	OSCILLATOR RANGE	CRYSTAL TYPE	TEMPERATURE TOL. —40°F TO + 150°F	OSCILLATOR (LESS CRYSTAL) PRICE
OT-1	70-200 kc	CY-13T	±.015%	$7.00
OT-2	200-5,000 kc	CY-6T	200-600kc ±.01% 600-5,000kc ±.0035%	7.00 7.00
OT-3	2,000-12,000 kc	CY-6T	±.0035%	7.00
OT-4	10,000-20,000 kc	CY-6T	±.0035%	7.00

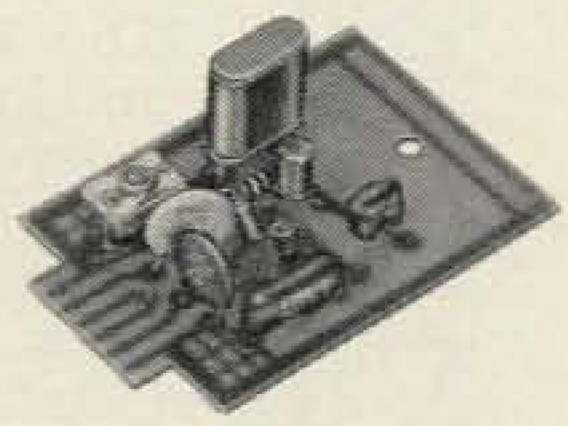
CRYSTAL FREQUENCY	CRYSTAL PRICE
70-99 kc	$22.50
100-200 kc	15.00
200-499 kc	12.50
500-849 kc	22.50
850-999 kc	15.00
1,000-1,499 kc	9.80
1,500-2,999 kc	6.90
3,000-10,999 kc	4.90
11,000-20,000 kc	6.90



INTERNATIONAL CRYSTAL MFG. CO., INC.

18 NORTH LEE OKLAHOMA CITY, OKLA.





FOT-20

FOT-10

AOC OSCILLATOR CASES

Small portable cases for use with the OT series of plug-in oscillators. Prices do not include oscillators. (When oscillator and crystal are ordered with FOT-10 case a 77° F tolerance of ±.001% may be obtained at $2.00 extra per oscillator/crystal unit. When oscillator/crystal units are ordered with FOT-20 case, a single unit can be supplied with temperature calibration over a range of 40° F to 120° F. Correction to ±.0005%. Add $25.00 to the price of FOT-20 and oscillator/crystal unit.)


FOT-20 For high accuracy calibration requirements. Includes battery and output jack, output meter circuit and battery check, as well as thermistor temperature measuring circuit. **$87.50**

FOT-10 Basic case with battery and output jack for general wider tolerance applications. **$14.50**

MT-1 Oscillator board mounting kit. **$4.95**

shaking hands on the deal instead of having a lawyer and a signed contract.

By the end of my first year with CQ my part time job had grown to full time and I had sold my hi-fi business. CQ had grown from 72 pages to 128 pages a month and was well in the black. Already I was having a hint of major problems to come though. I had to use every strategem at my command to get the bookkeeper to pay for articles published . . . and as far as being reimbursed for business expenses . . . haw! This was finally solved, for a while, when I decided that I just couldn't run a booth to sell subscriptions at hamfests and conventions all at my own expense at the low salary I was receiving.

My ability to sell subscriptions had brought in quite a bundle and rather than lose this entirely they offered to let me take my expenses out of the receipts if I would continue to go to conventions.

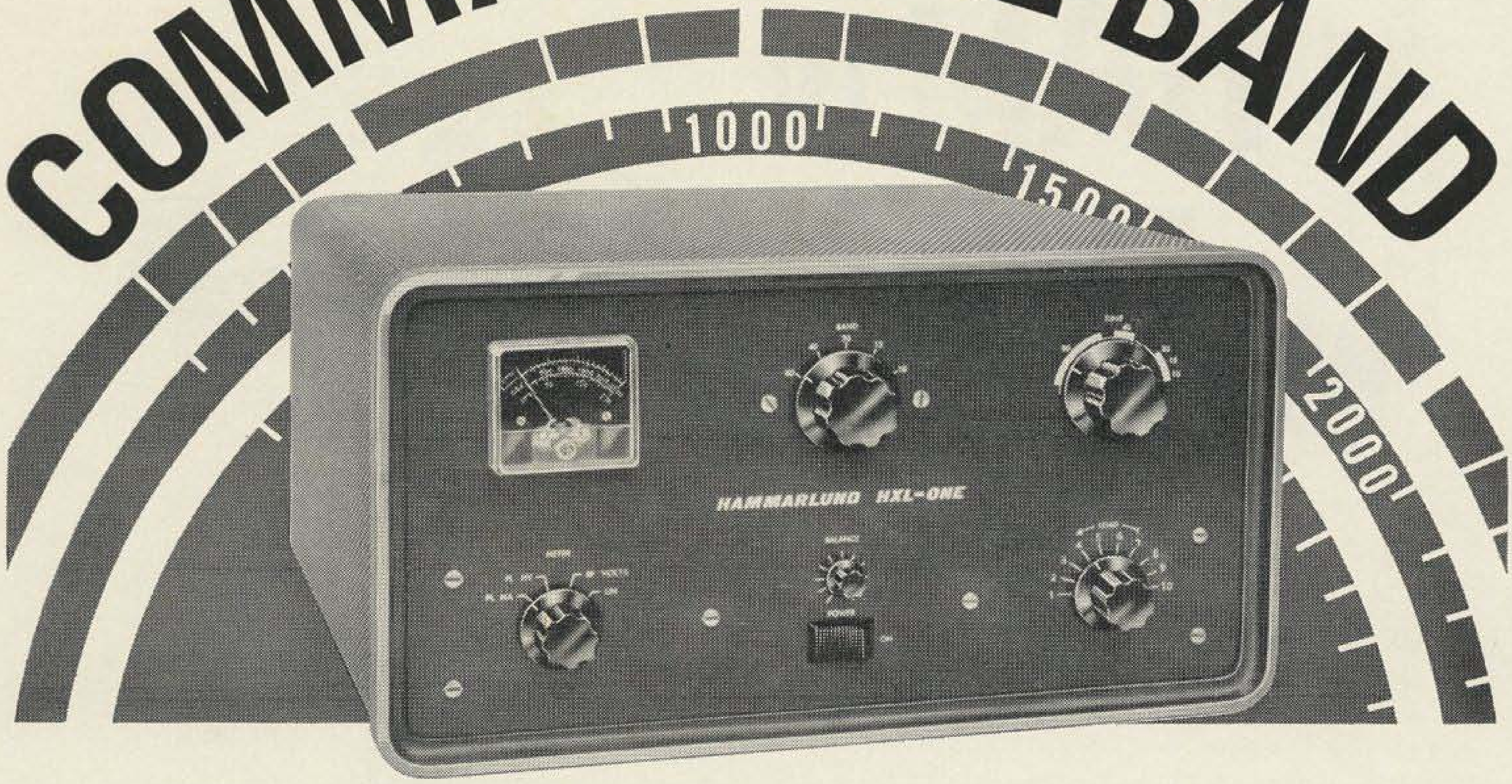
I was having such a good time as editor of CQ that I managed to largely overlook the growing problems that were facing me. I was quite annoyed at the enforced and strict editorial policy I had to live with. Advertisements were accepted from companies that I felt were not reliable. Article payments lagged more than ever. Many authors had to wait from one to three years for payment after submitting their articles. This made it so that I had a hard job getting any good articles and I had to pay for some of them out of my own pocket in order to get them written.

Late in 1959 things came to a head. There were many factors that swung the balance. On the money side there was the fact that I had had one small raise in the five years that I had been there, while CQ was obviously prospering well. Cowan had retired to a 56 foot yacht and his two sons were trying to run the business. I was owed over $5000 in expenses over a period of three years and royalties on the many books I had prepared for them. I have a signed statement still around here for over $2000 of the royalties which were never paid.

Add to all this the miserable situation that developed over the International Amateur Radio Convention. New York had not had a ham convention in over ten years so I went to work and sold Cowan on the idea of backing a convention. He liked the idea and I then went to the local clubs to get their moral and working support. They wanted to know about the financial end, naturally. Cowan made what sounded like a reasonable deal and things started to move along. Then I began to hear rumors. I could see that things were taking

(Continued on page 83)

COMMAND THE BAND



with the NEW HAMMARLUND HXL-1 linear amplifier

Regardless of the exciter you are now using—the HX-50, the HX-500, or any one of a host of compatible competitive units, you will TAKE COMMAND the moment you're hooked up to the incredible HXL-1.

The HXL-1 is so rugged, it can be held "key down" at a kilowatt for more than an hour . . . without damage. It delivers the full metered legal power of 1 KW CW input—1500 W PEP input. Here is a "no-nonsense" linear that delivers the power you pay for—the performance you want.

Send for complete technical literature today—or see and try it at your nearest authorized Hammarlund distributor.

FEATURES

- Complete coverage—80 to 10 meters
- Broad Banded Input Circuit
- 3 Element adjustable Pi-network output
- Built-in multi-purpose meter including linearity test
- Control circuitry compatible with most transmitters and transceivers (i.e. HX-50, HX-500, "S" line and KWM1, KWM2, etc.)
- Efficient Ground-grid circuit using 2 high dissipation triodes (United 572A)
- Husky, self-contained solid state power supply with silicon rectifiers
- Only connection required between exciter and amplifier is a coax cable. All relay switching built into amplifier.
- Power packed performance on SSB, CW and AM. 1500W PEP input; 1 KW CW input
- Designed for 115/230 volt operation
- Same physical size as the Fabulous HX-50. (17½" wide; 9½" deep; 9⅛" high)

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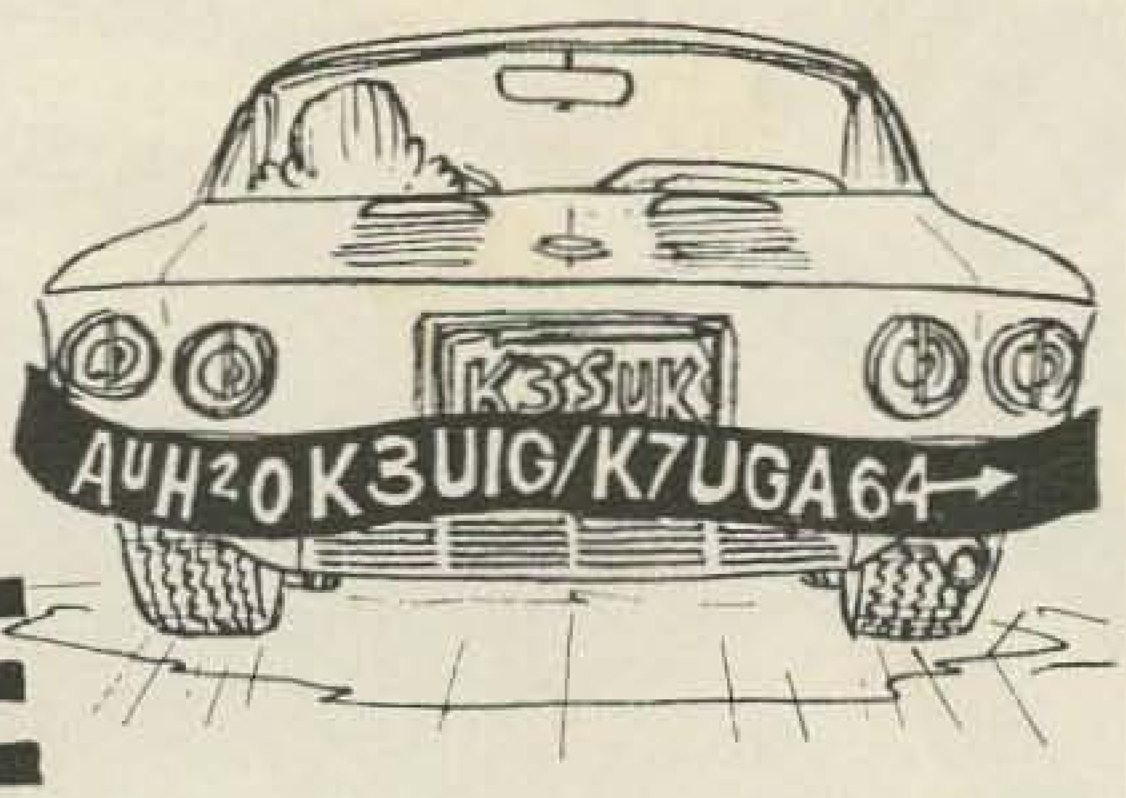
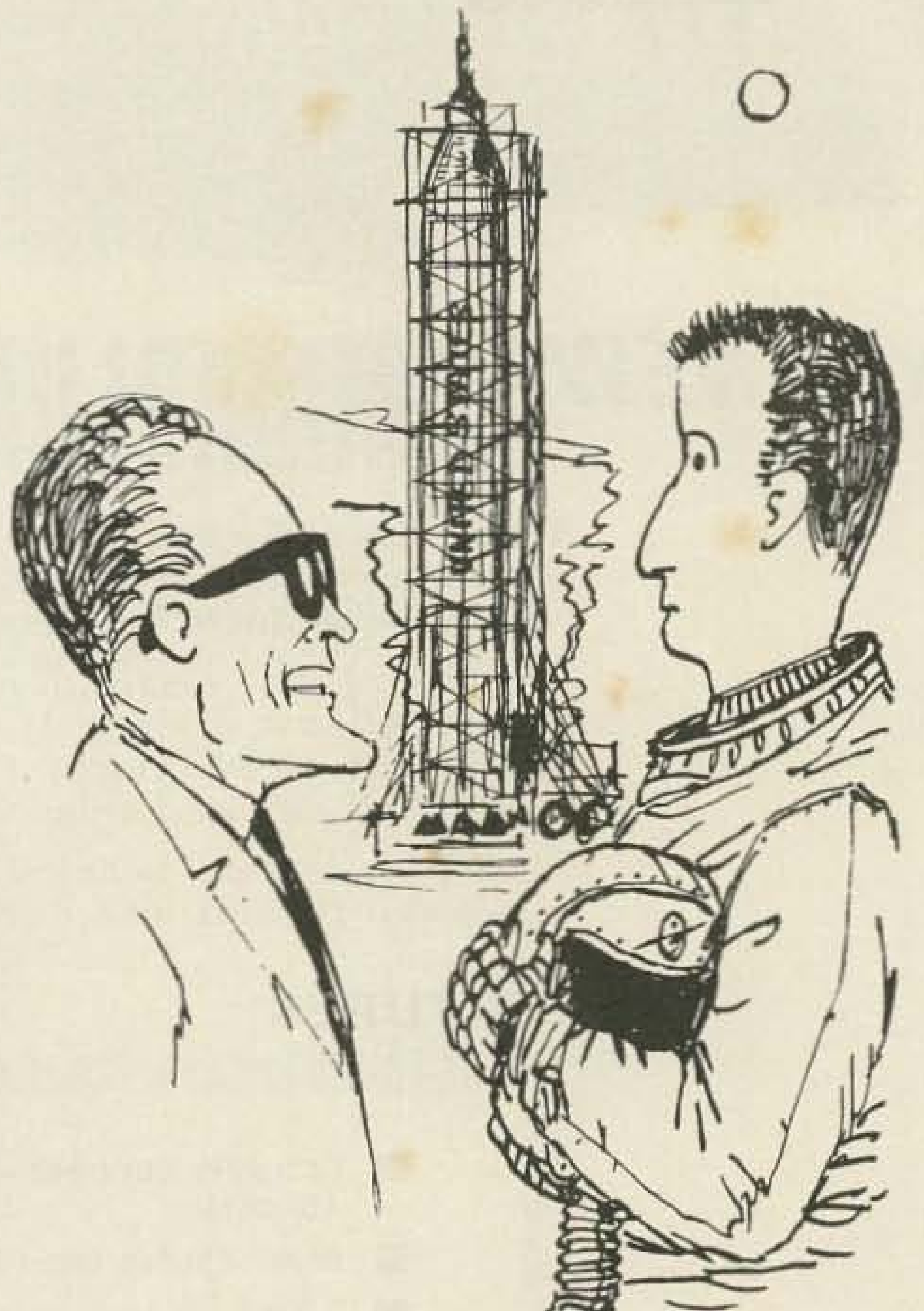
A HAM IN THE WHITE HOUSE ?

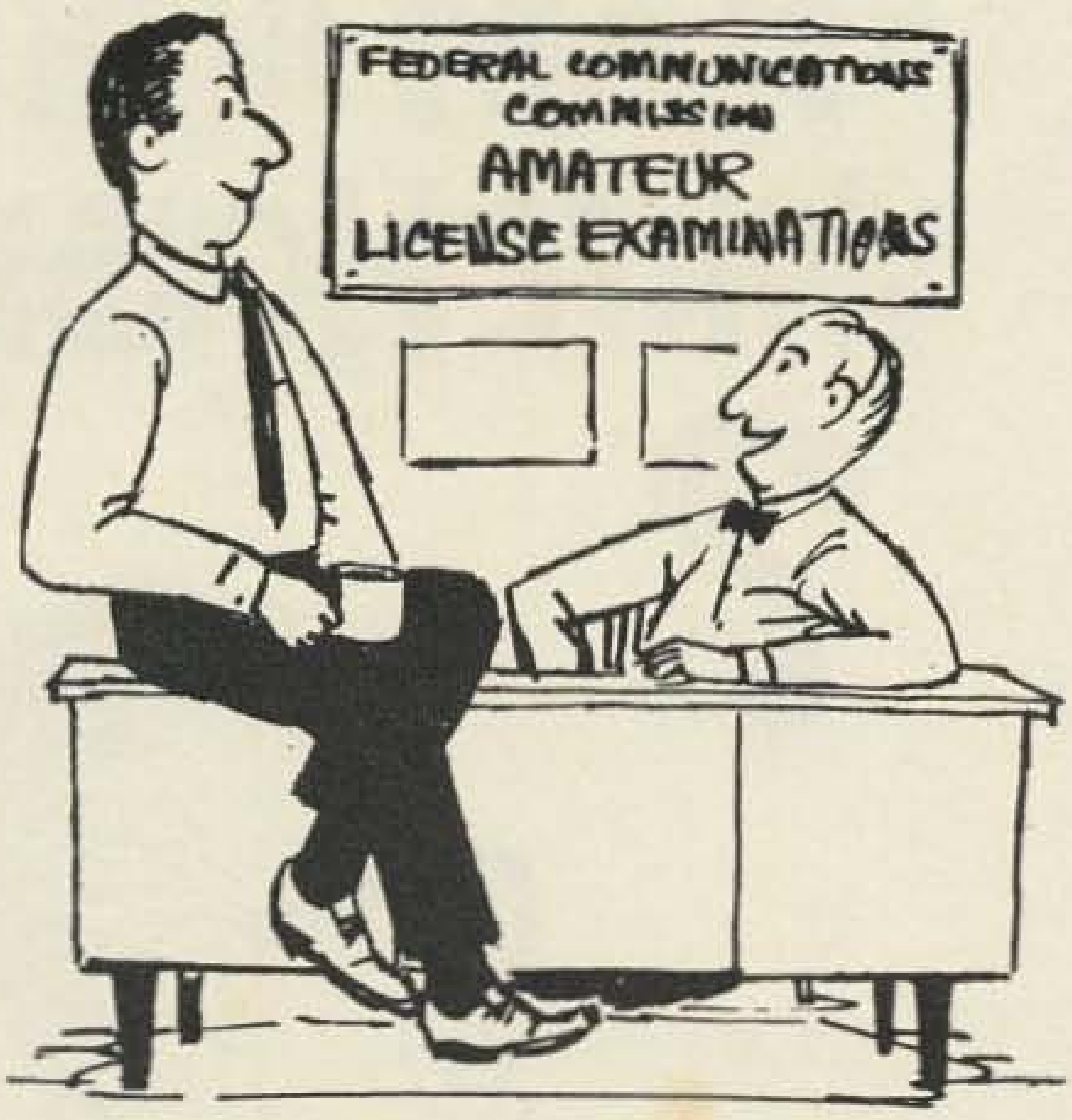


"MR. PRESIDENT... WILL YOU CONTINUE MR. JOHNSON'S EFFORT TO CUT DOWN ON THE WHITE HOUSE ELECTRICITY BILL?"

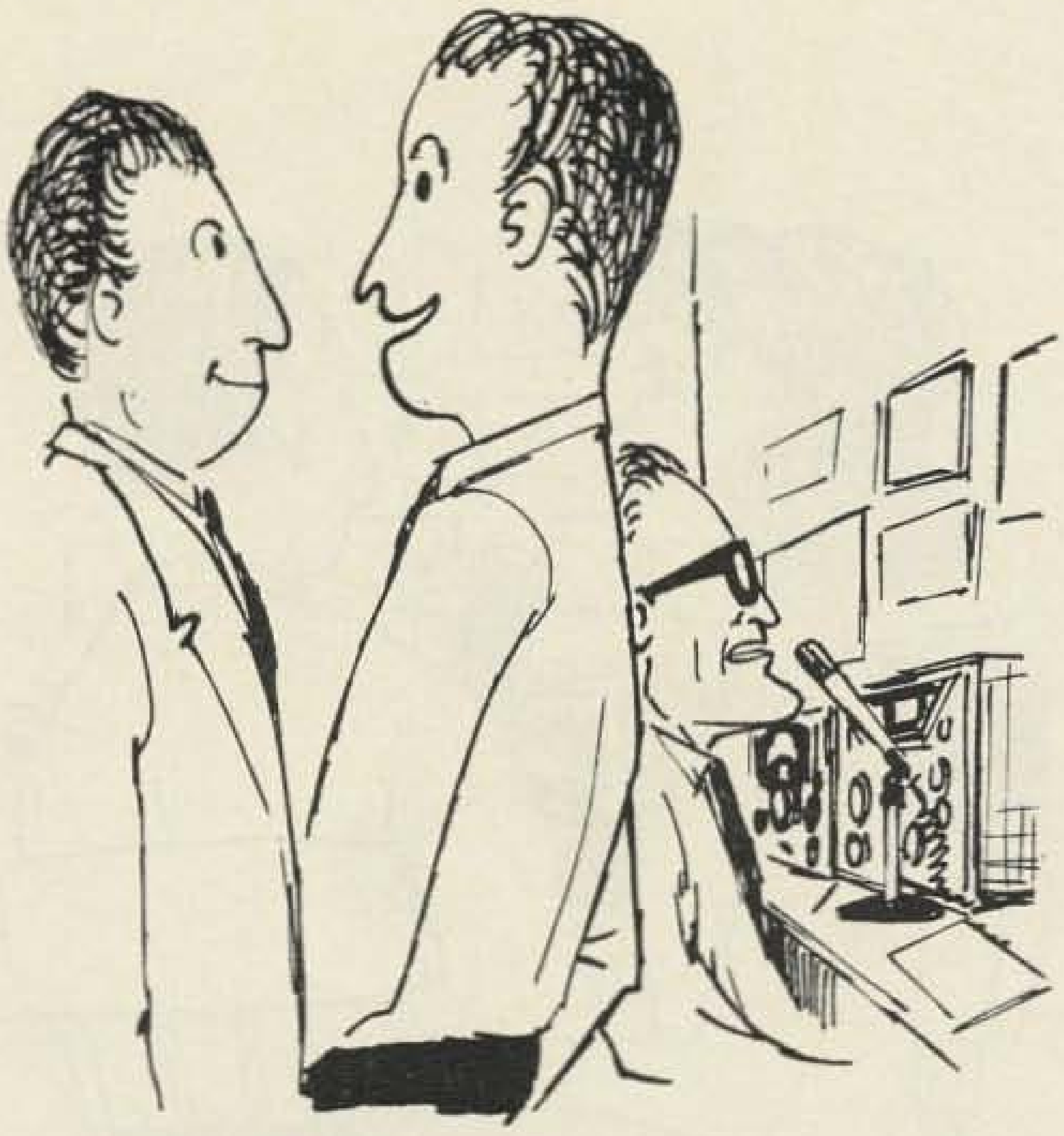


"ONCE AGAIN... YOU SHOULD LAND AT 0935... GIVE ME A CALL AT 0940 ON 7036 KC... THEN WE'LL TRY 20 AT 0950 ON 14.036... THEN ON 15 AT 1000 ON 21.036 ... RIGHT ON UP THRU THE BANDS ... SEE YOU NEXT THURSDAY... AND DON'T FORGET TO QSL..."

Wayne Pierce K3SUK

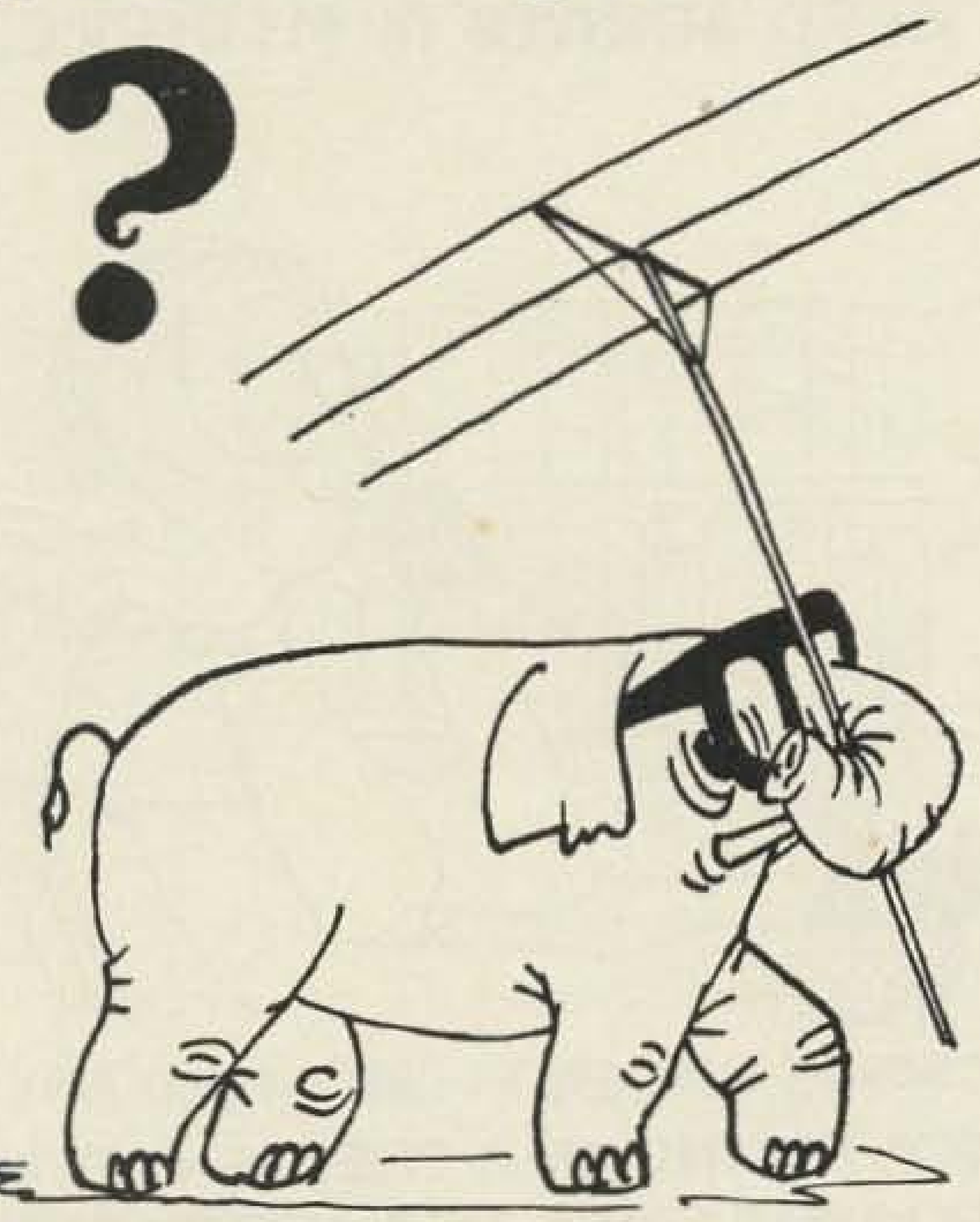


"EVER SINCE HE GOT IN THE WHITE HOUSE, HAM RADIO IS REALLY THE BIG THING... I'VE FLUNKED THREE SENATORS, TWO REPRESENTATIVES, AND A GOVERNOR SINCE MONDAY..."



"IT'S NICE TO KNOW THAT IF THE 'HOT LINE' TO MOSCOW GOES OUT OF ORDER, THERE'S ALWAYS TWENTY METERS..."

A HAM IN THE WHITE HOUSE ?



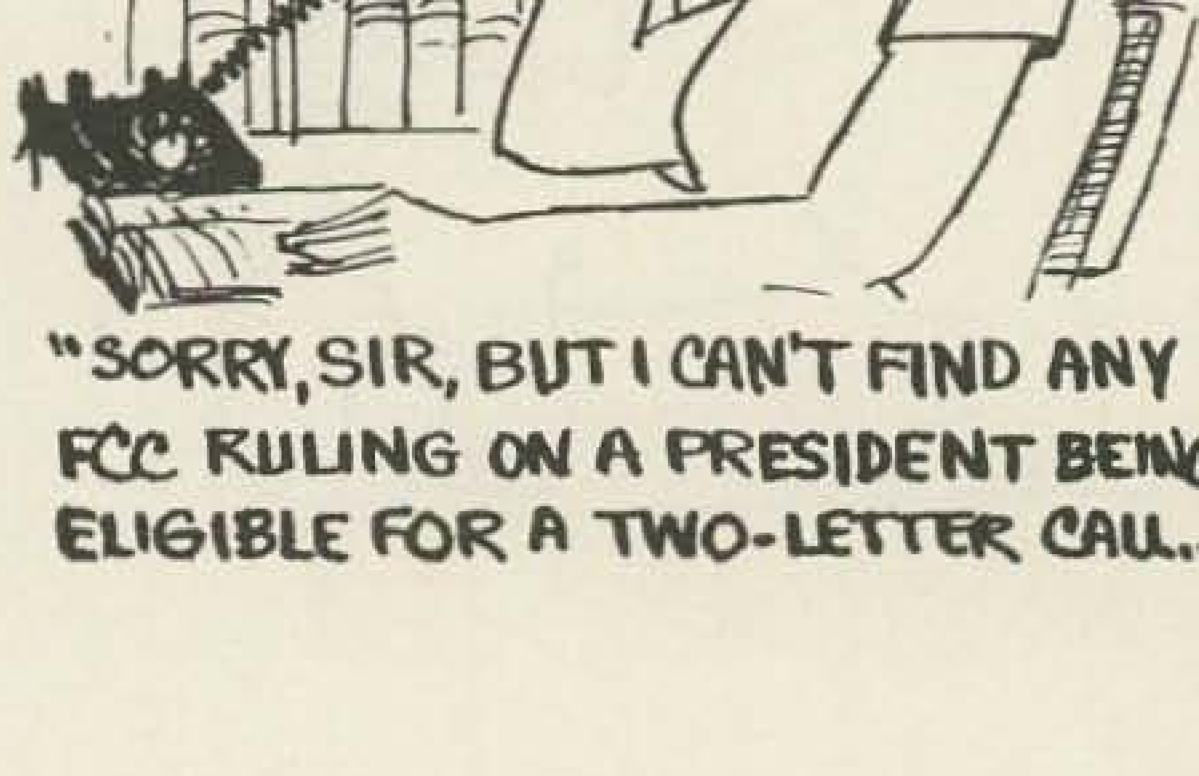
"MR. PRESIDENT... THERE'S SOMEONE OUTSIDE TO SEE YOU ABOUT SOME TELEVISION INTERFERENCE OVER AT THE RUSSIAN EMBASSY..."

A HAM IN THE WHITE HOUSE ?

"DEAR... ARE YOU SURE IT'S ALL RIGHT TO CALL THE PRESIDENT 'OLD MAN'?"

"HOWEVER, DIPLOMATIC RELATIONS WILL BE RESTORED IMMEDIATELY AFTER THE QSL CARD ARRIVES IN MY OFFICE..."

"DADDY... ASK THE MAN IF WE'LL GET TO SEE THE RIG..."



"SORRY, SIR, BUT I CAN'T FIND ANY FCC RULING ON A PRESIDENT BEING ELIGIBLE FOR A TWO-LETTER CALL..."

GONSET **SIDEWINDER**
TRANSCEIVER **Model 900A**

SOLID STATE "SCOOP" FROM GONSET!

FIRST AND ONLY TRANSISTORIZED SSB-AM-CW TRANSCEIVER FOR MOBILE, PORTABLE AND FIXED COMMUNICATIONS

The totally new Gonset Model 900A *Sidewinder* is the first and only transistorized SSB-AM-CW transceiver (except mixer, driver, final stages in transmitter) to provide complete coverage of the 2 meter amateur band in 4 segments 1 MC wide. Yet it's so compact it fits quickly under the dash of the newest cars! Transistor design makes possible a primary power requirement in the receiver of less than $\frac{1}{2}$ amp! Separate power supply accessories snap-fasten jiffy-quick to back of transceiver, or may be used for remote installation. Here's the trouble-free, solid state transceiver with power to spare for any fixed, portable or mobile application!

For complete information, visit your Gonset Distributor, or write Dept. ST-10.

CHECK THESE HIGH-PERFORMANCE SPECIFICATIONS:

TRANSMITTER: Transistorized (except for mixer, driver, final states) • **Frequency Range:** 144-148 MC • **Power Input:** 20 watts PEP SSB, 6 watts AM, 20 watts CW • **Spurious Suppression:** −50 db • **Carrier Suppression:** −50 db on SSB • **Unwanted Sideband Suppression:** −40 db • **Stages:** 3 stage MIC Amplifier; 15 MC Mixer • **Diodes:** 2 Balanced Modulator; Meter Rectifier • **Tubes:** 6EA8 Doubler, Mixer; 12BY7A Driver; 6360 Power Amplifier

RECEIVER: All-transistorized • **Frequency Stability:** Highly stable; utilizes same VFO as transmitter • **Sensitivity:** $\frac{1}{2}$ microvolts or better for 10 db $\frac{S+N}{N}$ • **Selectivity:** Lattice crystal filter for both receiver and transmitter • **Audio Output:** 3.0 watts • **Spurious Suppression:** −50 db or better • **Image Rejection:** −50 db (receiver and transmitter utilize double conversion) • **Stages:** RF; Mixer; Doubler; 9 MC Mixer; 2 9 MC IF; SSB, AM, CW Detector; Audio Driver; Push-Pull Audio Output • **Diodes:** AM Detector; AGC Detector; RF Gain Control

TRANSCEIVER: 9 MC BFO; 15 MC IF; High Frequency Crystal Oscillator; VFO; VFO Regulator; AGC; 9 MC IF • **Dimensions:** $8\frac{7}{8}$" W., $4\frac{7}{8}$" H., $7\frac{3}{16}$" D. • **Wt.:** 10 lbs.-8 oz. • POWER SUPPLY: **Dimensions:** (AC or DC) $8\frac{7}{8}$" W., $4\frac{7}{8}$" H., $5\frac{15}{16}$" D. • **Wt.:** 13 lbs.-8 oz.

PRICE: TRANSCEIVER: $399.50 Amateur Net; POWER SUPPLY: AC—$67.75 Amateur Net • DC—$79.50 Amateur Net

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ALTEC LANSING CORPORATION
LTV *A Subsidiary of Ling-Temco-Vought, Inc.*
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Francis McDonough W3PMV
1226 Clairhaven St.
Pittsburgh 5, Pa.

The TV* Antenna

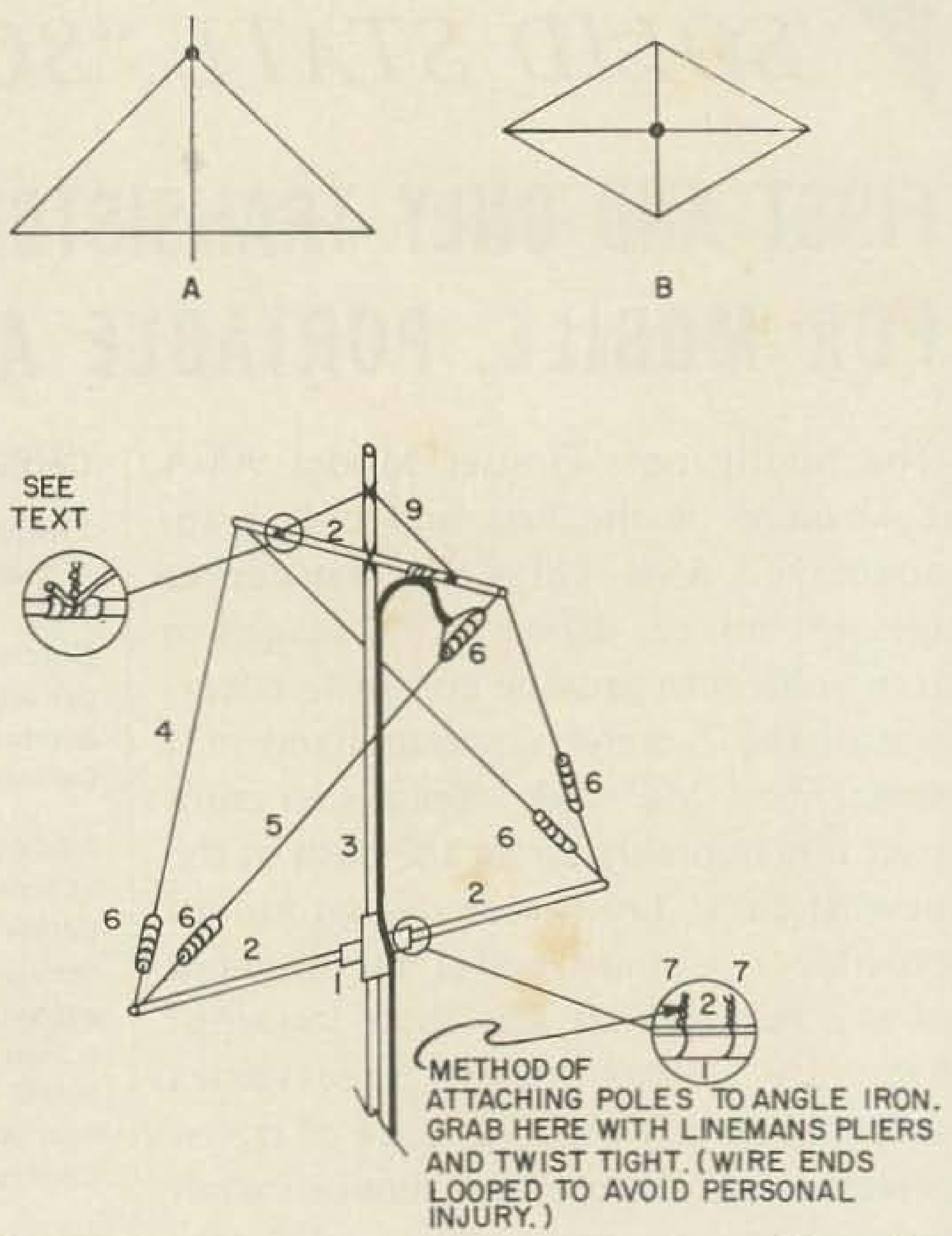
A Compact full size 20 Meter Beam with increase in height bonus

Have you just not quite enough antenna space? Do you desire a higher antenna without the added weight and expense of a taller tower or mast? Are utility lines, trees, etc. an obstruction to propagation? This antenna may possibly be a solution.

A glance at the sketches A and B will show that 33 feet of wire can be accommodated within a 24 ft span by raising the center approximately 12 ft, giving an average height increase of 6 ft. Horizontal separation of antenna, parasitic by 12 ft at the centers, and bringing the ends in closer, creates an average spacing of 6 ft, approximately .1 wave at 14 mc.

Construction

A hole is drilled in the center of each piece of angle iron to accommodate a one quarter inch (or larger) diameter nut and bolt. The pieces of angle are placed back to back to form the "X" and bolted tight. Additional support is not essential because when the antenna elements are mounted and secured, it will stabilize the array. Two horizontal 12 ft poles are then secured to one section of angle iron using galvanized iron wire as clamps, three clamps for each pole. The poles should first be wrapped with a layer of friction tape where the wires go around. The vertical 15 ft pole is then mounted to the angle using five clamps of iron wire, and when it is secure, the last 12 ft pole is lashed (at its center) to it (horizontally) three feet down from the top, but at right angles to the bottom hori-



Front view Top view

Oblique view

1. 2 pc angle iron (1" stock) ea 2 ft long (1/16" thick)
2. 3 12 ft bamboo poles
3. 1 15 ft bamboo pole
4. 35 ft #14 copper wire (ref.)
5. 33 ft #14 copper wire (ant.)
6. 5 small insulators
7. Galv iron wire (guy wire)
8. Misc pc #14 copper wire
9. Plastic clothes line 7 or 8 ft.
10. Roll friction tape
11. ½" or 5/16" nut ang bolt ½" long

* T shape structure; inverted V elements.

zontal poles. Here again a layer of tape is used over the poles, and several pieces of galvanized iron wire wrapped around, criss-crossed to secure well.

A support strut of plastic clothesline is used to prevent the sag of the top horizontal pole caused by the weight of the antenna and coaxial line. Tie a knot at each end of the plastic line, lay it along the pole (center of line at center of pole), wrap friction tape around line and pole at the knot, then secure with a piece of wire wrapped around on top of the layer of friction tape (per top insert sketch 3). Do this at each end of the line. The center portion of the line is wrapped with a layer of friction tape, and raised enough to keep the pole straight; secure line to vertical pole using a piece of wire.

Now to mount the antenna and reflector: With the structure placed so the horizontal top pole's heavier end up attach the center of the 35 ft reflector element to the end of the pole on the ground by means of a loop of copper wire tightly wrapped and twisted, then attach the ends of the reflector element to the ends of the horizontal poles at the base of the structure lying on the ground in similar manner. (Wrap tape over ends of poles wherever wires are attached).

Flop the array over and secure the center of the antenna element to the thick end of the upper pole, and ends of antenna to lower poles. (Similar manner as reflector).

The antenna and reflector end insulators are actually secured about a foot in from the ends and the element ends are left "hanging." Short pieces of wire or plastic line may be used as end supports from the insulators to the poles.

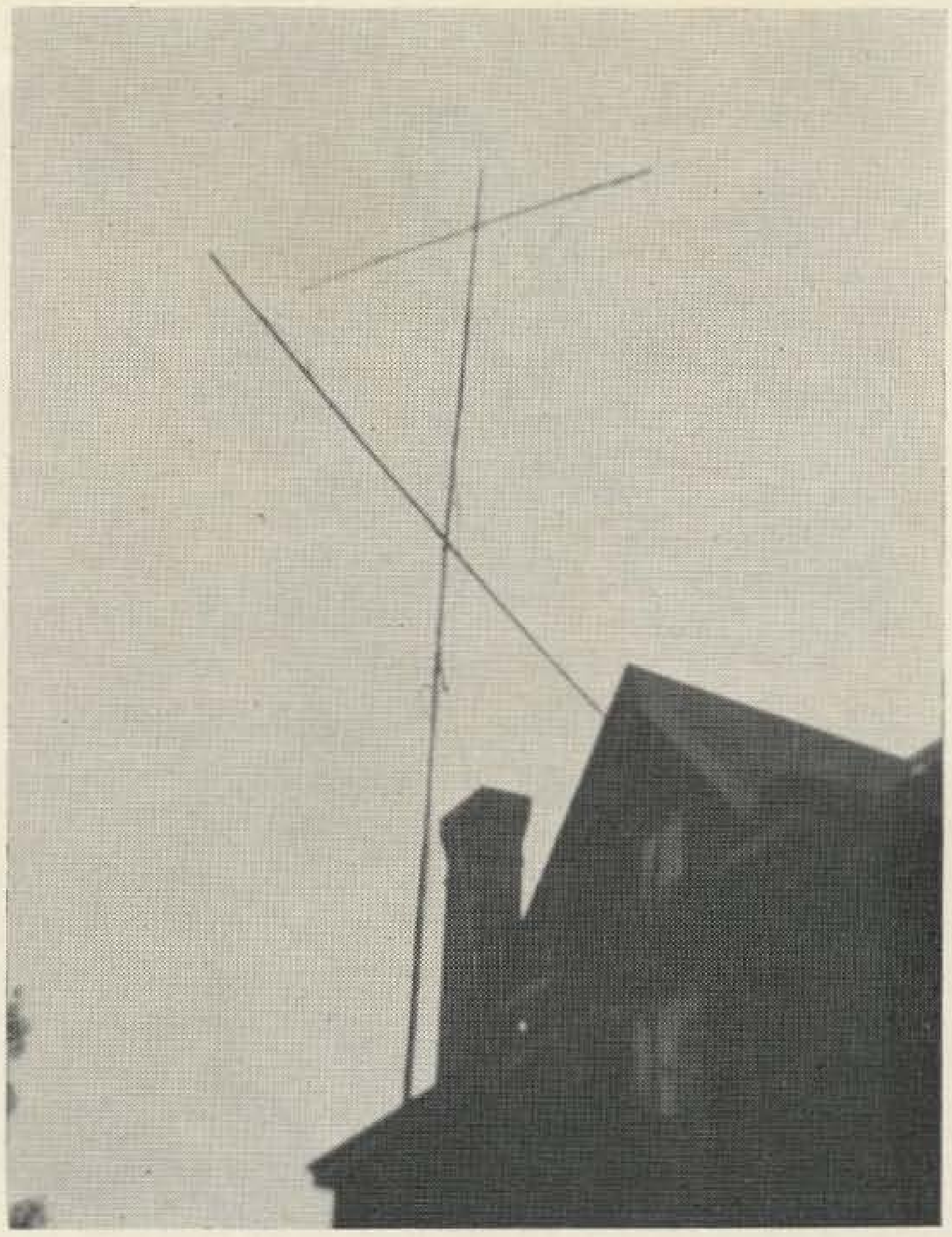
Connect coaxial feed line (50 ohms) to center of antenna, tape along poles where convenient.

The array is secured to a one inch pipe, top section of the mast* by means of five clamps, consisting of two sturdy 1½ inch hose clamps and three galvanized wire clamps, first wrapping the mast with some friction tape, so that when the angle and mast are clamped tight, the chance of wind twist is nil.

I recommend painting the iron and using linseed oil on the poles for greater durability. If desired, fiberglass rod arms may be substituted for the horizontal poles, and heavy wall aluminum tubing for the vertical pole. A standard TV antenna rotator may be used for remote control.

Results speak for themselves. DX stations QSO'd on 20 Meters were ET3AD, VQ8BL

* Dec 59 QST page 28 "Fold Over Mast"



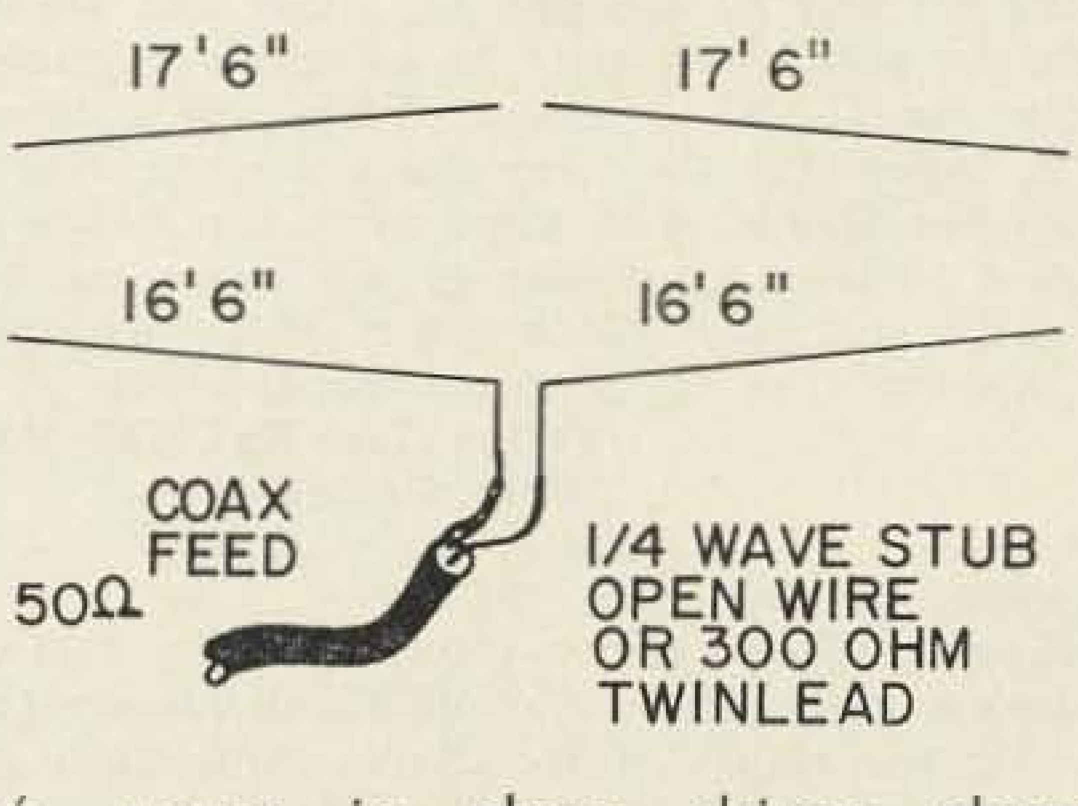
AC4NC KC4USN * YS1MS * W5NAX/EAØ * VQ9HBA VR3L KS6AM UM8FZ 5U7AD ZL4GA JA7AD CN8MB 6Ø1MT UAØKID VK5ZL and dozens of Europeans and So. Americans. (from July 61 to July 62 running 300 watts to homebrew xmtr, average city location) The SWR is 2:1 at 14,000 and 1.3:1 at 14,300 kcs.

The front to back and side ratios are not what one would obtain if a horizontal antenna were used, as there is an amount of vertical polarization present, but the major lobe is higher above the ground than would be obtained using a regular beam or ground plane antenna atop a 35 ft mast, which was the main purpose of this project.

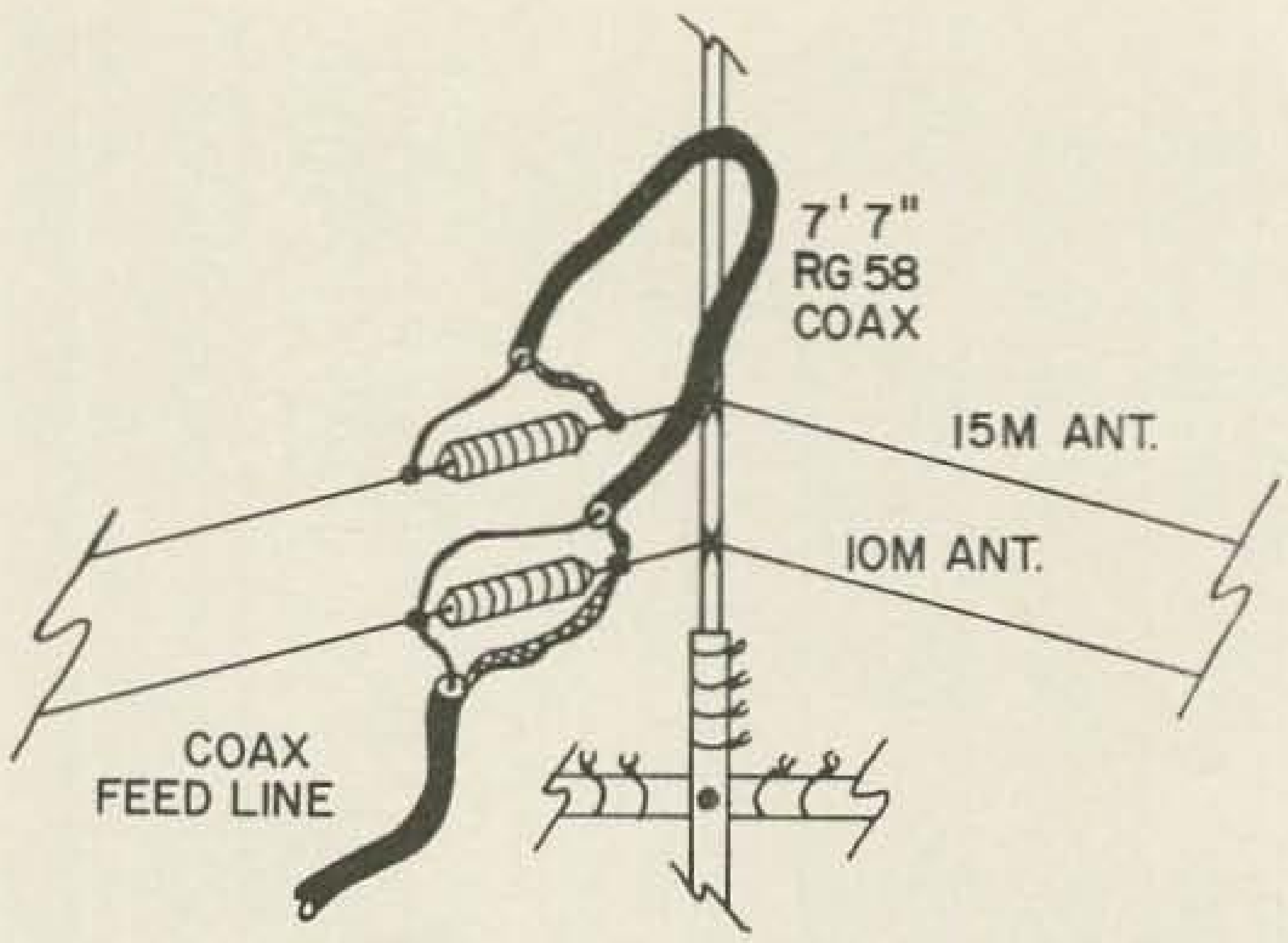
Adding 10 and 15 Meter dipole antennas

Desiring to operate also on the 10 and 15

* SSB



2 ½ waves in phase driven elements
2 refectors (one behind each driven element)



meter bands, the author included antennas for these bands on the same structure used for the "Compact 20 Meter Beam."

The center of the 15 meter dipole is mounted to the vertical bamboo pole about a foot above the angle iron, the ends secured near the ends of the horizontal lower poles. The 10 meter dipole is spaced six inches below the 15 meter antenna by means of a half dozen or so feeder spreaders. Dimensions are 22 ft and 16 ft 6 in of #16 copper wire for the 15 and 10 meter bands, respectively.

Feeding both antennas is accomplished at the centers by means of a single coax line (RG58) and a decoupling stub of 7 ft and 7 in RG58/AU between the antennas. (Without the stub, the SWR is not satisfactory). It is important that the feed line goes to the 10 meter antenna *first,* then the short coax stub feeds the 15 meter antenna. The stub is folded up and secured against the vertical pole with friction tape.

On-the-air-results indicate normal and satisfactory performance. DX is worked when 15 meters is open, and occasional 10 meter operation results in solid local and short skip QSO's.

Other Possibilities

An idea which occured while building the 20 meter beam was the possibility of converting it to a 10 meter four element beam. Collinear driven elements, (two half waves in phase merely by disconnecting the center coax feed, inserting a quarter wave stub of 300 ohm twinlead for 10 meters (6'6" considering the velocity factor) and feed the coax to the bottom of the stub.)

The 20 meter reflector could be opened at the center and it would then become two half wave 10 meter reflectors. The author experimented with this arrangement, making swr check which turned out very satisfactorily, almost 1:1 on 10 meters. However, being primarily interested in 20 meters and DX, the 4 element 10 meter beam was forgotten due to current band DX conditions. But here may be some food for thought for some of the VHF enthusiasts who may desire to "homebrew" antennas by altering the dimensions to suit the band desired.

I'd be interested to hear from anyone who may string up the 2 element 20 meter beam and 4 element 10 meter beam on the same framework. Also, if anyone goes to the extent to make field strength measurements of the 20 meter antenna alone and makes a graph indicating the actual radiation pattern, I'd be interested in the results.

. . . W3PNV

Letters

Dear Wayne,

I have been keeping up with the various controversies in 73 and QST. I suppose I don't have to tell you to keep up the good work and keep needling the QST-boys, they need it! This new "incentive licensing" is a double cross if there ever was one. You mentioned that there is a danger that we might lose portions of our ham frequencies. I would like to go one step farther and say that practically speaking 40 and 80 are one big mess and are lost out in the Pacific area. 20 meters is going also. I might add a plug for the U. S. operator. Whenever I tune to 20 meter CW invariably the nice clean, smooth CW signals come from the States. The same goes for AM and SSB. If you want to hear lousy signals just come out here and get an earful and you will wonder where the QST-boys got the idea that the U. S. hams are a bunch of lids.

Father Ted K9TXM/VK9TG
New Guinea

Dear Wayne,

I have been following the growth of the IoAR and I hope it does a good job as the ARRL did many years ago in defending the rights of the Radio Amateurs. It seems they are getting out of hand and needs to be controlled as the F. C. C. did need to many years ago! Enclosed find $10 for the membership (I hope they accept foreign members).

