

60 cents

hr

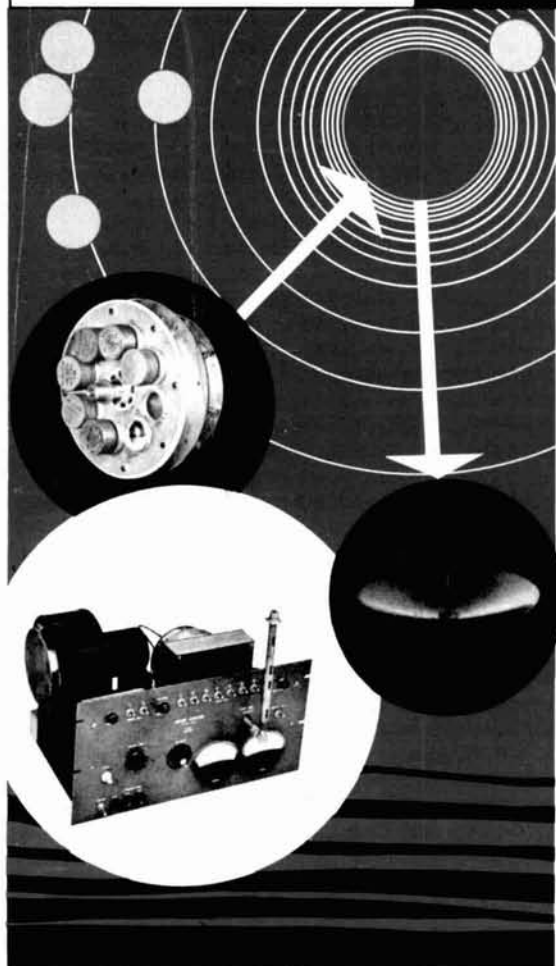
focus
on
communications
technology . . .

ham radio

AUGUST 1968

this month

- mosfet converter for 144 mhz 22
- converting to solid state 30
- ssb filters 40
- high-voltage trouble shooting 52
- novice superheterodyne 66



high-power linear amplifier for
1296-mhz moonbounce

TALK POWER



The AutoLevel is the ultimate in volume compressors. This unique device provides all the talk power your transmitter can use. The AutoLevel was designed for use with SSB or AM transmitters, with or without ALC capabilities.

The AutoLevel is not an audio or RF clipper - all compression is attained by a photo-optical regulator which provides 14 dB's of compression with a minimum of wave form distortion.

The AutoLevel is easily installed in the mike line, and it contains its own power supply; (there's no need to bother with batteries). It can also be used with your phone patch for the utmost in ease of operation.

When you're ready for the finest, ask your local dealer for the AutoLevel.

SPECIFICATIONS

dB's compression - 14 dB minimum

Wave form distortion - negligible

Input impedance - suitable for dynamic or crystal microphone

Output impedance - 50K (nominal)

Power supply - 115 volts AC

Dimensions - 2-3/4" x 4-11/16" x 6-3/8"
H W D

Weight - 32 ounces

Color - Bone White with Black front panel

Price - \$87.50

AUTHORIZED DEALERS (listed alphabetically)

AMATEUR ELECTRONIC SUPPLY

4828 W. Fond du Lac Avenue
Milwaukee, Wisconsin 53216
Tel: 414 - 442-4200

AMRAD SUPPLY, INC.

3425 Balboa Street
San Francisco, California 94121
Tel: 415 - 751-4661

AMRAD SUPPLY, INC.

1025 Harrison Street
Oakland, California 94607
Tel: 415 - 451-7755

ELECTRONIC CENTER, INC.

107 3rd Ave. North
Minneapolis, Minnesota
Tel: 612 - 338-5881

EVANSVILLE AMATEUR RADIO

1629 S. Kentucky Avenue
Evansville, Indiana
Tel: 812 - 422-4551

GRAHAM ELECTRONICS SUPPLY, INC.

122 S. Senate Avenue
Indianapolis, Indiana 46225
Tel: 317 - 634-8486

HAM RADIO OUTLET

999 Howard Avenue
Burlingame, California 94010
Tel: 415 - 342-5757

THE HAM SHACK

(Tel-Appliance Center, Inc.)
1966 Hillview Street
Sarasota, Florida 33579
Tel: 813 - 955-7161

HENRY RADIO STORE

931 N. Euclid
Anaheim, California 92801
Tel: 714 - 772-9200

HENRY RADIO STORE

11240 West Olympic Blvd.
Los Angeles, California 90064
Tel: 213 - 477-6701

ED MOORY WHOLESALE RADIO

Box 506 -
DeWitt, Arkansas
Tel: 501 - WH 6-2820

PIONEER-STANDARD ELECTRONICS, INC.

5403 Prospect Avenue
Cleveland, Ohio 44103
Tel: 216 - 432-0010

PIONEER-STANDARD ELECTRONICS, INC.

SREPCO ELECTRONICS DIVISION
314 Leo Street
Dayton, Ohio 45404

Tel: 513 - 224-0871

UNIVERSAL SERVICE

114 North Third Street
Columbus, Ohio 43215
Tel: 614 - 221-2335

VALLEY HAM SHACK

4109 N. 39th Street
Phoenix, Arizona
Tel: 602 - 955-4850

DEALERSHIPS AVAILABLE IN SOME AREAS

WRITE FOR FREE SPECIFICATIONS

RAYTRACK

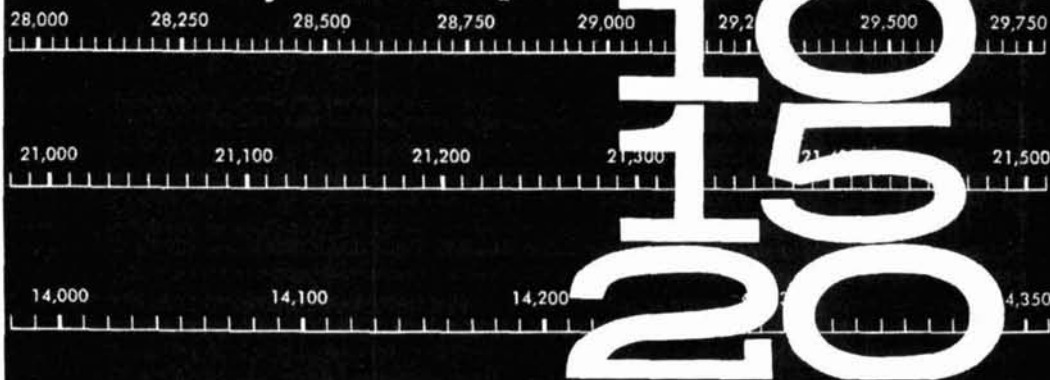


2111 SPRINGHILL DRIVE

Columbus, Ohio 43221

TELEPHONE 614/486-7090

NEW | **C**ubical **Q**uads by *Mosley*



Four NEW Two-Element QUADS

SINGLE BAND QUADS

Model MCQ-10 for 10 meters

Model MCQ-15 for 15 meters

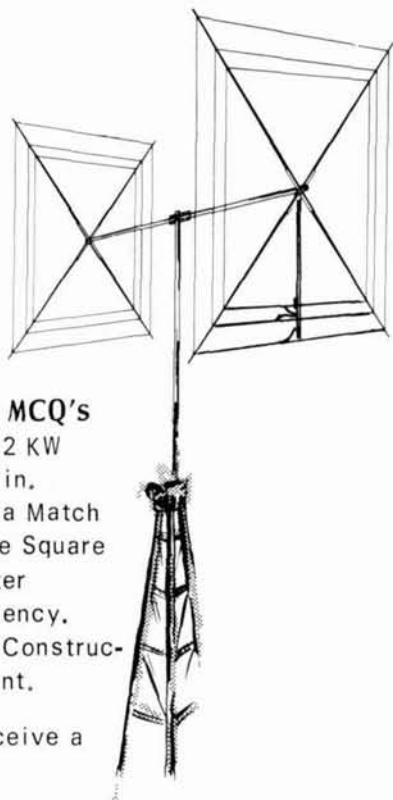
Model MCQ-20 for 20 meters

TRI-BAND QUAD

Model MCQ-3B for 10, 15 & 20 meters

Designed and Engineered for Superior DX, the new **MCQ's** (Mosley Cubical Quads) are rated to 1 KW AM and 2 KW P.E.P. SSB. Maximum Front-to-Back and Forward Gain. A Single 52 ohm Line feeds the Quads via a Gamma Match resulting in a low SWR over the full bandwidth. The Square Configuration of the **MCQ** Series guarantees better performance by providing optimum electrical efficiency. The Durable, Lightweight, Weatherproof Aluminum Construction yields a lifetime of maintenance-free enjoyment.

For detailed brochure, Write Dept. 169 . . . and receive a **FREE** 1968/69 Mosley Antenna Catalog.



Mosley Electronics Inc. Dept. 169
4610 N. Lindbergh • Bridgeton, Missouri 63042



“Drake 4-Line is the most satisfying...totally efficient...”

says WØYDB, Minneapolis . . .

To quote in part from a letter received from W. C. Higgins, WØYDB, Minneapolis, Minn., dated May 10, 1968 . . .

“... Enclosed are several snapshots of my hamshack and equipment. Since the Drake 4-Line is so predominant, I thought that you might like to add to your photo collection of Drake-equipped stations. Granted, the gear is not the new B series but it is still the most satisfying and totally efficient that this old-timer has used in 32 years of amateur, military and commercial electronic experience. I earn my living as a Production Manager of (aero-space) electronic instrumentation production . . . and I think I can recognize excellence in electronic engineering design and performance when I see it.

“Again, congratulations for developing the 4-Line. 73 . . .”

(Signed) Bill, W. C. Higgins

***Ask any ham who owns a Drake
4-Line Rcvr, Xmtr or Linear...***

or write for detailed specifications:

Dept. 488 **R. L. DRAKE COMPANY** 540 Richard St., Miamisburg, Ohio 45342



ham radio

staff

editor

James R. Fisk,
W1DTY

roving editor

Forest H. Belt

vhf editor

Robert M. Brown,
K2ZSQ/W9HBF

associate editors

A. Norman Into, Jr.,
W1CCZ/K2IEO
Nicholas D. Skeer,
K1PSR
James A. Harvey
WA6IAK

art director

Jean Frey

publisher

T. H. Tenney, Jr.,
W1NLB

offices

Greenville, New Hamp-
shire 03048
Telephone: 603-878-1441

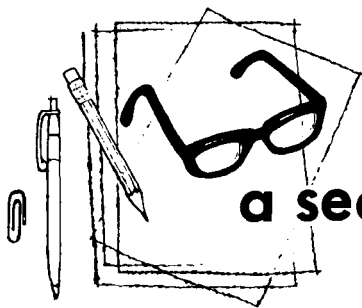
ham radio is published
monthly by Communi-
cations Technology,
Inc., Greenville, New
Hampshire 03048. Sub-
scription rates: U.S.A.
and Canada, one year,
\$5.00, three years,
\$10.00. Copyright 1968
© by Communications
Technology, Inc. Title
registered at U.S. Pat-
ent Office. Printed in
Montpelier, Vermont
05602, U.S.A.
Postmaster: Please
send form 3579 to ham
radio, Greenville, New
Hampshire 03048.

contents

Kilowatt Amplifier for 1296 MHz Peter Laakmann, WB6IOM	8
The Beta Master for Power Transistors J. Tom Lamb, K8ERV	18
MOSFET Converters for Two Meters Donald W. Nelson, WB2EGZ	22
Converting Vacuum-Tube Equipment to Solid State John J. Schultz, W2EEY	30
Audio and Squelch for FM Receivers Frank C. Jones, W6AJF	36
SSB Filters Forest H. Belt	40
J-Pole Antenna for Six Meters Harold E. Larson, K4SDY	48
Save That Beam E. H. Marriner, W6BLZ	50
Troubleshooting High-Voltage Circuits Larry Allen	52
How to be DX J. Michael Blasi, W4NXD	58
Amateur Radio in Space—A Bibliography Nicholas K. Marshall, W6OLO	60
Measuring Grid Current in Grounded-Grid Amplifiers William I. Orr, W6SAI	64
Novice Superhet for 40 and 80 Darrell Thorpe	66

departments

A Second Look	4	Propagation	72
Advertisers Index	96	Repair Bench	52
Ham Notebook	78	Short Circuits	34
New Products	82	The Publisher Speaks	6
Next Month	29		



a second look

by jim
fisk

If you patronize the bands below 30 MHz, a QSO with a KL7, a KH6 or a PY is practically an everyday occurrence. But when you can chalk up contacts like this on six meters, the band is really popping. Add CE, LU, OA, VP7, KA, KP4, all states and provinces of Canada and it's extraordinary. But that has been the way of six meters over the past few months.

And six meters is not the only band that has been busy. Two meters has provided some unbelievable openings via sporadic-E. W1YQI in Massachusetts reports working stations in Florida, Georgia, Alabama and Louisiana with +9 signals both ways. One station in Florida was using 75 watts and a 75-meter vertical, so power is no problem when conditions are right.

The same evening all this activity was going on, television reception was lousy in New England. Here in New Hampshire television reception was unbelievably bad because of co-channel interference from distant TV transmitters—even on channel seven! It's going to be a long time before we see another evening like that.

Earlier in June, WB6CXF in Riverside, California, worked WØJYC in Colorado, 750 miles away. Six meters was open simultaneously, and according to our propagation expert, the likelihood that this was tropospheric propagation is extremely remote—due to horizon screening and unfavorable terrain. The distance covered in this case is much shorter than expected and indicates that the maximum useable frequency for a 1400-mile path with the same reflection point may have been greater than 180 MHz!

Reports are slow in coming in, but from all indications, the experiences of W1YQI, WB6CXF and WØJYC are not isolated cases. Apparently during the month of June there

were more two-meter sporadic-E openings than ever before. Of course, there are far more openings than those recorded, but they occur at the wrong time of day and no one is on to take advantage of them. The opening on the East Coast was unusual because the band was still open at 9 o'clock in the evening. When that happens, there are a lot more stations around to take advantage.

Openings like this don't happen on 432 or 1296 of course, but on 1296, other things have been going on. WB6IOM has been hearing his own echoes with a kilowatt amplifier and a 10-foot dish. As far as I know, this is a record as far as antenna size goes. He is continuing tests with several well-equipped European stations, and it appears that a California-Europe moonbounce QSO on 1296 is just a matter of time.

Ray Naughton, VK3ATN, the famous moonbouncer from Australia, spent the early part of the summer in this country attending conventions and vhf get-togethers and planning his 1296-MHz moonbounce system. His home-made dish is coming along nicely, and as soon as he rounds up the necessary parts for his transmitter, I suspect we'll be hearing a big 1296-MHz signal out of Birchip.

If you're tired of working the world at the flick of a switch—if there's no challenge left on 10, 15, and 20—why not QSY up? The long, hot summer is only half gone. There's still plenty of time for putting up antennas and getting a vhf rig on the air. The sporadic-E season is just about shot, but the Perseids meteor shower in August and almost daily aurora displays offer some interesting opportunities for vhf propagation. So, if ham radio has lost some of its challenge, QSY up—the water's fine.

Jim Fisk, W1DTY
Editor

RELIABILITY

QUALITY

VALUE



SWAN 410C FULL COVERAGE EXTERNAL VFO

The Model 410C Frequency Control Unit is designed for full coverage of 80, 40, 20, 15 and 10 meters. It is intended for fixed station operation and plugs directly into Model 500C. It may also be used with Model 350C. Eight ranges, 500 kc each, 5 kc calibration.

\$115

DUAL VFO ADAPTOR

Provides for the addition of second VFO for separate control of transmit and receive frequencies. Plugs directly into Model 500C and may also be used with Model 350C and other Swan transceivers.

MODEL 22 \$32



MARS OSCILLATOR

Five crystal controlled channels with vernier frequency control. Plugs directly into Model 500C and may also be used with Model 350C and other Swan transceivers.

**MODEL 405X
(less crystals) . . \$45**

SWAN 500C SSB-AM-CW TRANSCEIVER

Five band, 520 watts for home station, mobile and portable operation.

The new model 500C is the latest evolutionary development of a basic well proven design philosophy. It offers greater power and additional features for even more operator enjoyment. Using a pair of the new heavy duty RCA 6LQ6 tetrodes, the final amplifier operates with increased efficiency and power output on all bands. PEP input rating of the 500C is conservatively 520 watts. Actually an average pair of 6LQ6's reach a peak input of over 570 watts before flattopping!

The 500C retains the same superior selectivity for which Swan transceivers are noted. The filter is made especially for us by C-F Networks, and with a shape factor of 1.7 and ultimate rejection of more than 100 db, it is the finest filter being offered in any transceiver today.

For the CW operator the 500C includes a built-in sidetone monitor, and by installing the Swan VOX Accessory (VX-2) you will have break in CW operation.

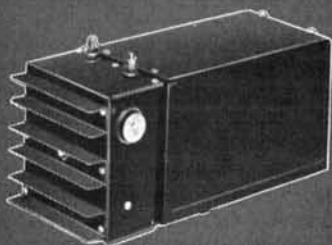
Voice quality, performance and reliability are in the Swan tradition of being second to none.

\$520

SWAN 117XC MATCHING AC POWER SUPPLY

Complete A.C. supply for 117 volts, 50-60 cycles, in a matching cabinet with speaker, phone jack, and indicator light. Includes power cable with plug for transceiver, and A.C. line cord. Ready to plug in and operate.

\$105



SWAN 14-117 12 VOLT DC SUPPLY

Complete D.C. supply for 12 volt mobile or portable operation. Includes cables, plugs, and fuses. Will also operate from 117 volt A.C. by detaching the D.C. module & plugging in 117 volt line cord. Negative ground standard. Positive ground available on special order.

\$130



SWAN

ELECTRONICS

OCEANSIDE, CALIFORNIA

A Subsidiary of Cubic Corp

**SWAN SPEAKS YOUR LANGUAGE
ASK THE HAM WHO OWNS ONE**

**Be sure to visit
your Swan dealer soon.**

ham radio and you . . .

a word from the publisher

Over the past several months or so, we've had the privilege of meeting a large number of our subscribers during many of the larger spring ham shows, such as the Dayton Ham-vention and the ARRL National Convention in San Antonio. This has been a very rewarding experience for all of us as it has given us a chance to learn first hand what the average reader thinks about **ham radio** magazine, and what he would like us to do to make it a more enjoyable and useful addition to his hobby.

It's been made very clear to us that **ham radio** is the kind of magazine that you've been looking for and that you don't want it changed. Don't worry—it won't be. It will only be improved.

Many good ideas were given to us, however. You'll notice several of them being used in months to come as we follow up on various suggestions for articles and possible improvements.

As we have met you, both by mail and in person, we have found a group totally interested in our new magazine and in its prospects for success. Many have asked what they might do to help with our growth. This month we are giving all of our subscribers an opportunity to do just that. Each envelope is being filled with two copies of this issue, and we are asking each of you to see that some ham friend of yours across town, across the

country or around the world receives the extra copy along with your impression of **ham radio**.

The success of this idea depends on you. No one can sell **ham radio** as well as a satisfied reader. We hope you are that reader. Give us a hand, and we'll be able to give you an even bigger and better magazine each month.

If you can use more than one extra copy let us know, and we'll send as many as you would like to pass on to friends or to give out at your next club meeting. While on the subject of your club, remember that we have special bulk subscription rates which are well worth investigating. Drop us a line and we'll be glad to let you in on the details.

Many of you have been very interested in just how well we've been doing. The answer is a most pleasant one for me to digress on for a moment or so. Before undertaking this venture, extremely detailed operating forecasts were prepared to determine whether there really was a place for **ham radio** magazine. Both our anticipated growth, and the price that would have to be paid to achieve it were carefully estimated, not only to prove our feasibility, but also to be used as a guideline during our development. We can happily report that our rapid growth has come as a surprise, even to our staff, and that the original projections now appear to be quite conservative. In virtually every category we are now ahead of our estimates, yet this has been done within the original budget which we thought was necessary to put our magazine on its feet.

The speed and warmth of your reception has certainly helped us over many of the difficult periods common to any young enterprise. Your letters and comments have meant a lot to all of us. There is still much hard work ahead to complete all of our plans for **ham radio**, but with your support, the road will be a lot smoother and a good deal shorter.

Skip Tenney, W1NLB
publisher

EIMAC

3-500Z's used in Drake's linear amplifier for 2 kW PEP at 3.5-30 MHz

The R. L. Drake L-4B linear amplifier shown here uses two of EIMAC's new 3-500Z zero-bias triodes in grounded grid circuitry to achieve 2-kW PEP SSB input and 1-kW dc input on CW, AM, and RTTY. Drive power is 100 watts PEP and 75 watts CW, AM, and RTTY.

Drake chose EIMAC 3-500Z's because these rugged, compact, high- μ power triodes are ideal for grounded grid operation. They can provide up to 20 times power gain in a cathode driven circuit. And the two tubes have a total plate dissipation rating of 1000 watts.

For more information on EIMAC's line of power tubes for advanced transmitters, write Amateur Services Department, or contact your nearest EIMAC distributor.

3-500Z TYPICAL OPERATION*

DC Plate Voltage	2500 V
Zero-Sig DC Plate Current**	130 mA
Single-Tone DC Plate Current	400 mA
Single-Tone DC Grid Current	120 mA
Two-Tone DC Plate Current	280 mA
Two-Tone DC Grid Current	70 mA
Peak Envelope Useful Output Power	500 W
Resonant Load Impedance	3450 ohms
Intermodulation Distortion Products	-33 dB

*Measured data from a single tube

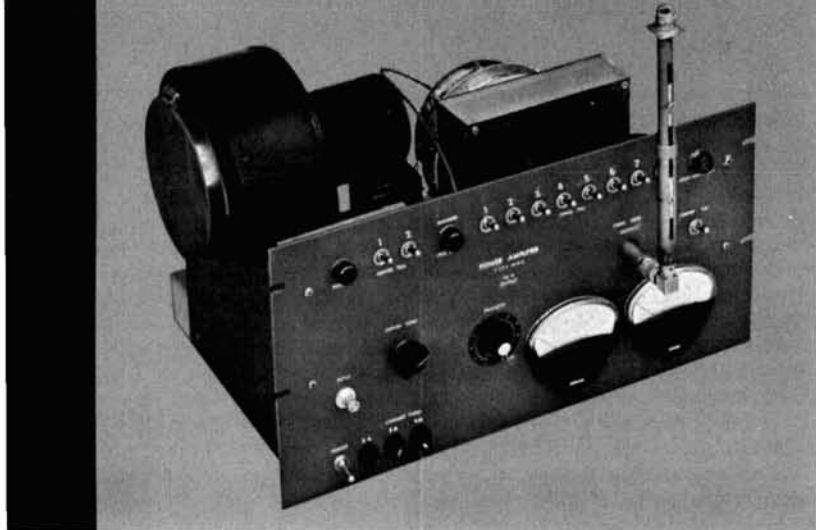
**Approximate

EIMAC

Division of Varian

San Carlos, California 94070





high-power linear for 1296 mhz

500 watts out
with an octet
of 2C39 ceramic triodes

Peter Laakmann, WB6IOM, 8001 Airline Avenue, Los Angeles, California 90045

The difficulty of generating useful amounts of power on 1296 MHz without using high-power klystrons has limited the interest of troposcatter and moonbounce enthusiasts. Commercially available high-power tetrodes such as the 7650 and 7213 are expensive and don't exhibit the power output and gain necessary for amateur use on 1296. These tubes are rated for service as uhf TV drivers or 1215-MHz radar use and are marginal at frequencies above 1215 MHz because of sharply decreasing power output and gain at only slightly higher frequencies. I have used a 7650 for the past two years; the best output I could obtain was 350 watts with 120 watts drive and total plate power input of 1.5 kW.

For these reasons, I've spent considerable effort replacing the tetrode amplifier with a parallel arrangement of eight 2C39A's. The high-power 2C39A amplifier described here can be easily duplicated by an experienced uhf'er; it uses a single power supply and exhibits nearly as much power gain and output as the average lower frequency linear.

the 1296 linear

The complete linear amplifier consists of two cavities on a single large chassis. The first one contains a pair of 2C39's in a square cavity, while the final consists of eight tubes in a round "radial-vane" arrangement. The required drive for full power output is 30

watts. Total plate current for both the driver and final amplifier is about two amps.

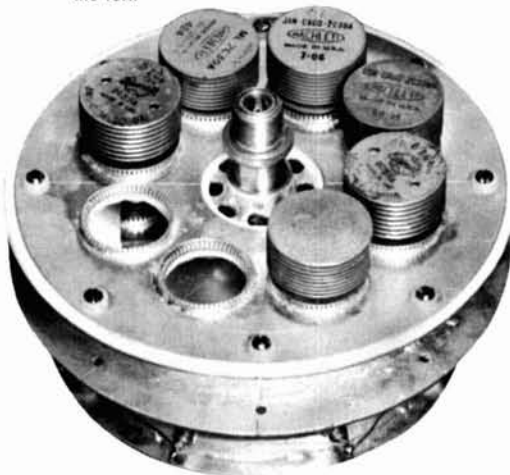
The square driver cavity was originally developed to drive a 7650 amplifier and was described in *QST*¹ as well as the 1968 edition of "The Radio Amateur's Handbook." It can deliver as much as 120 watts output with 30 watts drive; with about 15 watts drive, it will put out about 75 watts. Make sure that the tuning-screw guiding nut (6-32) is soldered to part B in *fig. 4* of the *QST* article.

The driver and final are both operated with their grids at dc and rf ground. Since the filament of the 2C39 is in common with the cathode, floating filament transformers must be used. Grid bias is obtained from a Zener diode and shared by both amplifiers. Both amplifiers operate in class B for low excitation and move toward class C with medium and full drive. With peak signal excitation, the grid bias is about 40 volts; grid cut-off bias is only 9 volts.

If you're not interested in using this amplifier on ssb, you can leave out the Zener diode and use two large cathode resistors instead. Peak output power is the same either way, but linearity is better with Zener bias. However, don't use fixed bias; it can't be used safely at the drive power levels used with these amplifiers.

All filaments are wired to front panel switches so the condition of each 2C39 can

The high-power 1296 amplifier, plate side up. You can see one of the tuning vanes through the open hole on the left.



be analyzed under operation. When a tube is turned off, a light comes on to warn against using the amplifier under full power.

A variable transformer is provided for adjusting filament voltage for the particular operating mode. For ssb and short bursts of CW or continuous operation as an a-m linear amplifier, full filament voltage is used. For long CW transmissions, the filament voltage should be reduced about 10% to prevent short tube life due to bombardment heating of the cathode by drive power. Operation of the amplifier at full output power without keying is not recommended for more than about 20 seconds, in which case the filament voltage should be dropped about 20%.

The 2C39 family is rated at 125 mA maximum cathode current. In ssb service the tubes will handle 300 mA peak current each. In CW operation, with normal keying speeds, they will provide excellent life when keyed up to 220 mA cathode current. When keyed at 300 mA, runaway effects can be noticed, and with higher currents the cathode is quickly destroyed.

Fortunately, cathode resistance keeps the current quite stable, so that amplifier operation is not critical. When operated at maximum power, the eight tubes in the final dissipate about 1000 watts peak and about half that when keyed. This is well within the ratings of the 2C39's, but the tubes must be well cooled to take the cathode-current overload.

cooling

The common blower for both cavities delivers about 300 cfm against a back pressure of two inches of water. The blower I use is a three-phase 220-volt unit operated with a capacitor and step-up transformer that adds 75 volts to the 110-V line. Two X-band waveguide sections are used as air outlets directly under each drive-tube radiator. The main air blast is directed into the center of the final tube ring (A) through a 3-1/2-inch hole in the square aluminum box as shown in the photograph.

The side of the box facing the tube assembly is lined with teflon and contacts the tubes; air escapes radially past the tubes, and holes are provided to pass some air through the cavity to cool the output coupler and tube

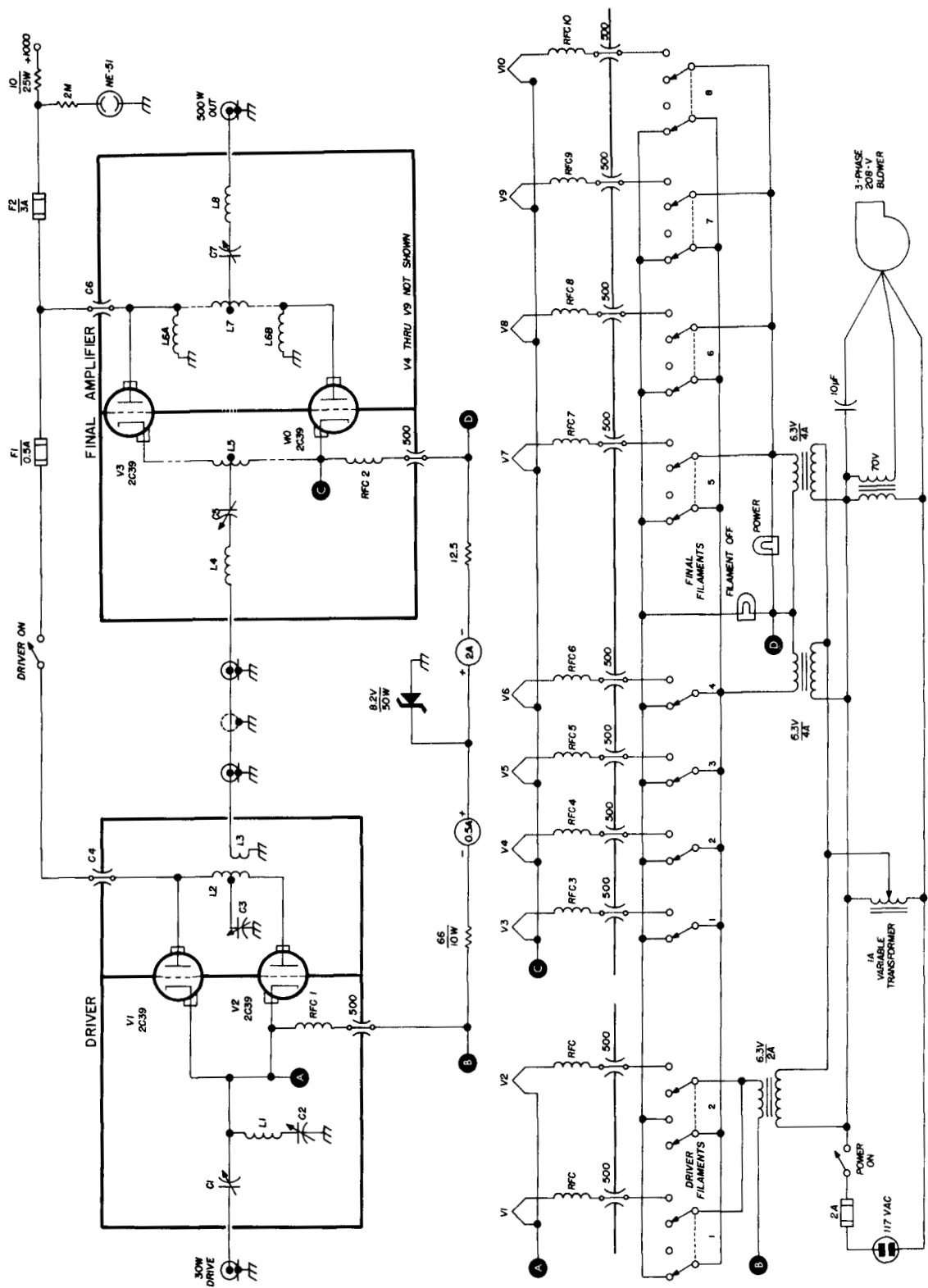


fig. 1. (Left) Schematic diagram of the high-power linear amplifier for 1296 MHz. Construction details for the dual 2C39 driver stage are given in the January, 1968 issue of QST; part numbers are the same. Although a total of eight 2C39's are used in the actual final amplifier, for clarity, only two are shown here.

- L4 Part of the input probe, fig. 4
- L5 Cathode disc, part F, fig. 2
- L6 Tuning vane, part J, fig. 2, 8 required
- L7 Plate cavity. Consists of parts B, C, and D, fig. 2
- L8 Part of output probe, fig. 3
- RFC 3-10 10 turns number 22 enamel, 1/8" diameter, 1 inch long
- RFC 2 4½ turns 1/16" wide brass strip airwound on 1/8" diameter
- C5 Part of input probe, fig. 4
- C6 500-pF feedthrough bypass
- C7 Part of output probe, fig. 3

cathodes. The 2C39's can be easily removed by unscrewing the output coupler, removing the box, and removing the filament clips.

the final cavity

The final cavity is based on a different concept than the driver and is applicable to any number of tubes. However, since the power gain of the 2C39 is 6 dB at 1296 MHz under maximum-efficiency drive conditions, the number of amplifier tubes should progress by a factor of four from amplifier to amplifier. The following progressions are therefore naturals: 1, 4, 16 . . . or 2, 8, 32 . . . The first chain would deliver about 1 kW out while the second could deliver 2 kW. Eight tubes in the final is a good choice since it's compatible with FCC regulations regarding maximum input power for amateur ssb transmitters.

The eight 2C39's are placed around a circle 3-1/2 inches in diameter. At this diameter, adjacent radiators clear by about 1/16 inch. The minimum size cavity that will provide room for eight tubes has an inside di-

ameter of 5 inches. However, the resonant frequency of this assembly is a good deal below 1296 MHz. To raise the frequency of the cavity, vanes are put into the space between tubes. These act inductively to raise the frequency of the cavity to any desired value. For 1296 MHz, the vanes protrude 3/4 inch into the cavity.

The vanes are fixed in place, and the cavity is tuned with a capacitive probe in the center. The capacitive probe also doubles as the output coupling circuit. It is split into two concentric rings with the outer one grounded; the inner ring is connected to the center conductor of a 50-ohm type-N coaxial fitting.

The probe is constructed from a dual female type-N chassis feedthrough connector (UG-30D/U). The threaded portion of a type-N male cable plug is soldered to the center hole of the plate cavity to serve as a guide for the dual female feedthrough. The longer end of the UG-30D/U is extended with a brass sleeve 1/2 inch in diameter and 3/8-inch long as shown in fig. 3. A 2-56 screw about 5/8 inch long is fastened to a 6-32 nut by screwing a 2-56 nut against the 6-32 nut as shown in fig. 3. The 2-56 screw just fits into the center pin of the UG-30D/U. The 6-32 nut should stick out 1/16 inch beyond the end of the brass sleeve. Wrap thin teflon sheet around the center probe until it is held rigidly by the sleeve. Solder can't be used to hold the 6-32 nut on the 2-56 screw because the high rf currents at this point will melt the solder.

The output is brought through the cooling air box and the front panel with a 50-ohm air-dielectric line to a type-C connector. The type-C connector acts as a tuning knob and rotary joint.

The output cavity does not have any provisions for adjustable impedance matching; its output coupler is designed to deliver maximum power into approximately 50 ohms. Exact impedance matching is accomplished with the slide tuner mounted on the front panel. This tuner was developed by W6DXJ and can match a 2:1 VSWR of any phase. It consists of a 9-inch air-dielectric 50-ohm transmission line with two moveable 1-1/2-inch long teflon slugs.

An exact impedance match between the driver and final can be established by alter-

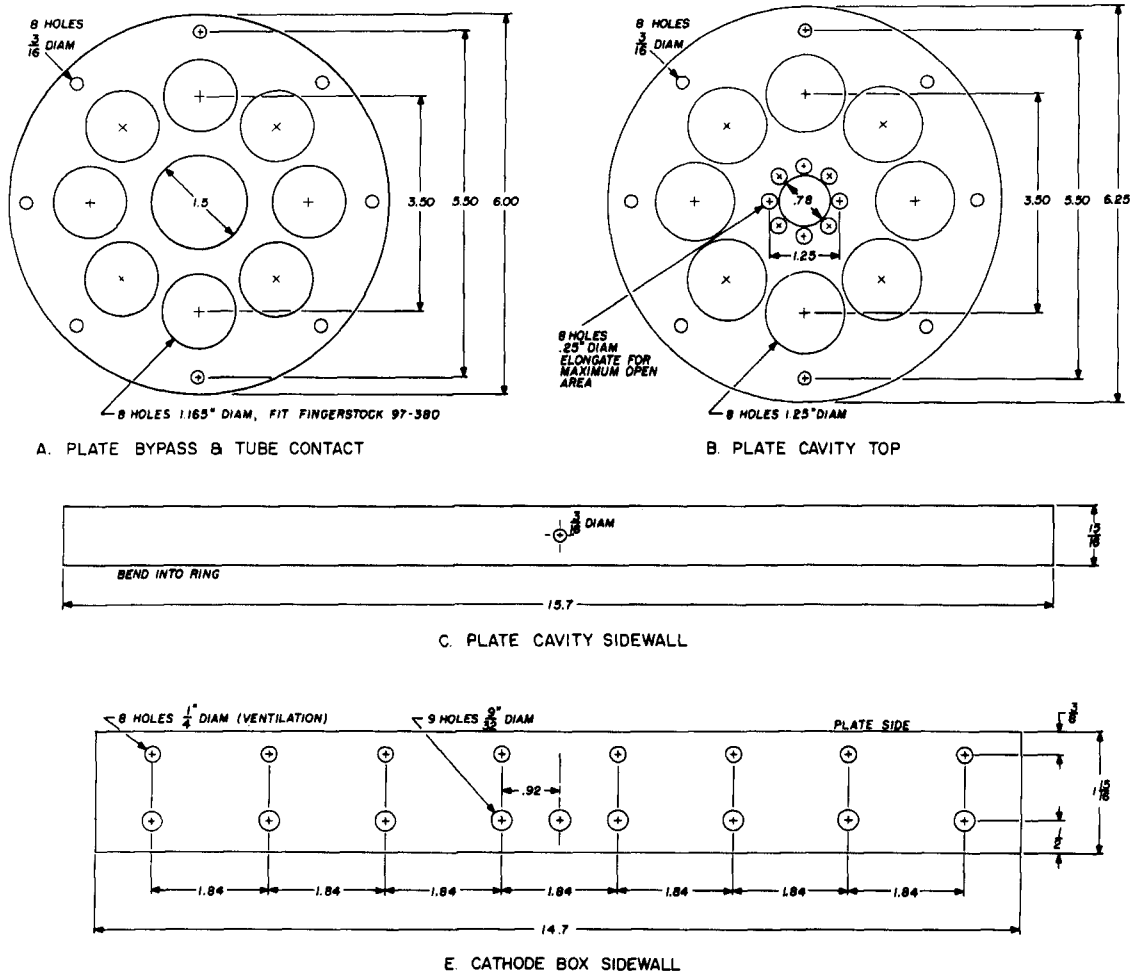


fig. 2. Mechanical parts of the high-power 1286-MHz linear amplifier. Material for all parts is .050" brass. Assembly of the parts is illustrated in fig. 5.

nately tuning the driver cavity and final amplifier input probe.

