

75 cents

hrcm

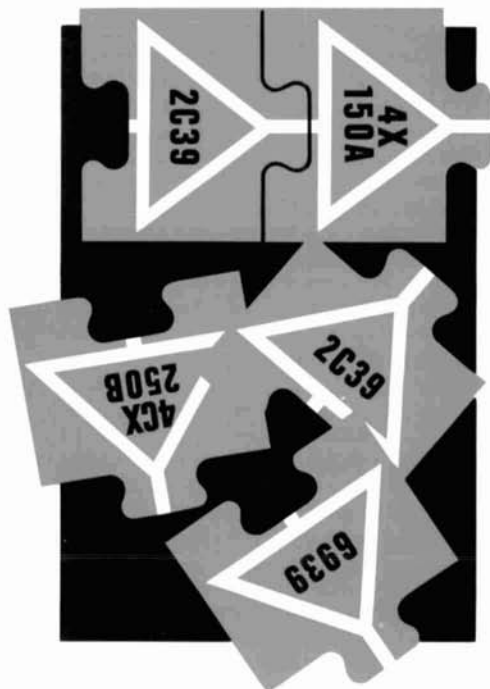
focus
on
communications
technology . . .

ham radio

magazine

JUNE 1971

a practical approach to 432-MHz SSB



this month

- fm carrier-operated relay 22
- audio agc systems 28
- practical intergrated circuits 40
- low-noise 1296-MHz preamplifier 50

THE ALPHA SEVENTY ISN'T FOR EVERYONE...

The *ALPHA SEVENTY* is to the serious amateur radio operator something like Porsche and Mercedes *combined* to the serious automotive enthusiast. Just as almost any car will transport you at maximum legal speed from point A to point B on a smooth, straight highway, so will almost any "legal limit" amplifier make your signal louder at the other end.

But the *ALPHA SEVENTY* is at the same time a thoroughbred high-performance machine and a quiet, luxurious workhorse.

The *ALPHA SEVENTY* is nimble and easy-handling in competition. Precisely resettable controls make six-second band changes routine; like a precision short-throw gear box, they make "hunting" unnecessary and reduce the probability of error. Should you nevertheless "miss the gate" during a fast middle-of-the-night band change, you won't end up off the air with a handful of burned up bandswitch contacts or a melted down tank coil (our bandswitch is rated for 6500 volts and 20 amperes, continuous). Battleship-rugged electrical and mechanical construction throughout takes abuse in stride.

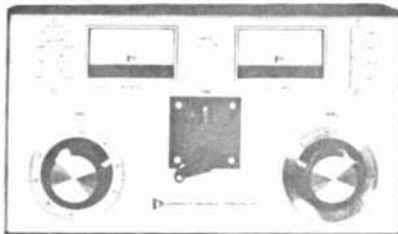
The *ALPHA SEVENTY* is all muscle. We believe that sheer size and weight are no more advantageous in high performance amplifiers than in high performance automobiles. Thoughtful design, and the utilization of state-of-the-art components (like a power transformer with core of tape-wound Silectron[®] steel, plus vacuum-dielectric plate capacitor and T/R relays), has eliminated dead weight and needlessly wasted space. The *ALPHA SEVENTY* sits right at your fingertips on the operating desk without shouldering everything else aside.

The *ALPHA SEVENTY* is ideal for applications demanding outstanding endurance. Despite its convenient size, it's as much at home on teletype or slow scan TV as it is on SSB or CW. Conservative electrical design and premium quality components insure an ample margin of safety even when running at a full locked-key kilowatt for hours -- or days -- on end. And of course that means it's tolerant of errors ... easy to use because it's hard to hurt.

For all its exceptional performance capability and ruggedness, the *ALPHA SEVENTY* is probably the most civilized amplifier you'll ever share your shack with. Even "flat out" it operates in luxurious quiet, thanks to exclusive vapor phase cooling. Total heat generation is reduced to an absolute minimum by ETO's electronic bias control -- plate dissipation is *zero* except when an RF signal is actually present. Heat is flushed quietly out the rear of the cabinet, away from the operator. It's perfectly safe to stack other equipment directly on top of the *ALPHA SEVENTY*, or to lay your Polaroids right above the amplifier tube!

No, the *ALPHA SEVENTY* isn't for everyone. But if you appreciate the *exceptional* in performance ... versatility ... craftsmanship ... *uncompromised quality* ...

THE ALPHA SEVENTY IS FOR YOU!

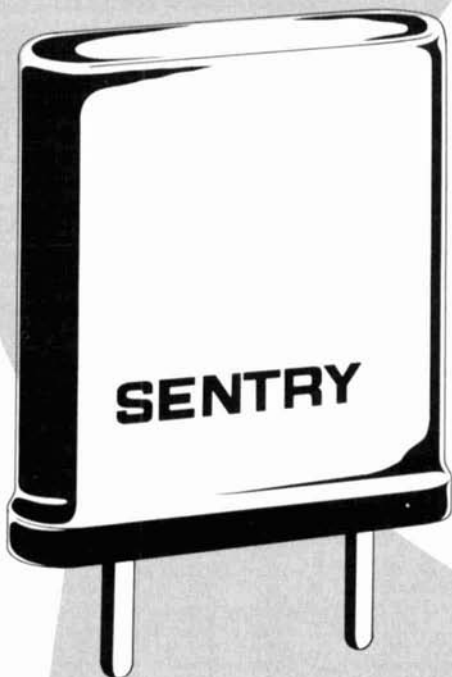


We haven't even mentioned many other unique features of the ALPHA SEVENTY space limitations. Write for a fully detailed and illustrated brochure.



EHRHORN TECHNOLOGICAL OPERATIONS, INC.
BROOKSVILLE, FLORIDA 33512 • (904) 796-8400

IF YOU'VE EVER USED A REPEATER,



YOU'VE USED A SENTRY CRYSTAL

If you haven't
already received
a copy of our **NEW**
1971 Catalog of Precision
Quartz Crystals & Electronics
for the Communications Industry,
SEND FOR YOUR COPY TODAY!

Somewhere along the line, in virtually every ham repeater in the world, you'll find a couple of Sentry crystals.

Repeater owners and FM "old-timers" don't take chances with frequency—they can't afford to. A lot of repeater users depend on a receiver to be on frequency, rock stable...in the dead of winter or the middle of July. The repeater crowd took a tip from the commercial "pros" a long time ago—and went the Sentry Route.

That's one of the reasons you can depend on your local repeater to be there (precisely there) when you're ready to use it. FM'ers use the repeater output as a frequency standard. And for accuracy, crystals by Sentry are THE standard.

**IF YOU WANT THE BEST,
SPECIFY SENTRY CRYSTALS.**

*"Ask the Hams and Pros
Who Build Repeaters!"*



SENTRY MANUFACTURING COMPANY
Crystal Park, Chickasha, Oklahoma 73018

PHONE: (405) 224-6780

TWX-910-830-6425

Brand new
from
Henry



TEMPO FM-V

*setting
new highs in
performance
and value!*

\$249.

Microphone included

EXTRA FEATURES

- **METERING TEST SOCKET**
A built-in test socket can be used with any 50-100 μ A meter to monitor all transmitter and receiver stages, including DISCRIMINATOR (for zeroing to frequency).
- **OPERATION/MAINTENANCE MANUAL**
A large manual includes photos and schematics as well as complete instructions for checkout, adjustment, and alignment of the transceiver.

FM-V PERFORMANCE SPECIFICATIONS

OVERALL
Frequency Range: 146-148 MHz
No. Channels: 8
Power Supply Requirements:
12-15 VDC at 2A

Dimensions:
2.36 in. high
5.9 in. wide
7.66 in. deep
Weight: 4.5 lb
Active Devices:
Transistors - 26
Integrated Circuits - 2
Diodes - 15

RECEIVER
I-Fs:
First - 10.7 MHz
Second - 455 kHz

Freq. Stability:
 $f_o \times 0.00001$
Sensitivity:
For 20 dB quieting - 0.6 μ V
Usable threshold - 0.3 μ V
Selectivity (at full quieting):
-6 dB at ± 6 kHz
-70 dB at ± 15 kHz
Audio out:
1.0W
TRANSMITTER
RF output: 12W
Multiplication factor: 12
Spurious:
Better than -60 dB
Freq. stability:
 $f_o \times 0.00001$
Deviation:
Adjustable, 5-15 kHz

- **OPTIONAL TEST-SET ACCESSORY**
An attractive test set is available as an optional add-on accessory. The test set mates with the built-in test socket, and includes a sensitive microammeter that can be switched to monitor transmitter oscillator, multiplier and driver stages as well as first and second local oscillator stages of the receiver and discriminator current. \$29.00
- **STANDARD HENRY WARRANTY**
The FM-V is backed by Henry's standard warranty that is your assurance of excellence in quality of equipment, both mechanical and electrical.

Henry Radio

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

The Tempo/fmv is also available at other selected distributors in different areas of the U.S. Or you can order direct and we will ship. . . across the street or around the world. Call or write for specifications and terms.

"World's Largest Distributor of Amateur Radio Equipment"

staff

James R. Fisk, W1OTY
editor

Nicholas D. Skeer, K1PSR
whf editor
J. Jay O'Brien, W6GDO
fm editor

Alfred Wilson, W6NIF
James A. Harvey, WA6IAK
associate editors

Jean Frey
art director
Wayne T. Pierce, K3SUK
cover

T. H. Tenney, Jr. W1NLB
publisher

John B. Morgan, K1RA
advertising manager

offices

Greenville, New Hampshire 03048
Telephone: 603-878-1441

ham radio magazine is
published monthly by
Communications Technology Inc.
Greenville, New Hampshire 03048

Subscription rates, world wide:
one year, \$6.00, three years, \$12.00.
Second class postage
paid at Greenville, N. H. 03048
and at additional mailing offices

Foreign subscription agents:
United Kingdom:
Radio Society of Great Britain,
35 Doughty Street, London WC1, England.

All European countries:
Eskil Persson, SM5CJP, Frotunagrand 1,
19400 Upplands Vasby, Sweden.

African continent:
Holland Radio, 143 Greenway,
Greenside, Johannesburg,
Republic of South Africa

Copyright 1970 by
Communications Technology, Inc.
Title registered at U. S. Patent Office.
Printed by Wellesley Press, Inc.
Wellesley, Massachusetts 02181, U. S. A.

ham radio is available to the blind
and physically handicapped on magnetic tape
from Science for the Blind,
221 Rock Hill Road, Bala Cynwyd,
Pennsylvania 19440.
Microfilm copies of current
and back issues are available
from University Microfilms,
Ann Arbor, Michigan 48103.

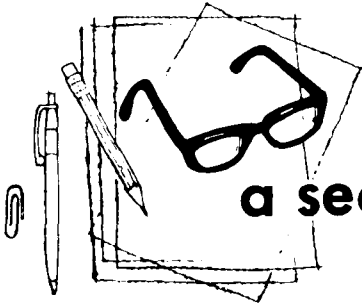
Postmaster: Please send form 3579 to
ham radio magazine, Greenville,
New Hampshire
03048

hr

ham
radio
magazine

contents

- 6 practical approach to 432-MHz ssb**
Frederick J. Telewski, WA2FSQ
- 22 fm carrier-operated relay**
Murray Ronald, VE4RE
- 24 high-frequency antenna matcher**
Albert G. Shafer, W4SD
- 28 audio agc systems**
Courtney Hall, WA5SNZ
- 34 antenna rotator repairs**
Fred M. Woolner, WA1ABP
- 36 electronic hand keyer**
H. Paul Clampit, K5TCK
- 40 integrated circuits**
Edward M. Noll, W3FQJ
- 50 low-noise transistor 1296-MHz
preamplifier**
Gandolph Vilardi, WA2VTR
- 56 transistor power-dissipation ratings**
James E. Nyffeier, WN9CGW
- 60 transmitter tuning unit for the blind**
Don C. Miller, W9NTP
- 63 Ten Tec RX10 communications
receiver**
T. H. Tenney, W1NLB
- 4 a second look**
- 94 advertisers index** **66 ham notebook**
- 40 circuits and techniques** **70 new products**
- 83 flea market** **94 reader service**



a second look

by jim
fisk

A whole new class of broadband high-power rf amplifiers is about to hit the market; under study for some time, they use both vacuum-tube and semiconductor technology. The EBS — electron-bombarded semiconductor — amplifier consists of an electron-gun modulation system, semiconductor target and output coupling network, all within a glass or ceramic envelope. The semiconductor target is simply a pair of silicon diodes, each consisting of two metallic electrodes with a pn junction under the top contact.

Amplifier operation is based on a well-known fact: A modulated electron beam can control the current in a reverse-biased semiconductor junction. In the EBS system shown in **fig. 1** the electron beam is intensity modulated by an input signal on the grid. The high-power beam electrons that strike the silicon target create thousands of electron-hole pairs. Since there is a high bias voltage across the target, the free electrons are attracted to the far contact; the holes return quickly to the bombarded contact.

In the absence of the electron beam there is negligible current flow through

the silicon. However, when illuminated by the electron beam, output current is proportional to beam current, and the device acts as a linear amplifier. The rf gain of the EBS amplifier is controlled by the current gain in the silicon target and the modulation sensitivity of the electron beam. Present laboratory amplifiers provide gains in excess of 40 dB with efficiencies over 65%.

The electron beam can also be deflection modulated as in conventional cathode-ray tubes. With a deflection-modulated EBS amplifier and two semiconductor targets, no beam current is intercepted when the beam is not modulated. With an input signal, the electron beam is deflected from one target to another; the positive portion of the sine wave is generated in one diode and the negative portion generated in the other. This is true class-B operation and provides high power-output capability.

The EBS amplifiers presently reaching the commercial market are limited to operation below 1500 MHz. However, engineers are working on new designs that should provide operation up to 5000 MHz. Although it will be some time before these devices find their way into the amateur market — and then probably by way of the surplus market — the EBS amplifier offers an alternate approach to the serious uhf amateur who wants to generate prodigious amounts of rf power on 1296 MHz and above.

Jim Fisk, W1DTY
editor

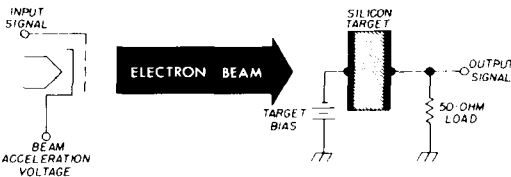
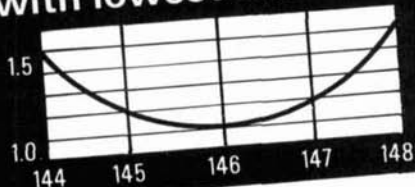


fig. 1. Basic EBS amplifier consists of modulated electron gun and semiconductor target.

with **HUSTLER** VHF mobiles

you can be sure of **OPTIMUM GAIN** with lowest SWR...

Typical
SWR—
BBL
Models



to push
your signal
MILES
more...

6 & 2 METER MOBILE

Heavy duty, precision fit, four section telescopic antenna tunable separately for combined six and two meter operation. Extends to 44". Collapses to 22".

Model HF-2: Antenna supplied with 3/4"-24 base to fit any standard antenna mount. \$9.50

Model HF-62: Supplied with automotive eight ball base for fender or cowl mounting. Includes 60" RG-58-U and connectors. \$11.95

Tops in Rooftops

140-500 MHz—UHF/VHF Antenna
Low profile, roof top with factory attached cable—installs from outside without disturbing car header. 17-7 PH stainless radiating element—field trimmed for frequencies between 140 and 500 MHz. Complete with 15' RG-58-U coaxial cable.

Model UHT-1
\$7.75

Trunk Lip Mount

140-500 MHz UHF/VHF
Easy to install on side or rear of trunk lip. No holes to drill or coax to trim. 17-7 PH stainless steel radiating element. Chart included for 140-500 MHz coverage. Complete with 17' RG-58-U and PL-259

Model THF
\$12.95

NEW!

2 METER POWER GAIN

143-149 MHz

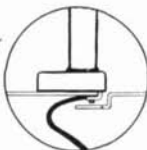
3.4 db gain— $\frac{1}{2}$ wavelength
Power rating: 200 watts FM

Get the experience of solid communications, extended range and full quieting with the Hustler BBL models. Optimized gain performance with lowest SWR and the superior mechanical construction will give you the extra advantage. Both models supplied operational, ready for easy installation.

Model BBL-144: Mounts on any flat surface in 3/4" hole—easy installation on roof, (without pulling cars' header), deck or fender—complete with adjustable, taper ground stainless steel radiator, stainless steel spring. Overall height approximately 47", 17' RG-58-U coax with PL-259 connector. \$27.70

Model BBLT-144: Same as BBL-144 with Hustler trunk lip mount for no holes to drill installation on side or rear of trunk lip. Heavy duty mount assures "stay-put" operation, positive RF ground for lowest SWR and completely hidden cable. \$34.70

Exclusive Hustler "break cable" assembly for simplest installation of all!



HF-62 HF-2



BBLT-144

BBL-144

World leader in Antenna Mounts—send for Catalog today!

NEW-TRONICS CORP.

15800 COMMERCE PARK DRIVE
BROOK PARK, OHIO 44142

Available From
All Distributors who
Recognize the BEST!

World Wide Export, Roburn Agencies, Inc., 349 W. 14th St., New York, N.Y. 10014, Cable Address: Roburnage - New York

a practical approach to 432-MHz ssb

A survey of
techniques
and devices
capable of generating
ssb on 432 MHz

Fred Telewski, WA2FSQ, 460-40 Old Town Road, Port Jefferson Station, New York 11776

This article is the result of a one year study of techniques and devices applicable to 432 MHz ssb. I believe the techniques described here represent the best alternatives presently available. In each case I considered a number of approaches; the most efficient* are treated in detail, while the disadvantages of the others are discussed in an effort to acquaint you with some of the pitfalls. This by no means implies that the techniques not advocated are impossible; the non-recommended methods are feasible but at a much higher overall cost.

In an attempt to make this article as comprehensive as possible, all components were built in modular form. While this adds slight additional cost because of patch cables it permits the ultimate in versatility and allows verification tests of all circuit arrangements. Finally, all tests were made with calibrated laboratory test equipment. This provides a valid data base in areas which are normally troublesome to the amateur (i. e. spurious output and intermodulation distortion).

introduction

While operating on the 432-MHz band during the past several years I have noticed a definite lack of effective modulation on most signals. Although a large number of operators cling to cw (and its

*Efficient in terms of electrical efficiency, number of components and cost.

weak-signal effectiveness cannot be disputed) it disturbs me to see many contacts severely limited in their ability to exchange information when conditions permit the use of higher density modulation. Though amateurs are not hampered in their ability to generate power at 432

the various devices that will function as amplifiers at 432 MHz. Linear uhf transistors are prohibitive because they are expensive and limited to low power.

Klystrons, amplitrons and cross-field amplifiers, while capable of high power, are not suitable due to cost and com-

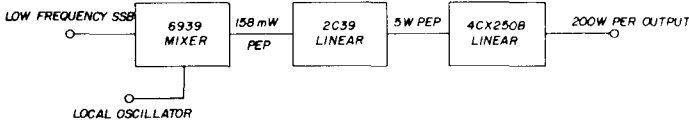


fig. 1. Proposed system for running 500 watts PEP input on 432 MHz. Efficiency of final stage is assumed to be 40%.

MHz they are apparently limited in their ability to modulate it efficiently.

It is the philosophy of this article to provide you with more than a cookbook which tells you where to cut, bend and drill. While much of the equipment discussed here may be duplicated it is my belief that few amateurs make identical copies. However, sufficient information is supplied to help you make intelligent decisions on the basis of economy and already existing equipment. Although the equipment discussed here was evaluated with laboratory-grade test equipment, the ssb units were aligned for maximum output power in an amateur manner, then evaluated, so the data is meaningful to the amateur without access to sophisticated test gear.

power considerations

It is helpful to acquaint yourself with

*The intermodulation distortion figures given here were measured in accordance with standard commercial practice: in reference to one of the two test tones. Amateurs normally measure intermodulation distortion in respect to peak envelope power; this yields IM figures 6 dB better than commercial practice. To compare these IM figures with other amateur radio articles you must increase the IM figure by 6 dB. In this case, 20 dB becomes 26 dB.

plexity. This leaves us with the family of power-grid tubes. Table 1 shows popular vacuum tubes and approximate gains which may be obtained as 432-MHz linear amplifiers. To make this information pertinent to the amateur both new and used tubes were tested.