I know how things can get when they are out of control as I live in a country where that has happened. Simply there is no control on the radio amateurs. They can run up to ten kilowatts P. E. P. and they are not controlled or put off the air. Most AM hams run 1.5 kw and sometimes twice that. At least 30% of the hams do not know how to tune their transmitter because they can get a license by just filling a petition to the office that gives the licenses. There is not examination to take (neither written nor code).

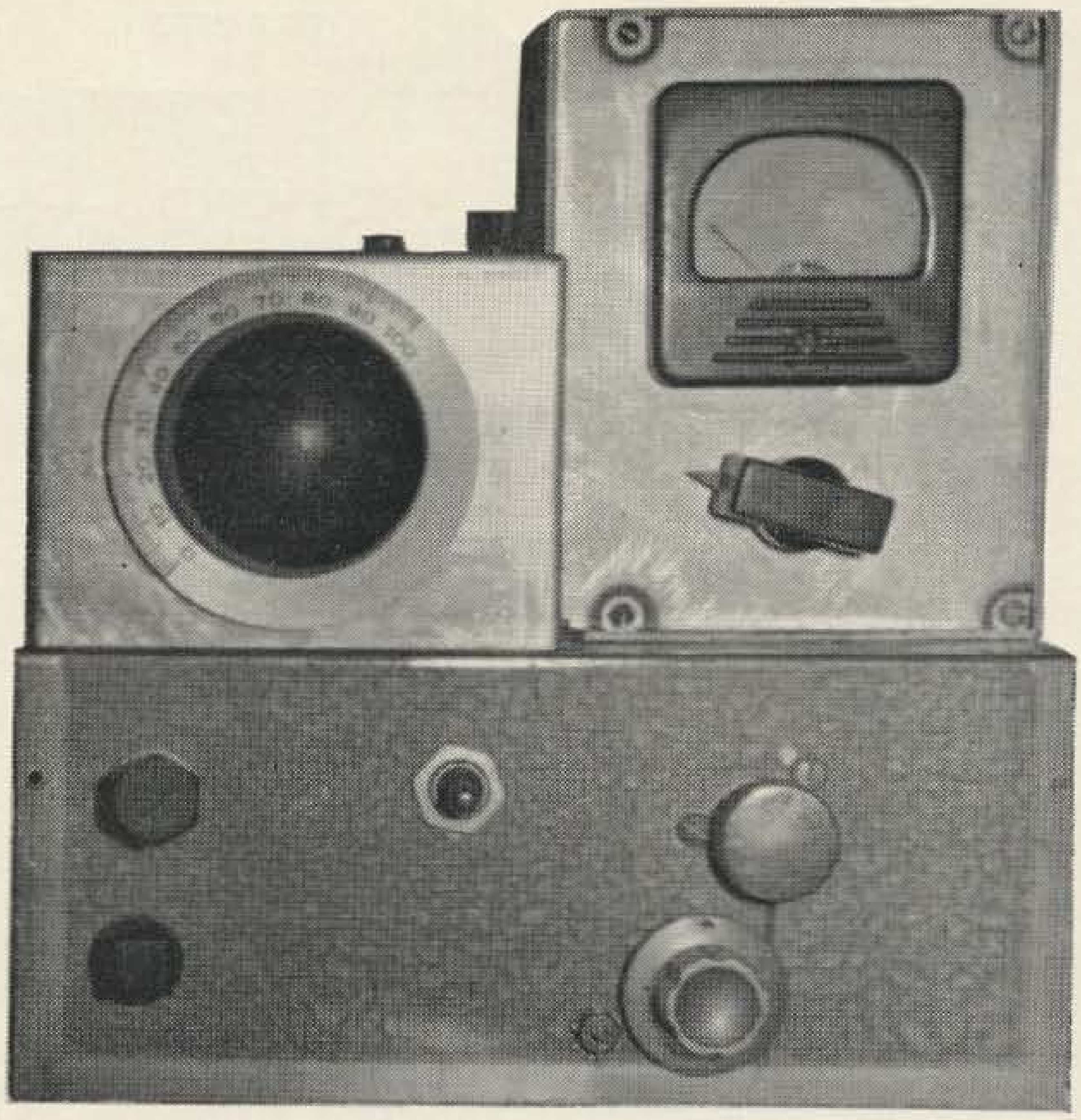
To point out how well this office of "Control de Radio" works there is a broadcast station whose assigned frequency is 825 kc plus or minus 20 cps and that station is operating on 822 kc, 3 kc lower. The office has received reports of the change of frequency from an F.C.C. monitoring station and the broadcast station was advised ten months ago of the "small" discrimination of their operatng frequency but they are still on 822 kc and advertising "Radio Titania, 825 kc"!

On the ham vhf bands, the only thing you can hear is commercial stations (some with ham calls). Most of them are used to communicate with farms or with taxis. There are more than 20 of these on six meters and many more in the two meter band.

Either too much control or too little, as here, in Costa Rica, is bad as you can see therefore I hope the IoAR does a good job.

TI2NA, Eric Roy
San Jose, Costa Rica

A Simple 160M Rig



Geoarge Thurston W4MLE
2116 Gibbs Drive
Tallahassee, Fla.

Opening 160 meters to amateurs in every state should stimulate a lot of activity on this "new" band this winter, even though power in many states is limited to 25 watts at night.

"Top Band" has long been a favorite of those who enjoy stable conditions, don't object to a little QRN, don't like a lot of QRM, and enjoy hamming in most of its phases. The sun spot cycle being where it is, DX is more and more to be found on "Top Band" even with severe power limitations.

Building gear for 160 is an unmitigated pleasure.

Low power means inexpensive parts, "stolen" in many cases from discarded BC and TV sets.

Low frequency means un-critical layout, uncritical parts selection and easy trouble shooting.

When 160 was opened in Florida, I found myself with a receiver but no transmitter.

The trusty old 6146 is an easy tube to coax power from, even at low plate voltages, so that became the tentative choice for a final.

The 6AH6 makes a good vfo. And a 6CL6 was available as a buffer.

This was to be primarily a CW rig, so many little niceties like one-switch spotting, time-sequence grid block keying and clamp-tube final protection were design "musts." Modulation was to be added to the finished unit later, so provisions were made to incorporate this feature without additional changes.

Spotting

Non-swish spotting is provided by a dpdt switch on the panel which kills the final plate and screen voltages while keying the oscillator and buffer.

Drive Control

A wire-wound pot permits adjusting the driver screen voltage from 250v to zero from the front panel. This gives proper values of grid current for the final.

VFO

There are a couple of unusual features about the rig. One of them is the vfo. It operates in the broadcast band.

There are many choices available for suitable coils for the purpose. You can always rob an old BC set of its local oscillator coil. This is then tuned in the vicinity of 825 to 1000 kc by padding it with proper values of capacitance—about which more later.

Several circuits are used in BC oscillators. The two most common are the Colpitts with a tapped coil, and the tptg type shown in the diagram. The tptg seems to be most common. Either can be used, but the tptg is to be preferred in this rig because of its better isolation from the plate load in this electron-coupled arrangement.

Another possible coil is highly desirable, if it is available, because it comes completely shielded. That's the bfo coil from the ARC-5 receiver which covers the range 1.5 to 3 mc. these receivers are not recommended for serious reception on 160 because they're broad, and therefore susceptible to severe loran interference—not to mention amateur QRM.

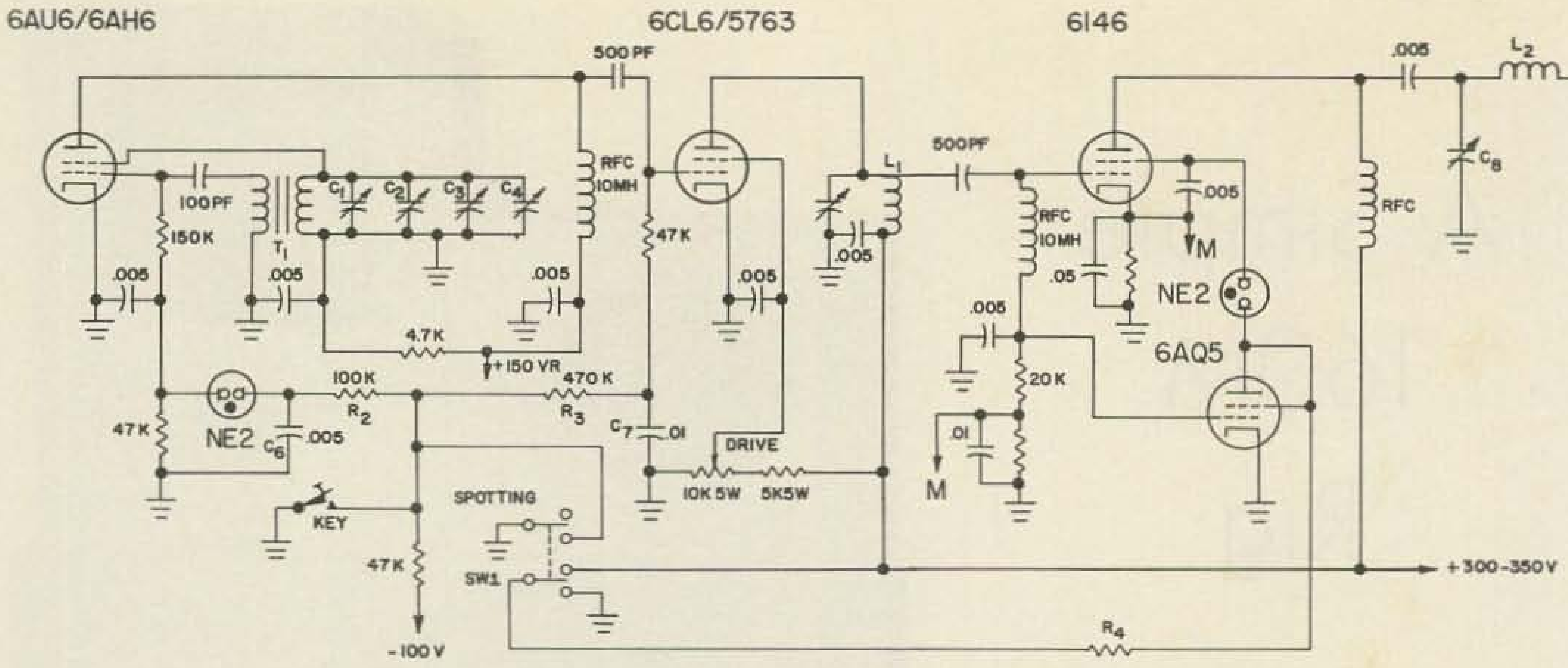


FIG. 1

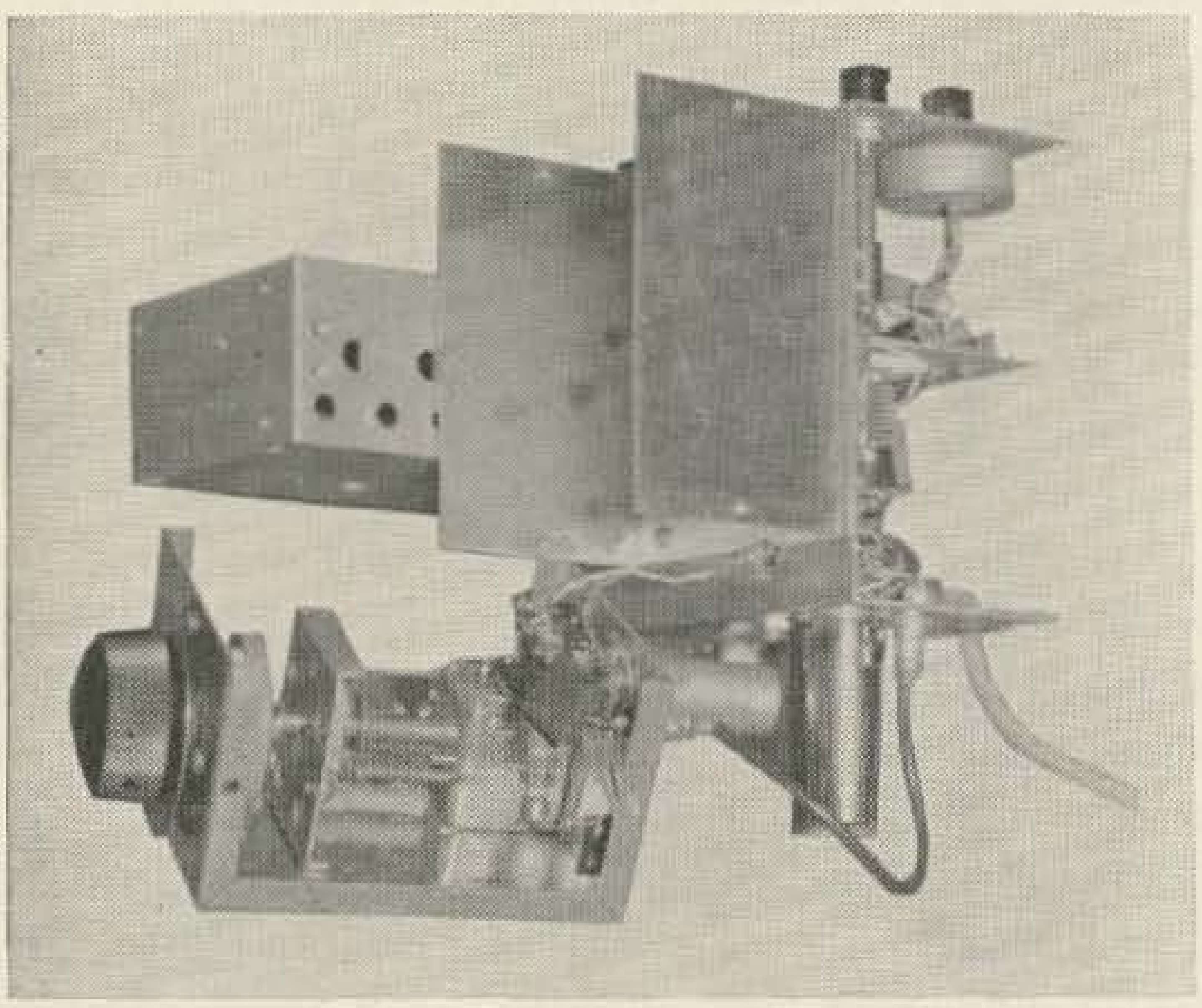
But the bfo coil is a beaut.

Like all the other bfo coils in these receivers, it is enclosed in a small aluminum can and contains a small air-variable padder, in parallel with a button-ceramic fixed padder. The difference is that in this receiver, the *if* is 705 kc—very close to the range we want.

Take off the shield can and remove the button-padder by snipping a lead or unsoldering it and removing its mounting screw. This leaves only the air-variable across the coil. Replace the shield can and mount the unit in the vfo.

The capacitance is built up again externally by connecting *air* variables in parallel with the coil at its terminal lug on the can. They can be screw-driver adjusted APC type for the most part. But while you're stripping that old ARC-5 receiver (any ARC-5 receiver), carefully removed the little "input tune" capacitor from the front panel, where it served as the antenna trimmer. Hook it in parallel with the other padders. It then becomes your calibration trim adjustment.

The vfo tuning capacitor is also an APC-type with a shaft designed for a knob. Remove all the rotor plates except two. They should both be "inside" plates—that is, when meshed, there should be a stator plate on both sides of both rotor plates.



All the air variables are mounted firmly to prevent mechanical vibrations from affecting them. They're connected in parallel and wired into the circuit as shown. This procedure should be followed whether the ARC-5 coil or a BC coil is used.

Wire the rest of the vfo circuit and apply 150 volts from a regulated source. Leave the bias supply off for preliminary adjustment. Some coils may refuse to oscillate until connections to *either* the primary *or* the secondary (not both) are reversed.

Set the main tuning dial for the low end of the segment to be covered (max capacity). Set the calibration trimmer at half-capacity.

Listening with a receiver at the low edge band marker, adjust the air padders until the signal appears. The tuning capacitor should now cover a 25 to 50-kc segment of the band—depending on which end you're tuning. The narrower coverage will occur at the low edge of the band where more padding capacity is required.

The 6-1 reduction dial drive makes this bandspread very easy to handle.

Keying

The time-sequence keying circuit is a direct steal from the Heath Apache transmitter. It works with elegant simplicity and results in a beautifully keyed note.

With key up, bias voltage is applied to the grid of the driver stage and, through the NE-2, to the grid of the oscillator, cutting both off.

When the key is closed, the bias voltage is removed. Almost instantly, the neon lamp extinguishes and the vfo oscillates. However, capacitor C-7 has been fully charged and it must discharge to ground through the 470 k resistor R-3. This time constant is much longer than the time constant of R-2 and C-6, so the buffer does not "turn on" until the oscillator is already on. Thus, the initial click does not get on the air.

When the key is opened, C-6 begins to recharge through R-2 and C-7 begins to recharge through R-3. Since the R-2/C-6 time constant is shorter, the vfo would cut off before the buffer—except for one thing.

The NE-2 is an open circuit until it fires. And it won't fire until the potential across it exceeds 50 volts. By the time C-6 has charged high enough to fire the NE-2, C-7 has charged up and has already turned off the buffer. So the "break" click doesn't get on the air either.

Clamp tube

The initial model relied on the 6AQ5 alone to hold plate dissipation of the 6146 down. However, idling current exceeded the dissipation rating of the tube. The use of a voltage regulator tube in the screen lead is fairly common. With only one small tube to control, and with a screen current of about 10 ma maximum, the NE-2 serves the same purpose admirably, occupying virtually no space and representing a 10-cent investment rather than the cost of the tube and socket.

Coils

The coils—for both the buffer and the final—were wound on parafined cardboard forms taken from an old surplus receiver. They're air core, about half an inch in diameter.

About 60 to 70 turns of "scramble wound" enamel #30 wire in a winding length of half an inch will resonate on 160 meters with 150 to 250 mmfd of capacity.

Resonance should be checked with a grid-dip oscillator if possible. FCC takes a dim view of amateur operations in the broadcast band.

Buffer input from the vfo is in the range of 900 to 1000 kc. Buffer output is in the 160 meter band. The final works straight through.

Output Circuits

Choice of output circuit will be determined to some extent by the kind of antenna you'll be feeding. If you're an antenna farmer with a 160 meter half-wave doublet available, use a conventional pi-tank designed for feeding 70 ohms or so.

If you're end-feeding a handy hunk of

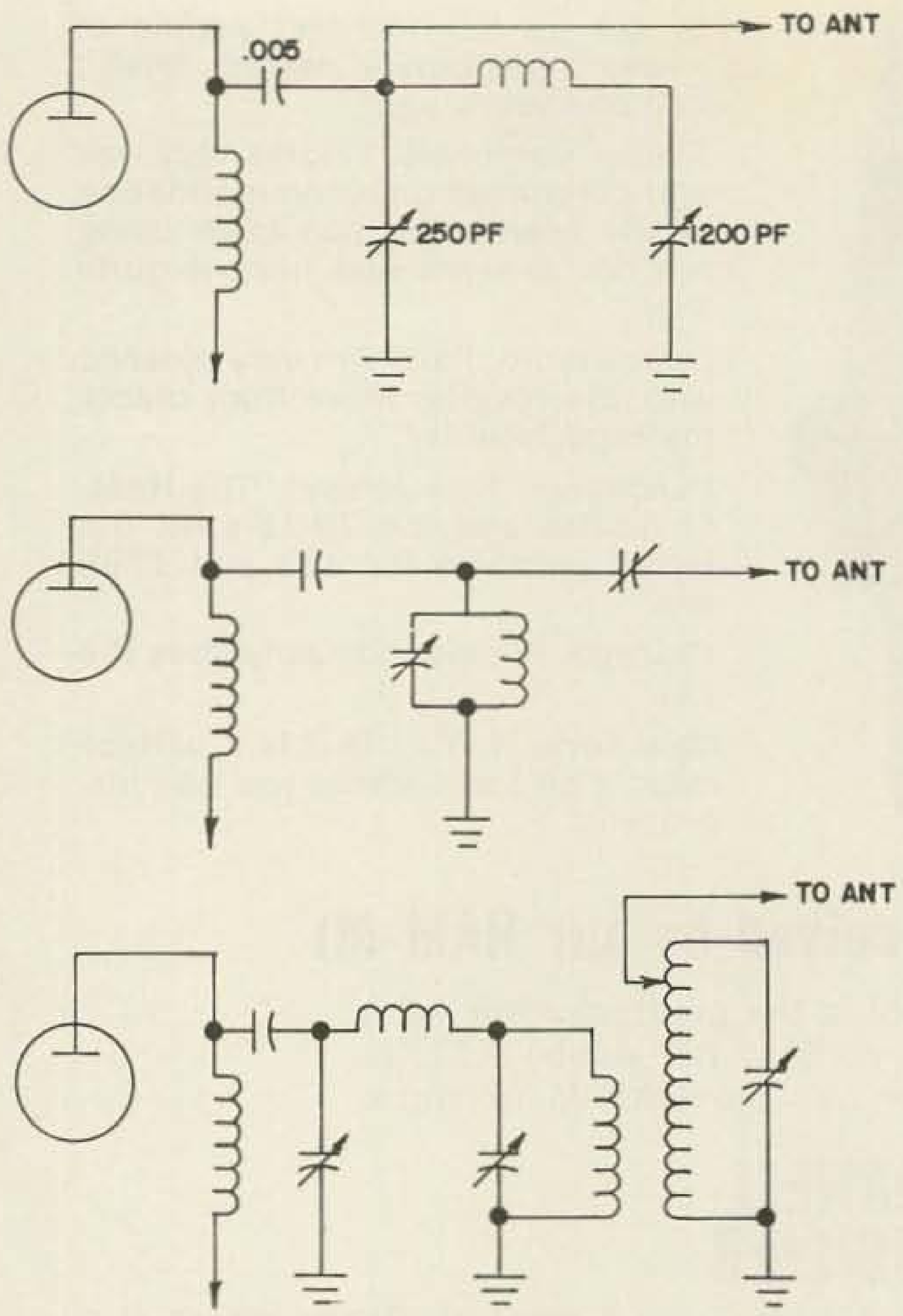


Fig. 2. Alternate output circuits.

wire strung around the back yard, you'll need something else with which to feed the thing. Feeding the 40-meter doublet with the feed line tied together comes in the category of "random" antennas.

The ARRL Antenna Handbook has a fairly extensive discussion of 160-meter antennas and the means of feeding them.

One of the various alternative output circuits shown in the accompanying diagrams will put rf into almost any piece of wire which is capable of putting out a 160 meter signal.

Modifications

The tube lineup is far from sacred. With appropriate changes in electrode voltages and circuit values (mostly grid leak resistors and screen resistors) where necessary, a tremendous variety of tubes would work well.

The buffer could easily be a 6AG7, 6F6, 6V6, 6AQ5, 12A6, 5763 or such.

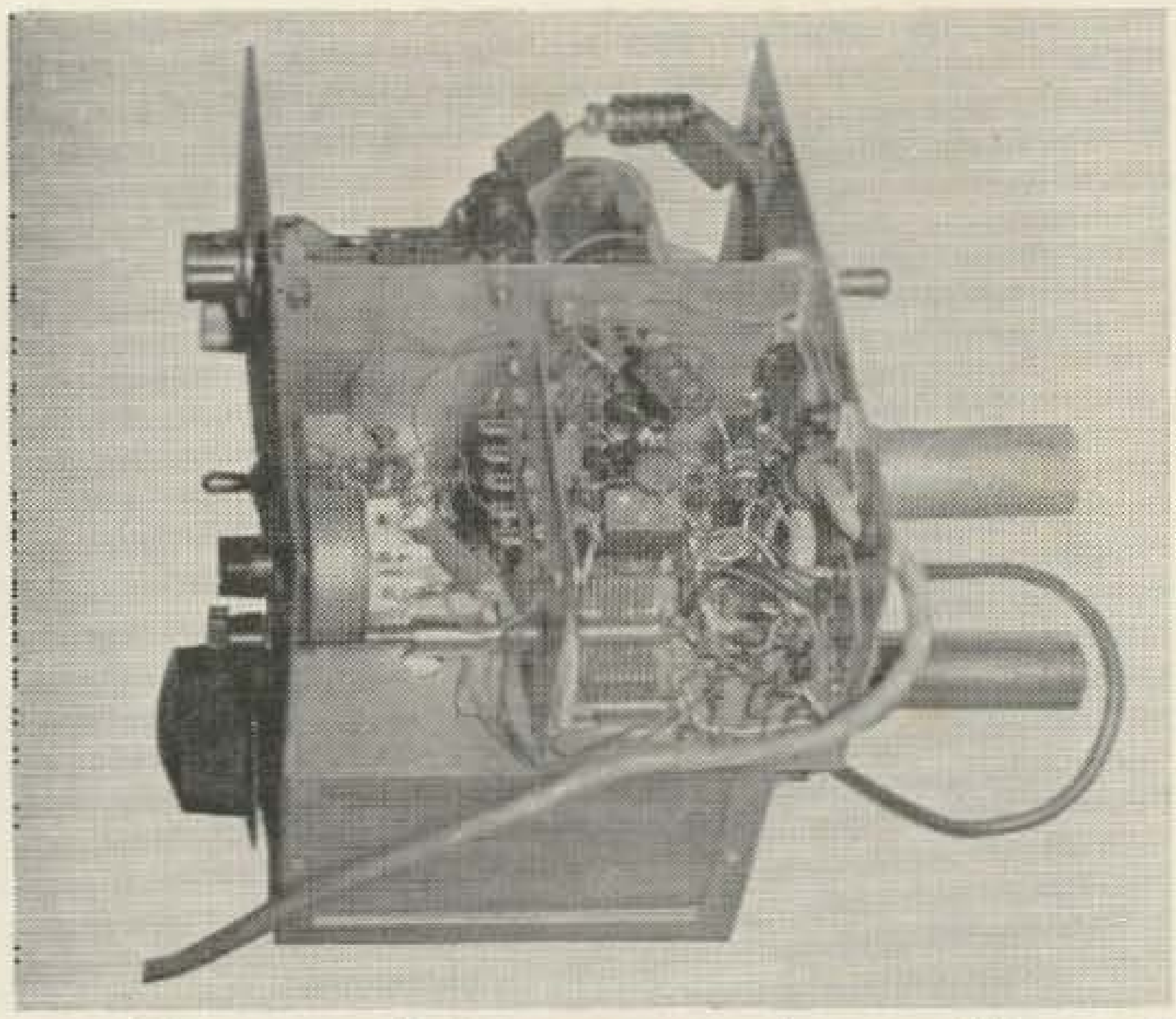
The final could easily be a 2E26, 807, 1625, 815, 6L6, 1615, 829-B, 832-A or such.

The value of resistor R-4 must be computed for each tube and for each power supply voltage. It should give the correct value of screen voltage for the tube being used.

Modulating the Rig

The modulator was omitted from this discussion for several reasons.

The most important is that I haven't built



one. However, it is very easy to provide modulation.

If phone-and-CW operation is desired, a few modifications in the switching arrangement must be made.

The send-receive switch should actuate relays to accomplish the multiple switching functions—or a two position rotary switch with multiple poles may be used since power levels are low.

For CW operation, the transmitter plate voltages are applied at all times. Closing the key puts you "on the air." Modulator plate voltages are "off."

For phone, the modulator and transmitter plate voltages are applied simultaneously, and the key line is grounded.

If phone-only type operation is required (why should anyone want to miss half the fun?) the bias supply and keying circuit may be omitted.

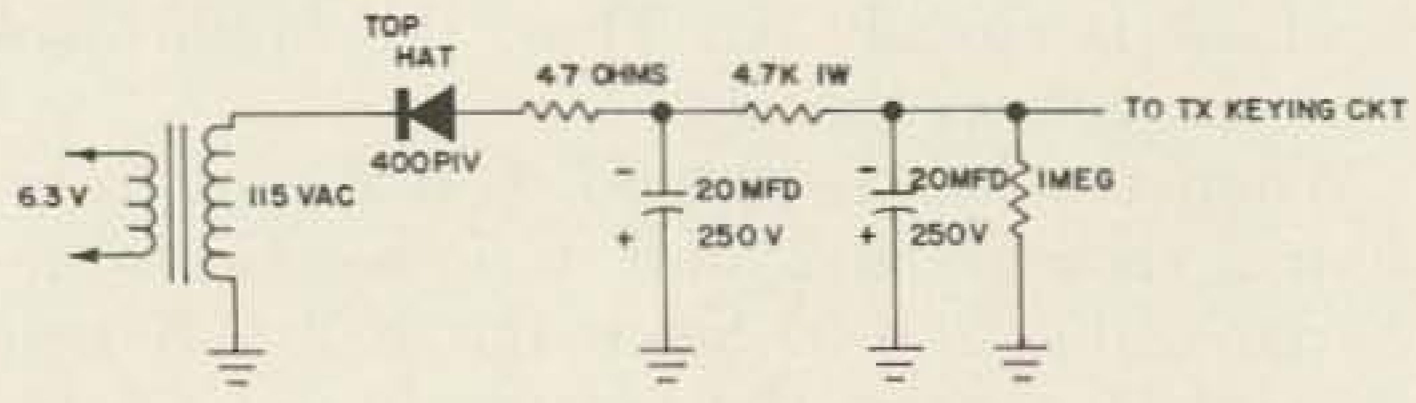


FIG. 3

Summary

Initial results with this rig have been excellent. Using a 200-foot random length wire fed at the end, I worked Florida, Georgia, Alabama, Nebraska, Ohio, Maryland, Iowa and Ontario in the first couple of nights of operation. Signal reports ranged from 449X to 589X.

Adjustment and operation have been absurdly simple. The rig required very little initial de-bugging beyond the usual cut-and-try experimentation with such things as coils, tuning ranges and such.

Total cash outlay? The $2.18 for the 6AH6.

. . . W4MLE

432 mc Preampliter Low Noise (Very)

Jim Kennedy K6MIO
2816 E. Norwich
Fresno, Calif.

Photo credit: Joe De Young WA6CQL

Most people who have had occasion to work with UHF are aware (in many cases, painfully) of the severe inadequacy of the conventional crystal or tube mixer type converters commonly used above 400 mc.

The most expensive diode mixers will, under the best of conditions, yield perhaps a 7 or 8 db noise figure with the more common types (1N82, 1N72, CK710, etc.) operating in the 15 db region. Noise figures even on the better tubes such as the 417A or 6AM4, run in the neighborhood of 13 db at 420 mc. These same tubes used as preamplifiers will do a little better, but still, 7 db is about all that can be expected.

This is alright if you are only interested in local work, but if you are seriously interested in working some DX, something will have to be done. With all this noise being produced it is obvious that many weak signals will go completely unheard. Reducing the noise figure of your converter can produce very dramatic results. A signal that is 7 db under the noise with a 15 db noise figure will be 3 db or more[1] above the noise with a 5 db noise figure.

The problem, then, is how do you reduce front end noise? One answer to the problem would be to employ a parametric amplifier. A paramp will provide more than sufficient gain to override converter noise and the noise figure should be under 2 db. However, paramps have some distinct disadvantages. They are difficult to tune up and their operation is likely to be very unstable unless considerable attention is paid to mechanical stability, voltage regulation thermal stability and low voltage regulation, thermal stability and low features, paramps have inherently narrow bandwidths. At 420 mc the bandwidth will be in the neighborhood of 100 kc. At 1296 mc or higher the paramp or the far more sophisticated (!) maser, seems to be the only answer at the current state of the art. At 420 mc, however, there is one other alternative, the 416B planar triode.

The 416B is a microwave triode commonly used by the telephone company in their 3 gc microwave gear. In this equipment it is used as a frequency multiplier and transmitting amplifier with outputs running in excess of 1.5 watts.

Aside from its transmitting applications, the 416B offers great advantages as a receiver amplifier. Primarily, it has a nominal G_m of 50,000. As a result of its high G_m this tube is capable of very high gain and very low noise.

It will be noted from Fig. 2 that there are actually two cathode connections made to the tube. The connection made to the base pin is for dc while rf is applied to the shell of the tube which is coupled through a built in capacitor to the cathode. The grid connection is the threaded ring and the plate, of course, is the tip on top.

The only major drawback in using this tube is that if the plate voltage and plate current setups used in transmitting applications are duplicated in a receiving amplifier, forced air cooling of the tube is required.

[1] New Thresholds in VHF and UHF Reception, Bateman and Bain, QST, January 1959.

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It is possible, however, to circumvent this difficulty, if desired, by lowering the plate voltage and fiddling with the grid bias. This will reduce the heat dissipation to a point that cán safely be handled by convection cooling.[2] This is done at a slight sacrifice in amplifier performance but the loss of gain is not serious.

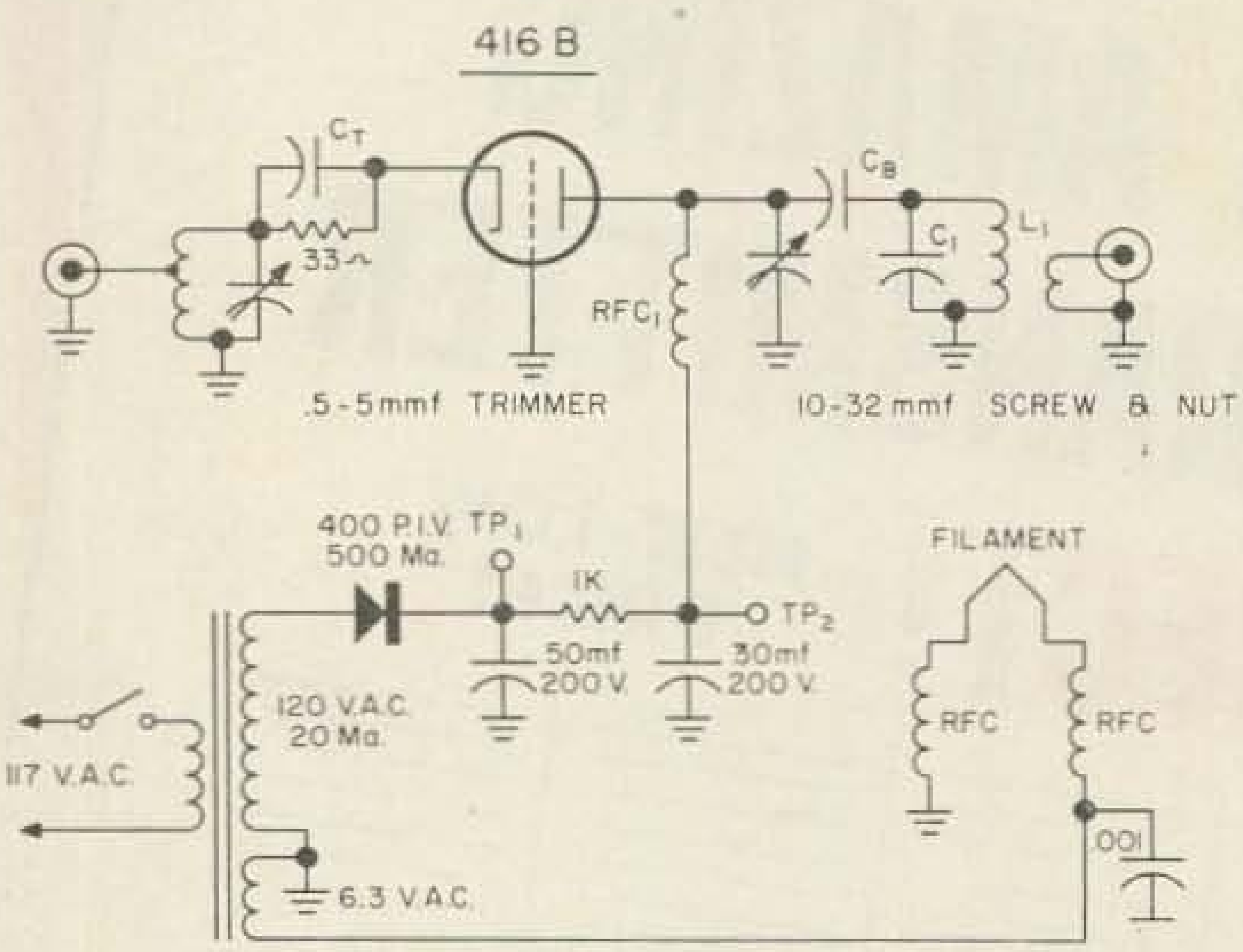


Fig. 1—Schematic diagram. C1L1 Coaxial Tank, CB Plate Blocking Capacitor (see text), CT built in Cathode Capacitor (see text), RFC1 formed by having B+ lead inside plate line, RFC2 filament rf chokes (see text).

Construction

One of the primary considerations in the construction of almost all UHF gear is mechanical stability. In order to comply with this standard, a rigid ¼ wave trough line was chosen as the plate tank circuit. The trough line offers most of the advantages of a regular coaxial tank and is somewhat easier to construct and lay out.

Again, in the interests of mechanical stability as well as simplicity, it was decided to insulate the line from dc with a plate blocking capacitor, allowing the cold end of the inner conductor of the plate line to be grounded for dc as well as rf.

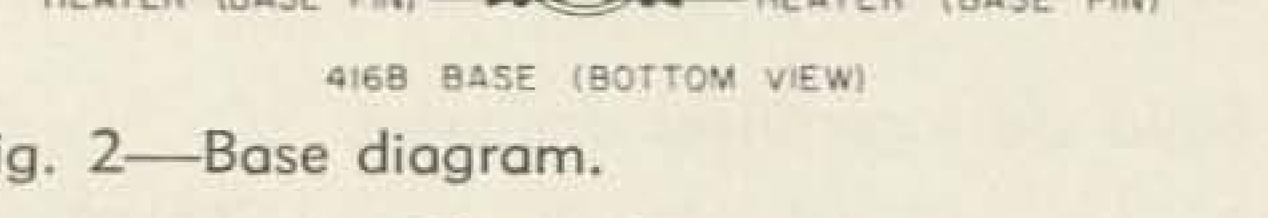


Fig. 2—Base diagram.

Plate Line

The trough is constructed of 1/16 inch brass sheet stock. The trough is formed by 5 separate pieces of stock. If one had access to brake that would make clean folds in this size stock, the trough could probably be made from one piece of stock.

The various parts of the trough are cut, drilled and tapped according to the templates in Fig. 3. The larger holes were made with the aid of a burring reamer.

The trough is now partially assembled. The side plates are soldered to the top plate with a propane torch. A vise and small "C" clamps are helpful. The side plates should be soldered to the bottom rather than the side of the top plate.

The end plate at the cold end of the trough may also be soldered in place.

When applying torch heat in the vicinity of previously soldered joints a wet paper towel or rag wrapped around the previous work can save much grief.

The grounded portion of the inner conductor is made of a 4⅜ inch length of 5/16 inch O.D. brass tubing. The ungrounded portion of the inner conductor is made of a 2½ inch length of 3/16 O.D. tubing.

A plate connector made from a small piece of 3/16 inch tubing is soldered to the 3/16 inch portion of the inner conductor. It should be attached about ¼ inch back from one end of the line. A rat tail file can be used to make notches which are cut in the other end. The tabs thus made are bent in to form a snug-fitting connector over the plate pin of the tube.

At the same end of the inner conductor a small circular piece of shim brass is soldered to cover the open end of the tubing. This forms one of the plates for the tuning capacitor.

One end of the B+ lead is soldered to the inside of the other end of this portion of the inner conductor.

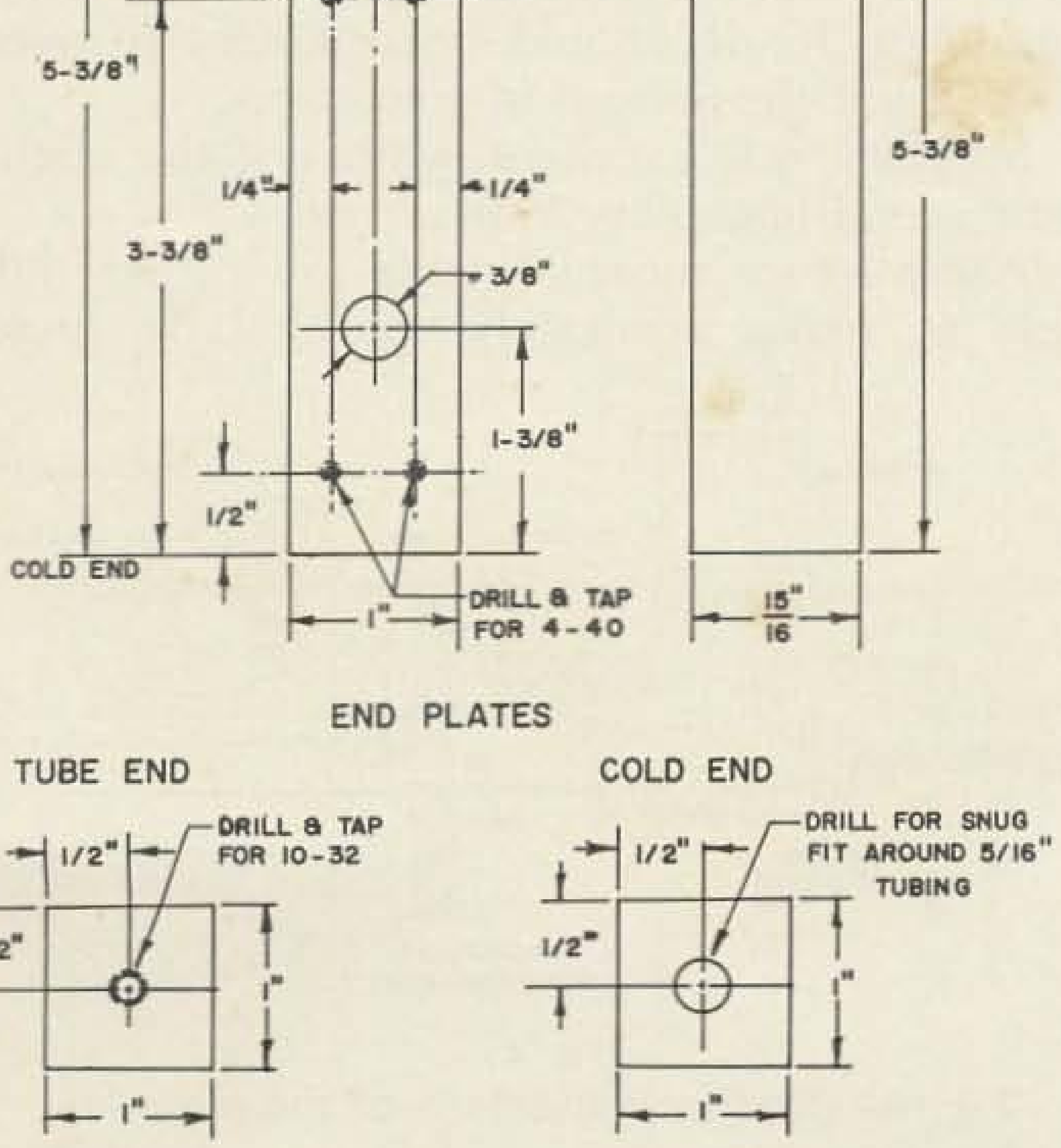
A piece of ¼ inch thick plexiglass is obtained from a hobby shop and cut to ⅞ inches square. A hole is drilled in the center for a snug fit over the grounded portion of the inner conductor. Two holes are drilled in one edge and taped for 4/40. These holes are placed ¼ inch each side of the center of the edge and should match the tapped holes at the tube end of the top plate. Fig. 4 should be referred to as a guide when completing the line assembly.

Several wraps of teflon, mylar, or cellophane tape are made over the 3/16 inch portion of inner conductor. Then the tubing, tape and all, is slipped into the 5/16 portion of the line—thus forming the plate blocking capacitor.

At this point it is wise to solder a volume control (not toggle switch) nut over the inside of the ⅜ inch hole at the cold end of the top plate.

A 1¾ inch strip 3/16 inch or so wide of shim copper or brass should also be soldered to the extreme cold end of the top plate. This should be bent over to form the output

TEMPLATES FIG. 3



loop. A female BNC connector should now be mounted in the volume control nut and the free end of the loop soldered to it. Trim off any excess.

The inner conductor may now be soldered in place and the assembly completed, including the 10/32 screw and nut used to tune the line. Be sure not to overheat the BNC connector.

The chassis is drilled similarly to the top plate, except that the ⅜ inch hole at the cold end is reamed so that it clears the circular shirt on the BNC connector. Also, the 4/40 holes are not tapped but, rather, drilled out to clear the screw.

Cathode Line

The main body of the tube is housed in a box. One side of the box was left open when the unit was built in anticipation of the possible necessity of forced air cooling. The box may be closed if desired, though being open seems to have no adverse effect on performance and it provides much easier access to the tube.

The box is formed by cutting a piece of 1/16 inch brass to 2 inches square with a 13/16 inch hole in the center. Another piece 1¼ inches by 6 inches, is bent into a block "U" shape and soldered to the 2x2 plate to form the sides and bottom of the box. A ⅜x40 nut should

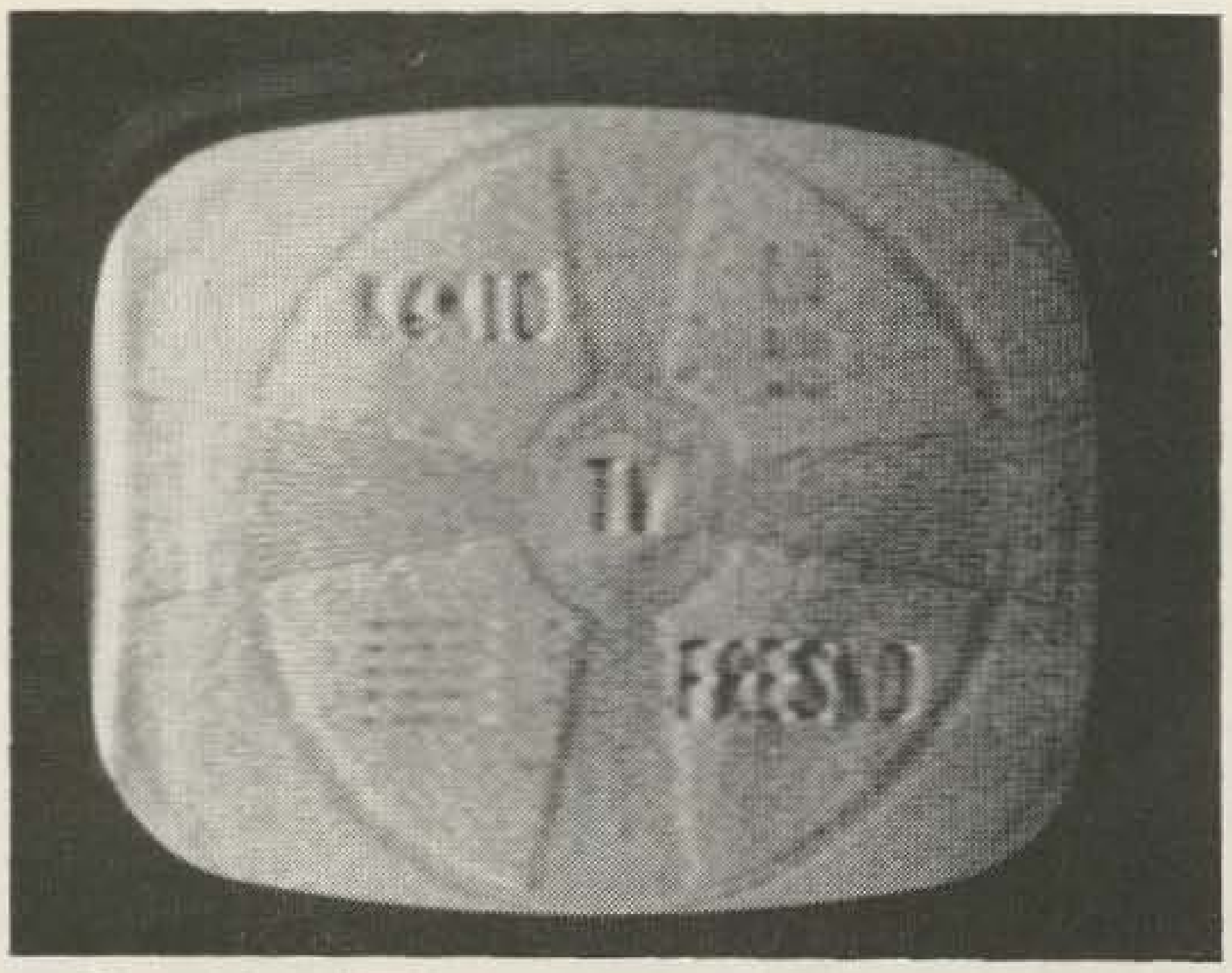


Photo 4—ATV picture without preamp.

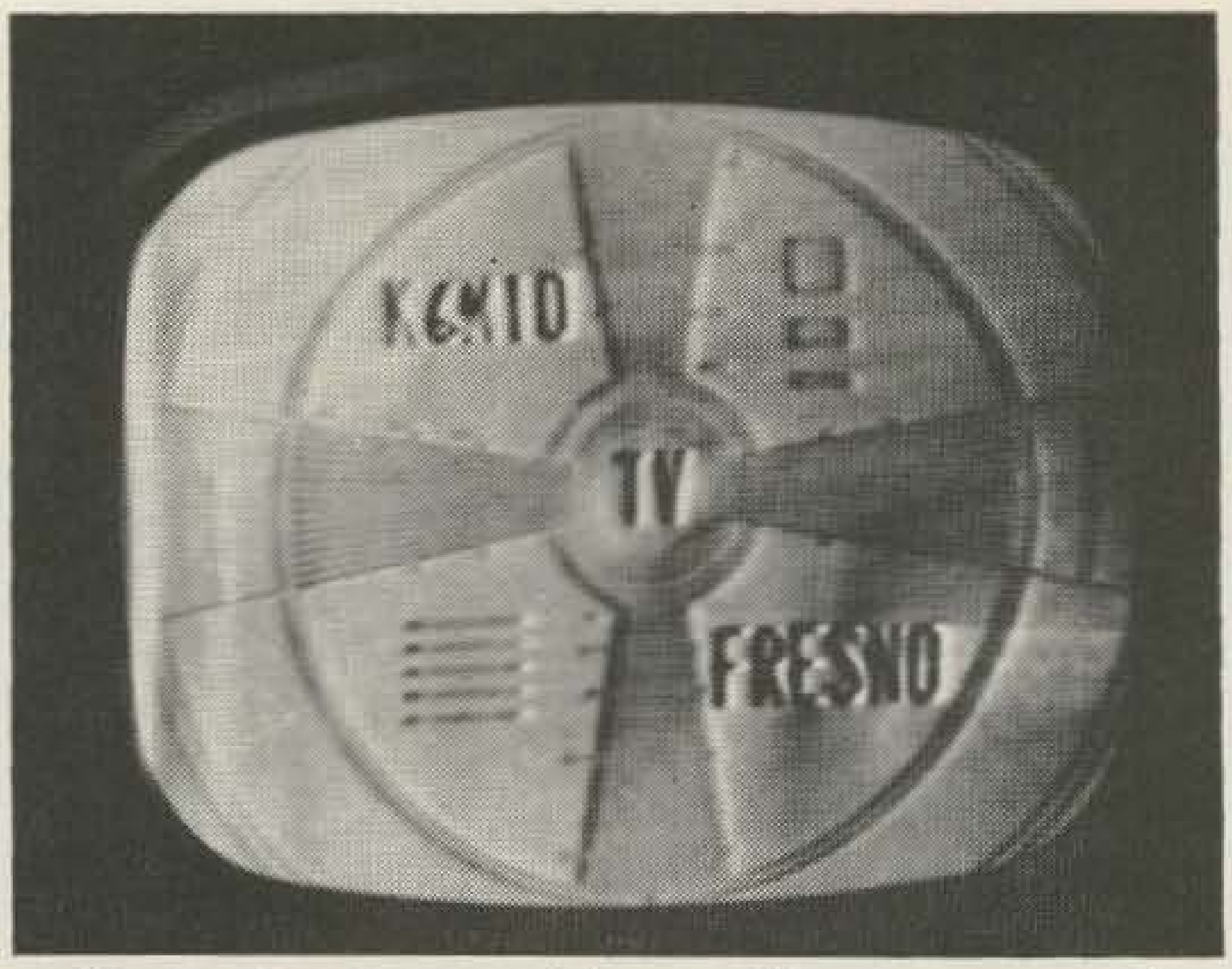


Photo 5—Same picture with preamp—all other conditions unchanged.

then be soldered to the bottom plate over the large hole in the center.

The cathode line itself is a 1-inch piece of copper shim from the bottom of the box to the top (or to the bottom, depending on which way you look at it) of the rf cathode ring. The top end of the line is soldered to a clamp made by forming a strip of copper shim around the tube and using a screw to "cinch" it up.

The input BNC connector is mounted near the top of the side of the box and taps directly into the cathode line very near the tube. A small 5 mmfd piston type trimmer is also tapped at this point and is used to tune the cathode line.

Final Assembly

A hole was drilled in the line end of the chassis to clear the head of the plate tuning screw.

The cathode box is bolted in place and likewise the plate line.

The base pin connections can be made in several ways. First of all, a "trans amp" cavity (more on this later) will provide a socket similar to the one shown in the photographs. If such is not available, connections can be made either by using pins from a broken miniature tube socket or cautiously soldering the leads directly to the tube pins.

The filament chokes were made by wrapping about 15 turns of number 28 wire around 1 meg ½ watt resistors. The exact number of turns is not critical. These should be connected to the filament pins with the shortest possible leads.

Two test points were installed, one on either side of the 1K resistor in the power supply. A voltmeter between these points will read one volt per milliamp of plate current and from one point to ground will read plate voltage.

[2] Frank Jones, VHF For The Radio Amateur, p. 140.

Tune Up

The 416B is installed, and plate and filament voltages applied to the amplifier. If nothing smokes inordinantly and the plate current is in the 7 to 11 ma range, connect the amplifier to your converter and antenna, and find a signal to tune up on.

It will be found that the input circuit is very broad and the peak achieved in tuning it is slight.

Conversely the plate line Q is quite good and the tuning is much sharper. Even so, the bandwidth seems quite sufficient to accept the better part of a double sideband TV signal 8 mc wide.

Once tuned up, the amplifier seems to need no special care. It has run many hours with 150 vdc on the plate at 9 ma with no apparent ill effects.

Results

The amplifier exhibited a gain of 15 to 17 db with each of three "reject" tubes tried. A new tube would undoubtedly provide more gain, but 15 db should be sufficient to override all but the noisiest of converters.

Stability was excellent, with not the slightest trace of instability in evidence.

Noise figure measurements are rather difficult to make accurately, particularly under

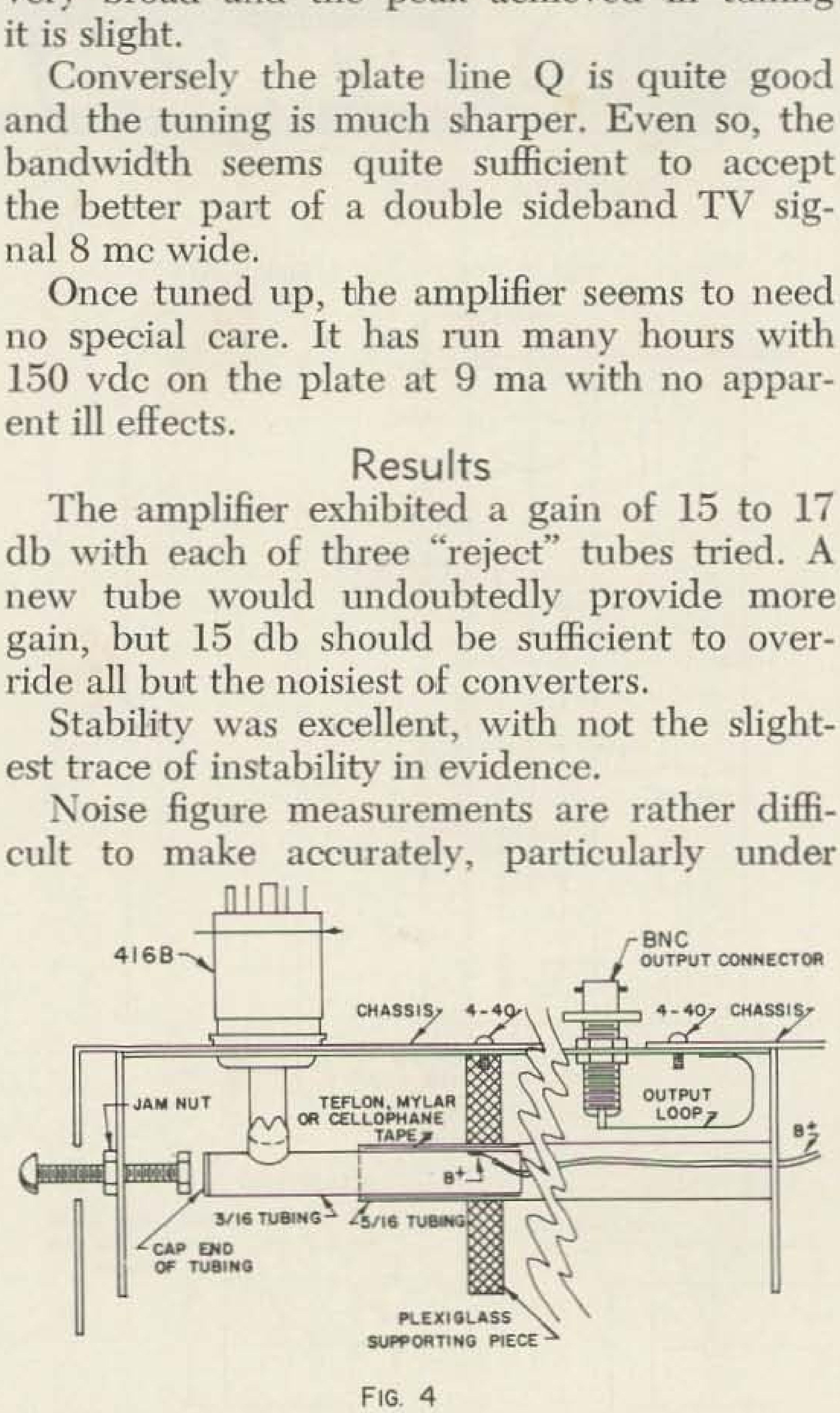


FIG. 4

Fig. 4—Mechanical details of the plate line.