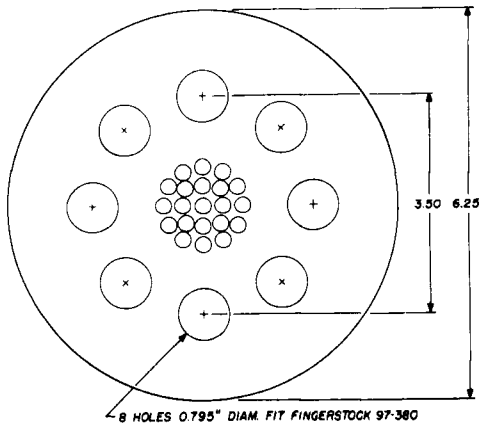
the cathode cavity

The cathodes of the eight tubes are connected to a 4.2-inch diameter brass plate with finger stock. This plate (F) is spaced 3/8 inch from the cavity bottom and is not resonant in itself. However, drive power is applied to the center of the disc with a resonant probe. Because of physical symmetry, drive power splits equally between the tubes.

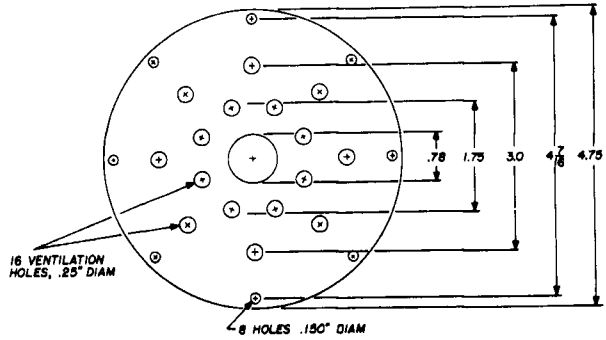
Input coupling is provided by a UG-30D/U connector modified as shown in fig. 4. The

threaded portion of a type-N male connector is soldered to the bottom of the cathode cavity as a guide. A 1/2-inch diameter brass or copper disc is soldered to a 1/8 inch wide, 1-1/4 inch long brass strip that is pushed into the center pin of the UG-30D/U female adaptor and soldered. The disc is spaced 3/4 inch from the end of the UG-30D/U. A hair-pin inductor 1/4 inch long is soldered between the strip and the face of the UG-30D/U. This inductor is also made from 1/8 inch wide brass sheet.

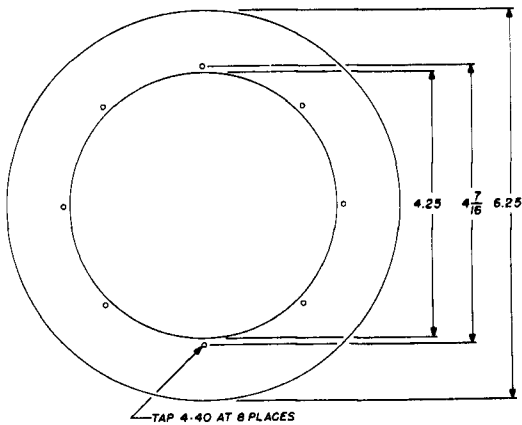
This arrangement provides an input impedance of approximately 50 ohms. It is not



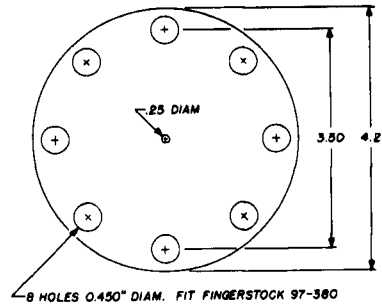
D. PLATE CAVITY BOTTOM



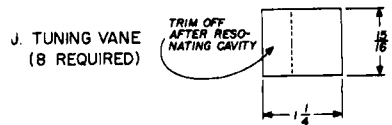
H. BOTTOM COVER



G. CATHODE BOX BOTTOM



F. CATHODE DISC



J. TUNING VANE (8 REQUIRED)

too critical because an exact impedance match is established by tuning both the driver and input probe for maximum power transfer. The coaxial cable from the driver to the final must be a low-loss, high-temperature teflon cable because the VSWR on this line may be very high. Don't make it any longer than is absolutely necessary.

Filament connections to the 2C39's are made with U-shaped spring brass clips which make a snug fit in the filament cup at the end of the tube. The common cathode choke (RFC2) should be made of 1/16 inch wide sheet brass to handle the current. To minimize the filament current flowing over the

cathode choke, the filament supply should be derived from two separate transformers or a center-tapped 12-V unit. If you use two transformers, they must be phased to operate like a center-tapped transformer so filament current through the cathode choke is zero when all tubes are turned on.

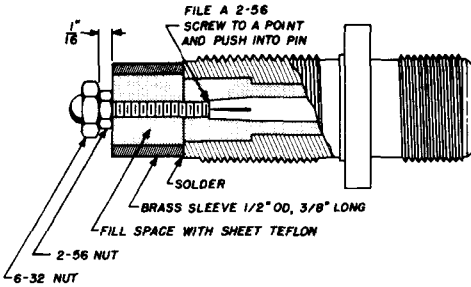
cavity construction

The cavity parts are cut out as shown in **fig. 2** with an electric or manual coping saw and filed to the proper dimensions. The tube holes may be punched with the nearest smaller punch and then reamed to the exact dimensions shown in the drawings. Size is criti-

cal for proper tube fit.

The first part in the assembly operation is the plate cavity. The grid finger stock* is performed by hand until it fits the grid holes without a gap between the hole and the fingerstock. The two discs (B and D) are then aligned with each other and the cavity wall

fig. 3. Output probe for the 1296-MHz amplifier.



(C), is formed into as round a shape as possible.

The assembly is clamped together and **slowly** heated over a gas stove. Avoid fast heating because it causes warping and bending that may remain after the unit has cooled down. The grid side of the cavity should face the stove, but the flame should not touch the sensitive fingerstock. As soon as the cavity is hot enough to melt solder, touch the outside of the fingerstock with acid flux and solder. The solder flows around the grid hole quickly and provides a clean solder joint.

When all the grid rings are in place, run solder along the wall of the cavity on the grid side and attach the plate side in as many places as you can easily reach. Let the cavity cool down slowly by reducing the heat gradually. Now invert the cavity and put the plate side toward the stove. Heat it up again gradually until it is warm enough so you can solder the cavity wall (C) to the plate disc (B) with a 200-watt soldering iron. Don't let the cavity get hot enough to melt the grid points you already made.

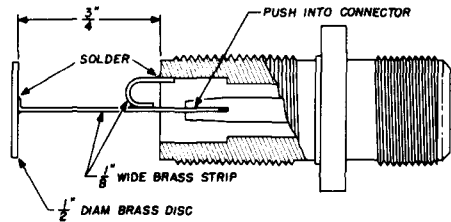
The next step is to solder the fingerstock to the plate-bypass disc (A). However, before proceeding, hammer the disc around the cen-

* Part number 97-380 from Instrument Specialty Company, Little Falls, New Jersey.

ter until it is slightly saucer shaped. This will result in a compression force when it's screwed against the top of the plate cavity. This will assure that the teflon insulator is compressed throughout. If you punch holes in the disc, this is probably its natural condition. Make sure that the fingerstock is installed on the proper side and in the right direction. The guide for the capacitive output probe may also be soldered in at this time.

The plate cavity can now be slotted for the vanes—preferably with an electric coping saw. Simply cut the eight slots by running the saw blade between the tube holes. The slots should extend about one inch into the cavity for sufficient adjustment range. Put pieces of

fig. 4. Input probe for the 1296-MHz linear.



thin brass in the slots and adjust for 3/4 inch protrusion into the cavity.

preliminary adjustment

The plate cavity may now be assembled for preliminary test and adjustment. The teflon insulator between the plate disc (A) and cavity is cut from 0.02-inch teflon sheet. Don't use a different thickness of teflon or the bypass may become resonant. The tube holes should be just large enough to clear the anodes. Be sure the plate ventilation holes are not obstructed. The shoulder washers used to assemble the plate bypass disc to the cavity should be either teflon or ceramic; nylon parts are so lossy at these frequencies that they will melt with only milliwatts of rf.

You can put the 2C39's in and check for mechanical alignment. If everything fits, couple about 20 watts of 1296-MHz rf through at least a 10-dB attenuator (40 feet of RG-58/U) to the output coupler. Put a number 49 lamp with a 1/2 inch diameter loop through the hole provided in the cavity

wall and tune the probe until lamp lights—indicating resonance. If necessary, adjust the vanes equally until resonance occurs with the probe about 5/16 inch from the bottom of the cavity.

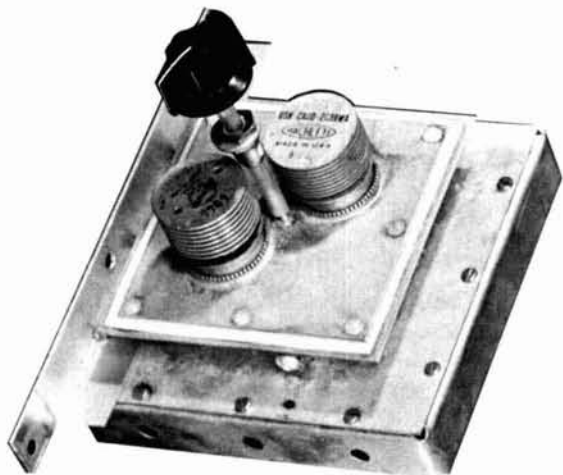
The cavity can now be disassembled and pre-heated so you can solder the vanes in place with a 200-watt soldering iron. Add the remaining parts by working with a soldering iron over the gas stove. Be careful not to over-heat the cavity or everything will fall apart. Assemble the cathode disc (F) in the same way as the plate bypass. When inserting tubes for testing under power, adjust the cathode disc so it is spaced uniformly 3/8 inch from the bottom of the plate cavity.

After checking everything for alignment, disassemble the cavity and have all the parts silverplated by a professional. This is a must to prevent contact-resistance heating, especially at the tube contacts. Don't try to do your own plating—it will only lead to disappointment later.

power supply

The power supply for the amplifier must be capable of delivering 2.0 A at a terminal voltage of at least 900 volts to obtain full power output at a safe plate current. Both efficiency and power gain are dependent on plate voltage; the higher the plate voltage, the more power the amplifier will deliver at

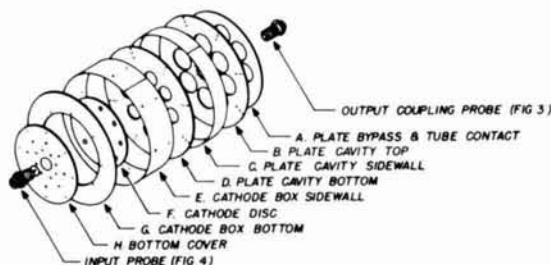
The dual-2C39 1296-MHz 100-watt driver amplifier.



the maximum safe cathode current level of 220 mA per tube (CW). On the other hand, to avoid arcing within the tubes, maximum plate voltage must not exceed 1200 volts. For these reasons, maximum power output will only be obtained safely from a well regulated supply. I use silicon rectifiers and a choke-input circuit with a bleeder; transformer voltage is 1250 volts. Regulation from zero to full load is 150 volts.

The power supply is provided with a 20-A circuit breaker in the 115-V line. This is an additional safety precaution to reduce the

fig. 5. Mechanical assembly of the amplifier. The tuning vanes are not shown, but their position is indicated by the dotted lines on parts B and D.



chance of prolonged exposure of the tubes to excessive cathode current. The circuit breaker trips after about 30 seconds operation at maximum power without keying.

The fuses are wired so that drive power is removed when the final-amplifier fuse blows. This avoids excessive grid current in the final. The fuses for both the octet and the driver must be fast-blow ceramic types. Glass fuses (3AG) will explode and form an arc in the fuse holder. This will destroy all the tubes in the octet if one of them develops a grid-to-cathode short. Type 3AB fuses are recommended; they fit the same fuse holder as the 3AG but have a ceramic body. Don't use larger fuses than the values shown in the schematic.

I spent a lot of time trying to develop an automatic overload protection circuit for this amplifier in case of tube arcing. I originally thought that a simple series pass tube with an overcurrent sense circuit would prevent final-amplifier tube damage by removing plate

voltage to the driver. However, after building such a circuit, I discovered that once an arc in one of the final tubes is initiated, removing plate voltages from the driver does not stop it; the final-amplifier fuse blows anyway.

The only remaining possibility is to remove all plate power from all tubes. This requires a large tube to pass two amperes of plate current with less than 100 volts drop. I tried it with three 6336A's in parallel; voltage drop was about 75 V. However, constant problems with false triggering of the high-speed circuit finally forced me back to fuses. This is really not such a bad method because arcing is only likely to occur during initial tuneup. The 10-ohm resistor in the high-voltage lead limits peak current to 100 A and is recommended with these tubes.

tuning up

After the driver is tuned up,¹ you can tune up the final. Apply about 50 watts of drive power to the cathode probe (plate voltage disconnected) and adjust the probe for resonance by monitoring cathode current; cathode current should be about 0.5 A. Alternately peak the driver and the cathode probe. If necessary, reduce power so you don't exceed 0.5 A. Check the clearance between the probe and the cathode disc. Resonance should occur with about 1/4 inch clearance. If resonance occurs with the probe too close to the disc, lengthen the probe or increase disc size.

Apply plate voltage and cooling air. Connect the output probe to a dummy load—through an impedance-matching device if possible. Slowly apply drive power. As soon as the final plate current comes up, resonate the output probe. Increase input drive to about 10 watts and tune the driver cavity input and output, cathode probe and output probe for maximum output.

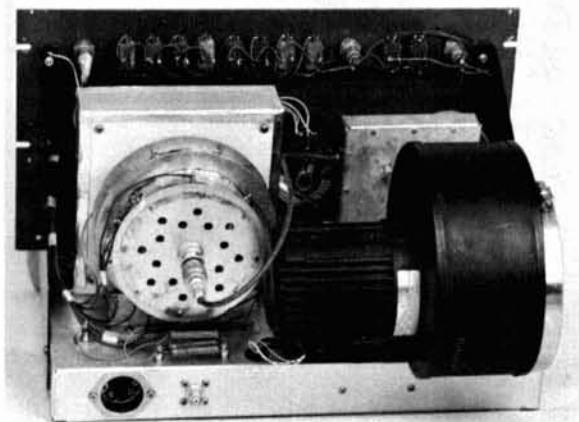
Shut down the amplifier and check the clearances of the input and output probes for safe values. Output clearance shouldn't be less than 3/16 inch and input clearance not less than 1/8 inch.

Reapply power and cooling air and peak up to full power. It helps to key the transmitter with an electronic key to keep the duty cycle down. Unscrew the input and out-

put couplings on the cavity and check for possible damage from overheating. If a fuse blows whenever you hit resonance at full drive, it's an indication that the output coupling is too loose.

You can increase output coupling (if you do not have an impedance matcher) by increasing the clearance slightly between the 6-32 nut and the brass sleeve. If you run out of ceramic fuses while tuning up, shut down and get some more. Do not use slo-blos under

Rear view of the complete high-power linear amplifier. The final is on the left; the dual-2C39 driver stage is behind the blower on the right. The large box behind the final is the air box.



any circumstances—they can wipe out all the tubes instantly.

checking tubes

To check the driver tubes, simply turn one or the other off, wait for the filament to cool down and record final cathode current after slightly reapeaking the plate circuit of the driver.

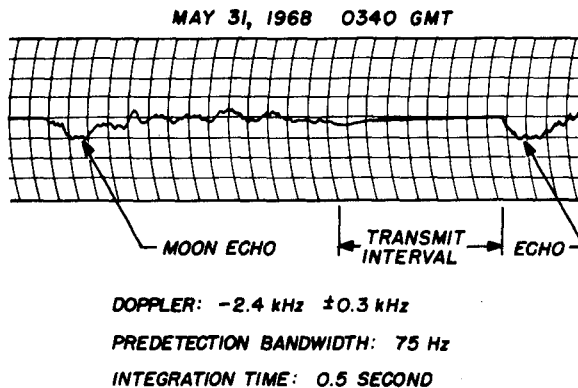
The best way to check the final tubes is to remove filament power from one of the driver tubes to prevent overload of the final tubes and set excitation power to the driver to a relatively low fixed value. Then turn off all but one filament in the final. This way you get a relative reading of emission for all tubes in the final.

Admittedly, this is a slow procedure, but it's a lot faster than pulling tubes. It takes about 15 minutes to go through all tubes in the linear. You have to wait until a tube cools down before you can get a reading on the next one and the driver has to be reaped for every new tube reading. It's a good idea to keep a log of tube condition near the amplifier for reference. If you take tube emission data at frequent intervals, you can locate an arcing tube quite rapidly after the amplifier has been in service awhile. A tube that arcs suffers cathode damage and shows a drop in cathode emission when compared to the last log entry.

tubes

Now a word about tubes. There are a va-

fig. 6. Chart recording of moon echoes received by WB6IOM on 31 May 1968 using this amplifier and a 10-foot dish. Signals peaked about 6 dB over the audible threshold. Although WB6IOM used a parametric amplifier at the receiver, his feedline has 1 dB loss, so a good transistor preamp mounted at the feed would do almost as well.



riety of tubes available under different type numbers that will work in the cavity. All are more or less identical and deliver the same power when in good condition. However, the ceramic types, 7289, 2C39B or 3CX100A5, are the most rugged. Some 2C39A tubes are ceramic, but most are glass. Glass tubes have a tendency to develop pin holes and leaks when pushed hard, and are not recommended for high-power work.

Tubes such as the 7211 have higher capacitance and don't tune with the same vane settings. However, this tube can put out more power than the 2C39 family since it can stand more voltage and has twice the cathode. Unfortunately, they are not readily available and are twice as costly new. I've tried them in several cavities; they don't work too well

with a 1000-V plate supply but should be quite a tube at 2000V at 250 mA.

safety

This amplifier delivers a substantial amount of microwave power and it can be dangerous if it's not handled properly. Radiation causes internal heating of body parts and eventual destruction. However, there is no danger in the vicinity of the amplifier since the amount of power leakage is low. The danger exists near feeds for parabolic antennas, open connectors and any other **physically small** antenna or radiating device. The radiation only causes a very slight increase of skin temperature and can easily be overlooked.

Most of the radiation is absorbed inside the body where there are no nerves to warn you. The most sensitive part of the body are

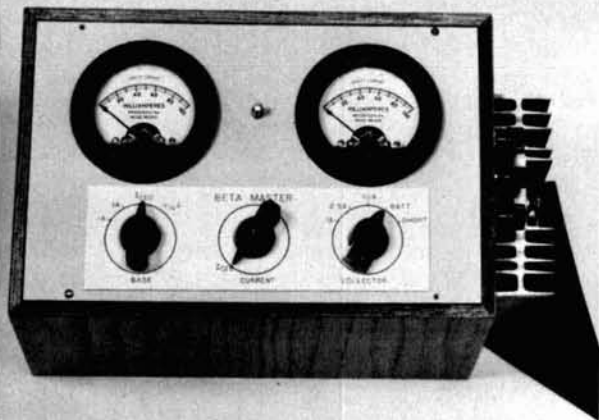
the eyes since they have no warning mechanism for heat. Never look into feeds under power at close range! The same applies to waveguides and other small antennas. However, it is safe to look into a large dish since the power density is low.

Take a look at the appropriate handbooks to determine safe distances for the antennas you are going to use. For amateur power levels, antennas 20 feet in diameter or larger are no problem at any distance. Smaller antennas, however, have a power-density maximum several hundred feet from the antenna that can be excessive.

reference

1. P. Laakmann, WB6IOM, "Cavity Amplifier for 1296 Mc," *QST*, January, 1968, p. 17.

ham radio



the beta master

Although designed primarily for matching PNP power transistors, the beta master will also measure many of their parameters

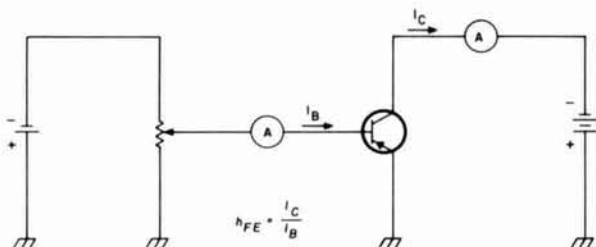
Tom Lamb, K8ERV, 1066 Larchwood Road, Mansfield, Ohio 44907

Transistors are often used in pairs, such as class-B modulators and dc-to-dc converters. Many semiconductor suppliers do not offer matched pairs, or if they do, they charge for the matching service. The **beta master** will quickly plot the dc current gain, h_{FE} , of any PNP power transistor up to a collector current of ten amperes.

A simplified circuit of the unit is shown in **fig. 1**. An adjustable known current (I_B) is fed to the transistor base and the collector current (I_C) is measured. The dc current gain, I_C/I_B , is designated h_{FE} . This current gain generally decreases with increasing collector current as shown in **fig. 2**. If all three transistors were measured at 1-1/2 amps, they would all exhibit the same current gain. However, only transistors **B** and **C** have nearly the same gain throughout the range, so only **B** and **C** are matched.

The complete circuit of the **beta master** is shown in **fig. 3**. An emitter follower, Q1, provides adjustable base drive of zero to 1

fig. 1. The basic circuit for measuring transistor dc current gain.



amp without a high-wattage potentiometer. The base-meter circuit uses a 100-mA meter that may be shunted to 1 amp; it may also be used as an input voltmeter.

The transistor to be tested is mounted on a heat sink containing a socket. The heat sink can be relatively small because the transistors only pass current long enough for the meters to be read. A 4 × 4-inch aluminum plate, 1/8-inch thick will do if a finned heat sink is not available. Jacks are provided for testing transistors mounted in equipment, or ones that will not fit the socket.

The collector circuit is similar to the base circuit—essentially a multirange ammeter. Collector current ranges of 0.1, 2-1/2 and 10 amps are provided. Two collector switch positions test for weak batteries and shorted transistors.

The collector supply battery must supply 10 amps for short periods without too much voltage drop. Nickel-cadmium storage batteries are ideal; these are occasionally available on the surplus market. At 10 amps discharge, the voltage drop is very small. Four Eveready 1.5-V E95 alkaline flashlight batteries connected in series-parallel will also work.

construction

The **beta master** is simple to build. Remember that large currents are being handled, and small voltage drops can cause errors, so use large wire in the emitter and collector circuits. S2 should have heavy duty contacts, or should have two sets of contacts wired in parallel. Q1 is mounted on a small aluminum sink. Either the collector of the transistor or the sink must be insulated from the rest of the circuitry. I bolted the transistor directly to the heat sink and mounted it on the meter terminals with insulating fiber washers.

calibration

Each of the meter shunts is adjusted experimentally by comparison against an external meter. The instrument supplies its own adjustable current. There must not be a transistor in the test socket during calibration and S3 must be depressed to take readings.

First, the R3-R4 combination is adjusted. Plug a 1-amp meter into the base and emitter

jacks, negative to the base. Put S1 in position 2 and adjust R1 for either a 1-amp or 500-mA reading on the external meter. Then adjust R4 by selection or padding until the same reading is obtained on M1.

Remove the external current meter and connect a low-range voltmeter in its place. With S1 in position 4, set the voltmeter to two volts with R1. Now adjust or select R3 for a full-scale reading on M1. The base meter circuit is now calibrated.

A power transistor is needed to calibrate the collector circuit. Insert any good transistor in the test socket. Break the collector lead and insert a 10-amp meter. The transistor will act as a variable low-resistance load, adjusted by R1.

When S2 is in the high current positions (2 and 3), collector current flows through the 0.1-ohm shunt, R9. This prevents contact resistance in S2 from causing large errors. R9 can be made from ten 1-ohm resistors in parallel or from a measured length of resistance wire.

Place S1 and S2 in position 2. Set the 10-A meter at 2-1/2 amps by means of R1. Select or adjust R5 for a full scale reading on M2; R5 will be in the neighborhood of 2 ohms. Other full-scale readings may be calibrated on position 2 if you're not interested in a 2.5-A range.

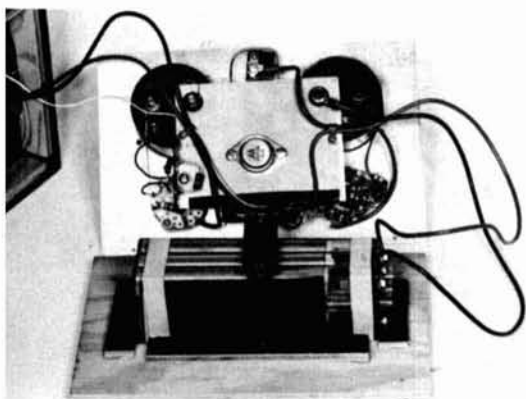
Now set switch S2 to position 3 and adjust the collector current to 10 amps. If you can't get 10 amps, adjust for 5 amps and calibrate



M2 for 5 amps instead of 10. Select R6 for a full-scale reading on M2; R6 will be about 10 ohms.

Remove the 10-amp meter and reconnect the collector lead. Change S2 to position 5 and jumper the collector and emitter jacks. A shorted transistor will result in this reading obtained on M2; it may be brought to full-scale by reducing R7 to about 30 ohms.

Now switch S2 to position 4. This places about a 10 amp load on the battery and reads the collector voltage on M2. Remove the transistor and jumper. Connect a volt-



meter across R8; it must read at least 2 volts, and M2 must read at least 8 amps. Lowering the value of R8 will increase the reading of M2. If you can't get 2 volts, check for weak batteries or voltage drops in the wiring. The voltage loss across R9 can be reduced by lowering the resistance of R9, but is limited when R5 reaches zero when calibrating the 2-1/2-amp scale. If all else fails, use more battery voltage or go to Ni-Cd storage cells.

operation

The **beta master** will check leakage current, dc current gain and transconductance. The tests should be made in the following order.

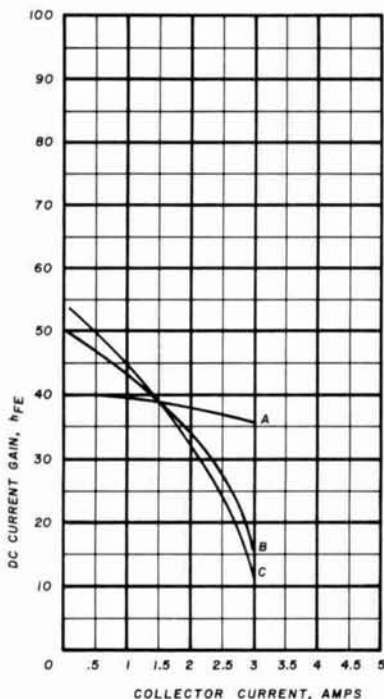
1. Place the transistor in the test socket and screw it firmly to the heat sink.
2. Place S2 in position 4 (Batt Test) and depress S3. Check for the current found in calibration, indicating that the battery is okay.

3. With S2 in position 5 (Short Test) and R1 at zero current, depress S3. M2 must read less than the value found in calibration, or the transistor is shorted and **must not be tested further**.

4. With S1 in position 3 and S2 in position 3, depress S3 briefly. Should a shorted transistor get past the short test, M2 will pin. A good transistor will give little, if any, reading on the 10-amp scale. Place S2 in position 1 and read the collector leakage current I_{CEO} on the 100-mA scale of M2. This reading is the collector-base diode leakage current multiplied by the transistor gain at the indicated collector current. I_{CEO} is an important indication of transistor quality; a low reading usually indicates a temperature-stable unit.

5. Collector-diode leakage I_{CBO} is indicated on M2 by shorting the base and emitter terminals. This leakage is usually quite small

fig. 2. Typical h_{FE} versus I_C curves for three different transistors. From these curves, you can see that transistors B and C are fairly well matched.



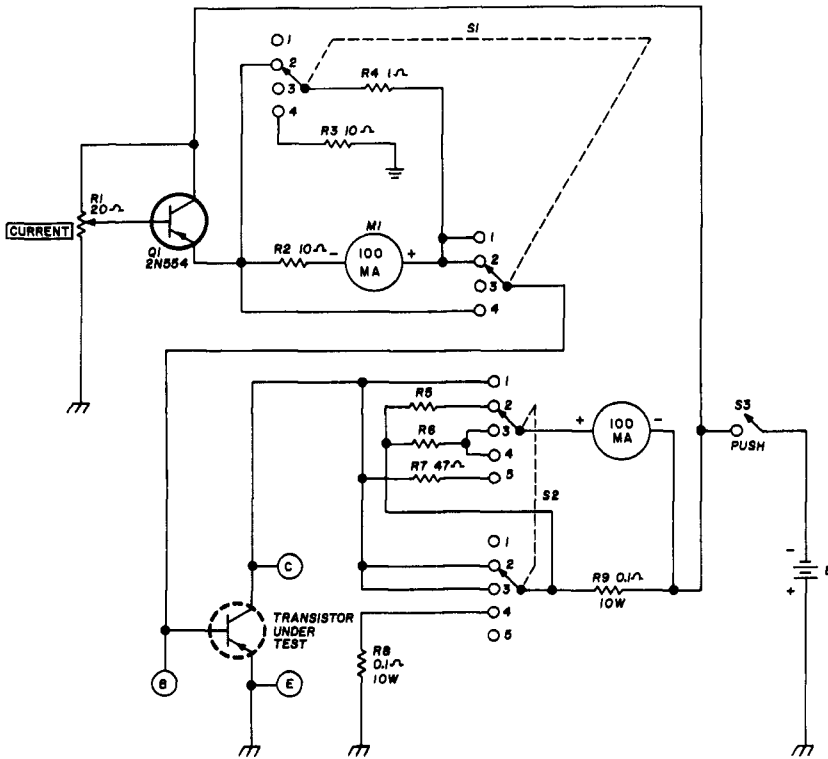


fig. 3. Schematic diagram of the beta master. Resistors are all 1 watt unless otherwise specified.

Switch positions:

- S1** 1 Base current, 100 mA
 2 Base current, 1000 mA
 3 Collector cutoff current, I_{CEO}
 4 Base-to-emitter voltage, 2 V full scale
- S2** 1 Collector current, 100 mA
 2 Collector current, 2.5 A
 3 Collector current, 10 A
 4 Battery test
 5 Collector-to-emitter short test

and cannot be accurately measured on a 100-mA meter.

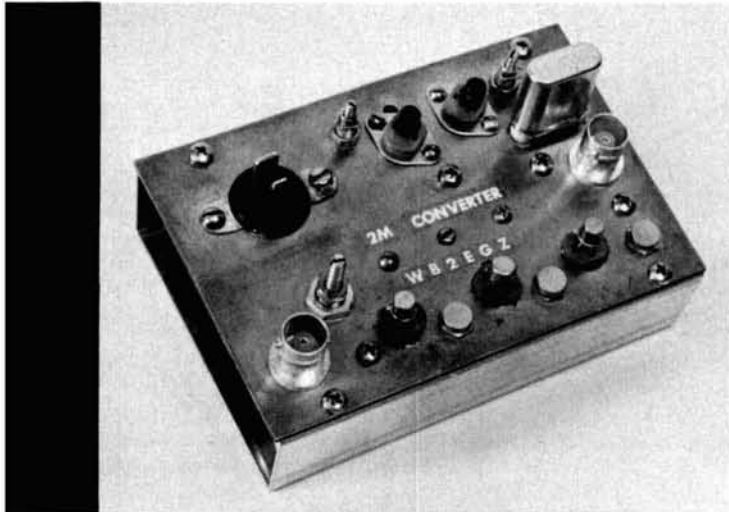
6. The current gain is measured next. Set S1 to position 1, S2 to position 2, and set the desired base current with R1. At each value of base current, read the collector current on M2 and record the readings. The collector current should be increased to, or slightly beyond, the rated value for the transistor being tested. Dividing each value of collector current by its corresponding base current gives the current gain at that collector current. Plot each set of values to form a complete curve like those of fig. 2. Compare the curves of all transistors of the same type and match up those having the closest characteristics.

7. An input voltage-output curve (transconductance) can also be plotted with the beta master. Just switch S1 to position 4 and

run a curve of input voltage vs output current. This curve is useful in determining the correct bias voltage for class-A and -B amplifiers.

The beta master has several other uses besides checking power transistors. The base-to-emitter terminals provide a source of metered, adjustable low voltage—fine for driving tunnel diodes. If M1 is accurately calibrated, these same terminals may be used for calibrating other meters in the 0.1- to 1-amp range. The high current drawn by the two-volt meter makes it ideal for testing flashlight batteries under load; connect them to the base and emitter terminals with S1 in position 4 and S3 not depressed. In addition, with S2 in position 5, the collector and emitter terminals make a low resistance ohmmeter out of M2.

ham radio



high-performance mosfet converter-- the two-meter winner

Here's
a solid-state
two-meter converter
that rivals vacuum tubes
in cross modulation
and excels them
in noise figure
and gain

Don Nelson, WB2EGZ, 9 Green Ridge Road, Ashland, New Jersey 08034

A successful design is usually more tedious than genius. The development of a solid-state two-meter converter that can outperform the better tube designs has, indeed, been a slow evolution. In recent years, bipolar transistors have been improved to the point where they are competitively priced and have better noise factors than vacuum tubes. However, the conventional transistor has two serious shortcomings: cross modulation and limited dynamic range. Nevertheless, solid-state converters and preamplifiers were designed and loudly praised for reduction of size and power requirements, low noise and even low cost—yet converters using 417A's, 416B's and nuvistors were never really challenged. The tube was still king at rf.

Not more than three years ago, the field effect transistor (FET) became the experimenter's pet. Although the concept of the modern FET predates the invention of the bipolar transistor by twenty years, no one tried to build one until 1958. As with most new inventions, high cost and marginal performance limited much serious amateur experimentation.

The first FET's priced within amateur reach were junction devices (JFET) that had good noise and cross-modulation characteristics, but suffered from lack of gain. By careful device selection and tricky neutralization schemes, it's possible to get 15-dB gain from a single-stage JFET amplifier at 144 MHz; it's more likely that the gain will be on the order of 10 dB.

It's only been in the past few months that the metal-oxide semiconductor FET (MOSFET) has been available at less than \$2. Low cost seemed necessary since this device was reputed to be very unreliable when handled. Everyone seemed to know of the static burnout possibility of the MOSFET; very few cared about its advantages.

the mosfet at two meters

My first experiments with the MOSFET were on 2 meters—mainly because 144-MHz circuitry was available from earlier experimental converters. I will discuss an evolution of three converters—all of which had desirable characteristics—with emphasis on the last which is affectionately called, "The Winner."

A relatively uncomplicated design was derived from data-sheet test circuits and W2OKO's two-meter converter which appeared in *RCA Ham Tips*.¹ A single-stage 3N128 provided rf gain for a 3N141 tetrode mixer (fig. 1). Output from the oscillator-tripler is injected at gate 2 of the 3N141. Without much fanfare, I had a useful converter with lower noise than my two-stage

nuvistor converter and considerably less gain. It is interesting to note that the sensitivity was superior to a similar design using 2N3823's; these are JFET's similar to the better known TIS34. Stations up to 120 miles away were heard during a brief band opening during the VHF Sweepstakes in January, 1968.

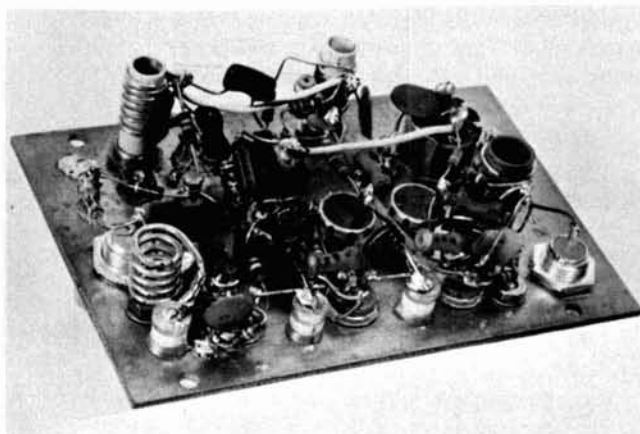
There is one noticeable difference between the JFET and the MOSFET; the feedback capacitance of the 3N128 in the common-source configuration is lower—even lower than a vacuum tube in grounded grid. Typical feedback capacitance of the 3N128 is 0.13 pF. Therefore, neutralization is not needed on two meters. The gain may be increased up to 3 dB by neutralizing, but I didn't try it.

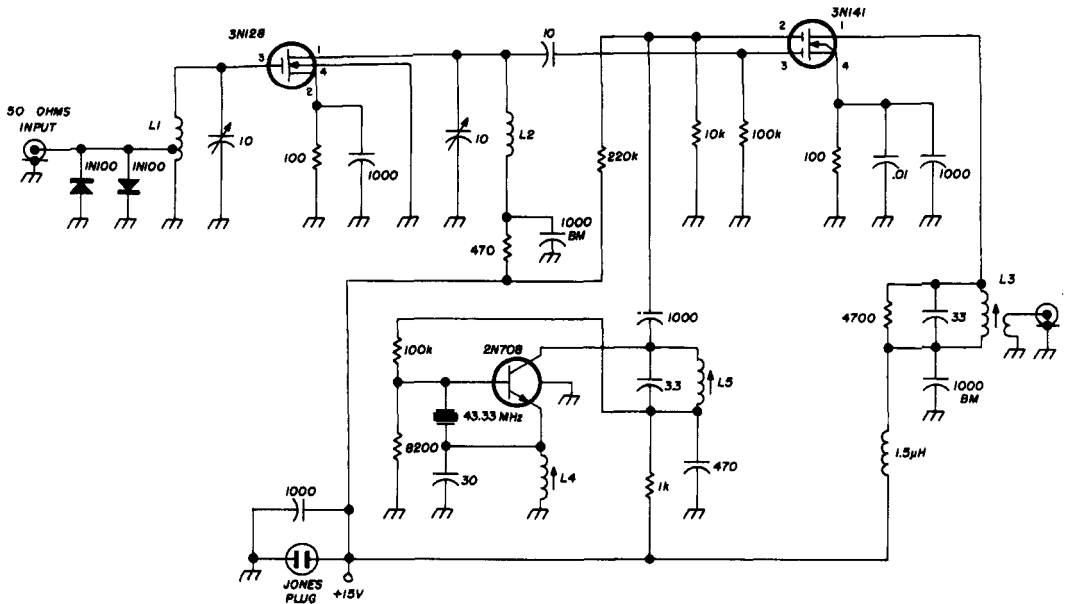
Low feedback is, indeed, important to the MOSFET; the relatively high feedback of the JFET is the primary limitation to its gain. While on the subject of circuit stability, it has been proven using Linvill's equations² that the 3N128 and similar MOSFET's are stable at 145 MHz when the input and output impedances are conjugately matched.³ A less scholarly explanation is that the circuit will "take off like a rocket" if you plug it into a six-meter antenna.

advanced circuitry using MOSFET tetrodes

The 3N128 converter was not the high-gain unit I had hoped to build. I changed the rf amplifier to a 3N140 tetrode (fig. 2), but there was no appreciable increase in gain; the advantages of a MOSFET tetrode as an rf amplifier were not immediately apparent. However, let's discuss the development of the MOSFET tetrode so we can better understand its characteristics.