The third-order intermodulation distortion (IMD) values* for the tubes I tested fall in the 20- to 30-dB range. While this may sound low in comparison to 20-meter standards, an objective analysis is necessary to determine what ill effects if any this will have on 432-MHz operation. The major objections to IMD are its generation of signals outside the communications passband and wasted power. The former is a particular concern on the high-frequency bands because of

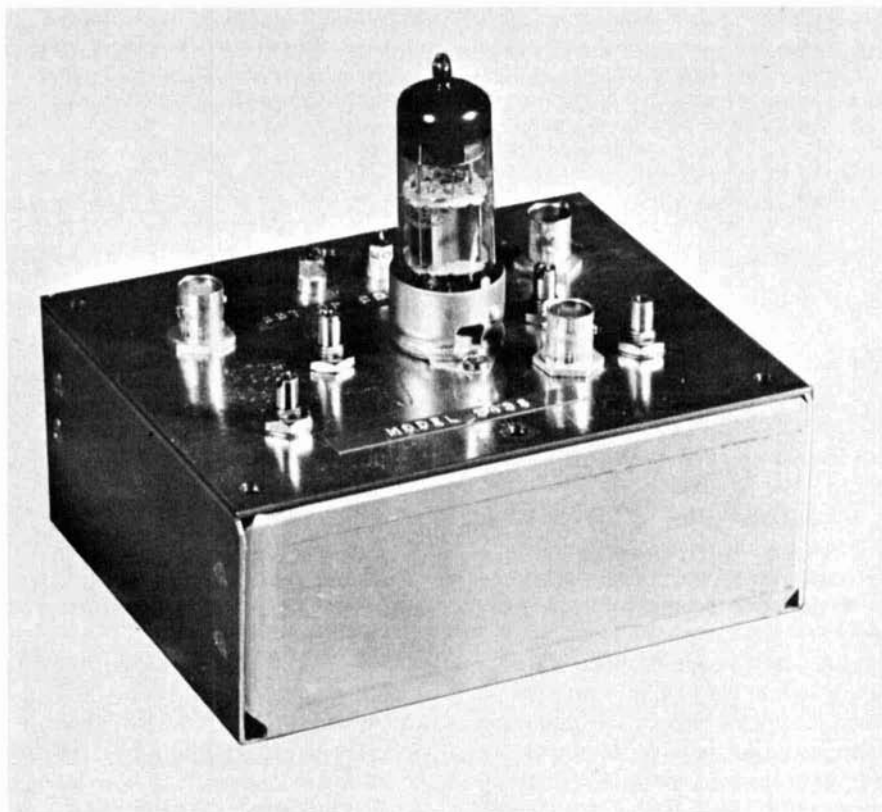
table 1. Typical linear performance of several readily available power-grid tubes.

type	gain (dB)	power output (PEP watts)	3rd order IM (dB)
6939	15	2.6	25
2C39, 2C39A	12.5-15	30	25-30
2C39B, 3CX100A5, etc.	14-16	40	25-30
4X150A (new)	15	80	20-25
(used)	14	80	20-25
4CX250B (new)	17	200	20-25
(used)	16	200	20-25

high signal densities. However, it is hardly worth mentioning at uhf. Wasted power seems to be of little consequence since an IMD ratio of 20 dB results in a 1% power loss. Most amateurs lose that

adjusting his station for maximum power output.

Considering a medium power system, 500 W PEP input with final-amplifier efficiency of 40%, the output power



432-MHz ssb mixer using a 6939.

much power in the first few feet of transmission line. Consequently, all designs presented here are based on achieving less than 20-dB IMD at the output, and assume that exciter IMD is 30 dB down.

IMD performance is given constant attention throughout this article. Measured values of IMD are presented for various levels of operation. It should be noted that all IMD tests were made with the equipment optimized for maximum power output, *not* minimum IMD. Therefore, the measured values are in line with what an amateur might expect when

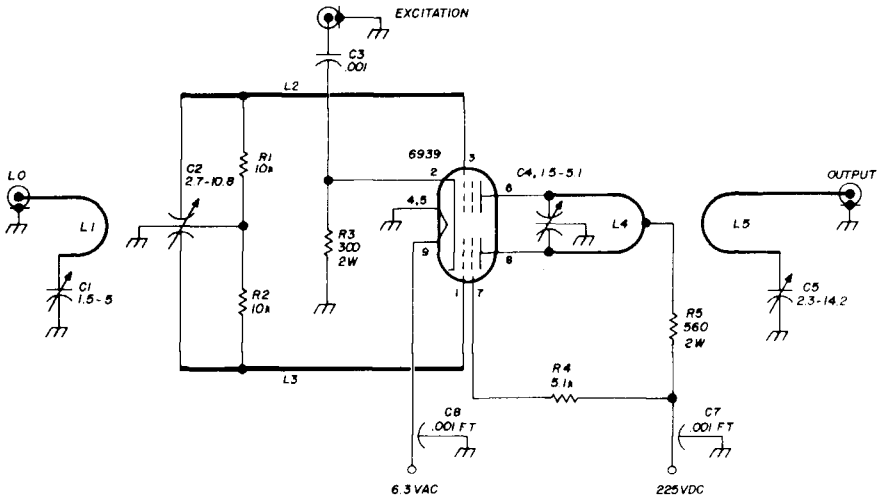
should be in the neighborhood of 200 W PEP or +53 dBm. A 4CX250B is capable of 16-dB gain, so its drive requirement is +37 dBm (5W PEP). A good 2C39 linear will drop the drive requirement to +22 dBm (158 mW PEP). At this point assume a mixer which will produce between 0.1 and 1 W PEP output.

Fig. 1 shows the proposed system. A power train of three stages will take low-frequency ssb and put it on 432 MHz at the 500-watt level. At this point, it appears to be no more difficult to put 500 watts on 3/4 meters than it is on 20 meters.

the mixer

The search for a suitable mixer covered a great deal of territory. It must be efficient, be stable, exhibit low IMD,

The Amperex 6939 seemed to be a good choice since it has already been successfully used as a high-frequency mixer.¹ However, it seems that most of the published designs are limited by their



C1 1.5-5 pF (Johnson 160-102)

C4 1.5-5.1 pF (Johnson 160-205)

C2 2.7-10.8 pF (Johnson 160-211)

C5 2.3-14.2 pF (Johnson 160-107)

fig. 2. 432-MHz mixer stage provides high efficiency. Stage requires approximately 100 mW local-oscillator power. Inductor construction is shown in fig. 3.

be easily reproduced and, perhaps most important, have low cost. Although I considered parametric upconverters, and did make one work in the laboratory, the parametric device could not be deemed a reproducible unit for the amateur without access to sophisticated test equipment (the unit also required 15 watts of pump power at 382 MHz). The second consideration was in the area of transistor mixers. Those transistor stages which were economical operated at low power levels (less than -10 dBm) and required an unreasonable number of linear gain stages to achieve respectable output power. Those stages which could handle higher power were cost prohibitive. Various diode mixer configurations were also examined but their limitations fall in the first transistor category. This narrowed the mixer field to our old friend the vacuum tube.

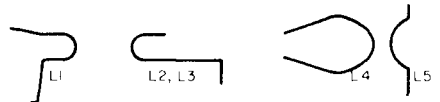


fig. 3. Coils for 6939 mixer (fig. 2) and linear-amplifier (fig. 10).*

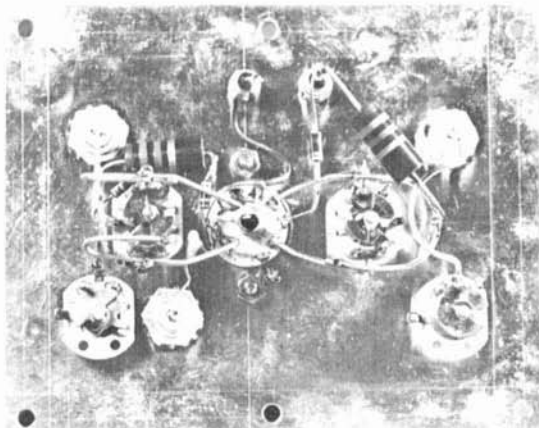
high local-oscillator power requirements. The circuit shown here (fig. 2) is somewhat similar to those previously published but may be driven with approximately 100 mW of local oscillator power instead of the usual watt or two.

Many of the problems encountered with vacuum tubes are in the area of coupling power into high-capacitance grid structures. You can get an idea of the efficiency of any matching network by measuring its reflection coefficient when

*Full-size templates of fig. 3, fig. 8 and fig. 18 are available from ham radio for 25c.

table 2. 6939 mixer operating parameters (plate dissipation, 6 watts).

Static		
plate voltage	(E_b)	225 Vdc
plate current	(I_b)	23 mA
Driven with local oscillator		
plate voltage	(E_b)	225 Vdc
plate current	(I_b)	28 mA
screen voltage	(E_{c2})	210 Vdc
screen current	(I_{c2})	6 mA
cathode voltage	(E_k)	9 Vdc
grid current	(E_{c1})	0 Vdc



Construction of 6939 mixer stage.

adjusted for maximum output power. It is a well known fact of network theory that any lossless, reciprocal, passive, two-port network will have its output reflection coefficient equal in magnitude to its input reflection coefficient. Since our networks are certainly passive, reciprocal, and hopefully, *not too lossy*, this is a good beginning for optimizing any grid circuit.

An idea of grid-circuit loss may be obtained by shorting the grid to ground (with B+ and bias off) and noting the input vswr; it should be greater than 10:1 if circuit losses are low. With the tube operating normally the input vswr should be less than 2:1 for a reasonable grid circuit. In general, the problem of coupling to a high capacitance grid structure may be easily dealt with through the

use of half-wave lines.² Quarter-wave circuits are usually ineffective since tube capacitance severely forshortens the line and it is difficult to place a tuning capacitor sufficiently close to the grid for proper operation.

The half-wave grid lines used in this mixer provide a vswr of 1.3:1 or less after one or two passes of the tuning wand. The rest of the circuit is quite conventional. The tube is operated within the normal ratings specified by the manufacturer consistent with reliability and economy. Table 2 lists the operating parameters of the 6939 mixer tube.

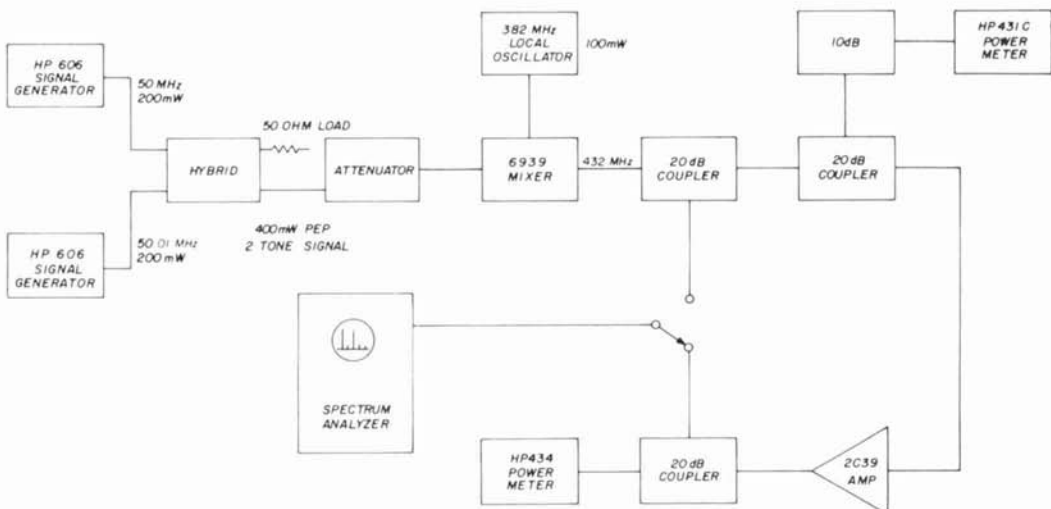


fig. 4. Setup for spurious output and intermodulation distortion tests.

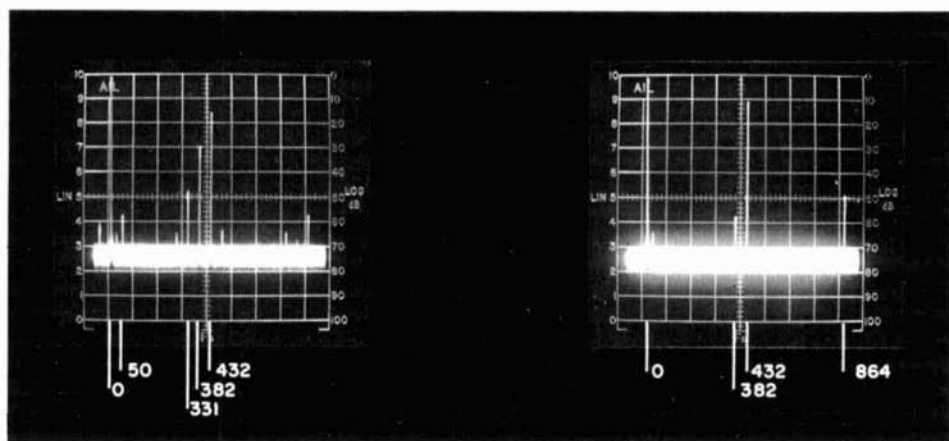


fig. 5. Spectrum analyzer display of 6939 mixer and 2C39 amplifier; horizontal, 100 MHz per division. 6939 mixer output, left, with 100 mW local-oscillator power, 400 mW PEP drive and 240 mW PEP output on 432 MHz. 2C39 output, right, with 10 watt PEP output on 432 MHz.

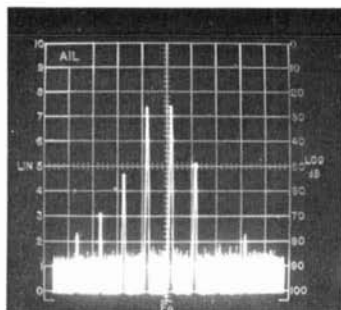
mixer performance

A few words concerning spurious mixer outputs are in order. The diagram in fig. 4 describes the spurious and IMD evaluation tests for 50 MHz excitation. Directly at the mixer output the local oscillator is suppressed 15 dB and the image is down 32 dB (see fig. 4). At the output of the first gain stage local oscillator feedthrough is suppressed 45 dB and the image is down more than 60 dB.

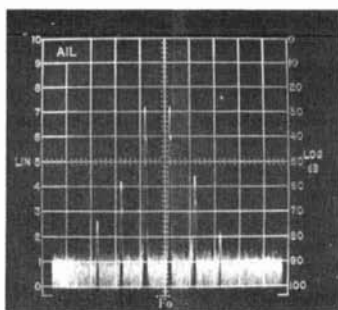
If 28 MHz excitation were chosen, at the output of the first gain stage the local oscillator would be suppressed 25 dB, and

the image would be 50 dB down. Considering the power level and typical off-resonance antenna efficiencies these numbers are adequate. With excitation below 28 MHz an interdigital filter such as the one described by W2COH³ should be used between the mixer and the first linear gain stage. With an interdigital filter in the system an excitation frequency as low as 9 MHz will provide spurious suppression superior to that obtainable with 28 MHz excitation without the filter.

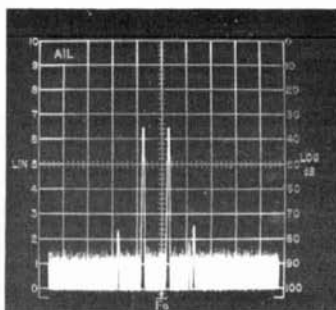
The IMD performance of the 6939 mixer at various power levels is sum-



local oscillator	100 mW
two-tone drive	40 mW PEP
432-MHz output	28 mW PEP
3rd-order IMD	-40 dB



local oscillator	100 mW
two-tone drive	240 mW PEP
432-MHz output	160 mW PEP
3rd-order IMD	-29 dB



local oscillator	100 mW
two-tone drive	400 mW PEP
432-MHz output	240 mW PEP
3rd-order IMD	-23 dB

fig. 6. 6939 mixer intermodulation distortion at various power levels.

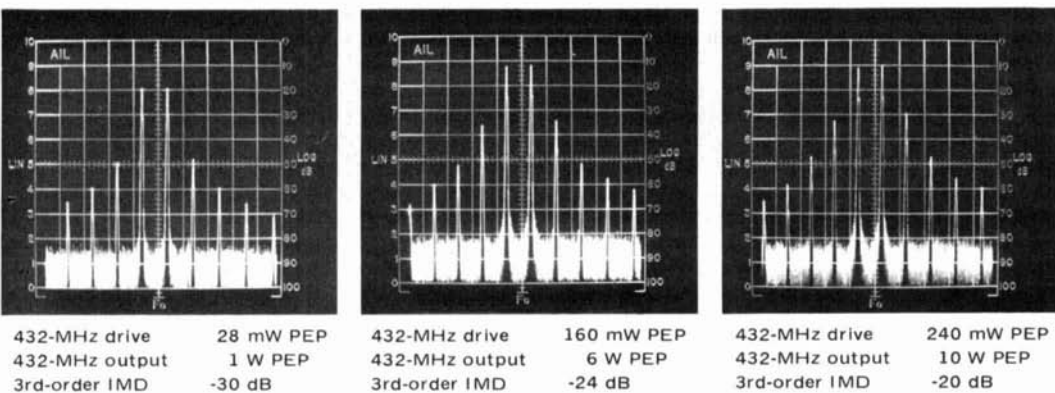


fig. 7. 2C39 amplifier intermodulation distortion tests. These tests were run simultaneously with the 6939 mixer test shown in fig. 6.

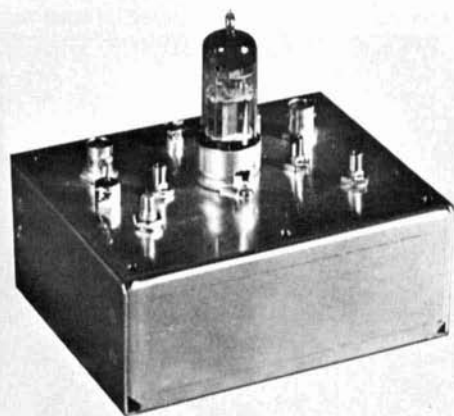
marized in fig. 6. The 6939 mixer, when operated according to table 2, with 240 mW PEP 50-MHz drive, is capable of 150 mW PEP output; IMD under these conditions is 30-dB down.

A chassis layout for the 6939 mixer is shown in fig. 8. If you use all new components in the construction of the mixer, total cost will be less than \$20. The 6939 tube, the most expensive part, lists at \$12.

linear amplifiers

Depending on the amount of power you want to put on 432 MHz, the linear amplifier can take any of the forms

6939 linear amplifier for 432 MHz.



shown in fig. 9. This chart shows various vacuum-tube combinations for power level from 5 W PEP to 2 kW PEP.

The 6939 linear amplifier stage in fig. 10 is capable of 6 watts PEP input with approximately 2.6 W PEP output. This represents a stage efficiency of 43%. This design uses essentially the same circuit as the mixer except that the cathode is directly grounded, an external bias port is provided for the grid, and the screen is fed from a regulated source (to improve linearity). Mechanically, the 6939 mixer and amplifier layouts differ only by three holes, so both chassis plates may be drilled simultaneously. Table 3 lists the typical operating parameters of the 6939 amplifier.

the 2C39

I compiled a good deal of information about the operation of the 2C39 family. Older tubes such as 2C39s and 2C39As, and used tubes of newer varieties, offer an interesting bonus: they may be operated as zero-bias triodes. New 2C39Bs, 3CX100A5s, etc., require some bias to achieve reasonable plate currents. While best linearity and maximum output power occur when the tubes are idled at approximately 60% of their rated dissipation (60 W), they may be idled as low as 15 watts with reduced power output.

Under zero-bias conditions this dissipation range typically corresponds to a

plate voltage range of 350 to 700 Vdc and output powers from 4 to 30 watts PEP. The gain of the tube varies about 1 dB between these two voltage extremes with the higher gain at the higher operating voltage. **Table 1** and **fig. 11** detail the typical properties of the 2C39 family. The dc operating parameters of the 2C39 stage used earlier (in the IMD and spurious products evaluation) were, $E_b = 400$ Vdc, $I_b = 60$ mA, plate dissipation = 24 watts. Spurious and IMD characteristics of this 2C39 amplifier are summarized in **fig. 7**.

Since the 2C39 amplifier I used to compile the 2C39 data uses a surplus cavity, no actual homebrew amplifier is described in this article. However, several

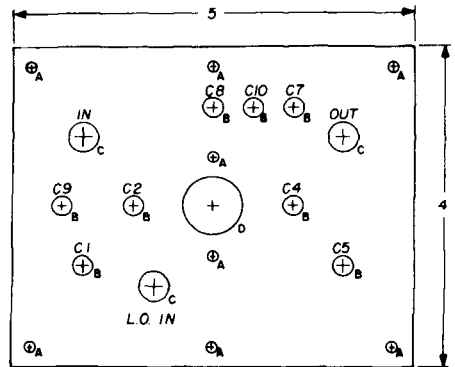


fig. 8. Layout template for 6939 mixer (**fig. 2**) and linear amplifier (**fig. 10**). For the mixer circuit omit holes for C9 and C10. For the linear amplifier omit the local-oscillator input. Hole sizes; A, 0.140"; B, 0.250"; C, 0.375"; D, 0.750".