There is just no better way of getting started in VHF than with the newest of the new in the Clegg line — the 22'er two meter transceiver. This ready-to-go station combines many of the fine features that have made the Clegg name famous in VHF ham circles for years plus refinements to make 2 meter AM phone operation more interesting and challenging. It is realistically priced — your distributor will have complete information.

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RECEIVER

1. Triple conversion
2. Crystal lattice filter providing selectivity of about 10 KC at 6 db and less than 16 KC at 50 db
3. Freedom from spurious response, IF leak through and images
4. Panel Meter doubles as calibrated S Meter on receiver and "relative output" meter for transmitter tune up
5. Full 143.8 MC to 148.2 MC coverage with calibrated tuning dial
6. Squelch
7. Excellent AGC performance
8. NUVISTOR RF stage and low noise first mixer provides .25 μv sensitivity (6 db S + N to N)
9. 3 watts audio output available with self contained high efficiency speaker for operation in high ambient noise associated with mobile operation
10. Effective Automatic NOISE LIMITER

TRANSMITTER

1. Broadband exciter stages to simplify rapid QSY
2. High efficiency straight through final amplifier with crystal controlled 18 WATT input
3. High level plate and screen modulation for typical Clegg "HIGH TALK POWER" performance
4. PUSH TO TALK with provisions to switch external LINEAR and VFO
5. TRANSMITTER frequency SPOTTING SWITCH
6. Self contained universal solid state power supply for 115 volts AC and 12 volts DC
7. Tube line-up

6CW4	RF Amplifier	6AQ5	Rcvr Audio/ Xmtr Modulator
6KE8	Tripler/1st Mixer	6AQ5	Transmitter Modulator
6EJ7	2nd Mixer		
6BA6	10.7mc IF Amplifier	6KE8	VLO/Buffer
		6KE8	Osc/Tripler
6BE6	3rd Mixer	12BY7	72mc Amplifier
6BA6	456kc Amplifier	12BY7	Doubler
6AL5	Diode Detector/ Noise Limiter	2E26	Xmtr Final Amplifier
12AX7	AF Amplifier		

Squires - Sanders, Inc.

Martinsville Road (Liberty Corner), Millington, New Jersey

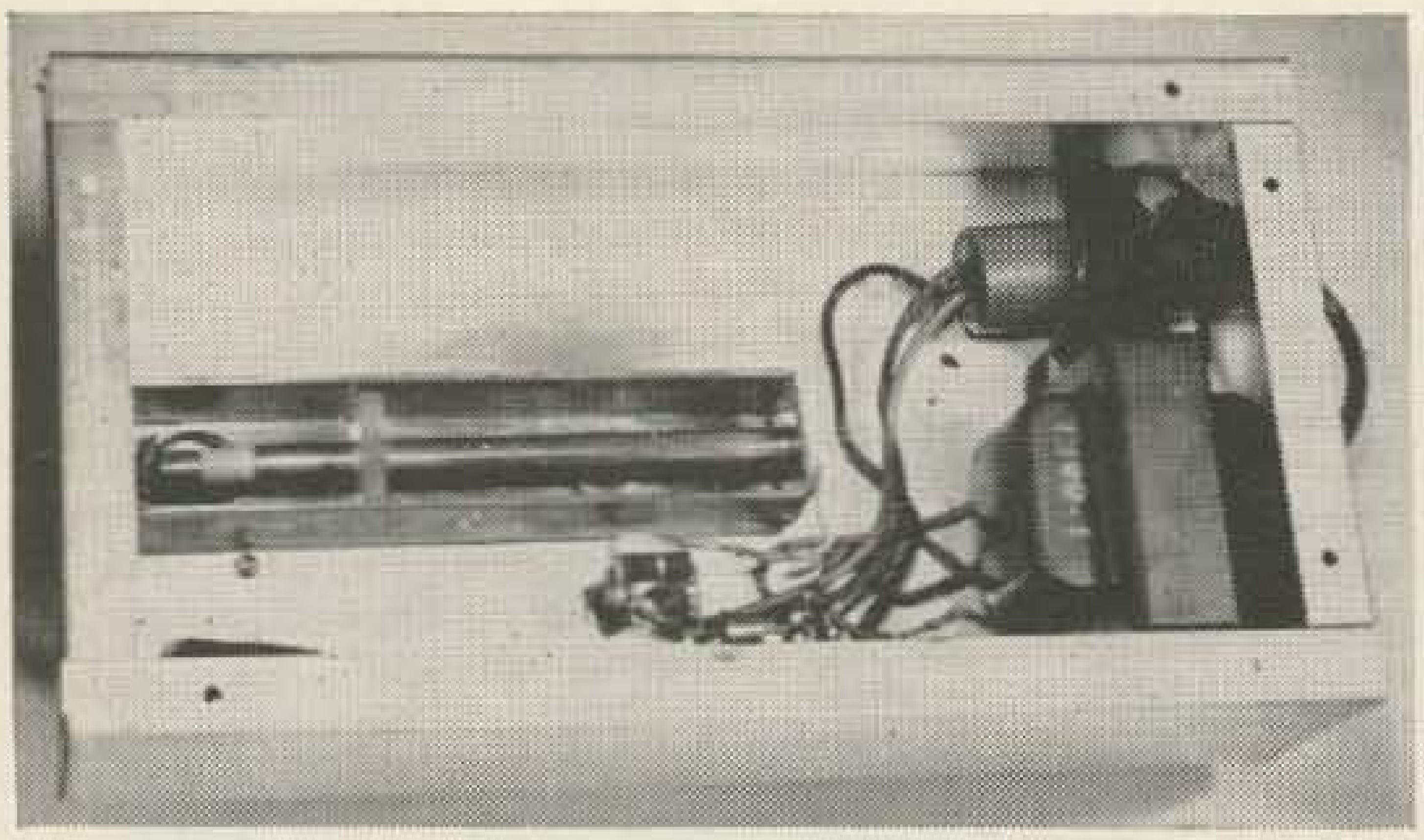


Photo 2—Bottom view of the amplifier showing the plate line and power supply.

any but laboratory conditions. But indications are that the preamp will perform in the 4 db or less region easily. Such noise figures will provide a dramatic difference in most converters. The "before and after" photos of the ATV picture pretty much speak for themselves. The converter used in the pictures was a 1N82 crystal set with a 417A *if* amplifier.

Comments

One problem encountered in a project of this sort is that, outside of the power supply components, most of the parts and materials are not exactly "over the counter items" at most parts houses. However, most are readily obtained with a little digging.

The various sizes of brass tubing are stock items in most hobby shops. The brass sheet stock can be picked up at almost any sheet metal shop.

The ¾ x 40 nut so nonchalantly mentioned earlier is a bit tougher nut to crack (ugh!). Apparently such nuts exist, though they have defied my persistent efforts to locate a quantity source. If you encounter similar difficulty there are several ways to circumvent this problem.

As previously mentioned, 416Bs are commonly used in telephone microwave gear. The various multiplier, mixer, and "trans amp" cavities in which they are used may be butchered to provide a plate with the appropriate thread.

Canvassing of the local machine shops revealed a couple who were willing to machine the thread in a piece of 3/32 or so sheet stock with a lathe. The price quoted was about $3.00.

The jam nut used on the 10-32 screw-tuning capacitor was made by drilling out and taping a piece of the teflon dielectric used in teflon insulated coax.

The teflon tape was also obtained from teflon coax. It is used as a protective wrap between the outer conductor and the outer jacket.

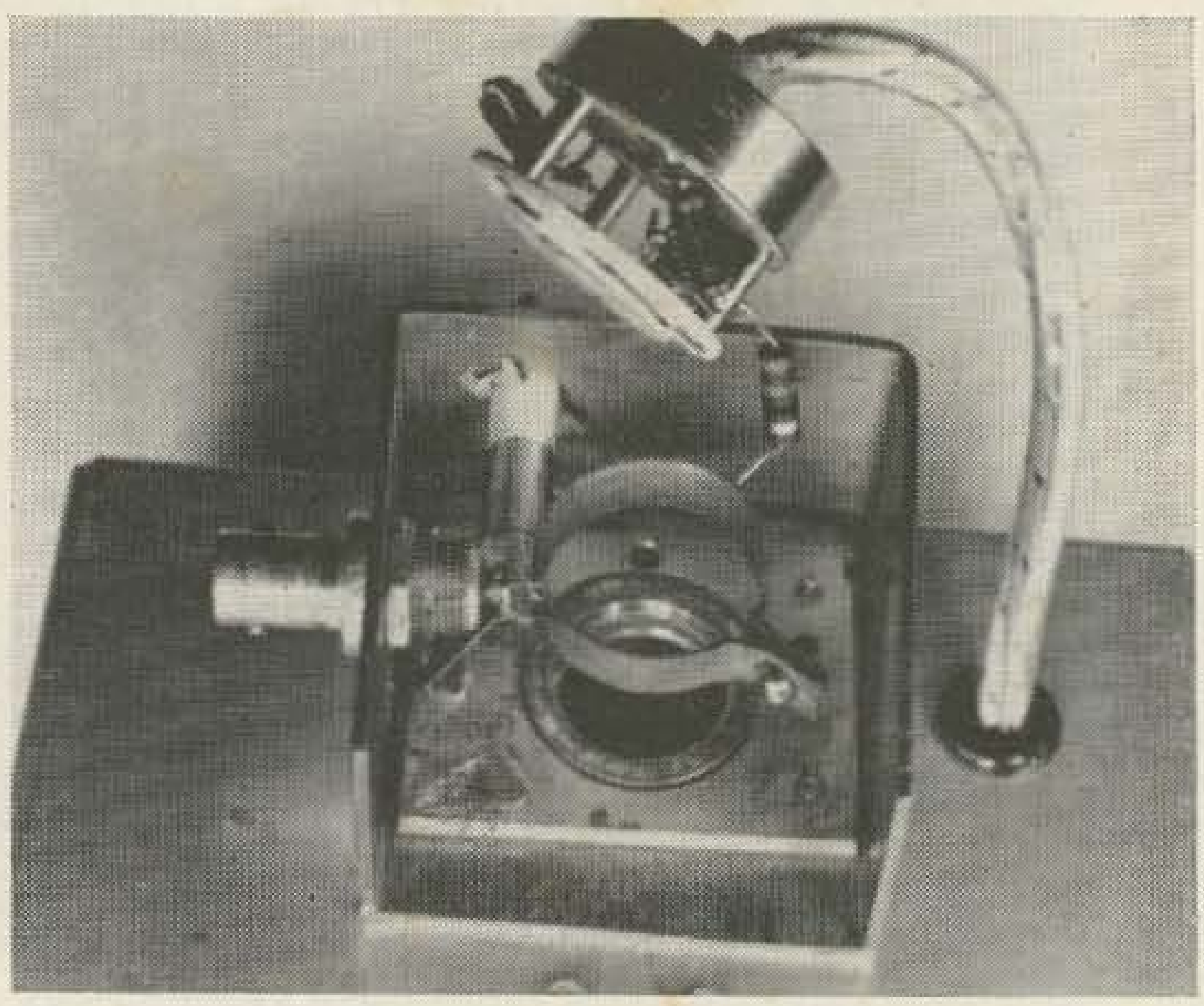


Photo 3—Close up of the cathode box, with tube removed, details of input circuit.

The 416Bs themselves have turned up on the surplus market, but even so are rather expensive. 416Bs (and 416As which may also be used) that have been removed from 3 kmc service often work quite well at 432 mc and it has been my experience that such tubes can be located with a little prudent snooping—generally at no cost at all.

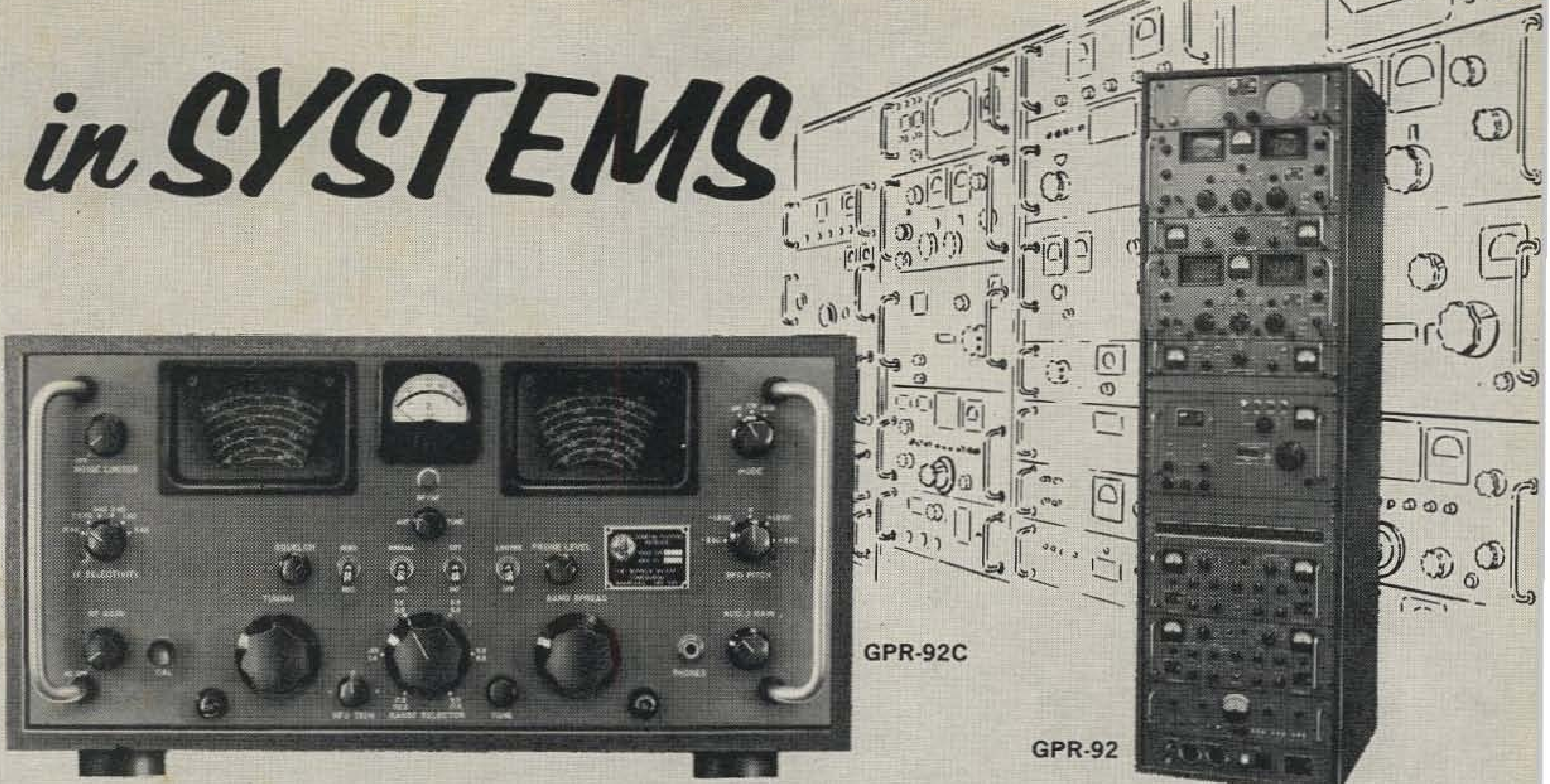
Most serious UHFers, whether AM, CW, SSB, RTTY or TV, will find this preamp more than worth the time, smashed thumbs, burned fingers and minimal financial outlay required.

Many thanks to Joe WA6CQL whose assistance was invaluable in the preparation of this article.

NOTE: You can improve the noise figure by at least a db by increasing the plate voltage to 250 and running a blower on the tube. This results in higher gain, lower noise, and short tube life.

. . . K6MIO

in SYSTEMS



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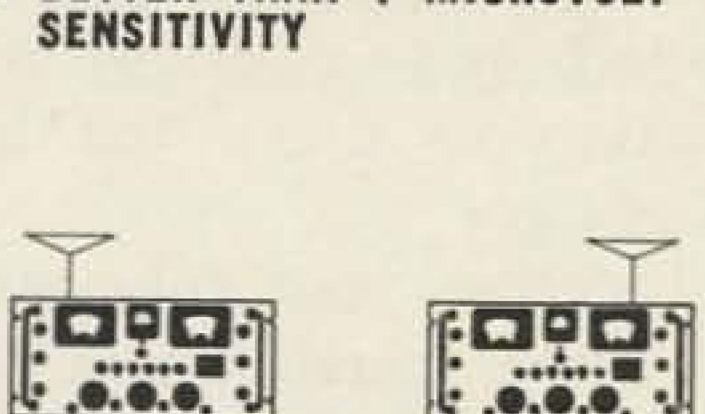
- BETTER THAN 1 MICROVOLT SENSITIVITY

MODEL GPR-92 ()



TRX-1

Selectable IF bandpass up to 15 kc as well as front panel selection of a product detector or a conventional detector allows reception of the above modes. (Adapters required for processing of ISB, FSK and FAX signals.)

Built-in buffer amplifiers permit control of the oscillators in a pair of these receivers from Model TRX-1 stabilized crystal oscillator to provide high stability diversity reception.

This general purpose receiver fulfills almost all of today's communication requirements from .54 to 32 mcs. Special bandspread dials offer ease in tuning on ham bands, international broadcast bands with a third optional dial for general tuning purposes.

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

The SJS Receiver

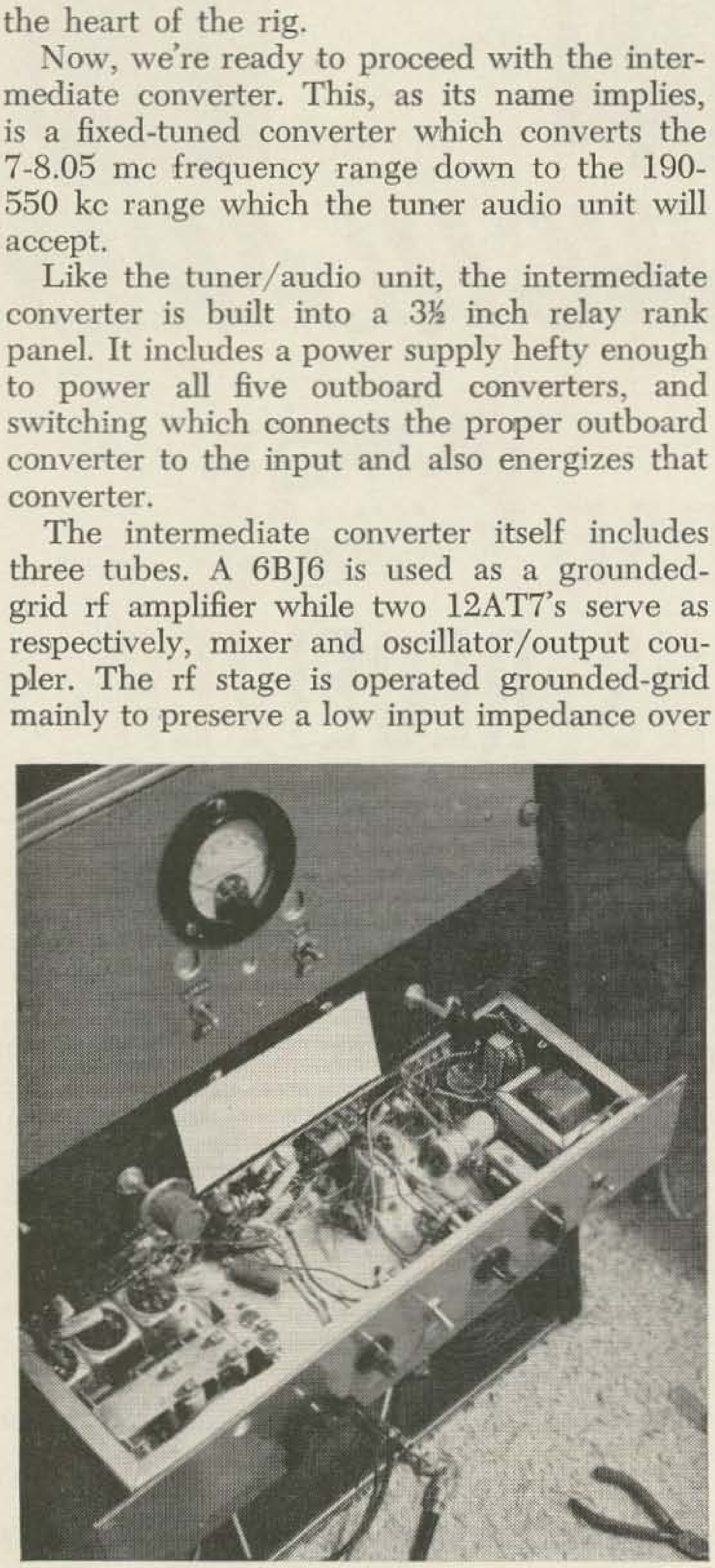
Part 2

In the preceding article, Sept. 64, page 34, I described the overall approach and configuration used in the SJS receiver, with detailed instructions on the tuner/audio unit which is the heart of the rig.

Now, we're ready to proceed with the intermediate converter. This, as its name implies, is a fixed-tuned converter which converts the 7-8.05 mc frequency range down to the 190-550 kc range which the tuner audio unit will accept.

Like the tuner/audio unit, the intermediate converter is built into a 3½ inch relay rank panel. It includes a power supply hefty enough to power all five outboard converters, and switching which connects the proper outboard converter to the input and also energizes that converter.

The intermediate converter itself includes three tubes. A 6BJ6 is used as a grounded-grid rf amplifier while two 12AT7's serve as respectively, mixer and oscillator/output coupler. The rf stage is operated grounded-grid mainly to preserve a low input impedance over



190-550 kc tuner

a wide frequency range, thus minimizing the number of tuning adjustments required.

The plate circuit of the rf stage and the grid circuit of the mixer comprise a tunable band-pass circuit which operates just like an antenna trimmer to peak the desired input signal. This circuit also rejects images, keeping the overall image ratio of the SJS at least as good as that of most commercial multi-conversion receivers.

The mixer uses the "like new" circuit described in these pages some time ago. The object was to minimize receiver noise since it was felt that listener fatigue would be minimized if receiver noise were kept as low as possible through all stages.

The oscillator is a conventional Pierce crystal circuit, with low plate voltage to minimize spurious responses. The other half of this 12AT7 was originally intended to drive an S-meter, but was used as a cathode follower to couple the mixer output to the line to the tuner/audio unit when this line appeared to be contributing some birdies because of high impedence pickup. The lack of an S-meter has never hurt operation in the six months this receiver has been in use!

The circuit is extremely straightforward, with the possible exception of the band-pass coupler. Fig. 1 shows all wiring except the filament line. All filaments are connected in parallel, with one side grounded and a single wire running along the chassis to make the bus.

Ready to build it? Let's go!

Start by gathering together your tube sockets, tools, and a $5 \times 3 \times 17$ inch chassis. If you use the same type of transformer I did, you can follow the layout (Fig. 2 and 3) exactly; if you raid the junkbox for a suitable unit, position it in the same area and find your own mounting hole positions. Then drill and punch all other holes, and de-burr them.

Second step is to mount all tube sockets, the transformer, and the converter-power-output sockets. I used single-hole mounting phono jacks for the rf input and output connections, but you can use anything you like which will fit into the space. Whatever you use, they should be mounted at this stage also.

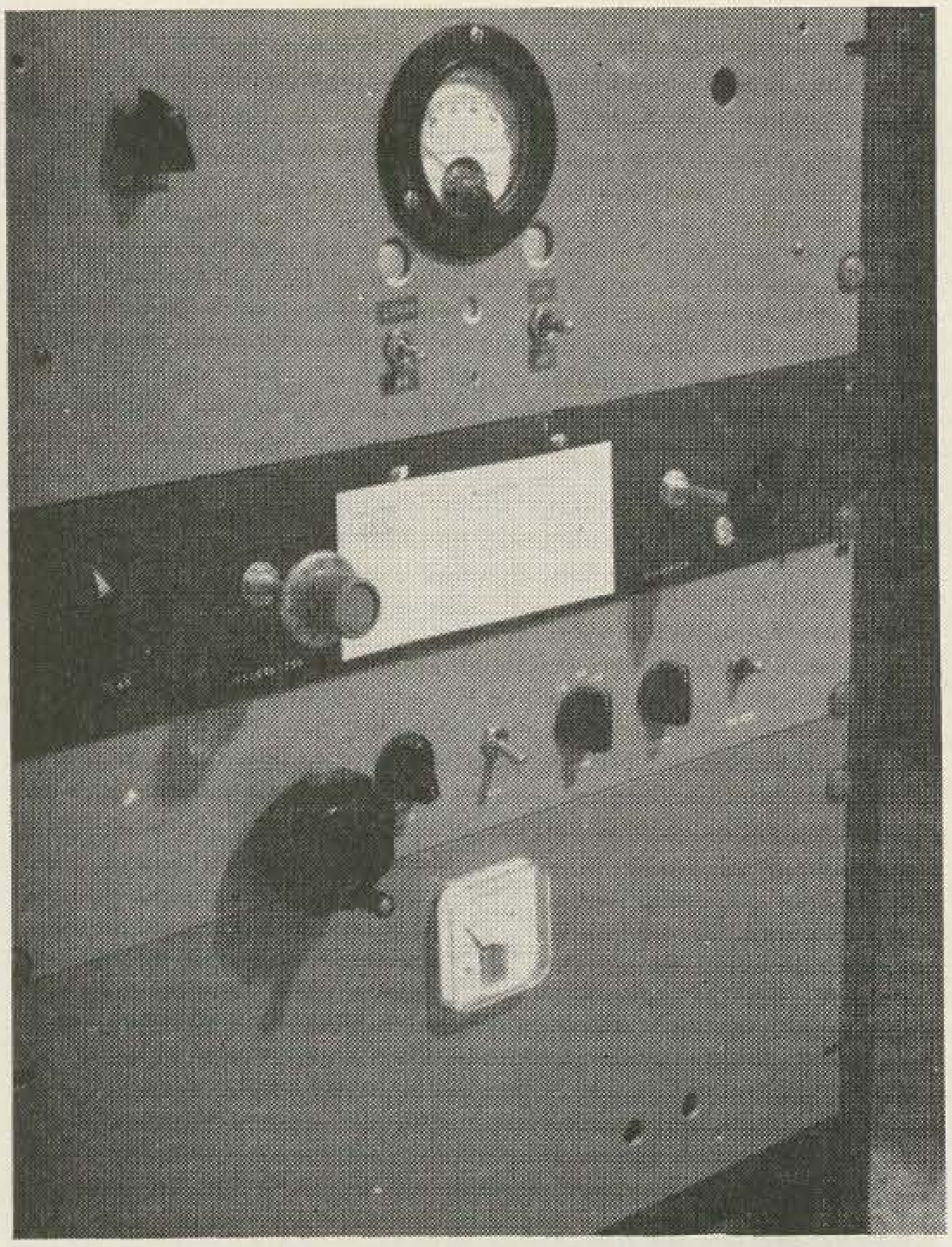
Now wire the filament lines and the power-supply circuits. Temporarily mount the power switch and the pilot bulb on the front side of the chassis while connecting them into the wiring. When this much of the wiring is complete, plug in all tubes except the 5Y3 and see if they light when power is applied. Turn off power, measure resistance from the 5Y3 filament to ground, and if it is not less than 45,000 ohms (total value of the bleeder resistors) after the initial charging surge through the filter capacitors, plug in the 5Y3 and re-apply power. Measure power supply output voltage at the top of the bleeder; it should be between 250 and 300 volts without additional loading. Plug in the OA2 regulator tube and measure voltage at the junction of the two 20K resistors in the bleeder string; it should be 75.

At this point remove power, wait a few minutes to let the capacitors discharge, and take out the tubes so they won't be damaged. Now, wire the power-distribution circuits, and all connections to the tube sockets (make the tube-socket end of the connections to the band-pass tuner and the bandswitch by using short chunks of solid hookup wire. You won't have much room to make the connections after installing the switches and capacitors!).

Next step is to pre-wire the band-pass coupler. I used a small surplus dual 35 mmfd variable made by Cardwell, with 270 mmfd silver micas padding each section for band-spread. However, you can eliminate the four extra padders by using a larger variable (say about 100 mmfd per section) if you can find one in your junkbox which can squeeze into the space. In this case, you would want the padders to be about 220 mmfd instead of 270. Total capacitance required to hit 7.0 mc with the specified coil is about 330 mmfd, not counting the strays.

The coils of the band-pass coupler are made from a single length of 5/8 inch diameter, 16-turns-per-inch prewound stock (Airdux 516). Six turns are removed in the middle of the piece, and turns are removed from each end to leave 14 turns on each coil. The six turns removed space the coils properly for about a 100 kc band-pass, thus minimizing the need to repeak the circuit when tuning over a limited range.

Since the quarters are a bit tight for wiring the whole coupler inside the chassis, I pre-wired the fixed padder capacitors and the coil set to the variable capacitor. The outside ends of the two coils go to the stator plates of the capacitor. The inside end of the rear coil goes

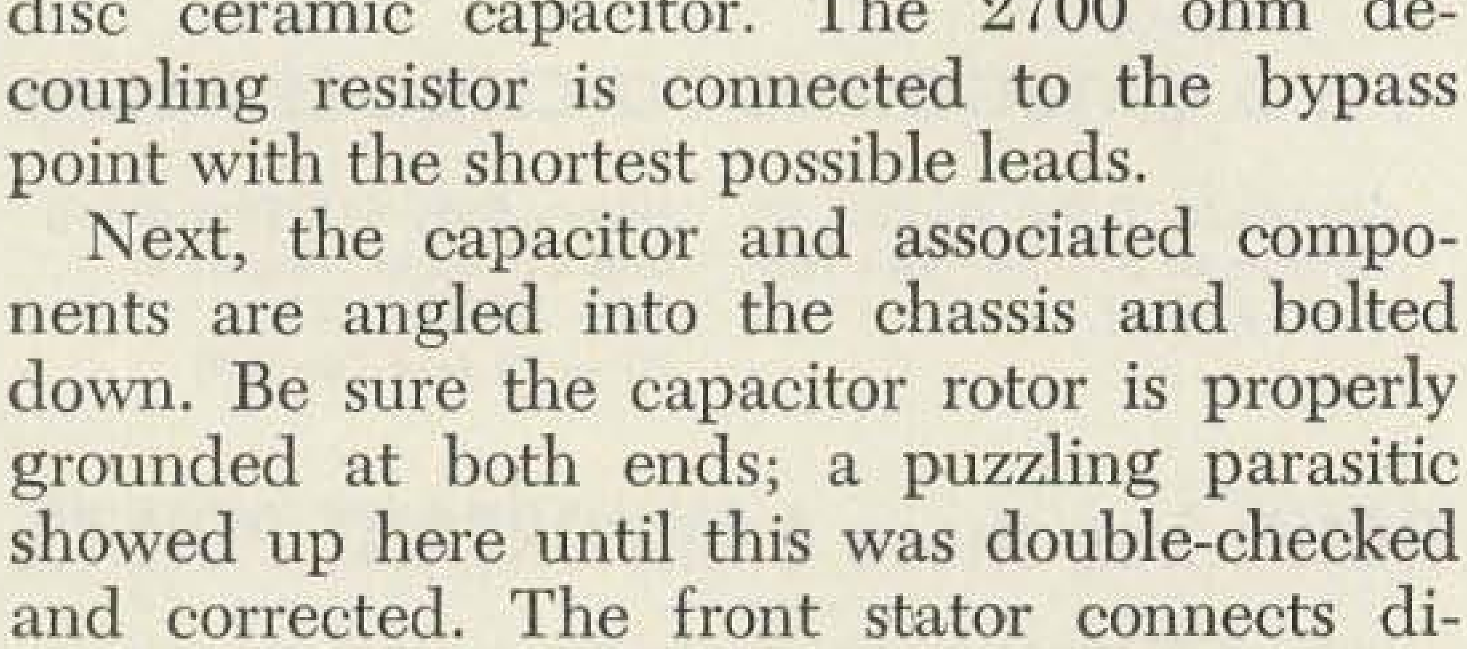


directly to ground, while the adjacent end of the front coil is bypassed with a .001 mfd disc ceramic capacitor. The 2700 ohm decoupling resistor is connected to the bypass point with the shortest possible leads.

Next, the capacitor and associated components are angled into the chassis and bolted down. Be sure the capacitor rotor is properly grounded at both ends; a puzzling parasitic showed up here until this was double-checked and corrected. The front stator connects directly to the plate (pin 5) of the 6BJ6, while the rear stator connects to pin 7 (signal grid) of the 12AT7 mixer.

If you are using the switched padders shown on the schematic, run direct leads from the two stators to appropriate wiper contacts on the bandswitch (which must be mounted for this). If you use a wide-range variable and eliminate these padders, the bandswitch need not be mounted yet.

Connect a coax cable from the cathode capacitor's free end (at the 6BJ6) to the converter switch arm. This cable should be dressed around the inside of the chassis and should be grounded at each end to prevent any stray pickup. Now cut a set of coax cables to reach from the appropriate switch points to the corresponding "input" connectors on the back panel, connect them, and solder to the converter switch. Again, ground the shields at each end. While you're at it, run the leads from the 150 volt and 250 volt sources to the wipers of the converter switch, and from the corresponding switch points to the appropriate converter power jacks at the rear. The converter filament wiring should be checked also, to make sure it wasn't overlooked when the other filament lines were run.



7000-8050 KC converter

You'll notice that no crystal sockets are shown. To minimize space requirements, I soldered short leads to the pins of the three oscillator crystals and connected them directly to the proper switch points on the bandswitch. If this bothers you, you can make up small metal brackets to hold crystal sockets. In either event, connect the 6800 kc rock so that it is in the circuit on position 1, the 7150 kc crystal for position 2, and the 7500 kc one for position 3—and the bandswitch wiring is complete. Double-check to make certain you haven't omitted any connections, and fire up.

With the tubes drawing current, voltage at the mid-point of the bleeder resistor should drop to approximately 50, with 150 still present at the top of the VR tube.

Alignment is simplicity itself. Set the bandswitch to position 1 and connect the intermediate converter's output to a tuner capable of reaching 200 kc (such as the tuner half of the SJS). Feed in a 7 mc signal. You may have to tune around a bit to find it since the 6800 kc crystal may not be on *exactly* 6800 kc. (my unit was approximately 9 kc low). When you have the signal located, turn the peaking control fully counter-clockwise and adjust the appropriate switched padder capacitors for a peak.

Now change the input signal frequency to 7350 kc and the bandswitch to position 2. Adjust the other pair of switched padders for a peak.

Finally, raise the input signal to 7700 kc and turn the bandswitch to position 3. See if you can peak the signal with the peaking control near the full counter-clockwise position. If you can, alignment is finished.

If you are using the bigger-capacitor, no-switched-padders approach, simply make sure you can reach a peak on a 7 mc signal near full counter-clockwise and on an 8.05 mc signal near minimum capacity. If you can't cover the whole range, you need to use a smaller fixed padder and remove a turn or two from the *hot* (outside) end of each coil; if range is excessive, you can add fixed padding capacitance until 7 mc is at the full-capacity position of the variable.

Since the input impedance of this converter is approximately 100 ohms, don't expect it to perform well on 7 mc without an outboard rf amplifier unless you feed it with a carefully matched, resonant antenna. However, it shows moderate performance when fed with a random length of wire! With any type of matching device at all ahead of it, performance is excellent.

And in the role for which it was designed—matching a VHF converter to the low-frequency tunable *if* strip, its performance is nothing short of sensational.

A word on operating procedure to minimize images. Since the band-pass coupler provides the *only* 7 mc selectivity, and the image frequencies range from 400 to 1100 kc below the desired frequencies, you may occasionally find one. However, if you calibrate the peaking control (or even keep in mind what its approximate position should be for a given signal frequency), you can readily determine whether the signal you are getting is a true signal or an image. I find, for instance, that with the tuner set for an incoming signal at 7200 kc but with the peaking control on the intermediate converter set around 7 mc, I can easily copy a shipboard CW station operating somewhere around 6400 kc. However, when the peaking control is swung up into the proper position for 7200 kc, not a whisper of the shipboard station comes through.

You may also, on occasion, run into a secondary image from strong signals 170 kc higher than the frequency you desire. This is an image problem in the tuner—but again, the peaking control can wipe it out. I frequently copy some of the local kilowatts (operating on 50.-250 mc) at an apparent frequency of 50.080. To do this, I must have the peaking control set at about 7.250 mc so that the full signal hits the tuner. If I move the peaking down to 7080 kc, the image goes away.

So there you have it—the Surplus and Junkbox Special. It's no "ultimate" receiver by any means — I've been doodling designs for another one since before this one was built. However, as I said to start with, it's inexpensive and it does perform well. For more than six months it's been the sole receiver at K5JKX, and in that time (with good converters ahead of it) has never failed to copy any signal audible on similar antenna systems in this vicinity! More than that, I can't ask—especially when the cost is next to nothing! . . . K5JKX

Sideband on 2M
The P + H 2-150

Glenn Camp K6LOP
10360 San Antonio Ave.
South Gate, Calif.

The introduction of VHF SSB has created new interest in the bands above 30 mc. It's all too easy to get up there and quack with the best of them if you have a low frequency transmitter or transceiver. Even if you don't, a trip to the local ham store will show tables full of the older SSB gear at a fraction of their new cost. Having a Gonset GSB-100 I decided to take one step forward. Being intrinsically lazy I always look to commercial gear.

The P&H 2-150 is essentially a linear mixing device followed by a linear rf amplifier; mixing from 20 meters for a signal in the 2 meter VHF band. All of the features of your 20 meter gear may be had at 2 meters: crystal or VFO control, VOX or PTT, AM CW USB LSB, with similar stability. Two meter frequency coverage will be the same as the 20 meter exciter without changing mixing crystals. More on this later.

A 6EA8 is used as a high stability oscillator and tripler, and will operate on any frequency from 130.0 mc to 133.5 mc. This will permit operation in any segment of the 2 meter band. My unit was supplied with a 43.333 mc crystal (X3 = 130 mc) for operation from 144.0 to 144.6 (with GSB-100). I changed this to 43.666 mc and realigned the unit to 145 mc as most of the SSB stations are above 145 mc in this part of the country, operating upper SB.

The oscillator signal is available at an RCA phono jack on the rear of the chassis permitting the same oscillator to be used for a receiving converter. The design is thus simplified and you have correct correlation between transmitter and receiver calibration. This is quite valuable when using a transceiver.

The 130 mc signal is link coupled to the push-pull grids of a 6360 balanced mixer stage. By adjusting the injection and grid bias, compensation is made for small variations in exciter output.

Exciters with outputs of 5 to 25 watts will drive the unit to full power. A switchable (in or out) internal Pi-section pad is used to attenuate the signal from the popular 100 watt class exciters. Also supplied is a large 3 db pad for AM operation and to correct for large differences in power levels.

Due to passive-screen single-ended injection, no tuning of the 20 meter input is required and superior mixing product attenuation is more easily obtained.

Following the 6360 mixer is a second 6360 used as a class A buffer amplifier. Mutual coupling between the buffer input and output circuits is minimized by shielding and isolation. The buffer plate circuit is overcoupled for further simplicity of operation, to the 7854 grid circuit. This tube operates class AB-1 as the final amplifier with efficiency up to 60%. The 7854 is an Amperex twin tetrode, designed for linear amplifier service at VHF frequencies. The high level rf amplifier circuit is completely shielded within the 15″ wide × 9″ high × 11½″ deep cabinet, with a cooling fan for the tube envelope and push-pull plate tank circuit.

The rf output passes through a harmonic filter to the antenna connector. It is sampled, detected, and filtered for relative rf output readings used in tune-up. Switchable metering is provided for the PA grid current, PA plate current and relative output. The meter scale is calibrated accordingly.

The built-in power supply provides all voltages for converter operation. Separate high voltage, low voltage, and bias supply; all are separately filtered. The PA screen voltage and oscillator voltage is regulated. The mixer and PA bias voltages are variable by pots at the rear of the chassis. Also at the rear of the chassis is a terminal strip for PA cutoff bias which is shorted on transmit. This must be open on receive because the diode noise, generated by the electron flow through the 7854 under the static current conditions of 50 ma, can be heard in the receiver. I used the external switch of a coax relay with a SPST switch in parallel for spotting with the exciter. The parallel switch is not necessary if you are tuning 14 mc on the receiver.

Tuning and loading is the same as for any class AB-1 linear amplifier used on the low frequency bands. It should be operated into a load with a low of SWR as possible. Retuning of the converter is normally not necessary unless large frequency excursions are made.

Input and output impedance is 50 to 70 ohms. Plate power input to the final amplifier is 175 watts PEP SSB, 165 watts CW, and 90 watts linear AM.

Construction is heavy duty throughout. Liberal use of inter-stage shielding below chassis, and better than average wiring technique is employed. The chassis is copper plated steel. All parts are arranged to minimize any difficulty in trouble shooting, should the need arise. After long hours of operating, the cabinet is only a few degrees above ambient due to the 200 cu ft/per min. of air flow from the cooling fan.

At first glance the instruction manual looks a little thin. True, it is not artistic, but it does contain the theory of operation, interconnection diagrams for high and low power transmitters and transceivers, alignment instructions, mixing frequency crystal chart, and installation and operation instructions. It should pose no problem to those familiar with SSB gear and linear amplifiers.

Also available is the model 6-150 for 6 meters. It is essentially the same as the 2 meter model but has a different tube line-up.

By now you are probably saying "OK so the thing works, why do I need SSB to work my buddy Joe across town?" The answer is that you don't, if you are only interested in working Joe across town, but if you like to try something new, make new friends and still keep the old ones on AM, give this a try. All of the advantages of SSB at the lower frequencies are there. I have increased my range many times over my old 65 watt AM rig, using the same antenna (8 element yagi) and receiver. True, SSB contacts are rather far apart, but when you do make one most of the time they turn into round-tables. With modern VOX this is just the thing for a DX rag-chew. Can you remember the days when you were one of a handful of SSB stations, operating an all AM band, and the good discussions?

. . . K6LOP

The 432'er

Transmitter RF Section

Bill Hoisington K1CLL
83 Bellevue Ave.
Melrose, Mass.

Philosophy

If you are only interested in construction, skip these paragraphs. But I assure you, there's plenty of meat here for anyone seriously interested in the amateur UHF art. Or perhaps it should be the art of being a UHF amateur?

The name "432'er" has several implications. The famous "TWO'ER"—low cost, running about a watt or so out, with an SR receiver—has provided me with lots of contacts. Not *my* Two'er though. I never had one. Being a confirmed 2 meter man since 1946, and 2½ meters before that (and 5 meters before that) I graduated up to a Johnson 6N2 years ago. But loads of Two'ers are on the air—immediately identifiable as a rule by that characteristic downward modulation. I even worked a VE1 who was using a 2'er in St. Johns, New Brunswick from here in Melrose, Mass. Elevation only 100 feet. Granted, he was using an 11 over 11 beam.

So the 432'er tends to be low cost if you build it yourself. You may only have to buy a few $1 or $2 tubes plus a few $4 2C39's, if you have a good UHF junk box. Reminds me of the two Hoboes: "If we had some eggs, we could have some ham and eggs, if we had some ham." I will try and add up a possible total. Later.

Receiver. This is working FB. *Not* a superregenerative. It's a super-het with a few $1 tubes and at least 2 frequency conversions.

Beam. A 14 element job, to start with. Nearly 20 db gain. Works great also.

Transmitter. Stop right here. This is the end of the road. Like when you are going mountain topping on a warm summer's day, 24 element Yagi folded on the car roof, Geodetic map of Newfield, Me., in your hand, and that "road" winds up in a barnyard. A real barnyard, with ducks, Geese, couple of cats, more kids, and what looks like the remains of the road wandering on up through an alder swamp. If you ask about the "road" you'll get blank stares. Putting on your more better pair of specs you note two additional items on the map. (1.) The road has become a dotted line at this point. (2) The date of the map says "Edition 1912." That's the way you feel when you try to make an *"economical," "easy to build"* transmitter for 432.

Don't look in the Handbooks unless you want to spend $20 per tube, or own a machine shop, or both. You meet sentences like these: "Any two meter rig with 10 to 20 watts output can be used for an exciter," or , "two 5894's are used, one as a tripler and one as an amplifier." $40 right there. And not any too rugged at that. What I've been after is a rig not too much bigger than a Gonset. Hopefully less dollars if store bought. One you can use mobile or mountain topping. One that you can build without that machine shop. The receiver is OK, as stated, see 73 Mag. The transmitter is based on the use of (A) 2C39 type tubes; (B) low cost series tuned trough-line cavities that you can build with tin snips and a medium size soldering iron; (C) store bought tuning capaci-

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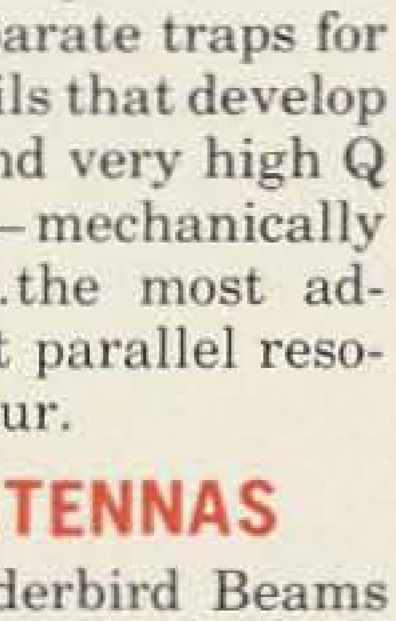


HY-GAIN ANTENNA PRODUCTS CORP.
8472 N.E. Highway 6—Lincoln, Nebraska

tors; and (D) doubling instead of tripling. The results: (?) 12 to 15 watts crystal controlled output on 432. Stable as rock and capabilities of upwards of 25 watts *output* with blower and more dc power. (And more modulator, too.) The tube is rated at 100 watts and is running now only around 35 watts with 400 volts.

We'll sneak up easy like on more power later. When I open up a mine of 2C39's.

Transmitter Tubes

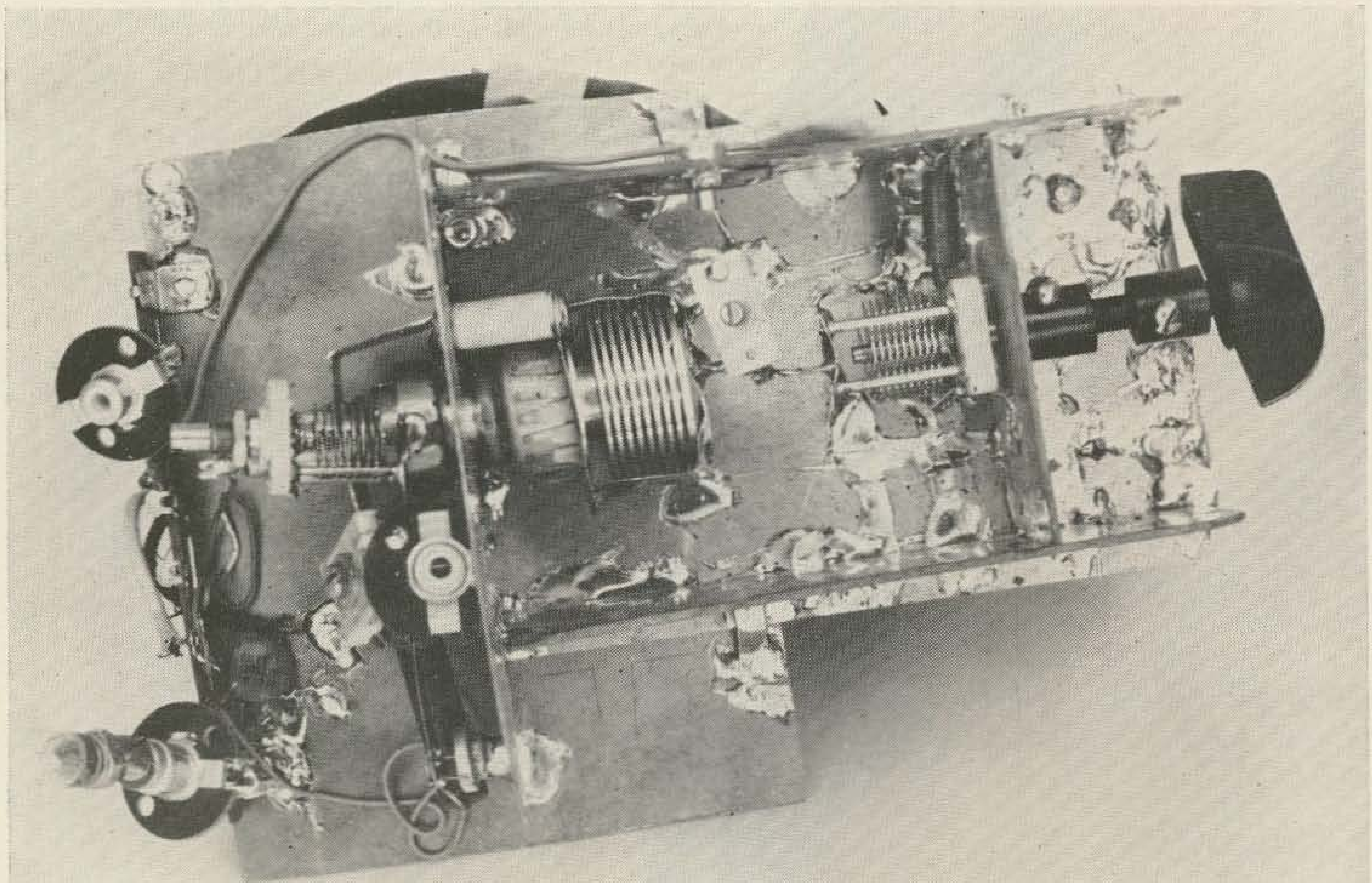
The question of what tubes to use is of course at the heart of the whole 432 deal. Not that there are large numbers to chose from. There aren't. Let's look over the few that are available. I originally considered and tried out the 6AN4. A nice clean little watt. Nothing to write home about, and no margin for increase in power. I also burned out several.

Next. The 6360. A nice delicate little bottle but not too good on 432. Lacking in reserve power for use as a doubler. Besides, it has a newer brother, the 6939, which is capable of 5 watts on 432. However, here again no power reserve at all. No possibility of graduating up to the next class of power. Not only that, but I have had several talks with different high band (UHF) mobile people who have tried this jumpy little compact on UHF and they had to give it up. Too touchy for production use. You can get one running, sure. But don't forget, this 432'er is being built and designed so that any number of junior type operators can build up on the first UHF band with a good assurance of success.

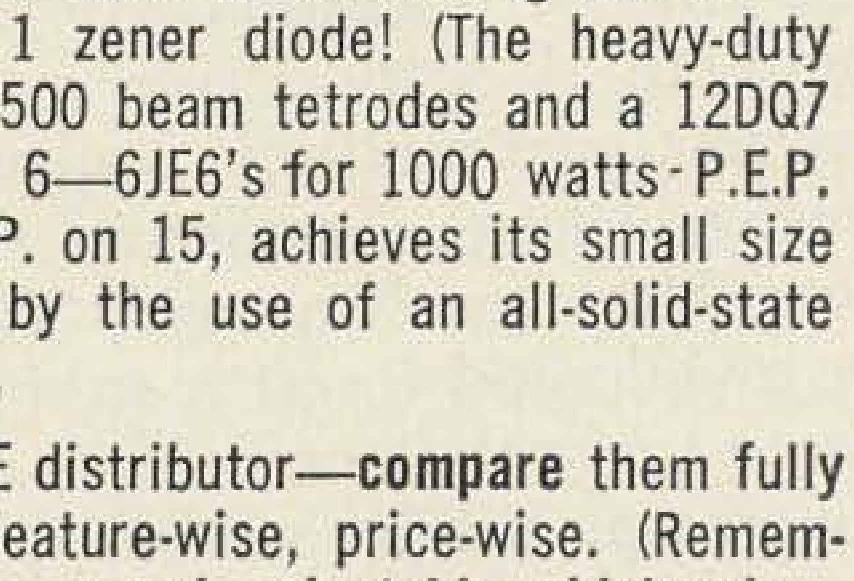
Next are the newer double pentodes, 6524, 5894, etc., the modern versions of the 815, 832, and 829. In the handbooks are a few words concerning these tubes such as: "A two meter rig such as a Gonset or similar is generally available for use as a driver." That does not suit for a rig in one box with a handle on it. These double pentodes do work and do put out on 432. So? The price: $20 or so *each*. They also must be used in push-pull, and this brings up something else. You can't double with them. Don't forget the fact that the rf is *not* referred back to the cathode. It "floats" back and forth from grid to grid, and from plate to plate. That's OK for push-pull, but not for single ended work. Also, you can't go on up to 1296 at all.

The field is getting narrower and narrower, as you can easily see. There are some beautiful ceramic planar (fancy name for disc-seal lighthouse tubes) tubes but believe me, don't even start to look up the price. If you have to *ask* the price of such tubes, you're in the wrong store!

All this leads up to the good old 2C39 type tubes. There are several versions, such as 2C39A's and B's, and even some four-number



Doubler 216-432 grounded cathode



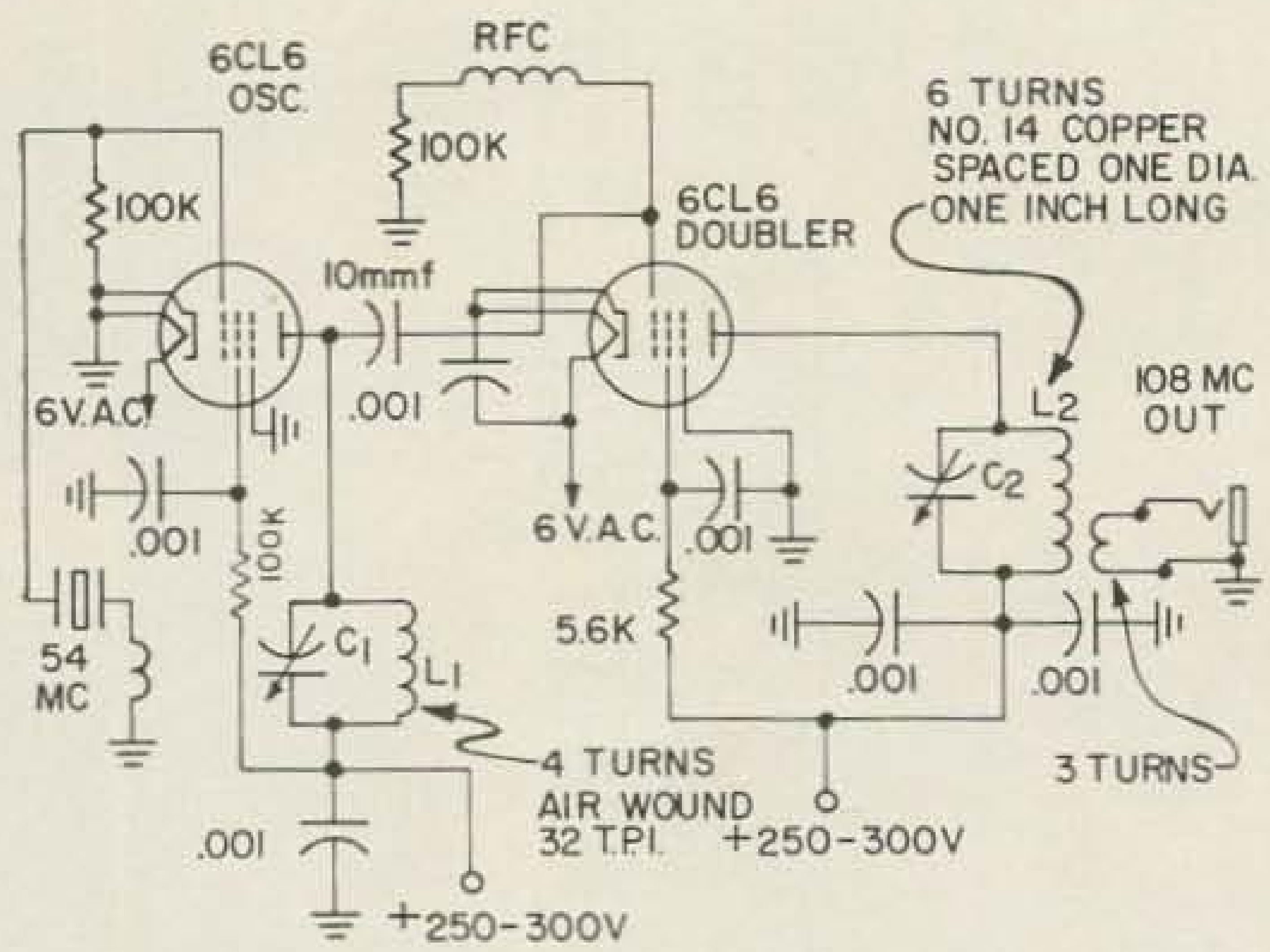


Fig. 1—Crystal oscillator and doubler
Note: ground doubler cathode.