When a strong signal in or near the band disturbs the signal of interest, it is called cross modulation. Conventional bipolar transistors exhibit the greatest amount of cross modulation. On the other hand, two 3N128's in a cascode circuit have a surprisingly high cross-modulation resistance.³ Because of this characteristic, the dual-gate MOSFET was developed to incorporate the cascode circuit in a single device. Actually, the 3N140, 3N141 and similar MOSFET tet-





L1 5 turns number 18 space wound $\frac{1}{4}$ " diameter. Tapped 1 turn from ground.

L2 4 turns number 18 space wound $\frac{1}{4}$ " diameter.

L3 Primary: 15 turns number 30 on $\frac{3}{8}$ " diameter slug-tuned form (J. W. Miller 21A000-2 with red

core). Secondary: 3 turns number 28 wound on cold end of primary.

L4 5 turns number 26 wound on $\frac{3}{8}$ " diameter slug-tuned form (J. W. Miller 21A000-2 with red core).

L5 4 turns number 26 on $\frac{1}{4}$ " diameter slug-tuned form (J. W. Miller 4500-4).

fig. 1. Two-meter converter using mosfet rf amplifier and mixer stages.

rodes integrate two triodes with the drain of the first internally connected to the source of the second. The resulting device has the following desirable characteristics:

1. Improved dynamic range; this results in high sensitivity for weak signals and no overload with strong ones.
2. A second control terminal which is used for agc or mixing service; agc is useful in improving cross modulation characteristics.
3. Good stability because of low feedback capacitance (less than 0.02 pF when gate 2 is bypassed). The socket, if one is used, is the limiting factor since it has much greater capacitance than the transistor. Low feed-through capacitance is ideal for broadband converter service and little or no neutralization is necessary.
4. Noise figure and power gain are slightly enhanced.

Armed with all this book-knowledge, I left

the 3N140 in the converter and loaned it to W2BV for evaluation while I began the third design.

Performance reports on the 3N140 converter show that its noise figure is 2.5 to 2.8 dB. This indicates that the noise of the 3N140 is running well below the 3.5 dB rating of the manufacturer. Despite the less critical oscillator injection requirements of the MOSFET as compared to a JFET, I felt that the 43.3 MHz oscillator-tripler wasn't completely satisfactory. When the converter was used with a Drake R4 receiver, sensitivity was adequate, but lack of injection exaggerated 20-meter feedthrough; a separate ground wire to the converter was helpful in reducing 20-meter interference.

an optimized converter

Finally, I built the two-rf-stage converter shown in fig. 3. Greater oscillator injection was provided by a 65-MHz crystal-controlled oscillator and separate doubler. Since this

converter has outpaced all other comparable converters, I have called it, "The Winner." Nevertheless, only time will prove its merit.

The first rf stage uses a 3N140 to capitalize on the better features of the MOSFET tetrode. Gate 2 is biased at 1.4 volts for good cross-modulation resistance; drain current is about 7 mA—this is near the point of optimum noise-figure while providing good power gain. If you want, you may be able to optimize circuit performance slightly by varying the bias on gate 2. Please bear in mind that anything higher than 6 volts exceeds the ratings of the transistor. Please remember—remove the transistor while you're changing bias resistors.

The optimum cross-modulation resistance will show an improvement of ten times over a bipolar transistor. However, at this level, gain will not be optimum for the 3N140. I use a gain reduction of 5 dB from optimum

Because of the less critical requirements of the second rf stage, I used a 3N128 triode. The exceptional gain provided by this stage allows very good broadband tuning. In fact, despite Linvill, you may have oscillation problems if you don't use stagger tuning. A lower gain FET, the RCA 40467, was tried successfully in this stage, but had poorer characteristics for broad-banding. The difference in cost—\$1.24 versus \$1.45—is not enough to consider the compromise in performance.

A few facts about the ubiquitous 3N141 are in order. Although this device may be slightly inferior to the 3N140 in rf service, it is outstanding as a mixer and exhibits very high resistance to cross modulation, reasonable local oscillator requirements and high gain. As you might anticipate, conversion gain of the dual-gate MOSFET increases within limits, with greater local-oscillator drive.

L1 5 turns number 18 space wound 1/8" diameter. Tapped 1 turn from cold end.

L2 4 turns number 18 space wound 1/8" diameter.

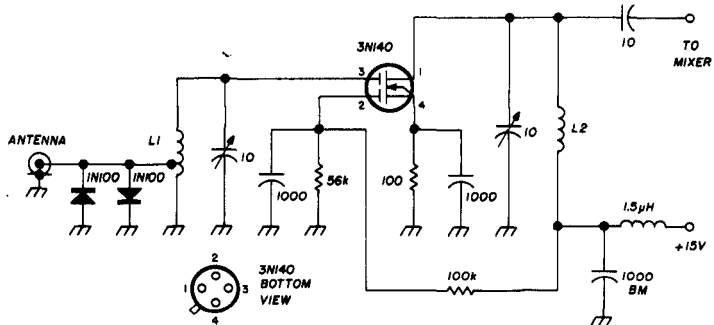


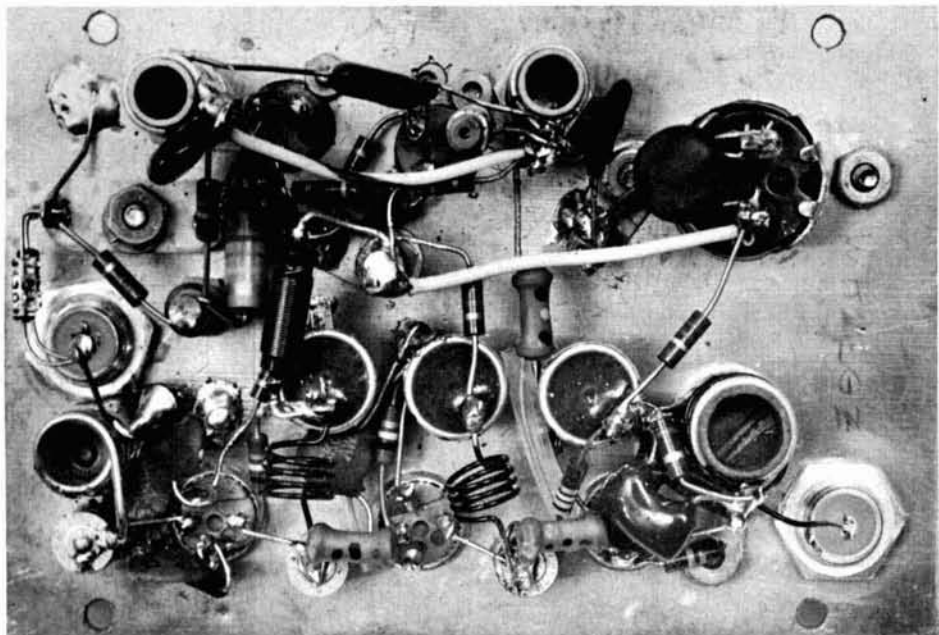
fig. 2. Tetrode mosfet rf amplifier used in the second two-meter converter. This simple change resulted in higher performance.

for the present level of operation. Expect some degradation of noise figure as well as gain.

Another technique for minimizing cross-modulation is to tap-down on the input coil to reduce the voltage swing on the gate. In most cases you'll find it necessary to tap the output coil at the same time to achieve an impedance match. I have illustrated how this may be accomplished in fig. 4, although I haven't optimized my own converter for cross modulation. The compromise is a matter of choice and depends on your proximity to high-power transmitters.

In my case, the dc bias on the second gate was optimized for the LO drive I had.

In using a 65-MHz oscillator and doubler, the number of harmonics is reduced from those present in the 43.3-MHz circuit, so the converter should have fewer spurs. The 65-MHz circuit also provides greater injection. Should cost be a factor, I feel that a 43.3-MHz crystal would probably do a good job in this circuit with only two changes; first, the tank capacitor should be increased to resonate with L5 at 43.3 MHz, and second, the 4.7 μ h inductor should be changed to 6.8 μ h.



Below-chassis construction of the two-meter winner.

construction

The use of small components results in tidy construction on copper-clad board. I was surprised to find that no shielding is necessary. Circuit board layouts are shown in **fig. 5** and **6**; **fig. 5** may be used for either single rf stage converter while **fig. 6** shows the layout for the double rf stage unit. Both layouts are designed to mount on a Bud CB-1626 chassis.*

mosfet handling

Handling the MOSFET requires some care. At a slight sacrifice to gain, I recommend the use of sockets. General applicable rules which should be followed in handling MOSFET's are listed here:

1. Keep MOSFET leads shorted until the device is ready to use. (They are shipped this way.)
2. When cutting leads, hold the lead and case with your fingers to reduce the possi-

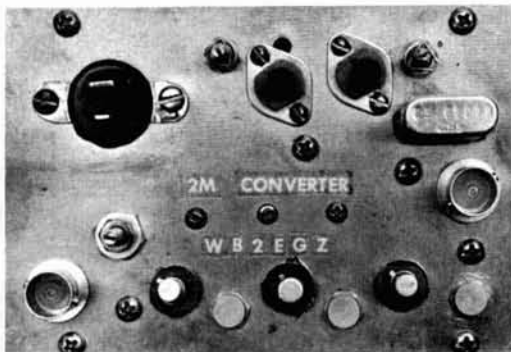
bility of electrical and mechanical shock.

3. Don't solder or change components with MOSFET's in their sockets.
4. Never insert or remove transistors when power is applied.

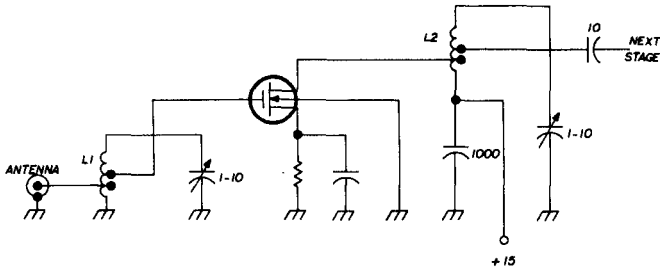
performance

This two-meter semiconductor circuit has performance to spare. With a noise figure between 2.5 and 3 dB, it falls short of the miraculously quiet JFET, but the MOSFET

The two-meter winner—extra performance on 144 MHz.



* The Bud CB-1626 chassis is available from Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680. Order catalog number 42E7812, \$5.55 plus postage; shipping weight, 12 ounces.



L1 5 turns number 18 space wound $\frac{1}{4}$ " diameter. Antenna tap at 1 turn from cold end. The gate tap is $1\frac{1}{2}$ to 4 turns from the cold end depending on the strength of the interfering signal. Best rejection at $1\frac{1}{2}$ turns.

L2 $4\frac{1}{2}$ turns number 18 space wound on $\frac{1}{4}$ " diameter. Adjust drain tap for optimum gain. The tap will be approximately the same number of turns from the power-supply end as the gate tap on L1 is from ground. The tap to the next stage is optional. If used, follow the procedure for the gate tap on L1.

fig. 4. Suggested method for tapping down on the tuned circuits to optimize cross-modulation resistance. Although this technique may be used at any frequency, the values given are for the two-meter band.

provides better hearing over wider bands. In fact, the gain-bandwidth of the five transistor converter easily surpasses that of two rf stage nuvistor converters. With this amount of gain, the circuit must be stagger tuned unless an agc system is used; 2- to 3-MHz bandwidth appears practical.

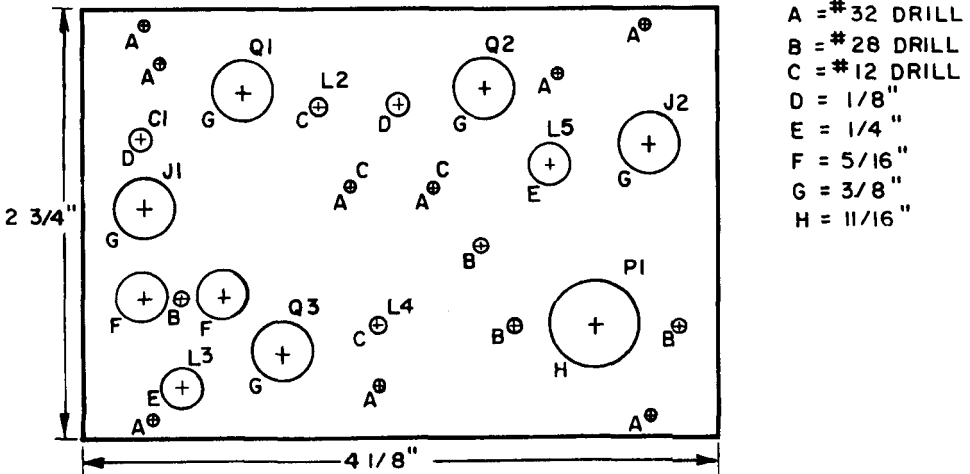
It is interesting to note that only three tuned circuits are used in the two-meter amplifiers and no shielding is needed. The absence of neutralization is a mixed blessing—tuning is greatly simplified, but over-all gain may be restricted. In the tetrode, any neutralization is for the socket and **not** the

MOSFET. I think the absence of neutralization is a benefit to cross-modulation resistance because high signal levels and high gain may upset stability in a neutralized circuit.

Cross modulation in this converter is about the same as in a vacuum-tube equivalent—a decided improvement over bipolar circuits. Dynamic range, which is about 25 times that of a bipolar transistor, is slightly better than vacuum tubes. The large dynamic range is a direct result of the fact that the MOSFET gate may be operated with either negative or positive bias.

As you will see when you build one, this

fig. 5. Chassis layout for the three-transistor two-meter converters.



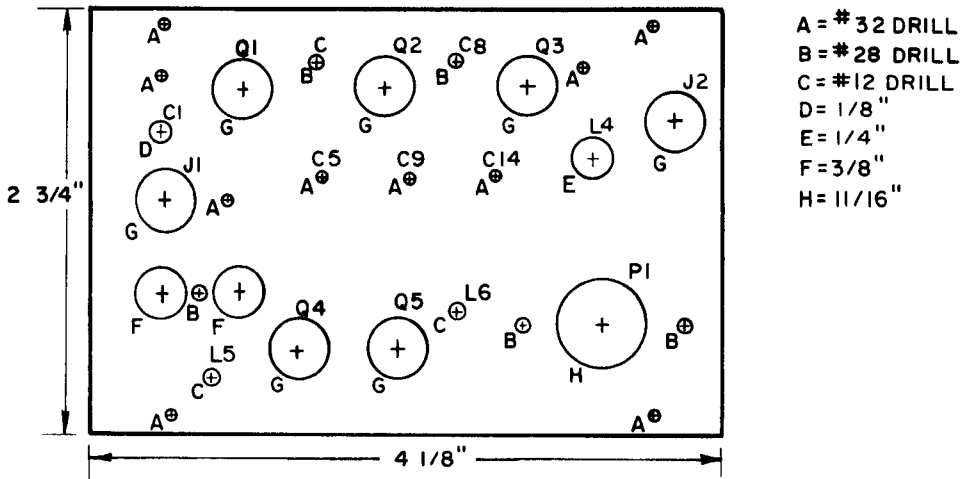


fig. 6. Chassis layout for the five-transistor two-meter winner.

is quite an impressive converter. If you're opposed to all the gain that is available with this circuit, a single rf stage may be a good choice since it improves the dynamic range slightly. Another interesting change might be two MOSFET tetrode rf stages; in this case, the bias on gate 2 of the second stage should be the same as gate 2 on the first stage for optimum immunity from cross modulation.

Although I am extremely pleased with the operation of this converter, time has not permitted extensive testing under varying operating conditions. If you build one of these circuits, your reports and comments will be appreciated.

acknowledgements

It is next to impossible to accomplish a design of this magnitude without the help of many persons, each of whom has experience in some related segment of the project. Mr. Burrell Warnoch, W2BV, provided particularly important test information on the converters. Consultations with Mr. Sy Reich of RCA, Mr. Dick Peterson, WA2CYE, and Mr. Bill

Schaefer, WA2EMB, were quite useful in establishing guidelines for the project. My thanks to them all.

references

1. R. M. Mendelson, "All-Transistor Two-Meter Converter," *RCA Ham Tips*, Winter, 1965-66.
2. J. G. Linvill and J. F. Gibbons, "Transistors and Active Circuits," McGraw-Hill, New York, 1961.
3. F. M. Carlson, "Application Considerations for the RCA 3N128 VHF MOS Field Effect Transistor," RCA Application Note AN3193, August, 1966.
4. D. W. Nelson, "A Solid-State AM Transmitter for Two-Meter Operation," *RCA Ham Tips*, Fall, 1966.
5. F. M. Carlson, E. F. McKeon, "Small-Signal RF Amplification of MOS Devices," *1966 NEC Proceedings*.
6. H. M. Kleinman, "Application of Dual-Gate MOS Field-Effect Transistors in Practical Radio Receivers," *IEEE Transactions on Broadcast and TV Receivers*, July, 1966.
7. C. H. Lee, S. Reich, "An FM Tuner Using Single-Gate MOS Field Effect Transistors as RF Amplifier and Mixer," RCA Application Note AN3535, December, 1967.
8. Joel M. Cohen, "An Old-Timer Comes of Age," *Electronics*, February 19, 1968.

ham radio

next month in ham radio magazine:

Single-Ended Kilowatt for 432

Thermoelectric Power Supplies

What You Should Know about Coaxial Cable

Frequency Translation for SSB

Tuning Up VHF Transmitters

Plus many more . . .



converting vacuum-tube equipment to solid-state

If you have
an old piece
of vacuum-tube equipment
around the shack,
here are some ideas
for converting it
to solid state

Unfortunately, you can't simply plug a transistor in place of a vacuum tube. However, in some cases you can replace tubes with easily made solid-state "plug-ins." With this approach, you can often improve the operation of an old piece of tube-type equipment.

If you wanted to, you could probably replace all the vacuum tubes in a receiver or low-power transceiver with plug-in, solid-state modules. The modules wouldn't be universal—you'd have to tailor make one for each tube circuit; a solid-state circuit that would use the components already on the chassis.

It's unlikely that you would ever want to convert an entire tube-type unit to solid-state. However, there may be advantages to converting individual stages or accessories. This is particularly true for vacuum-tube stages that require frequent tube replacement. Circuits that are unstable under mechanical vibration or high temperature conditions are also natural solid-state targets. Also, putting transistors in test equipment or station accessories has several advantages—less heat and easy battery-powered portable operation.

John J. Schulz, W2EEY, 40 Rossie Street, Mystic, Connecticut 06355

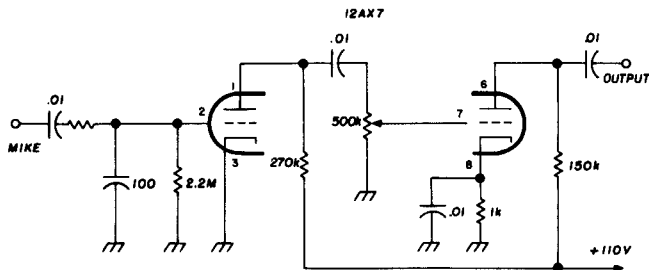


fig. 1. Typical two-stage vacuum-tube microphone preamplifier.

Before you can design a solid-state plug-in, you have to consider several aspects of the stage you're working with: input and output impedances, gain, frequency, bandwidth and the power supply voltages available at the socket.

Two or more transistors may be needed to compensate for the high input and output impedance of tube stages. This also helps in the gain department. Because of the constraints imposed by the components mounted on the chassis, it is rarely possible to replace a single tube with a single transistor. Several years ago the solid-state plug-in was too costly for amateur equipment, but today there are a multitude of low-cost, high-performance transistors available. In many cases several of them cost no more than one tube. Frequency is usually no problem—at least at hf and lower vhf—since many low-cost transistors developed for the television industry exceed the capabilities of comparable vacuum tubes.

Power for the solid-state plug-in can be taken from the plate or screen supply voltage through a voltage divider. High wattage di-

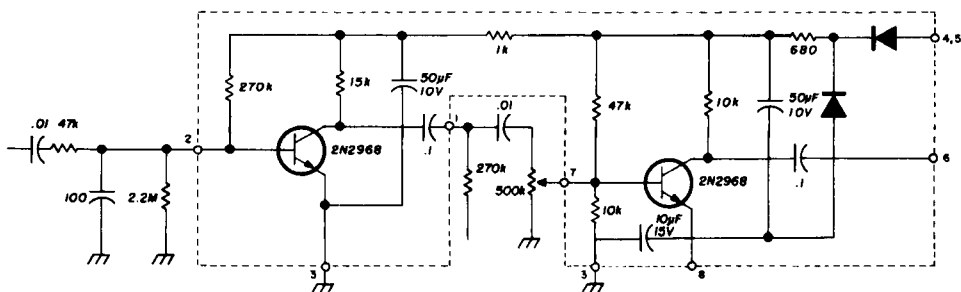
vider resistors are generally not necessary because of the low current demand of the transistors. Another possibility is the filament supply; just include a rectifier and filter in the plug-in.

In this article I'll describe solid-state conversions for several typical vacuum-tube circuits. They are not applicable to every tube circuit, but if the general methods of conversion are understood, you should be able to develop conversions for your own specific circuits. I have used the original components connected to the tube sockets whenever possible. When this hasn't been possible, only the input, output and supply voltage points have been used.

audio preamplifier

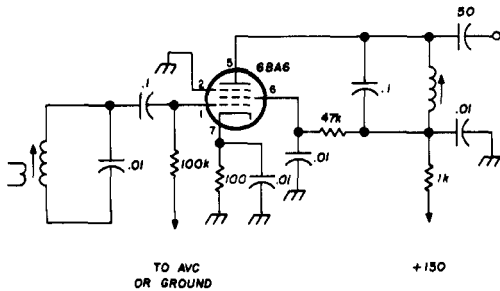
A typical two-stage high-impedance audio preamplifier is shown in fig. 1. It's typical of the type used in many modulators. The solid-state conversion is shown in fig. 2. A few of the original parts were used including the 2.2-megohm resistor which forms a bias network for the base of the first transistor and the 1k resistor in the emitter lead of the sec-

fig. 2. The transistor conversion of the vacuum-tube circuit shown in fig. 1. The terminal numbers correspond to the tube pin numbers given in fig. 1.



ond transistor. The gain control is included in the circuit by using a 0.1- μ F blocking capacitor. The supply voltage is provided by rectifying the filament voltage. The transistor stages are conventional grounded-emitter cir-

fig. 3. Vacuum-tube i-f amplifier; the grid resistor connection depends upon whether the stage is avc controlled or not.



uits. Because of relatively high transistor gain, it was possible to replace each tube section with only one transistor.

i-f amplifier

Fig. 3 shows a typical i-f stage using the ubiquitous 6BA6. There are two solid-state conversions for this circuit shown in fig. 4—one for avc, the other without. Both are usable with i-f frequencies up to 9 MHz. None of the original components were used in this conversion because their values weren't suitable. Voltage to operate the transistors is taken from the screen supply.

To obtain sufficient gain and high input and output impedances, I used two directly-coupled transistor stages. The extra transistor in fig. 4B is required to provide avc action without overloading the avc bus. This is because a vacuum-tube avc circuit is not designed to supply any current. The 2N697 performs the avc function by controlling the bias of the 2N293 stage.

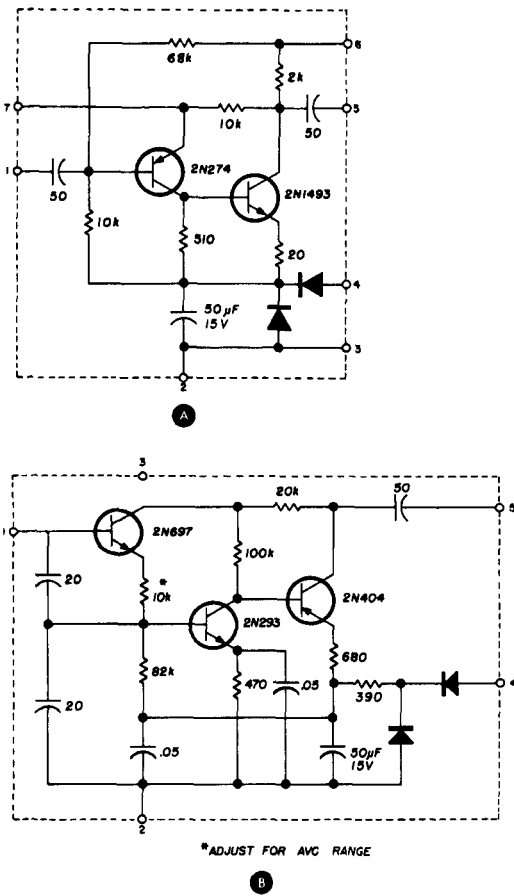
The rf signal is coupled to the base of the 2N293 through a capacitive voltage divider. These capacitors, as well as the output coupling capacitor, should be increased to 100 or 200 pF for low-frequency i-f's (455 kHz). In this circuit, the operating voltage is obtained through a rectifier in the filament voltage line.

oscillator circuits

It isn't any problem to convert the simple tuned-plate crystal oscillator shown in fig. 5. The RCA 40080 transistor will operate at frequencies up to about 15 MHz with reasonable output. However, you may have to retune because of the change in output capacitance.

The conversion of a vfo circuit is a little more complicated as illustrated in fig. 6. Two transistors are required to provide the neces-

fig. 4. Solid-state conversion of a vacuum-tube i-f amplifier. The circuit in B incorporates avc, while A does not.



sary feedback and output. The calibration of the vfo will probably change so you'll have to recalibrate it. If the calibration is too far off, you may have to put new padding capaci-

tors across the tuned circuit to retain the original dial calibration.

limiter circuit

The limiter stage shown in **fig. 7** illustrates a circuit which uses a dc feedback loop. The solid-state conversion of this circuit is somewhat limited by the original feedback circuit. The conversion shown in **fig. 7B** uses three capacitors.

The 0.1- μ F input coupling capacitor isolates the ac and dc components present on pin 1 of the tube socket. The ac signal is amplified by the two-stage 2N2968/2N1305 amplifier. The dc feedback voltage controls the collector current of the first 2N2968, thereby producing limiting action.

construction

One simple way of building a plug-in is to mount the components on a piece of Vectorboard which is wired to a plug to fit the tube socket. If you have an old burned-out tube around, you can use the base after breaking the glass envelope. For miniature 7- and 9-pin sockets, Amphenol type CP plugs are available.*

If you want, you can buy complete plug-in assemblies with a plug, perforated phenolic board and a shield can (Vector G2.1-8-4). These units are a little expensive, but they may be worth while if you want to convert a sensitive circuit where shielding is necessary.

* Available from Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680. For the 7-pin miniature plug, order 47E2649, \$.99; 9-pin, order 47E2652, \$1.38; plus postage; shipping weight 2 ounces.

summary

I have tried to present some ideas on how a variety of tube-type circuits may be updated to solid state. It should be pointed out, however, that the conversions shown

fig. 6. Clapp vfo circuit, vacuum tube (A) and solid-state (B).

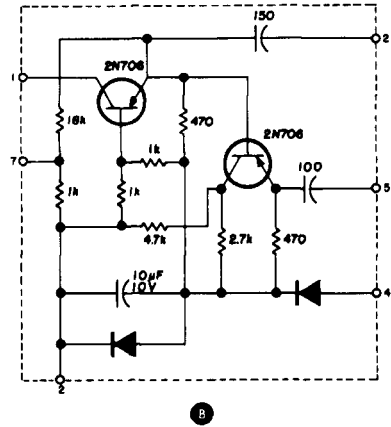
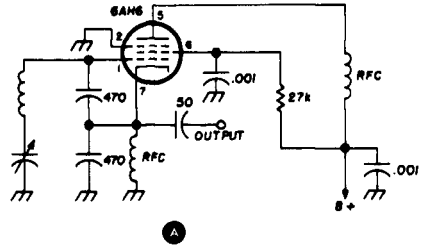
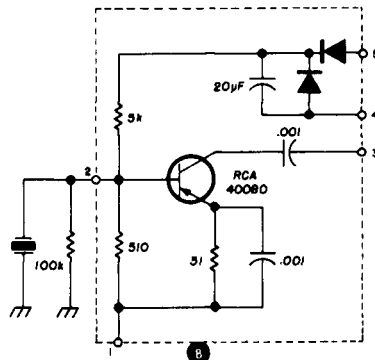
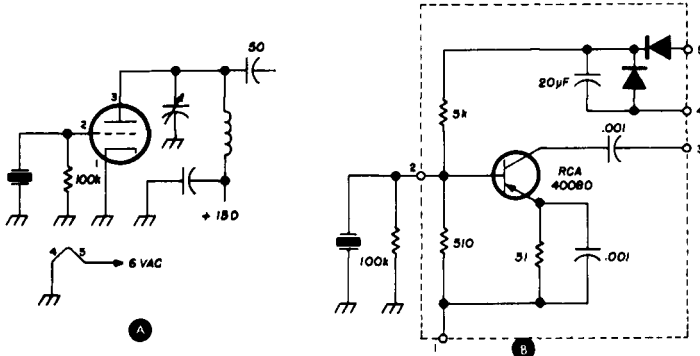


fig. 5. Vacuum-tube and transistor version of a low power crystal-controlled oscillator.



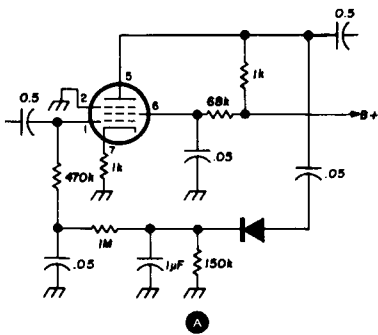
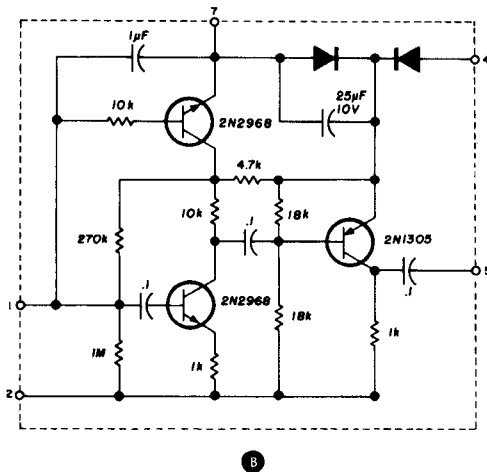


fig. 7. A limiter or compressor circuit (A) and a possible solid-state conversion (B).



when developing a solid-state replacement; simply adjust the component values for optimum performance.

The conversion of vacuum-tube power circuits is also possible, but it's complicated by several factors. First of all, power transistors usually require a medium-voltage (15 to 80 volts) high-current source; this is difficult to arrange in most vacuum-tube units without changing chassis-mounted components. Also, the problem of providing an adequate heat

sink makes construction rather difficult. Lastly, the input/output impedance conditions for rf power transistors is quite critical and difficult to achieve without rather complicated circuitry. Although individual transistors are shown here, integrated circuits may be used in vacuum-tube conversions and should be considered if the proper types are available at reasonable prices.

ham radio

short circuits

WB2EGZ six-meter converter

Don't ground L3 as shown in fig. 1 on page 23 of the June issue—it shorts out the power supply! On page 20, ignore the reference to the 2N2708—it's a 2N708 as shown in the schematic in fig. 1.

vhf fm

We have been advised by the Lynchburg Amateur Radio Club that they have not published their list of fm nets since March, 1964. The supply of these lists has long since been exhausted. If you have written to them, you'll receive a reply only if return postage was included with your letter.

K4ZAD also advises us that the Motorola Private line is a continuous low-frequency tone system, and not a tone-burst system as indicated in the article on page 90 of the

June issue.

amateur anemometer

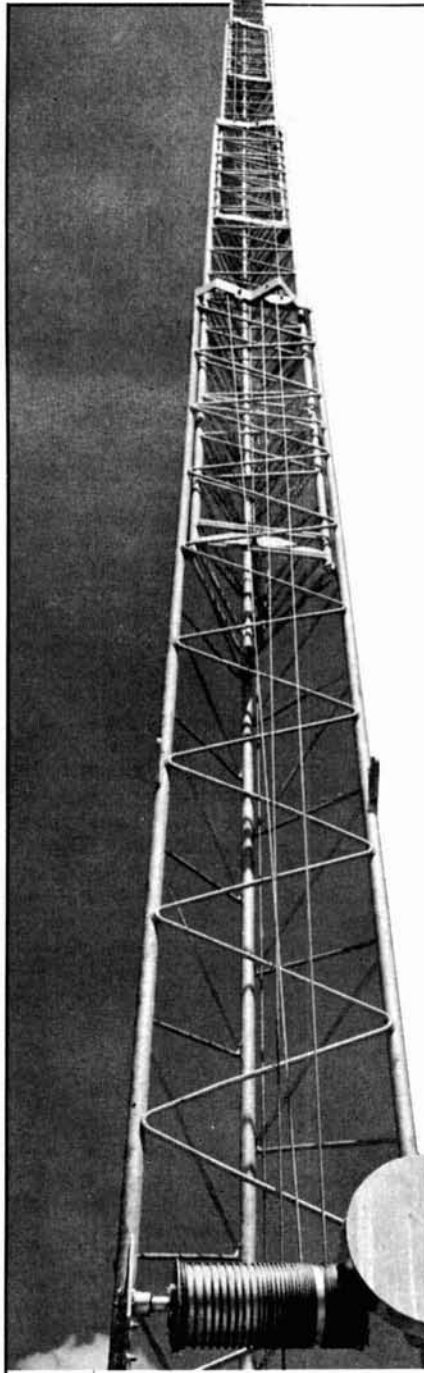
The μ L914 integrated circuit used in the anemometer circuit on page 53 of the June issue is manufactured by Fairchild Semiconductor; sorry we didn't mention it in the article. These devices are available from John Meshna, Jr., P. O. Box 62A, East Lynn, Massachusetts 01904. \$1.00 each postpaid airmail. Order 2-914, quad 2-input gate; the 2-914 contains two of the μ L914's.

stable transistor vfo's

In fig. 1, page 15 of the June issue, the numbers on C1 and C2 should be reversed to agree with the formula on page 20.

ham radio

LARGE ANTENNA LOAD



BUILT FOR WIND

THE TRI-EX FREESTANDING LM 470 (70 FEET HIGH)

This advanced state of the art tower is aerodynamically designed to reduce tower wind drag. This means you can carry more antenna than ever before. Tri-Ex engineers have made this possible by using high-strength, solid-steel rod bracing. Only at Tri-Ex do you get "W" type continuous truss bracing. Developer of the freestanding, crank-up tower, Tri-Ex prides itself on the quality of its products. More Tri-Ex crank-up towers are in use today than all other crank-up towers combined. Find out why the LM 470 tower is such an outstanding success. Write today for free literature.

AS LOW AS

\$1159⁶⁰

NO SHIPPING CHARGES WITHIN
CONTINENTAL U.S.A.

Tri-Ex TOWER CORPORATION

7182 Rasmussen Ave., Visalia, Calif. 93277

VRC19 receiver and
squelch module before
modification to solid state.



solid-state audio amplifier and squelch circuit

Although this audio amplifier and squelch circuit was designed for a solid-state VRC-19 receiver, the same approach may be used with other transistor FM receivers

■ The high noise levels experienced with a high-gain NBFM receiver during standby periods are always objectionable. Some form of effective noise squelch system is needed. The system shown here was developed in connection with the conversion of a vacuum-tube NBFM receiver to solid-state operation. With this particular receiver, the VRC 19, the squelch can be set to operate properly for signals of 2 microvolts or more. The switching transistor in the squelch unit snaps the audio amplifier on and off very nicely. Although this circuit was developed for the converted VRC-19, it may be used with other solid-state FM receivers.

The VRC-19 receiver has an audio and squelch system in one plug-in module which uses subminiature tubes with a larger miniature tube in the output stage. My task was to redesign the unit for transistors and diodes for use with a 12-volt storage battery.

The required audio output power of one-half watt requires at least 100 milliamperes of current at low voltage rather than 10 or 15 mA at 150 volts encountered with vacuum

Frank Jones, W6AJF/AF6AJF, 850 Donner Avenue, Sonoma, California

tubes. A class-A power amplifier running at 200 mA or so at 12 volts, or a class-B system running up to 100 mA at about 9 volts will provide approximately one-half watt output. I decided that an integrated circuit could be used for the complete audio amplifier job. The RCA CA3020 IC contains 7 transistors, 3 diodes and 11 resistors in one 12-lead transistor can for about \$2.50. This IC requires about 0.05 volt of drive to produce one-half watt output; this is available through an RC network from the discriminator transformer in the i-f unit of the VRC-19 receiver.

The original three-tube squelch system was replaced by a couple of low cost plastic-cased silicon NPN transistors—GE 2N2711's.

the circuit

The noise voltage appears on the low side of the discriminator input circuit when no signal is present. A surplus 44-millihenry telephone toroid and a .02- μ F shunt capacitor select the 5- to 6-kHz noise components to actuate the squelch system. Since voltages in the voice range are also present in this limiter stage when a signal is present, this filter must be used to prevent voice signals from operating the squelch circuit.

If a 44-mH coil and .02- μ F capacitor aren't available, an 88-mH toroid and .01- μ F capacitor may be used. A 30-mH rf choke and .02- or .03- μ F capacitor should also work for this purpose, although a toroid has less ex-

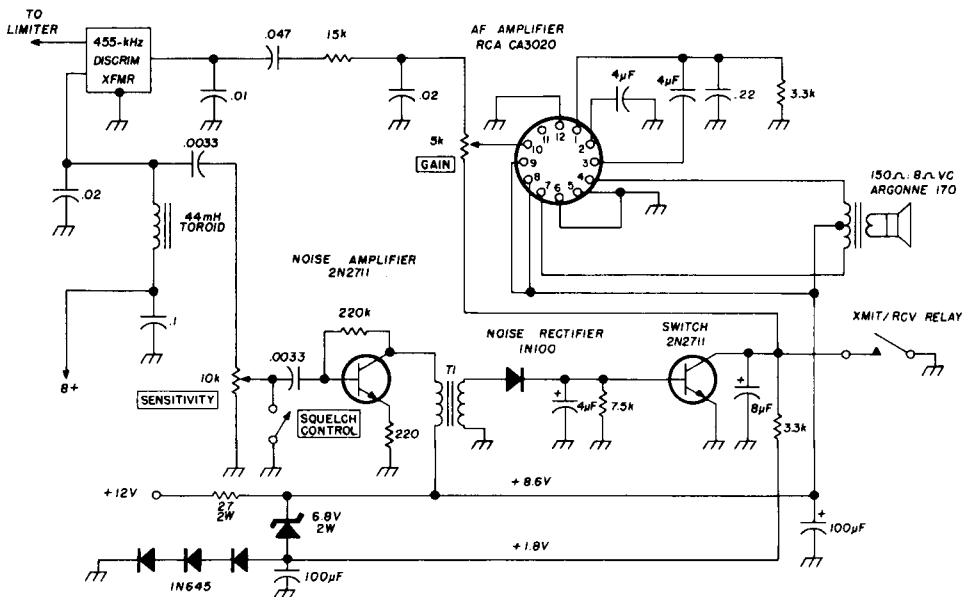


fig. 1. Schematic diagram of the solid-state audio output and squelch circuit used by W6AJF.