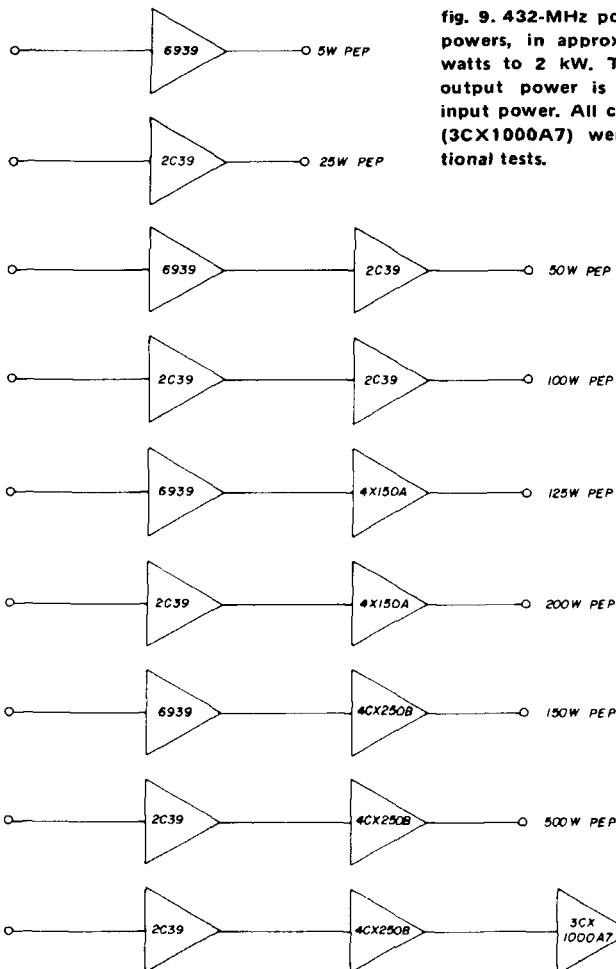


fig. 9. 432-MHz power trains for various output powers, in approximately 3-dB steps from 5 watts to 2 kW. The listed powers are input; output power is approximately 40% of the input power. All configurations except the last (3CX1000A7) were verified by actual operational tests.

table 3. 6939 linear amplifier operating parameters. (Power dissipation approximately 6 watts.)

plate voltage	(E_b)	225 Vdc
plate current	(I_b)	28 mA (static) 32 mA (dynamic)
grid bias	(E_{c1})	3.5 Vdc
screen current	(I_{c2})	6 mA (static) 15 mA (dynamic)

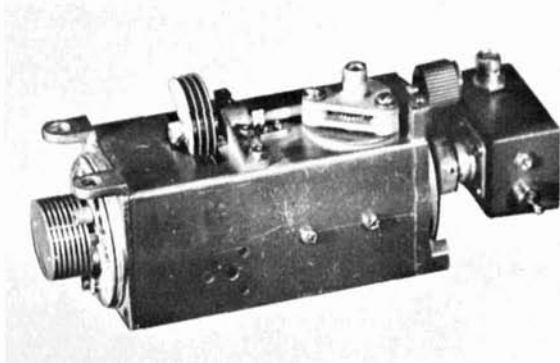
compact 2C39 designs appear in the W6AJF vhf handbook.⁵ These circuits, when used with half-wave cathode-drive circuits, function as well as the surplus cavity I used in my tests.

higher power

The 4X150A and 4CX250B pave the way to higher power on 432 MHz. Both tubes, when properly used, exhibit relatively high power gains (see table 1). The 4X150A is capable of approximately 200 PEP input at 432 MHz while the 4CX250B is capable of 500 W PEP input.

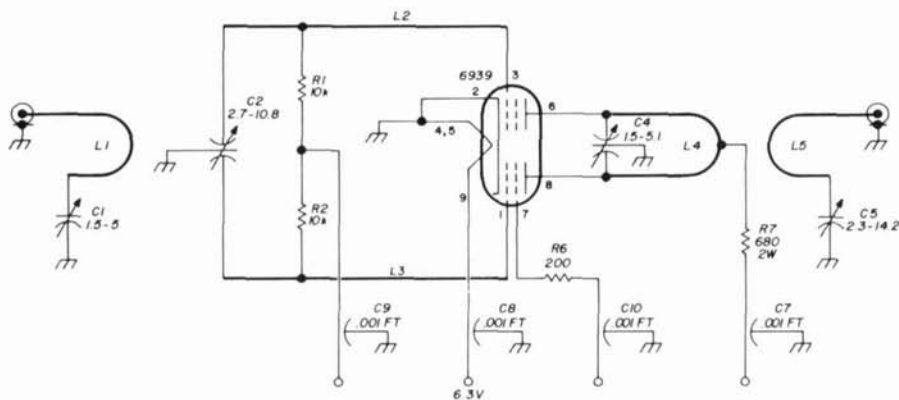
In keeping with the philosophy of this article, good design practices will be discussed first. This will allow you to examine your present 432-MHz gear and make the necessary modifications.

The first consideration is that of driving the tube. To start with, avoid using a large grid compartment as this may lead to many problems. Much of the rf drive may find its way into resistors, filament transformers and other dissipative struc-



Surplus 2C39 cavity used in the 432-MHz tests.

tures within the compartment. Another problem which tends to plague large grid compartments is that of multimoding. When the size of the grid compartment happens to coincide with certain preferred dimensions the entire compartment may act as a resonator. Usually the



C1 1.5-5 pF (Johnson 160-102)

C4 1.5-5.1 pF (Johnson 160-205)

C2 2.7-10.8 pF (Johnson 160-211)

C5 2.3-14.2 pF (Johnson 160-107)

fig. 10. 6939 linear amplifier operates at 43% efficiency. Inductors for this stage as shown in fig. 3; layout is in fig. 8. Operational data for this stage is listed in table 3.

result is multiple tuning peaks and erratic grid-network behavior. Incidentally, multimoding is also a problem in plate tank compartments which are too large. It is a good rule of thumb to keep two dimensions of the box well below one-half wave at the operating frequency to eliminate

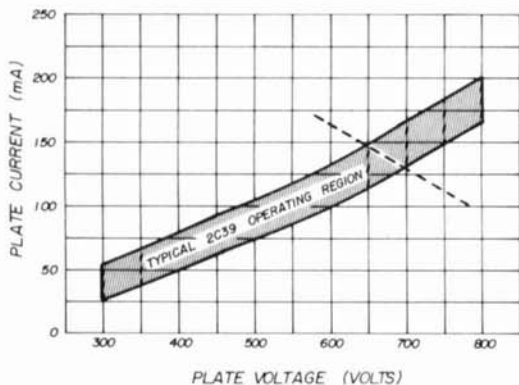


fig. 11. Zero-bias operation of tubes in the 2C39 family. To prevent excessive dissipation, bias should be used if the tube operates to the right of the dashed line.

multimoding (at 432 MHz this corresponds to approximately 13.5 inches).

grid circuit

Eimac engineers, when designing the SK610 socket, were kind enough to provide a means of fastening 1-5/8-inch tubing to the grid side of the socket, thereby allowing you to make a grid cavity. Since 1-1/2 inch copper plumbing pipe makes a snug fit to the base of the socket it's easy to make an efficient grid cavity.

You must now decide whether to use a 1/4- or 1/2-wave grid cavity. (Eimac Application Bulletin no. 14 gives many fine examples of 1/2-wave grid structures which are efficient and simple to construct.) In the amplifier discussed here a somewhat different approach to a 1/4-wave structure is taken.

The input reactance of the 4X150A, 4CX250B series of tubes is in the vicinity of 25 ohms capacitive. The length of the grid circuit in electrical degrees may be

calculated from the equation:

$$\theta = \text{Tan}^{-1} \frac{X_C}{Z_0} \quad (1)$$

where X_C is the capacitive reactance (25 ohms) and Z_0 is the characteristic impedance of the cavity. For the coaxial arrangement used here Z_0 is given by the equation:

$$Z_0 = 138 \log \frac{b}{a} \quad (2)$$

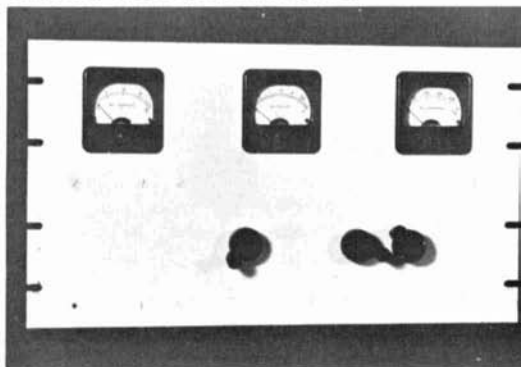
where b is the inside diameter of the outer conductor and a is the outside diameter of the inner conductor. K7UNL provided design data for other types of resonant lines in a recent article in *ham radio*.⁶

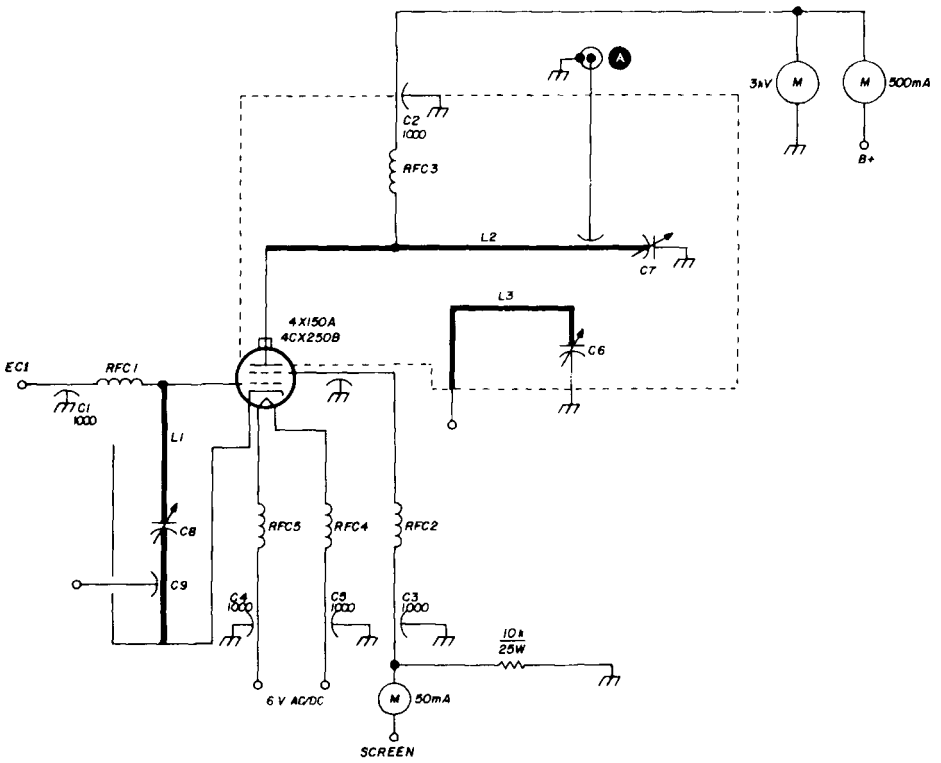
Choosing an inner conductor diameter of 3/4 inch and the outer conductor diameter of 1-1/2 inch, Z_0 is approximately 41 ohms. Running this through eq. 1 yields 31.4° . Proportion will provide the physical length of the line:

$$\frac{31.4^\circ}{360^\circ} = \frac{l}{\lambda} \quad (3)$$

where $\lambda = 69$ cm. (Equivalent wavelength for 432 MHz is 69 cm.) Therefore $l = 6$ cm or 2.3 inches. Unfortunately, this is a bit short and as yet there is no way of tuning the grid circuit. This verifies previous comments about quarter-wave lines being severely forshortened by high capacitance grid structures.

Front-panel layout of the 432-MHz power amplifier. Circuit is shown in fig. 12.





- | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>C6 loading capacitor. 0.4-8 pF piston (JMC1802 may be used) homemade capacitor used in amplifier in photos</p> <p>C7 air disc capacitor. 1-3/4" diameter, 1/8" thick brass disc soldered to 3 1/2" length of 3/4" diameter threaded bronze pipe. Pipe is mounted through threaded bronze flange (available at plumbing supply) (see fig. 13)</p> <p>C8 1" diameter, 1/8" thick brass disc capacitor (see fig. 15)</p> | <p>C9 1-1/4" length 1/4" brass rod soldered to BNC connector, braced with 1/4" Teflon rod (see fig. 13)</p> <p>L1 grid cavity (see fig. 13)</p> <p>L2 copper plate line (see fig. 15)</p> <p>L3 copper output strap (see fig. 15)</p> <p>RFC1 8 turns no. 22 enameled wire closewound on 1/8" form</p> <p>RFC2,3,4,5 8 turns no. 20 Teflon-insulated solid wire closewound on 3/8" form</p> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

fig. 12. 432-MHz linear amplifier stage using a 4X150A or 4CX250B. Alternate output coupling at A. Screen bypass capacitor is part of tube socket.

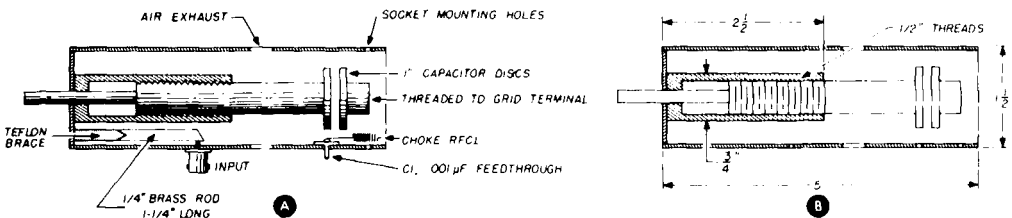


fig. 13. Tuned grid circuit for the highpower 432-MHz linear amplifier.

table 4. 4CX250B linear operating parameters.
For the 4X150A, maintain 6-volt filament voltage and adhere to manufacturer's reduced ratings for uhf service.

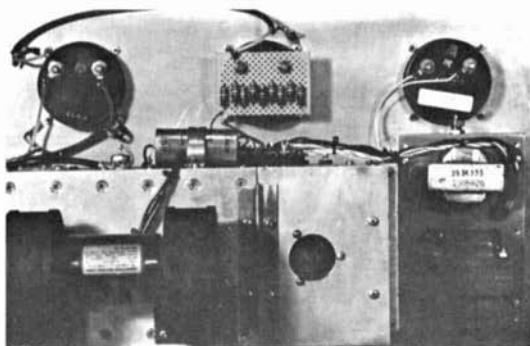
power input	375 W	500 W
plate voltage (E_b)	1500 Vdc	2000 Vdc
screen voltage (E_{c2})	350 Vdc	350 Vdc
grid voltage (E_{c1})	-55 Vdc	-55 Vdc
plate current (I_b)	100 mA	100 mA (static) 250 mA (dynamic)
screen current (I_{c2})	8 mA	5 mA

At this point, you would probably be tempted to install a variable capacitor across the high-voltage end of the line to tune it. This is undesirable as it would further shrink the already forshortened line. The solution to the tuning problem is a series variable capacitor between the grid and the line. Two parallel discs 2.5 cm (1-inch) diameter, spaced 1/2 cm apart exhibit approximately 9 pF capacitance. Using the equation for series capacitors

$$\frac{1}{C_t} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n} \quad (4)$$

The total capacitive reactance across the line is approximately 60 ohms. With 60 ohms as a basis, the recomputed line length (using eq. 1 and 3) is 4 1/4 inches. This is a reasonable length, and the grid resonator is now tunable.

High-power 432-MHz amplifier.



The overall length of the grid line is increased to 5 inches to account for the 1 cm spacing between the plates, the thickness of the plates (approximately 1/4 inch) and any non-computed second order effects (see fig. 13). Remember, if the line is slightly longer than necessary it may easily be shortened; however, if the line is too short to begin with you will have trouble trying to stretch it!

Another interesting problem associated with these tubes is the matter of forced-air cooling. In linear service it is advisable to use maximum recommended plate voltage to obtain maximum linear power output. Under these conditions the tube runs hot, and cooling it requires large amounts of air — provided by a moderately large fan or a smaller one operating at high speeds. Large fans are expensive

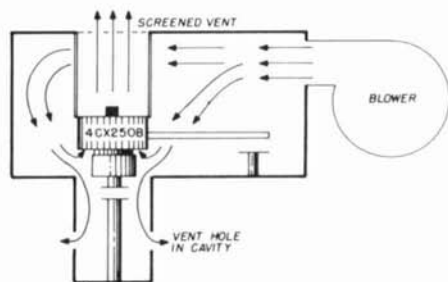


fig. 14. Air flow in the 432-MHz amplifier.

and bulky while small high speed ones are noisy. However, if you pressurize the plate compartment, disregard the conventional chimney and provide an exhaust passage from the anode radiator to the outside world (see fig. 14), the back pressure on the fan is considerably reduced. Under these conditions, the tube operates reasonably with a 3-inch 3600-rpm squirrel-cage fan at a pressure drop of 1.30 inch. This provides an added bonus in that the plate-tank components are air cooled; therefore the amplifier is free of resonance drift associated with the thermal expansion of the tank circuit.

The plate tank enclosure is made from 1/8-inch 2024-T3 aluminum stock with 1/2 x 1/2 x 1/8-inch aluminum angle at

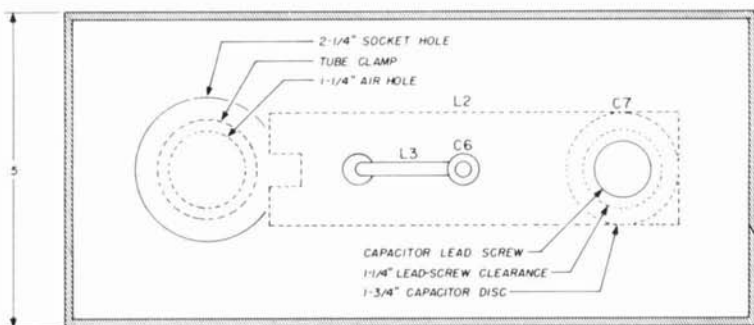
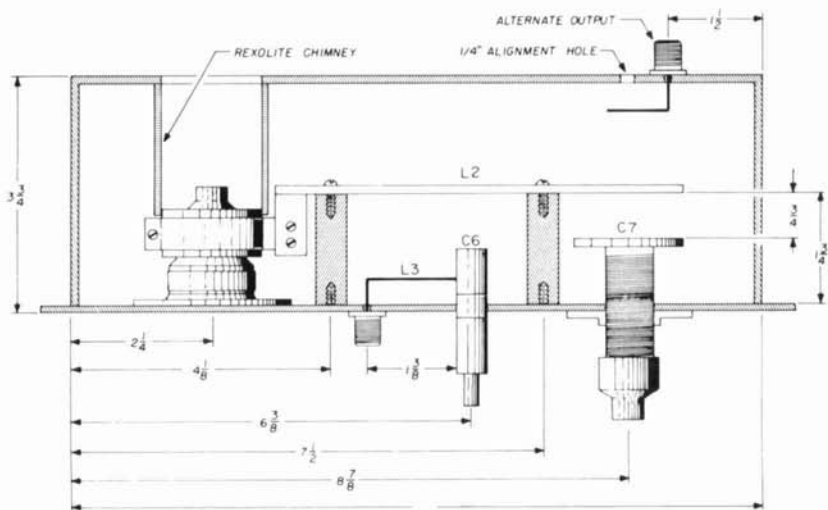
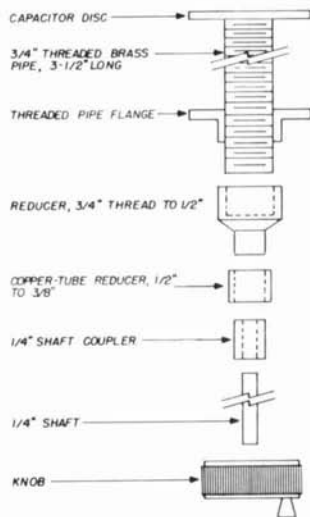


fig. 15. Layout details of the high-power 432-MHz power amplifier (fig. 12). Construction of capacitor C7 is shown at right.

the corners. The plate tank circuit is a conventional half-wave line. Output coupling may be accomplished with equal efficiency through inductive or capacitive probes as shown in fig. 12. Operating parameters are given in table 4.

filament voltage

Normally you reduce filament voltage at uhf to compensate for back bombardment of the cathode. Fortunately, back bombardment is minimized under the condition of linear operation. The usual criteria (i. e. minimum grid bias, high screen voltage and low grid drive) which minimize back bombardment are en-



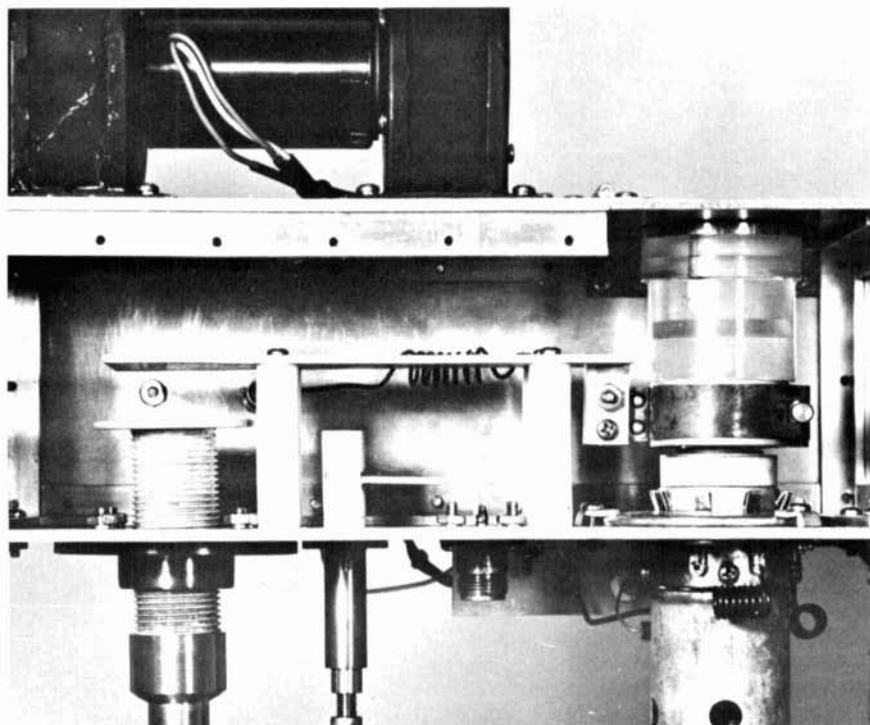


Plate compartment of the 432-MHz power amplifier.