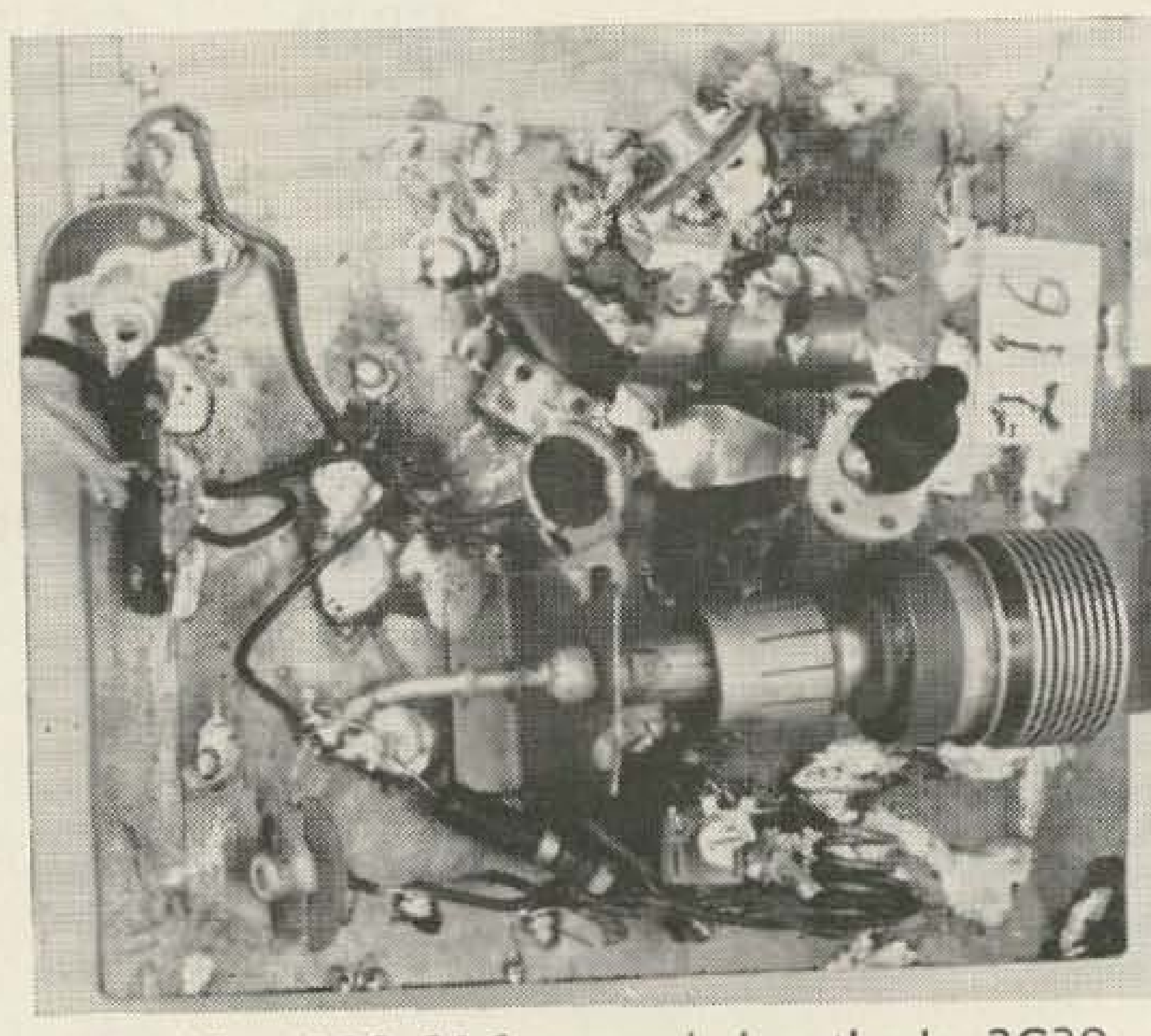
jobs, and the rugged types with WA after the numbers, and also some with real fancy handles like 3CX100A5, 3X100A11, and so on. This is natural because of the success of the original 100 watts at 2500 megacycles. Some say "full ratings at 500 mc" and some say "full ratings at 2500 mc." For 432 they're all good. And best of all, there are plenty of them surplus—both in and out of surplus sets—sometimes with cathode, grid, and plate connectors, if you're lucky. Prices I have paid have been $4 and up. In most surplus Goodie lists they are around $7. Not too bad. And that isn't all, by any means. You can operate them as grounded cathode doublers and take full advantage of their fantastic transconductance of 24,000! They have no leads on them, not even short ones. Just surfaces of good conducting metal. In grounded cathode work, power can be maintained and even increased instead of dropping down while frequency multiplying up into UHF. In some handbooks you find, "The tripler has a gain of one half." You won't get far with *that* kind of operation. As you will see in the complete rf section, we go up in rf output power as we multiply. You will notice the following in large commercial rigs, like UHF Tee Vee: They reach around 300 mc, then pause for awhile and insert a straight-through amplifier to bring the power back up again, and then go on up. While on tubes, I should mention that plenty of cathode surface emission of electrons is one of the reasons for the success of the 2C39 family. Keep in mind that Gm of 24,000.

Trough-Line, Series-Tuned, 1/4 Wave Cavities

By now I have built enough of these small signal rf amplifiers, mixers, and rf power amplifiers with different tubes, to find out that they do a fine job up to around 500 to 600 megacycles, or 432 and to spare. Using easily cut and soldered copper-clad bakelite, with perhaps one wall of thin brass where connections are made on *Both* sides and a 50 mmfd tuning capacitor, you get 20 db gain on reception, good filter action, and plenty of watts out on transmission. Reasonable size, too. 2 inches high, 3 inches wide, 4 inches deep. That's about it. This transmitter rf section appears to be a "break-through" for the amateur UHF art. Comments appreciated.

Circuit

Crystal-oscillator doubler. A 54 megacycle crystal and a 6CL6 starts the ball rolling. See Fig. 1. You can use a 27 megacycle crystal if you want to. But that takes another tube or complicates the circuit, and there's a chance for harmonics every 27 mc instead of only every 54 mc. Actually, with the link coupling used, this may not bother you at all. (Of course, it isn't *you* that would be bothered anyway!) The 6CL6 is a well known tube designed for video use, so it is a high gain medium-power pentode. Used in your present writer's phase-reversing crystal-oscillator circuit it puts out FB on 54 mc and will not put out on any other frequency. For those readers meeting this circuit for the first time, (After all, 73 Mag. *does* get new readers every month!) a crystal control functions by just that phase reversal. A mechanical pressure causes positive charges to appear on one side and negative on the other. Also, dc across the crystal causes it to shrink or expand mechanically. Ac on it will alternate such mechanical action. When the physical compression—expansion waves (which operate near the speed of sound in the crystal) bounce back and forth at sound wave resonance, the crystal has a very high Q at the corresponding electrical frequency of excitation (determined by the thickness of the crys-



Doubler 108-216 grounded cathode 2C39.

tal) and thus acts like an inductance, but *better*.

It will be noted that there is still, at any given instant, positive charges on one side and negative on the other. This phase reversal causes the oscillator circuit to be regenerative on the crystal frequency but degenerative at all others. This makes it quite fool proof, increases the power output, and starts it off with greater reliability. The next 6CL6 doubles to 108 megacycles, with the circuit designed for maximum power output. There are some new tubes around which may do better; one of these being the 6HB6 which has a transconductance of over 20,000 and a possible dissipation of ten watts. However, not having tried it yet I am not recommending it yet. The most positive and absolute lesson I have learned in some 43 years of electronic work (*Yes,* Junior, they used to call it Radio in those days!) is to not say anything about any part of electronic ideas that I have not yet tried. Once upon a time long long ago in Paris, France, I designed a type 24 tube oscillator-mixer which I did not realize was marginal in operation. In production nearly 100% of them squealed all over the BC band. Don't say I didn't warn you.

There is also a strong possibility that the good old 5763 (a "high-power video" tube famed for power frequency multiplying that is to be found in the transmitting tube section of the books rather than in the receiving sections) would put out more 108 mc rf. Here again, the 6CL6 is working FB now. Also, while I am not a fanatic on conserving power, there is no need to use up more dc than you have to. You will find that crystal control of a UHF transmitter will use *plenty* of power just in the multiplying stages.

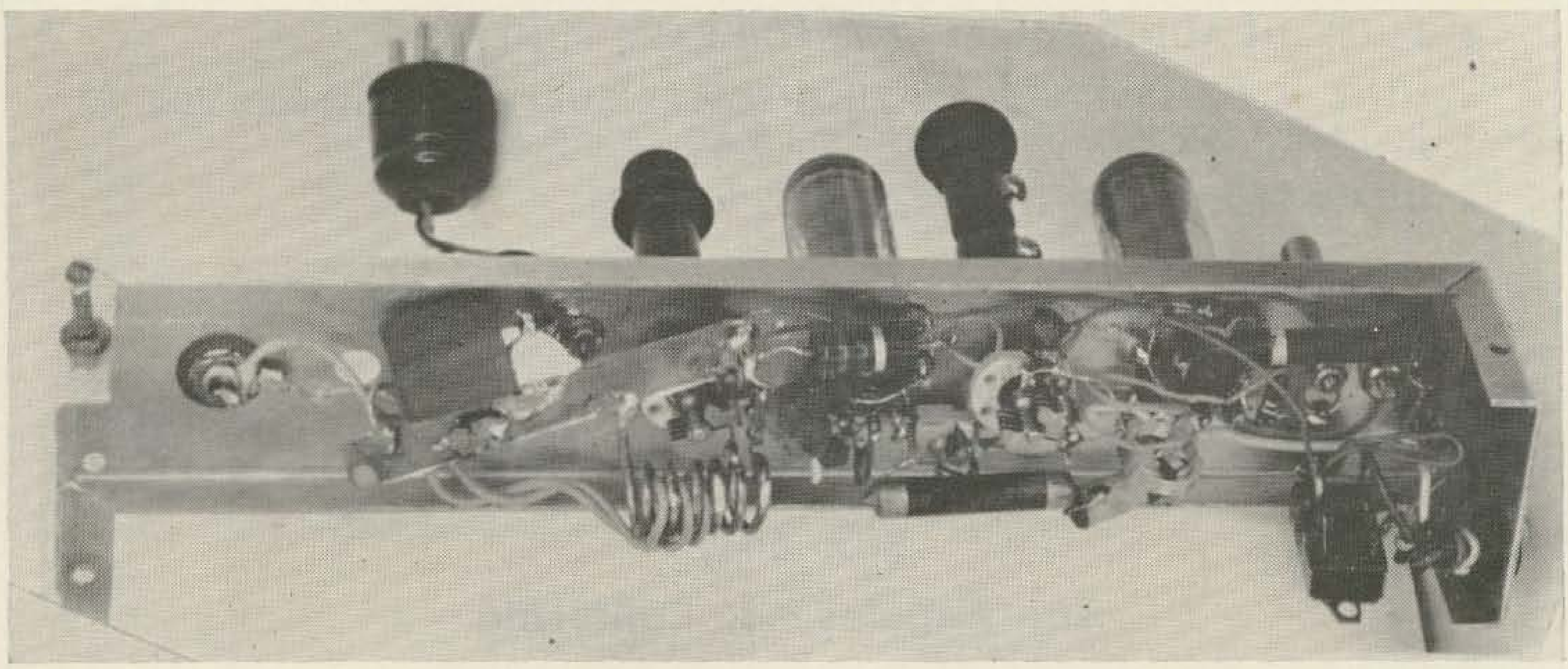
Link coupling is used on the 108 megacycle output. The rf at this point should register on a 6 watt 115 volt bulb. I just tried it again to see for sure. It lights about 1/4 to 1/3 brilliant.

108 to 216 Doubler

Good design data begins to thin out remarkably right about here. Lots of fine tubes are left in the lurch somewhere near 2 meters. Tubes which have terrific plate dip, even at triplers around 100 megacycles, and still put out something around 144, give up the ghost before reaching 216 mc. Like the 2E26, 6146, etc. The 5763 does not handle well on 216 either. Not wanting to go to the little but complex 6360 or 6939 midgets whose output is strictly limited, I installed my first 2C39 at this point, as a grounded cathode doubler. I have not regretted it since. Just a mention again that it will take 50 watts and laugh. You can just tie the B plus lead along with the 216 doubler stage and the final B plus, at the unmodulated point of course, and run it anywhere from 400 to 600 volts. Over 600 volts better use a blower.

The design philosophy calls for a compact complete station around 30 to 40 watts, without blower. For home, mobile, or mountaintopping, and field day work. With capabilities of 100 watts with blower, increased modulator power, and power supply. This last version, a "432'er Senior," would of course weigh out a little more on the scales. Perhaps not too good on a walk-up type mountain but still OK on the drive-up ones. Will be the subject of later articles.

Take a look at Fig. 2. You might say it looks easy? Simple like. Even old-fashioned? Well, that tube is from WW2. Some 20 years old, at least. They've made new ones but they all look remarkably like the old standard 2C39. The thing to remember here is that there are no leads or pins on these tubes. When you make a connection here you do it with at least



Exciter 54 mc crystal—108 mc output

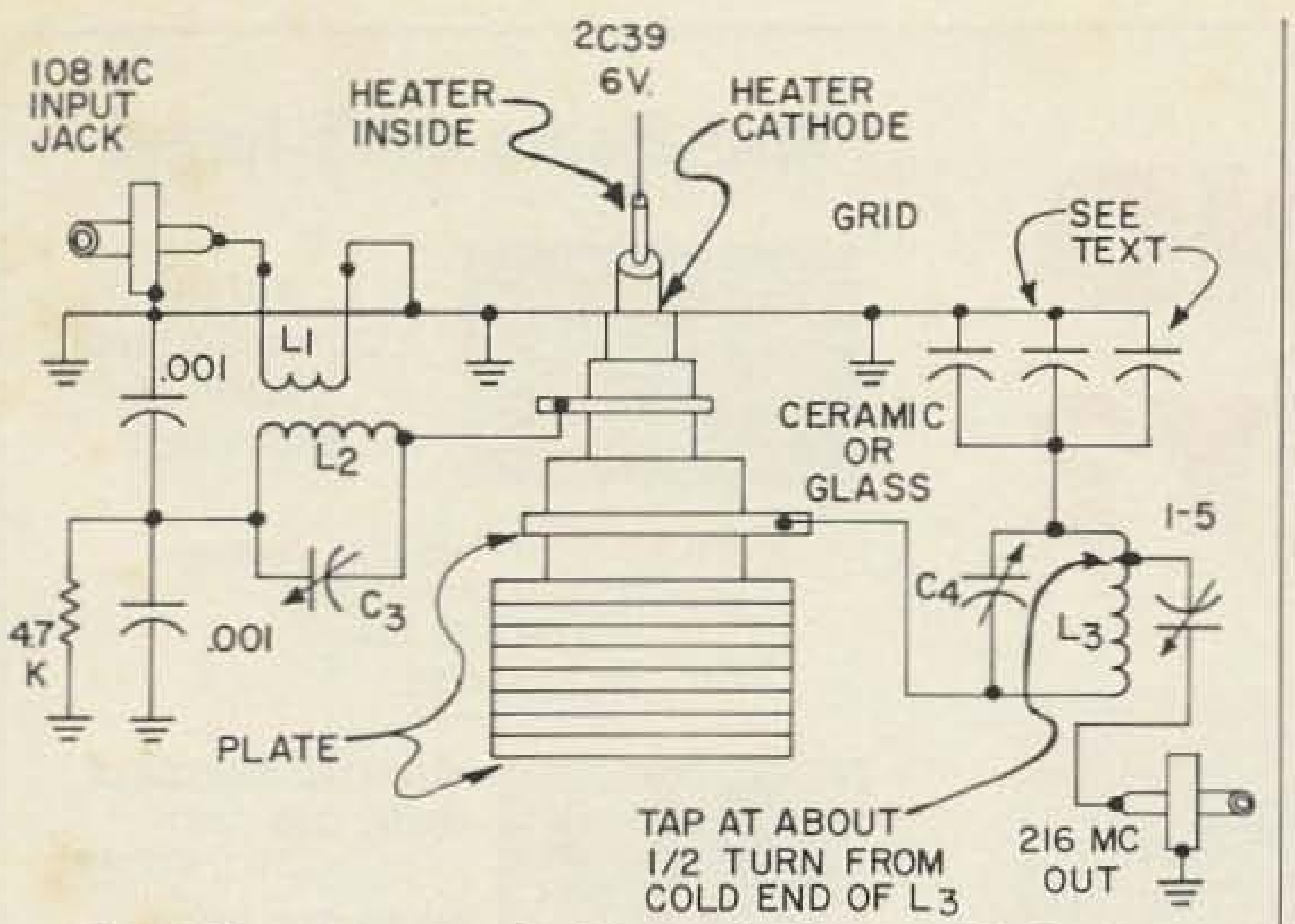


Fig. 2—Power doubler, 108 to 216 mc. L1 = 3 turns interleaved in cold end of L2. L2 = 4 turns no. 16 copper 5/8 long, 1/2 inch diameter. L3 = 3 turns copper strap, 1/4 inch wide, 1 1/2 inches long winding, 9/16 inch diameter O.D. Note: L2 connects to grid ring.

¼ inch copper strap, or finger rings. Anyway, it doubles FB from 108 to 216. More out than in. A power gain of around 2 times, with still only 100 volts on the plate. The 6 watt bulb is over ½ brilliance now.

So much for power. The circuit is beginning to be dependent on the construction at 216 megacycles. Using a copper-clad bakelite baseboard, the cathode is well grounded on a small upright bracket. I have been using mainly surplus 2C39 connectors so far, but have not located a mine of them as yet. Anybody help here? I also use ready-made heater-plugs, and cathode, grid, and plate finger rings from Instrument Specialties Co. in Little Falls, N. J. Actually the grid plate and cathode connections can be made with ¼ inch wide thin brass strap and 2/56 hardware. That heater plug is still a nuisance! It does have a part number at Instrument Specialties, tho.

Mount a resistor support for L2 so you can solder one tab directly to the grid connector. Do not use leads anywhere from here on up. Use as many bypasses as you please on the coil returns. I always have a collection of large and small disc capacitors taped onto the end of some "coffee sticks," with the leads cut to about 3/16 of an inch. Every now and then I go over the circuit, touching these test capacitors across the one (or ones) in circuit, and also in places where there may not be any yet such as filament leads, B plus terminals, etc. Whenever a difference in operation is noted on the meters or rf output I add another. The plate inductance L3 return actually has five of them on it right now. One small button, one large button, one .9 mfd disc, one bakelite encased mica, and one pressed glass mica. It's not really so much a

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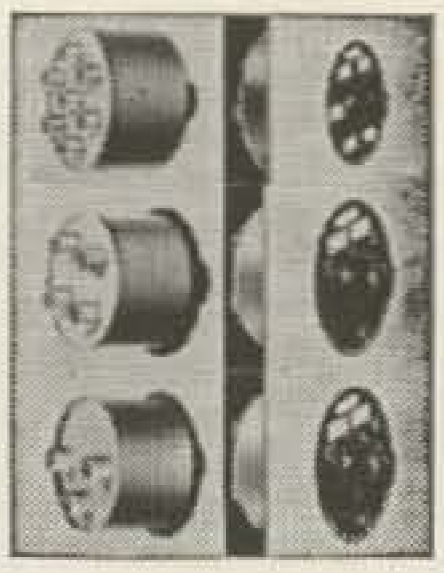

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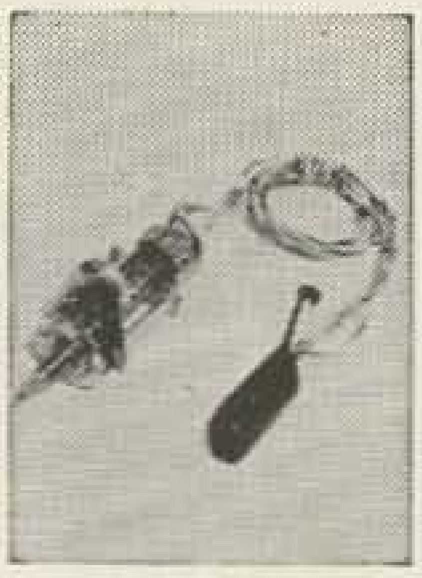

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matter of mmfd as it is a matter of lead length. And the fact that paralleling leads cut down the inductance of even a piece of wire only ⅛ inch long. That isn't all. On 432 it gets worse! The schematics may show some leads, but don't use *any!*

Incidentally, though I don't like to mention it, I use "phono" jacks and plugs throughout, even on 432. And even on 1296! There I'll admit I'm dead wrong. I mean, I *know* it's wrong, even though it works. More later on the subject of connectors. Some of those ceramic phono jacks and plugs can be made to work. Now let's see how to get to 432 without half trying. That is, without *you* trying. I've already done it the hard way.

Doubler, 216 to 432 mc

Things are getting tougher. Granted. It still isn't *too* hard tho. Just follow directions herein and study the "schematic," Fig. 3.

The cathode should be mounted first on the mounting bracket, which is a ⅞ inch wide brass strap mounted vertically on the baseboard. A large hole for the grid-plate insulator (glass or ceramic cylinder forming the center part of the 2C39 tubes) is cut in the front wall of the trough-line box. Leave plenty of clearance for the ceramic or glass insulator between the grid and plate. Not critical. As with a doubler there is no feedback that counts. See Fig. 3B.

L1 should be mounted so the hot, or tuned end is close to or touching the grid ring or strap connector. C2 has a screwdriver slot in it. Use an all-insulator screwdriver. J1 is mounted on the front wall near the middle of L1. No leads are used.

Getting into the plate box now. I used two pieces of ¾ inch vertical copper strap from the plate ring, or connector strap, to go around each side of the plate heat radiator. This leaves room to blow air through the radiator later if you decide to go up towards 100 watts. These straps are joined together and soldered to L2 which then goes only a short distance to C3. Actually of course, the plate inductance begins with the plate itself way up in the front wall hole. Then, out along the plate connection, around the heat radiator on the straps, onto L2, and continues on *through* C3 whose stator plate rods form the cold end of L2. It is not completely cold, due to the series tuning used with the 50 mmfd of C3. This is seen to make L2 nearly 4 inches long total. The B plus lead is attached to the coldest end which is the low impedance end of C3, then through a choke coil where there is not much rf *voltage*. There is plenty of current

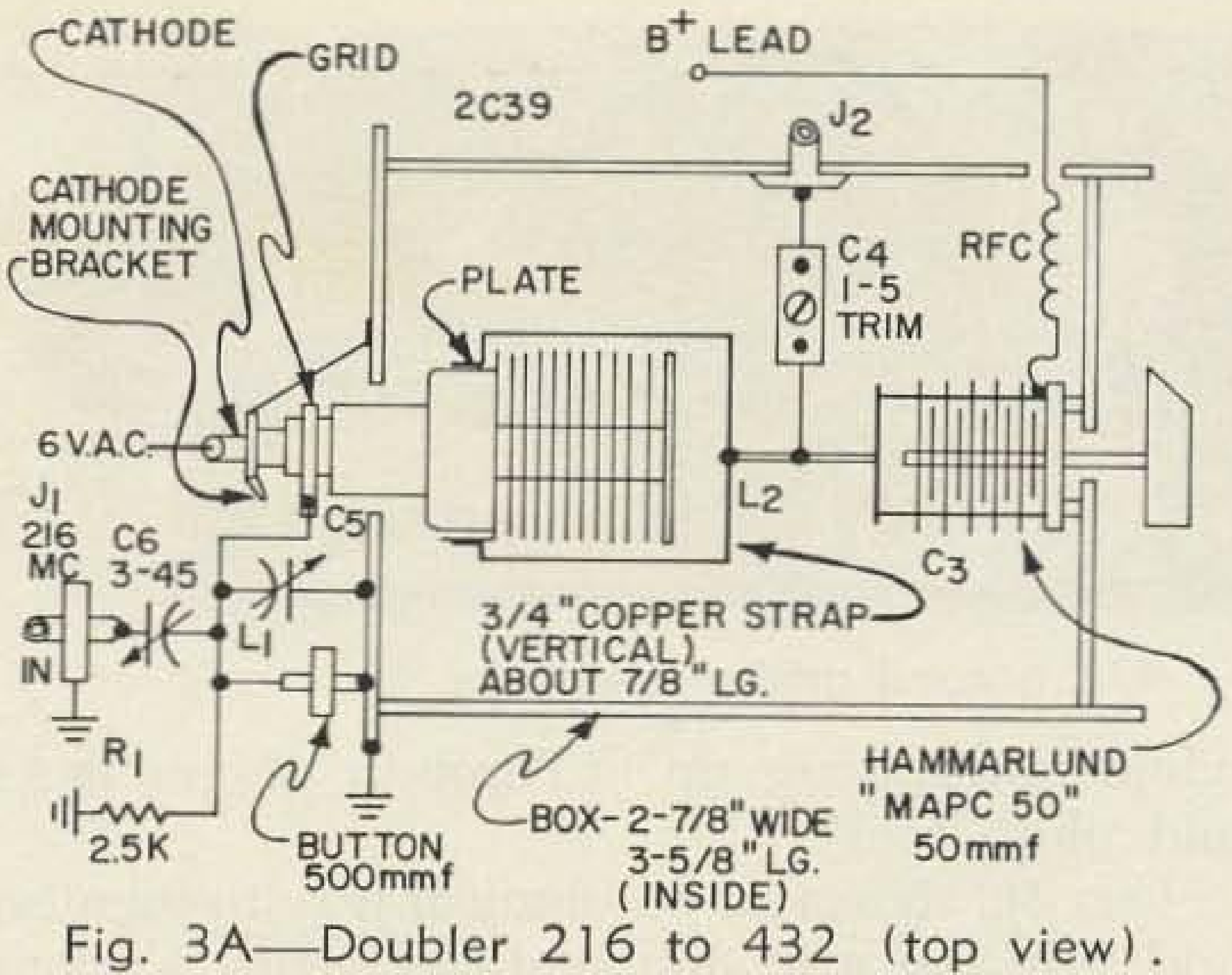


Fig. 3A—Doubler 216 to 432 (top view). L1 = Copper strap, ½" wide, 2½" long, spaced ½" from front wall
Correction: Strap is not L2, but connects L2 to C3. Cond. is MAPC-50B.

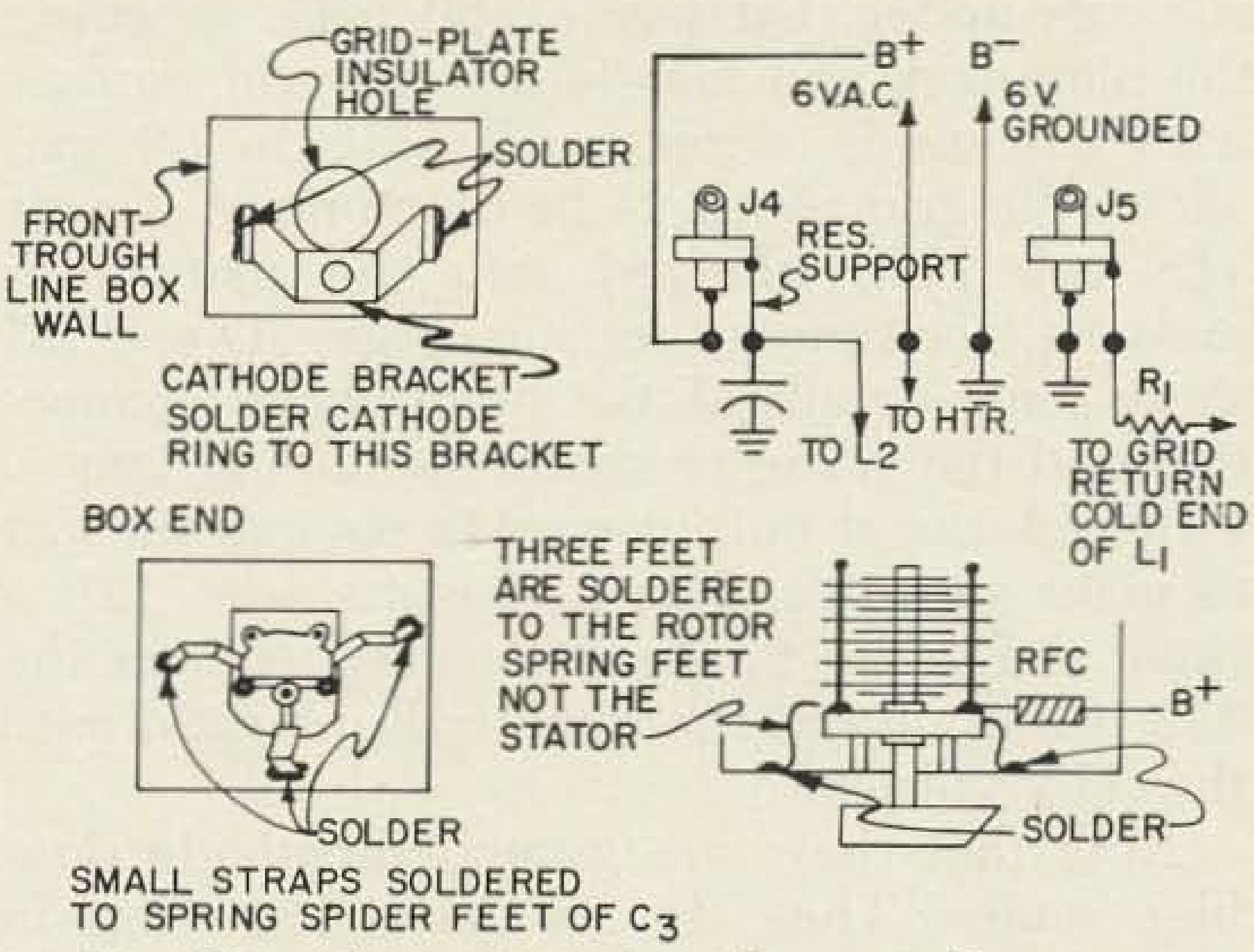
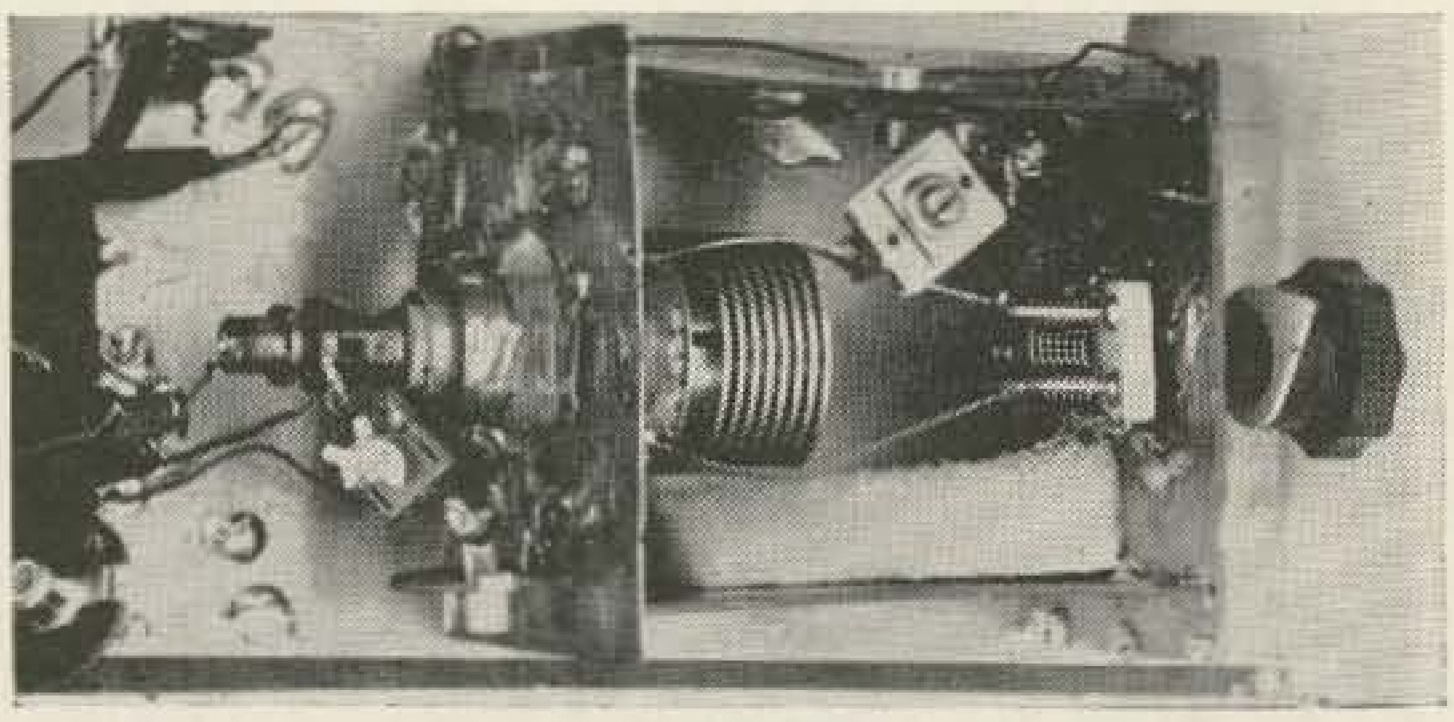


Fig. 3B—Front view, box front wall
Fig. 3C—Economical metering and "fusing." Note: Plug meters into J4 and J5 for current readings. Plug pilot bulbs into them for fusing and current indication.

though, but this is flowing through C3, over the grounding straps (see Figs. 3D and 3E), and onto the end of the trough-line box. From there the rf starts back to the plate-cathode region again via the box walls. Note in passing that this rf has nothing to do with the flow of electrons. This rf is the famous "Maxwell's displacement current," and goes at nearly the speed of light along the copper. The electrons flow from the cathode to the plate on positive grid pulses at less than one tenth the speed of light, and eventually establish an average equilibrium through the plate meter, power supply, B minus lead, ground, and back to the cathode.

C4 is a mica trimmer connected to J2, which is a phono jack soldered in three places to the side wall of the box. Note that these units (the various stages) are all link coupled with cables, and still manage an increase in power



432 ground grid rf amplifier

while multiplying up. (Through phono jacks and plugs too!)

Fig. 3C shows an economical way to monitor and fuse the grid and plate currents. Various bulbs can be plugged into the jacks. The heavy amp ones act as fuses. MA ones such as the no. 49 2 volt 60 ma, make a good indicator for currents under that figure (60 ma). Opening the plate jack and monitoring the grid current with a suitable meter, such as 0 to 50 ma, allows the grid circuit to be tuned up. A 6 watt 115 volt bulb plugged into the plate jack makes a nice tune-up resistor. Figs. 3D and 3E show some details of the plate choke connection and the C3 rotor spider grounding straps. I'll check the rf output on 432 once again just to make sure. It's close to 5 watts now. Just a slight difference in the brilliance between the 432 rf output and the same bulb plugged onto the 115 volt line.

Note that these are grounded-cathode doubler stages. They do *not* have the drop in gain associated with grounded grid stages. The tubes were designed for grounded grid. That is, the physical design allows their use in coaxial cavities. But that needn't stop you from taking advantage of the high Gm and the absence of electrode leads. I assure you, new tube design is not complete yet!

Rf Amplifier, 432 mc

I tried grounded cathode here also. NG so far. I'm still going to try some more, "when I get time." Too much interreaction between plate and grid. Mind you, this makes no-nevermind at all when doubling. Grid on 216, plate on 432, no trouble. But just put the grid on 432 and tune the plate thru 432 and whammo —grid current disappears, and results are N.G. I've got ideas on UHF neutralizing. But for the moment, let's get on the air!

Fig. 4 shows the circuit. And it does work. Like FB! If my plate supply would get up over 400 volts I'm sure I could burn out that 6 watt bulb! With the 400 volts, it appears to be somewhere between 12 and 15 watts of crystal controlled rf out. At least. Because those light bulbs are none too good as wattmeters, but any drop is on the beneficial side. That is, there may be *more* than 6 watts but there *can't* be less! And not a trace of feedback so far.

Note that in this final, the grid is grounded directly—both for rf and for dc. This raises problems in getting bias voltage. You can use a grid bypass ring or plate but this is not actually too easy. It also is very often a continuous and annoying source of feedback with oscillation, unless the capacity is high and *particularly* the inductance has to be low. At any rate, it isn't easy to do. The quickest and easiest way to do it is with a separate filament transformer for the final. See Fig. 4A. Grounded grid cavities have always had this problem. If you lift the cavity, with its dc grid connection off the ground, then you have to worry about your input and output cables shorting the grid bias voltage.

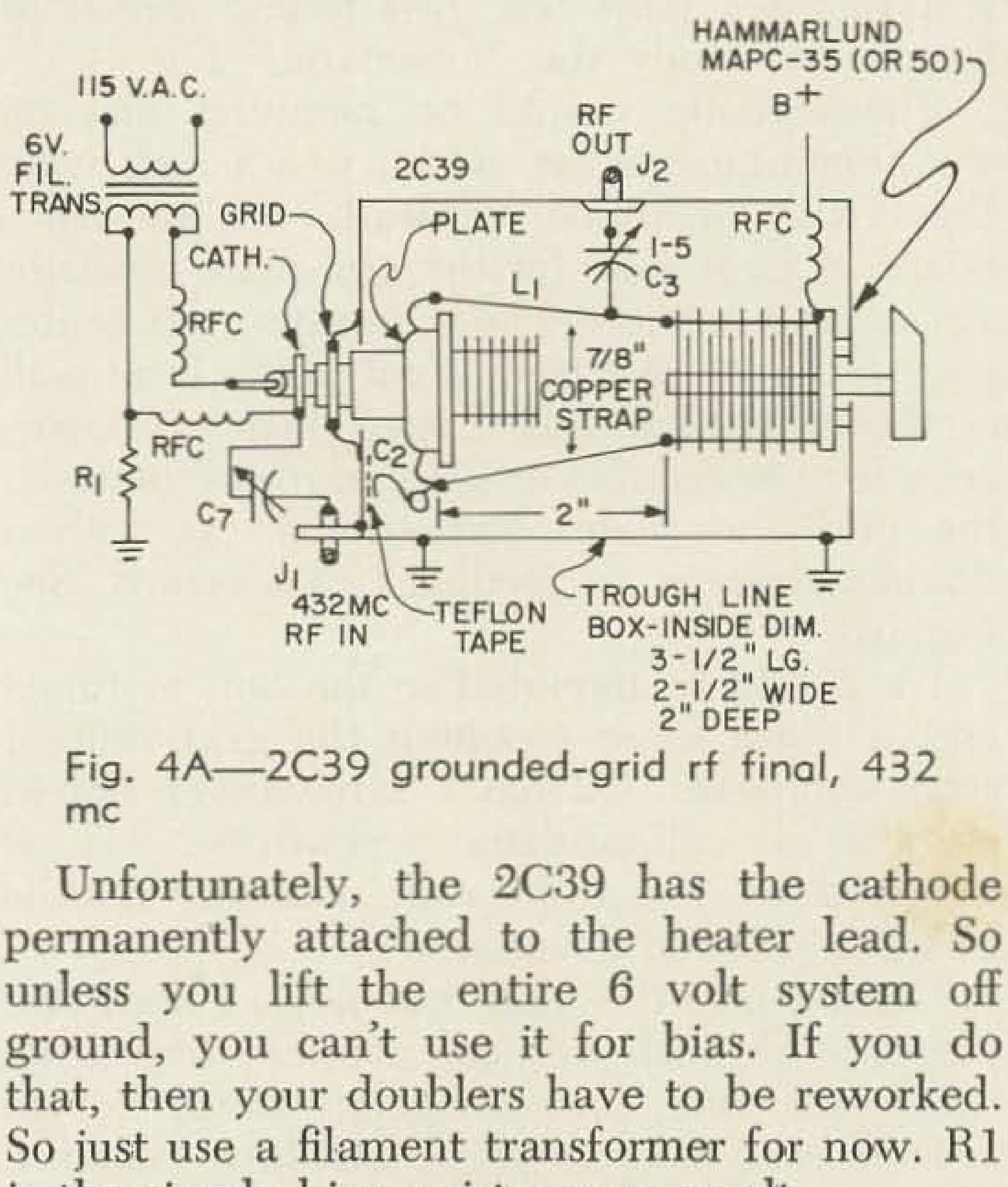


Fig. 4A—2C39 grounded-grid rf final, 432 mc

Unfortunately, the 2C39 has the cathode permanently attached to the heater lead. So unless you lift the entire 6 volt system off ground, you can't use it for bias. If you do that, then your doublers have to be reworked. So just use a filament transformer for now. R1 is the simple bias resistor as a result.

So far I have coupled the input directly to the cathode through C1 and pruned the cable length a little without other tuning of the

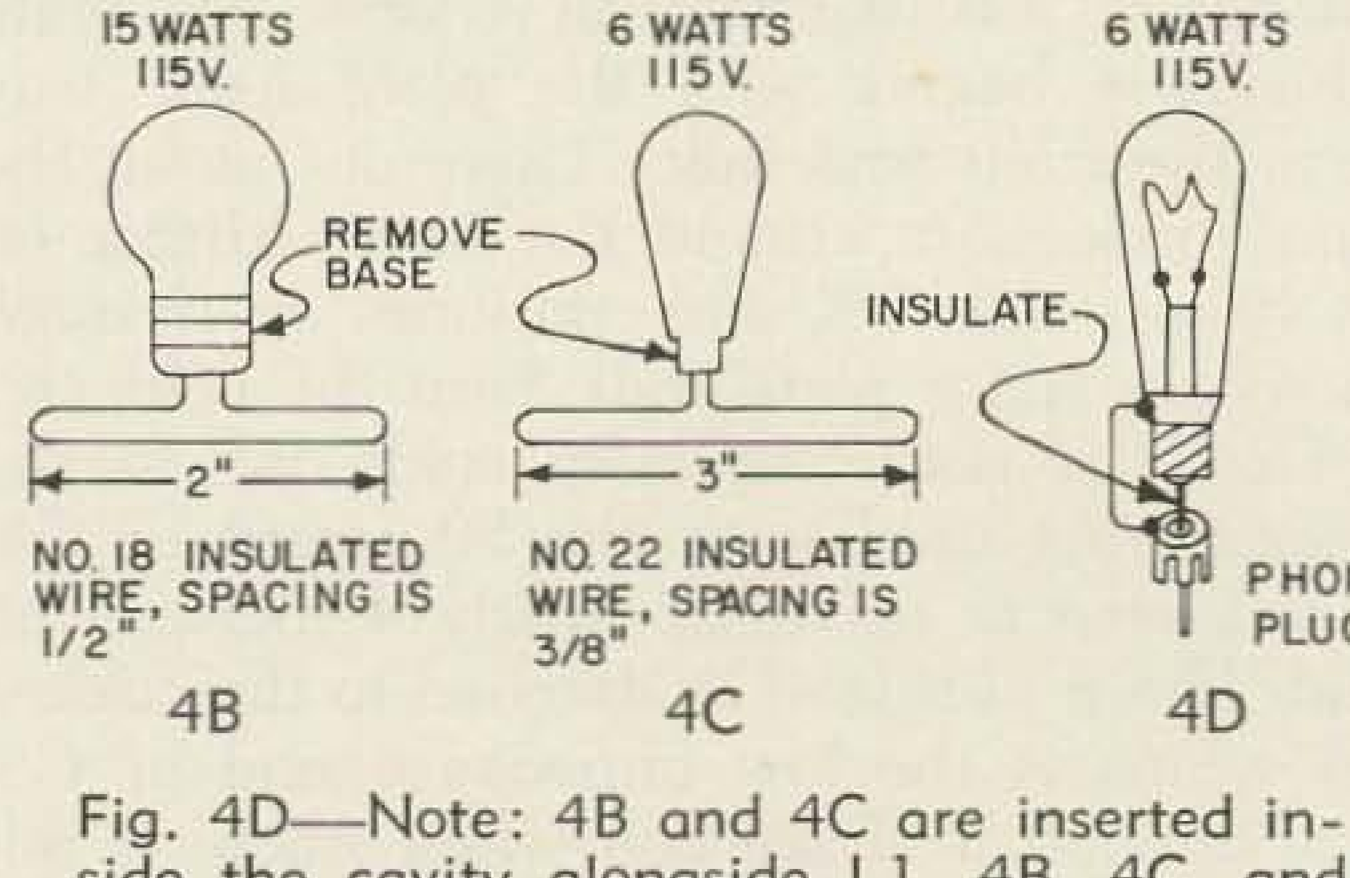


Fig. 4D—Note: 4B and 4C are inserted inside the cavity alongside L1. 4B, 4C, and 4D lamp bulb loads are shown for 432 mc cathode circuit, and have had plenty of drive. We'll check that again on high power. (After installing a blower.)

As for the plate circuit, I was pleased to see that with box and strap dimensions given, the frequency was a shade too high. Rather than rebuild the box I added C2, which is a copper tab about ¾ inch long soldered onto the plate ring and spaced about 1/16th inch from the inside of the inside of the front wall of the box. Adjusting this C2, you can set 432 to be near the maximum on C3, which is the highest Q position.

Rf test lamps that work, after a fashion, on 432 are shown in Figs. 4B and 4C. 4D shows one that can be plugged into the output jack. Some lower impedance lamps are better when used with those cable jacks. A variety of ranges in watts can be found in the "radio" stores.

Incidentally, 2C39's are available from Arrow Sales in Chicago at $4.95.

This about winds up the rf section. See you on 432. I'm on now.

. . . K1CLL

Improving the Heathkit Q-Multiplier

The Heath Q-Multiplier, particularly the current model HD-11 with internal power supply, is a very useful piece of gear overlooked by many amateurs as something to be used by the novice ham with his inexpensive receiver. Actually it is a very easily installed item, which will plug into an already prepared phono socket in 75S-1 and KWM-2 Collins gear, with no modifications. It should be used only in the null position, as this gear has all the selectivity it needs and will prove a revelation to ex-75A4 users who were used to that otherwise superb receiver's Q multiplier knocking the desired signal way down, along with the interfering heterodyne. The Heath can be tuned across the receivers *if* passband like a knife blade and causes no drop what soever in signal strength while nulling out whistles.

The circuit uses a 100 mmfd variable capacitor for tuning which is about ten times as large as is necessary making it a little hard to "hit bottom" with the null, in spite of the vernier built into the condenser. By simply removing four of the six rotor plates (wiggle them out with a long nose pliers) and redipping coil L2 so that the dial pointer is about midscale you will really improve an otherwise excellent and useful accessory.

. . . W9THN

The 432'er

Modulator

Bill Hoisington K1CLL
83 Bellevue Ave.
Melrose, Mass.

Except for one item, you can use your favorite modulator, if you have one. For my money I like a pair of 6L6GC's. 50 watts of audio. Actually rated for 55. That should take care of the 2C39's in the 432'er, even with blower, and running a cool (?) 100 watts. (We'll see how cool this can get to be). Except for one thing. You are supposed to modulate the driver of a grounded grid stage about 70%. I don't take this for granted. Also I learned on the air last night of a lad who modulates the driver of his grounded grid stage *without* modulating the final. That is, other than the drive being modulated. Makes it some kind of linear amplifier. (I hope, for his sake).

At the start of a new project read everything you can about it, do all the paper work you can, and then go to the bench and start building.

We were starting to talk about modulators. Again, you can use whatever you have to get going but how are you going to take care of that 70% business? Of course, my specialty is UHF, so this modulator is almost sure to be bettered. Let me know about it, please. But if you want to go right ahead and get on the air on 432, and I hope you do, because I've never heard of QRM yet there, just make up this one. It works, like the rf section. After all the "in the shack tests" with generator, power detectors, scope, etc., I like to take a rig over to a friend's house and then see if the audio can be understood a ½ mile away. Then I check to see if his voice is recognizable as his.

In general, one should use what can be considered "good practice." Of course, this won't bring you anything *new*. So you have to stick your neck out a little.

Again, this modulator works. See Fig. 1. There *is* a requirement. The driver modulation must be in phase with the final modulation. Don't get snowed under by "phase." It just means an event that occurs in both places at the same time. Even though Einstein says it can't *really* happen.

So, just be sure and modulate the driver. That is, the 216 to 432 mc doubler stage which is grounded cathode. Thank goodness, or we might have to modulate *that* driver too! The easiest way, however, is simply to modulate the driver along with the same modulated HV as you use on the final, and adjust the grid bias of the doubler for the best match. How does this sound on the air? First reports "Modulation very adequate." Also, there is now upward modulation.

Circuit

Again, handbook trouble. There are some nice little circuits in "the Books" using one of the many double triodes; one half as first stage, the other half as second stage. Immediately on building it I got af feedback. I don't like that. Not right away like that. Back to RCA basic books. I've mentioned this before several times. RCA, to push up sales and help keep them sold (a perfectly laudable ambition), publishes a lot of real handy-handy information. Read IT! What a tube is. Why it does what it does. How to connect it up. How to get it going right and keep it going.

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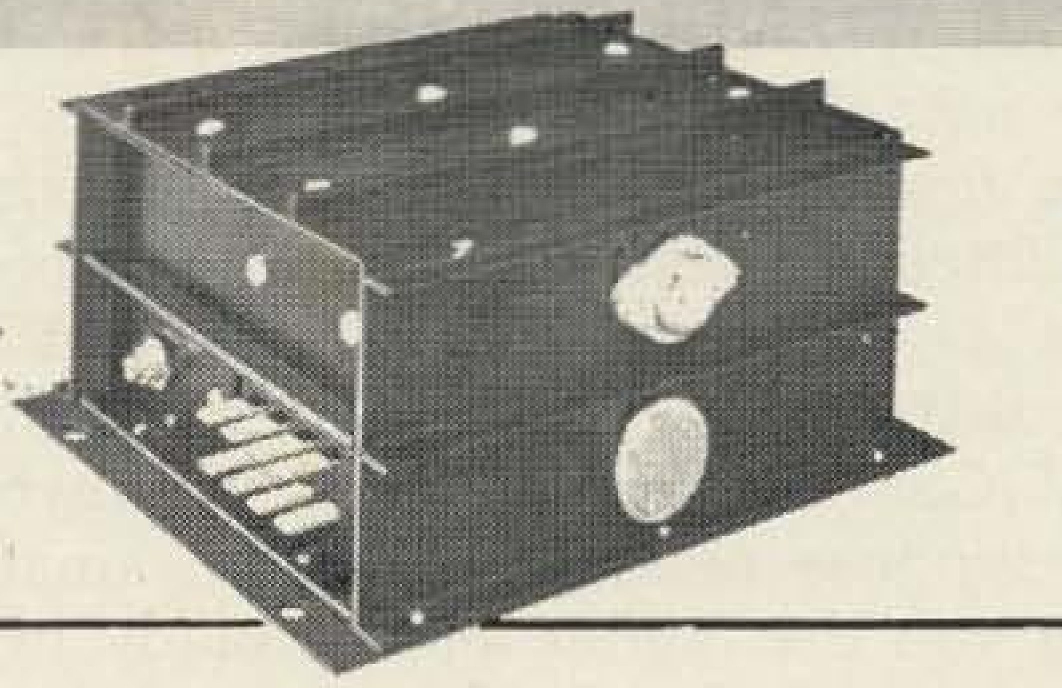

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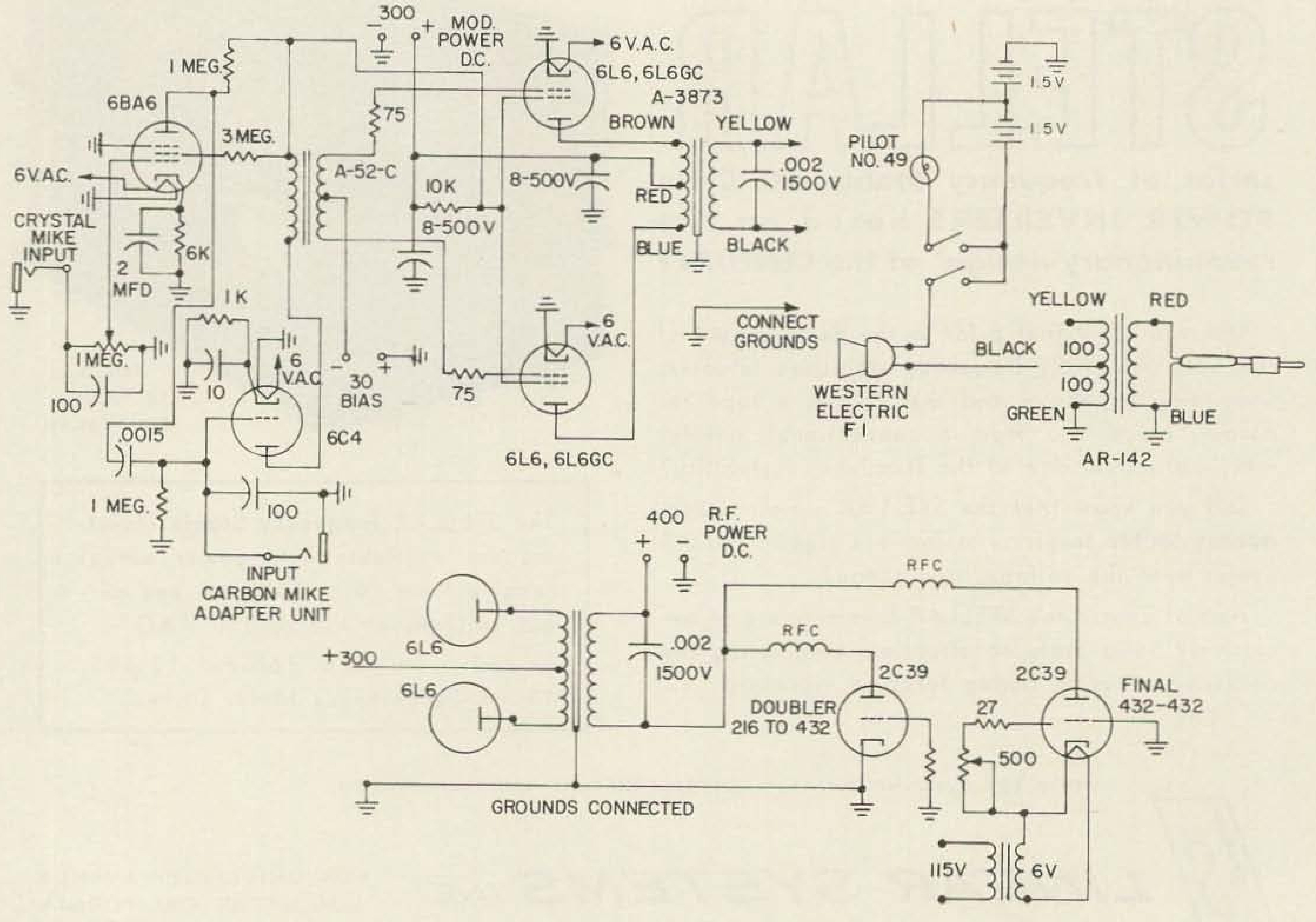
You want a first stage modulator? Dozens of tube choices all detailed out, grid resistor, cathode resistor, bypass, screen resistor and bypass, plate resistor and coupling capacitor to next stage, next stage grid resistor, voltage gain to be expected, gains from 12 to 400 detailed, etc., etc. For $1.50 how can you go wrong? All related of course to RCA tubes but why not? They're good. Same price, too.

So the first stage of the modulator uses a pentode fitted up with high gain components. Plenty of gain using a crystal mic. And what was the first result on the air? rf feedback! But bad! Gain control at zero, steamwhistle. I would suppose nearly 100% of all amateurs, including you the reader and certainly myself, have met up with this devil. As a matter of fact one of the stations I contacted on 432 last night on my historical (for me) first evening on 432, had it too! After a little playing around with grounds, practically useless at 432, bypasses (didn't work this time), shields, moving the mic cord around (an old trick) (didn't work either), I decided to "Cut the Gordian Knot." Some will say that's not sporting but it sure works! So I took the 6BA6 (was supposed to have been a 6AU6 but didn't have one on hand out and connected a very high gain carbon mic transformer to the grid of the driver stage. Results? No rf feedback since that moment.