Any NPN devices with an h_{fe} of over 30 can be used in the circuit shown here. This circuit picks off a little 5- to 6-kHz "hiss" noise from the last i-f or discriminator transformer and amplifies it with a high-gain audio amplifier stage through a squelch gain control and low-Q tuned circuit. The original half-megohm squelch control in the receiver was changed to a 10,000-ohm potentiometer and the tube circuit rewired to use the new components.

ternal field and lower dc resistance.

Added low frequency attenuation is provided by the .0033- μ F coupling capacitors associated with the squelch sensitivity control. As a result, voice signals are attenuated enough so that only a noise signal will operate the squelch system.

The noise amplifier drives a diode rectifier to provide a dc voltage of about 0.25 volt into the switching transistor which cuts off the input amplifier of the CA3020 IC. As long

as a noise voltage is present (no signal), the af amplifier is squelched, and the loudspeaker is quiet. When a signal of very few microvolts is present, the noise voltage disappears, the squelch voltage drops, and the audio amplifier functions normally.

construction

The toroid, the .02- μ F capacitor and .0033- μ F coupling capacitor are located in the i-f module of the VRC-19. The 47k resistor on the output side of the discriminator transformer is shorted out and the output shunted with a .01- μ F capacitor to provide an audio signal at the af amplifier.

The CA3020 is mounted on a piece of perforated 1-1/2 x 4-inch phenolic board with all the squelch and other components. All the original parts, including the output transformer, were removed from the module and a new 5000-ohm audio gain control installed in place of the old half-megohm control. With some rewiring of the power-plug leads, 12 volts is available in place of 150 volts.

A fixed voltage of + 1.8 volts is provided for the CA3020 input stage through the squelch system and af gain control by the voltage drop across three 1N645 200-mA silicon diodes. Each diode provides about 0.6 volt regulated from 1 or 2 mA up to 200 mA. Any small silicon diodes with a current rating of 150 to 500 mA should be satisfactory.

A two-watt 6.8-volt zener diode in series with the three diodes provides the regulated 8.6-volt supply to the CA3020 IC. Since the CA3020 has a maximum rating of 9 volts, it can't be used safely with a 12-volt supply. A regulated supply of under 9 volts output is needed because the IC draws 10 or 15 mA resting and up to 135 mA at full output.

There were some problems with audio "motorboating" when the CA3020 was used with high resistance gain controls and small value bypass capacitors in the regulator and squelch circuits. However, the values shown in the circuit seem to cure these problems.

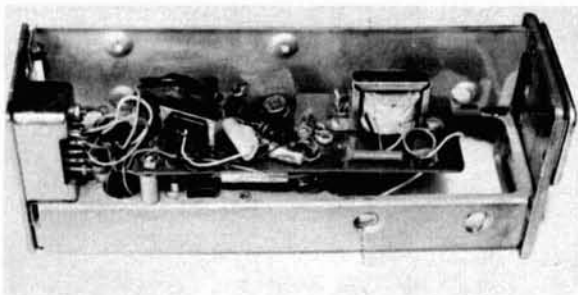
The CA3020 amplifier and Argonne 170 output transformer seemed to amplify the higher voice frequencies too much. This was overcome by using .22 μ F instead of the recommended .01 from terminal 1 of the CA3020 to ground, and by using fairly large

shunt capacitors in the discriminator output circuit. The high audio roll-off is greater than that used in the original vacuum-tube amplifier.

The noise rectifier can be nearly any kind of diode, silicon or germanium, since it functions at low voltage levels. The switching transistor base resistance varies from a very high value with squelch cut-off to a few hundred ohms while squelching. This means that the ac impedance of the noise rectifier is also low during operation.

A small audio step-down transformer is

VRC19 receiver af and squelch unit after changing it to solid state. Squelch parts at left and front edges of bakelite board mounted above old chassis. Af at center and right side.



needed between the noise amplifier and the rectifier; a small 20k:2k or 10k:1k audio interstage transformer is suitable. The input impedance of the noise amplifier is increased to a suitable value by not bypassing the emitter bias resistor. It may be necessary to increase the value of the 220k base-bias resistor shown in the circuit with other types of NPN transistors. If the voltage drop across the 220-ohm emitter resistor is between 0.25 and 0.5 volt dc, the base bias voltage is ok.

This squelch circuit should function quite well when connected into any NPN emitter follower of any audio amplifier in which the second audio transistor is coupled to the emitter of the controlled input stage. This type of amplifier has less than unity gain, but exhibits fairly high input impedance when compared to a base input stage with gain.

ham radio

NEW FET SIX METER CONVERTER



The Horizon VI incorporates the latest in solid state VHF techniques. Field-effect transistors are used throughout the unit to provide excellent protection against overload and cross modulation.

All power is provided by a built-in 115 volt AC power supply - (no need to buy extras). An additional crystal position has been provided to allow the owner the option of expanded frequency coverage. Local oscillator output is accessible from the front of the unit for those who desire transceive operation.

The low noise figure of the Horizon VI assures the operator of excellent performance when stations are weak.

See your local dealer for a demonstration of the Horizon VI; you'll be impressed by its exceptional performance.

SPECIFICATIONS

Freq. range: 50 - 54 MHz; **I.F. output:** 14 - 18 MHz; **Input impedance:** 50 ohms; **Output impedance:** 50 ohms; **Noise figure:** 3 dB typical; **Gain:** 15 dB nominal; **One 36 MHz crystal installed;** **Built-in power supply:** 115 volts AC; **Weight:** 18 ounces; **Dimensions:** L-6 $\frac{1}{4}$ " x W-3 $\frac{3}{4}$ " x D-2"; **Price:** \$59.95.

AUTHORIZED DEALERS (listed alphabetically)

AMATEUR ELECTRONIC SUPPLY

4828 W. Fond du Lac Avenue
Milwaukee, Wisconsin 53216
Tel: 414 - 442-4200

AMRAD SUPPLY, INC.

3425 Balboa Street
San Francisco, California 94121
Tel: 415 - 751-4661

AMRAD SUPPLY, INC.

1025 Harrison Street
Oakland, California 94607
Tel: 415 - 451-7755

ELECTRONIC CENTER, INC.

107 3rd Ave. North
Minneapolis, Minnesota
Tel: 612 - 338-5881

EVANSVILLE AMATEUR RADIO

1629 S. Kentucky Avenue
Evansville, Indiana
Tel: 812 - 422-4551

GRAHAM ELECTRONICS SUPPLY, INC.

122 S. Senate Avenue
Indianapolis, Indiana 46225
Tel: 317 - 634-8486

HAM RADIO OUTLET

999 Howard Avenue
Burlingame, California 94010
Tel: 415 - 342-5757

THE HAM SHACK (Tel-Appliance Center, Inc.)

1966 Hillview Street
Sarasota, Florida 33579
Tel: 813 - 955-7161

HENRY RADIO STORE

931 N. Euclid
Anaheim, California 92801
Tel: 714 - 772-9200

HENRY RADIO STORE

11240 West Olympic Blvd.
Los Angeles, California 90064
Tel: 213 - 477-6701

ED MOORY WHOLESALE RADIO

Box 506 -
De Witt, Arkansas
Tel: 501 - WH 6-2820

PIONEER-STANDARD ELECTRONICS, INC.

5403 Prospect Avenue
Cleveland, Ohio 44103
Tel: 216 - 432-0010

PIONEER-STANDARD ELECTRONICS, INC.

SREPCO ELECTRONICS DIVISION
314 Leo Street
Dayton, Ohio 45404

UNIVERSAL SERVICE

114 North Third Street
Columbus, Ohio 43215
Tel: 614 - 221-2335

VALLEY HAM SHACK

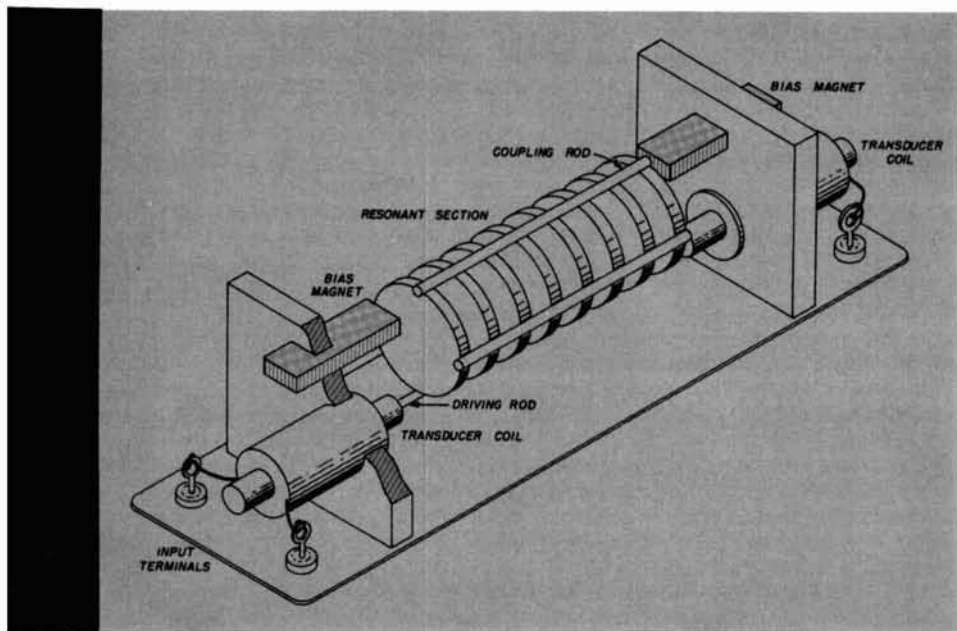
4109 N. 39th Street
Phoenix, Arizona
Tel: 602 - 955-4850

RAYTRACK
Company
NEW IDEAS FOR PROGRESS
IN ELECTRONICS

2111 SPRINGHILL DRIVE

Columbus, Ohio 43221

TELEPHONE 614/486-7090



single-sideband filters

The filters required
for generating a ssb signal
fall into
two general categories,
crystal and mechanical;
here is
a description of both

In a single-sideband transmitter, the signal coming from the balanced modulator is not yet an ssb signal; it still has both sidebands. Although the carrier has been suppressed, it is called a double-sideband suppressed-carrier signal. The job of removing the unwanted sideband is left to a device known simply as a filter.

In a communications receiver, incoming signals must be sorted out by the tuned circuits of the rf and i-f sections. These coil-capacitor combinations may allow adjacent signals through almost as well as the desired ones; their response is too broad. Removing those unwanted "side" frequencies is the job of a filter.

In a single-sideband receiver, every conversion the signal goes through generates an unnecessary extra sideband because of the nature of the heterodyning process. To recover the modulation, the ssb detector needs only the original sideband. The job of eliminating the unwanted sideband is turned over to—you guessed it—a filter.

On the schematic diagram of a modern ham receiver or transmitter, the filter is

Forest H. Bell, 119 Baker Avenue, South Plainfield, New Jersey 07080

identified merely by a box labeled F1, F2 or FL1, FL2, etc. The filter circuit is almost never shown. Nor is the type of filter indicated. If you look inside the enclosure, you learn very little more. The filter is a sealed “black box” that has been plugged in or wired into the circuit. What’s in it remains a mystery.

More important, of course, is what it does. From that standpoint, you can think of a filter as a three- or four-terminal device which certain signals are fed into, and out of which they come in some altered form. It is only a “black box” for all practical purposes. First, then, let’s examine what filters do in ham receivers and transmitters; then we can explore what’s in them.

shaping the curves

An important characteristic of any communications receiver is its **selectivity**. That is its ability to reject signals on either side of a desired one, while passing it freely. The selectivity you need depends on the kind of signal—that is, the modulation it carries.

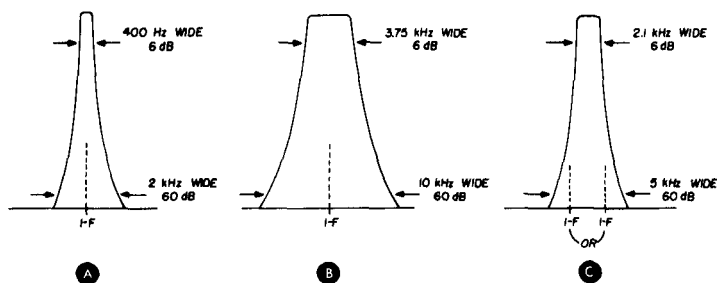
A CW signal, for example, has no modulation. It therefore has no sidebands on each

60-dB point. The ratio between the two bandwidths is called the **shape factor**. The filter in **fig. 1A** has a shape factor of 5. A low shape factor means the skirts are steep, making the filter respond strongly to the desired frequencies—within the passband—and deeply reject signals on either side. A shape factor of 1 is, of course, ideal; the skirts are vertical. In practice, a shape factor of 2 or 3 is acceptable.

Consider the selectivity required for an a-m signal. Since both sidebands are needed for proper demodulation, the receiver must pass a bandwidth of at least 3.5 or 4 kHz—enough for intelligibility. That width passes sideband products for voice signals up to 2 kHz. The filter represented by the response graph in **fig. 1B** is for a-m reception. It has a 6-dB response width of 3.75 kHz and a 60-dB response of 10 kHz. The shape factor is about 2.5—giving fairly steep skirts.

Both curves in **fig. 1A** and **1B** represent responses centered in the i-f passband. For example, if the i-f is 3.395 MHz, the filter in **fig. 1A** responds well to frequencies from 3.3948 to 3.3952 MHz. The 400-Hz response

fig. 1. Response curves for typical filters used in ham radio equipment. A for cw reception; B for a-m and C for ssb reception. 2.1-kHz bandwidth is standard.



side of the carrier. It consists of the carrier alone. A receiver with very, very narrow selectivity can pick up the CW carrier (keyed, probably, for code transmission) and avoid interference from other, nearby carriers. One of the best ways to attain such selectivity is with a special filter in the i-f amplifier. The curve in **fig. 1A** graphs the response of an i-f section using a very narrow CW-only filter.

Filter characteristics are rated by their response at two points: 6 dB and 60 dB below maximum. The response in **fig. 1A** is 400 Hz wide at the 6-dB point and 2 kHz wide at the

is spread 200 Hz to each side of the i-f center. The i-f section with the filter of **fig. 1B** (3.75 kHz wide) responds well from 3.393125 to 3.396875 MHz. The filter rejects frequencies above and below; nearby signals cannot get through.

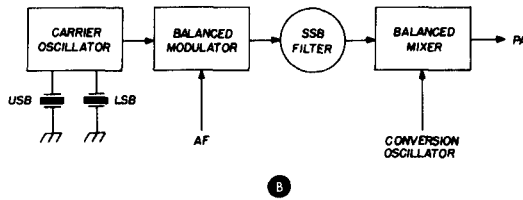
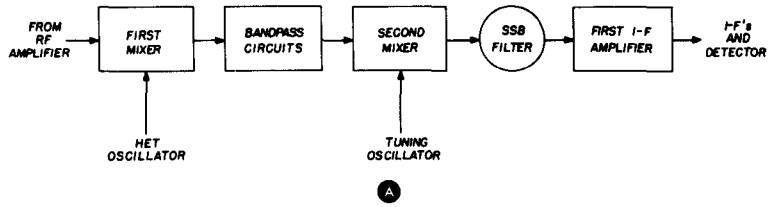
For single-sideband reception, the selectivity of the receiver can be narrower than for a-m, since only one of the sidebands is present. A bandwidth of 2.5 kHz is plenty. The curve in **fig. 1C** shows the response of the filter in one commercial ssb receiver. Its 6-dB response is 2.1 kHz; 60-dB response is

5 kHz. The shape factor is about 2.4.

There's something else special about the ssb filter in **fig. 1C**. Its response is not centered on the i-f. The "center" of the filter's bandwidth is off to one side or the other of the i-f, placing any i-f signal down on either the skirt, below the 6-dB point. Which skirt is chosen depends on which sideband must fall within the bandpass. If the upper sideband must be amplified, the i-f is placed on the lower-frequency skirt of the filter response.

In a superheterodyne ssb receiver, every frequency conversion creates two sidebands from the single-sideband signal. That's because the local oscillator signal beats with the incoming sideband and produces both sum and difference frequencies. Following the i-f amplifier stage, only one sideband is needed for demodulation. The frequency of the filter (**fig. 2A**) is offset from the i-f as already described, to eliminate the extra sideband that has joined the desired one.

fig. 2. Ssb filters in receiver (A) and transmitter (B).

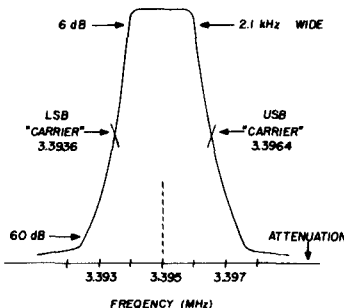


The rejection characteristic blocks the lower sideband.

filters at work

For ssb, a filter like the one in **fig. 1C** can be used in a transmitter or receiver. In modern transceivers, a single filter is used for both. Let's see how and why.

fig. 3. If the dsb "carrier" (which is suppressed) is placed in either position shown, one sideband is eliminated.



In the ssb transmitter, the chief job of the filter (**fig. 2B**) again is to eliminate the unwanted sideband. If well designed, it also removes any vestige of the carrier that might be left by the balanced modulator. Succeeding stages of frequency translation re-create a double sideband, but the two are far enough apart that it is easy to get rid of the unwanted one with ordinary tuned circuits.

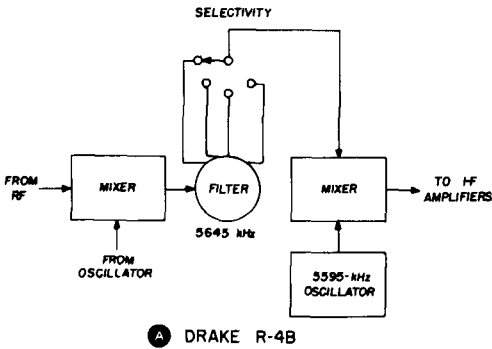
In a transmitter, there is also a need to switch from one sideband to the other. With a single filter, this is done by shifting the frequency of the carrier oscillator. Then, the signal that reaches the filter is on the other skirt. The sketch in **fig. 3** gives you some idea how this works. If an upper sideband is desired, the 3.3964-MHz USB carrier-oscillator crystal (**fig. 2B**) is activated. Even though the carrier is eliminated by the time the signals reach the filter, the upper and lower sidebands fall on each side of the position shown (USB "carrier") on the upper skirt of the filter response curve. The sideband fre-

quencies higher than the "carrier" are attenuated drastically; those below are amplified. (Don't be alarmed that this is called the upper sideband; when the signal passes through a stage of conversion after the filter, the heterodyning process will "flip the sideband over," making it an upper sideband in the transmitter output.)

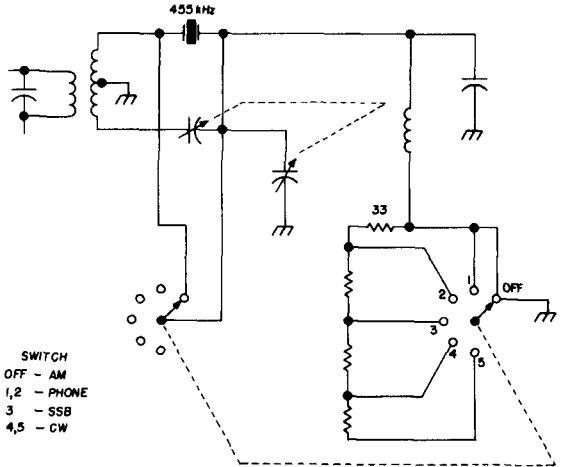
For a lower sideband, the other crystal is activated, generating the 3.3936-MHz carrier.

ers who develop the gear. A few of these are diagramed in **fig. 4**. They are merely examples of different ways filters are used in ssb receivers.

The circuit from the Drake R-4B has a variable-selectivity filter, with its center at 5645 kHz. The filter can be switched to four different bandwidths: 400 Hz, 1.2 kHz, 2.4 kHz, and 4.8 kHz. The first is for CW; the last is for a-m; the others are for various ssb



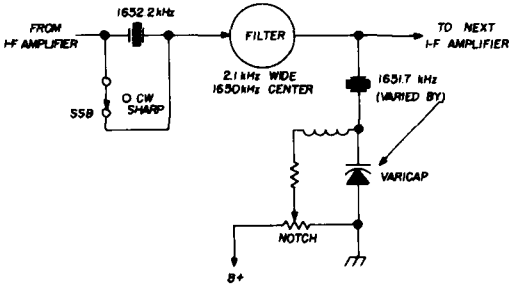
A DRAKE R-4B



SWITCH
OFF - AM
1,2 - PHONE
3 - SSB
4,5 - CW

B HAMMARLUND HQ-145

fig. 4. Selectivity filters in a few commercial receivers.



C HALLICRAFTERS SR-400

The sidebands fall on both sides of the position indicated as **LSB "carrier."** The sideband on the upper side is amplified, and that on the lower is attenuated. Again, the ensuing frequency conversion flips the signal over and produces a lower sideband at the output frequency.

commercial circuits

There are about as many ways of using filters in ssb equipment as there are design-

reception conditions. Not shown is an additional phase control that affects ssb reception.

Another way to obtain variable selectivity with a single filter is shown in the diagram from the Hammarlund HQ-145 receiver. The filter in this case is the simplest imaginable—a series-resonant crystal centered at the i-f. The widest bandpass is obtained with the crystal shorted out—the OFF position of the switch; it is for a-m reception. In posi-

tion 1, the crystal is in the circuit, but the response of the output tuning coil is at its broadest, thus loading down the crystal. In successive positions, additional series resistance is switched in, reducing the loading effect of the output circuit and making the crystal's effect sharper. At the 4 and 5 positions, selectivity is too sharp for ssb reception, but is excellent for "notching out" interference on CW.

A fancier notch-filter circuit, combined with a conventional selectivity filter, is used in the Hallicrafters SR-400. The filter centers at the *i-f*, 1650 kHz. For CW reception, the CW-SSB switch is opened, inserting a 1652.2-kHz crystal in series with the signal path to the main filter. The relationship between the two frequencies narrows the over-all bandwidth to less than 1 kHz; the series crystal bucks the filter's response near the upper skirt. The notch filter, which places a deep notch or dip in the pass band of the main filter, is a 1651.7-kHz crystal. The notch crystal's frequency is varied by a varicap (voltage-variable capacitor), which permits moving the notch back and forth. A NOTCH potentiometer applies voltage to the varicap to control its effect on the crystal.

one filter, two jobs

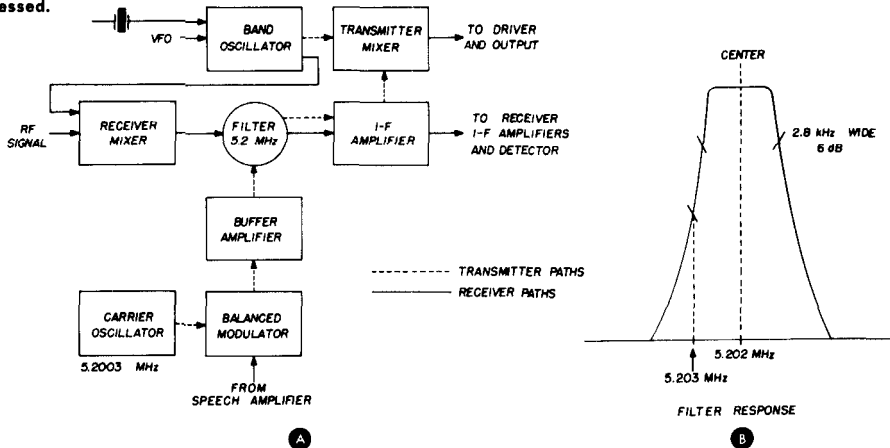
In ssb transceivers, a single filter is frequently used for both transmit and receive. The National 200 transceiver contains a good example of this, diagramed in fig. 5. The filter

is centered on 5.202 MHz. The local oscillator frequency differs from the incoming signal frequency by that amount, thus creating an approximate 5.2-MHz *i-f*. The specifications for the filter, which is a type called **crystal lattice**, list its 6-dB bandwidth as 2.8 kHz. The solid lines show the signal paths during ssb reception.

During ssb transmission, shown by dashed lines, the same filter and one of the receiver *i-f* amplifiers are used. Sideband elimination comes from feeding the double-sideband suppressed-carrier signal (produced by the *balanced modulator*) through the filter. The graph of filter response in fig. 5 shows how. The carrier oscillator operates at 5.2003 MHz. The two sidebands coming from the balanced modulator are on each side of that frequency. With the filter bandwidth 2.8 kHz wide, and its center at 5.202 MHz, the 6-dB point on either skirt is 1.4 kHz away from center. The 5.2003-MHz carrier is 1.7 kHz below the center of the filter response, placing it below the 6-dB point of the lower-frequency skirt. This position assures additional suppression of any remaining carrier, and complete obliteration of the lower sideband. The upper sideband, on the other hand, is at the peak of the filter response, and passes through unattenuated.

As you can see, the ssb signal is then amplified by an *i-f* stage before it is applied to the final mixer for translation up to the output frequency.

fig. 5. Using one filter for both receive and transmit. Filter response curve shows how the sideband is suppressed.



inside the black boxes

There's a natural curiosity about what is in a filter. Truly, there need be no mystery. Hams have been building their own filters for many years. Nowadays, the shortage of cheap surplus crystals has slowed down that sort of experimentation; also, commercial units are less costly. Nevertheless, it's nice to know what goes on inside your equipment and what makes it happen.

There are three kinds of filters in ssb rigs: **LC, mechanical, and crystal.**

The **LC filter** is, as its name suggests, a coil-capacitor combination. Several high-Q tuned circuits, cascaded, can have a response with very sharp peak and steep sides. At frequencies around 50 or 60 kHz, such filters may suffice. Below that, component size is a problem. Special designs overcome some limitations. For example, Barker & Williamson has a model—the 360—that uses toroid inductance windings and silver-mica capacitors; the center frequency is 18.5 kHz, with a 3-kHz pass band.

Above 100 kHz, the Q of LC components may not be high enough for practical filters. Commercially available LC filters are usually in the 50-kHz region. The Hammarlund HX-500 transmitter, which generates its primary carrier at 60 kHz, uses an LC sideband filter following the balanced modulator. Burnell's model S-15000 LC-type filter has its steepest slope at 50 kHz.

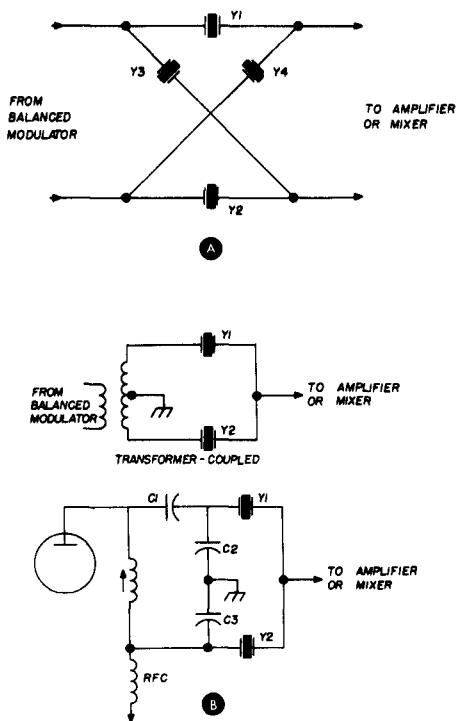
At 100 kHz and above, the **mechanical filter** becomes practical. Technically, it is electromechanical. A mechanical filter consists of an input coil tuned to the center of the i-f; a magnetostrictive transducer that converts i-f signal energy to mechanical energy; a "stack" of plates, rods or discs which are mechanical resonators coupled together by a coupling rod in their center or along their edges; an output transducer that converts the mechanical vibrations back to signal energy; and an output tuned circuit to couple the output signal to the next stage. A sketch of a mechanical filter is shown at the beginning of the article.

The best frequency for mechanical filters is around 250 kHz, although models are available from 50 kHz through 600 kHz. Almost never do you find one above 1 MHz. The response shape and center frequency

depend on the size and shape of the resonator elements. At frequencies below 100 kHz, the elements are too large for practicality; above 600 kHz, the close physical tolerances that are necessary become too expensive to achieve.

By careful selection of the sizes of resonating elements, the bandwidth of a mechanical filter can be sharply controlled. Also, the very nature of this kind of resonant shaping insures extremely steep response

fig. 6. Lattice-type crystal filters for ssb. Full lattice, or ring, circuit in A and two forms of half-lattice filters in B.



skirts—almost vertical, which means an extremely low shape factor. One of the better-known mechanical filters is the Collins F455Y-31; its center frequency is 455 kHz, its 6-dB bandwidth is 3.1 kHz, and its shape factor better than 2.

crystals in lattice networks

From 1 MHz up, ssb filters are most likely to be of the crystal variety. As you've seen already, crystal types are available below

that, but most are above 1 MHz. They are costly, but offer excellent performance.

One unit that has become popular in commercial equipment lately is the 9-MHz crystal-lattice filter. Its cost ranges toward \$50. For single sideband use, the bandwidth is standard: 2.1 kHz. The 9-MHz filter is used in the Galaxy V Mk2 transceiver, in the Hallcrafters SX-146 receiver and HT-46 transmitter, and in the Gonset 910-series transceivers—that I know of. In the transceivers, a single 9-MHz filter is used for both transmit and receive. One commercially available 9-MHz crystal filter is the McCoy 32B1; it retails for \$35.00.*

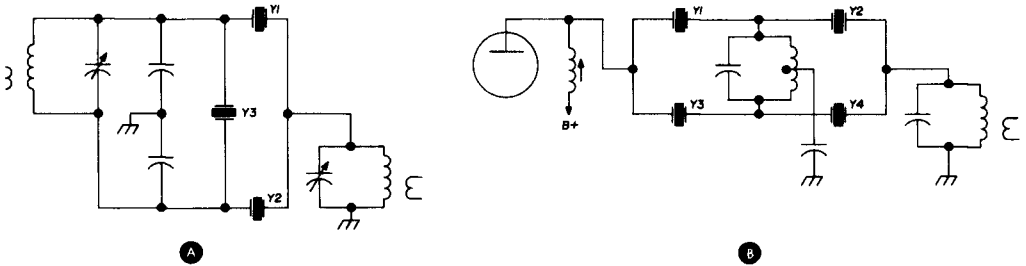
Two basic circuits are the foundation for all crystal filters (other than simple series

shape factor of most full-lattice crystal filters is down to 2 or better.

The crystals in half-lattice filters, like those in **fig. 6B**, are chosen so that the parallel-resonant frequency of Y2 is the same as the series-resonant frequency of Y1. The result is the bandpass curve needed for ssb operation. Occasionally, a capacitor is added across one crystal to warp its frequency for exactly the spacing needed to produce the correct bandwidth. Half-lattice crystal filters exhibit shape factors around 2 or a little higher—adequate, but not so sharp as full-lattice filters.

The differences in coupling in the two half-lattice filters in **fig. 6B** deserve brief comment. The half-lattice configuration depends

fig. 7. Variants on half-lattice configuration. With a shunt crystal (A), back-to-back for single-ended input (B).



crystals already described). Both are called **lattice networks**, and are shown schematically in **fig. 6**. The one in **fig. 6A** is called a **full lattice** and the two in **6B** are called **half-lattice**. The full lattice has also been called a ring filter, due to its resemblance in configuration to the well known ring diode modulator. The two half-lattice crystal filters in **fig. 6B** differ only in the manner of coupling signal energy to the crystals.

In **fig. 6A**, crystals Y1 and Y2 are a matched pair, series-resonant at the center frequency of the filter. They pass along the signals at resonance, but not signals on either side. Broadening the response of the filter are Y3 and Y4. In some filters, they are parallel-resonant at the center of the filter pass band; in others, they are series-resonant at frequencies to either side; in a few, they are chosen to impart special skirt characteristics. The

on the crystals being fed in push-pull, with the output taken in parallel. The transformer-coupled circuit does this easily; with a grounded center-tap, the secondary winding feeds the crystals in push-pull. To accomplish the same thing with the single-ended output from a tube is not that easy. With C2 and C3 across the plate coil, and a ground between them, the crystals are effectively fed in push-pull, after all. The rf choke keeps the bottom end of C3 from being grounded through the power-supply capacitors. C1 is merely a dc-blocking capacitor to protect the crystals.

There are several variations on the half-lattice configurations; two of them are shown in **fig. 7**. Another variation, not shown, is a cascaded series of half-lattice filters. This is seldom used in commercial filters because of the extra coupling transformers needed.

In **fig. 7A**, Y1 and Y3 are chosen for the same frequency, the center of the i-f pass

* McCoy Electronics Company, Mount Holly Springs, Pennsylvania

band; Y1 is series-resonant, though, while Y3 is parallel-resonant. Y2 is series-resonant at a frequency offset by the bandwidth desired. In one design, for example, Y1 and Y3 are picked for 455 kHz, and Y2 for 453.2; bandwidth is 1.8 kHz. Shape factor is 2.3, but one skirt is much steeper than the other. That's the side the signal is placed on.

The back-to-back configuration in fig. 7B exhibits a better shape factor than two cascaded half-lattice stages merely cascaded. This is also an excellent way to feed the signal from a single-ended stage. Y1 and Y2 are chosen to match in frequency. Y3 and Y4 match each other, but are 1.5 to 1.7 kHz away from Y1 and Y2 in frequency. This arrangement is used in one commercial ssb filter in the 5-MHz range.

checking filters

There isn't space to go deeply into testing ssb filters. Briefly, though, there are three methods. One is to use an oscilloscope, sweep generator, and marker generator to display an exact curve and examine its bandwidth, shape factor, etc.¹ Another is to use a signal generator and a VTVM with an rf probe; you can plot a response curve in just a few minutes, one point at a time. The third is to test the filter's operation with signals; if the receiver or transmitter cannot be aligned to receive or generate an ssb signal with proper modulation, suspect the filter.

In most cases, you'll be able to do nothing about filter trouble, beyond buying a new one. The sealed black-box nature of ssb filters precludes any repairs. At least, however, you know what should be going on in them.

references

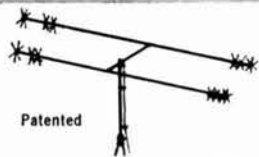
1. M. J. Goldstein, VE3GFN, "Instrumentation and the Ham," *ham radio*, July, 1968, p. 28.
2. C. E. Weaver, W2AZW, J. N. Brown, W40LL, "Crystal Lattice Filters for Transmitting and Receiving," *QST*, June, 1951, p. 48.
3. B. H. Vester, W3TLN, "Surplus-Crystal High-Frequency Filters," *QST*, January, 1959, p. 24.
4. D. J. Healey, W3HEC, "High-Frequency Crystal Filters for SSB," *QST*, October, 1960, p. 35.
5. B. Roberts, W0IEU, "Mechanical Bandpass Filters for I-F Ranges," *QST*, February, 1953, p. 22.
6. R. A. Genaille, K4ZGM, "Ferrite Coil and Crystal Sideband Filter," *Electronics World*, June, 1967, p. 46.

ham radio

NOW!

IN THE WEST

Now... 2000 Watts P.E.P.
Full Power/Minimum Size
FOR APARTMENTS • SUBURBAN HOMES
 Marine and Portable Operation
 Packaged for APO and FPO Shipping



6-10-15-20 METERS

The time proven B-24 4-Band antenna combines maximum efficiency and compact design to provide an excellent antenna where space is a factor. New end loading for maximum radiation efficiency. No center loading.

Bands	6-10-15-20 Meters
Power Rating	2000 Watts P.E.P.
El. Length	11'
Turn. Radius	7'
Total Weight	11 lbs.
Single Feed Line	52 ohm
SWR at Resonance	1.5 to 1.0 max.

Model B-24
Net \$59.95

MULTIBAND COAXIAL ANTENNA for 6-10-15-20 METERS

Needs no ground plane radials. Full electrical 1/2 wave on each band. Excellent quality construction. Mount with inexpensive TV hardware. Patented.

Power Rating	2000 Watts P.E.P.
Total Weight	5 lbs.
Height	11'
Single Feed Line	52 ohm
SWR at Resonance	1.5 to 1.0 max.

Model C4 Net \$34.95



Free Delivery On "MINI BEAMS" From QUEMENT ELECTRONICS

1000 SOUTH BASCOM AVE.
 SAN JOSE, CALIFORNIA 95128
 PHONE 294-0464 SINCE 1933

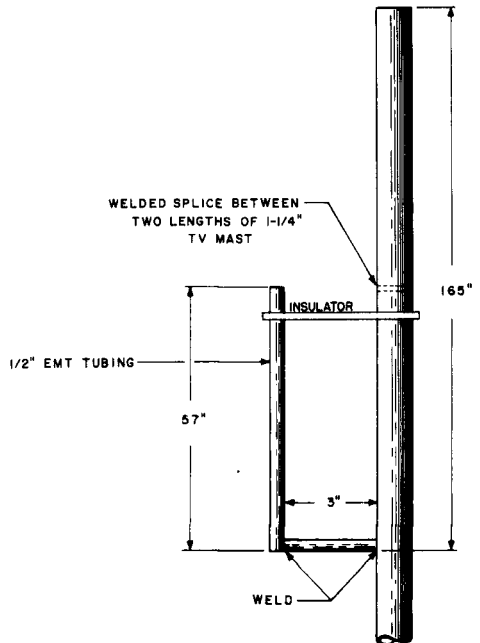
j-pole on six

If you have limited space
and are looking for
a simple antenna,
why not try
the J-pole?

Harold E. Larson, K4SDY, 6255-23rd Avenue North, St. Petersburg, Florida 33710

As all amateurs know, a good antenna is the heart of the ham shack. You just can't communicate without a good radiator. Some hams buy or build very elaborate systems, while others look for the easy way out. Since

fig. 1. The J-pole antenna for six meters.



I am somewhat confined by power lines, my property line and finances, I looked for an easy way.

When I wanted to check out my recently completed Knight TR-106 Transceiver, I used a piece of number-8 wire as an antenna. It worked out far enough, 3 miles, to contact Art Bond, K4HQA. Art is "Mr. Six Meters" of St. Petersburg. When he found out what I was using for an antenna, he suggested the J-pole to me. Since completing it, I've worked ground-wave stations up to 40 miles away with no strain. When the band is open, I can get in with the best of them with my 15 watts input.

The J-pole, although a rather simple antenna, has proven to be a very good performer. It doesn't take up much space and it's pretty inexpensive; all you need is two 10-foot sections of 1 1/4-inch TV mast, 5 feet of thinwall electrical EMT tubing, a small piece of lucite or plexiglass and two strap-type clamps.

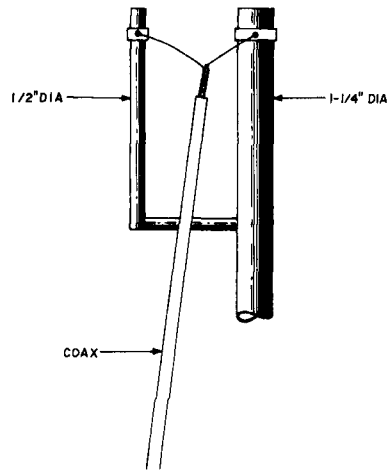
The one prime requisite is that the completed J-pole must be one continuous piece of metal. Weld or braze **all** the joints. The radiator is 165 inches long and is spaced 3 inches from the matching stub as shown in **fig. 1**. The matching stub is 57 inches long. The 1/2-inch tube between the radiator and the stub should be cut so that it mates with the circumference of the adjoining piece. This makes welding easier. Plexiglass is used as a spacer for the top of the matching stub; it should be at least 1/2-inch thick to accept two set screws. The details are shown in **fig. 2**.