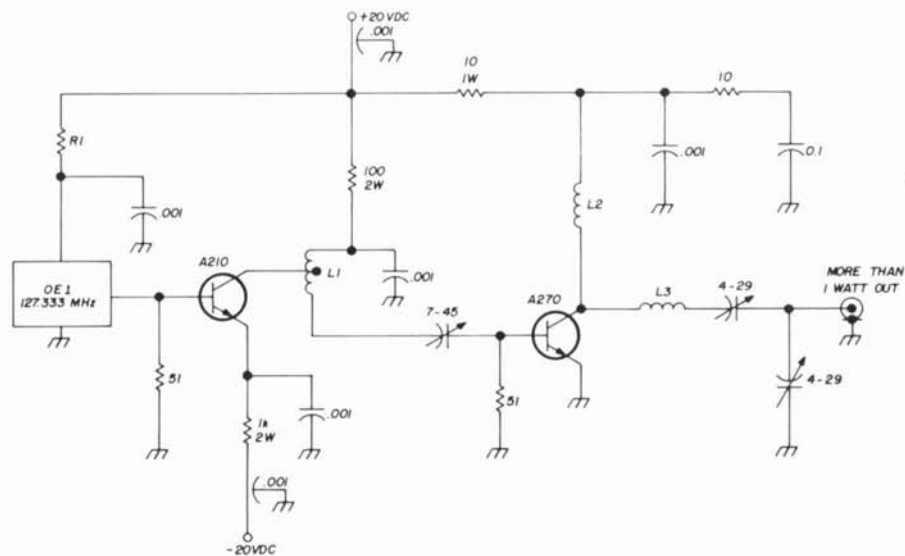


fig. 16. 127-MHz local oscillator uses International Crystal OE1 crystal oscillator with two-stage amplifier. Value of R1 is selected to give proper operating voltage for the OE1.

L1

6 turns no. 18, spaced one diameter, on 3/8" form

L2

1 μ H choke

L3

3 turns no. 16 enameled close-wound on 1/2" form

forced in linear service. At the same time, in linear ssb service, the duty cycle of the amplifier is significantly less than 100% thereby further reducing back heating.

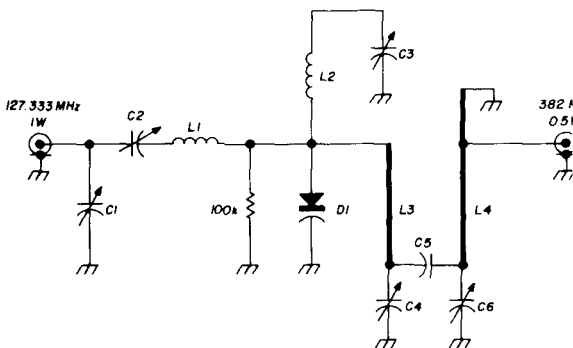
Consequently, the filament voltage is maintained at the normal 6V. Should you desire to operate this amplifier class C, you must remember to reduce the filament voltage accordingly. However, there is no practical reason for using class C since you already have the most effective voice system available. If you wish to operate cw the linear will not deliver sufficiently less power than its class C counterpart to make bias and drive-level changes worth-while.

local oscillator chain

The solid-state local oscillator chain described here uses an International Crystal OE1 overtone oscillator at 127.333 MHz followed by an amplifier (fig. 16) and tripler (fig. 17) to produce power at 382 MHz, which when heterodyned with a 50-MHz ssb exciter provides 432-MHz ssb. Other exciter frequencies (anything from 9 to greater than 50 MHz) may be used by altering the local oscillator frequency. The circuit in fig. 16 uses two Amperex transistors to amplify the 1 mW OE1 output to the 1-watt level.

The oscillator amplifier was put together on a 4 x 6-inch piece of double-sided copper-clad board and mounted upside down in a 2 x 4 x 6-inch aluminum chassis. The 1 W output drives a varactor tripler which provides the 100

mW required for the mixer. A varactor tripler is used with the contingency that many amateurs presently on 432 probably have a varactor tripler which could be tuned down to the local-oscillator fre-



- | | |
|----------|---------------------------------------------------------------------------|
| C1,C2 | 2.7-19.6 pF (Johnson 160-110) |
| C3,C4,C6 | 0.9-7.0 pF piston (JFD VC1G) |
| C5 | gimmick. No. 20 wire, twisted, 1" long |
| L1 | 7 turns no. 18, spaced 1 wire diameter, 3/8" form |
| L2 | 2 turns no. 18, spaced 1 wire diameter, 3/8" form |
| L3,L4 | hairpin made from 2" length of no. 18 wire. Hairpin 7/16" wide, 7/8" long |
| D1 | Amperex H4A or equivalent |

fig. 17. Varactor tripler is used with 127-MHz local oscillator (fig. 16) to provide injection at 382 MHz. Layout for this circuit is shown in fig. 18.

quency, thereby saving a component. An equally adaptable vacuum-tube local-oscillator chain appeared in an article by K6JC.¹

summary

Now that we have discussed the mixer, linear amplifiers and local oscillator chains as well as spurious and intermodulation distortion we have reached a point where everything needs to be put into perspective. The eight power trains shown in fig. 9, when properly operated, give IMD figures greater than 20 dB. In each case, spurious outputs were checked with the aid of a spectrum analyzer and found to be adequately suppressed (typically

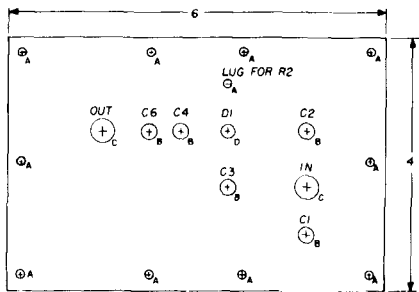
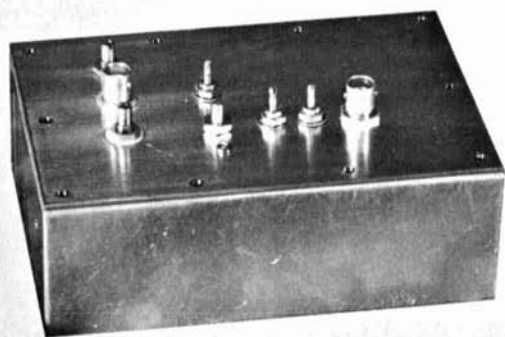


fig. 18. Layout for the 127-MHz to 382-MHz varactor tripler. Tripler is built on 1/16" brass. Hole sizes: A, 0.140"; B, 0.250"; C, 0.375"; D, 0.200".

greater than 40 dB for local-oscillator and image products). Power trains with two linear stages offer even greater spurious suppression.

Assuming tubes of reasonable quality the eight power trains in **fig. 9** have a gain margin of 2 dB; that is, the amplifiers could produce up to 2 dB less than the maximum gain in **table 1** and the circuits would still function adequately. The gain margin drops slightly more than 1 dB for excitation below 30 MHz. This is due to the insertion loss of the interdigital band-pass filter. Unlike the case of class-C amplifiers, if you fall short in gain by more than the margin, the system would still deliver a valid output but at a reduced level. This is because there is no drive threshold in linear amplifiers at which output suddenly falls off.

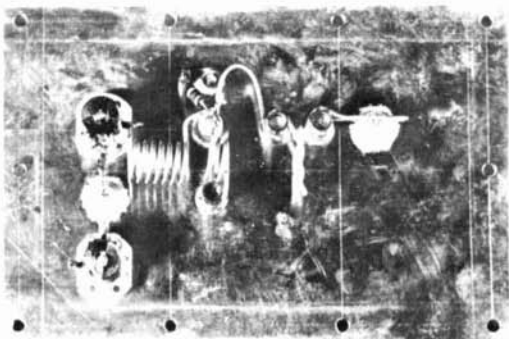


Varactor tripler provides output at 382 MHz with 127-MHz drive.

A power train using a 3CX1000A7 triode in grounded-grid linear service is described by W6SAI. This amplifier should easily be able to run one to two kilowatts PEP input. Although this particular configuration has not been verified by actual tests, calculations indicate that the 4CX250B should be capable of driving the high-power amplifier with ease.

Needless to say, there are more expensive tubes which will serve as excellent

linear amplifiers at 432. There are also tubes which will operate satisfactorily at reduced input at this frequency. However, keeping in mind the philosophy of this article, I have endeavored to select



Construction of the varactor tripler.

the most economical tubes which are not on the verge of losing steam at 432 MHz.

I would like to thank the Microwave Instruments Division of AIL for permitting the use of their newly developed microwave spectrum analyzer as well as other rf test equipment. I would also like to thank R. Kandle, K2RIW, for his comments and suggestions concerning the text. Thanks are also extended to W. Doesschate of Ampere Corporation and Bill Orr of Eimac Division of Varian for their valuable technical assistance throughout the course of this project.

references

1. James Brannin, K6JC, "SSB Converter for 432 MHz," *ham radio*, January, 1970, page 48.
2. Eimac, "An Eimac Family of 4CX600 Tetrodes," Application Bulletin no. 14, Eimac Division of Varian, San Carlos, California.
3. Reed E. Fischer, W2CQH, "Interdigital Band-pass Filters for Amateur VHF/UHF Applications," *QST*, March, 1968, page 32.
4. William Orr, W6SAI, "Two-kW 432-MHz Amplifier Using Eimac 3CX1000A7," *Eimac Amateur Service Newsletter*, AS25.
5. Frank Jones, W6AJF, "VHF For the Radio Amateur," Cowan Publishing Corporation, New York, 1961.
6. Harry Ferguson, K7UNL, "Linear VHF Tank Circuits," *ham radio*, November, 1970, page 56.

ham radio

solid-state carrier-operated relay and call monitor

Here are
two simple
but effective
circuits to enhance
fm operation

Murray Ronald, VE4RE, Box 974, Brandon, Manitoba, Canada

After the initial fascination of operating in the fm mode has worn off, the more technically adventurous want to add gadgets and refinements to their equipment. Preamps are popular; others go the route of tone calling, etc. Still others try the carrier-operated relay (COR), using it to trigger a tape recorder or activate a monitor for their private channel.

At this station I wanted to try some solid-state COR circuits and began experimenting with mockups using bipolar transistors (fig. 1). One of the problems encountered in using conventional transistors with a tube-type receiver was the undesirable loading effect introduced when the COR was attached to an i-f grid or to the squelch dc amplifier. Operation (especially in the squelch circuit) was upset considerably. By prefacing the relay driver with an fet (which has a very high input impedance) it is possible to attach the unit to the receiver without disturbing results.

carrier-operated relay

The COR shown in **fig. 2** has been tried in a number of Motorola Sensicon A and G model receivers and seems to work

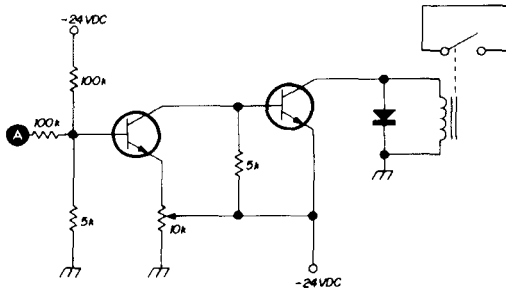


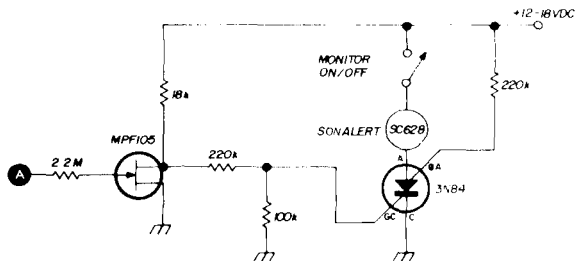
fig. 1. Carrier-operated relay using bipolar transistors. This circuit tends to load down the i-f amplifiers and squelch in tube-type receivers.

best when attached to the grid of the last i-f amplifier (455 kHz). Referring again to **fig. 2**, a negative voltage at point A of approximately 3.5 volts or greater will stop the fet from conducting and allow the voltage at the base of the transistor to rise. When this occurs, the transistor will conduct and pull in the relay. Typical swing in the Sensicon G receiver at the grid of the last i-f amplifier is from -1 volt with no signal to -4 volts with a 1 μ V signal.

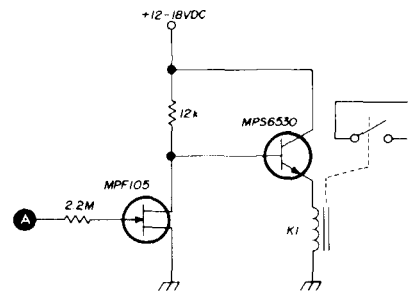
call monitor

Illustrated in **fig. 3** is a call monitor that will latch on and give an indication that a carrier has appeared on a channel. Experiments have indicated that the monitor is best attached at the grid of the

fig. 3. Call monitor that indicates when a carrier is on frequency. Experiments indicate that the monitor works best when attached at the grid of the dc amplifier in the squelch circuit.



dc amplifier in the squelch circuit. This is necessary because the monitor should be biased positively in the NO CALL mode to prevent noise from inadvertently triggering the 3N84. Typical voltage change in the Sensicon G at the grid of the dc amplifier is from about +3 volts with no signal to -3 volts with a 0.5 μ V signal. Operation of the fet stage in the monitor is similar to that of the COR circuit. Once the 3N84 is triggered, however, it will continue to conduct and operate the Sonalert until the anode circuit is broken. A suitable low-current bulb could be used in place of the Sonalert as an indicator is desired.



K1 = 400 TO 600 OHM, 5 TO 10mA RELAY

fig. 2. COR circuit using high-impedance-input fet ahead of the relay driver. Circuit works best when inserted at the grid of the last i-f in Motorola Sensicon A and G receivers.

Although the ideas in these circuits are certainly not new or original, it is hoped they will prompt some experimentation and building along these lines. Thanks go to Reg (VE4RW) for assisting in the wiring and testing of the circuits.

ham radio

one-man antenna matcher

A sensitive swr bridge
and milliwatt signal source
are featured
in this compact instrument

The adjustment of an antenna matching section (T-match, gamma, etc.) is usually a two- or three-man job — one at the antenna, one at the transmitter, and possibly a third to relay information. Because the matching adjustment involves the transmitter, some means must be used to reduce its output while carefully preventing overload of the final-amplifier tubes, particularly in many of today's rigs using TV sweep tubes. The radiation of considerable rf energy, necessary to give meaningful indications on swr meters such as the Monimatch and the wattmeter types, causes interference on already crowded bands.

The instrument described here eliminates all these problems. It's completely self-contained, weighs about a pound, and radiates only 0.1 watt maximum. One man at the antenna-matching section does the whole job; no assistants are needed, and the station transmitter is not used.

description

The instrument consists of a resistance

bridge and transistor amplifier (fig. 1) and an rf signal source (fig. 2). The signal source, constructed of readily available modular units,* can be put together in minutes.

Unlike the Monimatch, this instrument isn't frequency sensitive. One hundred mW will drive the meter to full-scale deflection on 10 through 80 meters.

The bridge uses 1/2-watt composition resistors. Resistor R_s , which determines impedance, must be close to the desired value for your equipment (e. g., 52 ohms for most transmitters and transmission lines). Bridge-arm resistors R_1 and R_2 must be closely matched, although their exact value isn't critical.

R_3 and R_4 should be close in value if comparable input and output readings are to be obtained. Likewise, diodes CR1 and CR2 (1N34A's) should be closely matched.

Capacitors are disc ceramics. The 2N107 transistor has medium gain and works well with a 1.5-volt dry cell. A lower-gain device may require 3 volts to give full-scale meter deflection. Polarities shown are for a pnp transistor; an npn can be used by reversing supply polarity.

Switch S1 is a 2-pole, 3-position switch. A rotary type or a slide switch with center position off can be used.

bridge construction

The bridge, meter, and transistor amplifier are contained in a 5-1/4 x 3 x 2-1/8 inch aluminum mini-box. The shielded compartment may be made from heavy aluminum or flashing copper. The shield is in the form of a

*International Crystal Mfg. Co., 10 North Lee, Oklahoma City, Oklahoma 73102. The OX oscillator is \$2.95; the PAX-1 amplifier is \$3.75. Both in kit form.

A. G. Shafer, W4SD, 683 S. W. 7th Street, Boca Raton, Florida 33432

Z-bracket, which is attached to the end wall of the minibox. The shield shown in the photo was made from two pieces of 1-inch aluminum angle stock fastened together to form a Z.

Shielding and parts assembly of the bridge are important. The only elements within the shield compartment are resistors R_1 and R_2 , which are mounted at right angles to each other. A piece of RG-58/U cable is connected between the SO-39 chassis connector at the opposite end of the box and an insulated stud within the shielded compartment. The center conductor is connected to the stud and the shield braid to a ground lug next to the stud.

Connections to the remaining bridge elements are made through clearance holes in the rear wall of the shield. Short leads are required up to and including the point at which R_3 and R_4 are connected. The usual soldering precautions are suggested, and the use of heat sinks (long nose pliers, etc.) is recommended. The layout of the other parts is not critical and follows a logical sequence. If the box size and layout shown are followed, be sure the meter doesn't extend inside the box by more than $7/8$ inch exclusive of

terminals. Note that the SO239 output connector and the insulated stud are centered close ($11/16$ inch) to the open side of the minibox.

After assembly and wiring, and with the battery in place, it will be noted that a small reading (a few microamps) will be indicated on the meter with the switch in either the FWD or REF position. This is the "no-signal" current of the transistor and is the "zero" indication of a perfect match when the bridge is in use.

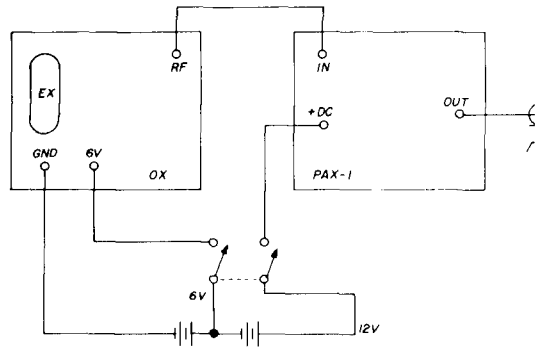


fig. 2. Signal source and amplifier. Units are available in kit form; easily assembled.

signal source

The OX Oscillator uses an EX Crystal of the frequency at which the antenna matching is to be accomplished. The OX - PAX-1 combination can be made to function over two adjacent ham bands by changing crystals and repeaking the coils. The OX - PAX-1 will put out up to 200 mW, which is more than enough to drive the bridge. The units are assembled in the same size minibox as the bridge. A much smaller box would accommodate the signal-source units, which are only $1\text{-}1/2$ inch square, but it was desired to mount the battery, consisting of eight penlight cells inside the box, requiring the extra space.

Note that a *double*-pole switch is used to turn off both the 6- and 12-volt lines. Disabling only the negative line will result in a battery drain in the OFF position (between the 6- and 12-volt taps).

The rf generator may be connected to

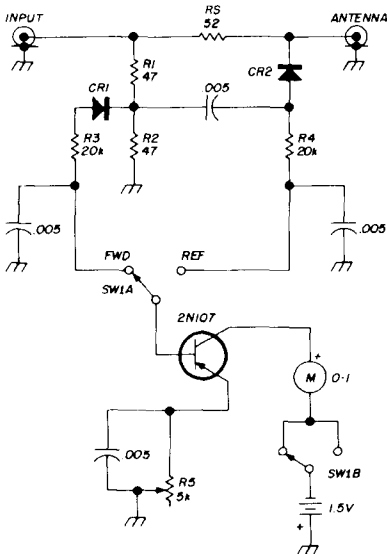


fig. 1. Schematic of the bridge circuit and transistor amplifier. Matched pairs are recommended for R_1 , R_2 ; R_3 , R_4 ; and CR1, CR2 (see text).

the bridge by a double male adapter or by a length of RG-58/U cable if the rf unit is placed in your pocket.