Remember that 432 radiates like mad from every little crack and lead and is picked up by every little lead also. In the speech amp, it may be a long process to adequately shield a portable speech amp for 432, especially when the complete station is going to be a compact—suitable for mobile, home, or mountaintopping. Incidently, there is *one* carbon mike that actually sounds like crystal on the air. But only one. This is the famous Western Electric Fl "Button." The ones you could buy in a telephone booth in the old days!

Fig. 2 shows the carbon mike plug-in unit. A good try will be made to get the crystal mike back in use again when assembling the compact station, but no guarantees on that. Maybe one of the little transistor amps will do the trick, if put in a *really* sealed-in box.

Let's take a look in the RCA books again about the modulator tubes and the prices. You can go through all the pages and I don't think you can beat the 6L6GC. The Eico modulator on my 100 watt two meter rig uses those nice English type tubes, but they cost more. The 6L6GC runs up to $2. Under pushpull Class AB1 amplifier service we find "Maximum signal output 55 watts." That's



Figs. 1-2-3

audio power. Modulator power. Plenty good enough for any 100 watts of rf for my $2.

As a shortcut to getting on the air I used about 30 volts of battery bias on the 6L6 grids. Someday, "If I ever get time," I'll build a little bias supply into one of the power units. This could help for protective bias, keying, etc. Oh well, in the meantime I'm on 432.

Another little item. I have a nice 60 watt modulation transformer. Multi-match and all. Had it here since 1954. So naturally it went into action. I'm used to hearing modulation transformers sing as they go into action, but this one sounded extra rattly like. Sure enough, it was arcing over inside, and I couldn't stop it. It kept it up right up until 6 PM Wednesday evening, with the gang due on at 8 PM. In desperation, as I moved out along the attic 3rd floor shack here (my junk box is 45 feet long) looking for my old KW modulation transformer, my eye lit on a nice little stocky shaped black unit. Oh Boy! "Modulation Transformer, A-3873, Audio Power 25 watts." In it went, outboard . . . B plus clip leads on the secondary over to the rf final and driver-doubler. Saved the day. Or rather the evening.

. . . K1CLL

The Heath Kit HP-23 Powers the Swan 100 Series

Glenn Camp K6LOP
10360 San Antonio Ave.
South Gate, California 90281

In the Swan Instruction Manual is a modification of the Heathkit HP-20 ac Power Supply. Since this is no longer available, having been replaced by the HP-23 ac Power Supply, it was felt that a modification of the HP-23 would be of interest to those that need a ac supply.

The HP-23 is a full-wave voltage-doubler for the high voltage, a half-wave voltage-doubler for the low voltage, and a half-wave rectifier as the bias supply. All rectifier diodes are silicon. High voltage is 700 volts under load instead of 600 as in the HP-20 and will drive the Swan to 175 watts PEP input. Dynamic regulation is improved over the older model, as well as a switch has been added wired in series with two terminals of the power output socket so that the supply may be located some feet away from the transceiver, at the end of a 8-conductor cable.

A 11 pin socket is used to bring out all voltages and control circuits. Four changes are necessary to use with the 100 series transceivers. First connect as per Heath Assembly Manual for a low voltage of 300 volts. The second change is to jumper pin 2 to 7 of the power socket, this grounds one side of the 12vac filament winding. 12vdc is needed for the Swan T-R relay so the third change is to add a silicon diode between pin 6 and unused pin 5, cathode to pin 5, most any PIV and ma rating should do. Also needed is a 100 mfd-50v electrolytic connected positive to pin 5, ground the other end.

A bias voltage of −100 volts dc with a 20 ma load is available at pin 1, labeled Fixed Bias. Also available is a adjustable bias voltage with a range of −40 to −80 volts dc, this would be fine except it is only rated at 1 ma, and 6 ma is needed. So back to the fixed bias supply for the fourth change. Add a 4.7 K/1 watt resistor in series with the yellow lead from lug 2 of terminal strip D. I used a 1 lug tie-point near the power socket to anchor one end. This change is required to lower the bias voltage (should be in the range of −70 to −100 volts dc) and to adjust for a Swan PA Bias of 25 ma.

A 8-conductor cable is furnished with the HP-23, connect as per chart, adjust PA Bias, Tune & Load, and be on the air Saturday evening after a good afternoons work.

. . . K6LOP

Function	Power Socket HP-23	Color	Power Socket Swan
Fixed Bias	1	yellow	3
300 vdc low voltage	3	orange	10
700 vdc high voltage	4	red	8
12 vdc relay	5	blue	5
12 vac filament	6	black	4
ground	7	brown	6
power switch	9	white	1
" "	10	green	2
External speaker			12
" " ground			6

Sinusoidally-modulated Calibration Oscillator

Ronald L. Ives
2075 Harvard St.
Palo Alto, Calif.

The problem of rapidly and surely identifying signals from the receiver's calibration oscillator has been with us for several decades, and has become particularly troublesome recently in some of our "electronically saturated" regions, such as Greater Boston and the San Francisco area, where literally dozens of unmodulated carriers of various frequencies may be on the air at any given time.

This problem was noted some years ago by Langford-Smith[1] who suggested that pulsing the calibration oscillator by means of a neon oscillator might be a workable solution. A number of neon oscillator modulated calibration oscillators have been perpetrated by the present writer[2], with results that were helpful, but not entirely satisfactory. The chief problems included difficulty of controlling the percentage of modulation, so that overmodulation, with resultant splatter, was most difficult to avoid; and "spread" of the calibration signal, due to the almost infinite number of audio harmonics resulting from the sawtooth output of the neon oscillator. These difficulties were not insurmountable, but made the neon-pulsed calibration oscillator a most tricky device to put into, and maintain in, satisfactory operation.

Requirements

For thoroughly satisfactory operation, a modulated calibration oscillator must have the following attributes:—

1. A stable high frequency oscillator, rich in harmonics.
2. A sinusoidal audio oscillator, poor in harmonics.
3. Adjustable modulation percentage.
4. A satisfactory and "clean" mixer.

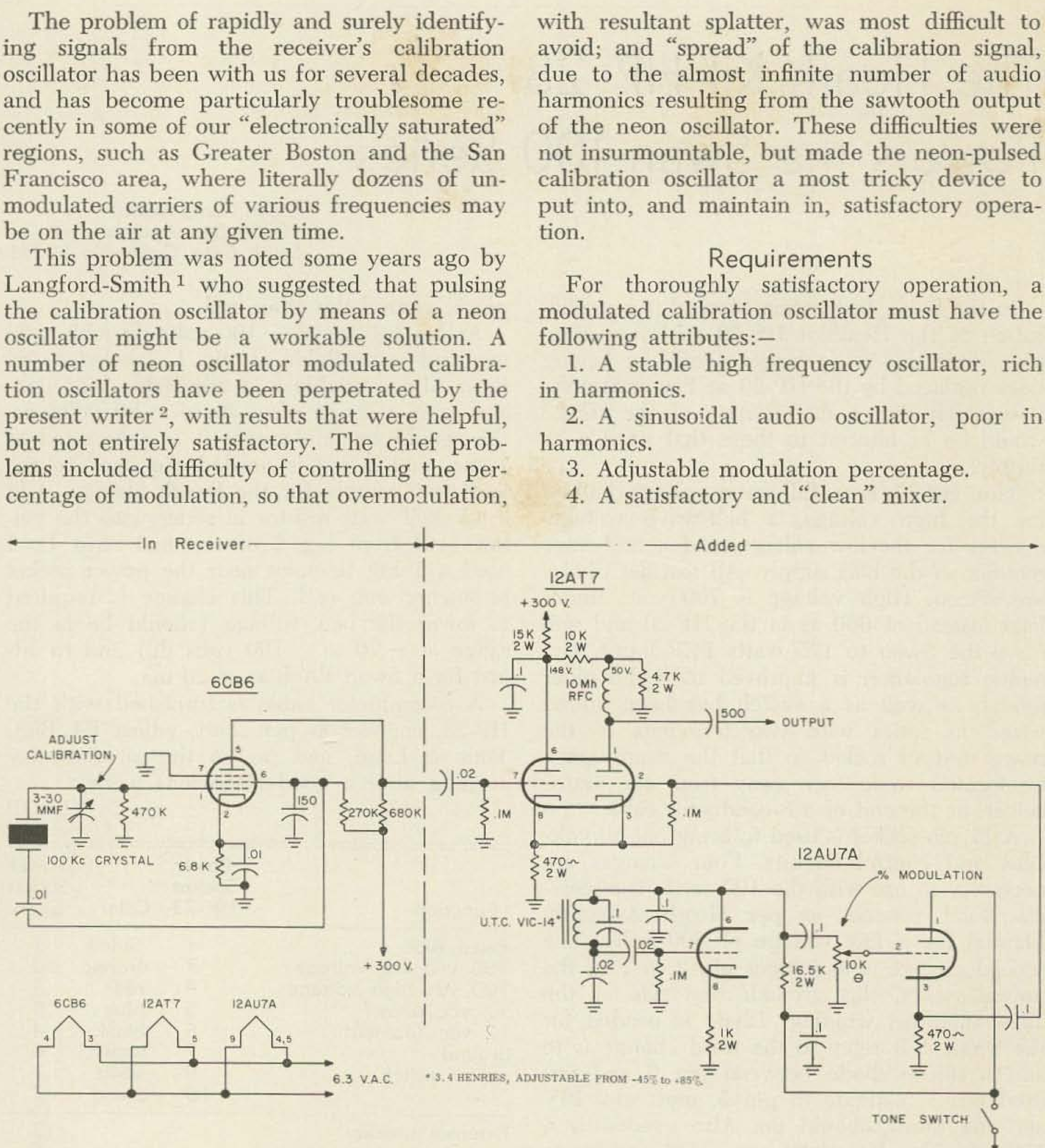
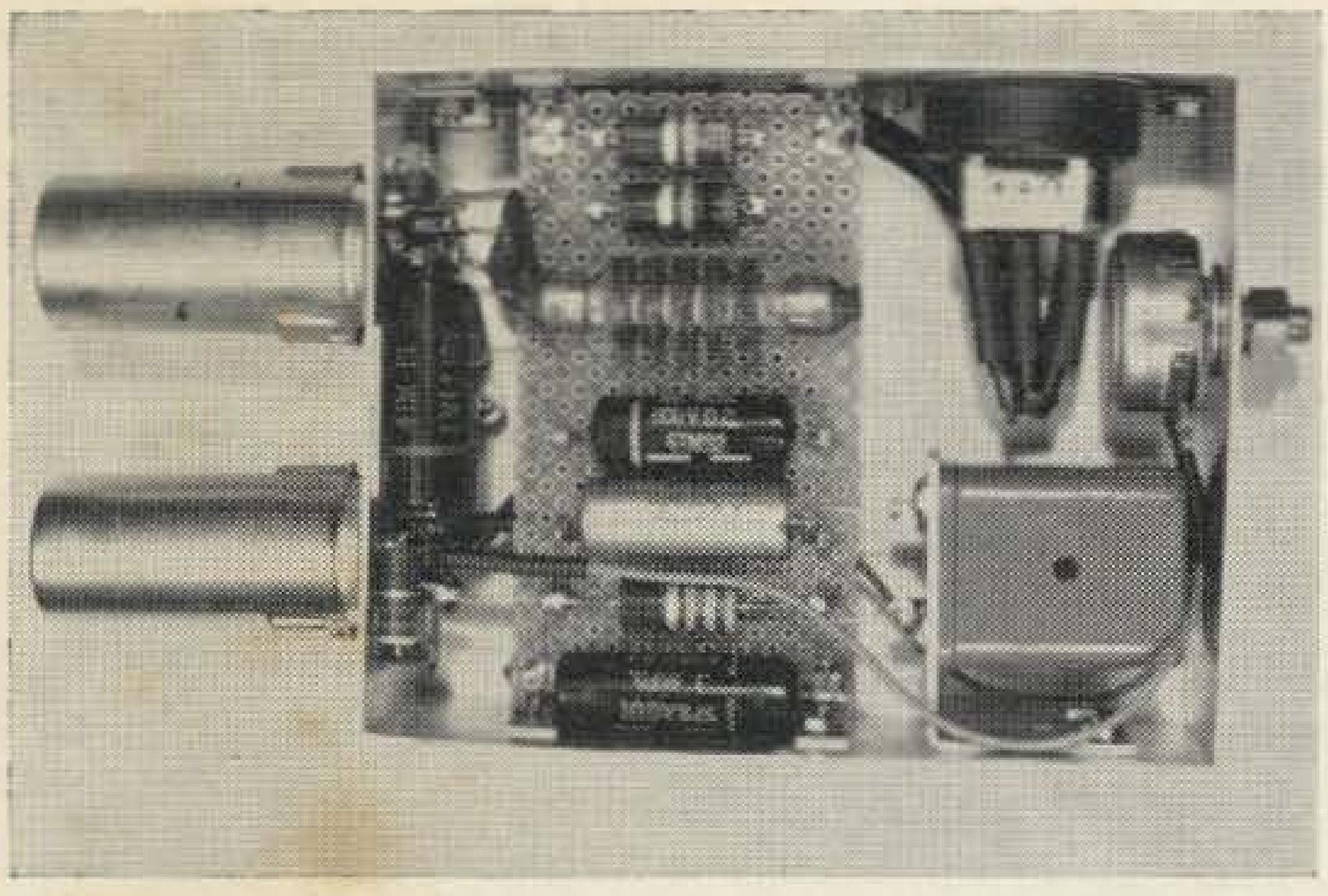
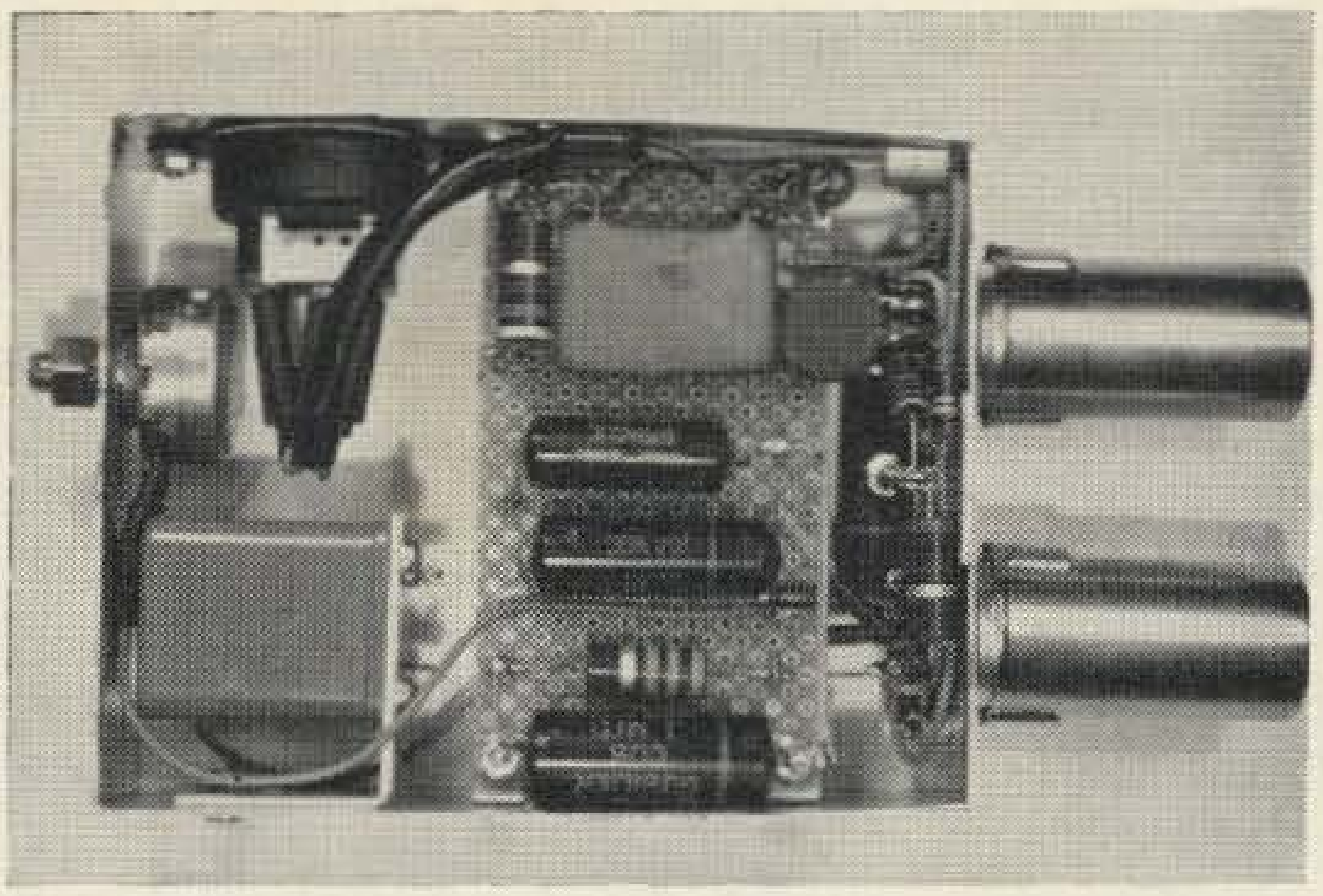


FIGURE 1



Top view of oscillator identifier with covers removed.



Bottom view of oscillator identifier with covers removed.

Happily, there are a number of very stable and satisfactory high frequency oscillators, among which the electron-coupled crystal oscillators are the most popular.

The sinusoidal audio oscillator, poor in harmonics, can be a conventional Colpitts circuit, using a single high-Q untapped inductance, with both high-C and degeneration to reduce the harmonic output.

Adjustable modulation percentage is easily provided by use of a conventional potentiometer between the audio oscillator and the mixer.

The mixer problem is adequately solved by use of the Pullen [3] dual-triode cathode-coupled mixer, which is remarkably free of unwanted mixer products (harmonics and the complicated beats produced by them), provided no part of the circuit is overdriven.

Working Circuit

With the foregoing fundamental requirements decided, the working circuit of Fig. 1 was developed, and, after rigorous checking, built as a permanent receiver adjunct. It should be specifically noted here that several alternative circuits, some using less tubes, are entirely workable; but once the "one function per tube" concept is abandoned, the apparent saving in components is likely to be offset by functional interaction, difficulty of adjustments, and other gremlins, some of which are most difficult to exorcize.

How It Works

The 6CB6 100 kc crystal oscillator produces clean signals at 100 kc and all integral multiples thereof up to roughly 50 mc, with some falling off of amplitude above about 30 mc. Because of the electron coupled circuit, frequency is substantially independent of load. As is conventional a trimmer capacitor is provided to permit zero beating of the crystal oscillator with some more accurate standard such as WWV.

The oscillator output is fed to the right half of the 12AT7 mixer, which is a cathode follower. The same signal, not voltage amplified, appears across the cathode resistor of the mixer, tube, and drives the left triode of the mixer. If no signal is applied to the left grid of the mixer, which has a low impedance to ground, the 100 kc signal, amplified, appears at the plate of the left triode of the mixer, which is the circuit output. Use of an rf choke in this plate circuit permits greater amplification at high frequencies than at low, a usually desirable condition.

When the audio oscillator (left 12AU7A) is energized, that circuit puts out a relatively strong sinusoidal signal, at a low frequency, determined by circuit constants and adjustment of the core screw of the VIC-14 inductance. Because of the high C of this circuit, and of the extreme degeneration introduced by the 1000-ohm cathode resistor, wave form is cleanly sinusoidal, and harmonics are at a minimum.

A selected portion of this signal is fed to the right half of the 12AU7A, which is a cathode follower, and from the cathode of this triode to the left grid of the mixer. Here, the audio signal varies the amplification of the mixer output tube, effectively modulating the high frequency already in the circuit. By adjustment of the "% Modulation" control, amount of modulation can be varied from 0 to somewhere around 200 percent.

The entire power supply is controlled by a switch already in the receiver. An added switch ("Tone SW.") is provided on the panel,

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[1] Langford-Smith, F. "Radiotron Designer's Handbook," Fourth Edition, 1952, Harrison, N. J. (**RCA**), 1261.

[2] Ives, R. L. "Dual Frequency Crystal Calibrator," **Radio-Electronics**, Vol. 26, No. 10, Oct., 1955, 34-36: "Identify Your Calibration Signals," **Radio-Electronics**, Vol. 31, No. 9, Sept. 1960, 56: "Modulated 10 kc Calibration Oscillator," **Electronics World**, Vol. 66, No. 6, Dec. 1961, 55-57.

[3] Pullen, K. A. "Conductance Design of Active Circuits," New York (**Rider**), 1959, 259-263.

to permit disabling of the audio signal, for zero beating of the xtal oscillator and other checking purposes.

Construction

Because the crystal oscillator was already an integral part of the receiver, necessary construction included only the audio oscillator and the mixer. Using all standard parts, this was easily fitted into a 2" by 5" by 6" utility box (LMB UC-972 cut down), which in turn fitted the space available within the receiver cabinet.

Tubes were mounted to project horizontally rearward. Power and signal connections were made by means of a plug at front right. Some components were wired directly to the socket prongs. The audio coil was mounted on a bracket at front left, with the adjusting screw up, so that the audio frequency could be adjusted easily. Remaining components were mounted on both sides of a glass epoxy board (Vector 85G24WE, with T 28 terminals), which was bracket mounted across the case. By judicious arrangement of the components, the wiring of the circuits is minimized. Alternative layouts, to fit available space or personal preference, are entirely feasible. The bulk of the identifier unit can be reduced by a factor of more than two by use of "miniature" components, at a considerably higher cost in parts and labor.

Adjustment and Use

When construction is complete, and wiring is checked, connect the identifier, and roughly check it to make sure all component circuits work. Then, using an oscilloscope, adjust the "percent modulation" to about 95. Do not, under any circumstances, exceed or crowd 100 percent modulation, as this will immediately cause splatter, which will not only make the calibration oscillator less useful, but may also cause interference over a wide area (several blocks), on several or many bands.

With modulation satisfactory, check coupling to the receiver. As the mixer is also an amplifier, reduction of the coupling is usually desirable, to prevent overloading the receiver input, with resultant cross-modulation and spurious signals. Coupling sufficient to give the calibration signals a strength of about S3 is usually optimum. Logging of the strength of the calibration signals at each end of each band will furnish a good check, at a later date, on receiver performance and its possible deterioration.

To give as sharp a calibration signal as possible, the audio modulation signal should be of as low a frequency as convenient. This can be set by adjusting the core screw in the UTC VIC-14 inductor. With constants shown, modulation frequency is 420 cycles with the screw all the way in.

In use, the calibration oscillator is turned on, with the audio tone operative, and the desired frequency is spotted by noting the audio tone. If a very high precision is desired, or for purposes of zero-beating, the audio tone is shut off, and the oscillator used without modulation. For most ordinary purposes, the oscillator can be used with the modulation on, the center frequency point being detected by watching the S-meter maximum. This is a perfectly workable procedure with a sinusoidally-modulated calibration oscillator, as the two sidebands are of equal width. It is not usually a sound procedure with a neon-modulated calibration oscillator, because the sidebands are usually of unequal width, due to the sawtooth waveform of the modulating signal.

The described calibration oscillator identifier has been in full service as a permanantly-attached adjunct of a GPR-90-R receiver for several months. Performance has been eminently satisfactory. The receiver case has not been opened for repairs or adjustments during that time. Further deponent sayeth not.

. . . Ives

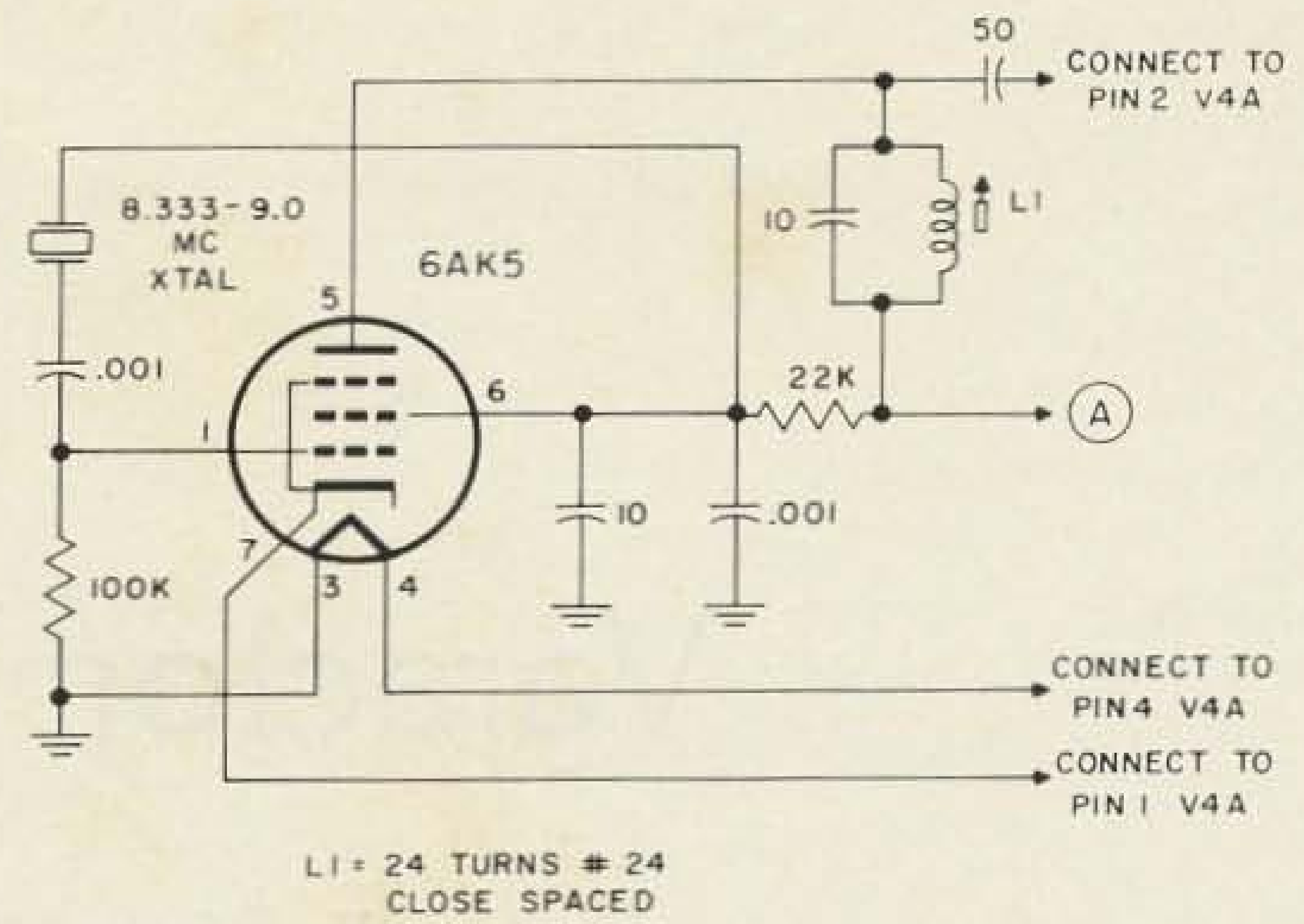
Converting the

Heath Tener

to

SIX

Robert Rose K6GKU
9332 Sage Avenue
Arlington, California



Many hours of pure pleasure were spent with my Heath HW-19 "Tener," both as a fixed unit and as a mobile rig. However when I moved to a new location, the sagging sunspots and general inactivity of 10 meters eventually caused a thick layer of dust to accumulate on this little transceiver. Therefore when I was stricken with a craving to do some mobiling from the nearby mountain-tops the little "Tener" was rebuilt into a "Sixer" and reactivated.

The largest addition to this conversion is the addition of an oscillator/tripler stage which makes use of 8 mc crystals. The circuit used was lifted from the January 1962 issue of 73[1] (where else). This circuit has been used in other rigs and has been found to be reliable and rugged. One change has been made in the circuit shown in the original article. The connection at pin 2 of the 6AK5 has been removed. The 6AK5 suppressor grid is tied to the cathode internally. If pin 2 is grounded, the oscillator will remain on while the receiver is on which tends to be annoying.

The unit was built on a small 2″ × 2″ sub-assembly and mounted on the upper right hand backside of the front panel behind the Heathkit emblem. To facilitate changing frequency the crystal socket was installed on the front panel.

The modification of V-4A into a doubler stage involves the rewinding of Coil L201 with 8 turns of number 24 wire.

The tank coil, L202, was also rewound with 8 turns of number 24 wire. One pointer: don't try to rewind the coil without removing the two turn link, and don't forget to replace the link once the coil is rewound.

The last step in the transmitter conversion is to remove the rf Trap, C209 and L203. This little device, if overlooked, will absorb most of the 50 mc signal because in the original 29 mc transceiver, its job was to attenuate the second harmonics.

The modification of the receiver section was a little tricky to nail down initially, but when the bugs were ironed out, it turned out to be a simple process.

To convert the receiver rf amplifier, remove C101, C102, R101, and rewind L101. L101 is rewound with 9 turns of the original coil, with the antenna tapped 2 turns from the cold (ground) end.

The regenerative detector was converted by trimming L102 to 8 turns of the original coil. Some experimentation was made with C111 to try to improve the quench frequency rate. It was found, however, that the original 100 mmfd capacitor produced the best tuning characteristics and was left as is.

The last two modifications, although arbitrary, have proven to enhance the operation of the transceiver. The regeneration control was moved to the front panel and placed between the volume control and the microphone plug. An 8:1 per 180° rotation vernier dial was added to the main tuning capacitor, C108. Although fine tuning is not an outstanding feature of the superregenerative receiver, the combination of vernier tuning and careful regeneration adjustment will produce a certain amount of selectivity.

The entire modification took about 4 to 5 hours. A manual is a great help to plow through the maze of components, especially if you didn't build the unit originally. The comments received on the quality of the signal from this station have been very gratifying and the receiver has proven to be disgustingly sensitive. In general the unit has proven to be ideal for the local nightly roundtables and it is felt by the author that this conversion was time well spent.

. . . K6GKU

[1] D. A. Smith, W3UZN—8 mc. Crystal Modification—Page 24.

Varactor Tripler to 432 mc

Tom O'Hara W6ORG
Resdel Engineering Corporation
Pasadena, California

Varactor multipliers now provide the typical 2 meter ham using a Gonset Communicator (or converted 522) the opportunity of operating the UHF bands. The problems and expense involved in building tube type multipliers and their associated power supplies are dispensed with. This artical describes a varactor tripler that generates 432 mcs with an efficiency of 70%. 3 actual watts out of a Gonset GC105 Communicator, as measured with a commercial wattmeter, will give 2.1 watts output.

This transmitter-multiplier system has reliably produced 5 x 9 signals over a 70 mile clear path in the Los Angeles area. Similar multiplier schemes are providing dependable results between the Hollywood hills and San Diego. This 120 mile path is not line of sight, but the results do speak of success.

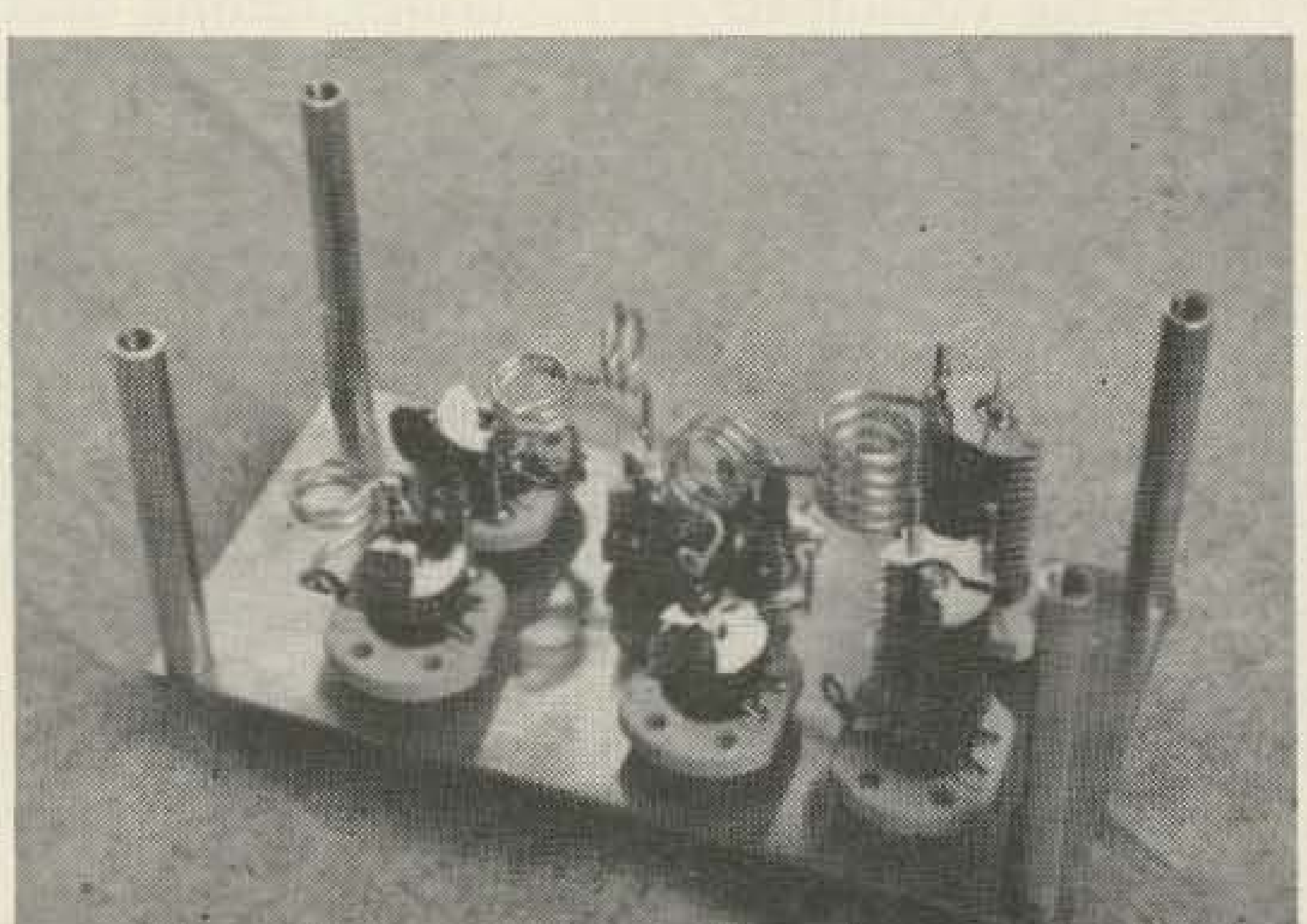
How They Work

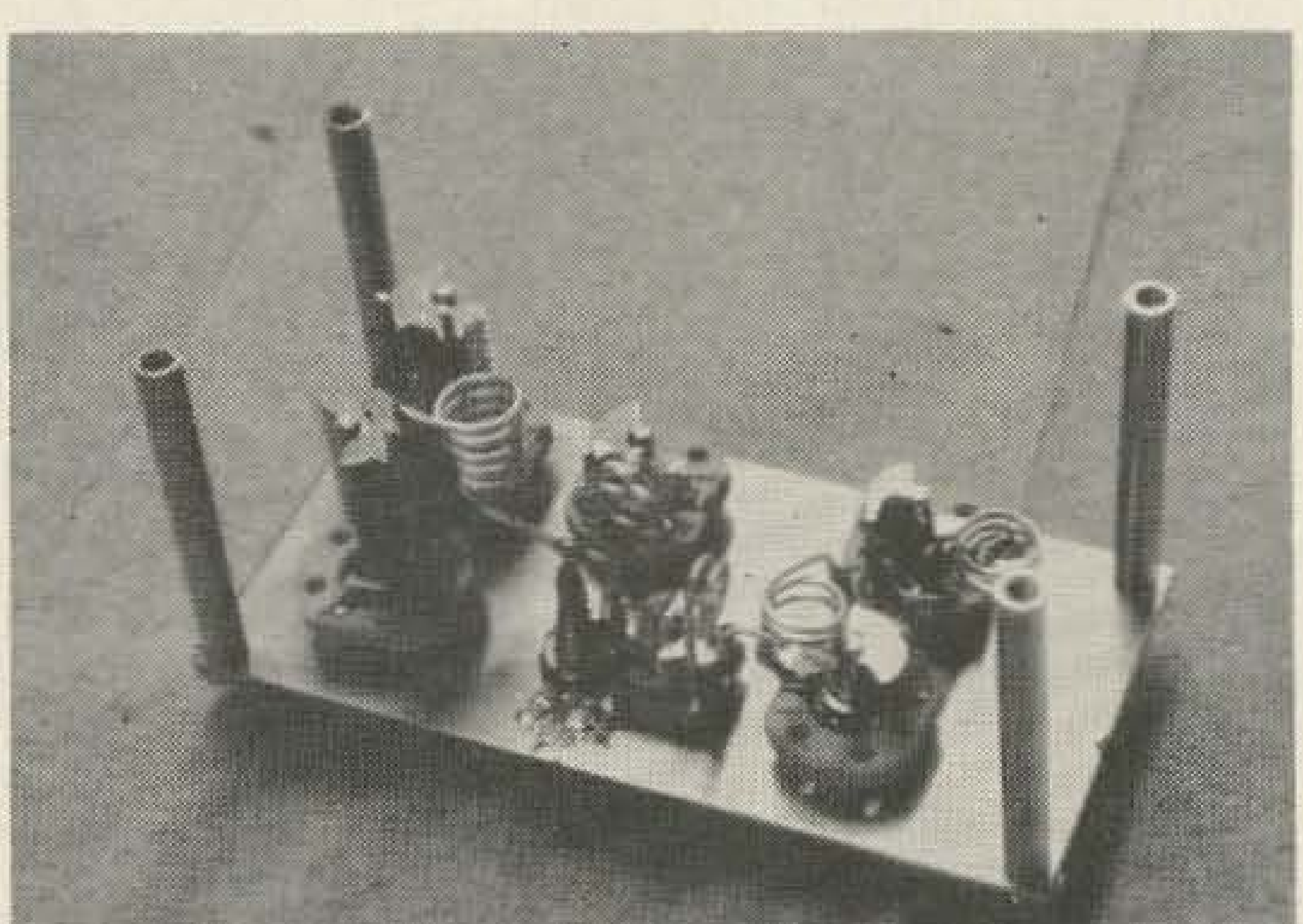
A varactor diode is simply a semiconductor diode which uses the non-linear capacity change as related to the voltage across its junction.

The varactor is always used in the reverse or back-biased connection. This particular circuit is completely self biased however. For heat dissipation considerations the cathode is grounded. As the depletion capacitance varies nonlinearly with voltage, the input signal is heavily distorted. This distortion produces the new frequency in a very efficient manner.

In following the power flow from the transmitter to the antenna (Fig. 2) we see it first enter the filter network at our driving frequency 1F. This filter must match the transmitter impedance (50 ohms) to the diode impedance (approx. 30 ohms). It also blocks the harmonic power from being reflected back to the transmitter.

The varactor, is now creating harmonics, of which the second harmonic is predominent. This harmonic flows through the 2F trap back thru the diode; since it is being blocked by the 3F and 1F filter networks. Practically all of the 2F power will circulate through the diode and *mix* with 1F to create 3F, or in our case 432 mcs, then flows through the 3F filter and into the load or antenna.





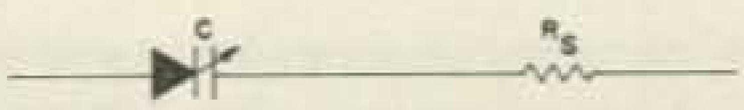


Fig. 1 Equivalent circuit of a varactor diode: Rs is the lost resistance of the diode, and is kept low for high efficiency.

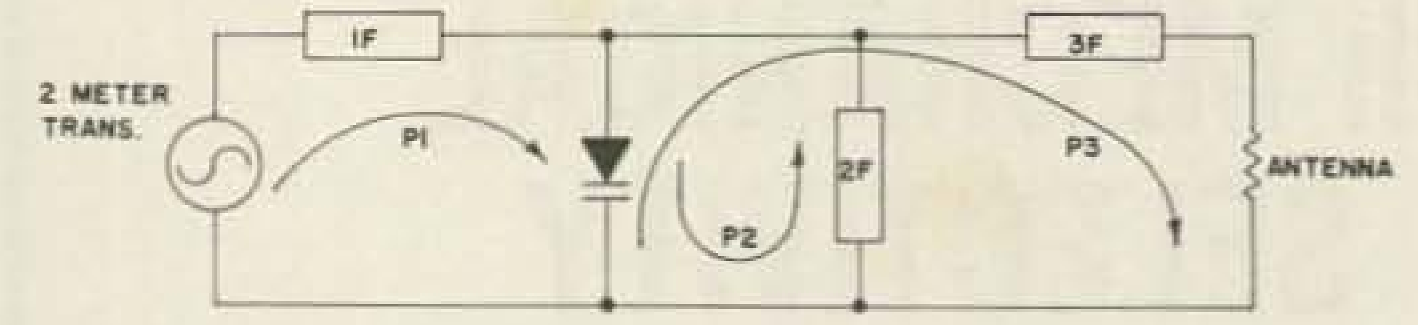


Fig. 2 Basic tripler diagram.

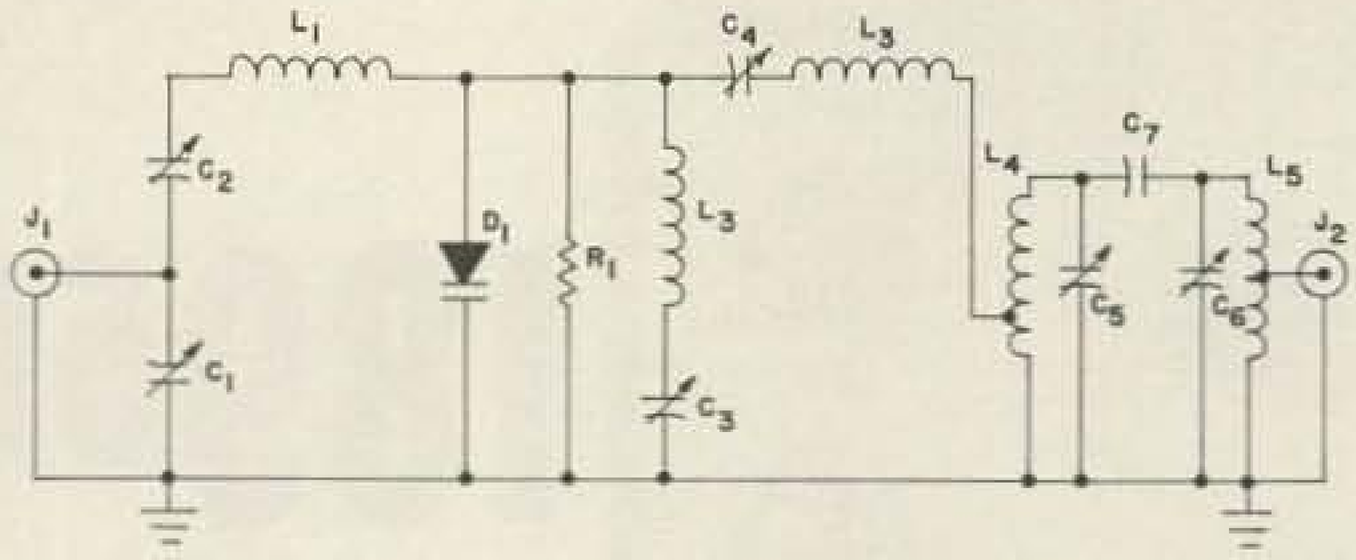


Fig. 3. Schematic diagram of varactor tripler to 432 mcs. See parts list.

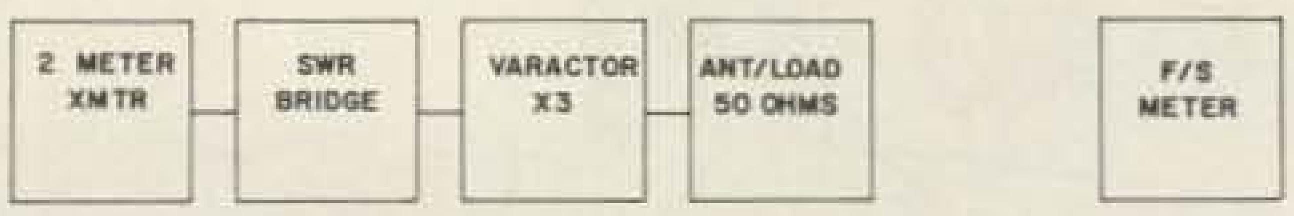


Fig. 4 Block diagram of test setup.

As usual the best efficiency can be achieved only by using good quality components and UHF construction practices. The buildup of this particular tripler should follow carefully the illustrations.

Construction

The cautious ham should have no difficulty in repeating the results if he follows the layout. If you prefer putting it on a chassis, you may do so. Make the brass board the same size as the corresponding chassis bottom plate and put the BNC connectors right next to the capacitors. Care must be taken to keep the current paths as short as possible. It may seem wasteful to break the ceramic off of the PLS6 coil form. However, this fitting grips the shoulder of the diode and provides a good heat sink. After bolting the diode mount to the board (coil form modified), puddle solder between the nut and board on the side nearest the edge. The 47K, ¼ watt resistor will also be grounded there.

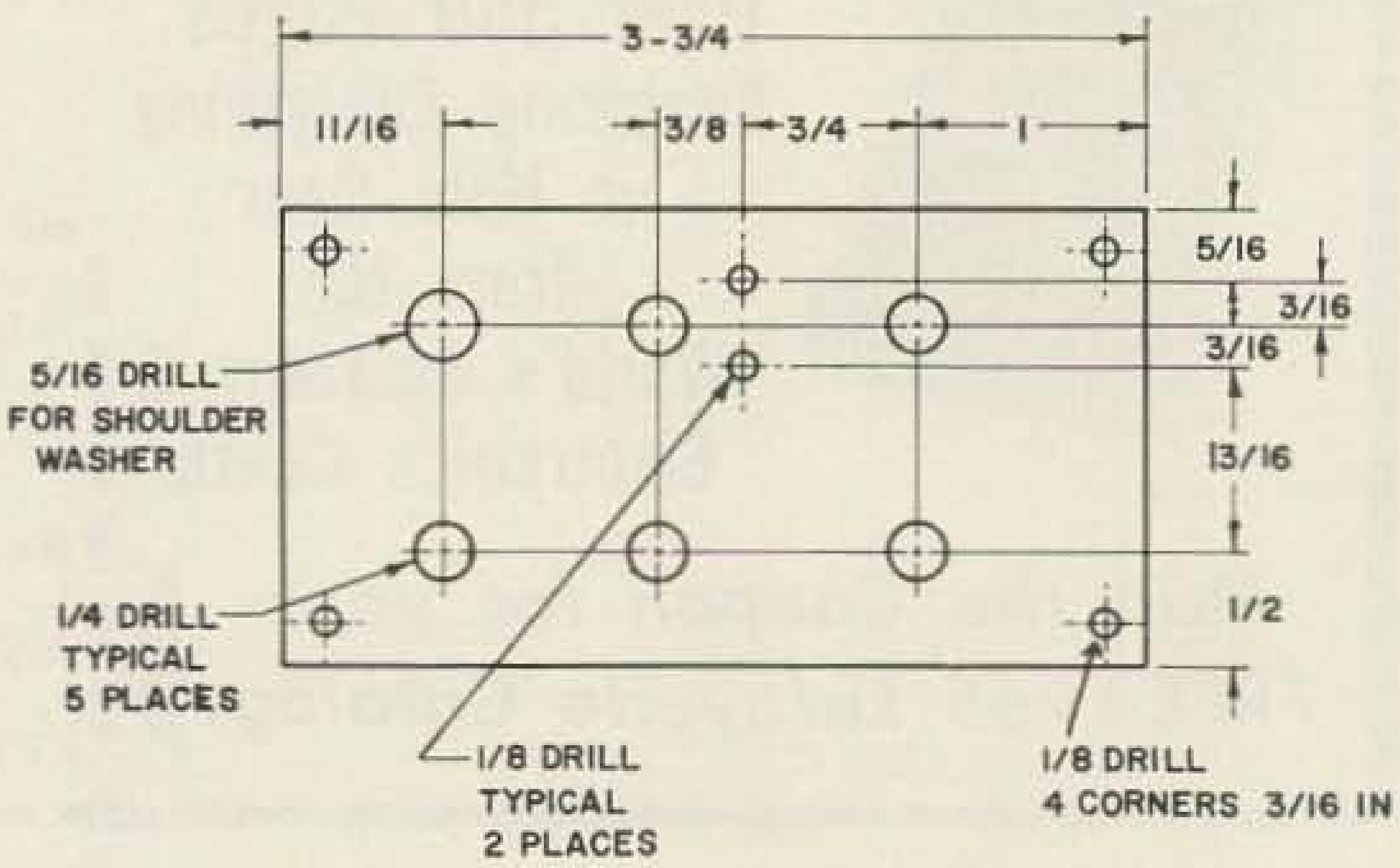
Solder all coils to their respective capacitors, leaving room on L1, L2 and L3 for the diode. You may have to spread the fingers a little after removing the tension bands from the diode holder. Gently push the diode into the holder. Solder the cathode lead to the other side of the board where it comes out. Cut off all but ¼" of the anode lead. Cautiously solder the junction of L1, L2 and L3 to this lead using no more than a 47 watt iron. You may solder normally to the lead of the diode as you would a small resistor, but do not apply heat directly to the diode shoulder.

Run a piece of #18 buss wire from the solder lugs next to the input and output capacitors, C1 and C6, long enough to reach the solder lugs underneath or directly to the body of the BNC connectors. This is to keep the ground path short for max. power out. Next, run a piece of #18 buss from the junction of C1 and C2 to reach the center conductor of the input BNC Connector. Check placement of the output BNC center conductor so that it lines up with its tap point on L5. Before you solder it in, make sure C2 is not grounded from improper seating of the shoulder washers. Insure that all solder connections are clean. Put the assembly in the box, solder the input and output connections and you are ready to tune up.

Tune-Up

A VSWR bridge is the best instrument for tune up, however a wave meter or field strength meter will suffice.

The 2 meter rig should first be tuned up at 144 mcs using a 50 ohm dummy load. Two 100 ohm, 2 watt carbons in parallel on a BNC chassis connector will do. You need not adjust the transmitter again after its tune up. Hook up the SWR bridge, varactor multiplier and 50 ohm dummy load as shown in Fig. 6, using a insulated tuning tool tune C2 for max. forward power on the SWR bridge and C2 for min. SWR. The SWR may still be high indicating that the output circuits are not resonant. Tune C4, C5, C6 for min. SWR and then go back and repeat tuning of C1 and C2. Next, tune C3 for min. reflected power. This adjustment is important so as to suppress radiation at 288 mcs, the second harmonic. It



also gives max. power out due to the mixing action. Go back and peak all adjustments for min. reflected power. The SWR should be below 2:1 with 1.5:1 typical. A wave meter or field strength meter tuned to 432 mcs can be used to peak the output and check for minimum radiation of the second harmonic at 288 mcs. Re-tune C3 for a null at 288 mcs.

Hook up an antenna and you are ready to operate. A word of caution: if you are using more than 8 watts *output,* you run the risk of overheating and destroying the diode. Also you will distort the modulation badly from overdriving the diode. If you are operating a Communicator 4 or higher power, use 2 diodes in parallel or a higher power varactor.

Note
Two'ers-Gonsets 1, 2, and 3's average 3-5 watts output. ARC-1's, 3's and SCR 522's average 5-8 watts output.

Picking The Diode

We usually don't pick our diode since some manufacturers give the hams a price break or as samples through clubs. The following is a comparison between a few of the more popular diodes used in amateur circuits. Most all are available from the various mail order parts houses.

The theoretical efficiency is figured as below:

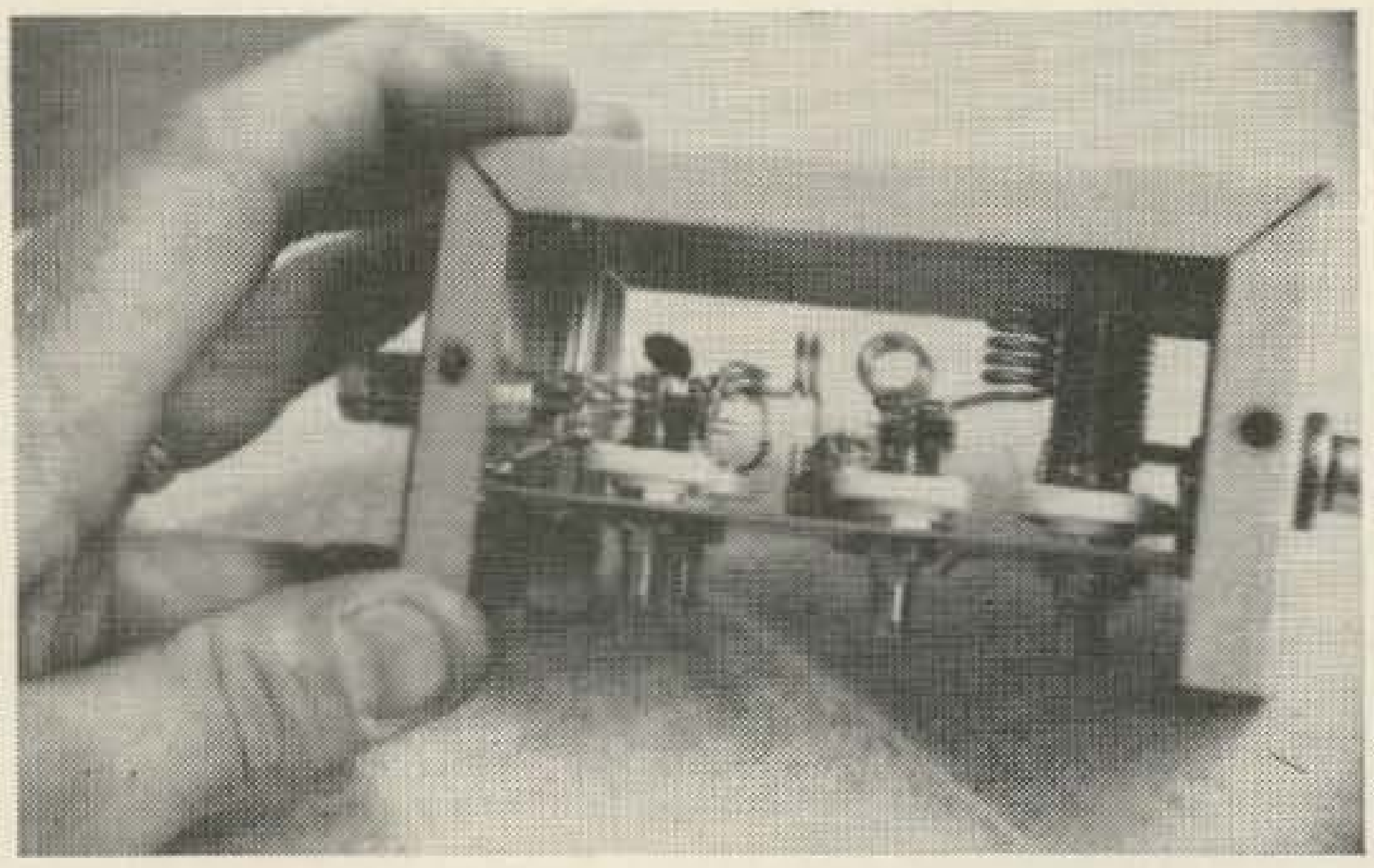
$Q = \frac{F_{co}}{F_{in}}$	MULTIPLIER X2	X3	X4
100	80%	70%	50%
60	70%	55%	35%
30	50%	35%	15%

Fin is the driving frequency. Fco is the cutoff frequency. Where Q = 1 at the voltage breakdown point Vb.
(assuming simple filters capable of 30db spurious reduction)

The prices are constantly being revised downward as more people use them. Effi-

Table I

Manufacturer	Type	Input Power	X3 Efficiency	Price
PSI	PC-116	8 max.	greater than 70%	$12.00
Microwave Associates	MA4060C	10	55%	$35.00
PSI	PV-002	16	greater than 70%	$16.00
Motorola	MV1804	30	50%	——



ciency and power handling are on the increase also. Motorola is experimenting with a pair of 1N4386's driving them with a Johnson Thunderbolt to 300 watts in at 50 mcs and getting 200 watts out as doubler.

. . . . W6ORG

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R. Gromer, Varactor Frequency Multipliers Simplified, personal paper, March 1964.

Parts List

C1, C2—3-32 mmfd variable (Johnson 160-130)
C3, C5, C6—5-1.5mmfd variable (Johnson 160-102)
C4—7.3-1.4 mmfd variable (Johnson Type V)
C7—1 mmfd silver mica (Elmenco DM15-010k)
D1—PSI PC-116 varactor (TRW Electronics)
J1, J2—BNC connector UG-657/U (amphenol)
L1—5 turns #18 copper buss ¼" dia. space wound
L2—3 turns #18 copper buss ¼" dia. space wound
L3—2 turns #18 coper buss ¼" dia. space wound
L4—2 turns #18 copper buss ¼" dia. space wound tap ¾ turn
L5—2 turns #18 copper buss ¼" dia. space wound tap 1 turn
R1—47K ¼ watt carbon resistor
diode holder—Cambion Thermionic type PLS-6 (see text)
tite-fit box chassis LMB J-875

The total cost of all parts is under $22.