The electrical connections to the J-pole are made with pipe straps or water-hose

clamps for ease of connection and adjustment. To provide a match to 72-ohm coax, the connections are about 6 inches up from the horizontal piece; about 4.5 inches up for 52-ohm line. If you want best efficiency, use an SWR bridge to make feedline adjustments. The center conductor is connected to the 1 1/4-inch mast, and the outside braid is connected to the 1/2-inch cross piece as shown in **fig. 3**.

Remember to keep the connections as short as possible. The coaxial cable should be fastened to the mast with clamps or tape to

fig. 3. Connecting the feed-line to the J-pole antenna.

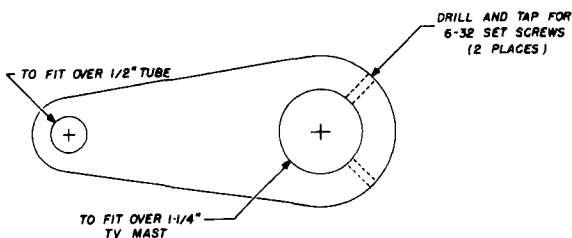


hold it in place. When matching the feedline, the antenna should be at least ten feet above the ground.

Installation is easy; it can be attached to sections of TV mast or a tower. For best operation, the tower or mast should be grounded. In my installation, I drove an inch-and-a-quarter TV mast five feet into the ground. Then two sections of mast were slipped on this piece with the J-pole on top. The top of the antenna is approximately 40 feet off the ground. It is attached to the roof line of the house and guyed once at the 25-foot level. In addition to being a very good antenna—both locally and on skip—the whole assembly is at ground potential, one big lightning rod. In Florida, as in many other areas, this is a definite advantage for safeguarding your home and ham shack.

ham radio

fig. 2. Layout of the insulator.



tips for keeping your beam

Amateurs driving past my house stop to look at the beam—it's black! The beam is wrapped with Scotch Electrical tape to protect it from the salt air blowing in from the ocean. The tape apparently has no adverse effects on beam operation; after years of use, the aluminum still remains bright. It takes about nine rolls of tape to wrap a 15-meter, four-element Cush-Craft beam, and this includes wrapping the boom and supports.

Down through the years, I have tried various methods to protect beams. Each new preparation was gleefully smeared on with high expectations and bad results. First came formvar varnish, boat paints, chrome, varnish, Rusto, fibreglass, epoxy and metal paint. You name it and I've tried it. Most of the concoctions eventually craze and flake off due to the sun's rays.

Aluminum elements seems to have special problems all of their own—a white powder caused by electrolysis pushes up under the applications and the coating comes off. Even fiber-glass and epoxy crack when moisture gets into the cracks. After awhile, the joints of the tubing develop insulating properties and the beam has to be taken apart. These troubles prompted the experiment with the Scotch Electrical tape. The U-bolts and hardware were painted with **Derusto** paint where they could not be wrapped. However, with care, the nuts and bolts can be wrapped and smeared with RTV-102 GE Silicon Rubber.

My mania for protection went as far as wrapping the tower with electrical tape; at least, that portion which sticks up above the garage and catches the salt breeze. Many of the rungs on my first tower broke from the twisting caused by the beam blowing back and forth on the rotor on top of the tower. The next tower I put up had the motor

mounted at the base, and a connecting piece of electrical conduit going up through the center. With this method of construction, the pipe twists and not the tower.

Sometimes the top of a triangular tower rusts out at the joints and the top section has to be removed. An antenna bearing mount can be made by using a triangular piece of two-inch thick oak and bolting it in place with lag screws. Boiling it in wax helps to weatherproof the block. While oak makes a good bearing, it is better if you can have a machine shop make a brass bearing and a collet to slip over the conduit as shown in

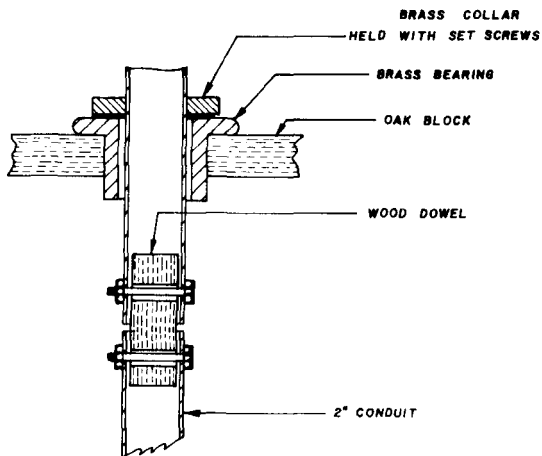


fig. 1. All open ends of the pipe and aluminum should be sealed with corks.

Many fellows have used conduit clamps to join two pieces of conduit. These conduit couplers don't hold up, even if the nut is tightened and set with drift pins. It is better to insert a dowel in each piece of conduit with 1/4-inch bolts to hold the piece from twisting (see **fig. 1**).

ham radio

Ed Marriner, W6BLZ, 528 Colima Street, La Jolla, California 92037

SPECIAL PACKAGE SALE!



hallicrafters



SR-400 Cyclone Transceiver

SR 400 \$799.95

DS 500 AC \$119.95

\$919.90

OUR PRICE \$775.00

HA-20 VFO WITH ABOVE PACKAGE \$124



HA-20 VFO

FRANCHISED DISTRIBUTOR AND SERVICE FOR



DISCOUNT PRICES. NO ONE ANYWHERE will beat our price! We will **TOP** any advertised or written price from any other dealer. We trade on both new and used equipment and we service what we sell. Instant credit on both new and used equipment. American Express and General Electric revolving charge.



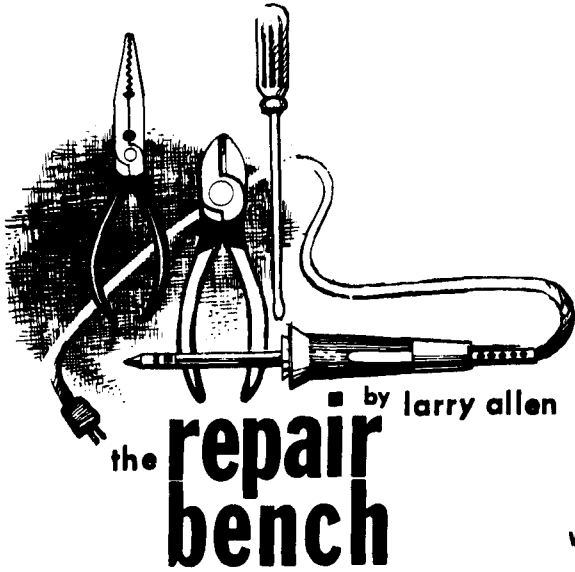
International Electronic Systems, Inc.

280 ARAGON AVENUE, CORAL GABLES, FLORIDA 33134

Cable: "INTEL"

Export orders our specialty

305-444-6207



high-power troubleshooting —keeping alive

On nights when the bands are open in all the right directions, and you're hearing reports that you're getting into Deep Zamba-Zambaland with a five-nine signal, and the XYL comes by the shack with fresh coffee and tells you she thinks you **should** buy that new beam, life is really worth living. Why take a chance of spoiling it? Operating high-power has responsibilities as well as pleasures. The key responsibility is preventing it from doing any harm—to you, to your family, and to visitors.

If you housekeep the shack like you should, and designed and built it well to start with, the last two mentioned are well taken care of. Danger arises when you—lord and master of the domain—get careless during troubleshooting. Let's face it. When you haul a 2-kW linear up on the bench and open it up, you're dipping into a powerful piece of machinery.

what the dangers are

When testing a high-power transmitter, or its power supply, you have three dangerous voltages to contend with. One is the primary supply. It may be "only" 115 volts of house ac, but it can be the most dangerous voltage in the equipment. Another is the high-voltage dc that supplies the plate of the power amp. Not only is it several thousand volts, but the supply has a powerful current capability—and it's current that does the killing. Third, and just as important, is the rf voltage developed in the final tank and along the antenna feed line. Rf is usually confined to a well shielded cage; but, remember, we're talking about when the unit is on the repair bench—you may take the lid off for some reason.

Each of these three dangerous voltages behaves differently. The primary power, usually 115 or 230 volts ac, has an awesome ability to push current through your body. Once contacted, it can contract your muscles so tightly you can't turn loose, haul your heart up motionless, and hold your lungs powerless to breathe. You can die of asphyxiation as easily as from heart fatigue.

An acquaintance of mine once survived a tangle with a shorted electric drill on a TV tower. He was bound up so tightly by the current, he couldn't release the trigger; he couldn't even yell. He did manage to grunt,

and someone on the ground yanked the plug. *Just plain lucky, he was. At that, he blacked out and hung upside-down for a while on the tower, and spent some time in the hospital overcoming shock. Rest assured, you had better respect that common old "everyday" line voltage.*

Just as deadly is the high-voltage dc inside the power supply or transmitter. A fellow I had only met once was killed by a 3,000-volt plate supply. He was troubleshooting the transmitter modulator. The trouble was an overload, and he had to cheat the interlocks **and** hold in the overload relay. He took all the normal precautions for working on live gear; he was a trained broadcast engineer. But, he lost his balance. One hand hit the transmitter cabinet and the elbow of the other arm landed on the 3,000-volt terminal of a coupling transformer. The horrible jolt to his body, heart, and lungs was too much. Revival was impossible.

I'm not trying to scare you, although if that's what it takes to teach you respect for transmitter voltages, then you'd better be scared. Safety in high-power equipment is a serious subject—you bet your life.

The rf voltage in a high-power transmitter has characteristics very different from line ac or power-supply dc. You don't even have to touch the wire or terminal carrying high-energy rf; it can jump out and burn you badly if you even get close.

If you're in good health, the rf voltage from a ham transmitter might do no more than give you one of the nastiest burns you can imagine. But high-power rf has been known to kill, and you shouldn't take the chance. Stay away from it. That isn't always easy, for reasons I'll explain, but you should learn how.

general precautions

The most obvious step to protect yourself from high voltages is to keep the equipment **off** while it's on the bench.

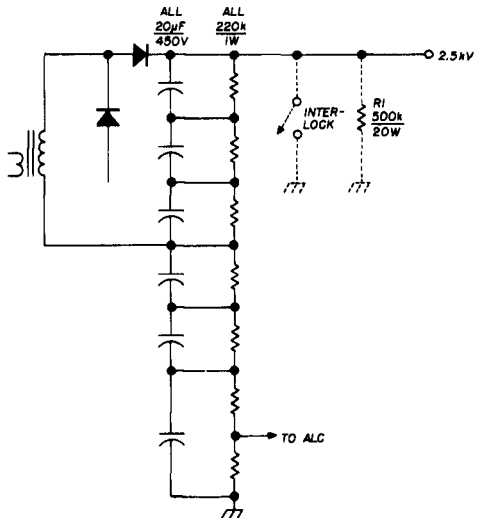
"That sounds nuts," you say. "How can you troubleshoot it?"

Well, in most cases you can. Practice using **resistance measurements** to guide you to the trouble. You can do that with the unit turned off. There aren't really so many parts and dc paths in the average high-power transmitter

or linear. It might turn out to be faster than going to all the trouble of wiring up the high-power unit for operation on your bench.

If you're convinced you have to fire up the equipment on the bench, first make sure there are no bare wires trailing anywhere. Use exactly the neat installation-type wiring you'd use if you were installing it permanently. The transmitting antenna lead must not be exposed. To "haywire" a test setup is courting danger. The primary power wiring must be through a cable and plug just the same as in a permanent installation; alligator-clipped connections won't do. Be especially careful of the wire carrying the high voltage from the power supply to the transmitter. It **must** be one solid piece, and

fig. 1. Protective bleeder resistors in a typical high-voltage power supply. R1 is an added safeguard, and the switch is an interlock feature to discharge the power supply if the cage is opened for service.



should be the highest-quality ignition wire you can find.

Try to do your troubleshooting without cheating the interlocks. They're included to automatically disconnect primary power from the high-voltage supply when the lid or door is opened. Sure, you may have to open up the unit to reach test points. But it's dangerous to cheat interlocks. Again, the old re-

sistance-measuring technique may save your life. When you have the interlocks cheated, and power is applied to all circuits, the open equipment is at its most dangerous. The primary ac, the dc high voltage, and the powerful rf energy are all right there waiting to zap you the instant you get careless.

Even with the set turned off, you're still not safe. The better equipment has built-in safeguards against some of the voltage hazards that lurk in a dead transmitter, but they can't always be trusted. (Suspicion is a useful companion where high voltages are concerned.)

For example, filter capacitors in the high-voltage section can hold a body-jolting charge for days and weeks after a set is turned off. To prevent this, bleeder resistors are almost always included. **Fig. 1** shows a high-voltage doubler circuit, with bleeders. What happens if one of them opens? The charge won't drain off. Safer transmitters include another resistor as bleeder for the whole supply (R1 in **fig. 1**). The safest units further include a switch that shorts out the high-voltage dc output whenever the protective shields are removed or the housing lid is opened. This is in case the primary interlocks are cheated, purposely or accidentally. The discharge switch also protects in case bleeders aren't doing their job.

Still, the watchword is: **don't trust them**. All these devices are fine, unless for some unusual reason they aren't working. It only takes once to ruin you. So . . . use a grounding stick, ALWAYS. This is something you can make. A long bakelite or fiberglass rod is best (**fig. 2**). Screw a small hook—stainless steel or aluminum—into one end. Attach a 2-foot piece of wire to the hook, making very sure of good electrical connection. To the other end of the wire, which can be heavily-insulated ignition wire, solder a good, heavy-duty clip.

When you open up a transmitter or power supply, clip the grounding wire to a **bare** chassis spot (paint insulates). Hold the rod at its free end. Then touch the hook to all bare wires or terminals that you have any slight suspicion may have carried dc voltage. Finally, hang the hook over the main high-voltage terminal—usually at the power-supply output. Leave it there until you are

finished troubleshooting. That gives you protection just in case you or someone else accidentally breaks an interlock.

Another precaution, often overlooked on the repair bench, is grounding. A ground from the chassis to a cold-water pipe or to an 8-foot copper ground rod is as important on the bench (maybe more so) as at the operating console. Without it, the chassis may become electrically hot with respect to ground, and offer a dangerous situation. The chassis might also, when you fire up the transmitter, take on some of the rf energy; that, too, is dangerous. Make a point of grounding the chassis carefully.

the live ones

Sooner or later you're going to insist on troubleshooting a transmitter **live**. It may even be necessary. You'll be tampering with dangerous stuff, though, and should act accordingly. There are some protective measures you can take.

First of all, READ THE INSTRUCTION BOOKLET. If you won't or can't, you have no business working on dangerous high-powered equipment. The manufacturer of your transmitter or power supply is well aware of the danger points, and will likely have printed cautions in the manual. Study them. Compare the schematic diagram with what you see in the chassis. If you have **any** doubts about where a test point is, trace it down with the unit turned **off** and with all the earlier precautions. Then you won't have to probe around later hunting for it. A live transmitter is no place to "learn" where the test points are.

Next, rehearse each test you're going to make. Sound silly? Nothing's silly that might save your neck. A written list of what you're going to do and what you expect to find will prevent that "hunting around" that breeds carelessness. A dress-rehearsal run-through, with the set turned off, will give you the confidence to go straight ahead with your plan when the power is on. You can't afford many mistakes—maybe none.

Once you start, the old ploy about keeping one hand in your pocket is still a good idea. It's based on the theory that you won't complete a circuit to the chassis and therefore won't get bitten by voltage. That theory

NATIONAL
NCX-200
complete 80
thru 10 meter
coverage for
SSB, CW, and AM



**SAVE
\$60.65**

National NCX-200 Transceiver	\$359.00
National AC-200 AC Power Supply	75.00
National XCU-27 100kc Calibrator	26.60
REGULAR PRICE	\$460.60

**SPECIAL PACKAGE PRICE
\$ 399.95**

- ★ **NO DOWN PAYMENT** WITH APPROVED CREDIT PAYMENTS AS LOW AS \$13 MONTHLY
- TIME PAYMENT ANYWHERE IN U.S.A.
- ★ **NO INTEREST OR CARRYING CHARGE** IF PAID WITHIN 45 DAYS
- ★ **IMMEDIATE DELIVERY**
- ★ **BIG TRADES** WRITE FOR QUOTE ON YOUR PRESENT GEAR

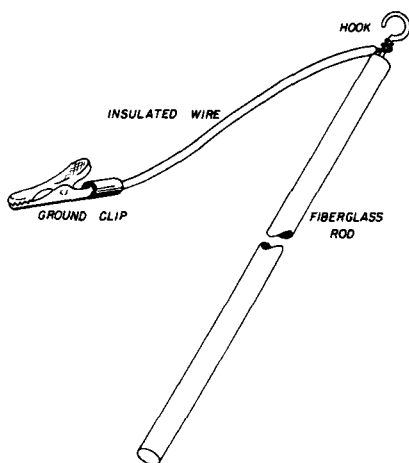
**EDWARDS
ELECTRONICS**

TELEPHONE PO 2-8759 / 1322 19TH ST. / LUBBOCK, TEXAS 79401

doesn't always work, because you can contact two points of voltage with one arm or hand. However, it can help keep the current from passing through your rib cage, and might very well save your life even if you get a nasty jolt.

Standing on a rubber mat is another good idea, especially if your floor is concrete. Again, it may not prevent your getting shocked, but it could keep the effects to a minimum.

fig. 2. Grounding stick for discharging high-voltage circuits. Heavy insulation on wire keeps it from contacting any circuit but the intended one.



In tuning a high-power transmitter, you may have to change taps on a coil. To make each change, shut down the transmitter, hook the grounding stick to the coil (other end of the wire clipped to chassis, of course); make the change; remove the stick; then fire up the transmitter again. This takes a little extra time, but not enough to matter when your health is at stake.

When messing around with tuning, keep away from that rf. It can reach out in some of the most unexpected ways. I saw a guy "testing for rf" (he said) by bringing his screwdriver blade near different parts of the plate coil. He judged by the little rf arc he could draw. He laid the screwdriver out of reach, so he tried it with a pencil. The burns

he got on three fingers and a thumb took three weeks to heal. He forgot the pencil-lead ran all the way up through the pencil. Good thing it was only a 250-watt transmitter. The only safe place for your hands in regard to a radiating transmitter is away from anything that even looks like a coil.

You have to watch how you handle tools, too. Not only can you damage your transmitter, you can damage yourself. Metal tools in a powerful rf field will overheat quickly, even though many inches away from direct contact. Keep them out of live transmitters. If you have an adjustment to make inside a radiating transmitter (not a very good design, and not likely in commercial units), use a plastic tool; plenty are available.

the bench itself

This is another factor worth consideration if you expect to work on a high-power transmitter. The bench should be wood; metal just isn't a good idea. Receptacles to fit various power plugs are important; you don't want to get tangled up in any jury-rigged power connections.

The all-important ground connection mentioned earlier is most handy if it terminates right there at the bench; that makes it quick to connect to. The wire lead to the pipe or the ground rod should be as short as possible and of the heaviest wire you can round up.

A well-protected antenna connection is a good idea, if you can't manage a dummy load. Coaxial cable is always best, but not feasible at all frequencies or with all transmitters. Just make the terminations at the rear of the bench space, so you don't accidentally touch them while the transmitter is radiating.

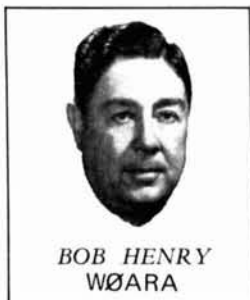
Finally, the bench should have an accessible switchbox that shuts off everything. You never know just when you might want to close down the whole operation suddenly, or need someone else to. Make it easy. One precaution: whoever can turn it off for you could also turn it on when you least expected or needed it. Add extra safety by having a hidden switch in series with the main one; when you want the bench to stay off, open them both.

ham radio

We're first... because we offer more.

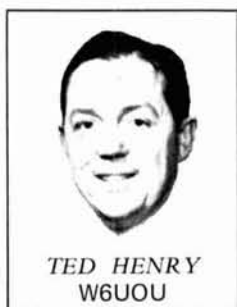
HENRY RADIO

Let us prove it to you.



FAST SERVICE: You can depend on faster service because Henry Radio has large stocks of Collins, Swan, Drake, Hallicrafters, Hammarlund, Hy-Gain, Tristao, Johnson, Mosley, National, Telrex, Waters, New-Tronics, Galaxy, Tri-Ex and many other receivers, transmitters, antennas, towers and parts at low prices. Plus, of course, the superb new 2K-3 Linear Amplifier.

BIG TRADES: Henry wants trade-ins. We trade big. Tell us what you want — what you have to trade. Get Henry's offer. We pay cash for receivers and transmitters too.



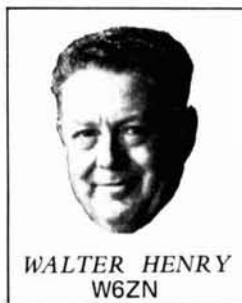
TIME PAYMENTS: Get what you want and pay by the month. Henry gives you better terms because we finance all terms ourselves.

SATISFACTION: Henry Radio has satisfied thousands of customers since 1927. Ask any ham about us.

PERSONAL ATTENTION: You get personal attention. Bob Henry runs the Butler store . . . Ted Henry is in charge at the Los Angeles store . . . and Walter Henry runs the

Anaheim store. Write, phone, wire or visit any of these stores for personal service. Send us your orders and inquiries. Export inquiries solicited. Also, military, commercial, industrial and scientific users . . . please write for information on our custom line of high power communication linear amplifiers and RF power generators.

SPECIAL OFFERS: Currently Henry is featuring a versatile antenna package program that is second to none. Write for literature.



WRITE, PHONE OR VISIT A HENRY RADIO STORE TODAY:

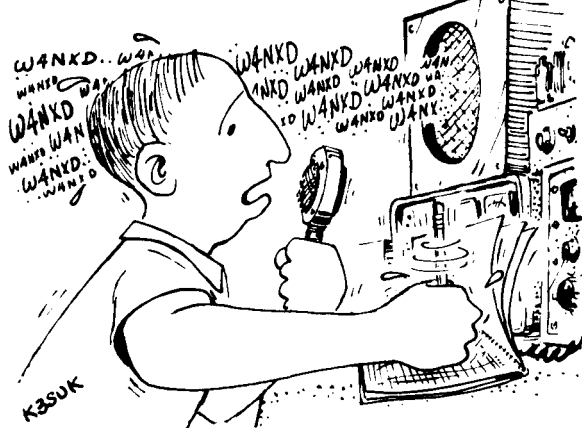
CALL DIRECT . . . USE AREA CODE

Henry Radio Stores

Butler, Missouri, 64730	816 679-3127
11240 W. Olympic, Los Angeles, Calif., 90064	213 477-6701
931 N. Euclid, Anaheim, Calif., 92801	714 772-9200

"World's Largest Distributor of Amateur Radio Equipment"

august 1968  57



how to be DX

Several weeks ago I decided to see if my transceiver still worked on ssb since I'm usually on CW. I cranked her up on the high end of 20 meters, made sure the final tubes weren't turning pink and gave a listen.

The high end of 20 meters, in the phone band, is a bit different from the lower portion. The stations are only two deep and every 2 kHz there's a net that always tells me they are running emergency traffic from a boy scout on the Island of Gamua to his 112-year old grandmother who thinks he went to the store for bread. This may be a bit exaggerated, but I think you get the idea of the general conditions. Generally speaking, however, I feel these people do a lot of good.

I found 14.336 kHz clear, so I asked if the frequency was being used. It was. A tremendous signal came on, told me he was W8UMR and that he was net control for the Independent County Hunters Net—did I want to check in?

Since I'm a cautious person by nature, I inquired what might be the purpose of this organization. I was told they tried to get rare counties on the air so those hams looking for awards could work them. This seemed reasonable to me, and I didn't think I'd get too much traffic for grandmothers. I gave my call, said that I was in Hall County, Georgia and sat back to drink a cup of coffee while I listened. This was not to be—about twenty stations wanted to know who was in Hall County.

This really threw me; I didn't know I was in a rare county, but since most of the local hams operate two-meter fm, I guess I am probably the only one who operates on 20 meters. The net control asked me to QRZ the frequency to see who needed Hall County, I did. The result was unbelievable; everybody was calling "W4NXD." Compared to this, Don Miller seemed to be as popular as a W8 calling CQ DX on 20 CW.

Using my lightning reflexes and years of hot-shot operating, I panicked. There must have been fifty stations on the frequency calling me; well, at least 30; would you believe 10? Seriously, it made Field Day seem like ten meters.

As I said before, my years of operating came through as I pushed the sweaty mike button and said, "QRZ W1 only!" There, right in my ears were about a dozen W1's calling me. I sifted them out, wrote the info in my log like a jack rabbit and called QRZ for W2's only.

My only trouble came when I got to the W9's (they always do it). There were so many I actually had to say, "QRZ W9's in Wisconsin only." In about 40 minutes I worked close to one hundred stations. Yes, little me in Hall County had been a rare one. I say had, because as of now, Hall County is no longer rare. I took care of that. All total, I worked many more stations over the next few days, but nothing like the first time I checked into that net.

So, if you'd like a quick dance in the spotlight, just check in and see if you're a rare one. Enjoy it while they need you, because nothing is sadder than a once rare county.

J. Michael Blasi, W4NXD, 1490 Enota Avenue, N. W., Gainesville, Georgia 30501

ham radio

THE NEW

MARK 3

5 BAND TRANSCEIVER MOBILE OR FIXED STATION

NOW--even Better than Ever!



GALAXY V MARK III	\$420.00
AC-400 SUPPLY	\$79.95
SC-35 SPEAKER	\$19.95
REMOTE V.F.O.	\$69.95
TOTAL LIST	\$589.95

WRITE FOR SPECIAL CASH PRICES

These NEW Features...

- New 500 Watt Power
- New Precise Vernier Logging Scale
- New Printed Circuit VFO
- New CW Sidetone Audio
- New CW Break-In Option
- New CW Filter Option

Plus all the great features that put the GALAXY V in a CLASS by ITSELF!

- Smallest of the High-Powered Transceivers. (6"x10¼" x11¼").
- Great for either Mobile or Fixed Station. No compromise in power.
- Hottest Receiver of any Transceiver — Special New Six-Crystal lattice filter.
- Complete 80-10 Meter Coverage. 500 KC on all bands, with 1 Megacycle on 10 Meters.
- Both Upper and Lower Selectible Sideband.
- Highest Stability. Drift less than 100 CY in any 15 minute period after warmup.
- The personal drift chart of every Galaxy that comes off our line goes with the unit to its new owner!

WHERE CASH IS KING — MONEY SAVING PACKAGE

WE STOCK COMPLETE LINE OF GALAXY AND MANY OTHERS.

EVANSVILLE AMATEUR RADIO SUPPLY

WILLIAM OGG — WA9RMO — Prop.
1629 S. KENTUCKY
EVANSVILLE, INDIANA 47714
Phone 812-422-4551

OPENING SEPTEMBER 1

L. A. AMATEUR RADIO SUPPLY
2302B ARTESIA
REDONDO BEACH, CALIF. 90278

EVANSVILLE AMATEUR RADIO SUPPLY
1629 S. Kentucky, Evansville, Ind. 47714

Send me your cash price on the following equipment:

- Galaxy V Mark III SC-35 Speaker
 AC-400 Supply Remote VFO

Name Call.....
Address
City State Zip.....

amateur radio in space - - a complete bibliography

With the rapid advances which are being made in electronics technology, and the great interest in amateur space experiments such as OSCAR and MOONRAY, a great number of space-oriented amateur radio articles have appeared in the past few years. The following bibliography is a result of a literature search that was conducted by NASTAR—Nassau College Amateur Satellite Tracking Society. NASTAR is an independent, non-profit amateur group which is currently working on MOONRAY, an amateur-band lunar translator.

Since the first OSCAR was put into orbit around the earth in 1961, there has been continual progress: OSCAR II in 1962 and OSCAR's III and IV in 1965. OSCAR V, built by a group of Australian amateurs, is due for launch in late 1968. MOONRAY, a five-pound translator operating in the 420-MHz band, is in the proposal stage. It is proposed that this package, with an isotope power supply, will accompany the third manned lunar landing.

The following bibliography is a collection of articles covering the amateur radio space effort. It has been made as complete as possible, and covers the major U.S. amateur radio magazines as well as other publications. The bibliography is broken down into four separate lists. One for each of the magazines **QST**, **CQ**, and **73**, and a **miscellaneous** category for articles appearing in other magazines. The articles in each group are listed chronologically with the most recent ones first.

QST

W. Dunkerly, WA2INB, "Moonray," *QST*, November, 1967, p. 56.
W. Smith, WB4HIP, "World Above 50 Mc," *QST*, July, 1967.
"Australis-OSCAR Arrives in U.S.," *QST*, July, 1967, p. 58.
H. C. Gabrielson, W6HEK, "Project OSCAR,

A Progress Report," *QST*, March, 1965, p. 56.
Sam Harris, W1FZJ, "The World Above 50 Mc," *QST*, February, 1966, p. 80.
"OSCAR IV due December 21," *QST*, January, 1966, p. 10.
"Project OSCAR Wins Christopher Columbus Award," *QST*, January, 1966, p. 31.
"OSCAR IV Launch Announcement," *QST*, December, 1965, p. 41.
"OSCAR III Calls Heard," *QST*, December, 1965, p. 63.
"OSCAR III—Congratulation to Project OSCAR," *QST*, November, 1965, p. 80.
"OSCAR II W6EE," *QST*, June, 1965, p. 28.
W. Orr, W6SAI, "OSCAR III Orbits the Earth," *QST*, May, 1965, p. 56.
H. C. Gabrielson, W6HEK, "Orbital Predictions for OSCAR III," *QST*, May, 1965, p. 60.
"OSCAR Calls Heard," *QST*, May, 1965, p. 63.
"Some OSCAR Participants," *QST*, May, 1965, p. 65.
"OSCAR III," *QST*, April, 1965, p. 84.
H. C. Gabrielson, W6HEK, "OSCAR III—Orbital Predictions and How to Use Them," *QST*, March, 1965, p. 11.
"OSCAR III—Photo Story," *QST*, March, 1965, p. 15.
Arthur Walters, W6DKH, "OSCAR III—Making Use of the Telemetry Signals," *QST*, March, 1965, p. 16.
W. Orr, W6SAI, and Arthur Walters, W6DKH, "Quickie Orbital Predictions for OSCAR III," *QST*, February, 1965, p. 11.
W. McKay, WØHRQ/W7QBR, "OSCAR III—Compatibility With Transmit—Receive Converters," *QST*, February, 1965, p. 17.
Charles Flink II, WA5BMF, "OSCAR III Recording," *QST*, February, 1965, p. 20.
"Slow-Scan via OSCAR III," *QST*, February, 1965, p. 20.
Don Norgaard, W6VMH, and W. Orr, W6SAI, "The OSCAR III Telemetry System," *QST*, January, 1965, p. 29.
J. McMechan, WØPFP, and Clayton Clifford, KØKPG, "A Different Satellite-Tracking An-

tenna System," *QST*, October, 1964, p. 34.

W. Orr, W6SAI, "Using the OSCAR II VHF Communications Satellite," *QST*, August, 1964, p. 17.

H. C. Gabrielson, W6HEK, and R. Tellefsen, W7SMC/6, "Experiments With OSCAR III," *QST*, July, 1964, p. 39.

Arthur Walters, W6DKH, "OSCAR III—Technical Description," *QST*, June, 1964, p. 16.

R. Tellefsen, W7SMC/6, and H. C. Gabrielson, W6HEK, "Communicating Through OSCAR III," *QST*, May, 1964, p. 26.

W. Orr, W6SAI, "Project OSCAR Finds A New Home," *QST*, October, 1963, p. 26.

"OSCAR Exhibit in Geneva, Switzerland," *QST*, April, 1963, p. 49.

W. Orr, W6SAI, "OSCAR II: A Summation," *QST*, April, 1963, p. 53.

W. Orr, W6SAI, "The OSCAR III: VHF Translator Satellite," *QST*, February, 1963, p. 42.

H. R. McClain, K6SPK, "A Statement from Project OSCAR," *QST*, October, 1962, p. 63.

W. Orr, W6SAI, "OSCAR I—A Summary," *QST*, September, 1962, p. 46.

"Flash: OSCAR II in Orbit," *QST*, July, 1962, p. 10.

W. Orr, W6SAI, "Project OSCAR II Flight Imminent," *QST*, June, 1962, p. 43.

E. C. Kunze, WØWVM, "Space Age Antenna Ideas," *QST*, June, 1962, p. 11.

Ralph Burhans, W8FKC and Roy Rankins, W8CWL, "Keeping Track of OSCAR," *QST*, May, 1962, p. 15.

Don Norgaard, W6VMH, "Eyeball and Eardrum Doppler Tracking," *QST*, April, 1962, p. 44.

W. Orr, W6SAI, "Looking Forward to Oscar II," *QST*, March, 1962, p. 51.

Edgar Hilton, W6VKP, "Making Your Own Orbital Predictions," *QST*, March, 1962, p. 23.

H. C. Gabrielson, W6HEK, "The OSCAR Satellite," *QST*, February, 1962, p. 21.

T. W. Lott, VE2AGF, "Communications for Project OSCAR," *QST*, February, 1962, p. 19.

W. Orr, W6SAI, "Honor Roll of OSCAR Participants," *QST*, February, 1962, p. 18.

"Radio Amateurs Congratulated," *QST*, February, 1962, p. 16.

W. Orr, W6SAI, "Sixty Years of Amateur Radio Communications—Marconi to OSCAR," *QST*, February, 1962, p. 11.

Editorial, "OSCAR," *QST*, February, 1962, p. 9.

"OSCAR—It's Up," *QST*, January, 1962, p. 9.

Editorial, "OSCAR," *QST*, November, 1961, p. 9.

Ralph Wells, W6QMJ, W. Orr, W6SAI, and Chuck Towns, W6LFH, "Tracking Information for the OSCAR Satellite," *QST*, September, 1961, p. 46.

J. A. "Doc" Gmelin, W6ZRJ, "Handling OSCAR Reports by Radiogram," *QST*, September, 1961, p. 18.

Arthur Walters, W6DKH, Ralph Wells, K6QMJ, and Carl Hillesland, K6LFI, "Project OSCAR Measurements and Tracking," *QST*, July, 1961, p. 59.

"OSCAR Ready to Go!" *QST*, July, 1961, p. 39.

"ARRL Adopts OSCAR," *Happenings of the Month*, *QST*, May, 1961, p. 64.

Russ Garner, K5VPN/6, and Ralph Wells, K6QMJ, "Ground Support for Project OSCAR," *QST*, May, 1961, p. 45.

Don Stoner, W6TNS, "Project OSCAR—Something of the Future," *QST*, February, 1961, p. 55.

W. Orr, W6SAI, "Project OSCAR—Something of the Background," *QST*, February, 1961, p. 56.

CQ

R. Ross, K2MGA, "Project Moonray," *CQ*, December, 1967, p. 44.

"Euro-OSCAR—A Status Report," *CQ*, July, 1967, p. 25.

R. Ross, K2MGA, "Project Moonray," *CQ*, July, 1967, p. 18.

George Jacobs, W3ASK, "OSCAR News," *CQ*, December, 1966, p. 58.

George Jacobs, W3ASK, "OSCAR News," *CQ*, October, 1966, p. 10.

Carl Ebhardt, W4HJZ, "A Simple Antenna Mount for Satellite Work," *CQ*, October, 1966, p. 42.

George Jacobs, W3ASK, "Transmitting Satellites," *CQ*, June, 1966, p. 87.

George Jacobs, W3ASK, "Weather Satellite News," *CQ*, May, 1966, p. 85.

George Jacobs, W3ASK, "OSCAR News," *CQ*, April, 1966, p. 87.

George Jacobs, W3ASK, "OSCAR News," *CQ*, March, 1966, p. 87.

George Jacobs, W3ASK, "OSCAR IV in Orbit," *CQ*, February, 1966, p. 24.

W. Scherer, W2AEF, "Oscillator Notes," *CQ*,

- February, 1966, p. 28.
- George Jacobs, W3ASK, "OSCAR News," CQ, January, 1966, p. 88.
- W. Scherer, W2AEF, "OSCAR Notes," CQ, December, 1965, p. 32.
- George Jacobs, W3ASK, "Early OSCAR Information," CQ, December, 1965, p. 83.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, November, 1965, p. 90.
- W. Orr, W6SAI, "W5LFL to Join Astronauts," CQ, August, 1965, p. 7.
- W. Scherer, W2AEF, "The Oscalator," CQ, August, 1965, p. 54.
- W. Dunkerly, WA2INB, "Hi OSCAR De WA2WEB," CQ, July, 1965, p. 40.
- "Late OSCAR News," CQ, July, 1965, p. 51.
- George Jacobs, W3ASK, "We Made it into Space," CQ, May, 1965, p. 53.
- "K2IEJ and K9AAJ QSO via OSCAR III," CQ, May, 1965, p. 56.
- George Jacobs, W3ASK, "OSCAR III Telemetry Data," CQ, March, 1965, p. 68.
- George Jacobs, W3ASK, "OSCAR III—an Active Communication Satellite for Radio Amateurs," Part II, CQ, February, 1965, p. 38.
- George Jacobs, W3ASK, "Expected Launchings," CQ, February, 1965, p. 77.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, February 1965, p. 78.
- George Jacobs, W3ASK, "OSCAR III—an Active Communications Satellite for Radio Amateurs," Part I, CQ, October, 1964, p. 54.
- D. Pitts, WA9EGU, "A Satellite Tracking Antenna," CQ, July, 1964, p. 56.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, July, 1964, p. 66.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, June, 1964, p. 60.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, April, 1964, p. 61.
- George Jacobs, W3ASK, "OSCAR Space Satellite Program of the IARU," CQ, March, 1964, p. 60.
- George Jacobs, W3ASK, "Memorandum on Amateur Experimental Space Satellite Activity," CQ, February, 1964, p. 65.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, February, 1964, p. 66.
- George Jacobs, W3ASK, "Space Communications Frequencies," CQ, January, 1964, p. 64.
- George Jacobs, W3ASK, "Transmitting Satellite," CQ, September, 1963, p. 51.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, August, 1963, p. 55.
- George Jacobs, W3ASK, "OSCAR II," CQ, July, 1963, p. 56.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, April, 1963, p. 54.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, January, 1963, p. 116.
- George Jacobs, W3ASK, "Statistics and Honor of OSCAR I," CQ, November, 1962, p. 69.
- George Jacobs, W3ASK, "Summary of OSCAR Accomplishments," CQ, October, 1962, p. 72.
- George Jacobs, W3ASK, "OSCAR II Reports," CQ, September, 1962, p. 59.
- George Jacobs, W3ASK, "Launch Details of OSCAR II," CQ, August, 1962, p. 75.
- George Jacobs, W3ASK, "Discussion of OSCAR II and III," CQ, July, 1962, p. 98.
- G. Giro, I1BMV, "Predicting OSCAR's Orbit with Ease," CQ, June, 1962, p. 58.
- George Jacobs, W3ASK, "Reporting OSCAR II Reception," CQ, June, 1962, p. 80.
- George Jacobs, W3ASK, "Results of OSCAR I," CQ, April, 1962, p. 69.
- George Jacobs, W3ASK, "OSCAR I Results," CQ, March, 1962, p. 69.
- "Practice OSCAR Beacon," CQ, March, 1962, p. 75.
- George Jacobs, W3ASK, "Project OSCAR: A Report, Its History and Future," CQ, February, 1962, p. 30.
- D. Stoner, W6TNS, "Project OSCAR: A Report, Launch, Details and Technical Data," CQ, February, 1962, p. 24.
- George Jacobs, W3ASK, "Transmitting Satellites," CQ, February, 1962, p. 106.
- George Jacobs, W3ASK, "U. S. Announces OSCAR I Launch Date," CQ, January, 1962, p. 56.
- Editorial, "OSCAR in Orbit," CQ, January, 1962, p. 58.
- George Jacobs, W3ASK, "Project OSCAR," CQ, October, 1961, p. 77.
- J. A. Gmelin, W6ZRJ, "The Second OSCAR Flyover," CQ, September, 1961, p. 59.
- W. Orr, W6SAI, "Project OSCAR White Paper," CQ, August, 1961, p. 89.
- D. Stoner, W6TNS, "Project OSCAR—Progress Report," CQ, February, 1961.
- George Jacobs, W3ASK, "Space Communications—Project OSCAR," CQ, December, 1960, p. 76.