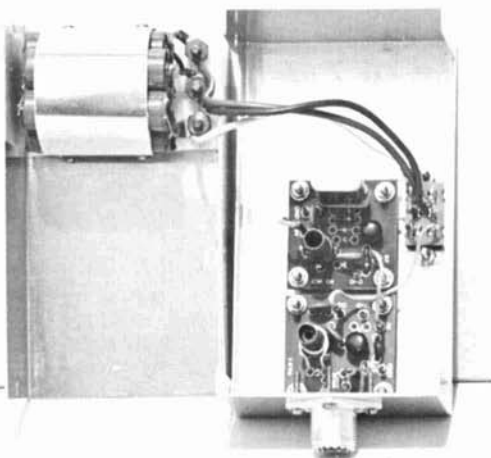
The connection between the bridge and the antenna matching section must be as short as possible. The matching section can terminate in a female connector such as the SO-239, or a couple of inches of RG-8U and a PL-259 could be used. If the SO-239 is used, the bridge should be connected to it by a double male adapter.

checkout

Before using the equipment for matching or swr measurements, the bridge should be tested. Solder a 52-ohm resistor into a PL-259 connector as a dummy load, and insert it in the output connector of the bridge.

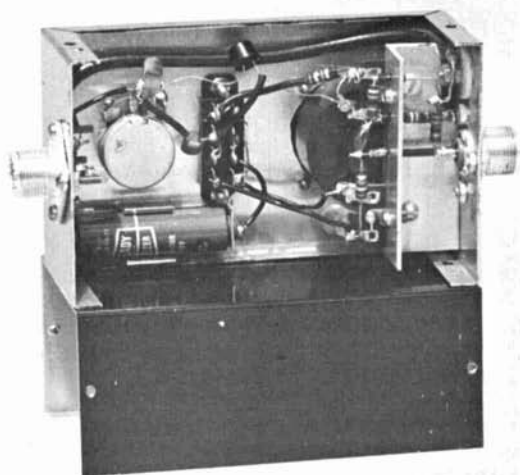
With the rf generator connected to the input of the bridge, position the switch to

Signal-generator portion showing International Crystal Co. kit modules. Power supply consists of 8 penlight cells.



FWD, and adjust the sensitivity control for a 1-mA reading on the meter. Positioning the switch to REF should reduce the meter reading to zero. If the meter doesn't drop to zero, bridge arms R1 and R2 are not equal, R_s is not 52 ohms, or coupling exists between the bridge elements.

If this test is satisfactory, remove the dummy load, and with the output open-circuited, adjust the meter reading for 1 mA in the FWD position. With the switch in the REF position, a 1-mA reading should be obtained. Repeat this last test



Bridge and meter portion of the antenna matcher. Shielding and parts placement are important. Power is supplied by a 1.5-volt dry cell.

with the output shorted by a *very* short wire, resetting the meter to 1 mA in the FWD position. It should read 1 mA in the REF position.

Slight resistor and diode variations may make such correlations not quite as exact as indicated, but such differences should not exceed a few microamps.

calibration

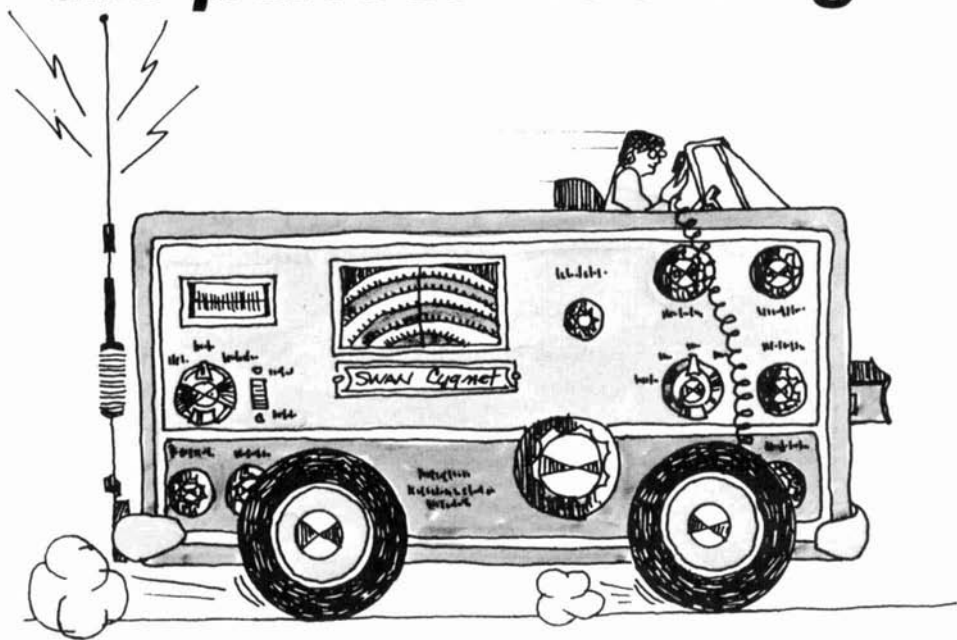
If accurate swr measurements are to be made, the meter should be calibrated by using resistors of two, three, and four times the value of bridge resistor R_s . These resistors should be soldered into a PL-259 connector for such calibrations.

acknowledgement

I want to express my sincere thanks to my SWL friend and potential ham Herwart Werker for the photos.

ham radio

the perfect mobile rig...



Swan Cygnet

Model 270 B \$399*

SWAN FACTORY
305 Airport Road
Oceanside, Ca. 92054
Phone: (714) 757-7525



SWAN
ELECTRONICS

A Subsidiary of Cubic Corporation

EASTERN OFFICE
P.O. Box 2288
Ocean, N.J. 07712
Phone: (201) 431-0707

Write for the complete 1971 Swan catalog.

*Factory price

audio agc

principles and practice

Audio agc
has many uses in
amateur equipment —
this article describes
how it works
and presents
a practical circuit

This article should provide you with sufficient information to build a simple audio agc circuit, understand its operation, and integrate it into your particular application.

Agc stands for automatic gain control; audio agc is a means of equalizing weak and strong signals and prevents overload and distortion in the agc amplifier and following stages when strong signals appear at the input. Fig. 1 shows a widely used agc circuit in block form. Signals

pass through the control element and are amplified to a level sufficient to be detected; the detector output is a dc voltage which increases when the input signal gets larger and decreases when the input signal gets smaller. This dc control voltage is fed back to the control element which attenuates the signal in proportion to dc control-voltage amplitude. The overall effect is that the output signal amplitude remains relatively constant as the input signal amplitude varies over a wide range, thus providing high gain for weak signals and low gain for strong signals. Manual gain control should always follow the agc circuit to adjust its relatively constant output to a level suitable for the following circuits.

applications

One of the most useful places for audio agc is between the microphone and transmitter. The agc circuit not only prevents overmodulation when speaking loudly into the microphone, it also minimizes decreases in modulation when voice level drops or the microphone is moved away. Once the manual gain control is set, no further attention should be required.

The current interest in direct-conversion receivers has brought another application for audio agc to mind. Several articles have been published describing these simple receivers, but few, if any, include any form of agc. Since most, if not all, of the gain of these receivers is provided in the audio amplifier, this would be the logical place for an agc

Courtney Hall, WA5SNZ, 7716 La Verdura Drive, Dallas, Texas 75240

circuit. Audio agc would prevent distortion and ear fatigue caused by strong signals.

Other uses include telephone amplifiers and tape recorders. Audio agc is also a deterrent to audio howl or feedback common in public-address systems; the howl appears as a signal to the agc circuit which then reduces gain to control it.

agc vs clippers

Speech clippers are not uncommon in transmitters and usually include two

bring the signal up to the level required to forward bias a diode. The agc circuit requires no low-pass filter for the signal but needs a detector and control element. The advantages of a clean signal with *almost constant amplitude* should be weighed against the slight increase in complexity of an audio agc circuit.

agc characteristics

There are practical limits to the performance of any circuit, and conflicting requirements often dictate compromises

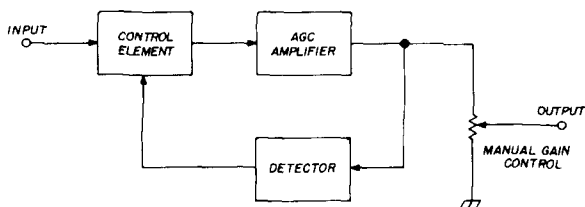


fig. 1. Block diagram of a basic agc circuit.

diodes which clip the positive and negative excursions of the audio signal when its amplitude reaches a certain level. Such clipping circuits can prevent over-modulation, but they have two shortcomings compared to audio agc. When a speech clipper is limiting the audio signal, it is also distorting it and producing harmonic frequency components not present in the original speech signal; this distortion decreases intelligibility. Filters following the clipper do not remove harmonics of the lower speech frequencies which fall within the passband of the filter. In addition to distortion, the clipper circuit provides no increase in gain if the audio signal falls to an unusually low level; this does not improve intelligibility either.

Audio agc circuits do not have to introduce distortion to perform their function. They can be designed to hold output constant within a few dB while the input varies over a range of 60 dB or more.

You may think that clipping circuits have the advantage of simplicity but this argument is rather thin. Both techniques require an amplifier with enough gain to

in design goals. The following paragraphs describe the important characteristics and limitations of audio agc.

At extremely low input signal levels, the agc amplifier does not have sufficient gain to cause the detector diode to conduct; therefore the dc control voltage is zero, and the control element does not attenuate the signal. As the input signal is increased the agc amplifier output voltage increases linearly until the detector diode begins to conduct and produce a dc control voltage; this point is called the agc threshold because it is the point at which agc action begins.

Input signals below the agc threshold are amplified linearly, and input signals above the threshold are amplified or attenuated as needed to hold the output voltage constant. The agc amplifier gain can be increased until the threshold is so low that agc action occurs with circuit noise. This assures agc action on the lowest usable signal, but the signal-to-noise ratio of larger signals will be seriously degraded.

If amplifier gain is increased without discretion the dynamic range of the

control element may be exceeded with only moderately strong signals, causing overload and distortion. Amplifier gain must be selected so that the threshold is at the optimum point with respect to expected input signal levels and acceptable signal-to-noise ratio.

Attack time is the time required to reduce the gain when a strong signal suddenly appears at the input. It is important that attack time be relatively fast so that gain can be reduced before distortion occurs. This parameter is highly dependent on the charging time of the filter capacitor in the detector circuit.

Release time is the time required to increase gain when a strong signal is suddenly removed from the input. This time is relatively long, on the order of one second, so that gain does not fluctuate between words and syllables. Release time is controlled primarily by the discharge time of the detector's filter capacitor.

Distortion is an important parameter in any audio system. A well designed audio agc circuit should not show any significant distortion of output waveform when viewed with an oscilloscope.

practical circuit

There are many configurations and variations used to accomplish audio agc. Discussion of all these techniques is beyond the scope of this article, so attention will be focused on one type of

circuit which I consider to be easily reproducible.

Bipolar and field-effect transistors have wide variations of parameters in

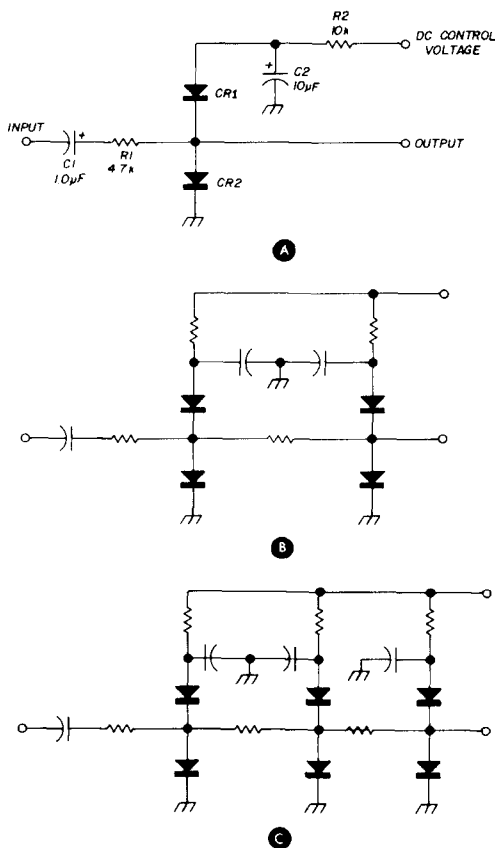


fig. 3. Voltage-controlled attenuators. A shows a one-section attenuator; two- and three-section attenuators are shown in B and C.

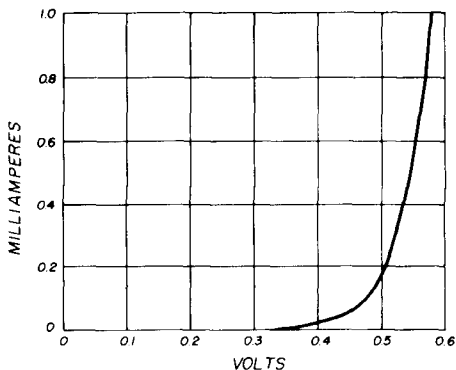


fig. 2. Forward characteristic of a 1N914.

devices of the same type. However, the forward-bias characteristics of silicon diodes are relatively uniform. Therefore, diodes are desirable for use as control elements if circuit reproducibility without selected devices is important.

Fig. 2 shows the forward voltage vs current for a 1N914 silicon diode. At forward bias levels less than 0.3 volt the diode is essentially off and has a very high

resistance. As forward bias voltage is increased, current begins to increase more and more rapidly, and the diode exhibits less and less resistance. Thus, the diode

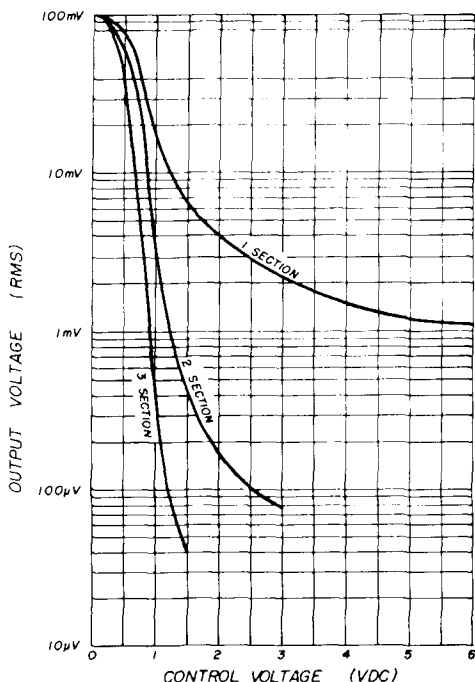


fig. 4. Response of one-, two- and three-section voltage-controlled diode attenuators.

can function as a voltage- (or current-) controlled resistor.

If the amplitude of the ac signal across this voltage-controlled resistor is kept small, resistance changes due to signal amplitude will be small, resulting in low distortion. The resistance shown by the diode to a low-level ac signal is called the dynamic resistance and is the reciprocal of the slope of the curve at any point. The slope of the diode's curve at 0.45 volt bias is approximately 1.1 milliampere-per-volt, and the dynamic resistance is about 910 ohms; at a forward bias of 0.55 volt, the slope and dynamic resistance are about 11 milliamperes-per-volt and 91 ohms, respectively.

A schematic of a single-section voltage-controlled attenuator using two 1N914 diodes is shown in fig. 3A. R1 acts as the series element of an L attenuator; CR1 and CR2 form the shunt element. C1 prevents control current from flowing in the input circuit; C2 bypasses the current limiting resistor, R2, out of the signal circuit. No dc control current should be allowed to flow in the output circuit.

Figs. 3B and 3C show two- and three-section attenuators, all sections being the same. Data taken on these attenuators is plotted in fig. 4. The input signal from a 1-kHz 600-ohm generator was held constant at 100 millivolts rms, and output signal voltage was plotted vs dc control voltage (from a power supply). Output waveform was monitored on an oscilloscope, and no significant distortion was detected.

The single-section attenuator appears to approach a limit of about 40 dB attenuation, indicating a minimum shunt resistance on the order of 50 ohms. More than 60 dB of attenuation is available from either the two- or three-section circuit. The two-section attenuator was judged to offer the best compromise between performance and number of components. Accurate readings below 100 microvolts were difficult because of noise.

If the two-section attenuator is followed by an amplifier having a voltage gain of 1000 (60 dB) the overall gain of the composite circuit could vary from less than one up to 1000, depending on the amplitude of the dc control voltage. Fig. 5 is a schematic diagram of a complete audio agc circuit. Q1, Q2 and Q3 make up the amplifier portion; CR5 is the detector. Q4 is a dc amplifier and C9 is the agc filter capacitor. The ratio of R9 to R7 determines the closed-loop voltage gain of the amplifier, which is 1000. If R7 is shorted the open-loop gain is about 56,000 (95 dB).

Amplifier bandwidth extends from 150 Hz, determined by C4, to 15 kHz, determined by C6. Other bandwidths can

be obtained by changing the values of these capacitors; the usual 300 to 3000 Hz communications bandwidth is obtained by using .01 μF for C4 and .05 μF for C6. R5, R10 and R11 provide dc bias stabilization, and C5 prevents signal feedback via this path. Power supply drain is about 7 milliamperes. The transistor types in parenthesis are epoxy devices which should perform as well as the hermetically-sealed types.

μV of input voltage.

Attack time is in the neighborhood of 40 milliseconds; release time is on the order of one second. Release time can be increased by raising the value of C9 and attack time can be decreased by reducing R12, but there will be some interaction in these adjustments. Some experimentation

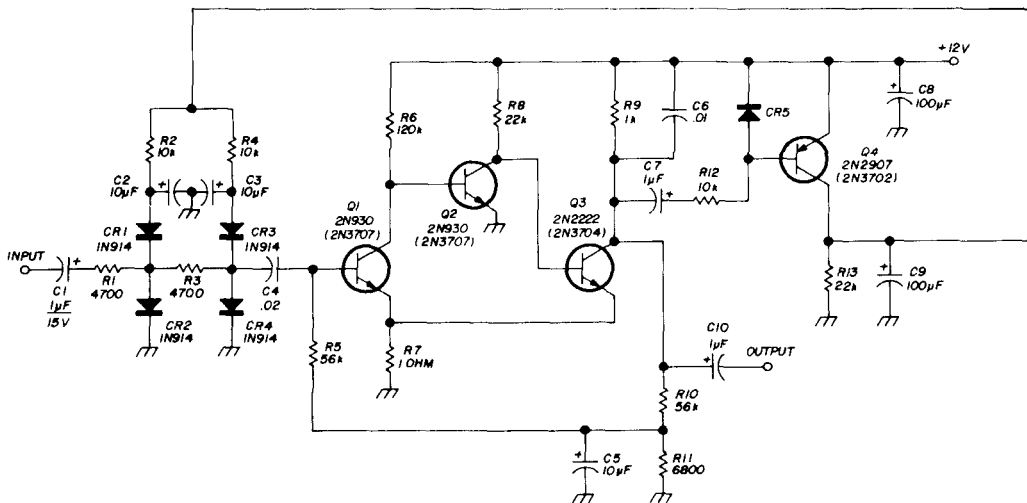


fig. 5. Schematic diagram of a practical audio agc circuit. Complete performance characteristics are shown in table 1. Input/output characteristic is plotted in fig. 6.

The input impedance of the amplifier, looking from C4, is about 56,000 ohms; this resistance and the two series resistors in the voltage-controlled attenuator form a voltage divider which reduces the maximum voltage gain of the circuit to about 860.

Test data on the circuit of fig. 5 is listed in table 1. The ratio of maximum to minimum gain is 1430, and the maximum amount of harmonic distortion was measured at less than 2.5%. Data is omitted where the signal was too small to be measured with reasonable accuracy. Input voltage vs output voltage is plotted in fig. 6. This graph shows that agc threshold occurs at approximately 300

should disclose the optimum values for these components. I have observed that when attack time is decreased below a certain point the circuit oscillates at about 1 Hz. This behavior has not been investigated to my satisfaction, but it is corrected by increasing R12, or by raising the amplifier's lower cutoff frequency (decreasing C4).

using the agc circuit

Successful incorporation of this circuit into an audio system depends heavily on proper interfacing at the input and output. If the agc circuit is inserted between the microphone and transmitter an attenuator should be placed between the

agc output and the transmitter's mike input. The maximum agc output, nominally 0.5 volt, should be reduced to the order of one millivolt to provide normal input level to the transmitter.