Blow up that Meter

(Methods for electrically expanding the scales of dc voltmeters)

C. E. Miller W1ISI
85 Hammond St.
Acton, Mass.

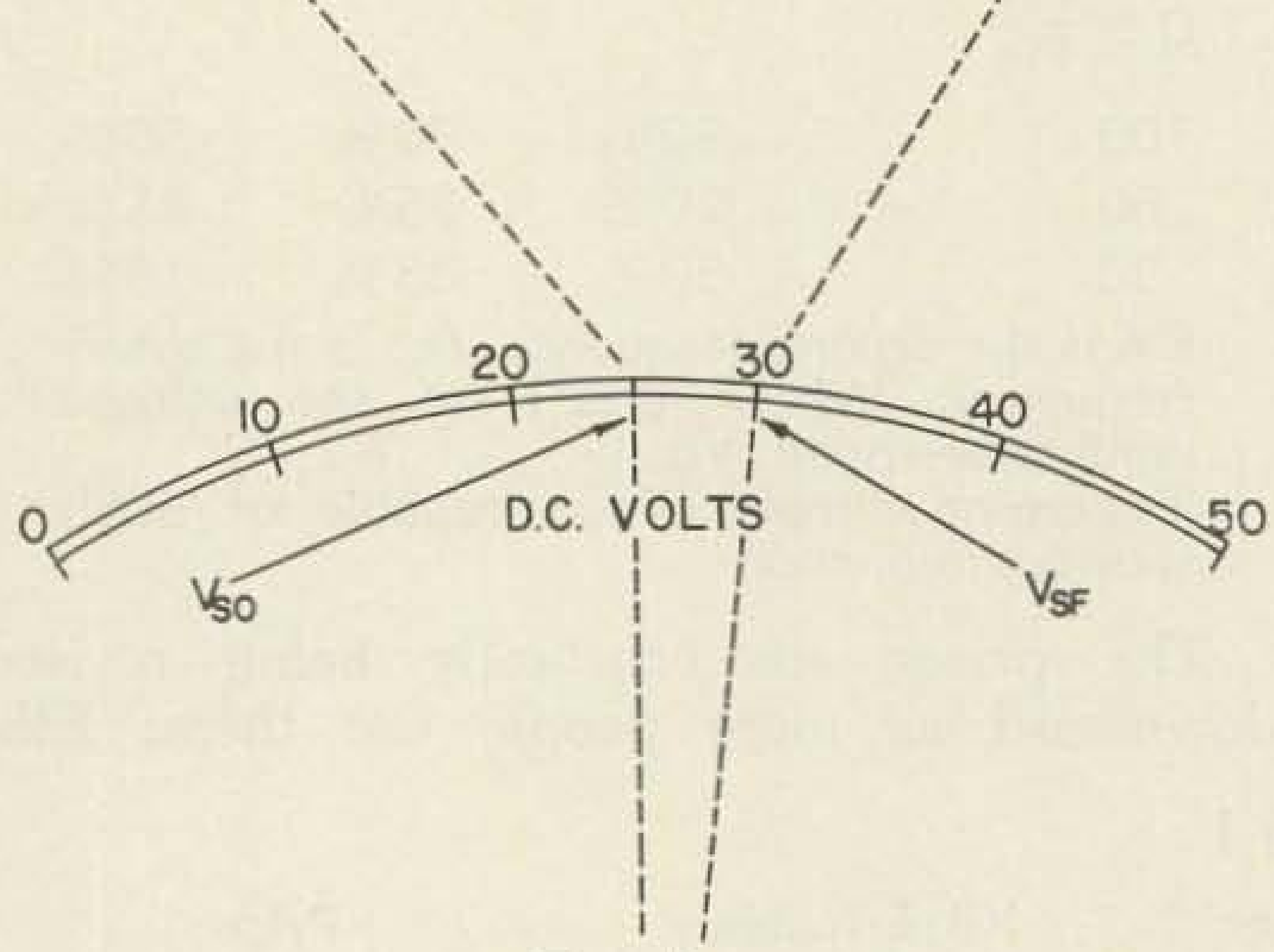

FIG. 1

Electrical expansion of a 2½" long scale to read the 25 to 30 volt dc segment is equivalent to a conventional meter with scale over two feet long.

No, not literally, although it is a temptation sometimes. Take the case of an ordinary panel meter which is used to adjust or monitor a normally constant voltage. To begin with, the meter is only specified to a certain accuracy and has only a limited scale length. The result may be a reading of questionable value and a mild case of eyestrain. As a monitor, small fluctuations from normal may go unnoticed unless one happens to be watching for them. Here again the limited scale length makes it difficult to read the magnitude of the fluctuations. We could place a magnifying glass in front of the meter scale, but you must have guessed that there is a better way. You're right. It's the offset or expanded scale meter. With it we use the entire scale length to read a small *segment* of *the total* range of an ordinary panel meter as illustrated in Fig. 1. The improved readability is obvious. It is also possible to increase the absolute accuracy of the original movement. Two of the many methods of electrical expansion of a meter scale will be outlined. Although the result will be an expanded scale dc voltmeter, the basic meter in either case may be a voltmeter or a milliammeter. The choice of method will depend on

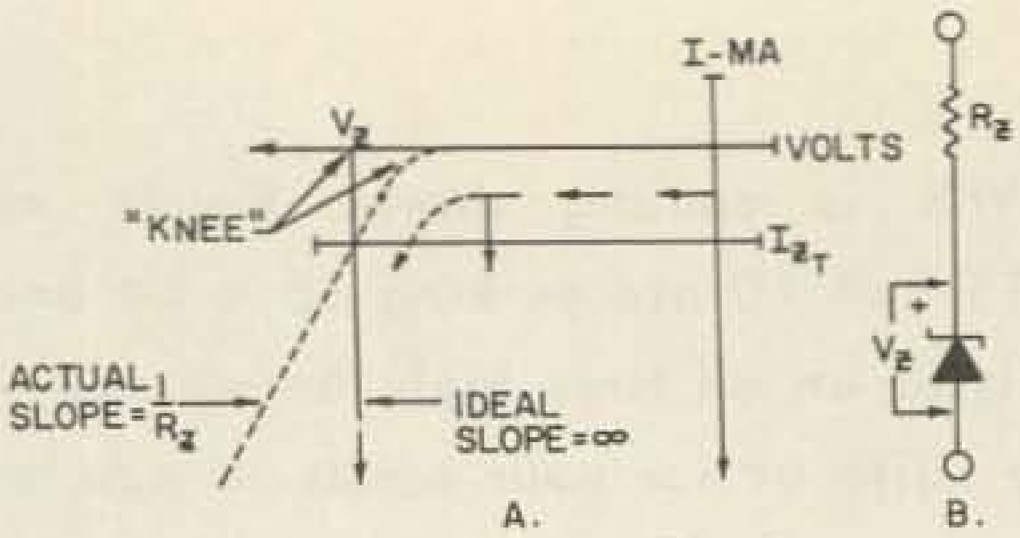

Fig. 2

Fig. 3

Comparison of characteristics of ideal zener diode with practical zener modeled at b). Simple method for expansion of dc voltmeter scale.

the end use of the meter and the desired final accuracy.

Both methods require a source of "offset" voltage. This constant voltage is equal to or less than the smallest voltage indicated on the expanded scale. A few years ago the only relatively simple sources consisted of either batteries or VR tubes. Batteries would be charged to death and their voltage was not constant, requiring frequent replacement. The use of VR tubes limited their application to the expansion of segments of relatively high voltage. The advent of relatively inexpensive zener diodes has made meter expansion both simple and practical. Zener diodes have their problems too, of course, as we may see from Fig. 2a. An ideal zener diode would show no reverse current until the voltage across it was as large as V_z. Beyond the knee, the voltage across the device would not change regardless of the current flowing through it. A practical zener diode on the other hand is characterized by a "soft knee" and an increase in the voltage across it as the current through it is increased. The latter effect is similar to the result we would have if we placed a fixed resistance in series with an ideal zener, as shown in Fig. 2b.

The first and simplest method of meter scale expansion is shown in Fig. 3. Here a voltmeter, typically a high-resistance device, is connected directly in series with a zener diode. The deflection of the meter pointer is proportional to the current flowing through it, but this will be zero as long as V_s is smaller than V_z. When V_s exceeds V_z, current will flow in the circuit, V_z will be a constant, and the meter will see and read the difference between V_s and V_z. For the example shown in Fig. 1, we would thus use a 0-5 volt meter and a 25-volt zener diode. The disadvantages of this system are imposed by the zener diode. The actual voltage, V_z, may be as much as 5-10% above or below the indicated value. Thus, with a zener having an exceptionally sharp knee at 23 volts, a 5-volt meter would indicate a V_s of 23-28 volts. Another problem typically arises due to the soft knee or relatively large change of V_z at low current. This effectively degrades the *linearity* of the expanded scale meter at the low end. This problem is typically worst in zeners of early manufacture and all higher power dissipation types. Best results will be obtained with modern zeners in the 250- or 400-milliwatt class.

The most desirable method of meter expansion involves the use of a simple bridge circuit. Here the peculiarities of the zener diode become relatively unimportant, and we may obtain excellent linearity and accuracy. The final accuracy will typically be governed by the accuracy of the standard we employ when setting two potentiometers. Fig. 4 illustrates the basic circuit which operates as follows. Consider the circuit between points *a* and *b* to be opened at point *x*. The zener diode and R1 form a shunt regulator circuit. Resistor R1 limits the current through the zener diode when V_s is greater than V_z. Under these circumstances, and assuming the zener to have a sharp knee, the voltage at point *a* with respect to point *c* will be equal to V_z. Resistors R2 and R3 form a simple voltage divider across V_s. The ratio of these two resistances will be set such that when V_s is equal to V_{so}, the voltage at point *b* with respect to point *c* will also be equal to V_z. Thus, with V_{so} applied to the input terminals, the bridge is said to be balanced, that is, the voltage appearing at point *b* with respect to point *a* will be zero. The circuit may be closed at point *x* and no current will flow through the meter. As V_s is made greater than V_{so}, the voltage at point *a* with respect to point *c* will not change, but the voltage at point *b* on the voltage divider will increase. Since the voltage at point *b* with respect to point *a* is increasing, the meter will begin to deflect upscale. It is only necessary then to select the values of R2 and R3 to give a null when V_s equals V_{so} and to select the proper

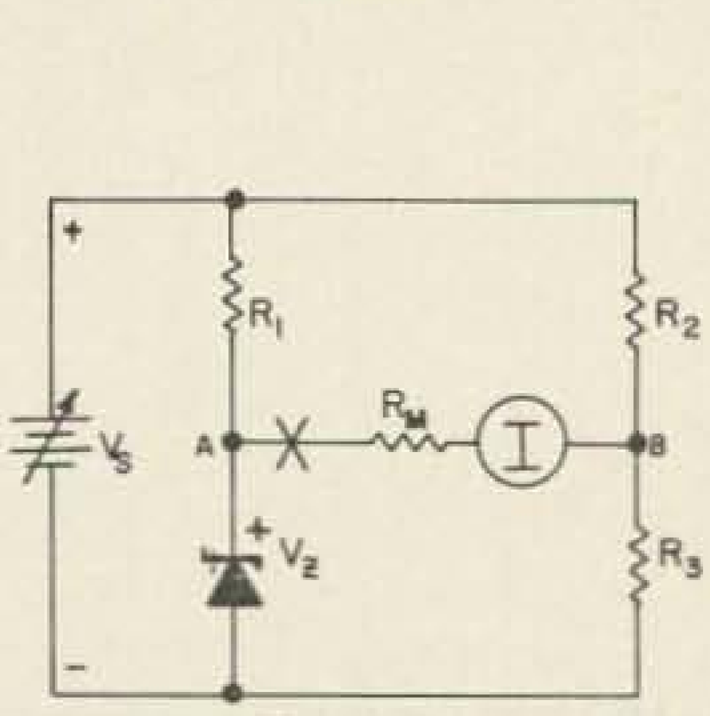

Fig. 4

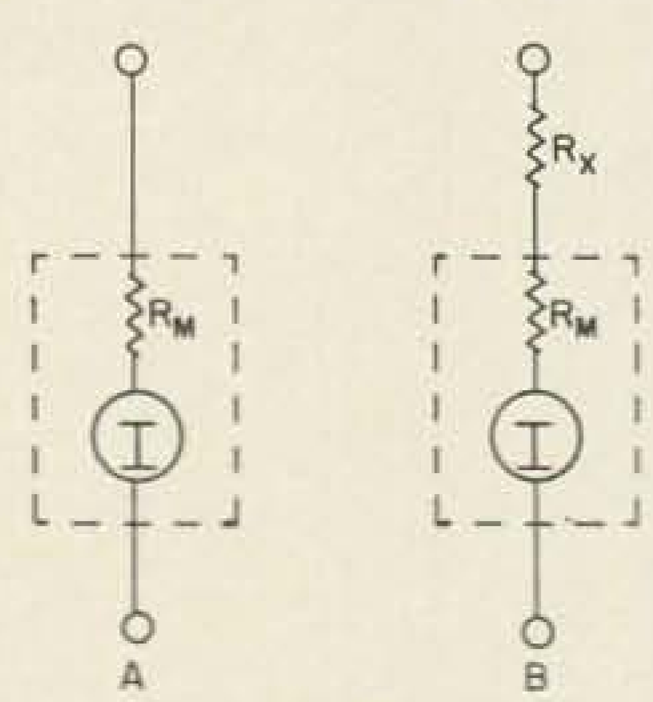

Fig. 5

Simplified schematic of bridge type expansion network. Choice of component values is considerably simplified by experimental determination of zener operating point.

Multiplier resistor R_x turns milliammeter a) into voltmeter b). Expansion of voltmeter may require removal of R_x (see text).

value of R_m to limit the meter current to the full-scale value when V_s equals V_{sf}.

A rigorous analysis of this circuit could be performed to include all the components. This would allow us to determine all values on paper. Because of the variability between zener diodes of the same type, however, rather broad adjustments of some values must be possible. Therefore, it is more practical to consider a simplified approach using less complicated calculations and based on experimental data.

Procedure

First it is necessary to decide upon the segment of voltage (V_{so}, V_{sf}) the meter will read. There are no set rules on this as the circumstances will be different in each application. The segmental range should certainly overlap the range of normally encountered fluctuations. For example, it may be very narrow if a highly regulated power supply voltage is to be monitored. A natural benefit of expanding a meter scale by *this* technique is an increase in the accuracy of the meter. In terms of per cent, this improvement will be approximately

$$\%\ \text{accuracy} \approx \left[\frac{V_{sf} - V_{so}}{V_{sf}}\right] \times \begin{matrix}\text{Basic meter}\\ \text{accuracy}\end{matrix} \qquad \text{Eq. 1}$$

For a 2% meter expanded as in Fig. 1, we could then read a voltage in the range of 25-30 volts to an accuracy of 1/3% full scale. On the other hand, it must be remembered that the meter will require initial calibration, and the standard must be of greater accurary than that of the expanded scale meter.

Almost any type of dc meter can be expanded by this technique. This allows us considerable latitude in the choice of the instrument to be used. One of the most important factors is typically the appearance of the scale. That is, a meter is often chosen such that its original scale calibration has some simple relation to the expanded voltage segment. This may save considerable effort and result in a neat professional appearance. Most panel meters are of the D'Arsonval or moving coil type and therefore have full-scale deflections in the microamp or milliamp range. Fig. 5a illustrates such a meter when run barefoot. The resistance of the wire in the moving coil is represented by R_m. This same meter may be used as a voltmeter simply by adding series resistance as R_x in Fig. 5b. In order to use the simplified equations, it will be necessary to know the full-scale deflection current for the meter movement selected. This may be marked on the scale, even in the case of many voltmeters. If you are not sure, a multimeter

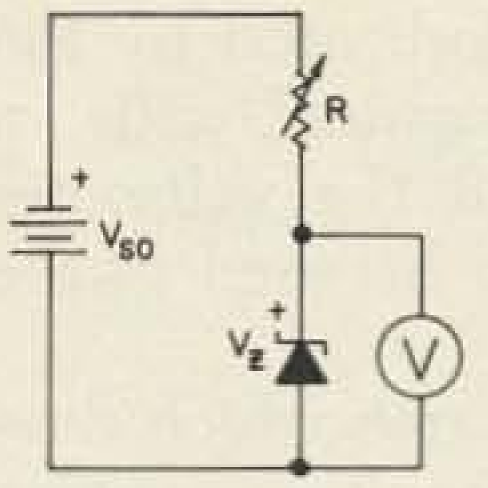

Fig. 6

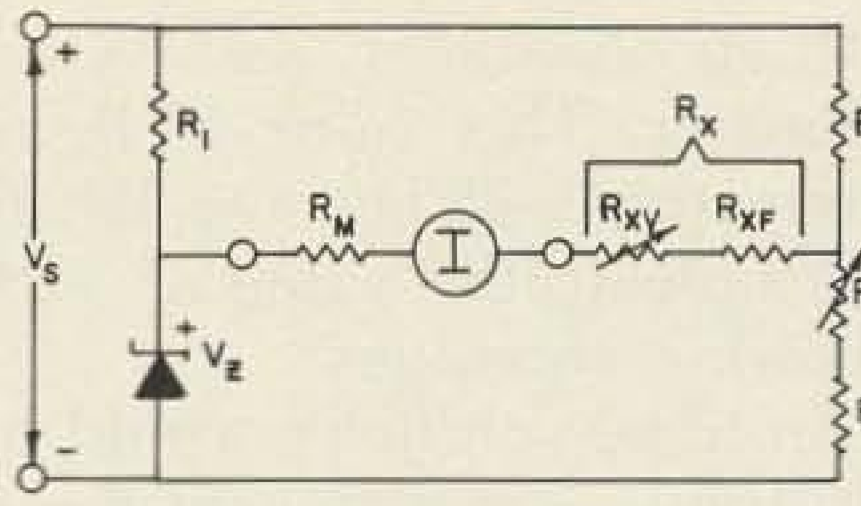

Fig. 7

Circuit for determining zener diode operating point and the value of R_1.
Complete schematic diagram of electrical expansion network.

in series with the movement and a voltage source will indicate the full-scale current with sufficient accuracy. If a milliammeter is to be checked in this manner, *be sure to include a very large value of resistance in series with the source* to limit the current to a safe value. The value of resistance may then be decreased until the needle reads full scale.

The zener diode may now be selected. Here again we will make a simple experimental determination which will enable us to considerably simplify our problem. As was previously stated, V_z should be smaller than V_{so}. For the normal zener diode, a V_z of approximately 6 volts is particularly desirable. This range is characterized by the sharpest knee, the lowest series R_z, and the lowest change of V_z with temperature. If it is felt that temperature effects will be of particular importance, compensated zeners are available in the 9-volt range with exceptionally low-temperature coefficients. Their cost is greater than that of uncompensated diodes and generally will not be worth the added expense. The use of low-powered zeners is advantageous due to their low cost and because they give the appearance of having a much sharper knee at low current than units capable of dissipating much more power.

Since R1 and the zener diode form a shunt regulator circuit, minimum current flows when V_s equals V_{so} and maximum current will flow when V_s equals V_{sf}. The circuit illustrated in Fig. 6 will yield almost all of the required information about the zener diode and resistor R1. The object is to determine the largest value of R which is consistent with a reasonably small change of V_z, indicating that we are operating beyond the zener knee. We begin with a very large value of R. As the value of resistance R is decreased, the voltage V_z seen by the meter should be seen to increase. The change in V_z will become more gradual as R is further reduced. Finally a point will be reached at which further reduction of the value of R will have only a *very* small effect on the value of V_z. The value of R at this setting may be measured with an ohmmeter, and V_z is indicated by the voltmeter. This value of R, measured with an ohmmeter, will become R1 and the voltmeter will indicate the value of V_z to be used in the following equations.

An ideal voltmeter would be one which does not draw current to load the circuit under test. The D'Arsonval meter will draw a known amount of current at full scale which is determined by its internal resistance. The expanded scale voltmeter using the same movement will draw several times as much current. This is one reason for using the largest practical value of resistance for R1. For the same reason we would like to use large values of resistance for R2 and R3. However, two important considerations must be taken into account. First, the ratio of R2 and R3 will depend upon the values of V_{so} and V_z. In addition, the impedance of R2 must be low enough so that when V_s equals V_{sf}, we are able to draw both the full-scale meter current and the current drawn by R3. A reasonable value for R2 is

$$R2 = (0.8)\left[\frac{V_{sf} - V_{so}}{I_{mfd}}\right] \qquad \text{Eq. 2}$$

where the 0.8 factor should assure that we can always obtain a full-scale meter deflection when V_s equals V_{sf}. The value of R3 is then found simply as

$$R3 = \left[\frac{R2\ (V_z)}{V_{so} - V_z}\right] \qquad \text{Eq. 3}$$

It should be remembered that the ratio of R2 and R3 must be such as to balance the bridge when V_s equals V_{so}. Either resistance could be varied slightly for this trimming operation, but it is preferable that R2 be fixed to be sure that the meter will always be able to draw full-scale current at V_{sf}.

Values for all components, except the meter resistance of Fig. 4, have now been determined. Since we know that more than full-scale current will be available for the meter when V_s equals V_{sf}, it will be necessary to add resistance in series with R_m. This resistance will also be variable and determined experimentally, so that I_m is just limited to the full-scale value when V_s equals V_{sf}. The total resistance of the meter will be greater than R_m for the milliameter in Fig. 5a, but may be less than $R_m + R_x$ for the voltmeter of Fig. 5b. The schematic of the final circuit appears in Fig. 7. Before actually constructing this circuit, it is important to estimate the maximum power that will be dissipated by the zener diode, given approximately by

$$\text{max. } P_d \approx \left[\frac{V_{sf} - V_z}{R1} + I_{mfd}\right] V_z \qquad \text{Eq. 4}$$

This power should not exceed the maximum rating given by the manufacturer. It is also wise to consider the effects of other component choices at this time. The most important factor affecting performance of the meter will be the various component temperature coefficients. The effect of the zener diode has already been discussed. The meter itself has a temperature coefficient of resistance, which cannot be altered. Fortunately, this is swamped out by the relatively large value of R_x which will be employed. For reasons of low-temperature coefficient, it is desirable that fixed resistances of the circuit be either metal-film or wire-wound types and that wire-wound pots be utilized for R_{xv} and R4. Carbon-film resistors may also be used, but standard molded-carbon types should be avoided except where the degree of scale *expansion* is small. The value of R4 should be approximately 10 to 20% of the value of R3 found from Equation 3. The value of R5 will then be given by

$$R5 = \left[R3 - \frac{R4}{2}\right] \qquad \text{Eq. 5}$$

The nearest available values for R1, R2, and R5 should be satisfactory due to the available range of adjustment of R4 and R_x.

Assembly

The expansion circuit may now be assembled and tested. The test will require the use of a variable voltage power supply and a good meter, to be used as a monitor. Typically, a 10K pot may be used at R_x for test purposes. The first step is to set the mechanical zero of the meter before any power is applied. The power supply is then adjusted for V_s equal to V_{so}. The meter is then set to zero deflection by adjustment of R4. Note that the meter will deflect downscale if V_s is smaller than

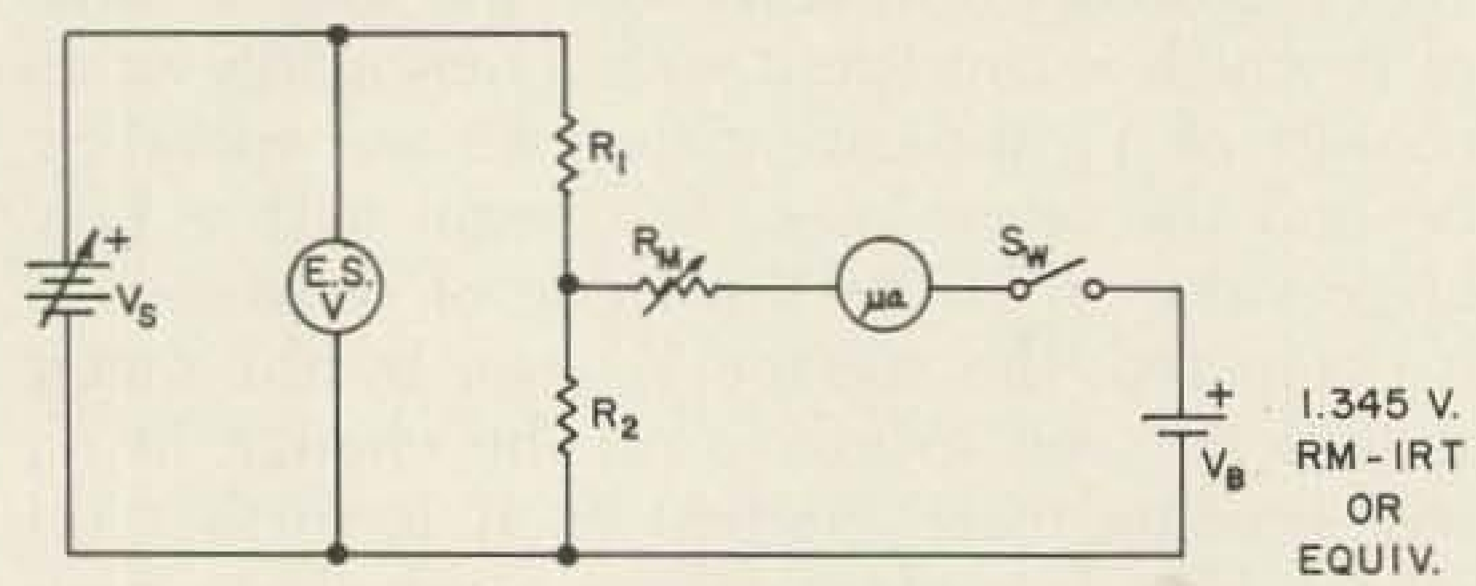

FIG. 8

Circuit for accurate calibration of meter. Resistors R_1 and R_2 should be accurate wire-wound types.

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V_{so}. This is a normal condition and should cause no concern. As was previously stated, the required value of R_x may be less than the internal resistance of the basic voltmeter being expanded. Under these circumstances the internal multiplier resistance must be removed. This requires opening the meter case and usually removal of the scale plate. The meter should not be damaged if this work is done in a clean area, and reasonable care is exercised. The author prefers to short-circuit the multiplier (series resistor) rather than to remove it. The meter may then be restored to its original condition merely be removing the shorting jumper. With V_s equal to V_{sf} it should be possible to adjust R_x for exactly full-scale deflection. The pot may be removed from the circuit and its value measured with an ohmeter. If a large variation of R_x caused a relatively small change in meter deflection, then the final circuit might employ only a wire-wound pot at R_{xv}. If variation of R_x seems to have a large degree of control over the meter current, then most of the resistance in the final circuit should be in R_{xf}, a stable, fixed resistor.
The value of the wire-wound pot will then be

$$R_{xv} = 2\left[R_x - R_{xf}\right] \qquad \text{Eq. 6}$$

Calibration

The value of the wire-wound pot will then be curate only if it is calibrated against a highly accurate standard. A quality laboratory type meter may be employed if available. If not, the familiar bridge circuit may be used as an inexpensive standard. This method will give good accuracy, but will be less convenient to set up. The circuit is diagrammed in Fig. 8. The open-circuit voltage of a mercury cell is the basic reference. The voltage across the expanded scale meter is divided by a precision voltage divider, R2 and R3 and compared to the reference by a microammeter. When the calibration bridge is at null the relation between its voltages and resistances will be

$$V_s = V_B\left[1 + \frac{R1}{R2}\right] \qquad \text{Eq. 7}$$

and must be calculated separately for calibration of the V_{so} and V_{sf} points on the meter. This means that three or four precision resistors will be required. A multimeter set to its most sensitive current range and in series with a 100K or 1 meg pot will suffice as the null indicator. The circuit is first set up with the proper resistors for calibrating V_{so}. The switch must be open and R_m set to its maximum value. With V_s set to approximately V_{so}, close the switch and note the deflection of M_n. Increase or decrease V_s until closing the switch causes no deflection of M_n. Reducing the value of R_m will increase the sensitivity of the null indication. When balance is achieved, R4 in the meter expansion network may be adjusted. The values of R1 and R2 are changed to those calculated from equation 7 for V_{sf}, and the balancing procedure is repeated. The calibration is then completed by adjusting the meter expansion resistor R_{xv} for exactly full scale deflection.

. . . W1ISI

City Life (Ugh)

Mike Schwartz WA2WYJ
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Flushing 55, N. Y.

Putting up an antenna in your back yard is relatively 'easy' because there is no one to stop you (except the XYL).

But if you live in one of the modern New York apartment buildings putting up an antenna may not be quite so easy—or legal. When my parents took this apartment (after living in our own house all my life) they signed a long thin piece of paper called a *lease*—WELL—it said on this unimportant little document that no tenant could put up any antennas TV or otherwise, on the roof, out the window or on the fire escape. Boy, what a position I was in.

Being the kind of person I am, I always learn the hard way

Within a couple of weeks of our arrival in Flushing (Home of the World's Fair) I had the roof of this building looking like the antenna farm you think you need 50 acres of land for. After many hours of work I was

very proud of what I had up there;
A pair of stacked seven element 2 meter beams.
beams.
A big wheel antenna.
A six meter five element beam.
A one element 15m rotary dipole.
A dipole for 80m.
A dipole for 40m.
A dipole for 20m.
A dipole for 10m.

One lovely evening after dinner the doorbell rang. My father went over to open the door and the Super was standing there. To the right of the Super was another man looking crosseyed at me. I was then informed that he was the lawyer the building had hired to take care of people who don't take care of themselves and fail to live up to the conditions stated in the lease. They both informed me that I was breaking the lease by having antennas up on the roof and instructed me to take the antennas down or I would probably get a summons from the fire department. I said to myself after they left that I would take the damn antennas down after the sked I had planned on two meters. The band was so great that night that I never got around to take down the antennas.

No one bothered me for about two months then I heard from the greatest fire department in the world (so they tell me). That night all my beautiful antennas were now down. The only things I had now was the big wheel under my bed.

In New York City apartment buildings there is an old custom that the Super of the building gets a tip from most tenants Around this time the Super is the nicest man in the world. One day my parents gave me an envelope to give the super. Upon receipt of this generous check he told me it would be alright if I put up a small dipole on the roof, he also told me that I could use the master TV antenna as a transmitting antenna. I tried to tell him that I would blackout every TV in the building out he would not listen.

After he received about a hundred complaints from potential tip givers he suggested that I put my old antennas back up and he would take care of the men from the New York Fire Department if they ever came around.

By the way the transmitter I hooked up to the master antenna was the little six meter transistorized transceiver described in the May 1963 issue of 73.

. . . WA2WYJ

Crystal Refrigerator

Robert Robbins K3HTB
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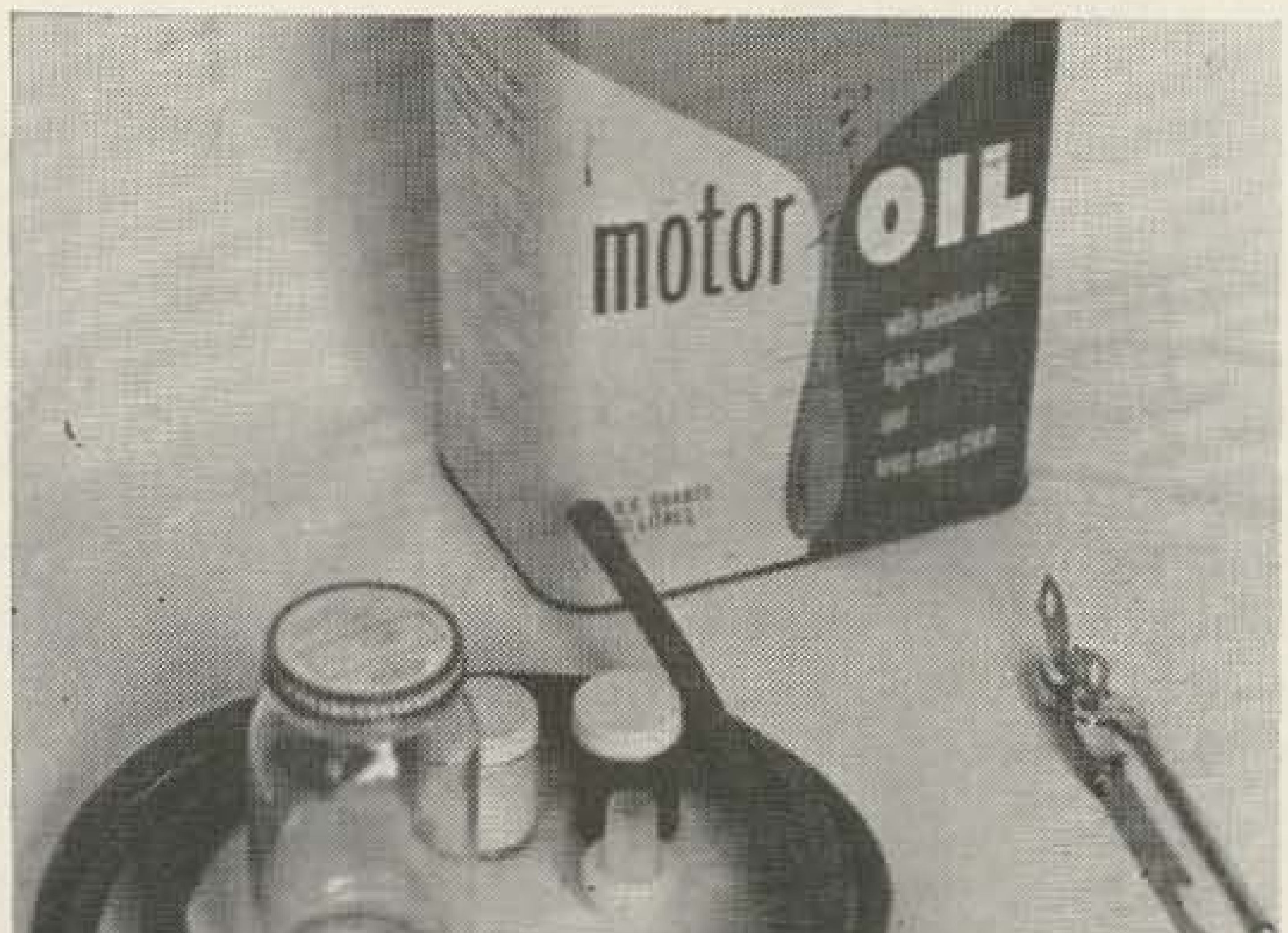
Dover, Delaware

Living in apartments, particularly on the third floor as we do, has many notable disadvantages for the amateur. The lack of adequate grounding facilities and limited antenna space (or any space, for that matter) are two of the more salient problems. On the credit side, however, they're cheaper: allowing more money for equipment. They don't have lawns to mow: allowing more time for operating. Living on the third floor also means shorter cables to my 1296 mc dish on the roof.

Everything seemed fine, that is until I read about K2TKN's Ultra-Stable Xtal Oscillator (73, Feb., '63, pg. 27). Coming up with a similar oscillator wasn't hard, but running a coax line from the third floor to the ground was something else (finnicky landlord). Anyway, encapsulating the oscillator in a thermos and burying it several feet underground meant chopping through eight inches of concrete—definitely out of the question, and I couldn't afford a crystal oven (finnicky XYL).

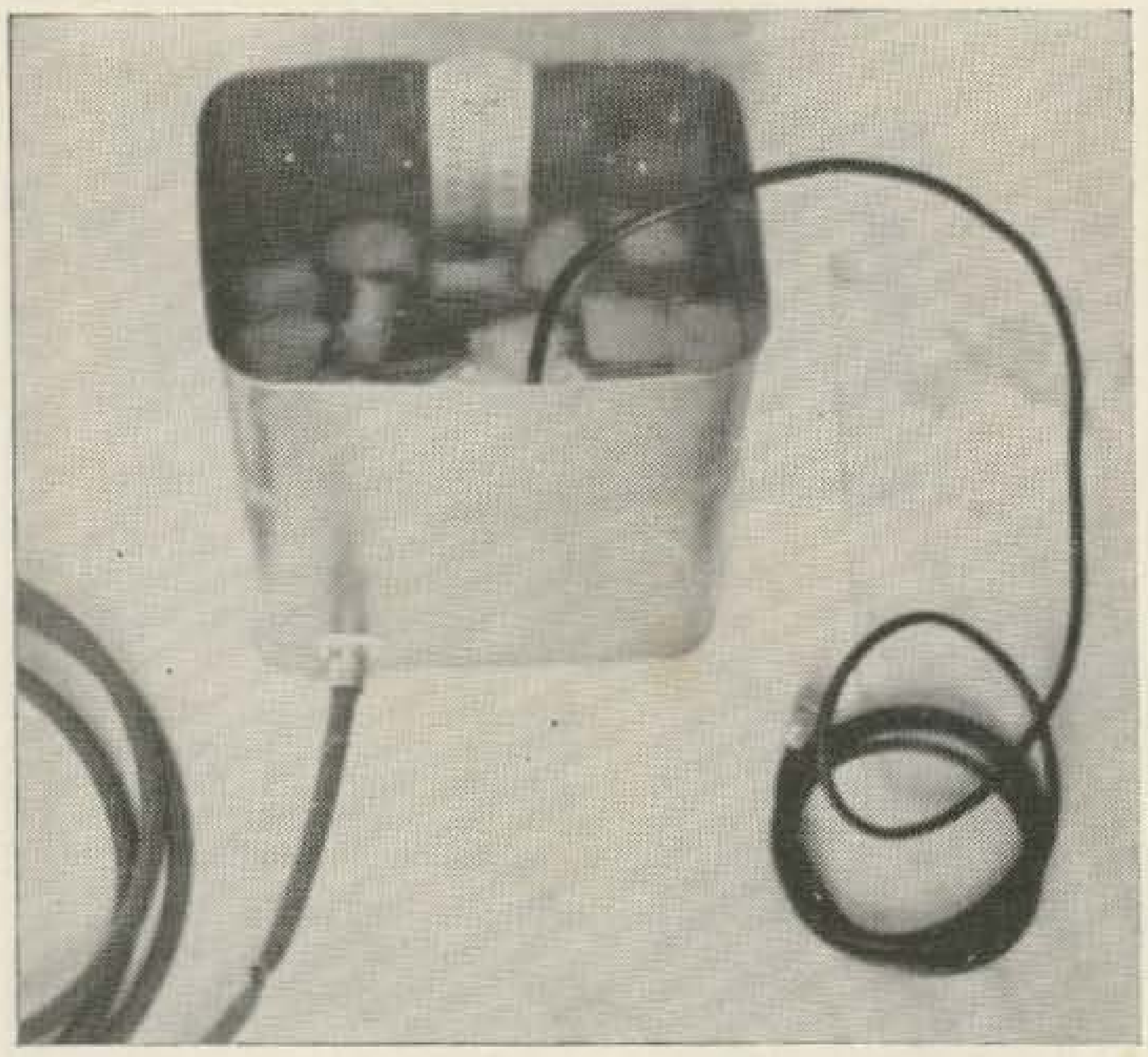


It looked like I was going to have to rely on our wall thermostat for my temperature stabilization, indeed, a sad state of affairs. Then I began thinking: look, the main purpose of a crystal oven is to maintain a *constant* temperature, not necessarily a particular temperature, but a constant one. K2TKN's idea of burying the oscillator was to utilize the near constant temperature of the earth several feet underground, not an attempt to achieve any specific one.

Not being in a fortunate enough position to use this method, I was forced to find another one, and there are other constants. The boiling point of water is one, but not desiring Transistor Newburg, I turned to another one: the freezing point of water or melting point of ice. They are both the same, but I won't go into a discussion of vapor pressures and equilibrium. When ice is melted in water, the solution will gradually reach a point of equi librium at 0° C. The temperature may vary plus or minus depending on the mineral content of the water in your area, nevertheless it will be a constant temperature.

What was needed then was a means of immersing the circuit in a bath of ice, and an enclosure to protect the oscillator. Also, it would be a good idea to have a thermometer to show that the temperature was remaining constant. As can be seen from the pictures, the only items necessary are a two gallon oil can for the ice, a mason jar to seal the oscillator in, and a convenient length of plastic garden hose with a fitting. The two little jars in the picture are the ingredients for mixing up epoxy glue.

A hole, just large enough to slide the coax through without damaging the insulation, is punched through the top of the mason jar lid. After sliding in the coax, seal around the hole with the epoxy (or rubber cement). When the cement dries, it's a good idea to screw the lid on the jar and test it in water before placing the oscillator inside. A small



fishing sinker may be needed for balast to keep the jar from floating.

The tank was made by cutting the top off of the oil can with a can opener (what else?), punching a hole near the bottom for the hose coupling, and sealing this with epoxy. The hose is used to drain off the excess water when more ice is added, and avoids the mess of trying to scoop it out with a cup. I borrowed (permanently) a large Bobby-Pin from the wife and bent it so that it could be used as a hose clamp. A shot of quick-drying copper spray paint completed the job.

Note that these are all items found around the average house and that any convenient substitute could be made. I had originally intended to use a picnic-size thermos jug, but the one we have doesn't have a large enough opening to receive the oscillator circuit. As it is, two trays of ice cubes to a gallon of water last about two hours. An open thermos could possibly double this. Temperature stability is achieved within twenty minutes, at most, and the resultant stability of the unit is excellent.

. . . K3HTB

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All About Noise Figure

"I don't believe in noise figure! The only measurement of receiver sensitivity that means anything to me is how many microvolts of signal my receiver takes before I can hear it."

This emphatic statement from a supposedly well-versed VHF enthusiast started us on a detailed examination of the whole idea of noise figure as a measurement of receivers—and we came up with some surprising discoveries, as well as no small amount of confusing data. And in view of all this, it struck us that it is again time for a detailed, *non*-confusing look at the subject.

Most surprising of the discoveries we made was that the attitude of disbelief was not unique to the one person who triggered our probe—several manufacturers, privately, admitted to sharing this opinion. It appears that, although the concept of noise figure as a measurement of receiver sensitivity has been around for nearly 20 years, it has been so surrounded by confusion that many people have simply rejected it rather than try to cut their way through the morass of conflicting data.

So let's try to cut it free of the confusion, once and for all. Ready? Let's go.

First, what is all this noise jazz anywey? We're all familiar with the fact that sometimes an incoming signal is just too weak to hear. "Down in the mud is the usual expression for such a situation. But what's "the mud?" Nothing but noise.

This noise is of the "hiss" type, rather than sputter or crash, and originates from the fact that electrons are always in motion at all temperatures greater than absolute zero. The higher the temperature, the greater the motion. Since the individual electrons don't think, there's no purpose behind their motion—or, in other words, the motion is random.

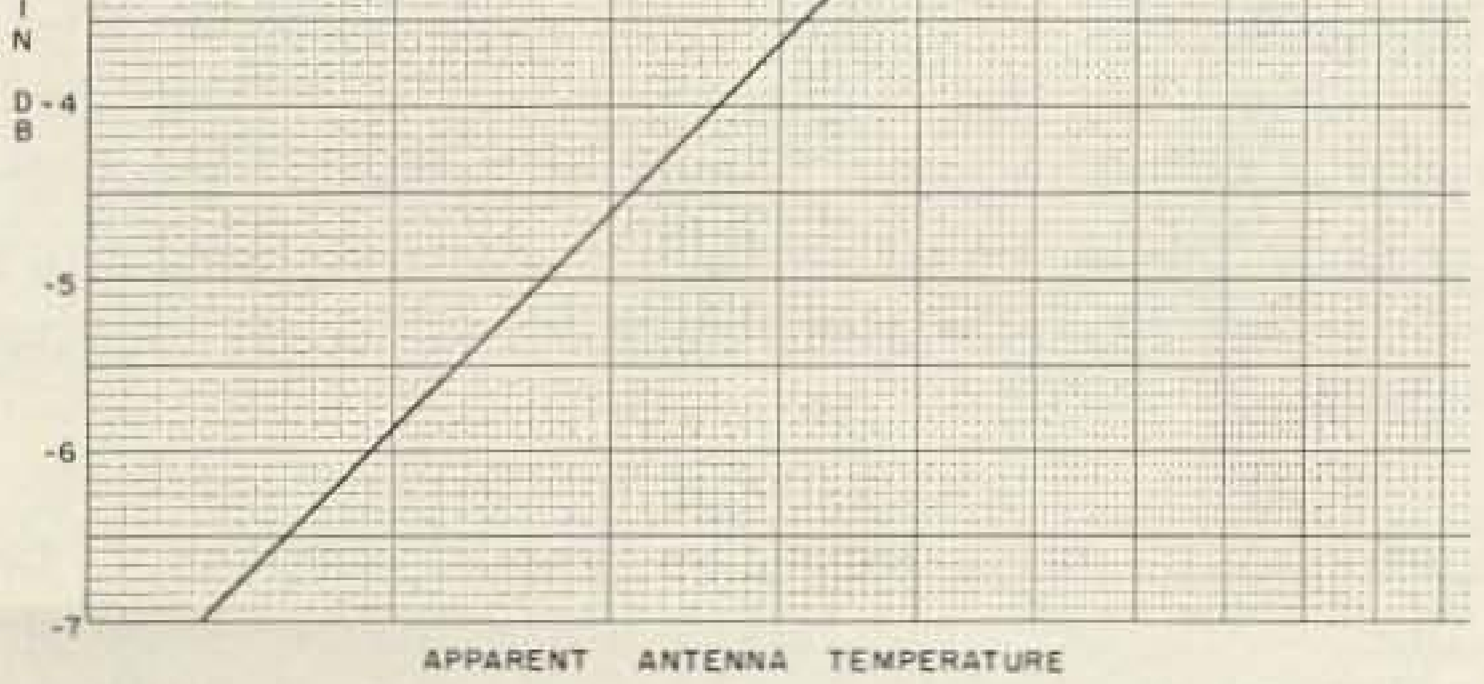
But every motion of an electron gives rise to a slight electrostatic voltage, which in a closed circuit becomes a normal voltage. The motion of a single electron results in a voltage so slight that it's of interest only to theoreticians—but any electric circuit contains millions of billions of electrons, and the total of all their votages at any given instant measures up close to a microvolt. This is well within the range of detectable signal, with enough amplification in use.

Since the motion of each electron is random, the resulting total voltage will consist of random amounts occurring at random times; it's completely unpredictable, and appears as simply a hissing sound in a speaker or as snow on a TV screen.

This "thermal noise" is distributed equally from zero frequency all the way up to (and past) the frequencies of light waves, so that no matter what part of the spectrum a receiver is tuned to, it will find some thermal noise.

And since the noise is distributed equally, it stands to reason that the wider the slice of spectrum you are listening to, the more noise you're going to get. That is, if you have all the selectivity in and are hearing a slice of spectrum just 10 cycles per second wide, you're not going to find as much noise there as you will in a slice 10,000 cps wide.

This result—the theoretical boys talk about it in terms of "noise bandwidth"—shows us what's wrong with absolute microvolts as a



Converting measured NF to apparent antenna temperature (see text). Example: If noise figure measures to be — 2.8 db, apparent antenna temperature is 150°K.

measure of receiver sensitivity.

To make it more clear, let's take an example. Suppose you have a receiver which is capable of good copy on a CW signal only 0.01 microvolts in strength; this would be an excellent receiver. If noise happens to be distributed over the slice of spectrum in which the signal is located at the rate of 0.001 microvolt per cycle-per-second of bandwidth, though, (and this is just an example—don't quote it as being fact, since actual noise is not nearly so predictable) then at a selectivity setting which gives you 10 cps bandwidth, the noise coming in will be 0.01 microvolts and the signal will be at the same level. Your signal-to-noise ratio will be 1 to 1, which is difficult copy. If bandwidth is cut to 1 cps, S/N will climb to 10 to 1. But if the bandwidth is expanded to 100 cps, the signal will be only one-tenth as strong as the noise—it will be so far in the mud that you stand only a ghost of a chance of ever telling it's there.

Now there's nothing wrong with the microvolt idea—*if* and only if the "noise bandwidth" of the receiver is specified at the same time. But without knowing the noise bandwidth, the sensitivity in microvolts tells you nothing at all!

And the rub here is that "noise bandwidth" is not the same as the ordinary bandwidth we all know. To determine "noise bandwidth" you have to solve an integral equation involving differential gain, and who wants to use calculus every time the receiver sensitivity must be measured?

Still, many people like to talk about sensitivity in terms of microvolts, since this quantity is relatively easy to measure. It doesn't hurt at all, if the noise figure is also given. Or if the noise bandwidth is given. But microvolts alone tell nothing about the weakest signals you'll be able to hear.

So how's with noise figures? The concept of noise figure was first described in 1944 by H. T. Friis, writing in the Proceedings of the IRE, and has come into wide use in the ensuing years. But can you define exactly what it is? If you can, you're doing considerably better than most people.

Even the engineers who deal with the concept daily vary quite a bit in their definitions. According to the 4th Edition of "Reference Data for Radio Engineers," page 375, noise figure is the ratio of available signal to noise at the input of the receiver to the available signal to noise at the output. According to the instruction booklet for the Polytechnic Model 904 Noise Generator, a laboratory type instrument, noise figure is the ratio of actual receiver output noise power to that developed by an ideal receiver. The ideal is not defined.

The common definition most often heard is that noise figure is the ratio of actual receiver noise to the noise of a perfect noiseless receiver. This approaches the idea but the statement itself has no meaning; the ratio it describes is N/O, and any number divided by zero is indeterminate.

Other definitions include "the ratio of output noise to input noise, divided by available power gain (4th Edition Reference Data, page 769) and "the ratio of carrier power available from the antenna to the theoretical noise power when mean noise power and carrier power are equal." And after that last mouthful, the people who don't believe in noise figure can hardly be blamed!

But the most accurate definition is the one we started with: noise figure is the ratio of input S/N ratio to the S/N ratio at the output. In a noiseless receiver, there would be no change in S/N ratio as the signal went through, and the noise figure would be 1. But all practical receivers of the conventional type introduce at least a little noise, which is added to both incoming signal and incoming noise alike, so the output S/N ratio is poorer than that at the input. This yields a noise figure greater than 1; in a very good receiver, it will be somewhere between 1 and 2.

These "noise figures" don't agree at all with those you normally see quoted, for a very good reason. The "noise figure" we are using at this point is a ratio only; it has no dimensions or units. In general use, however, this ratio is expressed in db. A ratio of 2 (in power, which noise figures are) is expressed as 3 db, while a ratio of 1 is 0 db. So the theoretically perfect receiver has a noise figure of 0 db, while a good one has between 0 and 3 db.

Now we have a noise figure in db. What does it mean? We saw earlier that the weakest signal a receiver could pick up was limited by noise, rather than by sensitivity in microvolts. We also saw that the amount of noise was influenced by the "noise bandwidth." The importance of noise figure is simply that it makes "noise bandwidth" cancel out, and thus indicates directly the relative sensitivity of the receiver.

That is, if you have two receivers side by side, and each has the same sensitivity in microvolts but one has a noise figure of 3 db while the other has a noise figure of 6 db, a weak incoming signal which is right at the noise figure of 6 db, a weak incoming signal which is right at the noise level on the 6 db receiver will be 3 db above noise level on the 3-db receiver, and will thus be considerably easier to copy. Continuing, a signal which is right at the noise level on the 3 db receiver will be way down in the mud on the 6 db receiver, and probably cannot be copied at all.

It's important at this stage to note that the noise figure indicates the *best* performance of which the receiver is capable, and this does not necessarily correspond with the result you'll actually get in practice. In the above example, if you were trying to read a CW signal with the selectivity controls set for 10 kc bandwidth, the signal could have been boosted well out of the mud on either receiver simply by narrowing the passband to remove the unneeded bandwidth and its noise contribution. Signal to noise ratio can be improved some 17 db this way in copying CW as compared to fone.

But when both are set for the same selectivity, and both have the same gain, the receiver with the lower noise figure will hear the weaker signal, while the other one loses out.

We can see from this that noise figure in itself doesn't seem to have much meaning either—but noise figure can be given along with total receiver gain, with microvolt sensitivity, or with receiver output level, as a measure of a receiver's ability to pick up weak signals.

We really don't have to go so far to see that noise figure *alone* has little meaning; a piece of hookup wire an inch long or so will have a noise figure of 0 db, but it won't be much of a receiver. The important thing is noise figure *plus* gain.

In view of this, the high emphasis on low noise figures might seem a bit useless except for one thing. To bring out this reason, we have to sidestep a moment and look at gain and noise separately.

If a signal is relatively free of noise, and if we have a noiseless amplifier (it's not possible, but don't worry about it), then we can get all the gain we need with no trouble.

If the signal is buried in noise when our noiseless amplifier gets it, we can't do much good. The noise will be amplified as much as the signal, and the result, though loud, will be just as unreadable as ever.

A paragraph back we said the noiseless amplifier was impossible. However, if the noise contributed by the amplifier is 60 db or more below the level of the incoming signal the amplifier is for all practical purposes noiseless. The amount of noise added will be so small in comparison with the signal that we will never hear it, and will have difficulty in even measuring it.

So the practical problem is how to get the signal some 60 db greater than the noise without adding more noise in the process. Actually, the 60-db figure is a broadcast-standard ideal. For ham purposes, where we can tolerate quite a bit of noise, 10 to 15 db is often considered enough.

Let's try an example to see how things work. Assume the signal is at a level of 1 microvolt and that each amplifier stage along the way adds 0.1 microvolt of noise. In addition, let's say that each amplifier stage has a voltage gain of 3.2, and that the signal coming from the antenna has no noise at all.

Input to the first stage will be 1 microvolt of signal and 0 microvolts of noise; this stage amplifies the signal to 3.2 microvolts and adds 0.1 microvolt of noise to the output.

The second stage receives 3.2 microvolts of signal and 0.1 microvolt of noise; it amplifies this to 10 microvolts of signal and 0.32 microvolt of noise, and adds another 0.1 microvolt of noise of its own to bring the noise content to 0.42 microvolt.

The third stage brings things up to 32 microvolts of signal and 1.35 microvolts of noise, and adds another 0.1 microvolt to the noise to give us 1.45 microvolt in the output.

Similarly, fourth-stage output will have approximately 100 microvolts of signal and 4.73 microvolts of noise. You can see that the ratio of noise to signal is continually increasing. It began at zero, was 1/32 at the output of the first stage, and by the fourth-stage output had climbed to 1/21.

But with the specific figures we have been using, the signal is still a little better than 21 times as strong as the noise after four stages. This gives us a signal-to-noise ratio of about 23 db, which isn't bad.

Let's go back and try a 0.1 microvolt input signal. First stage output is now 0.32 microvolts of signal and 0.1 microvolt of noise. Second stage output is 1 microvolt of signal and .42 microvolt of noise. Third stage gives 3.2 microvolts signal and 1.45 microvolts noise, while fourth stage gives about 10 microvolts signal and 4.73 microvolts noise. The signal is now only 2.1 times as strong as the noise, for a S/N ratio of 3 db, although it was noiseless when it entered the receiver.

We can see also that every additional stage of amplification *hurts* the signal-to-noise ratio in this case, because more noise is added in every stage.

Had the gain per stage been higher, or the noise added in each stage lower, the original purity of the signal would have been more closely maintained.

Let's see briefly how it would work with a stage gain of 10, the 0.1 microvolt input signal, and all other conditions the same as the previous example.

First stage output would be 1 microvolt of signal and 0.1 microvolt noise; second stage would give 10 microvolts signal and 1.1 microvolt noise; third stage would be 100 microvolts signal and 11.1 microvolts noise; and fourth stage would be 1000 microvolts signal and 111.1 microvolts noise.

Signal-to-noise voltage ratio at the output of the first stage would be 10 to 1. At the second-stage output, it would be 9 to 1. At the third, 9 to 1 also, and at the fourth, still 9 to 1.

Compare this with the second example. There, signal-to-noise voltage ratio after one stage was 3.2 to 1, after two was 2.38 to 1, after three was 2.2 to 1, and after four was 2.1 to 1.

And in the first example, after the first stage S/N voltage was 32 to 1, while after four stages it had dropped to 21 to 1.

This indicates that for good performance we must have good gain per stage; with the third example, the signal-to-noise ratio for a weak signal stayed fairly constant at about 9 to 1 regardless of the number of stages. In the earlier examples with less gain, S/N ratio got worse with every stage.

Before we get away from the numbers game, let's try one more example. This one is more complicated. It assumes that the first stage has a voltage gain of 20 and contributes 0.1 microvolt of noise, while the remaining stages have voltage gains of 10 and contribute 0.2 microvolts of noise per stage. As before, the input signal is noise-free, and we'll try it at the 0.1 microvolt level.

Output of the first stage will consist of 2 microvolts of signal and 0.1 microvolt noise, for a S/N voltage ratio of 20 to 1.

Output of the second stage will be 20 microvolts of amplified signal, 1 microvolt of amplified noise, and 0.2 microvolts of new noise. S/N voltage ratio is now 20/1.2 or 16.7 to 1.

Third-stage output will be 200 microvolts of signal, 12 microvolts of amplified noise, and 0.2 microvolts of new noise. S/N voltage ratio becomes 200/12.2, or 16.4 to 1.