HEY! HOW ABOUT THAT

S.W.R. BRIDGE

- MODEL SWB-2
- READS FORWARD AND REFLECTED POWER SIMULTANEOUSLY
- "EASY READ" METERS
- USE FOR REFERENCE POWER METER
- DUAL 100-MICROAMP METER MOVEMENTS
- LOW INSERTION LOSS
- SIZE-5"X2"X2"



\$15.95

ALLOW \$1.00 FOR
PACKING & SHIPPING
CALIFORNIA RESIDENTS
INCLUDE SALES TAX

THE BEST
VALUE WE
HAVE
EVER
OFFERED!

MAY BE LEFT
IN LINE, UP
TO 2000 WATTS.

GOOD THROUGH
2 METERS

SINCE 1933

FAST SERVICE

Phone CY 4-0464

QUEMENT ELECTRONICS

1000 SOUTH BASCOM AVENUE

SAN JOSE, CALIFORNIA

"Northern California's Most Complete Ham Store"

95128

73

- "Project Moonray," 73, April, 1968, p. 60.
J. Fisk, W1DTY, "Moonray," 73, July, 1967, p. 81.
Dwight Smith, KØCER, "OSCAR III," 73, June, 1965, p. 40.
Dwight Smith, KØCER, "OSCAR III," 73, May, 1965, p. 82.

Miscellaneous

- "Students' Moonray to go with Apollo," *EDN*, April, 1968, p. 8.
Thomas Tate, WA1GTA, "Project OSCAR and Beyond," *Tech Engineering News*, February, 1968, p. 77.
"Australis OSCAR A," *VERON VHF Bulletin* (Netherlands), January, 1968, p. 1.
"OSCAR," *VERON VHF Bulletin* (Netherlands), January, 1968, p. 2.
J. Roberston, "Radio Station on the Moon Proposed by Hams on Earth," *Electronic News*, March 28, 1966.
N. Marshall, W6OLO/2, "The OSCAR Amateur Satellite Program," *Proceedings of the*

- Radio Club of America*, September, 1965, p. 2.
"Amateur Satellite Tracking Station Atop Library," *Sky-Watchers, The NASCO Vignette*, December, 1964, p. 1.
"Fabulous Little OSCAR," *This Week Magazine*, October, 1962.
"Industry Observer (OSCAR)," *Aviation Week*, April 2, 1962.
"OSCAR—heet de Amerikannse aardsateliët," *Radio Bulletin* (Netherlands), March, 1962.
"Project OSCAR," *RGSB Bulletin* (England), January, 1962.
"Hams Orbit Their Own Satellite," *Electronics*, December, 1961.
"OSCAR I: Une Experience Originale de Co-operation Spatiale," *Radio REF* (France), December, 1961.
"UKF-Uwaga UKF-owcy!," *Radioamator* (Poland), November, 1961.
Russell Hawks, "OSCAR," *Aviation Week*, February 13, 1961, p. 771.
"OSCAR—Ein Satellitenproject von Funkamateuren für Funkamateure," *Der Jurwellenhorner* (Germany), January, 1961.

ham radio

grid-current measurement in grounded-grid amplifiers

William I. Orr, W6SAI, Eimac Division of Varian, San Carlos, California 94070

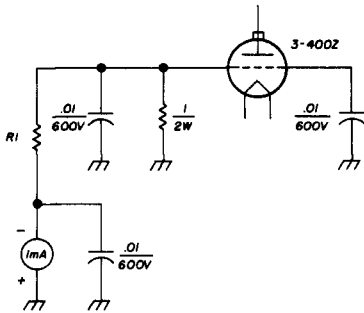


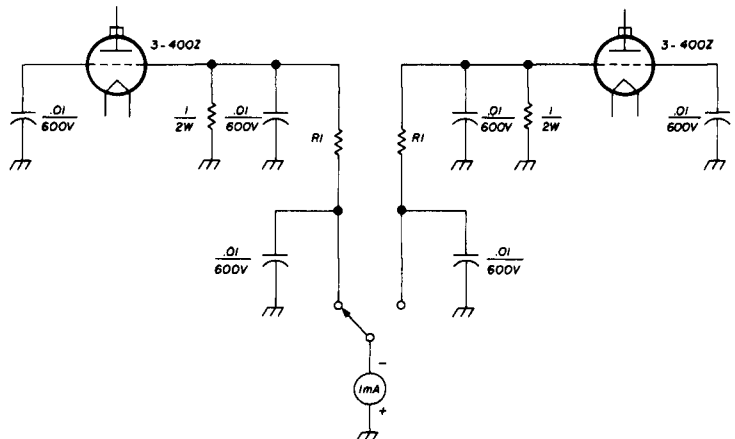
fig. 1. Measuring the grid current of a single grounded-grid stage.

Measuring the grid current of a cathode-driven amplifier can be a delicate and exasperating task; it's a ticklish job to "unground" the

grid sufficiently to use a metering circuit and still hold the grid at rf ground. The inherent inductance of most bypass capacitors lets the grid circuit "float" above ground at some high frequency, and as a result, the amplifier exhibits instability and parasitics.

This problem can be avoided with the measuring circuit shown in fig. 1. The control grid is grounded through a 1-ohm composition resistor that is bypassed with a .01- μ F disc capacitor. The voltage drop generated by the flow of grid current through the resistor can be measured easily with a millivoltmeter which is calibrated in terms of grid current. Individual grid current for each of a parallel pair of tubes may be measured with the circuit of fig. 2. The maximum current which can be measured is determined by the internal resistance of the milliammeter

fig. 2. Measuring the grid current of a pair of grounded-grid amplifier tubes with one meter.



plus the series resistance R1.

Suppose you want to read grid current on the order of 150 milliamperes; the meter should read 0-200 milliamperes. Since the original markings on the 0-1 mA meter scale can easily be multiplied by 200 to obtain the actual value of current, this is very convenient. Now, when 200 milliamperes flow through 1 ohm, a potential of 0.2 volt is developed across the resistor. Therefore, the meter should read 0.2 volt full scale to correspond to 200 mA of grid current.

Assume that the meter is a Triplett model 221-T, which has an internal resistance of 55 ohms. The voltage drop across the meter itself is 0.055 volts when one milliampere flows through it. To convert the milliampere to a voltmeter reading 0.2 volt full scale, you must

add a series multiplier. A voltage drop of 0.2 volt is developed across a 200-ohm resistor when one milliampere of current flows through it. Therefore, the **difference** between 200 ohms and 55 ohms, 145 ohms, must be added in series with the meter to convert it to read 0.2 volt full scale.

On the other hand, if you put the meter across the 1-ohm grid resistor without the series multiplier, it will provide a full-scale reading corresponding to 55 milliamperes. If the maximum grid current is below 55 mA, no series resistor is required. Conversely, high values of grid current will produce a greater voltage drop across the 1-ohm resistor and larger values of series-multiplier resistance are needed.

ham radio

code practice - - the rf way

There are many transistorized audio oscillators available for code practice, but almost all of them fail to give a realistic "on-the-air" quality to the signals. The rf oscillator described here provides a realistic signal and is copied through the receiver just as any CW signal. It is tunable of course, and if the receiver has a bfo, the pitch can be varied as well. Furthermore, construction is even simpler than the audio type code-practice oscillator—so much so that a printed-circuit board would accomplish nothing but to complicate construction!

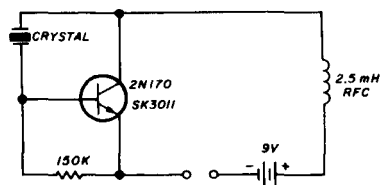
the circuit

The circuit is a simplified crystal-controlled Pierce oscillator. Since it's designed for one of the lower frequencies, the inexpensive 2N170 works very well. If you want to go to higher frequencies, other transistors can be chosen for operation on these bands. PNP types can be used by merely reversing the battery polarity.

construction

First, get the parts together—you should find most of them in your junk box. Then cut out the 2x3-inch perforated board and drill the mounting holes for the crystal sock-

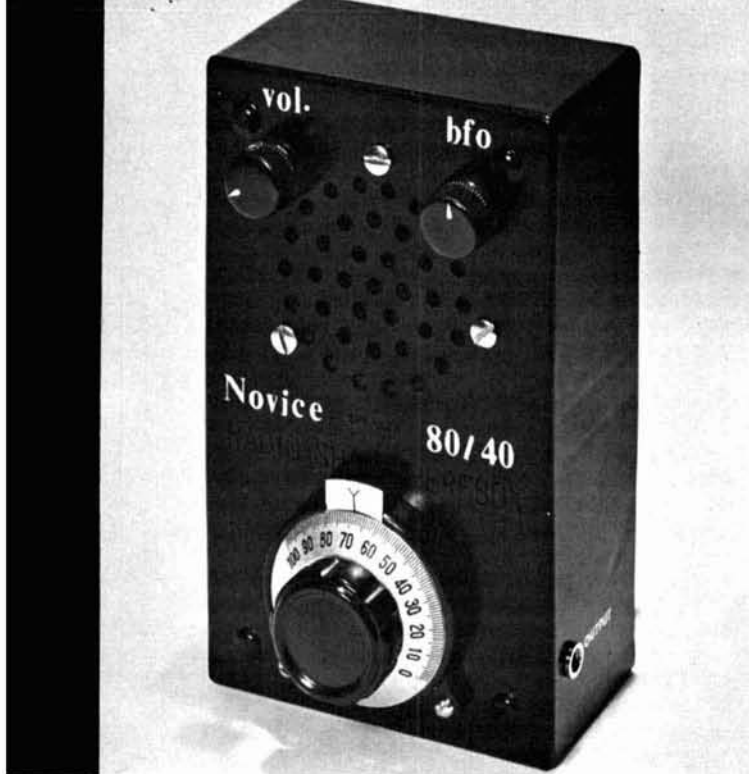
et at one end. Mount the transistor, rf choke and 150k-ohm resistor on top of the board and push the leads through the holes to the bottom of the board. Attach two soldering lugs for key connections and the battery clip. Then, solder all the necessary connections; use a heat sink on the transistor leads. If you make the physical layout like the schematic, most of the connections can be made with the component leads.



operation

Attach your key to the soldering lugs, put a crystal in the socket, hook up the battery and tune in the signal on your receiver. With a little practice, you can tell just how close the little oscillator has to be to the antenna lead to provide adequate signal strength in the receiver.

George Haymans, WA4NED



two-band novice

superhet

An easy-to-build
superhet receiver
for 80 and 40
that provides high
performance at low cost

Darrell Thorpe, 3110 N. 83rd Street, Scottsdale, Arizona

For the prospective novice, a first receiver can be a rather difficult choice, especially when he looks at the large price tags. He really doesn't have much choice—it's either "shell out" for the fancy factory-wired job or resort to a simple regenerative receiver. However, the red-hot superhet described here can open up a whole new receiver era for the beginning ham. This simple, easily built superhet can be built at a price that compares to the simple regenerative receiver, yet it gives big-set performance.

Total cost is only \$23 if you use all new parts. Sensitivity is around 1 microvolt; this is high performance when compared to the usual 10- μ V sensitivity of low-cost ready-made receivers. The outstanding performance of this receiver is achieved by using the latest solid-state devices and toroid cores. In addition, this top performer covers both the 80- and 40-meter bands without a lot of complex coil winding or bandswitching.

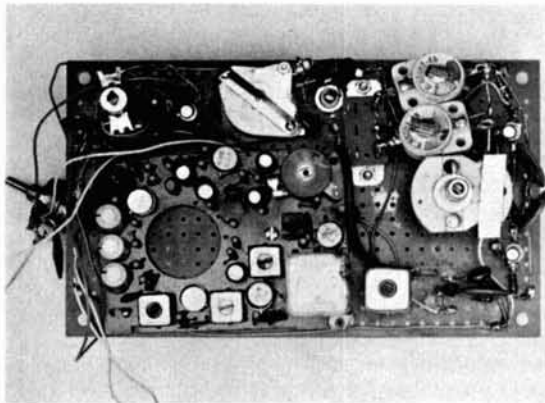
the circuit

The heart of the two-band novice receiver is an eight-transistor broadcast-band receiver that sells at discount stores in most cities for under \$5.00. This receiver, with only a couple of minor changes, provides a three-stage i-f amplifier strip and detector and supplies plenty of audio to drive a built-in or external speaker.

This is not only a compact ready-made i-f and audio package—you could barely buy the eight transistors for the price of the entire radio! Mentally add up the cost of the i-f transformers, speaker, capacitors and resistors plus the transistors, and you'll begin to see what a real bargain this ready-built module is.

Next comes a late innovation from the semiconductor industry—a field-effect transistor (FET) in a mixer circuit. The FET is used for its superior mixer performance. Similarly, toroid cores are used because they provide superior coils. In the oscillator, the toroid coil, which you'll find is about the easiest

Construction of the two-band novice superhet. The transistor broadcast radio and volume control are to the left; the oscillator is in the upper right and the FET mixer, in the lower right.



coil you have ever wound, provides very good stability, and a two-stage oscillator circuit maintains it. At the antenna, the toroid coil provides high-Q for better selectivity. Another advantage of the toroid is the small amount of space required as compared to

the usual 80-meter tuned circuits.

construction

Start by removing the case from the transistor radio. Look for two leads that go from the circuit board to the earphone jack and then to the speaker.

1. Disconnect the leads at the phone jack.
2. Remove the speaker and phone jack from the radio and mount them in the new cabinet (Radio Shack Perfbox 270-097).¹
A mounting hole for the phone jack is already provided in the cabinet. Drill three holes for the speaker-mounting screws. Note that the nuts grip the edge of the speaker frame.
3. Disconnect and remove the antenna loopstick after noting where the leads of the small winding are connected. One lead is connected to the base of the converter transistor and the other to the bias resistors for this transistor (see **fig. 1**). Solder a 2-inch length of insulated wire to each of these points; they will be connected to a new i-f transformer (T1) later.

4. Note that the collector lead from this same transistor goes to one winding on the oscillator coil. Use a short piece of insulated wire to short out this winding. This kills the oscillator and converter stage in the broadcast set and becomes an additional i-f amplifier. This additional stage contributes to the excellent sensitivity and selectivity of the receiver.

5. Clip or unsolder the wires going to the volume control. It's not necessary to remove the control, but make sure the "on-off" switch is always "on"; the power switch for the novice superhet is on the new volume control. Connect three 8-inch pieces of wire to the circuit board where the three leads from the volume control were connected. Be sure to note the center-tap connection. Solder the other ends of these wires to the new 5000-ohm volume control.

6. Clip the battery leads in half. These leads

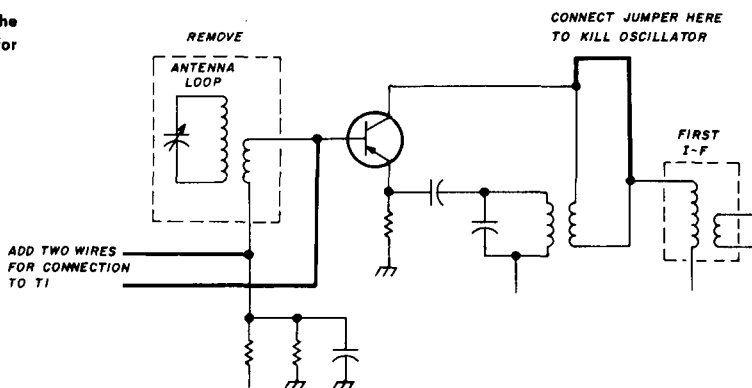
1. Radio Shack, 730 Commonwealth Avenue, Boston, Massachusetts 02215.

will be connected to the terminals on the perforated board.

These are the only changes to the broadcast radio, so it can be mounted on the perforated board. Flea clips are mounted in the perforated board near the radio for audio and power connections.

It is a good idea at this time to drill the remaining holes in the cabinet that are needed for the vernier dial, the volume control and bfo pitch control. The holes for the dial and the bfo pitch control are rather critical since they dictate the position of the tuning capacitor and bfo oscillator coil. In addition, drill a small hole in the bottom of the cabinet below the dial so you can tighten the set-screw in the dial.

fig. 1. Modifications to the transistor broadcast radio for use in the novice superhet.



Position the oscillator tuning capacitor on the perforated board so it lines up with the hole for the dial. Enlarge two of the holes in the perforated board to accept the stator lugs extending from the tuning capacitor. Put the tuning capacitor on the board and push two flea clips through the board right next to the capacitor lugs and solder.

Proceed with the wiring of the oscillator, mixer and bfo as shown in **fig. 2**. The oscillator trimmer capacitors are spaced away from the board so they clear the oscillator coil.

Notice that the bfo doesn't need any direct connection other than power.

alignment

Since the broadcast receiver is already aligned, there's practically no alignment

needed of the 455-kHz i-f. The new i-f transformer you added (T1) may need a little peaking; however, new transformers are very close to 455 kHz.

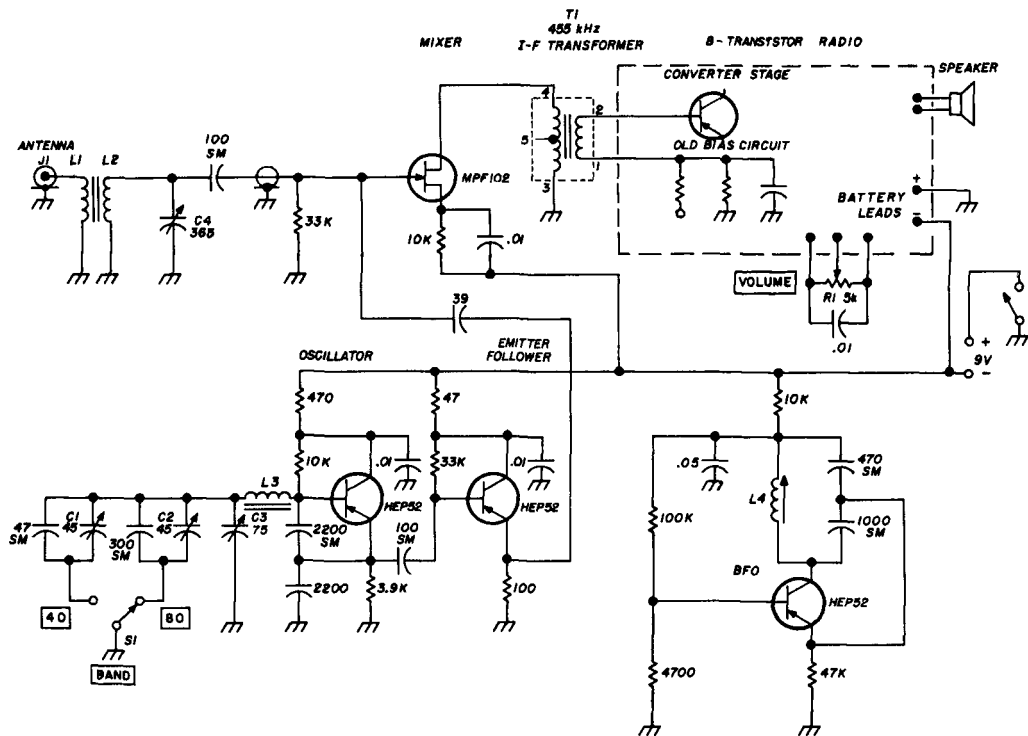
Start with the 80-meter band first. It's the easiest to adjust because you should be somewhere within the band regardless of where the tuning and trimmer capacitors are set. Set the main tuning capacitor to minimum capacitance, the antenna trimmer capacitor at about 3/4 of maximum capacitance and the bandswitch to the 80-meter position. Adjust the 80-meter trimmer until you hear phone signals coming through.

These phone stations will probably be on ssb, so they'll sound like a bunch of quacking ducks. As you tune the main tuning ca-

pacitor towards maximum capacitance, you will tune down through the novice and general-class CW bands to 3.5 MHz. The 80-meter CW bands will be spread over the entire range of the capacitor for easy tuning.

Since this receiver was designed primarily for novice use, the 75-pF tuning capacitor will tune the entire CW band and part of the phone band. If you want to cover the entire 3.5 to 4 MHz range, use a 100-pF tuning capacitor; however, the bandwidth will be reduced. The only adjustment of the bfo is the pitch control; this is tuned about mid-range until a beat note is heard.

The 40-meter alignment is a little more tedious. Set the oscillator tuning capacitor to mid-range, the antenna capacitor to about



- C1, C2 7-45 pF trimmer (Centralab 825BN)
- C3 75-pF variable (Hammarlund MAPC 75B)
- C4 365-pF variable (Radio Shack¹ 272 1341)
- J1 Phono jack
- L1 5 turns number 24 enameled wire wound between turns on ground end of L2
- L2 18 turns number 24 enameled wire wound on ferrite core (Amidon Associates² T44-15)
- L3 29 turns number 24 enameled wire wound on ferrite core (Amidon Associates T50-2)

- L4 bfo coil (Antenna loopstick) (Lafayette³ 32H4106)
- R1 5000-ohm volume control with switch (Lafayette 32H7383)
- S1 SPDT slide switch (Lafayette 34H3704)

- 1 cabinet (Radio Shack 270-097)
- 1 tuning dial (Lafayette 99H6030)
- 2 small knobs (Lafayette 32H2405)

fig. 2. Schematic diagram of the novice superheterodyne receiver for 40 and 80 meters. The transistors are inexpensive Motorola types.

1/4 of full capacitance and the bandswitch to 40. Adjust the 40-meter trimmer to receive 40-meter phone stations between 7.2 and 7.3 MHz. The 40-meter position provides several megahertz of tuning range, so the 40-meter band is only a small portion of the dial. Therefore, there's not nearly as much bandspread on 40 as on 80, but even so, this receiver has proven quite useful on 40.

final assembly

Note the position of the vernier tuning dial when the setscrew is aligned with the hole in the bottom of the cabinet. Then adjust the capacitor for this setting. On mine,

the dial read 70; therefore, I set the tuning capacitor to 25% of maximum capacitance. Then, when the assembly is installed in the cabinet and the setscrew is tightened, minimum capacitance will occur when the dial is advanced to 100.

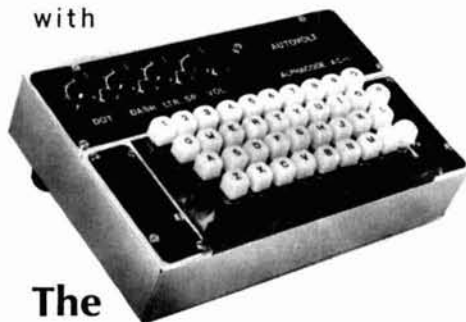
Now, mount the volume control and bfo coil and install the completed assembly in the cabinet. Tighten the setscrew on the tuning dial and install the knobs.

2. Amidon Associates, 12033 Otsego Street, North Hollywood, California 91607. \$1.25 will cover cost of cores and postage.

3. Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, L. I., New York 11791.

NEW!

TYPE PERFECT CODE
with



The Autovolt Alphacoder Model AC-1

The new Autovolt Alphacoder, AC-1, makes any letter or digit with one stroke of your finger. You can produce perfectly uniform code, including preset letter-to-letter spacing using the standard electric typewriter keyboard of the AC-1.

It is only necessary to start a letter, an automatic electronic latch will complete it and, indeed, let you depress the next key without disturbing it. The AC-1 has provision to make AR, SK etc. without gaps.

\$395.00

also

The Autovolt Memokey Mk-1 \$65.00 Mk-2 \$85.00

Self completing automatic keys
featuring

- Instant letter start
- Both dot and dash memories
- lambatic output

MK-2 includes sidetone system and
AC power supply

All of the units described are of solid state design. They include a 100 VA reed-type relay with "floating contacts" for greatest flexibility in transmitter control.

All prices FOB Boston, Mass.
25% with COD orders, please

To order or for further amplification of
details write



AUTOVOLT, INC.

68 RICHMOND RD., BELMONT, MASS. 02178 • 484-4954

about power supplies

A 9-volt power supply is recommended for this receiver. Don't use a supply that exceeds 10 volts or you may damage the transistors or electrolytic capacitors in the broadcast radio.

I have been using a battery pack with good results. For prolonged operation, six D-size flashlight batteries are recommended, preferably heavy-duty alkaline units. Alkaline batteries give up to ten times more service even under continuous operation. However, the standard D cells give highly satisfactory service. For short-term portable use, six AA batteries are okay, but alkaline cells are recommended for longer life. These battery packs can be charged many times and provide low-cost operation. Small 9-volt transistor-radio batteries will not hold up.

There have been a number of 9-volt power supplies described in different articles. Any of them will do the job. However, if you don't already have a power supply, the battery charger/battery pack may be the simplest scheme because large filter capacitors are not needed for the charger power supply.

antennas and operation

A good 80- or 40-meter antenna will give the best results, although highly satisfactory reception can be obtained with 30 to 40 feet of wire strung around the room. A good ground connection (water pipe, conduit, etc.) is also recommended, especially for battery operation. When the receiver is operated from an ac supply, sufficient grounding is obtained back through the power supply, and an external ground is not too important.

Operation is very simple since there are so few controls. Set the bandswitch to the desired band and peak up the antenna trimmer. Adjust the bfo pitch for a pleasing tone. You may find it necessary to repeak the antenna trimmer for weak signals as you go from one band edge to the other, but you don't have to peak it every time the dial is moved.

With a little practice, ssb voice signals can be tuned in. No switch is provided for the bfo because there are so few a-m phone stations. To listen to a-m, simply tune the bfo frequency out of range.

ham radio

Welcome New Readers
WE'VE BEEN LOOKING
FOR YOU!

we hope you've been looking for



Here is an exciting new amateur magazine devoted to the very best in home construction and technical articles. We were so sure you would like **Ham Radio** that we asked your friends to see that you received a copy.

Look it over carefully. Read the finest authors in our field. See the clean crisp new layout. Then check our subscription rates. Our three year rate is by far the **best value** in the amateur field today!

**ham
radio** magazine, greenville, new hampshire 03048

Please enter my subscription to **Ham Radio** as checked below.
My check or money order is enclosed.

- One Year \$5.00
- I'd like **one year free**.
Here is \$10.00 for 3 years.

Name..... Call.....

Address.....

City..... Zip.....

propagation predictions for august

High frequency
propagation forecasts
for the month of August
plus a discussion
of scatter
and short skip

Victor R. Frank, WB6KAP, 12450 Skyline Boulevard, Woodside, California 94602

Propagation of high-frequency signals over long distances during August will likely be somewhat improved over July. Higher F-layer maximum usable frequencies (MUF's), lower absorption and lower noise levels may be expected as the sun slowly progresses southward.

Summertime conditions will still prevail, however, in the temperate north latitudes. The MUF's will slowly rise during the day after their initial jump at dawn. Peak MUF's will occur near sunset, and MUF's will decrease gradually during the evening to a minimum just before dawn.

Sporadic-E activity will decline during the month. The Perseids meteor shower will liven the month for the vhf operators, and some trans-equatorial forward scatter (TE) may reappear during disturbed conditions.

Propagation predictions consist of two parts: first, determination of the path MUF (is the MUF above the operating frequency?), and second, determination of the path LUHF (lowest useable high frequency) is the operating frequency above the LUHF?). Generally speaking, the path MUF is not dependent on system parameters, while the path LUHF is. The system parameters are transmitter power, antenna gain and noise levels. These predictions assume 100 watts CW output and unity signal-to-atmospheric noise ratio in a 6 kHz bandwidth. Antenna gains over an isotropic radiator are: -6 dB for 3.5 MHz, 0 dB for 7.0 MHz, 6 dB for 14.0

MHz, and 10 dB for 21.0 MHz.

the muf chart

The MUF data is presented as a time chart of median monthly 4000-km MUF values against local time and latitude at the control point. This is essentially the form used by the Central Radio Propagation Laboratory (CRPL)* of the National Bureau of Standards until 1963.

You may consider, as a starter, that this pattern is fixed in space relative to the sun, and the earth rotates underneath. Therefore, the time chart is the equivalent to a contour map of MUF vs latitude and relative longitude. However, there is a sizeable variation of MUF with longitude for the same local time, due to the offset of the magnetic pole from the geographic pole.

Originally, CRPL divided the world into three prediction zones (E, I and W) to take this difference into account. Present day ITS ionospheric predictions are a series of MUF contour maps presenting the median monthly MUF contours vs longitude and latitude for 12 hours of the day.

When the world-wide distribution of MUF is required, the ITS ionospheric predictions** should be consulted. However, I think the time chart presented here is adequate for American amateurs who want to predict the times of band openings beyond 2500 miles in various directions.

noise level

The noise levels are assumed to be set by atmospheric noise, values of which are published in charts¹ as a function of season, geographic location, frequency and time of day. While last month's forecast of maximum distance assumed a fixed noise level for each band, this month's forecast assumes an averaged and smoothed noise level which varies symmetrically with time of day. Noise level at 10 AM is assumed to be the same as that at 2 PM local **standard** time.

While there is some error in the smoothing process, it is insignificant compared to the variation of noise with location. If you are located near a thunderstorm area, your working range, particularly on 3.5 MHz, will be decreased. If you are located on the West Coast, your working range may be increased over that forecast.

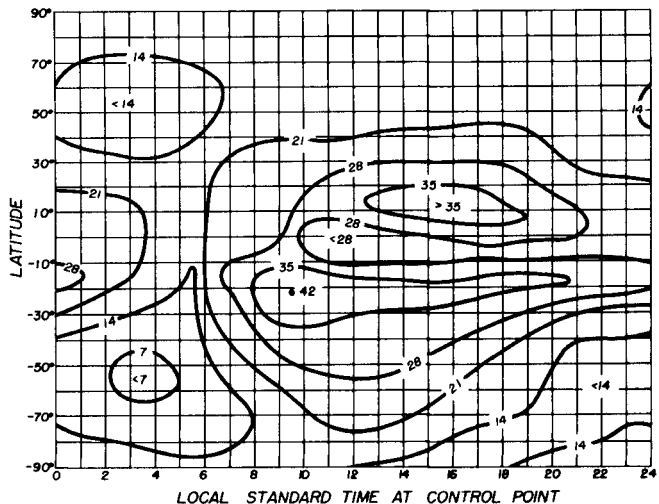
scatter propagation

While the MUF is not dependent on system parameters for regular on-path F-layer propagation, various scattering means will allow communication between well-equipped stations at frequencies **above** the

* Now the Institute for Telecommunication Sciences (ITS) of the Environmental Science Services Administration (ESSA).

** Available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20402, for \$2.75 per year.

fig. 1. Maximum usable frequency curves for August 1968 based on 75° W longitude.



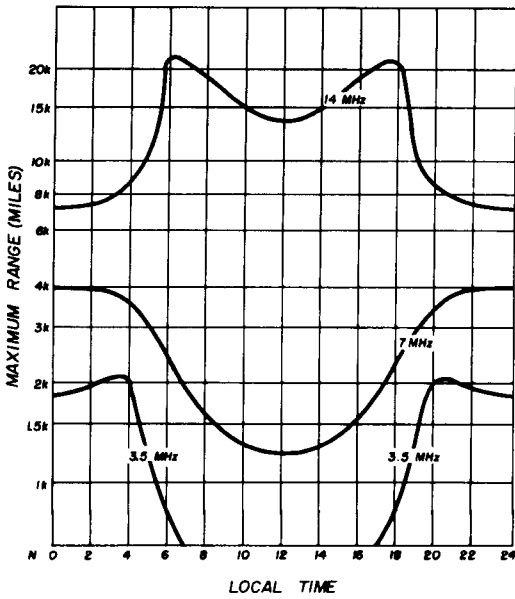


fig. 2. Maximum range to the north from 38° N latitude due to absorption.

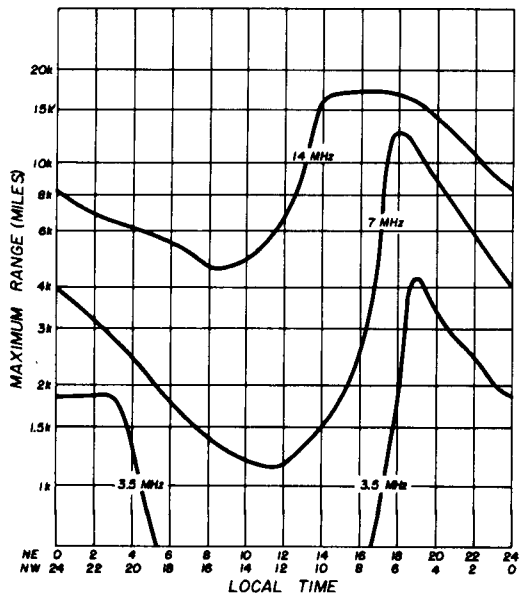


fig. 3. Maximum range to the north-east (top time scale) and to the north-west (lower time scale) from 38° N latitude due to absorption.

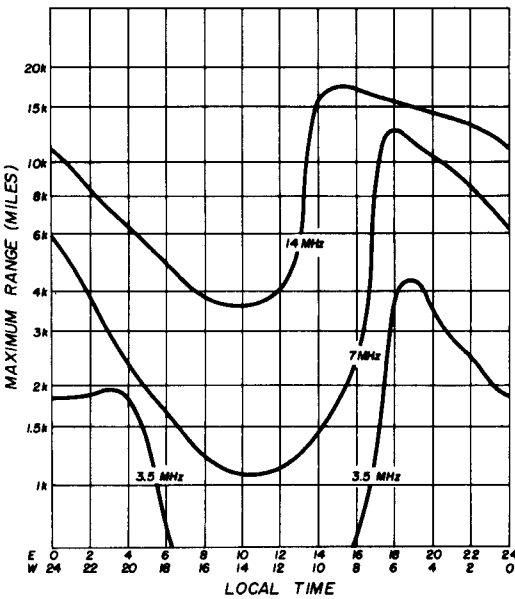


fig. 4. Maximum range to the east (top time scale) and to the west (lower time scale) from 38° N latitude due to absorption.

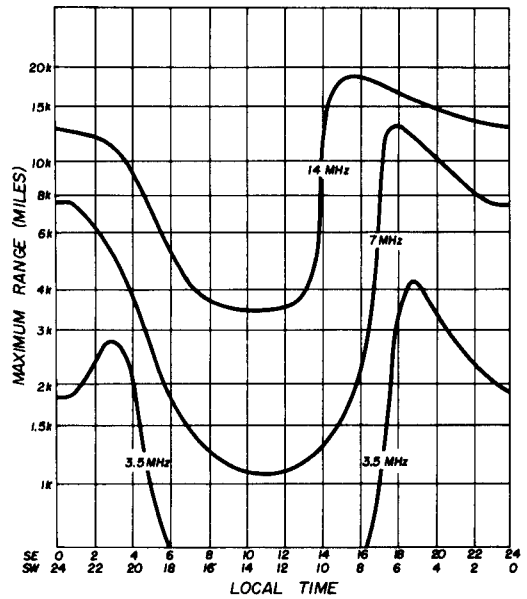


fig. 5. Maximum range to the south-east (top time scale) and to the south-west (lower time scale) from 38° N latitude due to absorption.

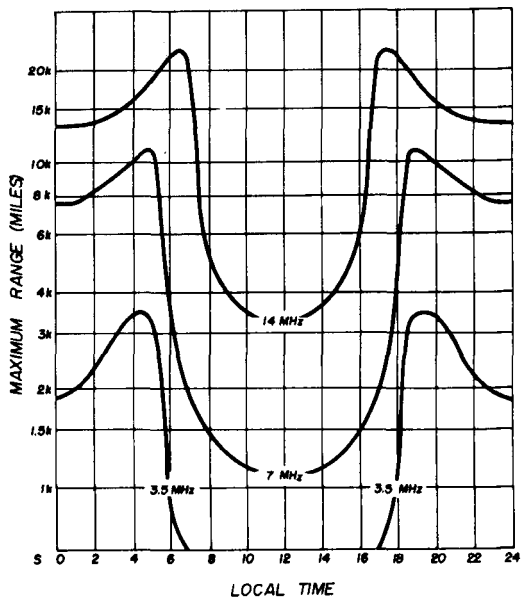
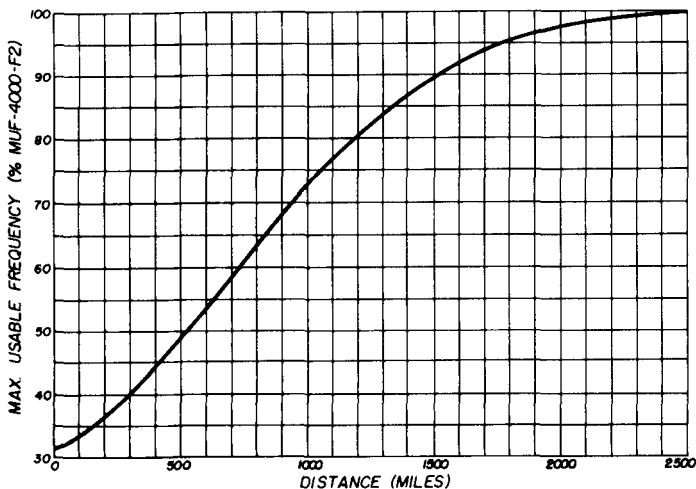


fig. 6. Maximum range to the south from 38° N latitude due to absorption.

path MUF between them.