Circuits connected to the agc output should not appreciably load the 1000-ohm output impedance, or the gain will be lowered. Assuming typical microphone output varies from 30 μV to 10 mV as sound level changes then a large

a microphone output of 30 μV . Assuming the preamp had the same equivalent input noise as the agc circuit the noise output from the agc circuit would be about 10 times higher or 22 mV. This would still provide a minimum signal-to-noise ratio of more than 20 dB in the agc range.

If the audio agc circuit is used with a simple receiver the receiver's audio should be amplified or attenuated to a level consistent with good agc action and

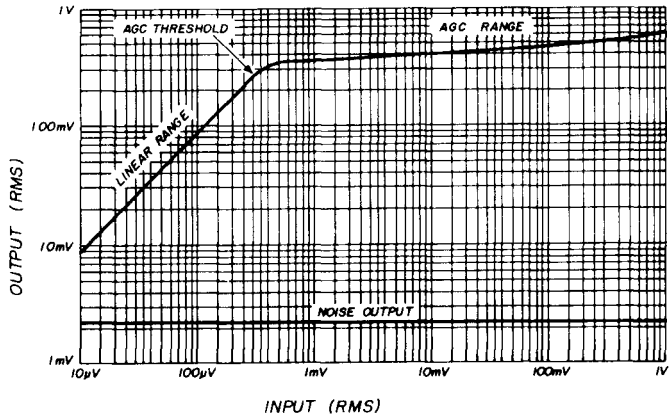


fig. 6. Input vs output of agc circuit shown in fig. 5.

portion of the lower level sounds would not be within agc range. If more complete sound leveling is desired, a 20-dB pre-amplifier could be connected between the microphone and the agc circuit's input. This would have the effect of decreasing the input voltages in fig. 6 by a factor of 10, and the new threshold would occur at

acceptable signal-to-noise ratio before feeding into the agc circuit. The receiver volume control should be connected between the agc output and the receiver's output amplifier.

A useful item to include in the agc circuit is a meter to monitor dc control voltage; this would provide a visual indication that signals are within the agc range. Such a meter circuit should not load the detector dc amplifier. It has been found satisfactory to use a 50- μA meter in series with a 100,000 ohm resistor as a 5-volt full-scale meter connected between the collector of Q4 and ground.

conclusion

This article is not intended to be an exhaustive study of audio agc theory and technique, but it is hoped that it will assist those readers who wish to experiment in this area.

ham radio

table 1. Performance of the agc circuit of fig. 5.

input voltage (rms)	output voltage (rms)	voltage gain	harmonic distortion (%)	dc control voltage (volts)
10 μV	8.6 mV	860	—	—
32 μV	27.4 mV	855	—	—
100 μV	85 mV	850	—	—
320 μV	270 mV	843	—	0.04
1 mV	360 mV	360	0.9	0.65
3.2 mV	380 mV	119	0.9	0.81
10 mV	400 mV	40	0.9	0.98
32 mV	430 mV	13.4	1.2	1.19
100 mV	460 mV	4.6	1.2	1.51
320 mV	520 mV	1.6	1.3	2.03
1 V	590 mV	0.6	2.4	2.95

fixing a sticky AR-22 rotator

Most sticking
AR-22 rotators
are caused by
the same problem —
easily fixed
with three rivets

Many amateurs use the CDE AR-22 rotator with great success, especially where there is little cold weather or icing. However, in areas subject to ice storms, operators may experience trouble with a sluggish rotator, or one that only goes part of the way around. When the AR-22 is strained by heavy loading, the rather husky motor tends to bend over the teeth in the drive gears.

The three drive gears, part number TRA-39, consist of three thin iron gears sandwiched together on one spindle. They drive the TRA-18 ring gear which goes around the perimeter of the rotator. If one of the gears in the sandwich happens to be a little larger, it will take all the strain and can wear to the point where the other two will wear unevenly. When all three gears are sufficiently worn, they start to bind. This usually starts at one particular point in rotation, but eventually spreads to the entire 360° and may cause the aluminum ring gear to snap in two.

The cure for this malady is rather simple: rivet the three stamped gears together. This way one gear won't take all the loading, and the three gears will wear evenly. Remove the TRA-18 ring gear and TRA-39 drive gears (use your instruction book for guidance). If your rotator has been binding, order a new TRA-39 drive gear from CDE.* Even a slight bend in these gears will lead to eventual trouble.

*Send all parts orders to Cornell-Dubilier Electronics, Rotor Parts Department, Desplaines, Illinois 60018, *not* to their factory in Fuquay Springs, North Carolina.

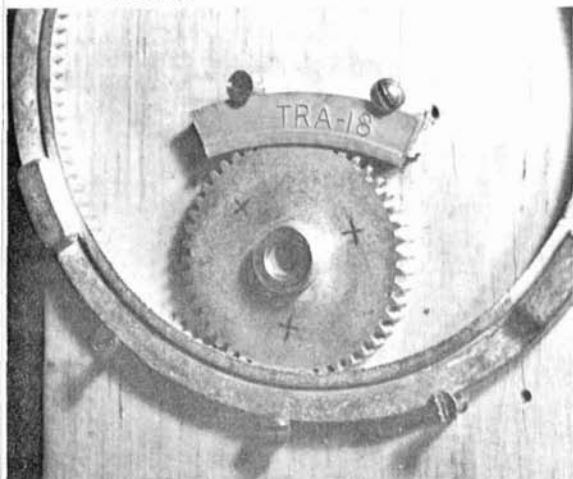
Ted Woolner, WA1ABP, 30 Cedar Road, Shrewsbury, Massachusetts 01545

Also inspect the TRA-18 ring gear for damage. Wash it off in solvent and look carefully for hairline cracks. This is also an opportunity to look over the rest of the parts in the rotator; if any are broken or badly worn, replace them.

Since each of the gears in the TRA-39 assembly was stamped out, each has a slight burr on one side. Do not try to file them flat. When mounting them on the spindle be sure to place them with the burrs toward the bottom; otherwise the gear stack will be too thick.

To drill the rivet holes in the TRA-39 gear, mount the ring gear on a piece of wood with screws as shown in the photo. Mesh the TRA-39 with the ring gear and hold it in place with a section of damaged ring gear. The beveled heads of the wood screws will force the gears together and hold them firmly in place. Drill three equally-spaced holes in the TRA-39 drive gear. If you have a drill press, use it; it will insure that the holes are perpendicular to the face of the gears. Use soft-iron rivets to hold the gears together; rivets 3/8-inch long are just about right. The rivets should be snug in the drill holes for maximum strength.

To drill the rivet holes, the TRA-39 drive gear is held down with a TRA-18 ring gear and sawed-off section from a damaged ring gear. The small crosses mark the rivet-holes locations.



Remember when reassembling that the ring gear should be placed in position last. Make sure that the line stamped on the cam gear is parallel with the edge of the motor-mounting plate as shown in fig. 1. In this position the pulsing-switch points should open; rotate the gears until this

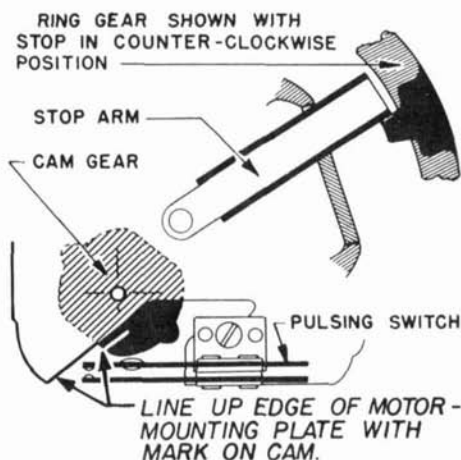


fig. 1. When putting your AR-22 back together, the line on the cam should line up with the edge of the motor-mounting plate as shown here. The ring gear should be against the stop arm in the counter-clockwise position.

happens. The stop arm should be pushed to the left (counterclockwise) as far as it will go. In this position the stop lug on the ring gear should be up against the stop arm.

Be sure that all the ball bearings are in place in the retainer spring clips. Thoroughly grease the gears with a good silicone grease such as Dow-Corning 44 or Lubriplate, a white lubricant available in many hardware stores; an 8-ounce tube is sufficient. Also, when replacing the top cover of the rotator, make sure the lugs in the ring gear rest in the recessed sockets provided inside. When the rotator is assembled in this manner it is in the North position, against the stops from a counter-clockwise direction through East. The control box should be oriented to coincide with this setting.

ham radio

the electronic hand keyer

An ordinary hand key
or bug
can be used
with this circuit
to form
perfectly shaped
code characters

Today's electronic keyers are controlled by some type of paddle with two sets of contacts — one for dots, the other for dashes. The "electronic hand keyer" is controlled by only one set of contacts. A standard hand key or a semiautomatic key (bug) will work perfectly. Dots or dashes can be made, and the spacing and ratio will be perfect. Suddenly your fist will sound like a million dollars!

operation

The electronic hand keyer will generate a dot or dashes depending upon how long the key is held closed. If the key is released before the correct dot interval is over, a perfect dot results. If the key is held down longer, a dash will be made. If the key is held down still longer, additional dashes or an additional dot can be made.

For example, to make a 9 requires only one press of the key. The key is pressed until four dashes are made and then released during the first one-third of the fifth dash, thus making it a dot. For characters similar to 9 the electronic hand

keyer is superior to the fully automatic twin-lever keyer. Unfortunately, a study of the character 4 quickly puts the electronic hand keyer back into its place.

The key must be released quickly to make a dot, or else a dash will result; so to make a 4 requires the character to be sent just as it would be with a hand key. The electronic hand keyer essentially takes the 4, as sent by the hand key, and corrects the spacing and dot-to-dash ratio. A character sent by a bug is corrected in the same manner. All characters can be sent normally by a hand key or bug to be corrected, or reshaped, by the electronic hand keyer.

basic keyer

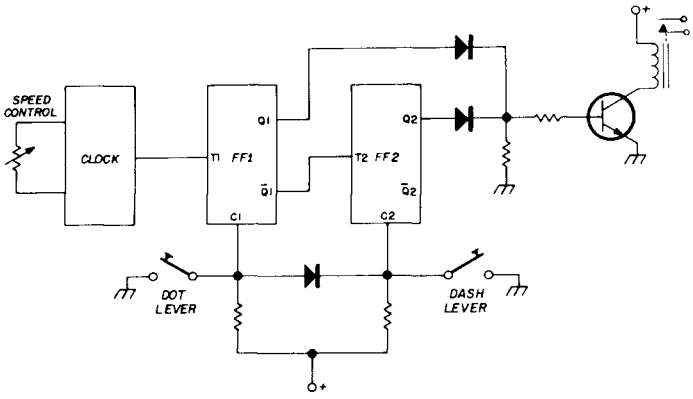
The circuit is essentially that of a simple electronic keyer with one connection changed. Only the basic function of the electronic hand keyer is discussed in this article. Detailed circuits with component values are not given. The electronic hand keyer is presented in this manner because of subparagraph 807 of Murphy's Law.* You are encouraged to study and understand the function of the circuit, then design and construct your own from available components.

A simple keyer is shown in fig. 1. The clock can be a free-running multivibrator, a unijunction relaxation oscillator, or almost any adjustable source of low-frequency periodic signal. FF1, FF2 can be any triggered flip-flop connected as a divider so that it will change state each time the negative (trailing) edge of the trigger signal is received. The Clear terminals (C1, C2) hold the Q terminal low as long as the Clear signal is high. A relay output is shown, but a keying transistor could easily be used instead.

The clock runs continuously, and both flip-flops are normally biased off (clear).

*Subparagraph 807 of Murphy's Law states that "The reader's junk box will never contain the components required by the magazine article."

fig. 1. Basic keyer circuit. The clock is a free-running oscillator. After the dot or dash lever is held closed, a negative edge from the clock triggers the flip-flops thus forming a character.



A character is started only after the dot or dash lever is held closed until a negative edge comes from the clock. Fig. 2 shows the signals that occur when the dash lever is closed and held closed beginning during some time interval, A. A diode pulls C1 low when C2 is forced low. The diodes connected to Q1 and Q2 serve as an OR gate to pull in the relay when either Q1 or Q2 is high, thus making a dash.

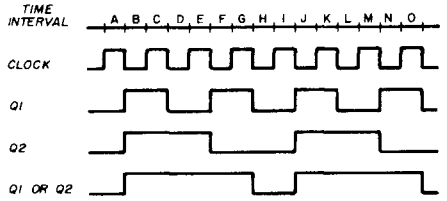


fig. 2. Timing diagram of dashes made with the circuit of fig. 1.

self-completion

The circuit of fig. 1 does not self-complete because the flip-flops are forced clear immediately when a lever is released, allowing the Clear terminals to go high. The character in progress will then be chopped off immediately if the lever is released.

Fig. 3 shows this same keyer with two diodes added to make the keyer self

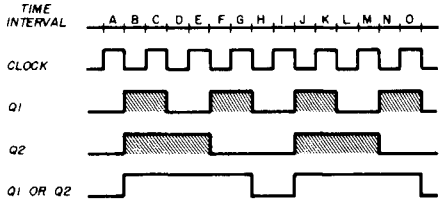
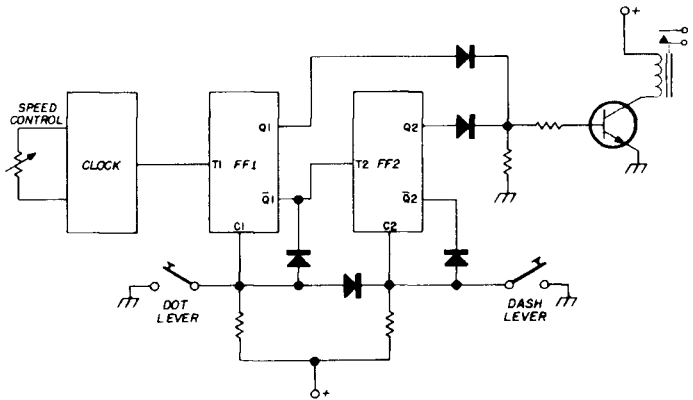


fig. 4. Timing diagram for circuit of fig. 3. Shaded areas show when flip-flop Clear terminal is held low by its associated \bar{Q} terminal.

fig. 3. Keyer circuit of fig. 1 with two diodes added to make the keyer self-completing.



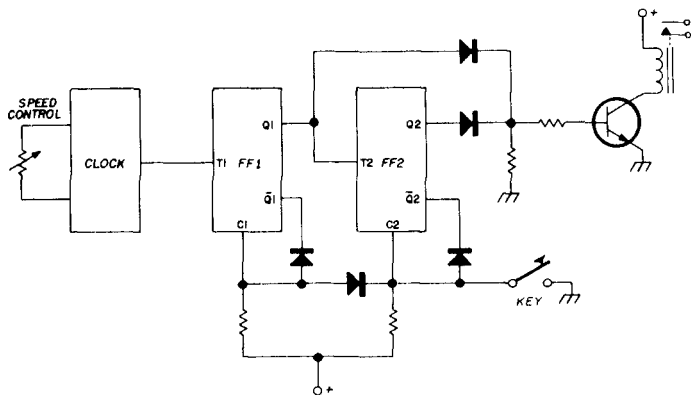


fig. 5. Circuit of the electronic hand keyer.

completing. The Clear terminal is now pulled low by the diode if the \bar{Q} terminal is low. The shaded areas of fig. 4 show the times when the Clear terminal is held low by its associated \bar{Q} terminal. When a dash is started the dash lever can be released, and $\bar{Q}2$ holds the dash Clear terminal low for two-thirds of the dash; then $\bar{Q}1$ holds the dot Clear terminal low for the remainder of the dash.

Notice that Q1 must go high before Q2 goes low or the self completion will be lost, and the dash will be terminated when it is only two-thirds complete. Fortunately, since FF2 is triggered by FF1, this condition is always met.

the electronic hand keyer

If FF2 is triggered from Q1 rather than $\bar{Q}1$, as shown in fig. 5, the timing diagram of fig. 6 results. The shaded areas again indicate intervals where the Clear terminal is held low by the associated \bar{Q} terminal of the flip-flop. Notice that during intervals C, D and K, L Q1 goes low before Q2 goes high. If a dash is

started and the lever released, the self-completion is lost when Q1 first goes low, and the dash is terminated when it is only one-third complete. If the dash lever is held for over one-third of the dash interval, $\bar{Q}2$ takes hold, and the full dash will be made.

summary

Fig. 7 shows the shaping capability of the electronic hand keyer. Poor code is reshaped perfectly if it is sent at or near the same speed as that to which the circuit is adjusted. To send a dot or a dash, it is necessary only to hold the key down until the character starts, then release it at the proper time.

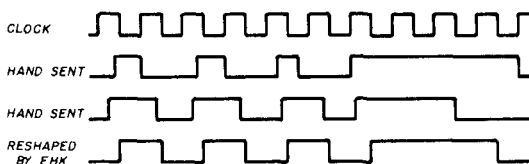


fig. 7. The shaping capability on the letter "V" by the electronic hand keyer.

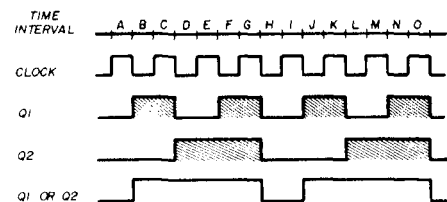


fig. 6. Timing diagram showing self-completion of dots and dashes of the electronic hand keyer.

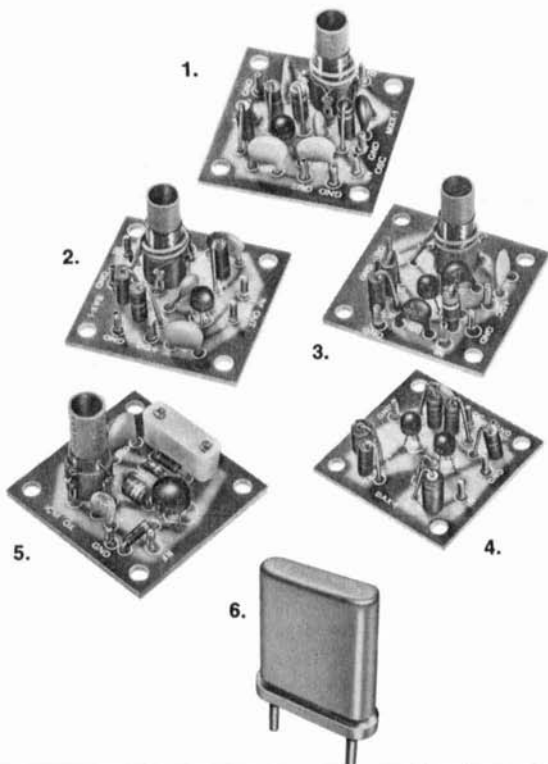
The electronic hand keyer will also make an interesting and educational project for the beginning digital and solid-state experimenter. The forward-looking amateur might want to add a switch at the T2 terminal to change the electronic hand keyer back to a regular keyer once he has progressed that far.

ham radio

for the experimenter!

INTERNATIONAL EX CRYSTAL & EX KITS

OSCILLATOR • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER



1. MXX-1 TRANSISTOR RF MIXER

A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering).....\$3.50

2. SAX-1 TRANSISTOR RF AMP

A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering).....\$3.50

3. PAX-1 TRANSISTOR RF POWER AMP

A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw, depending on the frequency and voltage. Amplifier can be amplitude modulated. Frequency 3,000 to 30,000 KHz.....\$3.75

4. BAX-1 BROADBAND AMP

General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL, Experimenter or Amateur.....\$3.75

5. OX OSCILLATOR

Crystal controlled transistor type. Lo Kit 3,000 to 19,999 KHz, Hi Kit 20,000 to 60,000 KHz. (Specify when ordering).....\$2.95

6. TYPE EX CRYSTAL

Available from 3,000 to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is $\pm .02\%$ when operated in International OX circuit or its equivalent. (Specify frequency).....\$3.95

for the commercial user

INTERNATIONAL PRECISION RADIO CRYSTALS

International Crystals are available from 70 KHz to 160 MHz in a wide variety of holders. Crystals for use in military equipment can be supplied to meet specifications MIL-C-3098E.

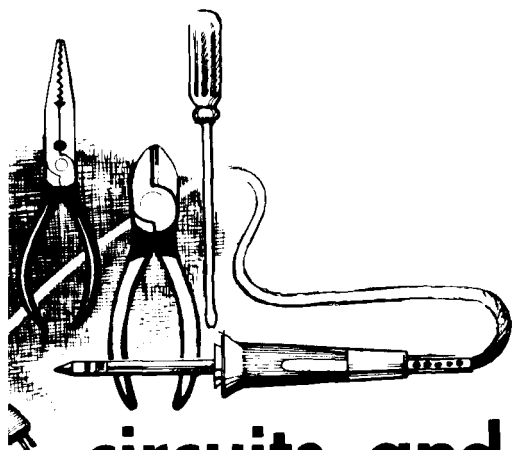
CRYSTAL TYPES: (GP) for "General Purpose" applications
(CS) for "Commercial Standard"
(HA) for "High Accuracy" close temperature tolerance requirements.



WRITE FOR CATALOG.