Following the same pattern, fourth-stage output will be 2000 microvolts of signal and 122.2 microvolts of noise; S/N will be about 16.38 to 1.

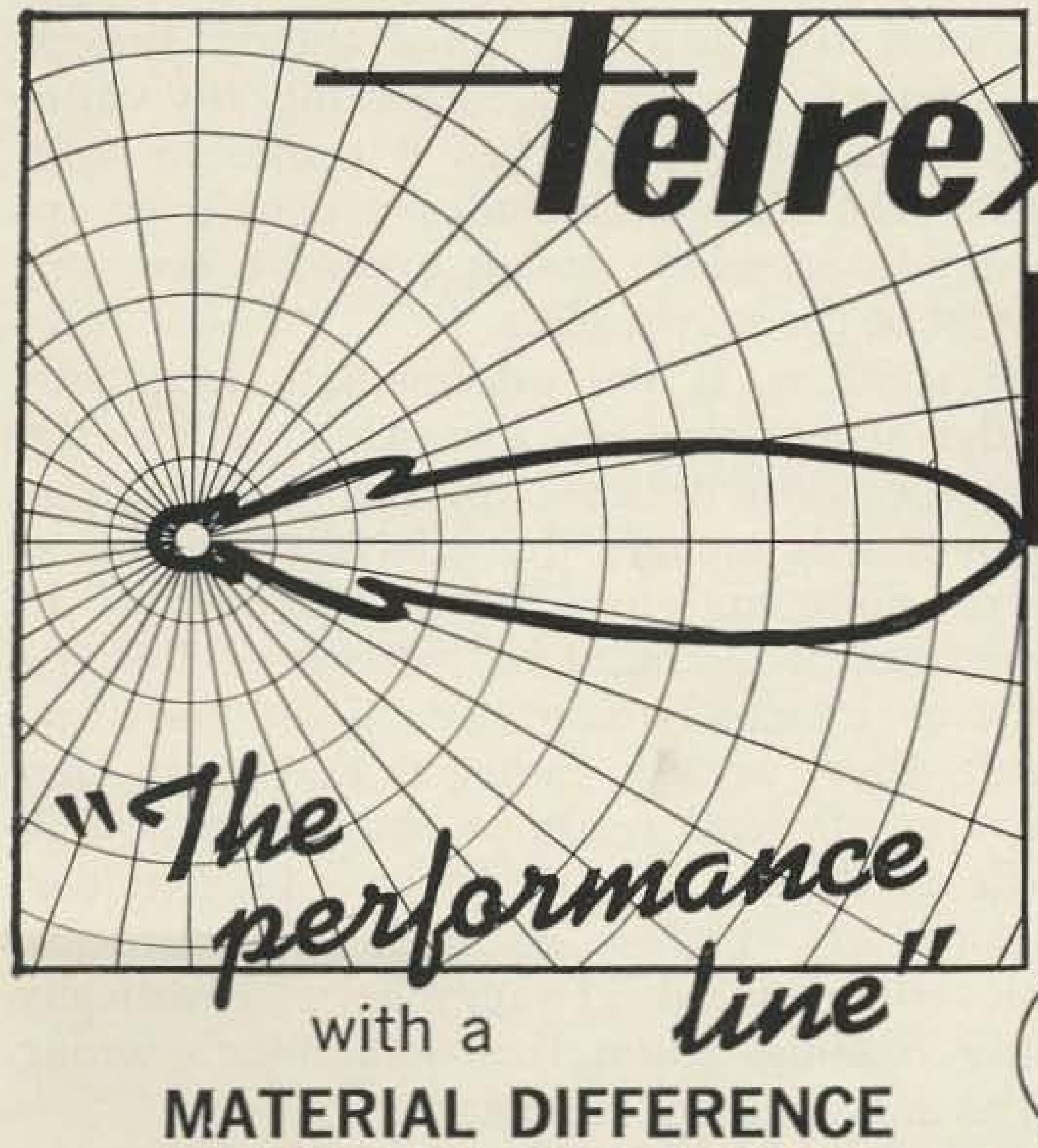
Note that after the first drop from 20-to-1 to 16.7-to-1, the S/N ratio doesn't suffer applicable degradation from that point on down the line. Even after a dozen or more such stages, the S/N voltage ratio should still be better than 15 to 1, which is a db value of more than 20 db! And this will amplify stages having individual gain to noise ratios of 50.

The difference here was in the use of a high-gain, low-noise first stage. It set the S/N ratio, and the following stages didn't do much to change it.

To get back to our subject of noise figures, this means that if one stage has a good noise figure and sufficient gain, the later stages need not have such good noise figures and can be designed with only gain in mind. To put it into a bit of engineeringese, the total noise figure of two stages in cascade is equal to the noise figure of the first stage plus the quotient of the noise figure of the second, minus one, divided by the gain of the first. This formula is *not* in decibels.

This information takes care of our little piece of hookup wire with a 0-db noise figure. It has zero gain also, so if we consider it to be a stage and follow it with a noisy amplifier, the total noise figure will be (converting from db back to ratio figures) noise figure of the wire, 1, plus noise-figure-of-second-stage-minus-one divided by gain of wire, 1. Which all boils down to the fact that the total noise figure will be that of the second stage alone.

It also brings out clearly the idea that the noise figure of the first stage, alone, sets the noise figure of the entire receiver. The second stage noise figure may degrade it, if first-stage



gain is not great enough, but nothing can improve it.

And here is the importance of the emphasis on noise figure. It provides a measurement of the relative merit of two different circuits, which is not dependent in any way on noise bandwidth present, and which tells us instantly which of the circuits will degrade the incoming signal the least. By using the stages-in-cascade formula, we can avoid being trapped by the 0-db noise figures of small chunks of wire, but we will always know that a 0-db noise figure indicates a better front end than a 3-db noise figure does, and so forth down the line. And when noise figure is measured through an entire receiver, the gain problem is automatically taken care of. If noise figure measures low, then the receiver has to have enough gain to make use of it! If the gain is too small, the noise figure simply won't be low regardless of how little noise is actually added by each stage in the receiver.

So now we know what noise figure is and what its importance amounts to. But we don't know yet the noise figure of our favorite receiver. How do we find this out?

It's fairly apparent that the only way to really find out is to measure it, since calculations could at best show only what it *might* be. But how is the measurement carried out?

Noise figure measurement involves the use of a noise generator. This, briefly, is a gadget which produces known amounts of noise. Two general types of noise generator are in use today; the first uses a silicon diode or other semiconductor as a noise source, while the second uses a "temperature limited vacuum diode."

The semiconductor noise generator is fine for rapid alignment or touch-up of a front end, but is useless for noise figure measurement since its noise output cannot be determined accurately. In other words, it is a *comparison* device rather than a *measurement* device.

The noise output of a "temperature limited vacuum diode" noise generator, on the other hand, follows a known mathematical rule. By measuring the current flowing through the diode, the noise output may be calculated almost exactly.

Don't let the long name of the device scare you off; several good ones have been described in the ham literature lately, and are cited in the references at the end of this article.

The technique of making the measurement is to connect the noise generator to the receiver input but leave the generator turned off, and take a reading of the noise output of the receiver. The generator is then turned on, and its noise output increased until the noise output of the receiver doubles. Since we're working with noise *power* rather than voltage, this will be a 1.414-time increase in voltage. A more accurate method is to introduce 3 db loss in the receiver, such as between the converter and the receiver itself, and adjust noise generator for the *same* indicated output. This avoids the problems of detector linearity and meter accuracy by using the detector and output indicator simply as comparison devices.

In either event, when the noise output from the generator causes the noise output of the receiver to be double that with the generator off, it's fairly obvious that the noise generator output is at the identical level as that of the receiver's own internal noise. To put it mathematically, what plus one equals two?

And with the amount of the receiver's noise determined, you have the noise figure. To get the reading in db, you simply work the equation: $NF_{db} = 10 \log 20IR$, where I is the noise generator current in amps and R is the noise-generator impedance, usually 50 ohms. When R *is* 50 ohms, this simplifies to $NF = 10 \log 1000I$, and the 1000 can be eliminated by taking the units of current as milliamps rather than amps. Thus a reading of 4 ma on the noise generator's current meter would indicate a noise figure of 6 db. A 2-ma reading would be a 3-db noise figure, and a 1-ma reading would be a noise figure of 0 db.

A couple of cautions—for maximum accuracy, take 15 to 20 readings and use the average of all of them. Also, don't worry about fractional db, as even the National Bureau of Standards has trouble measuring any closer than a half db or so when it comes to noise figure. The formula includes a couple of approximations, which makes excessive accuracy the rest of the way useless.

In addition, if the intermediate frequency of the receiver is so low as to allow the image response to be appreciable, the measurement will include the effects of image-response noise and may be as much as 3 db lower than it ought to be because of this. Be wary of extremely low noise-figure measurements—they usually indicate that error has crept in. Typical readings should be around 3 db on 50 mc, 4 to 5 db on 144, and correspondingly higher at higher frequencies, with conventional rf amplifiers. Drastically better readings mean that something's wrong in the measurement techniques.

Now let's back up a couple of paragraphs and throw a wicked curve of confusion—and hope we can untangle it before we finish! You'll remember that we earlier defined 0 db as the noise figure of a perfect receiver which added no noise and left the original S/N ratio unchanged. And a couple of paragraphs back we showed how a 1-ma reading on the noise generator indicated a 0-db noise figure. So what have we when the current reading is only ½ ma?

From the measurement point of view, the only thing it can be called is a negative noise figure. The formula works out to give us -3 db as the noise figure corresponding to this current reading.

But from the basic definition of noise figures, this would indicate a device which not only had no noise of its own, but stripped some of the noise off of the incoming signal—and that's hardly possible either.

Until a couple of years ago, all this would have been somewhat akin to arguing how many angels could polka on a pinpoint. But with the advent of paramps, masers, and such low-noise devices, the "negative noise figures" suddenly became of practical importance. We now have devices which, when measured in the conventional manner, do give negative noise figures.

However, this is not an inconsistency in definition, and the new devices do not strip noise off the signal. They *do* approach 0 db in noise figure, but they don't quite reach it—and barring some more breakthroughs, they won't reach it until someone figures out how to make things work at absolute zero.

What makes us come up with negative noise figures is one of the assumptions on which those approximations in the measurement formula are based. The particular one causing the trouble is an assumption that the antenna is at room temperature, and views space with approximately the same temperature. This assumption allows the simple figure "20" to be used instead of a complicated expression involving the charge of an electron, Planck's constant, and absolute temperature. But it also makes the formula fail to work right when you get near 0 db.

To keep from having to overhaul the whole concept of receiver noise figures set up in the past 20 years, the state-of-the-art people are presently sidestepping the whole question by dropping the use of "noise figure" at around the 2-db point and using "apparent antenna temperature" instead. The apparent antenna temperature upon which noise-figure calculations are based is 288 degrees Kelvin; this is equal to 15 degrees Centigrade or 59 degrees Farenheit.

Use of apparent antenna temperature also includes the effects of all types of "antenna noise," so that it is actually a more comprehensive measurement of receiving capability. However, the major use of the temperature concept today is in low-noise UHF work;

noise figure still reigns in the VHF/upper HF range.

Noise-figure calculations, whether they come out positive or negative, can be converted to apparent antenna temperatures and vice versa by the use of the accompanying graph. As a side point, effective antenna temperatures of around 50 degrees are in use today—but they require highly exotic equipment. A good paramp, however, will get to the 100-degree region.

But this talk of apparent antenna temperatures is a bit off our subject of noise figure. Let's look back and see what we've found out about noise figure itself:

Noise figure is the ratio of the input signal-to-noise ratio to the signal-to-noise ratio at the receiver output, and as such is a measure of the amount of noise which the receiver itself adds to the signal. The noise figure is usually expressed in decibels, with 0 db being the limiting case of a perfect receiver which adds no noise at all to the incoming signal; such a receiver cannot exist.

The importance of noise figure is that it provides a measurement of the relative merit of two different receivers for weak-signal use; with strong signals, noise figure is unimportant, but with weak signals, the noise figure indicates how weak the signal may be before it becomes "lost in the mud."

Noise figure can be measured by use of a noise generator whose output is accurately known; however, almost any sort of error which can occur will make the noise figure appear to be better than it actually is.

Negative noise figures can *appear* to show up during measurements of exceptionally low-noise devices, but they do not actually exist. They appear in measurement because the measurement formula assumes that everything is at a standard temperature, while in a low-noise device the effective temperature is far below the actual temperature and the noise figure measurement formula no longer gives accurate results.

And for the mathematically minded operator, here's an extra given by noise figure: when calculating range by the decibel method, (in which (a) transmitter powers are converted to decibels above one watt, (b) receiver sensitivities are converted to decibels below one watt, and (c) all path losses are put into db also; so that the final result is a string of db values to be added to determine working range) the noise figure can be plugged right into it too.

And there we have it—all about noise figure (well, almost, anyway). With this kind of background on the subject, you need never have any fears about "believing in noise figure" again. And if you want to look for some more detailed data—goodness knows there are reams of formulae which were carefully avoided in preparing this article—you can start with the references listed below.

. . . K5JKX

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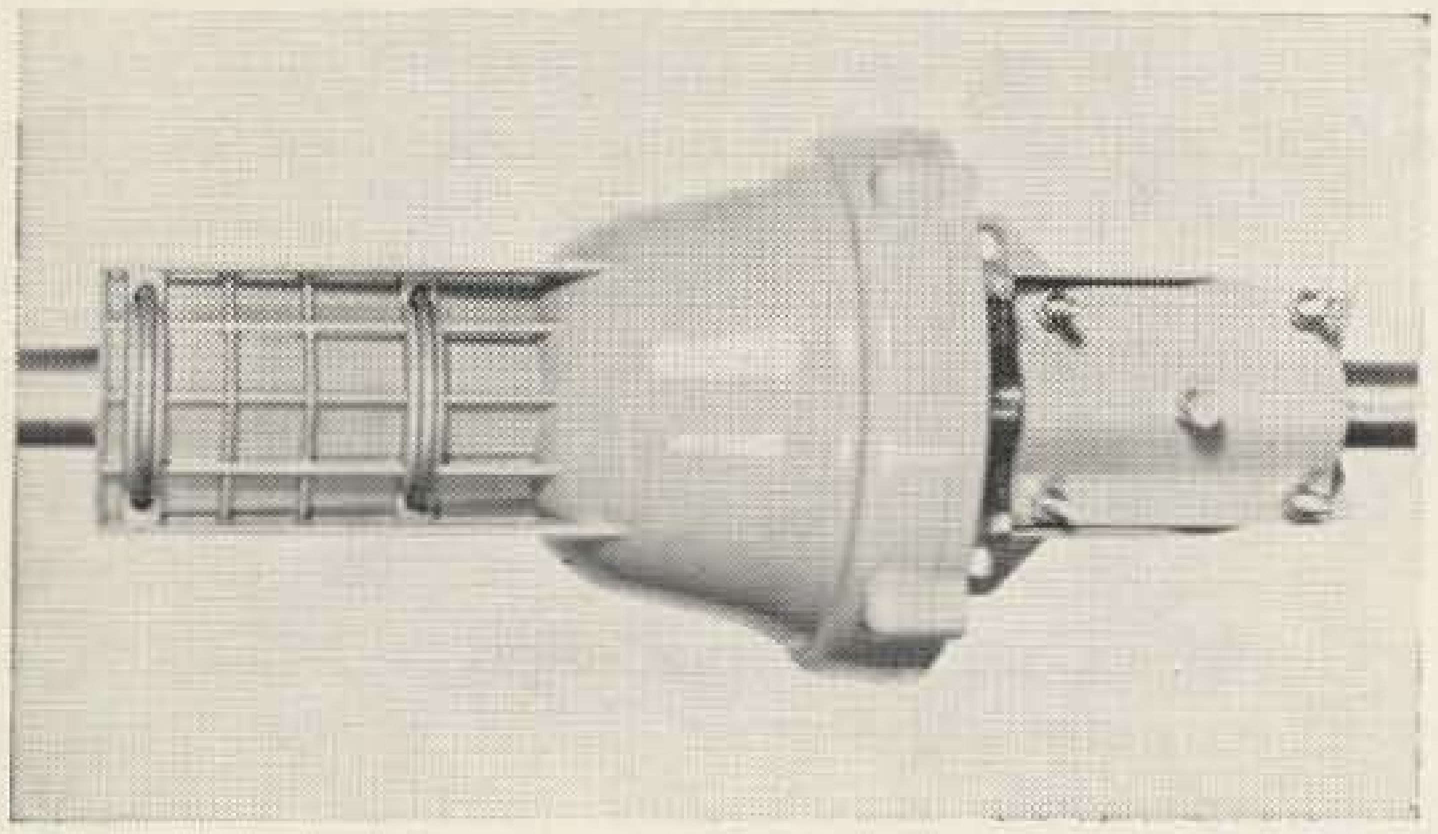
CDR TR-44 Rotator



Wayne Green W2NSD/1

Immediately I am in the soup. What do you write about a rotator? We got three of the new TR-44's for use on the mountain. We opened the boxes . . . they looked like Ham-M's. We installed them with no problems whatever in Rohn, KTV and E-Z Way towers. They worked exactly like Ham-M's, which is to say they were all you could ask for in a rotator. The only difference I've seen so far is that the 44 doesn't have an illuminated dial on the indicator. We're swinging a huge 48 element colinear-yagi beam around with one, a Hy-Gain tribander with another, and a 96 element 432 mc beam plus a 32 element 220 mc beam with the third.

They work excellently. They don't windmill. They don't do anything wrong. And the price is only $59.95. Cornell Dubilier is out of their minds to sell them so cheap.

Conversion of the APX-6 To 1290 mc Operation

Gianni Lovisolo I1LOV
Malnate, Varese, Italy

This piece of equipment can be easily modified to make a complete transmitter-receiver set for the 24 cm band. It is ideal for mobile work, since the necessary ac, dc power supplies, the modulator and receiver audio stages can be accommodated in the existing cabinet with room to spare.

The useful parts of this equipment are: the rf section, the *if* strip, the front panel and cabinet. All the remaining (and it is much!) goes to the junk-box. The transmitter is a self excited tunable cavity triode oscillator using a 2C42 lighthouse tube. To make it oscillate on nonpulsed voltages as low as 280 volts, some form of feedback must be used; more on this later. The receiver uses a 1N21 crystal mixer, a tunable cavity 2C46 local oscillator and a 60 mc *if* strip made with six 6AK5 tubes; the original output is video so the strip must be converted for audio detection and amplification.

To facilitate adjustment, testing and trouble shooting, the converted unit is wired in such a way as to be disassembled in three main parts by just removing a few screws and unplugging two octal and one phono plug:

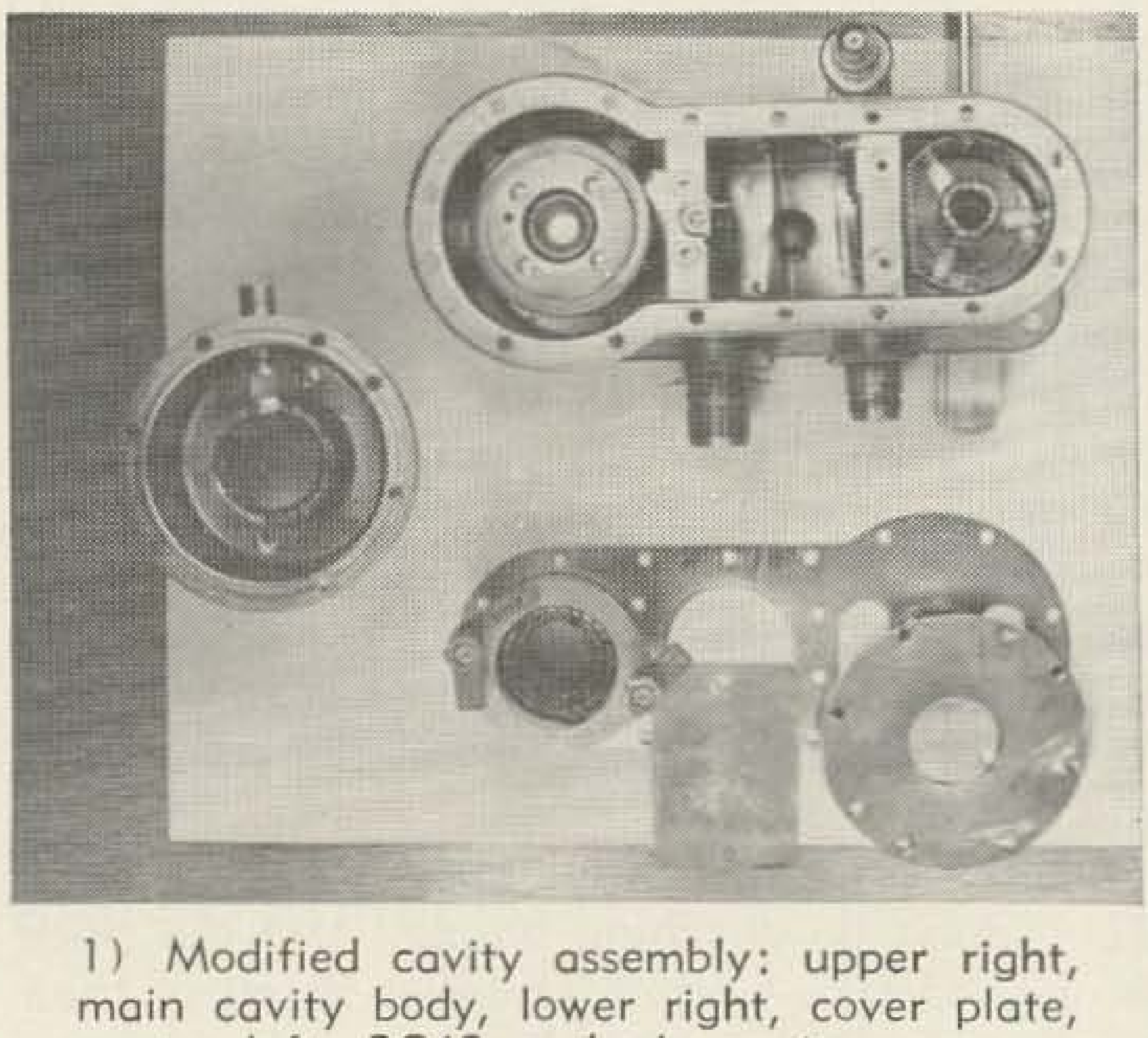
1) Power supply and modulator chassis.
2) Cabinet containing: mike input, loudspeaker, on-off sw and ac input plug.
3) Front panel containing the rf section, *if* and audio strip, switching circuit, meter and sensitivity control. Connections of rf and *if* sections go to the existing terminal strip mounted on the panel so even they can be mounted and removed with a minimum of fuss. Another advantage of this layout is that wiring is and appears "clean" and uncrowded.

Disassembly

Remove front panel from cabinet by removing the screws holding the hinges of the panel and disconnecting all wires from the vertical 12 terminal binding post. Save the screws of the binding post as this will be used later. Strip all of the cabinet save for the two fuse holders on front. Completely strip panel, putting aside rf and *if* assemblies and binding post. Now the front panel can be used as drilling template for a new panel or for a thin aluminum cover to hide unnecessary holes: see picture 7.

RF Assembly Conversion

The rf assembly is made of two parts: the lower contains the gear drive of the tuning plungers while the upper part is the main cavity body. Looking at it from the back as

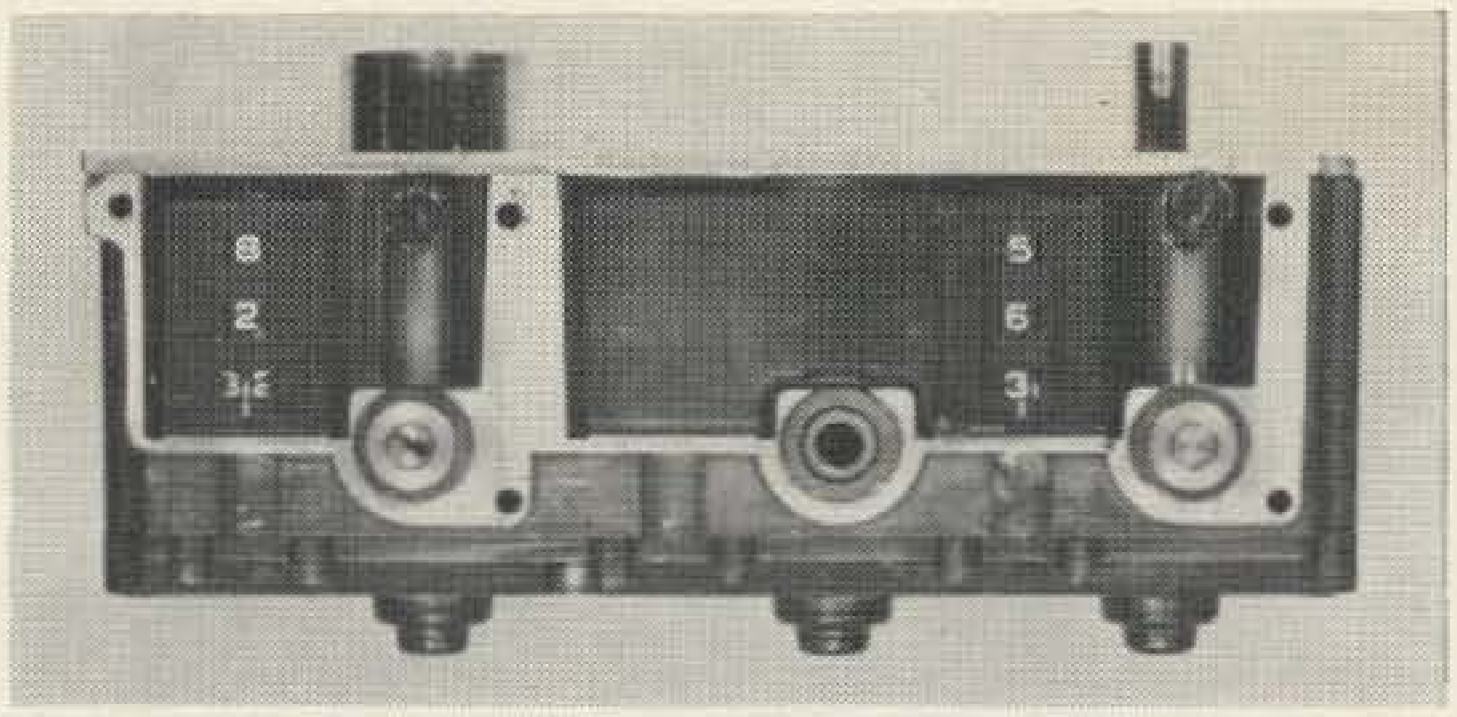


1) Modified cavity assembly: upper right, main cavity body, lower right, cover plate, center left, 2C42 cathode cavity.

in picture 5, the right hand cavity is the transmitter, the left hand one is the local oscillator, the center is the diplexer cavity, originally used as changeover switch. It contained at 1B40 tube excited by the pulsed B+ to the 2C42 tube. This cavity was detuned by the firing of the 1B40, thereby protecting the mixer diode from burnout. The diplexer must be eliminated for the following reasons:

1) Stable operation of transmitter oscillator; otherwise the 2C42 oscillates strongly only at certain settings of the diplexer cavity.
2) Receiver tuning ease; otherwise tuning would require the simultaneous setting of local oscillator and diplexer knobs.
3) Safety for the mixer crystal which easily burns out during transmission even with a neon lamp in place of the 1B40.

After modification, a partition takes the place of the diplexer cavity, providing complete insulation between transmitting and receiving cavities. This in turn requires the in-

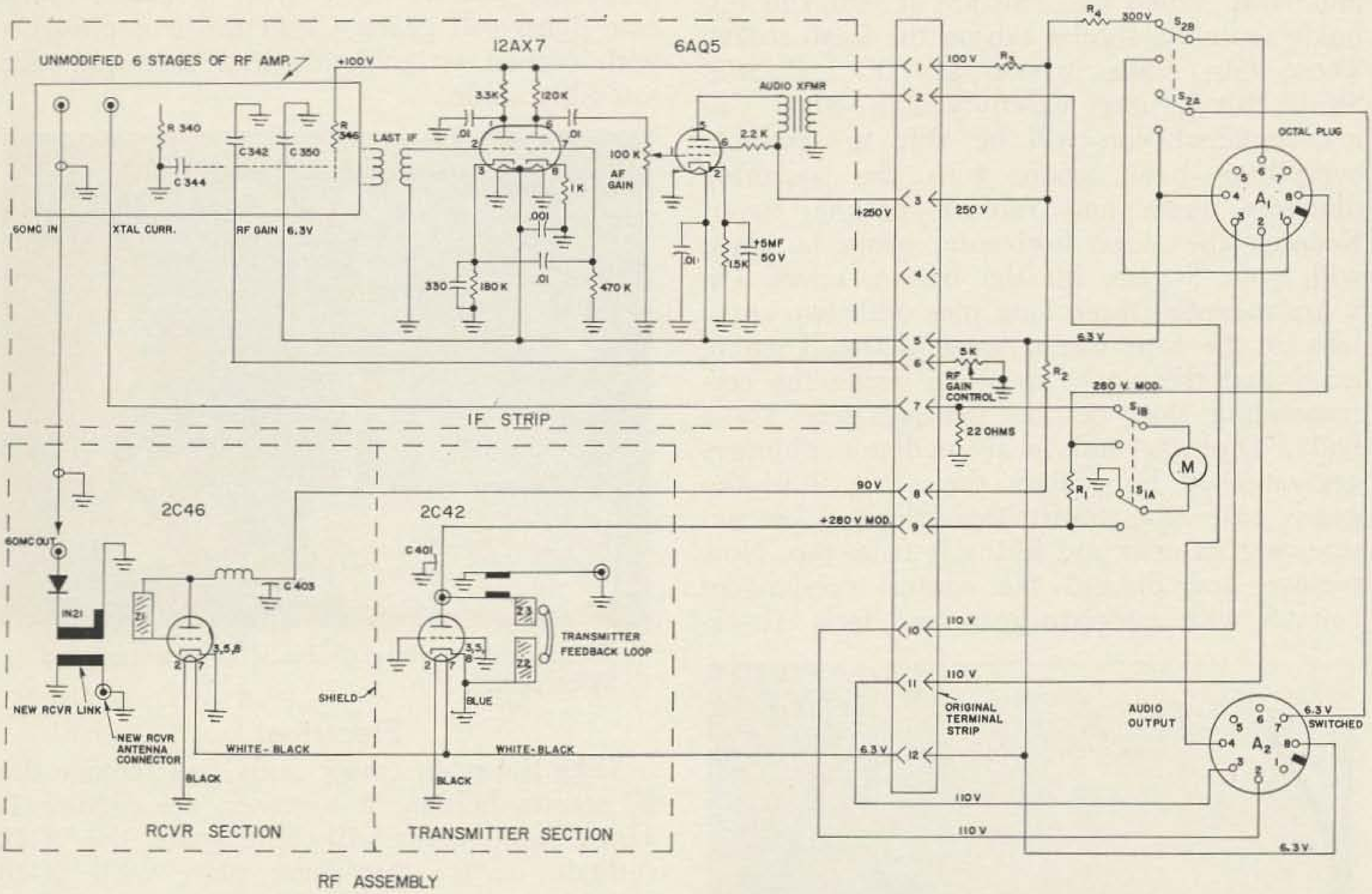


2) Gear drive tuning mechanism after modification.

stallation of a new antenna input connector for the receiver and a new input circuit. Another necessary modification is the cutting of local oscillator and transmitter plungers, since this equipment was not designed to work at this high frequency.

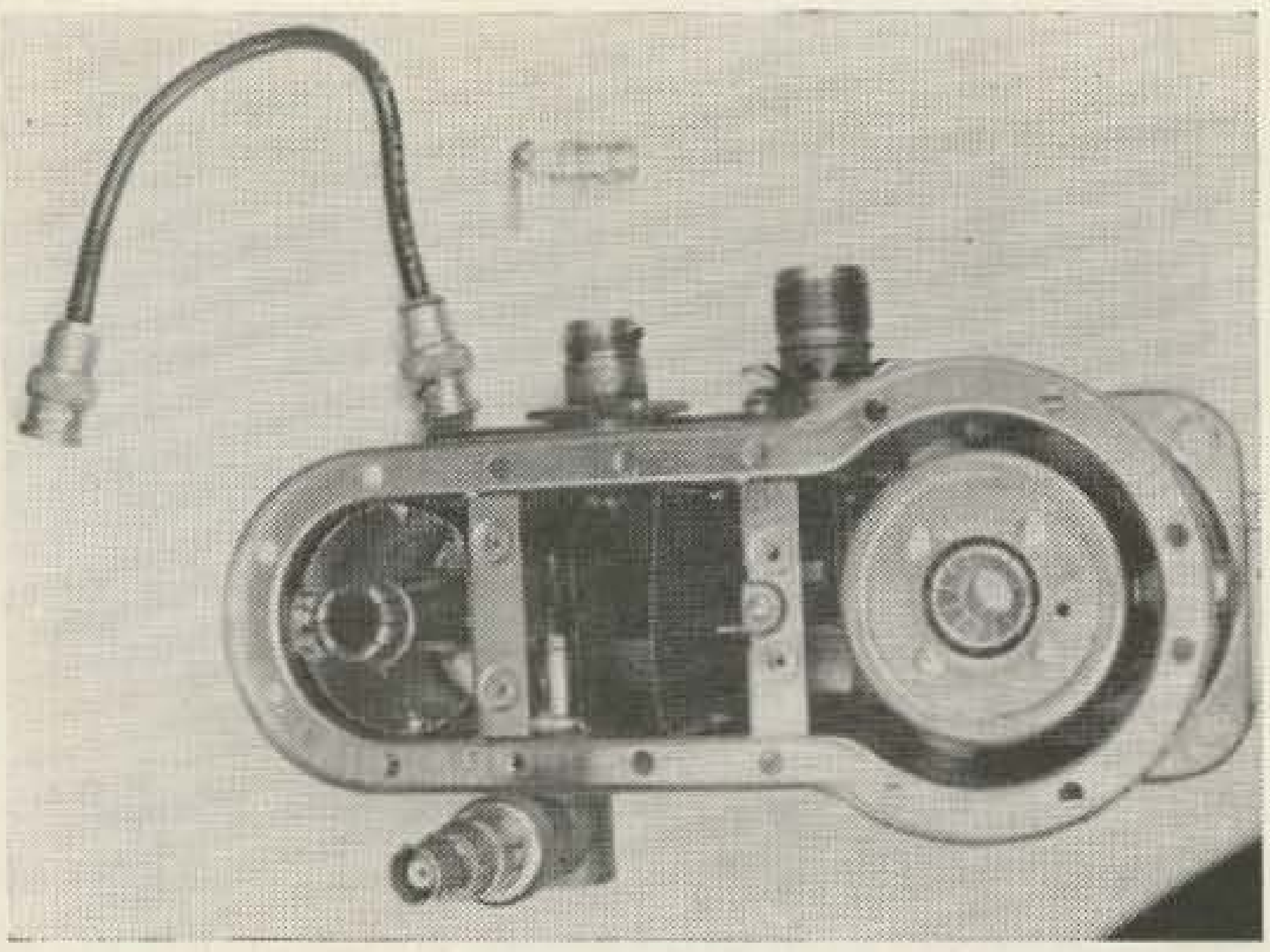
Mechanical

Remove the gear drive assembly from the main cavity body: see pictures 2 and 3. The gear drive has three plungers coming out from top. Remove the upper plate (plungers side), remove the back cover plate (the one with



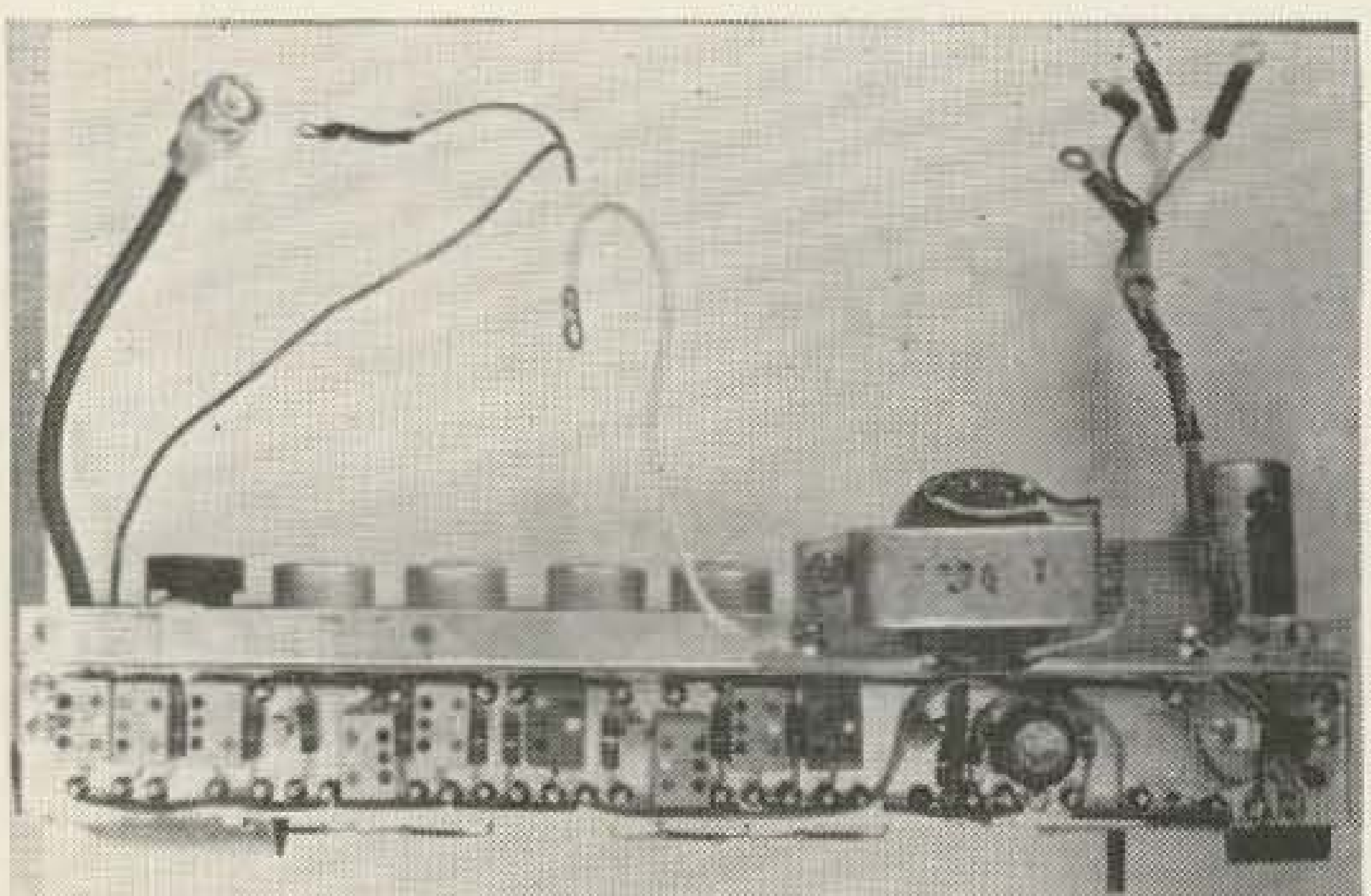
Z1 L. O. cavity.
Z2 Transmitter cathode cavity.
Z3 Transmitter plate cavity.
* All voltages marked are nominal values. They must be trimmed for best signal to noise ratio working on values of resistors R2 and R3. R1 is meter shunt, R4 adjusted for 250v.

M 0-3ma meter with shunt for 0-150ma.
S1 meter switch shown reading xtal current, other position reads 2C42 plate current.
S2 Transmit-Receive switch, shown in receive position.
A1 Octal plug, plugs into B1 socket on power supply and mod. chassis.
A2 Octal plug, plugs into B2 socket on cabinet.



3) Main cavity body after modification. Note how the receiver input link is connected to the N connector.

spare fuse holders on it). This done, you can see the drive gears. Put the tuning knobs back on their shafts and rotate all three to read 000 on the veeder-root dials: the plungers are now at maximum length. While turning the knobs, you will see that each of the horizontal gears has a small tab on its outer rim. When the dials are at 000, this tab holds against a similar tab on the knob shafts. These tabs make it stop at 000 and 999. Study this position carefully and, when you are confident you will be able to assemble everything back again, turn the assembly plungers down and remove bottom cover. Keeping the three horizontal gears in place with your fingers, lift the bottom cover. On it are mounted three long pins with two small tabs at the top; when reassembling, keep in mind that these tabs must go inside the corresponding slots cut on the plungers' lower body. Diplexer and local oscillator plungers are removed by pulling them out from the gear's side; the transmitter plunger by unscrewing its gear and lifting it from top. Now remove and discard the central veeder-root counter with associate gears and lock. To re-

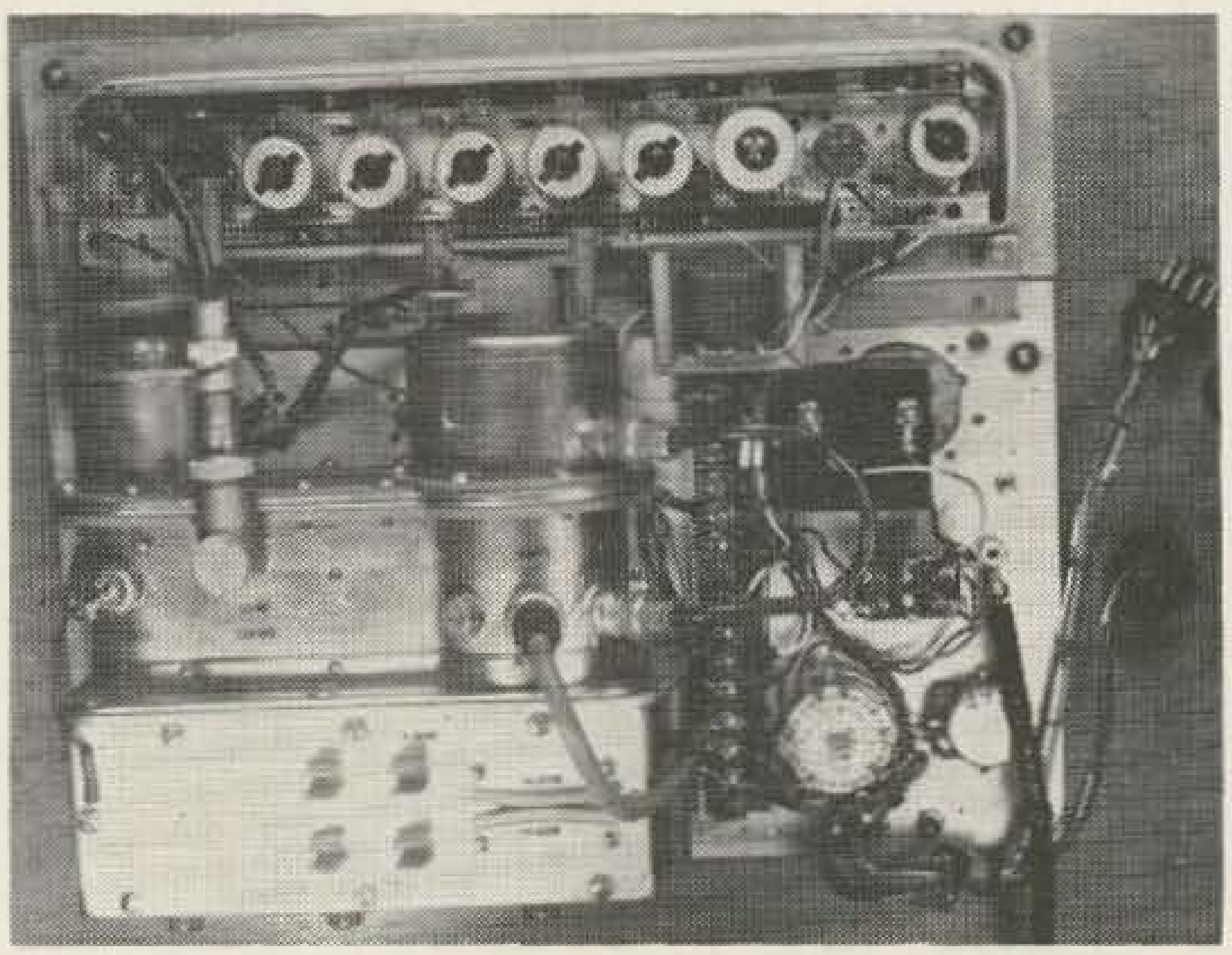


4) Modified if strip now containing audio detector and af amplifier.

move the center shaft (on which the diplexer knob is mounted) push out with hammer and thin punch the pin running through it.

The best way to cut the local oscillator and transmitter plungers is to have them cut by lathe. If this is no possible, handle very carefully to avoid scratching of the very smooth surface, cut with fine toothed saw. Cut off a 9/16" length from the transmitter plunger and a 3/8" length from the local oscillator plunger. If by accident the local oscillator plunger is damaged, it can be substituted by the diplexer plunger.

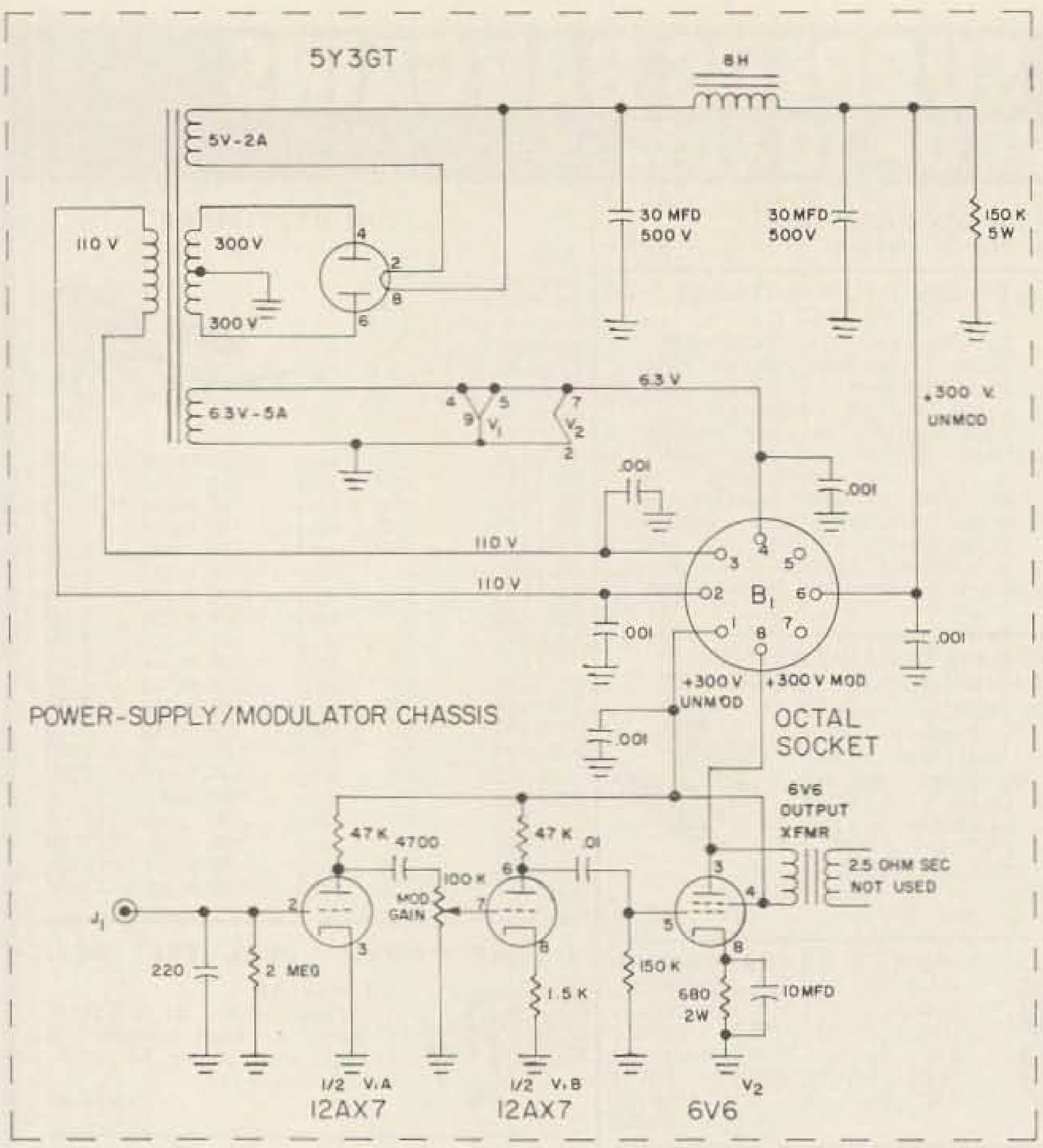
To reassemble the unit, put the two dials back to 000, if they have moved while handling, by turning their small gear. Screw for two or three turns only the gear on the local oscillator plunger and put it in its hole from gear's side; do not engage this gear with the one on the knob shaft yet. Now position these two gears to have their tabs facing, then push the plunger gear in place. The same holds for the transmitter plunger, except it must be inserted in its hole before screwing the gear on it. Before putting back cover in place, lubricate lightly all gears. Clean the two plungers with carbon tetrachloride and then put this assembly aside.

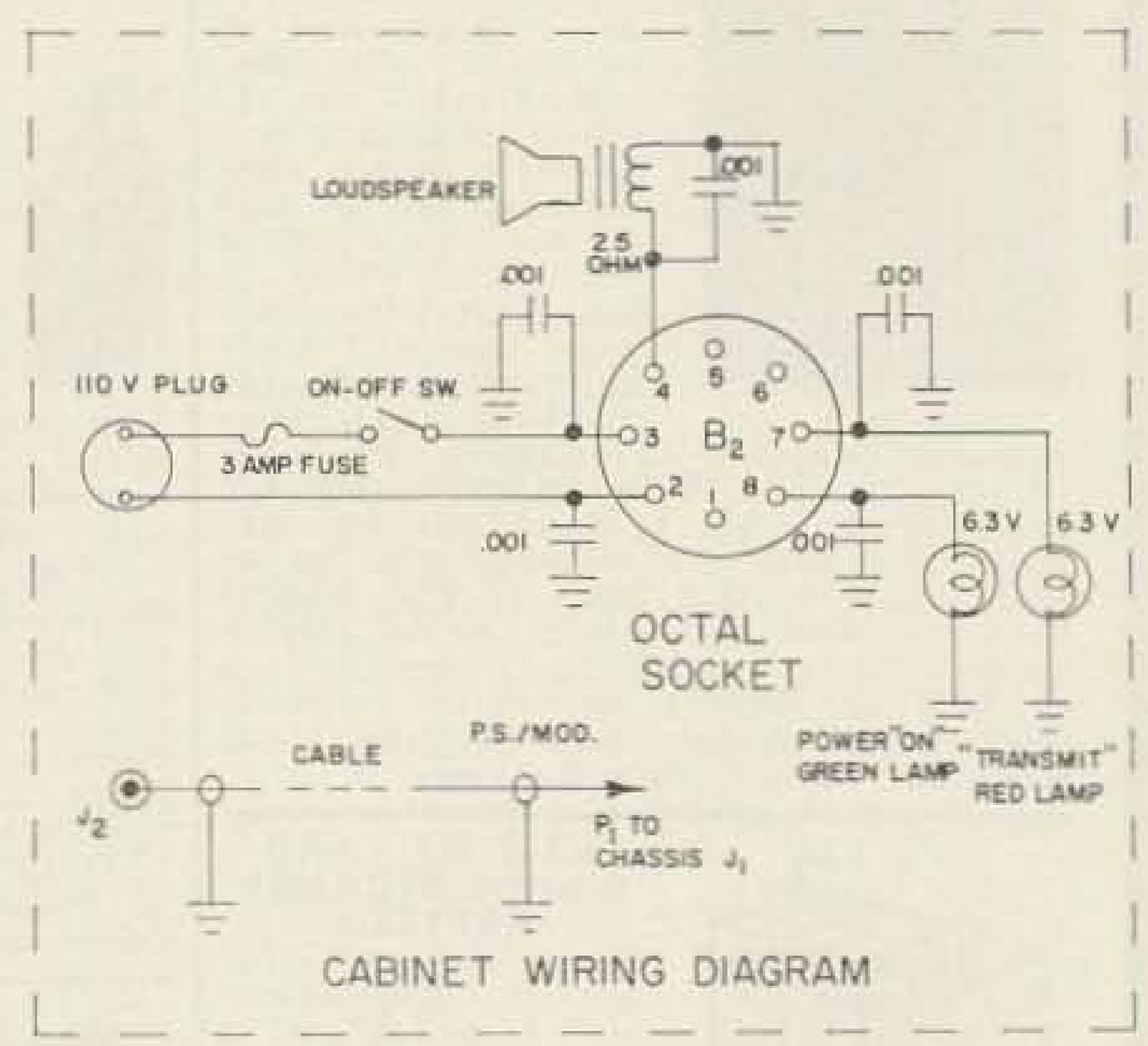


5) Complete view of back of reassembled front panel.

Electrical

Take the main cavity body and remove the 20 screws holding it together. see picture 1. Three main pieces will come apart: the 2C42 cathode cavity, the cover plate with 2C46 cathode cavity and diplexer cavity attached to it, and the main cavity body proper. Modify the main cavity body as follows (see picture 5.) Drill a ⅜" hole, centered between the B + connector hole and the right hand insulator holding the plate drum. This hole must be level with the B + hole and insulator. At this hole, solder the nut of the BNC connector





shown in picture 3. Turning the connector in this nut will provide variable coupling for 2C42 excitation. A copper shield must be installed between 2C42 and 2C46 plate cavities. Position it as shown in pictures 1 & 3. Prepare the receiver type antenna connector as shown in detail A. Now drill a 7/16″ hole level with the existing transmitter connector. The center of this hole is at 1⅞″ from the center pin of the transmitter connector. Solder the new connector in place. Cut the receiver antenna coupling link as shown in detail B. Solder it to the extended receiver connector tip. The other side of this link is soldered to ground near the local oscillator link; see picture 3. These two links run parallel; the exact distance between them will be found during adjustment.

Modify the cover plate as follows; remove the diplexer inner conductor by unscrewing the three screws holding it to the outer conductor. Now saw off the diplexer outer conductor. Cut the copper square to cover the hole left by diplexer as in detail C. Also cut the copper round cover as in detail D. Also see picture 1.

Modify the 2C42 cathode cavity as follows: cut away the two bean shaped objects protruding from the cathode cavity inner conductor. Trim off the square flange from a BNC connector. Now put back this cavity on the main cavity body; be careful to align the mounting holes of the flange (see picture 5). Drill a hole ⅜″ in diameter on the cathode cavity. This hole, in the vertical plane, must be level with the hole with the nut soldered on it, and must be ½″ high from the cathode cavity mounting flange. Now solder in this place the trimmed BNC connector; then solder its center tip to the inner conductor of the cavity by means of a small strip of copper. Reassemble all the main cavity body, leaving off temporarily the copper square.

The two octal sockets of the 2C46 2C42 must be connected as follows: black and blue wires to ground, white–black wire to 6.3 volts filaments. The blue wire is the 2C42 cathode connection; it can go to ground through a potentiometer, but tests have shown that best results are with cathode at ground potential.