One of the scattering means is side scatter. This is ground scatter from an area well to the side of the direct path, where the MUF's to both transmitter and receiver are both above the transmitter frequency. Using this mode, stations in Europe may communicate with stations in the States by way of ground reflections in Northwest Africa. Both stations simply point their beams at Northwest Africa.

fig. 7. Maximum usable frequency for distances under 2500 miles as a percentage of the MUF plotted in fig. 1 on page 73.



direct path

The direct-path MUF for a path less than 2500 miles is lower than the MUF shown in fig. 1. Fig. 7 shows the ratio of the F2-layer ordinary-wave path MUF for path lengths between zero and 2500 miles to the MUF shown in fig. 1. The actual direct path MUF will be due to the extraordinary-wave whose MUF is between 0.1 and 1.4 MHz above the ordinary-wave MUF and depends on the orientation of the path to the earth's magnetic field and the path length.²

More on ordinary and extraordinary waves in a later column.

F2-layer MUF for paths under 600 miles in length will seldom be above 28 MHz, but stations this close may be worked by a variety of scattering modes on 28 MHz. The strongest mode is usually ground back-scatter from a commonly-illuminated area 1200 to 2500 miles away.

Ionospheric forward scatter and meteor scatter will furnish some communication out to distances of 1200 miles for well-equipped stations. Round-the-world propagation will furnish some signal inside the normal skip zone.

propagation summary for august

80 and 40 meters. Summertime noise levels and absorption will limit DX possibilities. European and Asian broadcast stations will become more troublesome because of decreased absorption over the pole as the equinox approaches.

LOW PRICE, QUALITY, COAXIAL SWITCHES...



Don't pay for the 5th and 6th position. The average HAM rarely uses more than 4!

SPECIFICATIONS: Silvered Contacts. Write-on ERASABLE escutcheon plate. AVAILABLE EITHER 4 PST (COAX-4) OR LINEAR (COAX-LINEAR) IN-OUT VERSION. Handles 1000 W AM or 2000 W SSB. Insertion loss negligible to 160 Mc. VSWR: Less than 1.2 at 160 Mc. Size: 3/8" dia. x 1 1/4" overall. Single hole mount. SPECIFY MODEL. \$7.65 ea.

COAXIAL LIGHTNING ARRESTORS

Zero power loss. No increase in SWR at 150 Mc. Does not attenuate signals. Model 210 for 1000 W (AM) or 2000 W (SSB). Model 211 Electronic static arrestor for 50 W (AM) or 100 W (SSB). SO-239 UHF type fittings. Other fittings available. Size approx. 3 1/2" x 1/4" dia. #210 \$3.15 ea. #211 \$4.65 ea. SPECIFY model #.



PRICES above are amateur net. Shipped ppd. in U.S.A. Send Check or M.O. (N.J. ADD 3% Sales Tax)

OTHER PRODUCTS: Feed thru capacitors. Tuned noise filters. Alternator, generator, low-pass and field filters. SEND FOR CATALOG.

"COMMUNICATION ENGINEERED"
By "HAMMIE" RICHARDT—W2WIY

ELECTRONIC APPLICATIONS CO.
ROUTE 46, Pine Brook, N. J. 07058

TELL YOUR
FRIENDS
ABOUT . . . *ham*
radio

REVIEWED IN MARCH, 1968 HAM RADIO

oscillator/monitor

- a sensitive broadband RF detector gives audible tone signal in the presence of any RF field from 10mw to 1 kw and 100kc to 1000mc
- a CW monitor with positive "RF" switch uses only 8" pickup antenna and NO connection to rig or key
- a code practice oscillator with adjustable tone & built in speaker
- high gain 4 transistor circuit powered by long life AA pcell
- 16 gauge aluminum cabinet in white & black epoxy finish, 3 1/2" by 2 3/8" by 1 1/4", weight 8 ounces
- 100% US made and guaranteed



1295 (batt incl)
ppd usa & can
send cert ck or m.o.
ny res add 5% tax

the James research company
11 schmerhorn st., brooklyn n.y. 11201

20 meters. Twenty will be best for evening and early morning hours. The MUF will remain above 14 MHz in the Northern Hemisphere except for the predawn minimum period. As a consequence, non-amateur operations from various parts of Northern Asia will continue to clutter the band during evening hours.

15 meters. Fifteen will be the band for DX during daylight and early evening hours although transpolar openings will be spotty.

10 meters. Ten may appear to have died with the decrease of sporadic-E and sporadic-E assisted propagation, but openings should continue to the Southern Hemisphere.

6 meters. There are a few good sporadic-E openings left in August. During the Perseids meteor showers, widespread meteor-induced sporadic-E is expected. After the Perseids, some TE and even Aurora may occur during disturbed conditions.

2 meters. August is a good month for tropospheric openings but is more noted for the Perseids meteor shower. Most useful schedules will be between midnight and 11 AM local standard time at the path midpoint. Distances of 600 to 1200 miles are easily covered by well-equipped stations using schedules and fast break-in. Distances of 1200 to 1500 miles are more difficult to cover, but the more adventuresome may be scheduling out to 1500 miles.

The more adventuresome may also be trying 220 MHz for meteor scatter. What is really needed, in my opinion, is an amateur "Janet" type system with high-speed tele-type, interrogation and storage for making the maximum utilization of each burst.

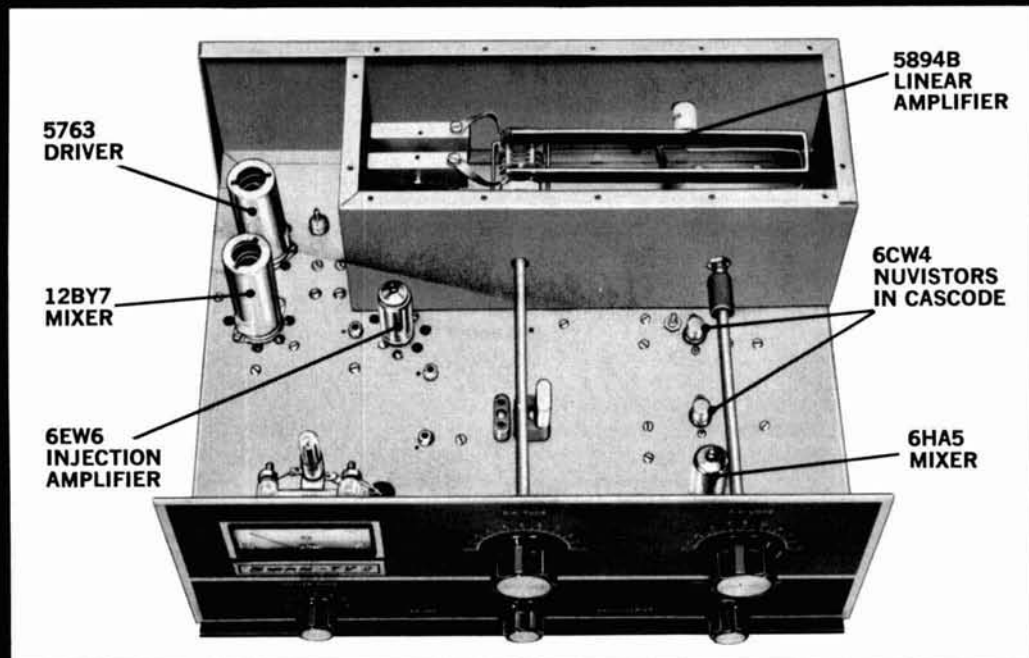
references

1. CCIR Report 322 (1964), *World Distribution and Characteristics of Atmospheric Noise*.
2. K. Davies, *Ionospheric Radio Propagation*, National Bureau of Standards Monograph 80, U. S. Government Printing Office, Washington, D. C., 1965, p. 181.

ham radio

2 METER SINGLE SIDEBAND

144-148 mc 240 WATTS P.E.P. INPUT



THE NEW SWAN TV-2 TRANSVERTER

A receiving and transmitting converter for the 2 meter band, designed to operate with Swan Transceivers, models 250, 350, 350-C, 400, 500, and 500C.

SPECIFICATIONS:

14 mc intermediate frequency is standard. Thus, when operating the Transceiver from 14 to 14.5 mc, the Transverter functions from 144 to 144.5 mc. Additional crystals may be purchased and switched in for other portions of the 2 meter band, such as 144.5-145, and 145 to 145.5 mc. Three crystal positions are available.

Alternately, the TV-2 Transverter may be ordered for an I.F. in the 21, 28 or 50 mc bands, if desired. Of course, for use with a Swan 250 six meter transceiver, the Transverter must be ordered for 50 mc. Otherwise, the standard 14 mc I.F. is recommended since bandspread and frequency read-out will then be optimum. The Transverter can easily be adjusted in the field for a different I.F. range, if required.

A 5894 B Power Amplifier provides a PEP input rating of 240 watts with voice modulation. CW input rating is 180 watts, and AM input is 75 watts.

Receiver noise figure is better than 3 db, provided by a pair of 6CW4 nuvistors in cascode.

Only a Swan Transceiver and Swan AC power supply, Model 117-XC, are required. The power supply plugs into the Transverter, and the Transverter in turn plugs into the Transceiver. Internal connections automatically reduce the power input to the Transceiver to the required level.

Tube complement: 5894B Pwr. Amp., 5763 Driver, 12BY7 Transmit Mixer, 2N706 crystal osc., 6EW6 Injection Amp., 6CW4 1st rec. amp., 6CW4 2nd rec. amp. in cascode, 6HA5 rec. mixer.

The Swan TV-2 may also be operated with other transceivers when proper interconnections and voltages are provided. A separate Swan 117-XC power supply will most likely be required.

Dimensions: 13 in. wide, 5½ in. high, by 11 in. deep.
Weight: 13 lbs. **\$265**

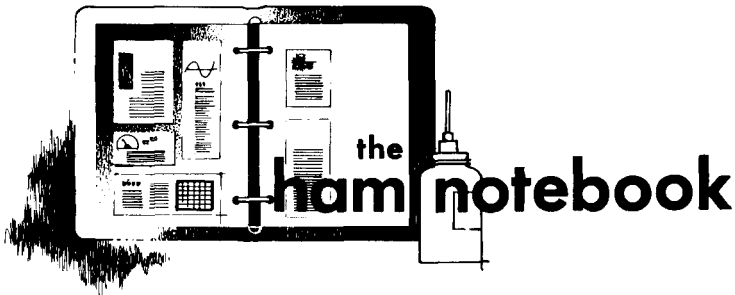


MODEL 250 \$325
MODEL 350C 420
MODEL 500C 520

MODEL 117-XC
AC POWER SUPPLY .. \$105

MODEL TV-2
144 mc TRANSVERTER


SWAN
ELECTRONICS
Oceanside, California
A SUBSIDIARY OF CUBIC CORP.



a dab of paint, a drop of wax

When building gear, there are times when you would like to build, align and forget various assemblies. The perfect example of this is the vfo. The only snag in such wishes is that most modules or assemblies require regular maintenance because, more often than not, the screws holding them together loosen from mechanical vibrations and such. Or perhaps the tuning slugs move a fraction of a turn. Then, the vfo starts to drift, the chirp sounds like an electronic bird-cage and mis-alignment can lead to out-of-band operation.

Take a hint from the Japanese and put a dab of paint or fingernail polish on each joint. This will prevent the screws from loosening and reduces the number of times you will have to overhaul a unit. Remember, however, that paint is not equivalent to epoxy glue and should not be used as a substitute for lock washers or other hardware. If you ever have to open a "painted" seal, a quick jerk with a pair of pliers will do the trick.

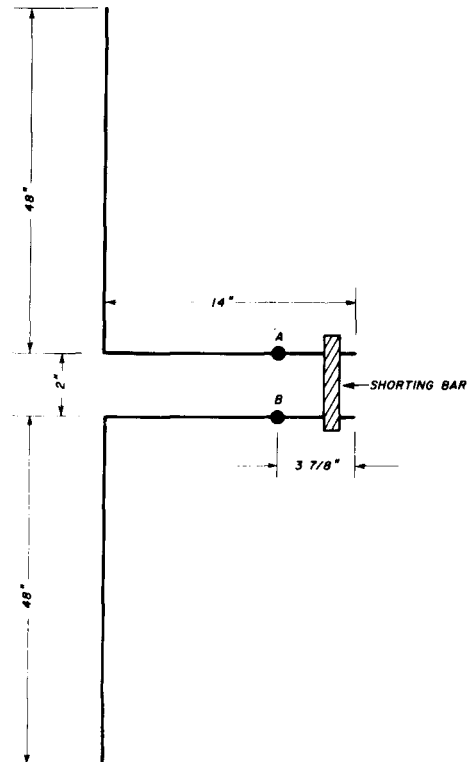
To keep tuning slugs put, use the wax drippings from a lighted candle, preferably a small birthday-cake type. If you use paint on the slugs, the paint may find its way into the threads and prevent the slug from turning—permanently!

D. E. Hausman, VE3BUE

simple 2-meter antenna

There are many commercial two-meter antennas available for home use, but here's a simple one you can put together economically in just a few minutes. It has a low angle of radiation and some gain, and can be mounted on a wood 2 x 2 with wood braces and plastic insulators. The antenna is fed at points A and B with a simple half-wave, 4:1 balun constructed of 26 inches of RG-58/U or RG-8/U.

Ed Marriner, W6BLZ

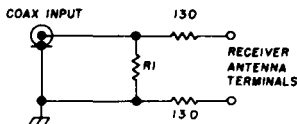


receiver impedance matching

Here's an idea if your receiver is designed for a 300- to 500-ohm transmission line and you want to use coax. For maximum performance, an impedance-matching device is a must to take advantage of everything the antenna delivers. The circuit of **fig. 2** will do just that with little loss. A small perforated circuit board, 2 x 2 inches, will handle the coaxial jack and the three resistors; number-14 wire will support the board when it's connected to the antenna screw terminals on the back of the receiver.

John Davison, WØZFN

fig. 2. R1 is 51 ohms for 50-ohm coax, 75 ohms for 75-ohm coax; these are standard 5% values.



zener diodes

The zener voltage (rated voltage) of any zener diode is somewhat dependent on the temperature of the devices. This temperature dependence is more noticeable in higher voltage units. You will observe a voltage increase during the first few seconds after it is turned on; this is caused by heat generated by current passing through it.

The voltage rating of zener diodes is determined at some specified test current. Smaller currents will cause zener voltage to be slightly less than its rated value. Good engineering practice is to operate 1-watt zeners at about 1/2 watt or less. This provides voltage temperature stability plus a safety factor for over-voltage conditions.

Several zeners of about equal voltage may be connected in series to obtain a higher wattage unit than would be possible from a single higher voltage unit. When two zeners are put in series, the zener voltage be-

comes the sum of the two voltages and the power rating also becomes the sum of the two units. (Example: a 12-volt and a 10-volt 1-watt zener are placed in a series; the result is a 22-volt, 2-watt unit.)

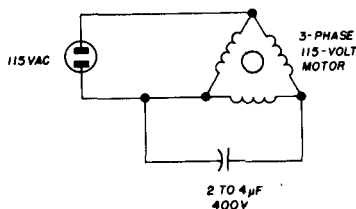
Don't connect zeners in parallel, even if they have the same voltage rating, because one of the units will take all the load.

M. Weinschenker, K3DPJ

three-phase motors

A three-phase blower motor can be run very easily from single-phase ac by connecting it as shown. It will not develop full power but will run smoothly at somewhat reduced speed. The optimum size for the capacitor should be determined experimentally. If the motor runs backward, connect the capacitor to the other side of the line.

Fred Brown, W6HPH



using noise generators

A noise generator can be used to improve the performance of any vhf or uhf converter. An effective device I use in my shack is shown in **fig. 1**. A silicon diode should be used (a 1N21 or 1N23) and held in place with a common fuseclip. The time you spend in constructing the noise generator will be more than made up by the increased performance you'll get out of your receiving system.

General procedure for tuning up (or optimizing) a converter is to adjust it first for maximum gain—with a signal generator tuned to the frequency most used—and then measure the noise figure with a laboratory-type noise generator.* This serves as point of

*there's a reason for
the S/LINE's reputation
and*

**ELECTRONICS CENTER has
it in stock**

The main reason is performance. Amateurs around the world praise the S/Line's clean, strong signal. But there are design reasons, too. The S/Line is an engineered system. Each unit augments the others to provide single sideband operation at its best.

You can operate the system as a transceiver, or transmit with the 32S-3 and receive with the 75S-3B on separate frequencies. The S/Line offers upper and lower single sideband and CW operation . . . plus AM reception. Two linear amplifiers round out the full-performance S/Line.



Pictured is the
DESIGN INDUSTRIES DIPLOMAT
COMMUNICATIONS CONSOLE
\$395

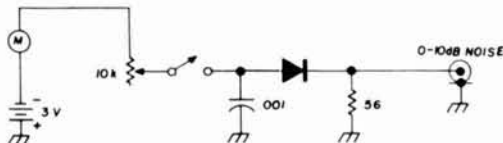
Chair not available

Send for wife pacification kit . . .
includes literature on both the console
and the Collins equipment.

electronics center, inc.
2929 N. HASKELL 214-LA6-2023 DALLAS, TEXAS 75204

reference. Let's say it's 9 dB.

Next, the silicon diode noise generator is connected to the receiver. The receiver is adjusted as described below until optimum performance is obtained. Then, when rechecked against your reference, you'll have an indication of how poorly your system was adjusted. A laboratory-type noise generator isn't required if you're not interested in this statistical comparison; you should be able to audibly note a marked improvement in over-all performance.



The technique is actually quite simple. Output from the noise generator is fed into the converter simultaneously with a signal source. This can be from a signal generator or another ham transmitting across town. First, the noise generator is turned off and the converter is peaked for maximum signal strength. Then slowly adjust for minimum noise when the source signal is removed. Turn the noise generator on and continue adjusting for minimum noise level.

By adjusting both for maximum signal strength and minimum noise, you will find that for optimum differential, S-meter readings will not be as high as you had expected. Remember: sensitivity has nothing to do with signal strength; it is the noise level which determines the difference between mediocre performance and outstanding converter sensitivity.

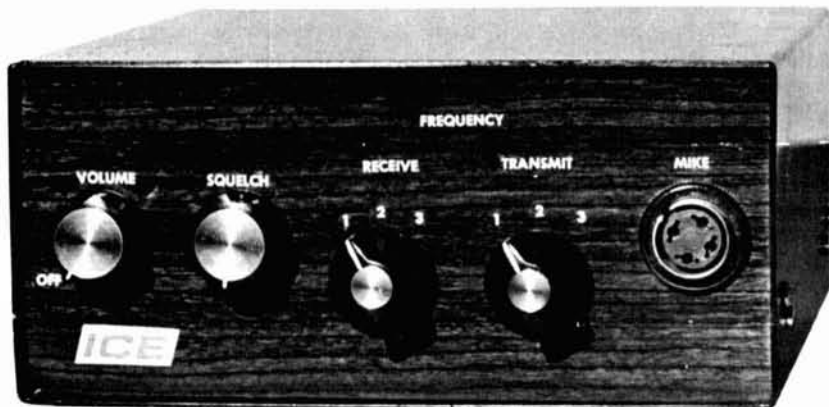
Incidentally, repeat this procedure periodically. Equipment is known to age rapidly during warm summer months and tubed-converters (yes, there are still many around) require frequent "optimizing." In using the meter, by the way, 1 mA of reverse crystal equals roughly 10 dB of noise. You can change the intensity by varying the 10k pot.

* J. A. Huie, K2PEY, "A VHF Noise Generator," *QST*, February, 1964, p. 23.
H. Olson, W6GXN, "The Noise Diode Caper," *QST*, February, 1964, p. 28.

Bob Brown, K2ZSQ/W9HBF

AT LAST!

2 METER FM TRANSCEIVERS



SPECIALLY FOR *HAMS*

FULLY TRANSISTORIZED — NO TUBES

Operates on — 117 VAC — 12 Volts DC — Or Optional Internal Batteries — Separate receiver and transmitter 3 channel operation — Self-contained 3 x 5 speaker — Strong fiberglass Epoxy printed circuit boards — Power supply even regulates and filters on 12 VDC operation — cannot be damaged by Reverse Polarity — 21 transistors — 14 diodes — Double conversion crystal controlled receiver with 3 full watts of audio output and better than .3 μ V sensitivity (12 DB SINAD) — Transmitter and receiver may be ordered in either wide or narrow band at no extra charge (wide band supplied unless specified) — Small size 8" w x 3 $\frac{1}{2}$ " h x 9 $\frac{1}{2}$ " d — Light Weight - Less than 4 $\frac{1}{2}$ lbs — True FM receiver not a slope detector — Dynamic microphone input with push to talk — Built in 117 VAC power supply — Simply plug in proper power cable for either 117 VAC or 12 VDC operation — Transmitter power output 4 watts minimum.

Complete with one set of crystals on 146.94, 117 VAC and 12 VDC power cables, less microphone and antenna \$285.00

Extra crystals (transmit or receive) \$7.00 Mobile Mounting kit \$7.00

ICE

INTERNATIONAL COMMUNICATIONS AND ELECTRONICS, INC.

1817 NW MILITARY HIGHWAY/SAN ANTONIO, TEXAS 78213 512 341-1311

new products

tompkins tunaversers

An interesting new line of rf converters has been announced by Tompkins Radio Products. Six new models are available—several for the amateur bands. These converters feature a fixed output frequency of 1500 kHz in the standard a-m broadcast band. Tuning is done at the converter rather than at the receiver; a calibrated dial with 6 to 1 reduction is provided for this purpose. One crystal position is also included so that the unit can be changed to fixed-frequency operation with the flip of a switch.

Models for amateur frequencies include the 273X for 26.9-30 MHz, the 504X for 50-54 MHz and the 1450X for 144-150 MHz. Other models are available for police, fire, marine and aircraft bands. The unit is powered by a self-contained 9-volt battery. The X-line converters are supplied complete with a mobile-mounting bracket and are guaranteed for one year.

Accessories offered by the manufacturer include crystals for your exact listening frequency and an adapter for coupling to the loop or external antenna of portable and home receivers. The price of the X-line converters without accessories is \$32.95, post-paid from Herbert Salch and Company, Woodsboro H, Texas 78393.



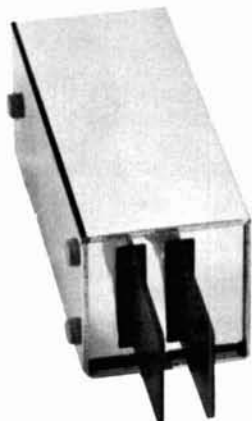
westcom noise blanker

The new Westcom noise blanker is designed for the vhf operator who is looking for maximum noise suppression for reception of weak DX and scatter signals. This device uses four high-gain FET amplifiers with two stages of noise clipping to efficiently remove ignition noise and other forms of pulse interference.

Automobile ignitions, power distribution circuits, motors, radar and other sources of high-energy pulse interference cause severe problems in vhf receiving systems. The noise pulses excite tuned amplifier circuits in the receiver and produce mixer and i-f amplifier overload. In most communication receivers, the noise limiter is placed at the output of the i-f amplifier strip. However, by the time a strong noise pulse has passed through the i-f amplifier, it has been amplified and stretched to the point where it totally masks weak signals. To complicate matters, ssb receivers with fast attack-slow recovery agc systems will hang up on the amplified noise pulse and reduce receiver gain. Loss of receiver gain at this point will cause even moderate signals to disappear into the background noise. To distinguish

weak signals in the presence of noise pulses it's desirable to remove the interference before it is introduced to the receiver.

The Westcom noise blanker is connected in the coaxial cable between the vhf converter and the receiver, and provides an effective means of suppressing noise at the converter output frequency. Since the noise pulses are eliminated before the pulse amplifying and stretching circuits in the receiver, the signal-to-noise ratio is improved significantly. The Westcom noise blanker is available with i-f ranges of 40, 20 or 10 meters. Other i-f ranges are available on special order. \$29.95 from Westcom Engineering Company, P. O. Box 1504, San Diego, California 92119.



the permaflex key

The James Research Company has just introduced a new key for electronic keyers that is a unique departure from standard key design. This new switch mechanism is completely enclosed and combines the twin lever for electronic keys with a straight hand key in a pivotless two-paddle design. With this key, CW operators have an instant choice of automatic, semi-automatic, or straight hand keying in one compact unit.

Although the **permflex key** was designed specifically to key the low currents associated with integrated-circuit keyers, it will



The latest evolutionary development of the Classic Model 350

The new SWAN 350-C 5 band, 520 Watt SSB-AM-CW TRANSCEIVER

The introduction of the new model 350-C at no increase in price over the popular 350 is a real triumph of value engineering.

Power rating of the 350-C is the same as the Deluxe Model 500-C, which is 520 watts P.E.P. input on single sideband, 360 watts CW input, 125 watts AM input. A pair of rugged, blast-rated 6LQ6 tubes handle this input with ease. Selectivity is provided by the same superb crystal lattice filter used in the 500-C, with skirt selectivity and ultimate rejection superior to any other filter being used in amateur equipment today. Audio quality has the same degree of fidelity which Swan has stressed from the very first single band transceivers.

The 350-C is designed to operate automatically on the normally used sideband with extended frequency coverage of all five bands, 10 through 80 meters. Basically the difference between the 350-C and the 500-C is in the deletion of optional features which are not essential to communication. These include such things as crystal calibration, sideband selector, CW sidetone, automatic noise limiter, automatic level control, etc. For the operator who desires these features, we are proud to recommend the deluxe model 500-C. However for powerful and reliable communications without all extras, we now offer the new 350-C, and we are confident that you will rate it a truly exceptional value.

\$420

ACCESSORIES

117XC Matching AC supply with speaker \$105
14-117 12 VDC Mobile Supply \$130

**WANTED:
WE BUY USED AMATEUR
AND CB EQUIPMENT FOR CASH!**

**RECONDITIONED USED GEAR:
FULLY GUARANTEED**

JOHNSON

2000 Complete . . . Very Good \$525.00
500 Complete . . . Very Good Cond. \$325.00

LOTS OF GOOD CHOICE GEAR FOR SALE OR
TRADE — WRITE FOR LATEST LIST.
IN STOCK FOR IMMEDIATE DELIVERY, GALAXY,
SWAN, SBE AND DRAKE.

Bob's **AMATEUR**
ELECTRONICS

Phone CE 5-6387

"THE COMPLETE HAM STORE"

927 N.W. 1st Oklahoma City, Oklahoma 73106

"WE TAKE TRADE-INS ON ALL LINES OF NEW EQUIPMENT"
TWO-WAY RADIOS — SALES • SERVICE • INSTALLATIONS

you're
missing
some
top notch articles
and
great ideas

If
you
aren't
getting

new



the monthly
for
amateurs
that's
different!

To quote one of the many
reader comments so far —
*"you obviously have embarked
upon a fresh, new approach
to amateur radio."*

**to see for yourself, write —
free copy, or**

4 months @ 2.00
12 months @ 5.00
3 years @ 10.00

to
HAM RADIO magazine
GREENVILLE, N.H. 03048

Include address, call and
zip code.

handle transmitter currents up to 8 amps. The contacts are gold-diffused pure silver for protection from corrosion and are adjustable from zero to 0.06 inches. Paddle weight is adjustable from 5 to 50 grams. The paddles are made of rugged fiberglass epoxy with gold-plated copper conductors to ensure a long-term, low resistance, anti-corrosion keyer.

The cabinet is 16-gauge chrome-plated steel, with an inner chassis that can be quickly removed for contact gap and tension adjustment. The low-mass paddle design and durometer rubber feet permit accurate high-speed keying with a minimum of "walking". \$19.95 postpaid from the James Research Company, 11 Schermerhorn Street, Brooklyn, New York 11201.

mosley cubical quads

Mosley Electronics has introduced a new line of cubical quad antennas for single and multi-band operation. These quads feature well-insulated aluminum spreaders for greater strength, a light-weight, low wind load spreader mount that eliminates wind-resistant webbing at the hub and the time-tested Mosley boom-to-mast clamp with stainless steel U-bolts for greater quad stability.

These new cubical quads are designed so that the voltage and current minima and maxima are located between the corners. This eliminates possible signal loss due to spreaders intersecting with the wire elements at these critical points. These quads incorporate gamma matching with a single 52-ohm coaxial feed line to the antenna. The Mosley cubical quads maintain an SWR of 2.2:1 or better with exceptionally flat response across the full bandwidth.

Four models are available: the MCQ-10 for 10 meters, the MCQ-15 for 15 meters, the MCQ-20 for 20 meters and the MCQ-3B three-band quad for 10, 15 and 20. For more information on these new cubical quad antennas, write to Mosley Electronics, Inc., 4610 N. Lindbergh Boulevard, Bridgeton, Missouri 63042.

BOOKS

FOR YOUR AMATEUR RADIO LIBRARY



Radio Society of Great Britain Publications

AMATEUR RADIO CIRCUITS BOOK

Completely revised - new addition just now available. A very handy collection of many useful circuits for amateur use. Loaded with good ideas for that new converter, exciter or other project you are working on. **Only \$2.00**

RADIO DATA REFERENCE BOOK — Second Edition — By G. K. Jessop G6JP

Here in a 148 page book is one of the most complete compilations of radio and electronic charts, nomographs, formulas and design data available. Sections are included which permit you to design everything from rf power amplifiers to TVI filters. Also included is much related information such as world-wide frequency allocations and commonly used mathematical tables. Whether you design, build or operate, this is a book you should have. **Only \$2.50**

WORLD AT THEIR FINGER TIPS — John Clarricoats G6CL

A very interesting history of the RSGB and of amateur radio in Great Britain. It gives a great insight into the development of our hobby in England and Europe and the effects these events have had on amateurs here in the United States.

Paper back edition \$2.50 Deluxe edition \$6.50

HANDBOOKS BY RADIO PUBLICATIONS, INC.

BEAM ANTENNA HANDBOOK by William Orr, W6SAI

New edition. Theory, design, construction, and the installation of rotary beam antennas! SWR data! Multiband beams, 40 meter beams, 20 meter DX beams! How to make your beam work! 200 pages. **\$3.95**

VHF HANDBOOK by Orr, W6SAI and Johnson, W6QKI

First complete Handbook covering the VHF spectrum! Many VHF construction projects! Design and construction of VHF transmitters, receivers and antennas! Make your VHF station work! **\$3.75**

ELECTRONIC CONSTRUCTION HANDBOOK by Robert Lewis, W8MQU

All about design - construction - layout and testing of electronic equipment. Non-technical guide for kit-builders and your best key to better performance of your equipment! **\$2.95**

ALL ABOUT CUBICAL QUAD ANTENNAS by W6SAI

Construction and tuning data. Multiband Quads. Charts, drawings and photos for your Quad. Full complete data on home-made Quad antennas. The new X-Q Quad. **\$3.95**

NOVICE & TECHNICIAN HANDBOOK by W6SAI and W6TNS

All about amateur radio in nontechnical language! How to learn the code. How to assemble your ham station. Transmitters! Receivers! DX! How to Get QSL cards. **\$2.95**

BETTER SHORTWAVE RECEPTION, by Wm. Orr, W6SAI

Your introduction to shortwave radio. How to hear DX. How to buy a receiver. Amateur radio. How to align your receiver. Antennas! QSLs. Getting your ham license. **\$3.25**

S-9 SIGNALS by William Orr, W6SAI

Inexpensive DX antennas for your station! Multiband ground plane, \$5 beam antenna, 2 and 6 meter beams, Demi-Quad beam, and others! **\$1.00**

ALL PRICES POSTPAID IN U. S. A. AND CANADA

ORDER TODAY FROM

book division

comtec

Box 592 • Amherst, New Hampshire 03031

"WE ARE THE EXCLUSIVE NORTH AMERICAN DISTRIBUTOR FOR RSGB PUBLICATIONS — DEALER INQUIRIES INVITED"

For optimum voice power and clarity

Simply connect the Comdel CSP-11 between your audio source and equipment and get instant voice clarity with a 10 dB increase in talk power. Unlike conventional speech clippers the CSP-11 tailors the audio bandwidth and introduces no harmonic distortion. It is equally effective in Audio AM, FM and SSB systems. For further information call or write.

MODEL CSP-11
PRICE \$120



COMDEL
inc.

**COMMUNICATIONS
EQUIPMENT**

beverly airport, beverly, massachusetts 01915
tel. (617) 927-3144

the man behind the mike

If you're interested in professional broadcast announcing, this brand-new book offers the practical help needed by most aspiring announcers and station and broadcast personnel. Many of the pointers contained in this book will help broadcasters suffering with growing pains to solve the lack of readily available professional talent; both seasoned veterans and neophytes will gain by reading this helpful book.

The Man Behind the Mike is based on many years experience in training beginners and practicing broadcasters, and offers practical and helpful guidance on every phase of announcing. It is well suited for everyone in broadcasting—managers and program directors will find a wealth of material to guide them in their daily role as well as a host of management and programming ideas. \$9.95 from TAB Books, Blue Ridge Summit, Pennsylvania 17214.

pin-point tv troubles in 10 minutes

If your family ever calls upon you to fix the television set, here's the book you need if you want to get the job over with in a hurry. It offers the type of help not usually found in books of this type. It contains large photos of different picture-tube troubles that are keyed to trouble-finding charts which identify over 700 possible defects. With this aid, you can pin-point almost any trouble in a tv set in a matter of minutes.

In addition, this book describes and illustrates methods for checking component performance. Also included are explanations of circuits used in the majority of tv receivers manufactured since 1953. For problems that require special troubleshooting methods, suggested procedures are outlined which will lead you to the trouble in a hurry. In addition, the beginning of each section gives information on circuit peculiarities, methods for improving set performance, service tests and adjustments and checking individual components. \$4.95 paper; \$6.95 hardbound from TAB Books, Blue Ridge Summit, Pennsylvania 17214.

FACTORY NEW BRANDED IC'S

Manufacturer's name withheld, but you will find it marked on every unit. Manufactured to Fairchild 900 RTL Series. All first grade, spec sheets included. A really amazing buy. Never previously offered by anyone at these ridiculous prices.

Any number shown below at
\$ 1.00 each
or \$10.00 per dozen

Shipped prepaid airmail delivery.

Buffer	900
Dual Input Gate	2-903
Quad 2-Input Gate	2-914
JK Flip Flop	923
Dual JK Flip Flop	2-923
Dual 2-Input Gate, Dual Expander	1-914, 1-925
Dual 2-Input Gate Expander	925

MESHNA SUMMER CATALOG 1968 - 2
NOW OUT

Send 25¢ mailing and handling charge
SUPER - STUPENDOUS - ASTOUNDING
BARGAINS GALORE
Fattest Catalog Yet

JOHN MESHNA, JR. P. O. BOX 62A
EAST LYNN, MASS. 01904

For the Ham with SPACE PROBLEMS...

America's most complete line of
Free Standing & Guyed Crank-up Towers.
Write for FREE Catalog.

TRISTAO TOWER CO. P. O. Box 115, Hanford, California 93230

SURPLUS EQUIPMENT WANTED TO BUY BY THE FASTEST GUN IN THE EAST



No horsing around, we pay fast . . . in 24 hours . . . and we pay more. We'll swap or trade new equipment too . . . We quote fast too. We also pay for shipping, insurance, etc. You call fast, now, collect, for fast quot.

SPACE ELECTRONICS
div. of MILITARY ELECTRONICS CORP.
4178 Park Avenue, Bronx, New York 10457, (212) CY 9-0300

NOVICE CRYSTALS

Fundamental frequencies in FT-243 holders. Pin size .093 in., spacing .488 in. Tolerance .03%/ measured in oscillator with 32 mmfd. capacity.

80 meters 3705-3745 kc.	\$1.75 ea.
40 meters 7155-7195 kc.	1.25 ea.
15 meters 7034-7082 kc.	1.25 ea.
2 meters 8058-8186 kc.	1.25 ea.

Add for postage and handling per crystal: 8c first class; 12c airmail. Specify frequency desired and nearest available will be sent. Other frequencies in stock. Send for free list. Satisfaction guaranteed.

NAT STINETTE, P.O. Drawer Q-1, Umatilla, Fla. 32784

FOR THAT
"Extra Class"
 YOU NEED THE



Listen for the hundreds of LK-2000 linears now on the air and judge for yourself. Write for free illustrated brochure or send \$1.00 for technical and instruction manual.

**BTI LK-2000
 LINEAR
 AMPLIFIER**

For SSB, CW, RTTY
 Maximum legal input
 Full loading 80-10M
 Rugged Eimac 3-1000Z
 Dependable operation
 Easy to load and tune
 No flat topping with ALC
 Distinguished console
 Instant transmit
 High efficiency circuit
 Designed for safety
 Fast band switching
 Real signal impact

Price . . . \$795.00
 READY TO OPERATE!

BTI AMATEUR DIVISION

Hafstrom Technical Products

4616 Santa Fe, San Diego, Ca. 92109



"Your Friendly Supplier"

IN STOCK! OFFERS

**THE DRAKE
 R-4B RECEIVER**



The Drake R-4B offers many fine features . . . Linear permeability tuned VFO with 1 kc dial divisions. Covers 80, 40, 20, 15 meters completely and 28.5 to 29.0 Mc of 10 meters with crystals furnished. Four bandwidths of selectivity, .4 kc, 1.2 kc, 2.4 kc, and 4.8 kc. Built-in Notch filter, Noise Blanker, and 25 KC crystal calibrator. Product detector for SSB/CW, Diode detector for AM . . . Plus many other features . . .

R-4B Receiver **\$430.00**

ALSO IN STOCK:

T-4XB Transmitter **\$430.00**

AC-4 AC Supply **99.95**

and other Drake Accessories

We also have a large selection of used equipment - Write for Latest Complete List.

OPEN HOUSE SEPT. 14th, 1968

Evans RADIO

BOX 893

CONCORD NH 03301

PHONE 603-225-3358

COMPONENTS

FROM
HAMS SERVING HAMS

**OUR OWN METER
 PROTECTOR —**



PROTECT THAT EXPENSIVE METER WITH OUR PROVEN, TESTED, GUARANTEED METER PROTECTOR. WILL PROTECT METER MOVEMENT AGAINST 100% OVERLOAD WHEN INSTALLED ACCORDING TO INSTRUCTIONS. COMPLETE WITH INSTRUCTIONS.

75¢ EA or 4 FOR \$2.50 PPD

**1N430 TEMPERATURE COMPENSATED
 REFERENCE ZENER DIODE**

1/4 WATT 8.4 VOLT 10 MA. OPERATING CURRENT. TEMPERATURE COEFFICIENT .001% PER DEGREE CENTIGRADE. TEMPERATURE RANGE -55 TO +100 DEGREE CENTIGRADE. REMOVED FROM NEW EQUIPMENT AND TESTED — LIST \$16.00 EA. OUR PRICE \$1.25 EA PPD



WESTERN ELECTRIC FILTER CAPACITOR

200 MFD @ 350 VOLTS. SUPPLIED WITH MOUNTING HARDWARE. REMOVED FROM NEW EQUIPMENT. APPRO. SIZE 1 3/8" DIA X 5" LONG. 3 FOR \$2.00 PPD

MINIATURE ALLIED CONTROLS RELAYS

DPDT CONTACTS RATED 2 AMPS 115 VOLTS AC RESISTIVE. COIL RESISTANCE - 850 OHMS. THESE RELAYS ARE REMOVED FROM NEW EQUIPMENT AND WILL OPERATE RELIABLY ON ALL VOLTAGES BETWEEN 14 AND 40 VOLTS. APPROXIMATE SIZE 7/8" X 3/4" X 3/8".