CRYSTAL MFG. CO., INC.
10 NO. LEE • OKLA. CITY, OKLA. 73102



circuits and techniques

ed noll, W3FQJ

integrated circuits

The foreboding opinion that integrated circuits will stop amateur experimentation and stymie ingenuity is unfounded. In fact, so much reliability and versatility have been built into these devices that there appear to be an infinite number of external circuits and systems yet to be tried. Each amateur can look forward to a lifetime of fun and experimentation with solid-state devices and systems; the integrated circuit is just an extension of the solid-state science of packing active devices into ever smaller spaces. Diodes, transistors and resistors are the primary components used in integrated circuits although a limited number may include an occasional capacitor or coil.

Since capacitors take up considerable space it is customary to use circuits that do not require capacitance. Also, it is difficult to design a precise value resistor into an integrated circuit. On the other hand, there is no great problem in including two or more resistors of exactly the same value even though a *certain*

absolute value is difficult to attain. Hence, internal circuitry uses balanced configurations that require equal-value resistors but are not critical as to absolute value. All of this boils down to the fact that the most common integrated circuit is the balanced dc amplifier.

basic differential amplifier

The differential amplifier is the mainstay of integrated circuits. It is basically an emitter-coupled configuration (fig. 1); as a dc amplifier it has fine stability and good rejection of undesired signal components. Since it is a direct-coupled amplifier no interstage coupling capacitors are needed.

Ideal differential operation requires that the two collector resistances be the same and the characteristics of the two transistors be identical. In terms of discrete component circuits this is a disadvantage because perfectly matched transistors and resistors are necessary. However, in ic production these conditions are met quite readily and at low cost. In basic operation the differential amplifier emphasizes the signal difference that exists between base inputs, developing equal-amplitude and out-of-phase collector signals.

It is stated that a *differential-mode* input signal is applied. In practice this is done by applying the desired ac signal to just one of the base inputs. Since no signal is applied to the opposite base the difference voltage between the two equals the magnitude of the signal applied to the one base.

When two equal-amplitude similar-polarity signals are applied to the base inputs the ac signals across the common emitter resistor are subtractive. When in perfect balance the differential amplifier

performs in bridge-like manner — there is no output observed from collector to collector and very reduced output from each collector and common. Such an applied signal is referred to as a *common-mode* input signal. This is usually the form of undesired signals such as hum and interference.

In the difference-mode operation a signal applied to base 1 appears at the

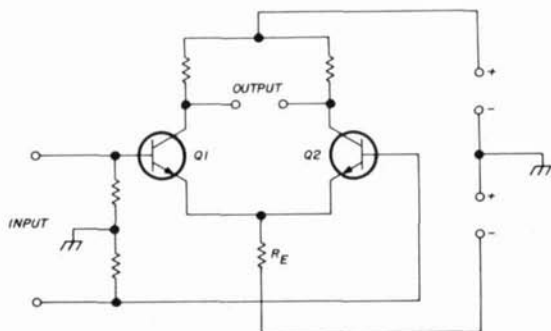


fig. 1. Basic differential amplifier.

collector output of transistor 1 and also across the common emitter resistor. The latter signal component serves as the input signal for transistor 2. As a result the output at collector 2 is opposite from that at collector 1. The differential amplifier acts as a phase splitter, developing two equal-amplitude but opposite-polarity signal components at the output.

The differential amplifier has a high order of dc stability, reducing the influence of supply voltage changes, temperature, etc. It is even practical to construct a multistage affair using the difference concept. A differential amplifier or a group of them connected in cascade arrangements are the most common circuit configurations built into integrated circuits.

In the differential amplifier, not only are the interstage coupling capacitors eliminated, the emitter bypass capacitors are eliminated as well. In making a

comparison between ics and discrete circuits it should be noted that an integrated circuit has fewer passive components (resistors, capacitors and coils) and more active components (transistors and diodes) than a comparable amplifier built of discrete active and passive components.

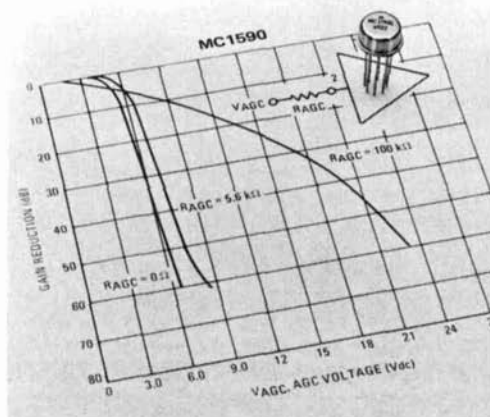
stability

In a perfectly balanced differential amplifier there is stable amplification with changes in dc operation conditions and temperatures. A change in leakage current and/or gain in one side of the differential circuit is balanced out by a like change in the second side. Such balance, and the ability to compensate for any imbalance, sets the operating limits of the differential amplifier.

Reduction of common-mode signals depends upon the degenerative effects of the common-emitter resistor. Of course, the higher the ohmic value of this resistance, the greater the rejection. Such increase is limited by supply voltage requirements and the greater difficulty of including high-value integrated resistors.

The answer to this problem is to include a constant-current emitter source composed of an additional active component, rather than a high value resistance. The fundamental arrangement is

Performance of the Motorola MC1590 integrated circuit.



shown in **fig. 2**. In this circuit the combination of the transistor and its low value emitter resistor acts as a high-resistance constant-current source. The presence of a common-mode signal on the differential transistors affects base voltages and junction resistances. However, emitter and collector currents are held constant by the constant-current emitter source. In fact, the undesired voltage change appears totally across the constant-current source, which is highly degenerative. Thus, the differential gain of the amplifier in terms of common-mode signals is greatly reduced.

The diode in the base circuit of the constant-current source provides temperature compensation. Exact compensation

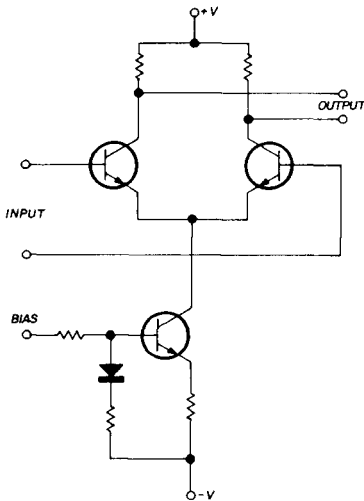


fig. 2. Constant-current bias source with temperature-compensating diode.

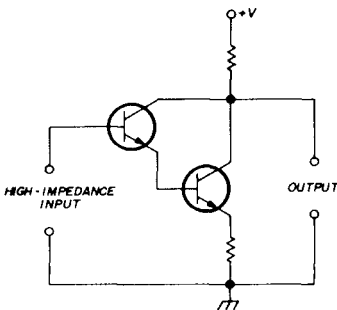


fig. 3. Basic Darlington pair.

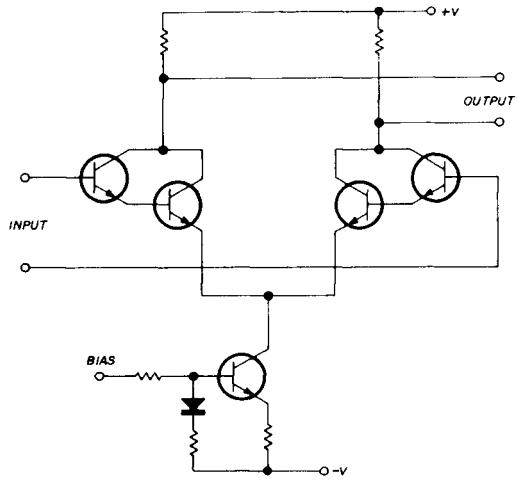


fig. 4. Differential amplifier with Darlington pairs.

is obtained when the characteristics of the base-emitter junction of the constant-current transistor and the diode junction are identical. With a rise in temperature there is an increase in the conductance of the base emitter junction. Since the compensating diode is physically near the transistor there is a similar change in its conductance, and a compensating change is made in the base bias, keeping the collector-emitter current constant. The circuit of **fig. 2** is a very common integrated-circuit configuration.

darlington circuit

The differential amplifiers in **figs. 1** and **2** have low input impedances. High input impedances can be obtained by using Darlington circuitry which involves the addition of two more active elements. A simplified Darlington combination is shown in **fig. 3**; a typical application in an integrated circuit differential amplifier is shown in **fig. 4**.

In the normal transistor operation the base-emitter junction is forward biased and conducts. Resistance is low and approximates the product of beta times the emitter resistance. To some degree the input resistance can be increased by increasing the ohmic value of the emitter resistance at a sacrifice in gain. A better

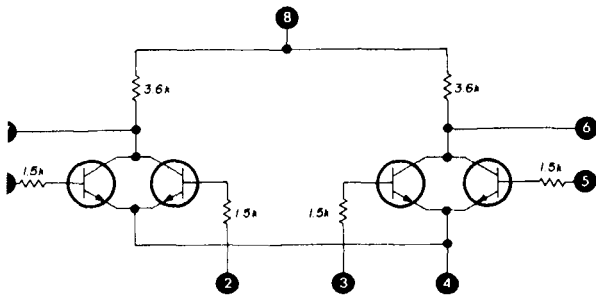


fig. 5. The Motorola HEP580 integrated circuit.

approach is to use the input resistance of a second transistor as the emitter resistance of the first transistor; the input stage then operates with a highly degenerative emitter circuit, and consequently, high input resistance. Both stages contribute output with a gain figure that is comparable to that obtained using a single transistor of the same type but operating with a much lower input resistance. Two such identical circuits are needed for the two separate inputs of a differential amplifier.

Motorola HEP580

The HEP580 is a low-cost integrated circuit composed of six resistors and four transistors. Internally the transistors are connected in pairs with separate base inputs (fig. 5). All emitters are joined together at pin 4. It is a basic differen-

tial-amplifier configuration using paired transistors instead of single devices. If desired, an external stabilizing constant current source can be added at pin 4; equal 3.6k collector load resistances are included. Series base resistances increase input resistance, reduce tendency to parasitic oscillations and provide additional isolation.

Fig. 6 shows two ways that are used to depict integrated circuits. The differential

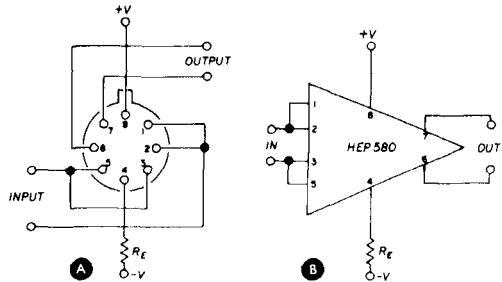


fig. 6. Two methods of representing the Motorola HEP580; arrangement in (B) is preferred.

circuit in fig. 6A is arranged around base pin designations of the ic. The triangular arrangement of 6B is more common, and more instructive, because the circuit layout can be set down with well defined input and output sides regardless of pin numbers.

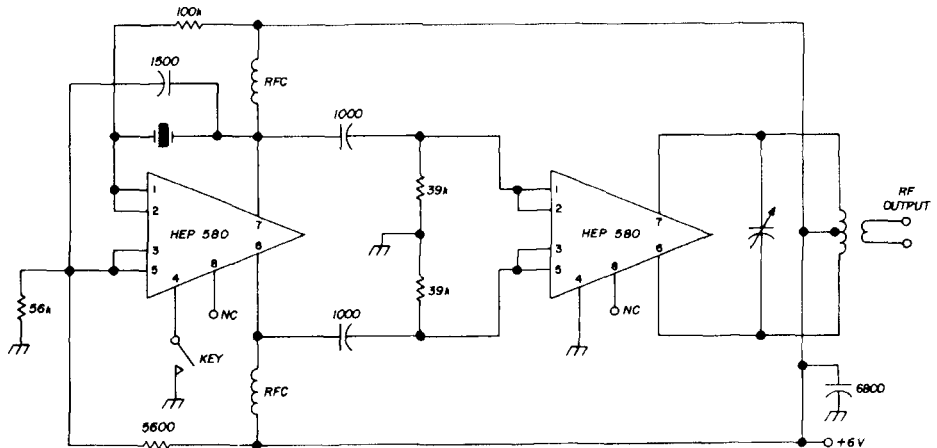
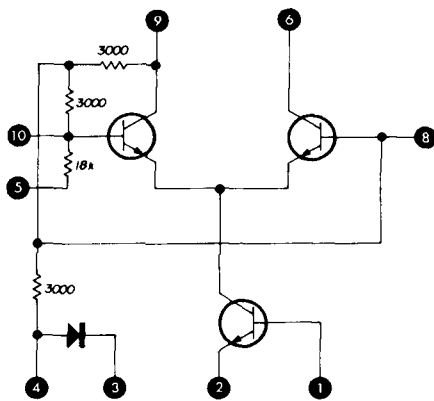


fig. 7. Integrated-circuit transmitter has output of 100 mW on 40 meters.

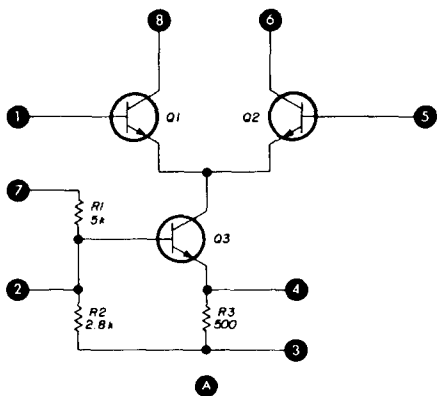
ic transmitter

A 100-milliwatt QRP transmitter can be built from two HEP580s, **fig. 7**. I have had no trouble working several hundred miles on 40 meters with this simple ic rig. The first section of one of the ics operates as a crystal oscillator; the second section as a phase inverter. Choke output is used, and approximately equal-amplitude and opposite-polarity rf signals are available for driving the output ic which operates as a push-pull amplifier. It will draw 20 to 30 milliamperes from a six-volt lantern battery. Dc input power is 120 milliwatts or more.



PIN 7 CONNECTED TO CASE

fig. 9. Circuit diagram of Motorola HEP590 integrated circuit.



A

RCA CA3028

The RCA CA3028 integrated circuit is a high-frequency unit that will function to 100 MHz and higher. It can be used successfully as an rf amplifier, converter, mixer, oscillator or limiter.

The internal diagram of the CA3028 is shown in **fig. 8**. The circuit is the classic arrangement consisting of a differential pair and constant-current bias source. Bias resistors are included. **Fig. 8B** shows the very few external components needed to use this ic as a differential rf amplifier. Signal is applied between pins 1 and 5 which connect to the bases of the differential amplifier. Output is taken from pin 6. Schematic **8C** shows how the same ic can be connected as a cascode rf amplifier. Signal is applied to pin 2 which connects to the base of transistor Q3. Its collector is direct coupled to the emitters of transistors Q1 and Q2 in cascode fashion. Output is taken from pin 6.

ZL4LV has used the RCA CA3028 integrated circuit as a balanced modulator, **fig. 10**.¹ The carrier signal is applied to the base of differential transistor Q1 (pin 1). The audio signal is applied in a differential mode while the

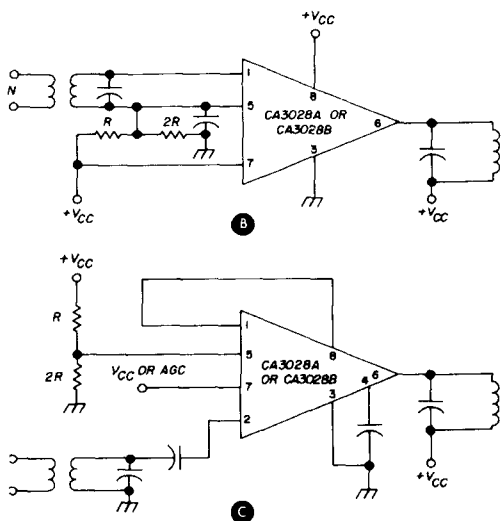


fig. 8. RCA CA3028 Integrated circuit. Internal circuit (A); as a balanced differential amplifier (B); as a cascode amplifier (C).

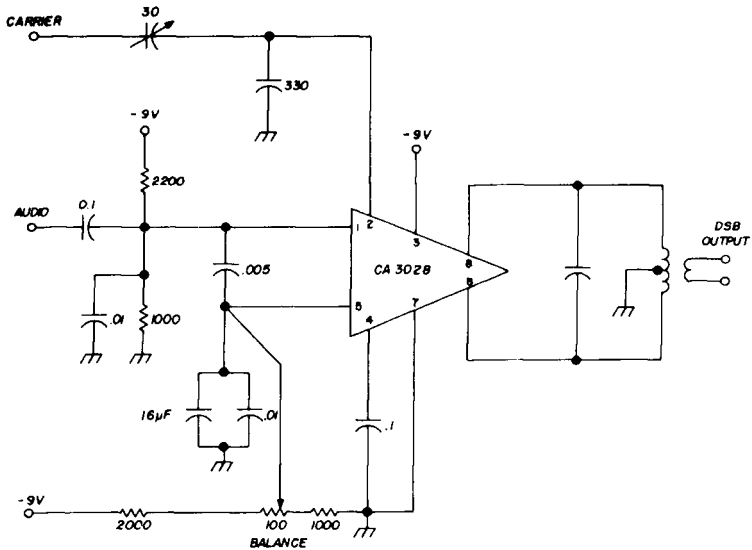


fig. 10. Integrated-circuit balanced modulator designed by ZL4LV.

carrier is applied as an in-phase component. Therefore, with proper balance, the carrier cancels in the collector-to-collector output circuit of the differential pair. Double sideband components are developed across the same output.

The Motorola HEP590 is a similar integrated circuit except that a temperature-compensating diode is a part of the package (fig. 9). Bill Hoisington, K1CLL,² has used the HEP590 successfully as an rf amplifier on both 6 and 40 meters, fig. 11.

Although these integrated circuits have been used principally in receivers they have dissipation ratings of several hundred milliwatts and would no doubt work well in QRPP transmitter circuits and in the earlier stages of QRP transmitters.

balanced modulator/demodulator

The Motorola MC1596G has been designed specifically for use in sideband systems. Internal circuit configuration and external circuit plan for a double-sideband suppressed carrier generator are given in fig. 12. Two differential amplifier pairs are included and incorporate individual transistors in their common emitter circuits to supply constant current bias. A second transistor is included

in each leg for injecting the modulating signal. Carrier is applied in differential mode to the pairs of differential transistors. Outputs of the differential pairs are out-of-phase and under true balance the net carrier voltage is zero. Out-of-phase audio is applied to the transistors located in the emitter legs of the differential pairs. Upper and lower sideband frequencies develop across the output while the modulating wave is canceled.

The carrier signal is applied between pins 8 and 7; the modulating signal is between pins 1 and 4. Biasing for these latter two transistors is obtained from the -8 volt source connected to the arm of the carrier-null potentiometer. This

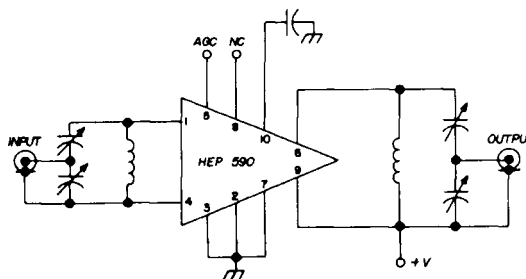
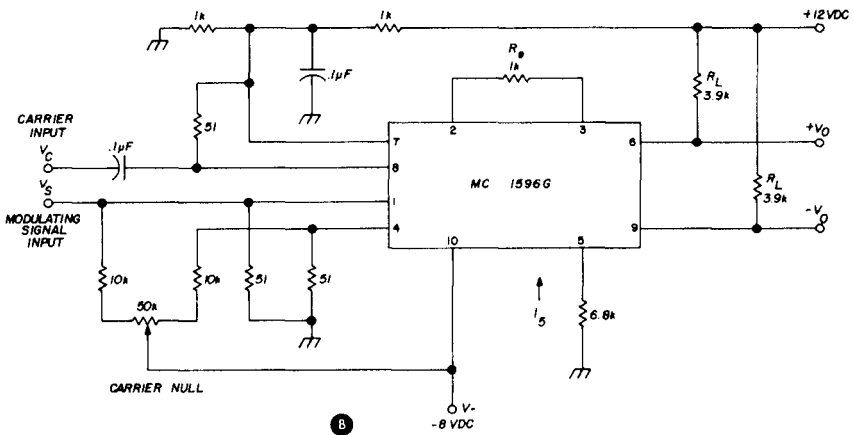
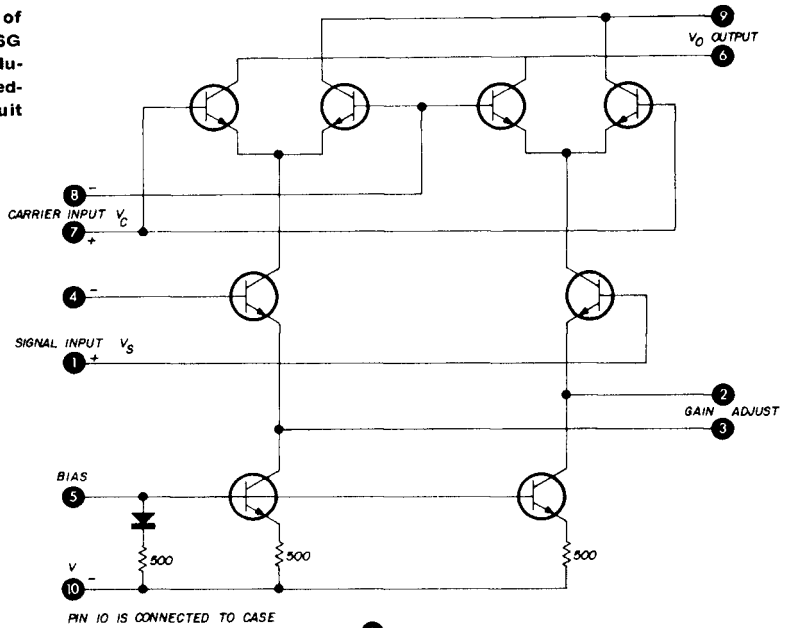


fig. 11. 50-MHz integrated-circuit amplifier built by K1CLL.

fig. 12. Circuit of Motorola MC1596G modulator/demodulator (A); balanced-modulator circuit (B).



biasing sets bias and permits an appropriate adjustment for balancing out the carrier.