IF Strip Modification

Unsolder the wire connected to the hot end of C-301, also remove the 22 ohm resistor connected between this point and ground. Now solder on this point a much longer wire; this will go to the meter to read xtal current. Connect to ground junction between R-310 and C-344. The wire connected to the hot side of C-342 goes to the rf gain control. Now remove and discard all components connected to tube sockets V-309 V-308 and V-307. Be *extremely careful* when unsoldering the leads of the last *if* transformer from V-307. Remove tube sockets V-307 and V-308. At V-307 goes a 9 pin socket for the

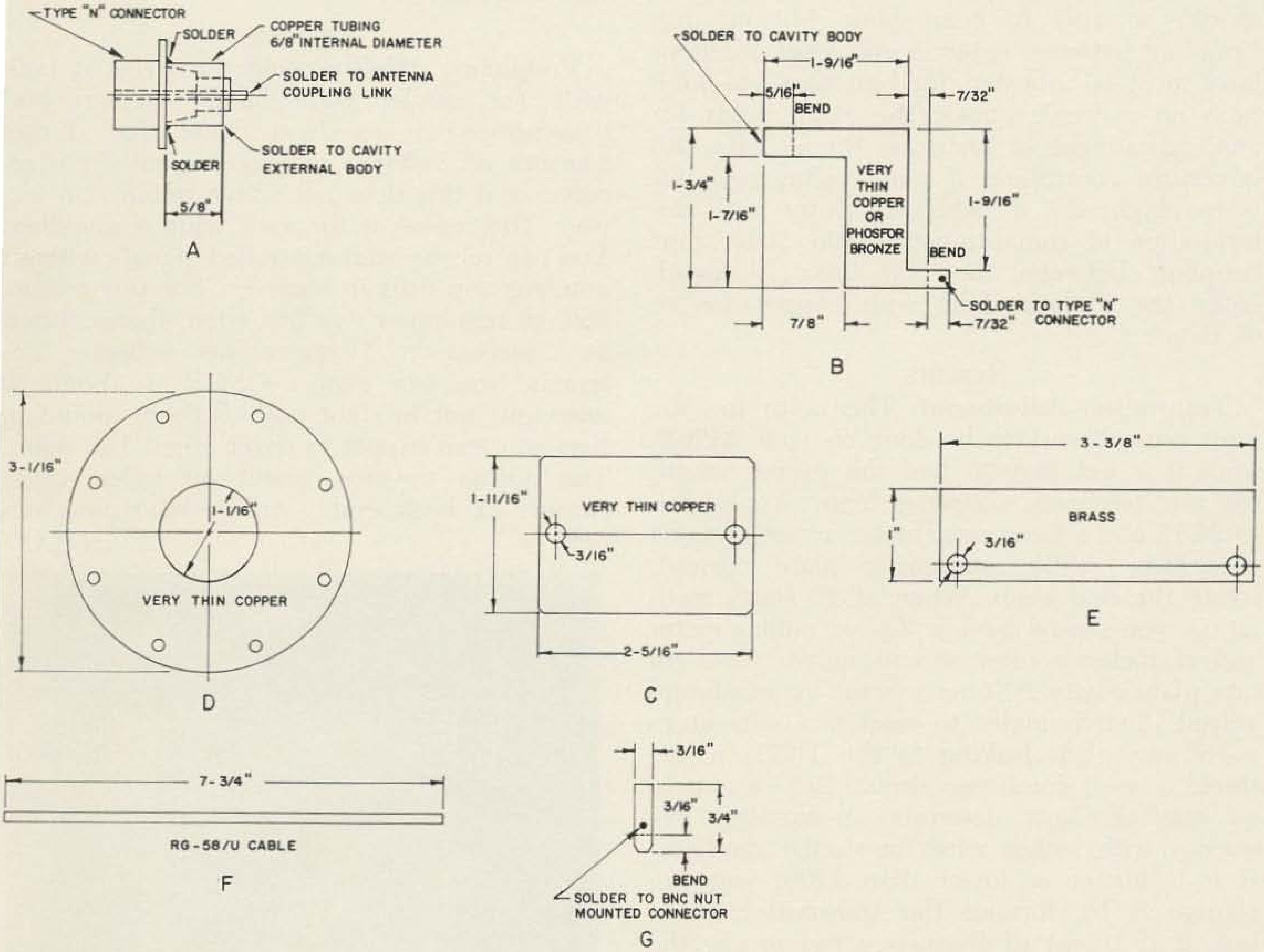
12AX7, at V-308 goes the potentiometer for volume control. Now wire as shown in schematic diagram. First triode section of 12AX7 is an infinite impedance detector, all following is conventional. This detector was the one which gave best results in this application. The audio output transformer is mounted on a brass plate as shown in detail E and picture 4.

Wiring

All external connections of the modulator power supply should go to its octal socket. The same holds for all parts mounted in the cabinet. Units mounted on front panel should be connected with the 12 terminal strip, and through this strip to the panel controls. Connections between front panel, power supply and cabinet should be made only through the two octal plugs. Other details in picture 6 and schematic. Using a 5½" x 12" chassis for the modulator power supply will leave space for a dc power supply for mobile use.

Adjustment and Operation

Test power supply and modulator by connecting a jumper between pins 6 and 1 of B1 octal socket on mod/pwr-supply chassis. To monitor modulator, plug a record player into J1 and connect a loudspeaker across the unused secondary of JV6 output transformer. To test *if* strip, inject a 60 mc signal to the BNC input connector. The bandwidth of the *if* should be of about 10 mc; *no attempt should be made to reduce this bandwidth* modifying the six stage 6AK5 *if* amplifier as this can *lead to a lot* of trouble as experienced by the author. With rf and audio gain controls set to maximum, sensitivity should be quite high, even with signal gen. loosely coupled. This done, connect the *if* strip to mixer output and, *while monitoring 1N21 current,* connect B+ to the local oscillator feedthru condenser C-403. Start with a value of 25K for resistor R2 after you have found the value which gives 250v at R4. When the 2C46 starts oscillating, a hiss is heard from



A) receiver antenna connector, B) receiver antenna coupling link, C) copper square cover for hole left by diplexer cavity, D) 2C42 cathode cavity cover ring, E) of out put transformer mounting plate, F) feedback loop cable for 2C42. Cable length with BNC connectors soldered on it should be, tip to tip ¾". Start with this length and trim for best results, G) feedback link for plate cavity of 2C42 tube.

6) View of cabinet and power supply-modulator chassis.

the loudspeaker. You can now lower the value of R2 to get more xtal current *which must not to be more of 1.5 ma.* Now, with a piece of wire connected to the antenna connector, you should be able to heart your 144 mc rig. Coupling between antenna and local oscillator links must be adjusted for best signal-to-noise ratio on a weak signal; the same holds for final adjustment of resistors, R3 and R2. R3 is resistor controlling *if* plate voltage; if this is too high, the *if* gets very noisy with deterioration of signal-to-noise ratio. After best coupling between the two links is found, cover the diplexer hole with copper square of detail C.

Results

Transmitter Adjustment: This is, by far, the most critical work to be done on your APX-6, since it is not easy to find the proper length for the feedback coupling loop. Apply B+ to 2C42 and a lamp or rf meter across antenna connector; while monitoring plate current, rotate the dial knob. When 2C42 starts oscillating, you should have a dip on milliammeter and rf meter pointer should move. Now rotate plate acvity BNC connector for maximum output. Switch meter to read xtal current to see if any rf is leaking to the 1N21; if the shield is well done, you should get *absolutely no reading.* Now determine transmitter frequency with lecher wires or similar methods. If it is higher or lower than 1296, you can change it by turning the transmitter knob; but, if it is out of frequency too much, the 2C42 can stop oscillating. If this happens, make a longer cable if it was too high, a shorter one if it was too low. When the rig is on frequency, trim the loop cable for best output. Plug the microphone into J2, set mod. gain to maximum and speak: you should get fairly high kicks on the plate meter with modulation applied. Remember: the stronger you modulate, the better you will be heard with this sort of rig. Plate current, with 300 volts, should be around 50 ma. This is a bit much for a 2C42, but I have been using one at this input for more than one year (leaving sometimes the rig on for one hour, or more, continously during duplex work) and it is still going strong.

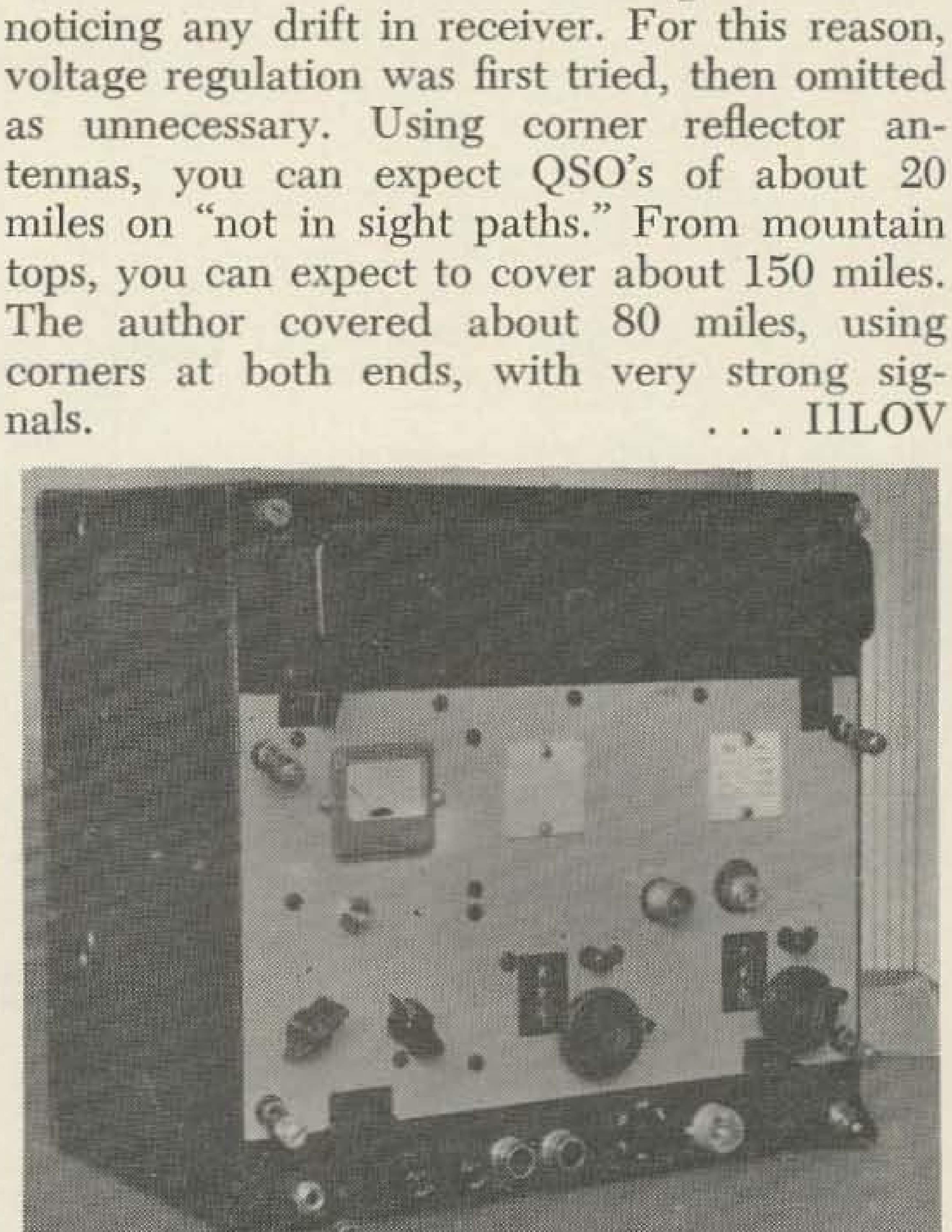
To date, four units have been so modified by the author without undue trouble. Calibration of the two dials differs much from set to set since this is affected by tubes capacity, voltages, and so forth. However, average calibration is (but do not depend on it!):

TX dial: 1276 between 875 and 915
1296 " 930 and 970
RX dial: 1276 between 680 and 715
1296 " 740 and 780

The most sure calibration of receiver can be made using the 9th harmonic of your two meter rig tuned to 144.000 mc.

Results

Frequency stability using these rigs at both ends (or similar wide band receivers and transmitters) is excellent. Note that during transmit all voltages are taken away from receiver and this does not affect stability in any way. The reason is the very wide *if* amplifier. You can receive xtal controlled signals without noticing any drift in receiver. For this reason, voltage regulation was first tried, then omitted as unnecessary. Using corner reflector antennas, you can expect QSO's of about 20 miles on "not in sight paths." From mountain tops, you can expect to cover about 150 miles. The author covered about 80 miles, using corners at both ends, with very strong signals. . . . I1LOV



7) Completed unit.

(Continued from page 4)
a nasty turn. If this kept up the clubs would get absolutely nothing out of the convention.

Meanwhile a new employee had been added to the Cowan staff. This chap, with his eye on a better job, saw the problems that I was having and decided to help things along. Much as I dispise the type of person he is, I will be forever grateful for his part in my future. I might have bumped along for quite a few months or maybe even years in spite of the difficulties. It is so difficult to make major changes in one's life.

He brought up the idea of starting a new magazine . . . he even thought of the name. I laughed at this for I knew that there was virtually no way to get a new ham magazine started. Educated estimates ran to about $500,-000 to get something like that off the ground . . . and the low price of QST advertising put a lid on the profits that could be made. Absurd.

He didn't give up that easy. He visited the Cowan office one night and came up with copies of the company financial statements. I was flabbergasted to find that CQ and our other books had made a net profit before taxes of over $100,000 the previous year! This particularly burned me when I remembered the $5 Christmas Bonus, complete with note saying that Cowan wished it could be more. Another little gem was copies of the circulation records for CQ. I had been trying in every way possible to find out how the magazine was doing. I wanted to see if there was any correlation between special issues and circulation, etc. The answer was always the same . . . "sorry, you can't see the circulation records." When I got a look at the actual circulation and thought back to the sworn figures that were shown to advertisers I was dumfounded . . . and I understood why these were so secret.

I didn't have long to worry about this though. The next morning Cowan was in a frenzy and demanded the circulation figures. My friend had told Cowan that I had them, but neglected to tell him that he had given them to me. I left and he got that better job. Cowan apparently assumed that I was the one that dug them out. He promised to pay up my expenses, royalties, etc. I haven't seen a nickle yet. I'll not hold my breath. Cowan, I hear, eventually found out that he had been duped and fired the fellow.

It was a tremendous relief to get out of that situation. If only I had had the courage to leave two or three years earlier when I saw the handwriting on the wall.

I went to work for one of the largest ad agencies on Long Island and got together with the Hudson Amateur Radio Council, which was just being formed at that time. I pitched in with them to put on a convention and before long Cowan had to announce that CQ's convention was canceled. I must admit that I read that with considerable satisfaction.

After three months of being an account executive I knew that this just wasn't what I wanted. Sure, I could easily make twice my salary at CQ . . . but I wanted to be back in the ham business. I decided to see what I could do about starting that new ham magazine.

After several weeks of visiting amateurs who might be in a position to bankroll me I found that I was the only one the seemed to have any confidence that a new magazine could be successful.

It was time to make a decision. I figured the absolute minimum that I would need to get started and found that if I sold everything of mine that I could I might just barely make it. I found a tiny furnished office with very low rent and invested in a Ditto machine. Letters flowed out to authors inviting manuscripts and guaranteeing payment on acceptance. No longer would an author have only a choice of no payment at all from QST or a long long wait from CQ. The response was encouraging. Excellent manuscripts began to come in.

Next I wrote to every club I knew of and invited subscriptions. My reputation at CQ paid off here as pre-publication subscriptions poured in.

The first issue, by virtue of subscriptions and, the support of many advertisers, was in the black. It has been a slow building process since then. I've probably made a lot more serious mistakes than I should have, but we're growing all the time and we're still in the black though just barely.

So much for history. I thought you might be interested in some of it on this fifth anniversary of my starting 73.

As you know, when I started 73 I put in many changes that I had wanted to make in CQ. We concentrated on articles and left the operating news stuff to QST. The emphasis was on simple construction projects and technical articles for the average ham . . . not the engineer.

Then, last year, the growing internal problems of the League resulted in their proposal to the FCC, RM-499. I could see the future of our hobby in jeopardy unless someone had the guts to speak up and try to stop things. The situation was far more serious than almost anyone recognized. I looked around and there was no one else to speak up. It had to be me.

My editorials have been strongly worded. Oh, I try to be unemotional about these things, but I can't really because I am in love with amateur radio. I don't know how else to explain it.

Let me give you a little thought. The other day I was sitting up on the mountain working fellows on two and six meters. It was like being at a huge cocktail party where I could turn in any direction and enter into a conversation with anyone I wished. I was in the middle of a world full of people all having a good time. Then I turned off the "big switch" and there I was all alone in the fog and rain up on the side of a mountain in remote New Hampshire with no one else for miles around.

Ham radio is like that. No matter where you are you have friendly people to talk to as soon as you get on the air. While in Los Angeles a few days ago I got on the air from WA6JNO and immediately the air was filled with people saying hello to me from Hawaii, Wake, and around Los Angeles. It brought a warm friendly feeling.

I ask the forgiveness of those of you to whom amateur radio is just a hobby . . . or a service. I'm in love. I love to work DX . . . I love two meters . . . I love six meters . . . I love rag chewing . . . I love to build equipment . . . I love converting surplus . . . I love contests. Yes, I even love writing this goddam editorial. I'm going to do everything I can to protect my love. I'm not going to let prestige-hungry ARRL directors and the bad management they have bequeathed us continue without a battle. I'm going to work as hard as I can for the success of the Institute, which I feel is the great ray of hope for the salvation of amateur radio.

It pains me to read the attacks on me in CQ, Huntoon's Dirty Letters, and their satellite Washington News. It pains me even more when I get letters from readers who believe these people. When this happens I know that my typewriter has failed me . . . that I have not communicated what is going on. This is my fault and I know it. A great deal of the problem is my terseness . . . I must learn to to explain things more carefully.

For example, while visiting California I was the guest of several radio clubs. Members and local League officials came to hear me and to torpedo me. They admitted it. By the time I got through explaining what was going on in detail the torpedos never came. I had a hard time getting away after meetings and I want to thank every one that attended these meetings for the encouragement they gave me and the great friendliness they showed (after the meetings) (hi).

So, here I am, the self-appointed savior of ham radio . . . the Mr. Hornblower, as W8HHS calls me. I hope you don't mind me volunteering for this duty . . . and I hope you'll join me up on my soap box. This is a big soap box and it's lonely up here.

Skunk

A club in California called the other day and offered to fly me out to talk about current amateur events They then tried to get Bill Orr to debate with me, but he begged off, adding that being near a skunk, some of the smell is bound to rub off. He suggested West Coast Director Harry Engwicht W6HC Harry choked a little when he heard the proposition and said he had a previous engagement, though no date had been as yet mentioned Next they called Huntoon He couldn't give an answer until he consulted his "superiors" After the debacle at Harvard last spring when Huntoon and Baldwin came up to debate and ended up refusing to answer any of my questions, I can see why they would rather eat nails than face me.

K3IOP

Inspite of muddled reporting in other ham magazines, the K3IOP case has been settled satisfactorily with an Order by the FCC granting Seaman an unrestricted General Class License. In 1963 he had been issued a General license which had a condition prohibiting operation in the 50 mc band.

Goodby 73 Mountain

It has been a lot of fun operating up on "my" mountain, but the time comes when I really have to be practical. I can see now that I am not ever going to have enough time to do an adequate job of setting up and operating from up there. Between 73 and my many other half and quarter baked schemes I do very well to get up there once a week, which means that I only get on the air about 30 nights a year. Weighing this against the investment makes it obvious that I am being impractical.

This would be a great spot for someone with the time to set up on 220 and 432, as well as the lower bands, for you have a pipe line right down into New York and Philadelphia. I wanted to hit all bands up to 1296 . . . I even have a small dish for it and a converted APX-6 as a starter. I wanted to be on 432 mc TV, and have the camera to prove it. Now, after two summers of having the place, I admit, even to myself, that I can't even see far enough ahead to when I would have time to pursue these interests.

The mountain is only about an hour out of Boston and some four hours from New York and it is a gorgeously beautiful quiet and remote vacation spot. From the front porch you can see for over a hundred miles. Sigh.

In Unity There Is Strength

Several ARRL officials have been bringing this tried and true (?) cliché into play recently. This is a dandy for people who think in terms of slogans instead of thoughts. Even a moment's reflection should recall the extensive use of this phrase by Hitler. It is essentially an unarguable truth, unless one decides to try to apply it to specific situations.

What is meant by unity? If this means that all 260,000 amateurs should get together and work for some common goals than I am 101% in favor. But what do we do about the fellow that doesn't want to work for those goals . . . the lazy ham that excuses himself by saying that he doesn't have the time for our goals . . . and besides, they weren't his idea anyway. Do we force him to conform or let him do what he pleases? And what happens when 200,000 of the 260,000 decide the same way?

Or 259,000?

Does Unity mean that everyone should ignore what ARRL HQ did to WA2USA, K2US, WØJRQ, WØGZD, W2BIB, and others? Shall we turn the other cheek and lengthen the list?

Perhaps Unity means that everyone should join the IoAR? A great many problems arise in the forming of a new organization and it is indeed fortunate that the Institute has not grown any faster than it has already. Any large influx of members would paralyse things.

Or does Unity mean, "Shut up and do things our way."

VHF Contest?

Though activity in the CQ VHF contests has seemed to have been dropping off more and more with each succeeding contest, I thought I would give their August one a try. After two hours of contesting on both six and two meters I gathered that no one else on two meters was taking it seriously and about three on six were trying with any enthusiasm. Of course I could only hear what was going on in the New England-New York-Philadelphia areas and there might have been all sorts of activity out in Ohio or California.

Somehow it just didn't seem reasonable to spend twenty four continuous hours in a contest with two or three other fellows.

Channel A

The initial response to my suggestion last month to put CB gear up on ten meters on a calling channel of 28.6 mc has been encouraging. I hope to be set up on that channel on 73 mountain before long myself.

I have more than a little reason to believe that the FCC intends to make the new CB regulations stick. I won't spill the beans on how they are going to do it, but it'll be something you'll not forget soon . . . and something that will make a very strong impression on any CB'ers who think they are going to ride out the new regulations, hamming away.

Though the CB manufacturers I've talked to minimize the impact of the new regulations, I can't help but think that quite a number of the approximately 80% of those now hamming on eleven will get discouraged and want to dump their gear. We may find some mighty fine ten meter gear available for peanuts in a few months. Eventually there may be even more CB licensees than there are today . . . but obviously activity on the channels will be much lower than now. We may find some CB manufacturers turning to ham manufacturing while the slack created by the present mob leaving is taken up by the new users of the band, a slack which could take several years.

Fortunately the ham market is coming back to life after the crushing blow of RM-499 last winter. It has been estimated that something over $6 million dollars in ham sales have been permanently lost due to this blunder. Full confidence in the future of ham radio cannot be regained until the FCC acts to turn down this petition.

Besides our getting cheap equipment for ten meters there is one other beauty of the new CB regs . . . magazines, such as S-9, which have been encouraging hamming on eleven, will probably fade away.

NEWS OF THE INSTITUTE OF AMATEUR RADIO

The Institute of Amateur Radio was created to enhance the amateur radio fraternity, both nationally and internationally in scope. It also encourages improvement in individual operating techniques and individual technical advancements in the state of the art of amateur radio communications.

Now is the time to join the Institute of Amateur Radio. A lot of leg work has been done by the General Secretary and the Interim Board of Directors to get the organization on its way. The organization is feeling its growing pains. It is expanding rapidly and concurrently with this growth, greater effort has been expended to firm up rules, regulations and organizational lines.

Fellow Radio Amateur—give serious thought to your becoming a founding member now and placing yourself in the position of sharing, in the near future, responsibilities for the operation of the growing organization down to area, state and club functionaries.

How to Join

Write to the General Secretary, Institute of Amateur Radio, Peterborough, New Hampshire, and request the brochure which includes the application form.

What the Directors Are Doing

Recently the General Secretary traveled to the West Coast to discuss and coordinate affairs of the IOAR. Subsequently, with the benefits of combined thinking and inputs from these Directors, a meeting was held by Directors on the East Coast to weld together all thoughts and ideas for the conduct of business activities for the fall and winter period. This includes the drawing up of the constitution and bylaws for the ratification by the IOAR membership. Also on the agenda is the expansion of the bylaws to designate the positions and titles of officers and qualifications for office holders, and to delineate the finite lines of organization and control down to the State Director or Representative level, to include major objectives within the scope of each level. This is a big job and cannot be accomplished overnight. Progress, however, is being made in these directions.

Many Volunteers

Scores of letters have been received both at the office of the General Secretary and at the Washing-

IoAR News *–cont'd*

ton office from individual radio amateurs, members and non-members, volunteering their services for the promotion and enhancement of the IOAR organization. To those of you who have not received replies to your fine letters, let us ask you not to be discouraged, as all the mail will be answered, and the information you supplied and the qualifications stated are being categorically filed in order that interim and future requirements may be supplied from these sources. Members of the Washington office have been assigned the task of replying to your letters. Please be patient with us. It cannot be over-emphasized that your genuine and sincere interest is truly appreciated.

Dues Study

The Board of Directors at present is studying the economics of the Institute at its present level and is forecasting costs of future operation as opposed to future potential resources. A serious consideration is underway to retroactively reduce annual dues and to include with such dues a tangible, direct benefit that the IOAR members will immediately apreciate. Appropriate announcement will be made when a decision of the Board has been reached.

Milestones and Goals

Looking back over the past 18 months, it has not been an easy road. It takes money to establish and promote a new organization. The founding membership dues were established at $10.00 in order to effectively promote the Institute. The first financial statment has been sent to the members. Without going into details, funds have been spent for such things as membership certificates, dues cards, postage, stationery, brochures, banners, buttons, paper stock, reproduction charges, labor, and financial assistance to radio amateurs involved in legal cases pertaining to the operation and maintenance of an amateur radio station.

Now that the Institute is bordering 1,000 members, an established goal has been set at 10,000 by July 1965.

A Real Accomplishment

The Institute of Amateur Radio has now established a registered lobbyist to function on behalf of the Institute and to carry out instructions of the Board of Directors in connection with legislative matters concerning amateur radio or its related activities, with Members of the Congress of the United States. The registered lobbyist resides in the Washington area.

Food for Thought

It is the dedicated aim of the IOAR to maintain a truly democratic organization in which members may consider themselves as individual representatives having a voice on important policies and other matters affecting the status or preservation of amateur radio. These facts will be borne out in the constitution and bylaws soon to be released.

If the geopolitical situation remains at its present level there will be, in all probability within the next three years, an International Telecommunications Union Convention for the review and reestablishment of the world radio frequency allocations and assignments. It is the goal of the IOAR to secure enough economic strength to be placed in a position to be recognized and to be heard in connection with the acquisition of additional amateur radio frequencies and/or in the defense of the existing amateur radio frequencies allocated within Region II.

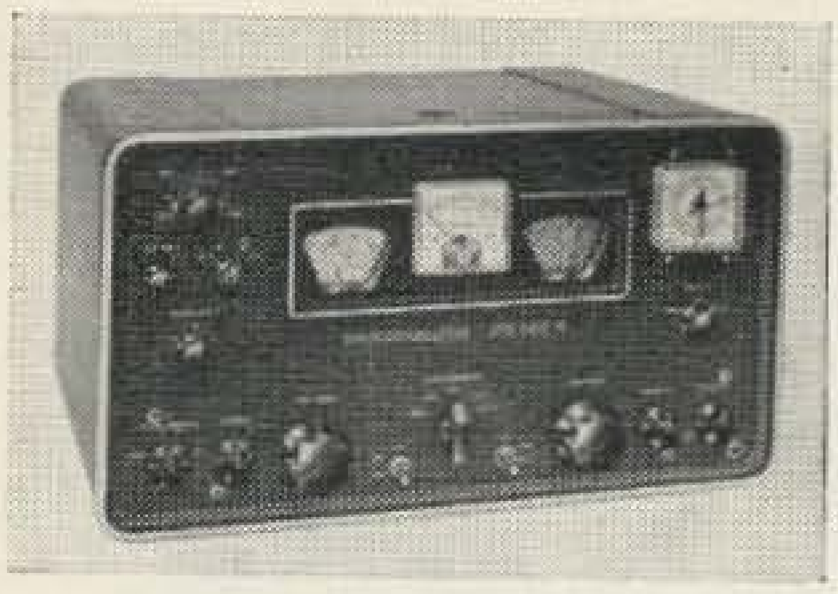
A growing concern of the Institute of Amateur Radio is the witnessing of a recent ill experience of crass commercialism within the sphere of the amateur radio hobby and service. It appears that amateur radio per se has been linked unnecessarily but by design with two well known manufacturers. In some areas there is evidence that amateur radio has become a testing ground for the professionals. While we do not wish to 'cut off our nose to spite our face,' it must be borne out that the amateur radio spectrum should be utilized by radio amateurs and for radio amateur operations and controlled as such by the FCC as a purely amateur spectrum, except for bona fide Government sharing of frequencies. The portion of the radio spectrum assigned to radio amateurs is fully justified in the United States and its possessions by FCC Regulation 97.0, *Basis and Purpose.* This paragraph alone, of the Regulations, is the crux of the justification for amateur radio operation upheld by the U. S. Government at International Conventions, notwithstanding important national defense considerations. Let no one threaten this amateur privilege through mercenary actions and selfish exploitation of the amateur radio hobby and service. In further substantiation for the existence of amateur radio in this country, one cannot overlook the economic factor in connection with the free enterprise system of our country. In this respect the hobby of amateur radio does support a share of the gross national product. Where does the IOAR fit in? The IOAR intends to influence the binding together of all radio amateurs for the common good in support of amateur radio and for the protection against an encroachment by the commercial services to potentially enter upon currently authorized amateur frequencies. The IOAR, as a body of amateurs, intends to guard against greedy, mercenary influences and the exploitation of the radio hobby by those few who would divide the multitude and the ranks for personal gain and other convenient reasons benefitting only to a minority. The IOAR concepts are to steer the generation of ideas and proposals through its membership. What say you?

Edwin M. Schaad
Director, IOAR
WA4PDX/W9AIY

How to Join

Send your name, call, address, and $10 dues to Peterborough, N. H. You will receive your membership certificate, membership card and insiders' newsletter in a few days.

New Products



HQ-145A

Hammarlund has added some important improvements to their very popular 145. The "A" now has separate detectors for AM, SSB, and CW, improved electrical and mechanical stability, silicon rectifiers (for much lower heat and higher effiiciency), and 115/230 volt operation. The price is $289! More info is available from Hammarlund, 53 West 23rd Street, New York 10.

Lafayette HA-350

Lafayette Radio Electronics Corpcration, 111 Jericho Turnpike, Syosset, L. I., N. Y. announces a new ham radio receiver, Model HA-350. One of the most important features of this unit is the use of a mechanical filter in the 455Kc IF section offering high selectivity of 2KC bandwidth at 6 db down and 6 Kc at 60 db down. A tuneable preselector circuit gives a sensitivity rating of less than 1 microvolt for 10 db signal to noise ratio. The 100 Kc crystal calibrator and 15Mc WWV band provision assures accurate calibration. SSB reception is improved by the use of a product detector which provides selectable upper or lower sideband. It measures 15W x 7½H x 10" D. The net price is $189.50. Its matching speaker model HE-48 sells for $7.95.

Squalo Tree

Cushcraft's Squalo antenna turned out to be an instant success. Now they're stacking the Squalos starting with the 40M one on the bottom and going on up to 6M on top. The whole works is only 27' high and 16' wide. If you leave off the 40M Squalo it is only 11' high and 8' wide. Write Cushcraft, 621 Hayward, Manchester, N. H.

Short Treatise for Curious Hams and Amperex Stockholders

Amperex has been coming out with new transmitting tubes faster than we can count them these days. One of the many interesting ones is the 8163. All of you that use linears with bias and screen supplies can read the specs and weep. It's a high mu power triode for use as a zero bias class B linear in sideband applications up to 110 mc. Dissipation is 400 watts and as you can see from the photo, the anode is very rugged. A cheap low velocity blower will keep it happy; no need for an air system that could be used for testing a Boeing 707. Drive requirements are modest, distortion is very low and efficiency is excellent.

One of the most popular VHF tubes around these days is the 6360. This little dual tetrode is self neutralized, very easy to drive and has a respectable output. Amperex, who introduced the 6360, has announced some new extensions of its family. The 8457 is very similar to the 6360 but is especially suited for frequency multiplication. The 8458 uses a Novar base and can provide 30 watts at 175 mc with only one watt of drive. Like the other tubes, it is internally neutralized and hence very easy to handle.

Most of us will agree that transistorized equipment has many advantages over tube equipment. Even the spark boys are getting interested in semiconductors. But respectable output at practical cost now requires that you use tubes in the output. This hurts since most tubes draw large amounts of filament power even when you're not talking. Amperex has a complete line of transistors for transmitting, and now they're rapidly bringing out the instant heating tubes to use in the driver and

Letters

Dear Wayne,

In regard to the SB-400 article you published in this month's "73," I have further information which you might like to pass on to your readers.

When the SB-400 is used in conjunction with its companion receiver the SB-300 in the separate transmit/receive function and the CW mode, one is able to detect a very faint 1 kc note while receiving. At first I believed this to be the sidetone oscillator running continuously. It turns out, however that the carrier generating circuit which does run continuously in the SB-400 is feeding its signal back to the receiver product detector via the MUTE and ANTI-VOX connecting cables. The following procedure was used to affect a sure cure:

1) Connect a .005 mfd disc capacitor across the ANTI-VOX jack at the rear apron of the SB-400 chassis.
2) Remove the grey wire from the MUTE jack also on the rear apron of the transmitter. Connect a 300 uh (value not critical) rf choke in series with the grey wire and the MUTE jack it was formerly connected to.

William J. Hall K1RPB

Dear Wayne,

The members of the Radio Amateur's Explorer Post 73, of Abilene, Texas are in the process of equipping a small trailor for emergency communication purposes. We plan to have a complete ham shack with its own power source.

We've held several car washes in an effort to acquire the neccesary equipment, but these haven't produced very good results. So now we are making an appeal for contributions. Anyone that would care to contribute a piece of equipment, whether its in working condition or not, or would like more information on our project may write to;
Earl Bradley—WA5CWZ
1765 Jackson Street
Abilene, Texas

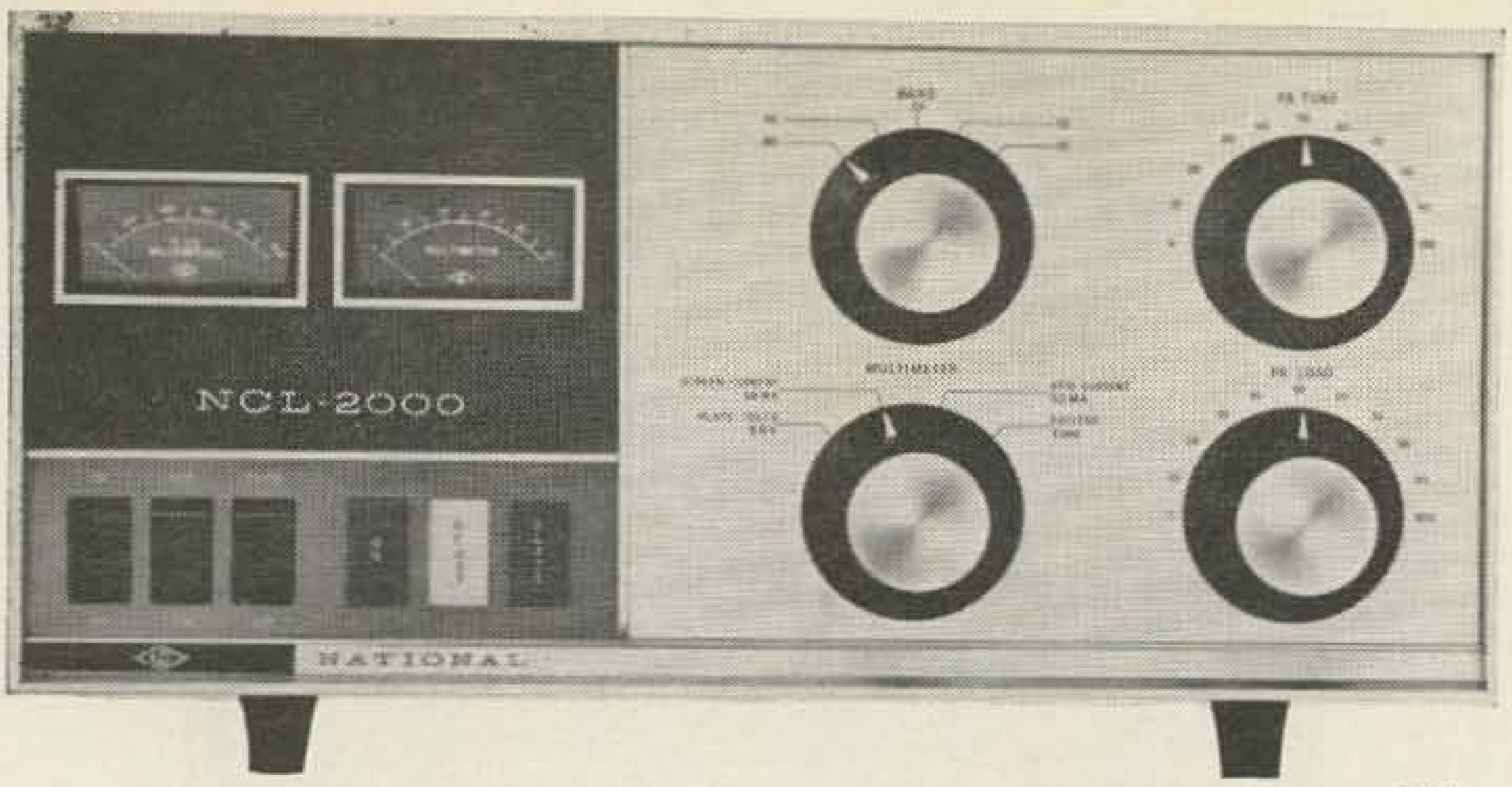
We can't offer anything in return to any contributers except possibly a note every once-in-a-while on how our project is progressing, but we will certainly appreciate any help we receive.

Earl Bradley WA5CWZ

Amperex . . . cont'd.

final stages. These tubes use the "Harp Cathode" that provides quick heating with low current drain, yet provides sufficient emission for efficient operation. An example is the 8463. It delivers 6.7 watts on 6 meters and over 3.6 watts on 2 with only 1½ watts of filament power. It is particularly useful as a driver for higher power instant heating finals. Another is the 8343, very similar to the popular 6360. It can put out 16 watts at 200 mc. The 8509 is the instant heating version of the 5894 dual tetrode. It is self neutralized and will deliver 96 watts to the load at 250 mc under ICAS conditions. For more information about these or other Amperex tubes, contact M. Smoler at Amperex, Hichsville, L. I., N. Y.

. . . WA4HWW



The NCL-2000

Val Barnes W1ALU

It can't be that small! A 2000 watt PEP amplifier with power supply just would not fit in that little cabinet! These were some of the initial comments made by on-lookers as I unpacked the white carton that had just arrived by truck from Melrose. I must admit that it did seem a bit improbable.

Pushing aside a pile of QSL cards the NCL-2000 was placed next to the NCX-3, which was used as the exciter. Hmm, same blue cabinet and extruded aluminum, anodized front panel that resists scratching. Installation took only a couple of minutes, consisting of connecting a piece of coax for the exciter output, a short length of zip cord for the relay interconnection, an antenna, and plugging in the power cord

Setting the Band Switch to 20 meters, I pushed the primary power switch and waited for the ready lamp to light, indicating that the tubes were warmed up enough to apply plate power These boys at National think of everything. After about a 60 second delay the ready lamp blinked on and plate power was applied. A quick adjustment of the PA TUNE and LOAD controls and I was ready to call F7GA in Paris to maintain our usual Friday schedule. Hmm, 40 db over S9 in France, well guess I don't have to worry about signal strength. Frank made a tape recording of my transmission and played it back to prove it.

The NCL-2000 covers the 80 through 10 meter bands with a 1000 watt average, 2000 watt PEP power input. The amplifier was not used on 15 or 10 however, as the exciter available did not cover these bands. Two 8122 miniature ceramic tetrodes are used in parallel, which provide 800 watts of available plate dissipation, thus allowing the amplifier to be operated at full legal input without straining anything. It will operate at 1000 watts steady carrier input for AM, CW, FM and RTTY service.

The NCL-2000 uses a passive untuned grid circuit, which allows the amplifier to be driven to full output by an exciter providing between 20 and 200 watts output. This means no fooling around with those attenuators to reduce the output of the exciter to a desired level. Also in the grid circuit is a 100 watt non-inductive resistor which may be used as a dummy load when tuning the exciter. The relative output can be read on the amplifier's multimeter.

The amplifier has the necessary built-in relay and coax jacks for using it with transceivers, or separate transmitter-receiver combinations, making any other controlled relays unnecessary.

A jack is provided so you can connect the amplifier ALC circuitry to your exciter if it has an ALC input.

In addition to primary fusing, a plate overload relay is included to preserve the tubes. The safety interlocks, of which there are two, idiot-proof the amplifier and make it virtually imposible to receive an unpleasant jolt of high-voltage. A lid interlock breaks power to the plate relay and a spring-actuated mechanical shorting bar discharges residual plate voltage to ground when the lid is raised. The shorting bar also gives protection against the possibility of plate interlock failure or an open bleeder resistor.

The amplifier may be used with either a 230-volt, 3-wire or 115-volt, 2-wire power main. The NCL-2000 may draw in excess of 10 amperes from a 230-volt line or in excess of 20 amperes from a 115-volt line under peak power input conditions. The 115-volt service in our shack is already well loaded and since 230 volts provides superior regulation to a normal 115-volt circuit, I used it for our test.

With an NCX-3 as an exciter and a 3-element Cushcraft 20 meter beam on a 70 foot tower, the amplifier was given a good workout for a period of about a month. Numerous quality checks were made on the air with both state-side and DX stations, with only favorable comments being received. A number of questions about the amplifier and its operation were answered over the air.

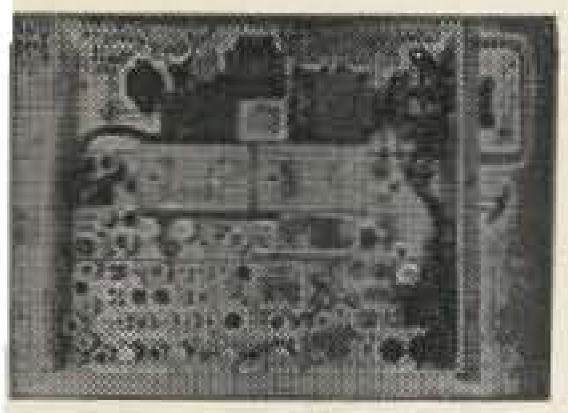
The station log shows that I was more active than usual during the time the NCL-2000 was available for test, with the addition of about a dozen new countries to my check-list.

Only after numerous threats of bodily harm from Wayne, did I finally pack the NCL-2000 in its white carton and call the Railway Express truck to take it back to Melrose.

INDEX TO ADVERTISERS

To aid you in finding ads which are not running in this issue we have listed the last ad run by each company in 73.

F. M. SPECIALS

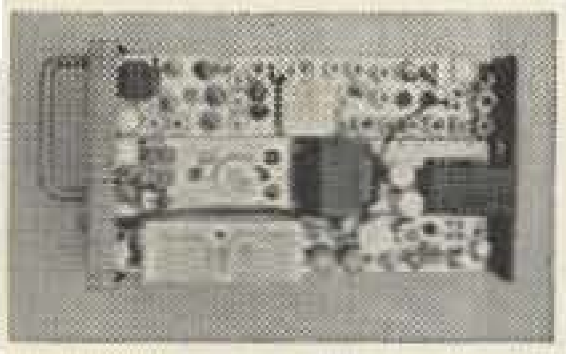


MOTOROLA T44A

432 MC FM CRYSTAL CONTROLLED MOBILE Motorola T44A-6 6/12 DC Power Supply 18 W Transmitter 2C39 Tripler 2C39 Final Receiver is triple-superhet with 0.8 uv. sensitivity. Simple mechanical changes necessary to convert these 450-460 MC units to 432 MC

All Units Complete with 2C39s and Crystal Info., and Schematics

T44A-6 .... $52.50
T44A-6A Later, Improved Version 64.50
Cases for above 2.50



FMTR-41V

150 MC CRYSTAL CONTROLLED MOBILES Motorola 41V 10W RF 2E26 Final 12VDC Schematic Included

FMTRU—41V 12VDC .. $34.95
Cases for above 4.00

SEND FOR LATEST FLYER
SALES LIMITED TO AMATEURS
NO CONTROL HEADS OR CABLES AVAILABLE

F M SURPLUS SALES CO.

1100 TREMONT ST., ROXBURY 20, MASS.
617-427-3513

OIL CAPACITORS

					Shipping Weight	Price
6	MFD	3	KVDC	Pyramid	8#	$6.00
4	MFD	5	KVDC	Aerovox	24#	7.50
2	MFD	5	KVDC	Pyramid	7#	4.00
.5	MFD	25	KVDC	C.D.	98#	15.00
.5	MFD	5	KVDC	GE	4#	2.00
.01	MFD	22	KVDC	GE	25#	7.50
4	MFD	30	KVDC	Sangamo	400#	150.00

ELECTROLYTIC CONDENSERS

					1 ea.	lots of 10
60	MFD	350	VDC	Aerovox	40c	$2.50
80	MFD	150	VDC	Aerovox	40c	$2.50

.05	MFD	3	KVDC	Gudeman Co.	1#	$0.50
.05	MFD	8	KVDC	Plastic Capacitors	1#	$1.50
.002	MFD	7.5	KVDC	Gudeman Co.	1#	$0.75
.06	MFD	10	KVDC	Glass Mike	1#	$1.50
.002	MFD	20	KVDC	Plastic Capacitors	1#	$1.50

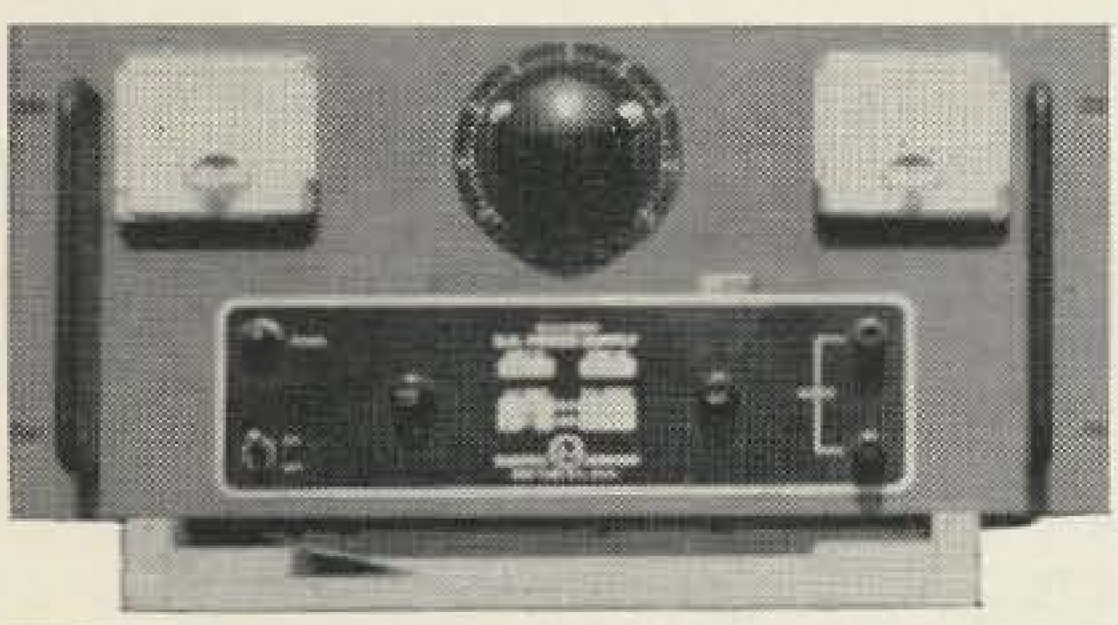
FILAMENT TRANSFORMERS

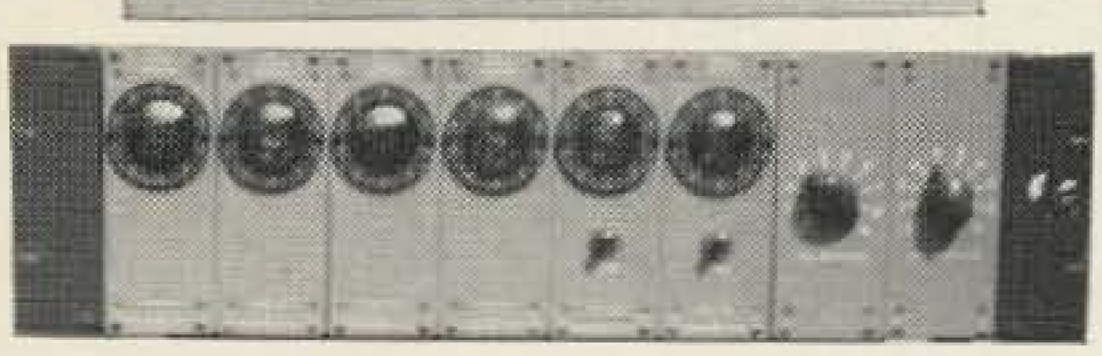
Pri. 115V 60cy. Sec. 30V @ 2 amps 3# $1.50
Pri. 115V 60cy. 1-177 Tube Checker Transformer 4½x4¼x4″ 5¼ lbs. $2.50

E. F. Johnson Variable Capacitor type 169-20 50-150 mmfd. 4500 V. .125″ air gap 6# $2.50

All items new and guaranteed
Minimum order $3.00. Please send sufficient money to cover postage. Will refund unused amt.
Ohio residents add 3% sales tax

Western Sales
1224 Prospect Avenue
Cleveland 15, Ohio 44115





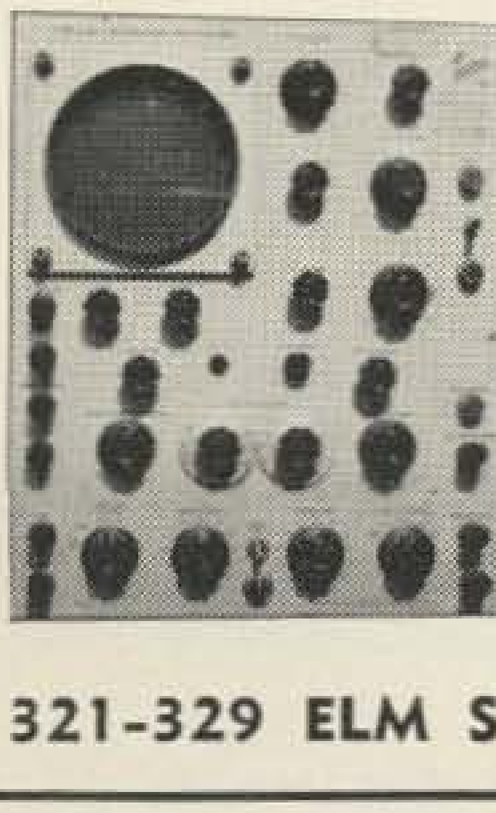
Opad KM75 Power supplies 0-32 volts, 5 amps $40.00

TS 418A 400-1000 meg signal generators, AM, PM or CW emission $325.00

Baird Atomic 162 Glow transfer counters $100.00

Baird Atomic 8015 Industrial counters with model 380A supply $100.00

Narda Model 440 power meters $99.50
Borg-Warner assembly no. 1462 2.7-3.0 KMC Free running signal gen. $325.00
Approximately 17,000 unwound Ferrite memory cores $12.00
10 lbs. epoxy resin with catalyst, Type XR-5034 .... $6.00



Tektronix 513D Scopes $300.00
Tektronix 514D Scopes $275.00

Orders FOB Cambridge, Mass.
Sorry we do not issue catalogs or lists

ELI HEFFRON & SONS, INC.

321-329 ELM STREET **CAMBRIDGE 39, MASS.** **EL 4-8572**

Propagation Chart

EASTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7*	7	7	7	7	7	7	14	14	14	14
ARGENTINA	14	7	7	7	7	7	14	21	21	21	21*	21
AUSTRALIA	14	7	7	7	7	7	7	14	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	14	21	21	21	21*	21
ENGLAND	7	7	7	3*	7	7*	14	14	14	14	14	7
HAWAII	14	14	7	7	7	7	7	7	14	14	14	14
INDIA	7	7	7	3*	7	7	14	14	7	7	7	7
JAPAN	14	7	7	3*	3*	7	7	7	7	7	7	14
MEXICO	14	7	7	7	7	7	7	14	14	14	14	21
PHILIPPINES	14	7	7	7	3*	7	7	7	7	7	7	14
PUERTO RICO	7	7	7	7	7	7	14	14	14	14	14*	14
SOUTH AFRICA	7	7	7	7	7	14	14	21	21	21	21	14
U. S. S. R.	3*	3*	3*	3*	7	7	14	14	14	7	7	7
WEST COAST	14	14	7	7	7	7	7	14	14	14	14*	14

Good: 9-21, 27-28
Fair: 1-2, 6-8, 25-26, 29-31
Poor: 3-5, 22-24
Es: 13-22 occasional
(High MUF and/or freak conditions)

CENTRAL UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	14	14	14	14
ARGENTINA	14	7	7	7	7	7	14	21	21	21	21	21*
AUSTRALIA	21	14	7	7	7	7	7	14	14	7*	21	21*
CANAL ZONE	14	7	7	7	7	7	14	21	21	21	21*	21
ENGLAND	7	3*	3*	3*	3*	7	7	14	14	14	14	7
HAWAII	14	14	7	7	7	7	7	7	14	14	14*	21
INDIA	7	7	7	7	7	3*	7	14	7*	7	7	7
JAPAN	14	14	7	7	3*	3*	7	7	7	7	14	14
MEXICO	14	7	3*	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	7	7	7	3*	7	7	7*	7	7	14
PUERTO RICO	14	7	7	7	7	7	14	14	14	14	21	21
SOUTH AFRICA	14	7	7	7	7	7	14	14	14	14	14*	14
U. S. S. R.	7	3*	3*	3*	3*	7	7	14	14	7	7	7

J. H. Nelson

WESTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7	14	14	14	14
ARGENTINA	21	7	7	7	7	7	7	14	21	21	21	21*
AUSTRALIA	21*	21	14	7	7	7	7	7	14	7*	21	21*
CANAL ZONE	14	7	7	7	7	7	7	14	14	14*	21	21
ENGLAND	7	7	3*	3*	3*	3*	7	7	14	14	7*	7
HAWAII	21	21	14	7	7	7	7	7	14	14	21	21
INDIA	7*	14	7	7	3*	3*	3*	7	7*	7	7	7
JAPAN	14	14	14	7	7	7	7	7	7	7	14	14
MEXICO	14	7	3*	7	7	7	7	14	14	14	14	14*
PHILIPPINES	14	14	14	7	7	7	7	7	7*	7	7	14
PUERTO RICO	14	7	7	7	7	7	7	14	14	14	14*	14*
SOUTH AFRICA	14	14	7	7	7	3*	7	14	14	14	14	14
U. S. S. R.	7	3*	3*	3*	3*	3*	7	7	14	7*	7*	7
EAST COAST	14	14	7	7	7	7	7	14	14	14	14*	14

* Means next higher frequency may be useful.

Announcing an extraordinary achievement in amateur radio

THE NATIONAL HRO-500 RECEIVER

The National HRO-500 is the result of thirty years of "improvement of the breed" From the first HRO *Senior* of 1933 to the present, the HRO series has been almost legendary. The HRO-500 continues this proud tradition, and incorporates important technological advances resulting from National's leadership in the field of solid state physics, frequency standardization, and frequency synthesis.

By any criterion, the HRO-500 is extraordinary.

1. Design Concept: The HRO-500 is totally solid state. Frequency is determined by a phase-locked crystal synthesizer* feeding a VFO-controlled tunable IF. Similar circuit techniques are found only in advanced military communications equipment.

2. Reliability: The use of transistors throughout assures amazing reliability as a result of their enormously long life and minimum heat generation. The HRO-500 is hand-wired . . . compact . . . but *not* miniaturized.

3. Versatility: The HRO-500 may be operated anywhere . . . from flashlight cells, 12 volt car battery, or from 115V/230V 50/60 cycle sources. Total battery drain is less than that required for two dial lamps.

4. Frequency Coverage: *The HRO-500 covers the entire VLF through HF spectrum* . . . Five kilocycles through 30 Mc. in 60 synthesized 500 Kc bands, with equal stability and dial accuracy throughout its tuning range. No need to confine operation to ham bands only . . . the HRO-500 provides total coverage of MARS, commercial, foreign broadcast, marine, VLF communications, test and experimental frequencies. All required heterodyne frequencies are generated by the frequency synthesizer.

5. Dial Calibration and accuracy *over the entire tuning range* is one kilocycle, employing a linear VFO and National's famous PW epicyclic dial mechanism. 1 Kc divisions are ¼" apart, allowing easy interpolation to 200 cycles or better. VFO tuning rate is identical on all bands.

6. Stability: The HRO-500 employs a 500 Kc reference crystal standard, output of which is synthesized and phase-locked to produce crystal-stable high frequency oscillator signals. The VFO is electronically regulated. The use of transistors throughout practically eliminates internal heat generation. Long term stability from turn-on is better than 100 cycles over any ten-minute period, including supply voltage variation of ±10% and ambient temperature variations of 30° C.

7. Selectivity: The HRO-500 employs a *tunable* six-pole filter to meet any selectivity requirement. Bandwidths available are 500 cycles, 2.5 Kc, 5.0 Kc, and 8.0 Kc . . . the widest selectivity range of any amateur receiver. *Passband Tuning* in the 500 cycle and 2.5 Kc positions provides ease of sideband selection and adjacent channel interference rejection found in no other receiver manufactured today. A *Rejection Tuning* network allows rejection of interfering heterodynes by 60 db.

8. HRO-500 sensitivity and noise figure is substantially superior to the previous standard of comparison, all earlier HRO models! Amateur net price will be approximately $1000.00, with delivery this fall. If your requirements demand the finest amateur receiver obtainable at *any* price, the National HRO-500 is your only choice.

*Patent Pending

NATIONAL RADIO COMPANY, INC. **37 Washington Street, Melrose, Mass. 02176**

World Wide Export Sales: Ad. Auriema, Inc., 85 Broad Street, NYC Canada: Tri-Tel Associates, 81 Sheppard Ave. W., Willowdale, Ontario