35¢ EA or 4 FOR \$1.00 PPD



**BURROUGHS NIXIE TUBES
 TYPE B6091**

RATED LONG LIFE WIDE ANGLE. IONIZATION VOLTAGE - 170. MAX CATHODE CURRENT - 4.5 MA. RANGE 0 TO 9. THE TUBES ARE REMOVED FROM NEW EQUIPMENT AND TESTED. SUPPLIED COMPLETE WITH SOCKETS.

\$3.75 EA or 4 FOR \$14.00 PPD

ALL ORDERS PROPERLY PACKED AND PROMPTLY SHIPPED

MINIMUM ORDER \$3.00 PLEASE
 PA. RESIDENTS ADD 6% PA. SALES TAX

M. WEINSCHENKER K3DPJ

PO Box 353

Irwin, Pa. 15642



ROMEY says
FM is
the hottest thing in Amateur Radio
and

the **NEW ICE 2** meter transceiver
is the hottest thing in **FM**



An exciting all solid state transceiver featuring crystal controlled operation on any of three channels. Includes a built in speaker and internal power supplies for 12 volt dc or 117 volt ac operation.

write today to
DEPARTMENT H
10 GRAHAM ROAD WEST · ITHACA, N. Y. 14850
TELEPHONE AREA CODE 607 273-9333



stellar industries
DIV. OF STELLAR I, INC.
SALES AND SERVICE

Your central New York headquarters for not only the ICE 2 meter FM transceiver, but also for all new and used ham gear — sales and service. Mail orders welcomed.

Hours: 9:00 A.M. to 5:30 P.M. Monday through Friday 9:00 A.M. to 5:00 P.M. Saturday



**FOURTH ANNUAL
LONG ISLAND
HAMFEST**



RAIN OR SHINE

Sponsored by the Federation of Long Island Radio Clubs Inc. A day out for the entire family. Swimming, Sunbathing, Playgrounds, Boardwalk, Barbecue Grills, Tables for

**PICNICKING · GAMES · AWARDS · CONTESTS
AUCTION · SWAP SHOP · MOBILE ACTIVITIES**

Talks by Prominent Radio Amateurs

SUNDAY, SEPTEMBER 1, 1968

9:00 A.M.

**HEMPSTEAD TOWN PARK
POINT LOOKOUT, LONG ISLAND**

For further information write to
FLIRC, P. O. Box 304, Long Beach, N. Y. 10115

**LET W3KT
FORWARD YOUR
DX QSLs**

Join the thousands of satisfied hams who have been using this service for the past seven years. During 1967 alone, over 200,000 QSLs were forwarded to DX stations. This is a DELUXE service, insuring prompt and continuous mailings, and involving a minimum of effort on your part.

Just fill in your QSLs and send them to W3KT. You don't have to address the cards, or indicate the QSL manager, or send any SASEs. Where a DX station uses a stateside QSL manager, your card will be sent to him with an SASE, and the reply will come back to W3KT, who will send it to your call area QSL bureau. Other QSLs will be sent to the proper QSL Bureau, or, if necessary, direct.

Remember, your QSL is a personal message. Therefore W3KT sends it by FIRST CLASS MAIL only.

The charge: Four cents per QSL, 30 cards per dollar. **NO MEMBERSHIP FEE.**

SAVE TIME! SAVE MONEY!

W3KT QSL SERVICE

RD 1, Valley Hill Road Malvern, Penna. 19355

IMPORTANT ANNOUNCEMENT

ALL VANGUARD CONVERTERS NOW USE R C A DUAL GATE MOSFETS FOR BOTH THE RF AND MIXER STAGES



The performance and features of our new converters are so spectacular that they can only be fully described in our new illustrated catalog which is available **FREE**. Send for it today and see our entire line of converters, pre-amps and other communications equipment.

VANGUARD now makes the best converters. Buy one and be convinced.

VANGUARD LABS

196-23 Jamaica Ave. Dept. R
Hollis, N.Y. 11423

radio amateur callbook



GET YOUR NEW ISSUE NOW!

Over 283,000 QTHs
in the U.S. edition
\$6.95

Over 135,000 QTHs
in the DX edition
\$4.95

These valuable EXTRA features included in both editions!

- QSL Managers Around the World!
- Census of Radio Amateurs throughout the world!
- Radio Amateurs' License Class!
- World Prefix Map!
- International Radio Amateur Prefixes
- Radio Amateurs' Prefixes by Countries!
- A.R.R.L. Phonetic Alphabet!
- Where To Buy!
- Great Circle Bearings!
- International Postal Information!
- Plus much more!

See your favorite dealer or order direct (add 25¢ for mailing in U.S., Possessions & Canada. Elsewhere add 50¢).

**WRITE FOR
FREE
BROCHURE!**

RADIO AMATEUR
callbook INC
Dept. 4844 W. Fullerton Ave.
Chicago, Ill. 60639

DIODES

EVERY DIODE WE SELL IS CURVE TRACED ON A SPECIAL TESTER THIS TESTER DRIVES 2 AMPS AVERAGE CURRENT THROUGH THE UNIT IN THE FORWARD DIRECTION WHILE THE REVERSE LEAKAGE IS MEASURED (25 MICROAMPS). THE OPERATOR EXAMINES THE CURRENT-VOLTAGE PLOT OF EACH DIODE ON AN OSCILLOSCOPE SCREEN WE FULLY GUARANTEE EVERY UNIT SOLD OR YOUR MONEY REFUNDED

PIV	TOP-HAT 1.5 AMP	EPOXY 1.5 AMP	EPOXY 3 AMP	STUD-MOUNT 6 AMP
50	.04	.06	.12	.15
100	.06	.08	.16	.20
200	.08	.10	.20	.25
400	.12	.14	.28	.50
600	.14	.16	.32	.58
800	.17	.20	.40	.65
1000	.20	.24	.48	.75

ZENERS

ALL UNITS TESTED AND GUARANTEED
ALL 1 WATT

5% 3 for \$1.00		10% 4 for \$1.00	
11	12	13	15
16	18	20	22
24	27	30	33
36	39	43	47
51	56	62	68
75	82	91	100
110	120	130	150
160	180	200	
VOLTS			

3 YEARS OF SERVICE
TO THE AMATEUR FRATERNITY

HAMS SERVING HAMS

PLACE YOUR ORDER WITH

M. Weinschenker K3DPJ
PO Box 353
Irwin, Pa. 15642

PA Residents Please Add 6% PA Sales Tax Minimum Order \$3.00 All Orders Ppd in USA

VER - R - RY INTER - R - ESTING BARG - AINS.

Send for our ver-r-ry inter-r-esting 68 page catalog 25¢ (Free with an or-r-rder)

P.P. = Postage Paid.

TRANSISTOR TONE OSCILLATOR

Do not confuse this well-made military unit with low price commercial "ice cube packs." This unit operates from 1.5 to 6.0 volts, and has transformer isolated output. Frequency is 1000 Hz, may be varied with external pot. New wa karr, and complete with spare set of transistors.

Applications: Continuity, component, and semiconductor tester, code practice oscillator, keying monitors, alarms, RTTY SHIFT Oscillators, etc. TTC \$2.00 P.P.

TELETYPE SPECIAL — GOV'T SURPLUS

101 New packaged spare parts for models 14, 15 and 19 teletypes. Over 40 different items include cams, balls, reels, covers, springs, type, key caps, etc. Government cost over \$900.00. The first part used will cover the cost of the kit, and you will have the added advantage of being back in operation immediately. This is one of our most popular items. Price: \$5.90 plus postage (include \$1.00 east of Miss., \$2.00 west).

PRINTED CIRCUIT BOARDS

— 8 for \$1.25 P.P. These new packaged boards were spare parts to a high speed Gov't Computer. Each board contains a total of 22 components of 10 HIGH GRADE DIODES, & 5% capacitors etc. All components are good. We sell 184 COMPONENTS/80 DIODES for \$1.25 postage paid. 8 PCB — \$1.25



PATCH BOARD. This is a handy item for the electronic experimenter. The board acts as a tie point in an electrical system by means of taper pins inserted into each side of the board. Interconnections are easily changed by pulling pins and reinserting them. By soldering components to taper pins circuits may easily be bread-boarded, changed and reused. Board with 360 taper pins removed from new equipment. 3PBA. 3 for \$2.50 P.P.



MINIATURE 6V SYNCHROS.

For all remote control applications! For Amateur & CB Antennas, Weathervanes and other indicating uses! Used originally in aircraft equipment. Compact, ruggedly built. Designed to operate on 26 VAC @ 400 cycles. Guaranteed to operate efficiently at 6 VAC @ 60 cycles. With wiring diagram. Size 1 3/8 x 1-9/16", shaft 1/8 x 1/2". JOS. \$2.50 pr. P.P. XFormer for above \$1.25 P.P.



Unleash that TIGER under your HOOD! Special Close-out Buy DUAL-TRANSISTOR IGNITION SYSTEM made to sell for \$39.95. Easy to install with fully wired harness to all components. For easier starting, longer lasting points and plugs, due to higher ignition voltage. Brand new w/instructions. Makes an ideal gift. (Postage \$1.00 east of Miss., \$2.00 West.) DTIS \$10.00



BENRUS — Government surplus wrist watch in one-piece unbreakable green delrin plastic case — water-resistant, shock-resistant, anti-magnetic construction. Unbreakable main-spring, sweep second-hand, 24-hour black luminous dial with white hands. Made to tough military specs, designed for everyday hard combat use. In excellent condition, with nylon strap. BWW \$8.95 P.P.

Would you believe a Digital Voltmeter for \$15.00? Would you believe \$25.00?

We supply a large 6 digit numeral precision counter, a In429 precision reference zener diode, a 10 turn 0.25% linearity potentiometer, and a D.C. motor. For \$15.00. You must beg, buy, borrow or steal a \$10.00 operational amplifier (Analog Devices Nexus or equivalent) and your ready to roll. Schematic included list price of components we supply is over \$175.00. Digital Voltmeter Kit DVM \$15.00



RECEIVER SHELL.

Antique telephone receiver shell - black plastic in perfect condition. Perfect encasement for walkie talkie miniature radio - almost anything! Alone, used as paperweight, also as float for those nautical bent. Anyway you have it a fun thing. Makes neat Salt & Pepper Shakers . . . ATR 4 for \$1.25 P.P.

B & F ENTERPRISES

GOV'T SURPLUS • ELECTRONIC • OPTICAL • HOROLOGICAL • MECHANICAL

P. O. BOX 44, HATHORNE, MASS. 01937



formerly FM BULLETIN

THE national FM'ers' journal

A monthly Ham Magazine for the Amateur who is interested in . . .

- SIMPLEX FM
- REMOTE OPERATION
- SIGNALING & TONES
- CONTROL TECHNIQUES
- CONSTRUCTION
- DECODING
- FREQUENCY LISTINGS
- MOBILE FM
- MOBILE RELAYS
- AUTOMATIC PHONES
- DESIGN DATA
- REPEATER INFO
- TRENDS
- OPERATION
- NEWS & VIEWS
- HUMOR
- SATIRE
- CLUBS
- ACTIVITIES
- DIRECTORIES
- EVENTS

\$3.00 per year or 2 years for \$5.00

SAMPLE COPY 35¢

FM MAGAZINE • 2005 HOLLYWOOD AVE., GROSSE POINTE, MICHIGAN 48236



NOW

RAZOR SHARP CW
RECEPTION WITH
YOUR TRANSCIEVER!

WITH A *Main* CWF-1
Between Your Headphones
And Your Rig

REQUEST BROCHURE \$19.95
Money Back
Guarantee

- ★ No Power Required
- ★ Plugs Into Phone Jack
- ★ Low Insertion Loss
- ★ 120 Cycles Narrow
- ★ 2 to 4 Ohms In. 2K Out



Dept. H-6
353 Pattie
Wichita, Kans. 67211
(316) 267-3581

BARRY PAYS . . . CASH FAST
You can be sure with Barry - Fair dealing since '38
Send lists of your unused TUBES, Receivers,
Semi Conductors, Vac. Variables, Test Equipment.
No Quantity too Small, No Quantity too Large
Write or Call now . . . BARRY W2LNI
BARRY ELECTRONICS
512 BROADWAY - NEW YORK, N. Y. 10012
212-WA 5-7000

BUILD YOUR AMATEUR RADIO LIBRARY

See Page 85

ETCHED CIRCUIT BOARDS

Novice Trans.	2.75	Novice Recvr.	2.75
RTTY Encoder	2.50	RTTY Decoder	4.00
UHF Dippers	2.25	SWR Bridge	1.25
Lab Supply	3.50	144 Conv.	5.75
Keyer	4.95	CP Osc. Mon.	1.25

Conn. Residents add Sales Tax.
Send order or Catalog request to . . .

**HARRIS CO., BOX 985,
TORRINGTON, CONN. 06790**

NOW!!! STOCKED IN U.S.A.

JOYSTICK

VARIABLE FREQUENCY ANTENNAS

Send for Brochure

SHORTWAVE GUIDE

218-H GIFFORD ST., SYRACUSE, N. Y. 13202

HIGHEST \$ \$ PAID FOR TUBES



120 WEST 18th STREET

NEW YORK 10011 . 212-242-7400

Free Tube List

BUCK-TEN BAGS

SILICON DIODES

PIV	1	12	20	40	50	100	240
AMP	AMP	AMP	AMP	AMP	AMP	AMP	AMP
50			.25	.50	.55		1.50
100	.12	.25	.35	.75	.80		2.00
200	.15	.30	.50	1.00	1.05	1.50	2.50
400	.18	.35	.70	1.25	1.30		3.00
500	.20	.50	.90	1.50	1.60	2.00	4.00
600	.24	.65	1.00	1.75	1.90		4.40
800	.30	.75	1.30	2.00			5.00
1000	.35	.90	1.40	2.35			

- 2N670 Germ Audio. Gain over 100 10/\$1.10
- FET's mostly C610-C615 types. w/spec sheet 3/1.10
- 200 miniature glass diodes, unchecked 200/1.10
- 2N424 MESA 80 watt 3/1.10
- CK-722, a real value 6/1.10
- VARACTORS experimental pack w/sheet 20/1.10
- 2N2875 20 Watt Planar 4/1.10
- 2N697 Hi freq 2 watt TO-5 15/1.10
- 2N696 Hi freq 2 watt TO-5 15/1.10
- VARACTOR 40 Watt sim to MA-4060A w/cir. ea. 5.00
- 1N251 Silicon diode, UHF mixer 20/1.10
- TO-5 Sil. power mix 2N498-2N546-2N549 10/1.10
- TO-3 Mix, 20-50 watt, 2N155-2N255 8/1.10
- MICRO TRANSISTOR Planar Epitaxial w/sht 25/1.10
- FLY SPECK transistor, micro miniature 8/1.10
- MICRO DIODE silicon 20/1.10
- 2N706 Hi freq. 400 mc 7/1.10
- BI-SWITCH make lamp dimmer etc. w/sheet 2/1.10
- 2N1417 Audio silicon NPN 15/1.10
- 2N670 Silicon audio 10/1.10
- 2N1059 NPN Germanium AF 10/1.10
- 2N613 PNP Germanium AF 8/1.10
- 2N404 Popular type PNP switching 8/1.10
- 2N414 PNP IF Germanium 6/1.10
- 2N990 Germ. RF factory branded 6/1.10
- 60 WATT silicon 2N1208-2N1209-2N1210 types 3/1.10
- 4 WATT silicon Mesa 2N498 4/1.10
- ZENER - 6 volt .2 amp 4/1.10
- GERMANIUM diodes Cleveite EM-1 20/1.10
- IN82 Hi freq. mixer diode 25/1.10
- TO-18 Hi-freq. switching RF transistors 25/1.10
- TO-5 Hi freq. switching RF transistors 25/1.10
- BI-DIRECTIONAL Silicon transistors 15/1.10
- 2N223 PNP germ AF, good gen. purpose 6/1.10
- 500 uufd Mica feed-thru button 15/1.10
- IBM MEMORY CORES w/spec sheet 200/1.10
- RESISTOR - MIX 100 units 1/2 watt 100/1.10
- DISC CERAMIC CAPACITORS, mixed 100/1.10
- 2000 volt 1 amp diode ea/.80
- 3000 volt 1 amp diode ea/1.20
- REED SWITCH miniature glass 6/1.10
- PHOTO-CELL resistive type 2/1.10
- PHOTO-CELL, generates electricity 2/1.10
- SILICON DIODES 1 1/2 amp mixed voltages 15/1.10
- GEIGER COUNTER chassis, less tube 4.50
- INFRA RED viewing tube, see in dark, w/specs 4.50
- AIR FORCE throat mike w/strap .60
- MICROPHONE, small spy type w/experiment sht 3/1.10

All above material shipped postpaid in the U.S.
Send 25c for large catalog of many many interesting items.

Above transistors may be marked or unmarked.

**JOHN MESHNA JR P.O. BOX 62
E. LYNN MASS. 01904**

MOCHTEN SIE WISSEN WAS DIE VHF- UND UHF- AMATEURTECHNIK IN EUROPA LEISTET?

Lesen Sie die UKW-BERICHTE, die autoritative Viertel-Jahres Veröffentlichung in Deutscher Sprache. Jedes Heft enthält sechzig Seiten mit praktischen Artikeln über VHF- und UHF-Radiotechnik, beige-tragen von den führenden Amateuren Europas.



INTERESTED IN WHAT EUROPEAN HAMS ARE ACCOMPLISHING AT THE HIGHER FREQUENCIES?

Read UKW-BERICHTE, the authoritative German quarterly, now with English summaries! Applications of the latest VHF and UHF techniques; equipment and antenna construction details. Each sixty-page issue packed with practical articles written by the most outstanding amateurs in Europe.

Annual subscription U.S.A. \$3.00, Canada \$3.25

H. Ingwersen, PAØAFN Box 87, Topsfield, Mass. 01983

INTERNATIONAL FIELD DAY

AUGUST 18
Sponsored by

BURLINGTON AMATEUR RADIO CLUB

HAS MOVED TO THE COUNTRY

THE OLD LANTERN INN
CHARLOTTE, VERMONT

ANTENNA RAISING CONTEST
MOBILE RF OUTPUT CONTEST
JUNK BOX AMPLIFIER CONTEST
BINGO FOR THE LADIES
SWAP SHOP & AUCTION SALE

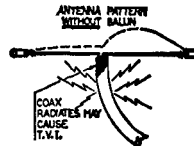
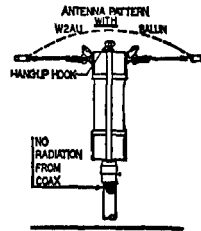
PRIZES • FOOD • FUN
& MUCH MORE

\$3.00 at the Gate
\$2.50 Early Bird Registration

WRITE

BILL FAKE, W1FS
30 South Hill Drive
Essex Junction, Vt. 05452

W2AU BALUN LETS ENTIRE ANTENNA RADIATE!



STOP WASTING YOUR SIGNAL! REMEMBER, YOUR ANTENNA IS THE MOST IMPORTANT PIECE OF GEAR YOU OWN.

- No Radiation from Coax
- No Center Insulator Needed
- Perfect for Inverted Vees (Use Hang-up Hook)
- Built-in Lightning arrester
- Broad-Band 3 to 40 Mc.
- Takes Legal Power Limit
- Two Models:
 - 1: 1 50 ohm coax to 50 ohm balanced
 - 4: 1 75 ohm coax to 300 ohm balanced
- A must for Inverted Vees, Doublets, Quads, Yagis and Multiple Dipoles.

\$12.95 AMATEUR NET

W2AU Complete pretuned Fiberglass Quad\$99.95
W2AU Complete pretuned Vinyl Quad.....\$64.95

UNADILLA RADIATION PRODUCTS
Unadilla, New York 13849

GET IT from GOODHEART!

EVERYTHING UNCONDITIONALLY GUARANTEED

SILIC. RECTIF. 8000 PIV 400 MA. Large user's termin. invent., not rejects! Slater SLA08-2. Max: reverse, 2 uA; fwd drop, 8.2 v. Cost \$8 ea. PAIR Postpaid \$5.30

Brand New VHF rcvrs look like BC-453 Command but are 9-tube 108-135 mc. 2 uv sens., 2 rf's, 3 IF's; noise lmtr; avc. W/schem., instruct., spline knob, & graph to set freq. by counting turns. A.R.C. Type 13B, 28v htr wiring; shpg wt 7 lb. **\$27.50**

R-23/ARC-5 Cmd rcvr 190-550 kc. Shpg wt 9 lb. 14.95
A.R.C. 12 #22 Cmd rcvr 540-1600 kc. 9 lb. 17.95
LM-14 freq. meter, .01% 125 kc-20 mc. 15 lb. 57.50
TS-323/UR freq. meter 20-480 mc. .001% 169.50
BC-221's OK \$57.50 TS-175 OK 125.00
CLOSING OUT Radio Receivers 38-4000 mc at CRAZY LOW PRICES! Ask for APR-4Y/CV-253 sheet.

SP-600-JL Rcvr. 0.54-54 mc, aligned, grtd. 250.00
R-392/URR grtd OK, w/AC sply & book. 525.00

WANTED: GOOD LAB TEST EQUIPT & MIL COMMUNIC.

TIME PAY PLAN: Any purchase totaling \$160.00 or more, down payment only 10%

WE PROBABLY HAVE THE LARGEST & BEST INVENTORY OF GOOD LAB TEST EQUIPMENT IN THE COUNTRY, BUT PLEASE, DO NOT ASK FOR CATALOG! ASK FOR SPECIFIC ITEMS OR KINDS OF ITEMS YOU NEED! WE ALSO BUY! WHAT DO YOU HAVE?

R. E. GOODHEART CO. INC.

Box 1220-HR, Beverly Hills, Calif. 90213
Tel: Area 213, office 772-5707, messages 775-5342

WE PAY HIGHEST PRICES FOR ELECTRON TUBES AND SEMICONDUCTORS

H & L ASSOCIATES

ELIZABETHPORT INDUSTRIAL PARK
ELIZABETH, NEW JERSEY 07206

(201) 351-4200

**HAMS! DON'T BUY USED TUBES —
COMPARE THE FOLLOWING PRICES**

6J6	.45	0B2	.60	807	1.95	404A	2.25
6TB	.75	2X2	.50	6146	2.50	1A2X	.39
6UB	.72	25L6GT	.45	6360	3.00	25L6	.48
0A3	.80	7025	.55	12AU7	.52	2E26	2.50
0C3	.60	6A05	.55	2021	.45	811A	3.75
0D3	.60	6BQ7	.88	65A6	.65	8236	12.95
0A2	.70	6CG7	.54	417A	2.25	4-65A	10.00
4-125A	28.00	UX200A	1.50	4-400A	37.50	4PR60B	55.00
4X150A	12.50	4-250A	35.50	4-1000A	80.00	4CX250B	21.00
80	1.15	10Y	.59	1625 (same as 807-12V)	.95		
250TH	25.00	3-1000Z	42.00	4-1000Z	72.00	WE807/350B 1.25	

NO PULLS — NO REBRANDS — ALL BRAND NEW
Weston Dual Microammeters 0-200, \$3.98; Muffin Fans 115V AC Rmvd. from New Equip., \$4.98; Howard Fans 100 CFM 115V AC Rmvd. from New Equip., \$2.98; 25 ft. 2-3 Wire Shld. RC Cable #14, \$1.35; 12 V DPST 150 Ohm Relay, .73; 12V Solenoid 40 Ohm 300MA, .89; Dual Crystal Sockets, 10; Ohmite Rheostat 25 Ohm 1A, .49; All sizes Allen Bradley Vol. Controls, .75; 500 Ohm Vol. Control Wi. Sw. 1/2, 2 Meg., .35; 500 K Vol. Control w/o Sw., .25; Silicon Repl. for 024, 5U4, 5Y3, 5A5A, 5Z4, .98; Kit of Tested Germanium Diodes, 1N34A, etc., \$1.00; 8 Top Hat 450 PIV, 500 MA, \$1.00; 8 Sil. Epox. Diodes 400-750 PIV, 1 Amp, \$1.00; 4 Power (20W) Transistors, \$1.00; WE 701A-1000W Tetrode \$5.95; 5 Transistor Circuit Boards containing up to 6 Transistors, plus Diodes, Resistors, Capacitors, etc., .89. Sale on brand new CH & H & H Toggle Switches — never used — Removed from new equipment.

SPST 8 amp	\$1.50 ea	SPST 8 amp	\$1.65 ea
DPST 15 amp	2.95 ea	DPST 15 amp	1.85 ea
		SPST Slide SW.	8/91.00

Oil Condensers: 600 W.V.D.C. 1000 VDC 3MFD 2000 VDC — SPECIAL \$2.00

1 MFD 40	10 MFD 2.25 (5 MFD 3.00)	2 MFD 48
4 MFD 65	25 200V 11.00	1 MFD 10
1 MFD 80	10 2 MFD 800V 31.00	8 MFD 185
10 MFD 95	1 MFD 100V 4.25	8 MFD 18.95

6.3V Fil. Transf. PRI 115V Sec. 6.3V 1.5A, .39; 6 Audio Output Trans., \$1.00; 12 Asst. Dual Controls, \$1.00; 12 Spkr. Cords w/Plug, \$1.00; 100 Asst. AB-IRC 1/2-1-2W Res., \$1.00; 50 Asst. Mica Cond., \$1.00; 15 Controls, \$1.00; 50 Asst. Paper Tub. Cond., \$1.00; 12 Asst. Elec. Cond. Kit, \$1.00; 20 Asst. Wire Wound 5-25W Resistors, \$1.00; Universal Tape Recordg. Motor H.D. 1500 rpm, \$3.95; Dual Speed Recordg. Motor 2000 & 3000 rpm, \$3.50; FM Tuner can be hooked up, superhet w/Tube & Dial, \$2.67; UHF TV Converter, \$3.95; All Types Hi Volt. Xmitg. Cond.: Write for Lowest Prices. Canadians Must Remit in U.S. Funds. No C.O.D. Orders. The above is only a sample of over 5,000 bargains we have. Min. order \$5.00 not including postage (extra). Send card for bargain tube and parts catalog. Write for quotes on brand new RCA, GE, EIMAC Tubes.

UNITED RADIO COMPANY
56 FERRY ST., NEWARK, N. J. 07105
Established 1920

NOISE BLANKER

Removes interference generated by auto ignitions, appliances, radars, and other sources of high energy pulse noise.



Specifically designed for VHF operators requiring maximum noise suppression for reception of weak DX and scatter signals. Connects in the coax between converter and receiver. Solid-state design features silicon Field Effect Transistors for reliability and minimum cross-modulation. Specify converter output frequency. Choice of 12-18, 100-140, 125-170 V DC; Phono or BNC connectors. Send for technical brochure \$29.95 ppd.

WESTCOM ENGINEERING COMPANY
P. O. Box 1504 San Diego, Cal. 92112

ATV'ERS

For the largest US ATV magazine; Technical reports & ATV directory SEND \$2 for a 1 year subscription TO:

A5 MAGAZINE

150 Delong Ave.,
Dumont, NJ 07628

SURPLUS WANTED

EQUIPMENT WITH PREFIXES ARA, ARC, ARM, ARN, APA, ASN, ASA, APN, APR, ARR, ASQ, GRR, GRC, GRM, GPM, VRC, UFX, URA, URR, URM, USM, UPM, SG, MD, PRM, PSM, PRC, TMO, TRM, TED, SPA, SRT, CU. COMMERCIAL EQUIPMENT BY ARC, BIRD, BOONTON, BENDIX, COLLINS, MEASUREMENTS, H-P, NARDA, GR, SPERRY, ETC.

TOP CASH DOLLAR PAID OR TRADE

WE STOCK NEW HAM GEAR

WRITE - WIRE - PHONE (813) 722-1843
BILL SLEP, W4FHY

SLEP ELECTRONICS **CO.**
2412 HIGHWAY 301 N. ELLENTON, FLORIDA 33532
PHONE (813) 722 1843

**CQ de W2KUW
BEST OFFER!!**

Paid for any piece of aircraft or ground radio units, also test equipment. All types of tubes. Particularly looking for 4-250 • 4-400 • 833A • 304TL • 4CX1000A • 4CX5000A et al. 17L • 51X • 390A • ARM • GRM • GRC • UPM • URM • USM units.
TED DAMES CO., 310 Hickory St., Arlington, N.J. 07032

RADIO COMMUNICATION CO.

THE COMPLETE HAM STORE
SERVING COLORADO and ADJACENT STATES
W. 100 Avenue and Alkire Street
Arvada, Colorado 80002
303-466-3000



KEEP UP TO
DATE ON
YOUR DXING

A weekly magazine (16 to 24 pages each week).

Current DX that's on the air, and info about what's planned for the immediate future. What's being heard by the boys. Etc.

FULL DX INFO EVERY WEEK.

Per year—Surface mail (they say most 1st class mail actually goes via air) \$11.00

The DXERS Magazine, (W4BPD)
Route 1, Box 161-A,
Cordova, S.C. 29039

the permaflex key

- both a twin lever & straight hand key in a pivotless 2 paddle design.
- gives instant choice of automatic semi-automatic & straight hand keying.
- use directly with any transmitter or through an electronic keyer.
- 8 amp. gold diffused silver contacts adjust from 0-.060" & 5-50 grams.
- distinctive blue paddles are of rugged G-10 fiberglass epoxy.
- cabinet is 16 gauge polished chrome steel: 1.95" sq. x 3.75", paddles extend 1.25", weight app. 1 pound.
- silicone rubber feet for stability.
- 100% US made & guaranteed for 1 yr.



1995 complete, ppd. u.s.a. send cert. ck. or m.o. n. y. res. add 5% tax

the James research company
11 schermerhorn st., brooklyn n.y. 11201

WE PAY CASH FOR TUBES

LEWISPAUL ELECTRONICS INC.
303 W. Crescent Avenue
Allendale, New Jersey 07401

HAM CLUBS

SPECIAL GROUP RATES AVAILABLE

WRITE

HAM RADIO MAGAZINE

Greenville, N.H. 03048

Radio Amateurs Reference Library of Maps and Atlas



WORLD PREFIX MAP — Full color, 40" x 28", shows prefixes on each country . . . DX zones, time zones, cities, cross referenced tables postpaid **\$1.00**

RADIO AMATEURS GREAT CIRCLE CHART OF THE WORLD — from the center of the United States! Full color, 30" x 25", listing Great Circle bearings in degrees for six major U.S. cities; Boston, Washington, D.C., Miami, Seattle, San Francisco & Los Angeles. postpaid **\$1.00**

RADIO AMATEURS MAP OF NORTH AMERICA! Full color, 30" x 25" — includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus informative information on each of the 50 United States and other Countries. postpaid **\$1.00**

WORLD ATLAS — Only atlas compiled for radio amateurs. Packed with world-wide information — includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica — a complete set of maps of the world. 20 pages, size 8 3/4" x 12" postpaid **\$2.00**

Complete reference library of maps — set of 4 as listed above postpaid **\$3.00**

See your favorite dealer or order direct.

**WRITE FOR
FREE
BROCHURE!**

RADIO AMATEUR

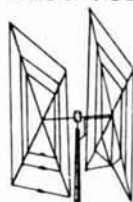


callbook INC.

Dept. Q 4844 W. Fullerton Ave.

Chicago, Ill. 60639

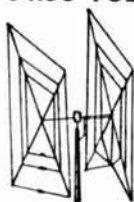
64.95 FOB



ATTENTION! ALL QUAD USERS!

A NEW FIRST IN QUAD SPREADERS NEW TYPE QUAD SPREADER THAT BREAKS THE PRICE BARRIER.

64.95 FOB



W2AU now brings you a new W2AU Super 2el. tri-band 10-15-20 meter quad using the all new EXCLUSIVE heavy duty vinyl jacketed spreader.

This new spreader is made of selected bamboo entirely encased in a heavy duty vinyl covering, making it salt spray proof and completely weather resistant. No varnishing or treating necessary. Dark brown in color for resistance to ultra violet sun rays.

W2AU Super 2el. tri-band, 10-15-20 meter quad with vinyl coated spreaders. Introductory price **\$64.95** complete quad.

W2AU Fiberglass model 2el. tri-band 10-15-20 meter quad **\$99.95** complete quad.

W2AU QUAD ACCESSORIES NOW AVAILABLE TO HOME-BREWERS

Set of 8 Vinyl Jacketed spreaders, 12'6" long (sets only)	\$21.50 set
W2AU quad spiders to fit 2" boom, heavy cast aluminum	\$6.95 ea.
Set of 8 Fiberglass spreaders 12'6" long (sets only)	\$54.95 set
Boom to motor-driven mast mount plate, complete with all hardware	\$5.95

ALL PRICES FOB UNADILLA, N. Y.

UNADILLA RADIATION PRODUCTS, UNADILLA, NEW YORK

Manufacturer of W2AU Baluns and Quads. See page 93 this issue.

YES! *ham* *radio*

will now accept

CLASSIFIED ADVERTISING

Starting with the September issue of **Ham Radio** we will have a classified advertising section each month open to both commercial and non-commercial ads.

The dead-line for each issue will be the 15th of the second preceding month. So hurry if you want to get rid of that old receiver or what ever you have.

Ham Radio can not check out each advertiser and therefore can not be held responsible for claims which are made. Our liability for correctness of material will be limited to a corrected ad in the next available issue. **Ham Radio** reserves the right to reject unsuitable copy.



Non-commercial ads 10¢ per word.

Commercial ads 25¢ per word.

Payment must be included with your order. No agency discounts.



Send your order today to

**CLASSIFIED ADS
HAM RADIO MAGAZINE
GREENVILLE, N. H. 03048**

Advertisers iNdex

A-5 Magazine	94
Aerotron, Inc.	Back cover
Autovolt, Inc.	70
B & F Enterprises	91
Barry Electronics	92
Bob's Amateur Electronics	83
Ceco	92
Comdel, Inc.	86
Comtec, Book Division	85
Dames Co., Theodore E.	94
Drake Co., R. L.	2
DXer's Magazine	94
Edwards Electronics	55
Eimac Division of Varian	7
Electronic Applications Co.	76
Electronics Center, Inc.	80
Evans Radio	88
Evansville Amateur Electronic Supply Co.	59
FLIRC	89
FM Magazine	91
Goodheart Co., Inc., R. E.	93
Gordon Co., Herbert W.	Cover III
H & L Associates	93
Hafstrom Technical Products	88
Ham Radio Magazine	71, 84, 96
Harris Co., The	92
Henry Radio Stores	57
International Communications and Electronics, Inc.	81
International Electronic Systems, Inc. .	51
International Field Day	93
James Research	76, 95
Lewispaul Electronics, Inc.	95
Main Electronics, Inc.	92
Meshna, John, Jr.	87, 92
Military Electronics Corp.	87
Mosley Electronics, Inc.	1
Quement Electronics	47, 63
Radio Amateur Callbook, Inc.	90, 95
Radio Communication Co.	94
Raytrack Co.	Cover II, 39
Shortwave Guide	92
Slep Electronics Co.	94
Stellar Industries	89
Swan Electronics	5, 77
Tri-Ex Tower Corp.	35
Tristao Tower Co.	87
UKW Magazine	93
Unadilla Radiation Products	93, 95
United Radio Co.	94
Vanguard Labs.	90
W3KT QSL Service	89
Weinschenker, M.	88, 90
Westcom Engineering Co.	94

YAESU FL-2000

A Sensible Price for a Linear Amplifier of Excellent Design

(Only \$250.00 FOB Harvard)



Two months ago readers of this magazine noted our advertisement in this space on the Yaesu FTdx400-500 transceiver, which we are selling so many of these days. Its companion linear amplifier is especially noteworthy for it is priced beneath the level of comparable American kit manufacturers without the cost or worry of taking the time to build the item. Yet, it does an amazing job of working with the average transceiver which needs a further boost in power. The Yaesu FL-2000 linear is a grounded grid linear, using 4 type 6KD6 General Electric tubes. Its design includes ALC with an external tap for exciter control, a built-in low pass filter, which is especially important these days, plate current and VSWR monitoring from the front panel. Either manual or automatic relay operation is controlled by the exciter, without cable changing. This amplifier includes a whisper quiet cooling fan.

This is an 80 meter through 10 meter full band coverage linear, rated at maximum power input of 1000 watts DC and 1500 watts PEP input, with less than 10% dis-

tortion. It is not recommended for use in AM operation. It requires between 30 and 100 watts of PEP input for full power output.

The FL-2000 will operate on either 115 volt or 230 volt, 60 cycle power, but is normally wired and furnished for 115 volt operation. The input impedance is 60 ohms; the output impedance is made to match anything between 50 and 100 ohms. This is an attractive desk-top linear, 6¼ inches high, 14½ inches wide and only 11½ inches deep. Its net weight is 40 pounds, with shipping weight about 55 pounds. The panel is beautifully finished with a non-specular chrome finish and back-lighted meters. The amplifier is beautifully built internally and adequately designed for long service. This linear should be the choice of those who are interested in obtaining maximum performance and minimum price. We carry these linears in depth and do sincerely recommend them! They can be used with all standard brand transceivers that we know of. Send in your order today.

HERBERT W. GORDON COMPANY

Harvard, Massachusetts 01451 • Telephone 617 — 456 — 3548

"Helping Hams to Help Themselves"

Amateur Equipment



GSB 201 SSB RF LINEAR AMPLIFIER

Exceptionally compact — only 8½" high, 12½" wide and 17" deep — the GSB 201 lends itself readily to table-top mounting. Finished in blending light greys, it presents a handsome, clean-cut appearance. This linear amplifier provides 10 db gain on the 80, 40, 20, 15 and 10 meter bands.



3341 2-METER & 3342 6-METER COMMUNICATOR IV

Transmitter power of the Communicator IV is greater than ever at 24 watts input. High level speech clipping and 10 watts of audio insure full talk power! Transmitter is crystal controlled, offers choice of six frequencies. Broadband circuitry in driver eliminates panel controls.



GSB-6 SIDEBAND COMMUNICATOR

SSB, AM and CW operation. VFO or Crystal Control. Matching AC or DC Power Supply. Covers 6 meter band in 1 Mc segments. Designed for SSB, AM and CW operation on the entire 6 meter band, the superb Gonset 910B Sideband employs solid state design in all low level circuits for maximum dependability and minimum current consumption and utilizes common circuits in the oscillator, IF section and crystal lattice filter to minimize size and weight.



903A & 913A RF POWER AMPLIFIERS

The 2 meter and the 6 meter VHF amplifiers have a power input of 500 watts peak. Operating Class AB, for SSB, service and class C for AM, CW MCW, FSK, FM and PM service, they also have an extended frequency range to cover the MARS, CAP and other military frequency allocations. In addition, both units are rated for CCAS (Continuous Commercial and Amateur Service).



See your favorite distributor • Write for free catalog
GONSET A DIVISION OF AEROTRON, INC.
P. O. BOX 6527 / RALEIGH, NORTH CAROLINA 27608