A balanced output is available between pins 6 and 9; single-ended output can be derived between either pin and common.

more power fets

The Siliconix 2N3970 is a switching fet that performs well as a high-frequency amplifier and oscillator. Its power output is about one-half that of a U222 power fet but at only one-quarter the cost.

Device dissipation is 1.8 watt. Maximum drain voltage is 40, and in typical circuits the transistor draws 50 to 100 milliamperes. A TO-18 heat sink helps heat dissipation.

The 2N3970 performs well in a variety of oscillator circuits including the Miller, Pierce, Colpitts and push-pull. It oscillates efficiently 10 through 160 meters. A Pierce crystal oscillator and class-C amplifier is shown in fig. 13. This effective QRPP transmitter requires only a single resonant transformer.

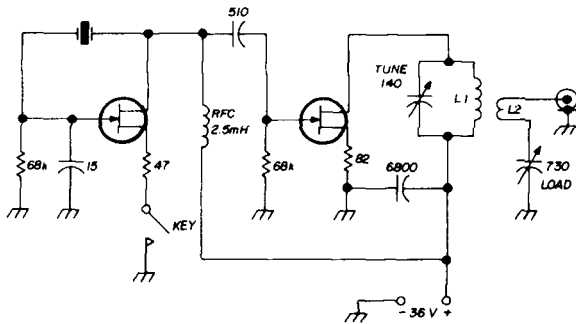


fig. 13. Simple two-stage fet transmitter for 40, 80 and 160 meters.

	160	80	40
L1	65 turns no. 26 on 1-1/4" coil form	40 turns no. 24 on 1-1/4" coil form	21 turns no. 22 on 1-1/4" coil form
L2	20 turns no. 26, bifilar wound on cold end of L1	13 turns no. 24, bifilar wound on cold end of L1	7 turns no. 22, bifilar wound on cold end of L1

Note how the fundamental class-C fet circuit closely matches conventional vacuum-tube practice. The resistor-capaci-

tor combination at the fet gate develops the required cut-off bias. The source resistor, like the cathode resistor of a vacuum-tube amplifier, limits device current to a safe value when rf excitation is lost. A source current meter shows a dip when the drain is tuned through resonance. Likewise, the magnitude of the dip current rises as antenna coupling is increased.

Power outputs up to one-half watt are obtained on 40, 80 and 160 meters with somewhat less on 20 meters. A supply voltage of 36-volts is obtained by connecting three 12-volt lantern batteries in series. Drain current is typically 60 to 75 mA.

Outputs of 1 watt and higher can be obtained on 40, 80 and 160 meters using the push-pull circuit of fig. 14. The circuit arrangement is similar to that given for the U222 160-meter cw transmitter presented in the April issue of *ham radio*.³

References

1. Pat Hawker, G3VA, "ZL4LV High-Frequency Balanced Modulator," *Radio Communication*, July, 1969, page 466.
2. Bill Hoisington, K1CLL, "ICs for Amateur Use," *73*, October, 1970, page 22.
3. Ed Noll, W3FQJ, "Circuits and Techniques: Power FETs," *ham radio*, April, 1971, page 34.

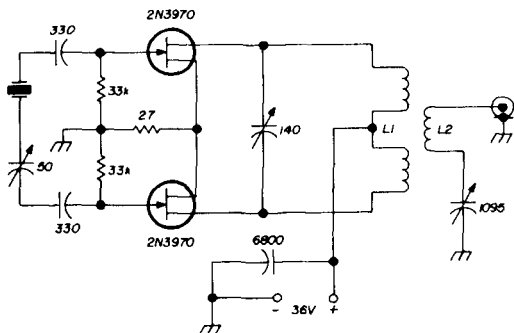
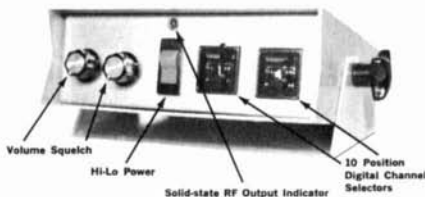


fig. 14. Push-pull fet power oscillator for 40, 80 and 160 meters.

	160	80	40
L1	65 turns no. 26 on 1-1/4" coil form, centertapped and divided	40 turns no. 24 on 1-1/4" coil form, centertapped and divided	21 turns no. 22 on 1-1/4" coil form, centertapped and divided
L2	20 turns no. 26 between halves of L1	13 turns no. 24 between halves of L1	7 turns no. 22 between halves of L1

ham radio

AT LAST THE DYCOMM 10-10 LAND MOBILE



**An American made FM Transceiver
For the amateur who needs quality communications
But at a price below the imports**

- 10 independent Receive-Transmit Channels
.34, .82, .88, .94 Transmit — .76, .82, .88, .94 Receive supplied
- Full 20-30 watt output
- Frequency stability .001% -20° to +60°C
- .3μV sensitivity for 20 db quieting
- All solid state
- Control Head 2" x 5" x 6" — Main Unit 2" x 10" x 11"
Cabling supplied for trunk or other location mount
- FCC type accepted Receiver-Transmitter design

DYCOMM MINI FM BOOSTERS

JUST INSERT BETWEEN YOUR ANTENNA AND TRANSCEIVER,
ADD 12-14 VOLTS AND QSO
ALL WITH AUTOMATIC RF SWITCHING

101-500C "FM BOOSTER"

4-12W input for
12-30W Max output.

Size: 3" x 4" x 4" Price \$59.95



101-500E "BRICK BOOSTER"

1-3.5W input for
10-30W Max output.
Typically 20W out
for 2W in.

Low introductory price only \$69.95



101-500D "BLOCK BOOSTER"

8-15W input for
20-55W Max output.

Size: 3" x 4" x 6" Only \$89.95

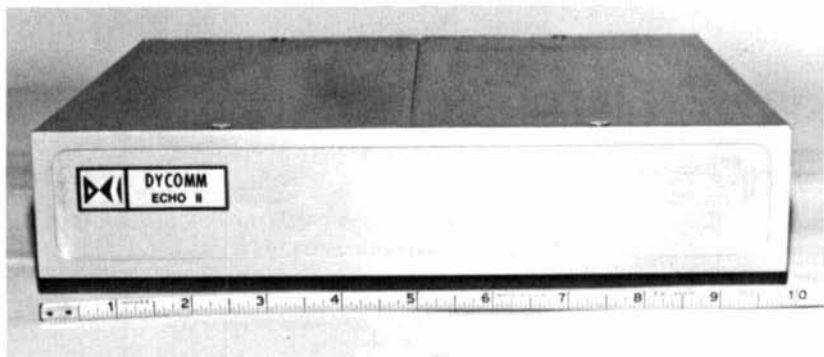


10-0 100 WATT FINAL

8-10W input for
100W output.

Just \$185.00

WRITE TODAY FOR PRICE AND FULL DETAILS ON
THESE DYCOMM PRODUCTS!



**DYCOMM
ECHO II**

... NEVER BEFORE ...
a repeater designed specifically for amateur use.

This compact little package contains a complete 2 meter FM solid-state repeater, including a receiver with useable sensitivity better than .2 microvolts and a transmitter with a guaranteed output of 12 watts (15 watts typical). We think this package is going to revolutionize amateur repeater installations. Look over the spec's and we are certain that you'll agree.

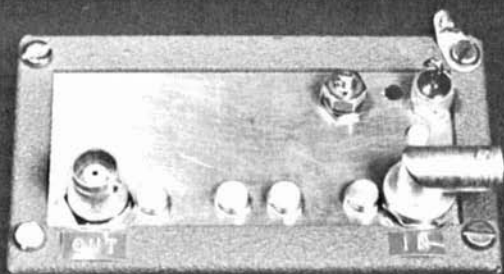
- Solid state — no relays
- Withstands most severe environment, fully weatherproof
- Multiple frequency operation — remote selection capability
- Protected against antenna short or open circuit or mismatch
- Deviation 5 kHz adjustable to 10 kHz
- Desensitization less than .25 microvolt at 200 kHz separation — negligible at 300 kHz
- Power 12-15 volt operation — 40 ma receive — 1.5A transmit
- Terminals provided for all necessary controls and monitoring

Call or write today for information
on these exciting New Dycomm Products

JIM W4MRI

DYNAMIC COMMUNICATIONS, INC.

P. O. BOX 10116 • RIVIERA BEACH, FLORIDA 33404
305-844-1323



low-noise transistor 1296 MHz preamplifier

This high-performance
1296-MHz preamplifier
provides a real breakthrough
in noise figure
and may spell the end
for paramps on 1296 MHz

Dolph Vilardi, WA2VTR, 14 Oakwood Terrace, Spring Valley, New York

The state of the art in amateur receiving techniques has made dramatic strides during the last few years. Noise figures for devices available are now less than 1.5 dB at 432 MHz, and a recently announced Japanese transistor provides a noise figure of less than 3 dB at 1296 MHz with gain in excess of 13 dB.*

The 1296-MHz preamplifier developed by K2UYH,¹ and described in an improved two-stage version by myself² used KMC 5200 and 5500 transistors with noise figures less than 3 dB at 1000 MHz. Early reports of "around 3 or 4 dB at 1300 MHz" proved optimistic; noise figure measurements conducted by W2CCY, W2CQH and W2IMU showed that most devices were nearer to 5 or 6 dB with a few as low as 4.5 dB noise figure, although K2TKN claimed some devices he measured were around 4.0 dB.

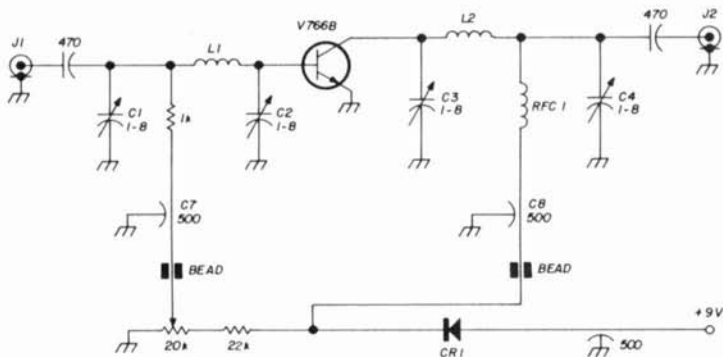
With the best diode mixers available at that time the noise figures of the better front ends were measured optimistically at 7 dB — but most were nearer to 9 or 10 dB and many have been measured as high as 18 dB. With these noise figures it is easy to see why you needed two stages

*The Nippon Electric V766B, available in single units for \$18 from California Eastern Laboratories, 87 Terrace Hall Avenue, Burlington, Massachusetts 01803.

to have sufficient gain to overcome mixer noise and establish a reasonable front-end noise figure.

inexpensive hot-carrier diodes such as the Hewlett-Packard HP2800. With such a converter it is now feasible to establish a

fig. 1. Circuit diagram and parts information for the low-noise 1296-MHz rf preamplifier. Construction is shown in fig. 2. Ferrite beads are available from Amidon Associates, 12033 Otsego Street, North Hollywood, California 91607; \$2.00 per packet.



- C1,C2,C3,C4 1 to 8 pF, high-quality short piston capacitor (Johanson used by author)
- C5,C6 500-pF feedthrough, button mica or ceramic
- CR1 protective diode, 10 mA or more

- J1,J2 Teflon-insulated BNC chassis connector
- L1,L2 brass strip, 3/8" wide (see fig. 2)
- RFC1 2-3/4 turns no. 30 airwound on 1/16" diameter form

Modern converters with hot-carrier diode mixers and filters between the multiplier trough and the mixer³ can achieve noise figures of about 8 dB with

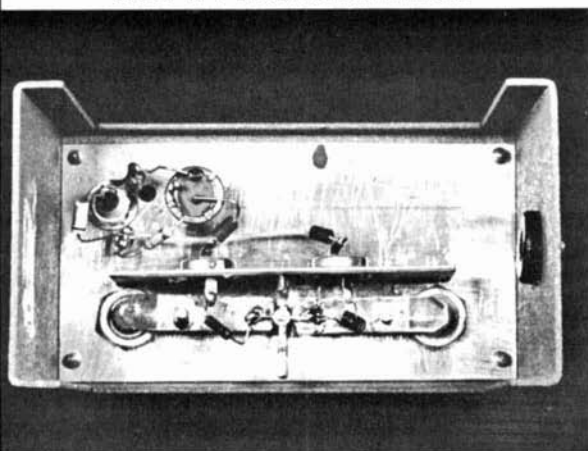
front-end noise figure based on the preamplifier parameters with a single stage if the preamplifier has a gain of at least 11 or 12 dB. The preamplifier described here meets these requirements.

the circuit

The circuit (fig. 1) is essentially that of the first stage of the 1296-MHz amplifier described in the 1970 ARRL Handbook with an rf choke substituted for one of the resistors. This provides slightly better gain. Also, the bias adjustment pot is changed to give smoother control with the parameters of the V766B transistor.

The physical changes from the original design are very important from the standpoint of stability and protection of the parts. Dimensions should be followed closely. An alternate and preferred method of mounting of the transistor is shown in fig. 3B. This construction makes it easy to remove and replace the transistor without damaging it.

The 1296-MHz preamplifier is installed in a 2 1/4 x 2 1/4 x 4-inch minibox.



construction

The preamplifier is built into a minibox for convenience and shielding, but all construction is done on 3/32 or 1/16-inch thick brass plate which is held in place by

the base lead opposite; the two remaining leads are emitter leads.

The minibox shown in the photographs is slightly deeper than necessary since I built an ac power supply into my unit.

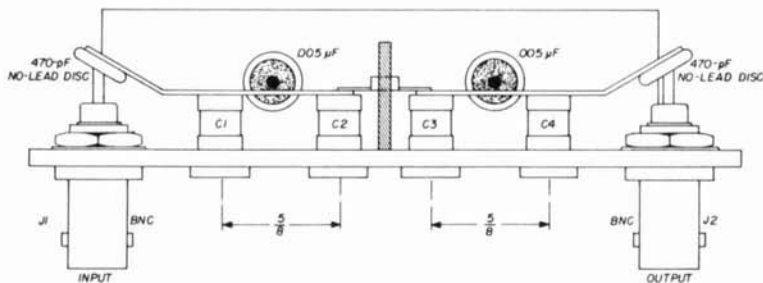
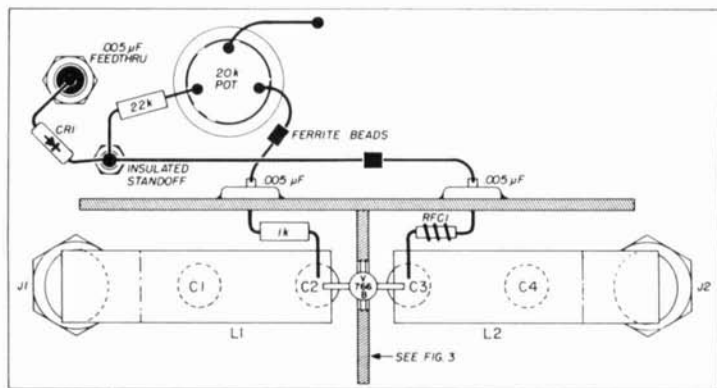


fig. 2. Construction details of the 1296-MHz preamplifier. For shield detail, see fig. 3. This unit is designed to fit into 4x2½x2½" minibox. RFC1 should be air supported; use a ¼-watt 1000- or 2000-ohm resistor if oscillations occur. This illustration is full size.

four screws (see fig. 2). This makes assembling and construction much easier as well as making the whole device very rigid. When working with the transistor, the collector lead is the longest one with

If the power supply is external the minibox can be much shallower.

If silver-impregnated epoxy is available it can be used at the transistor junctions and at the no-lead disc capacitors to avoid

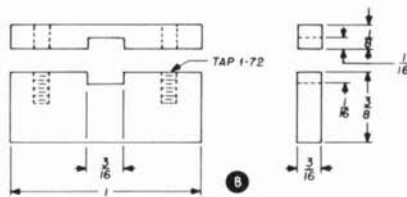
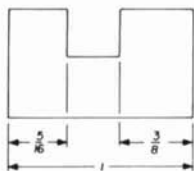
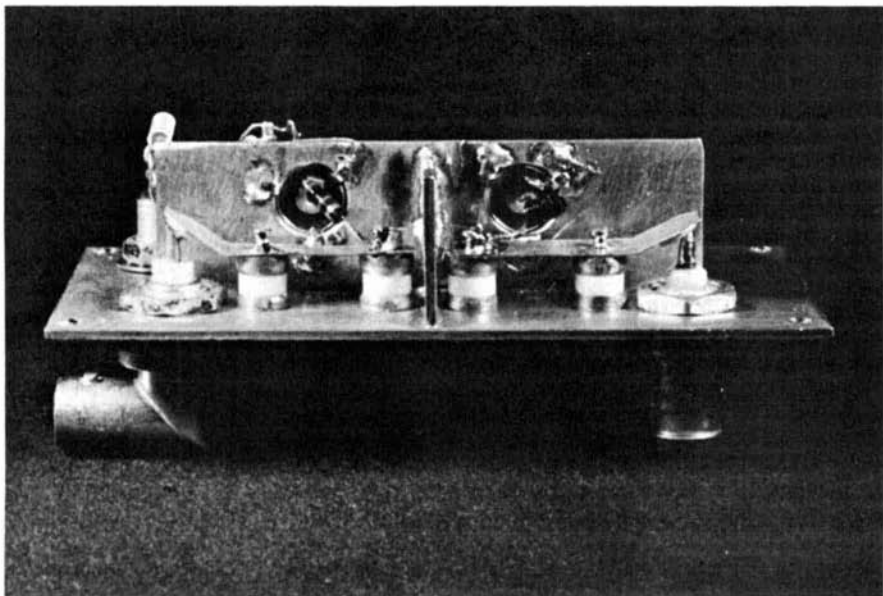


fig. 3. Transistor shield. Layout in (B) is preferred to arrangement in (A) as it permits easy transistor removal.

heat damage. The no-lead capacitors are difficult to find. You can make a good substitute by completely cutting off the leads from a ceramic disc capacitor and carefully filing the ceramic off the flat

to avoid overheating the capacitors when soldering. The brass striplines are mounted on top of the tuning capacitors and soldered directly to the tops. The capacitors are mounted on 5/8-inch



Simple construction of the low-noise preamplifier for 1296 MHz.

surfaces. You may spoil one or two disc capacitors but you'll eventually get the hang of it. Connections are soldered directly to the exposed surfaces.

The vertical partitions in the preamplifier are made of the same brass stock as the base and are preferably hard soldered, although regular "soft" solder will do.

Handle the transistor with care, especially when soldering it into the circuit. The Brookstone Company* sells a high-conductivity, low-temperature solder (TIX) which melts at 250° F and is excellent for this purpose.

The tuning capacitors are Johanson 0.8-8 pF units, but JFD equivalents, or any good quality *short* piston capacitors, will work. Use *thin* brass for the striplines

centers; the part of the strap left over is bent upward at about 45° to accommodate the modified disc capacitors between the stripline and the BNC connectors.

tuneup

Initial tuneup is best accomplished with a 1296-MHz signal (a typical 1296-MHz weak-signal source is shown in fig. 4). Apply about 6 volts to the transistor preamplifier and monitor collector current with a 10-mA meter. Adjust the bias control so collector current is 1 to 2 mA.

Start the tuneup procedure with all the capacitors at minimum capacitance; turn the output capacitors in one-half turn at a time until obtaining maximum reading on the receiver S-meter. Now adjust the input capacitor one turn at a time, repeaking the input capacitor near the transistor for maximum.

*Available from the Brookstone Company, 5 Brookstone Building, Peterborough, New Hampshire 03458.

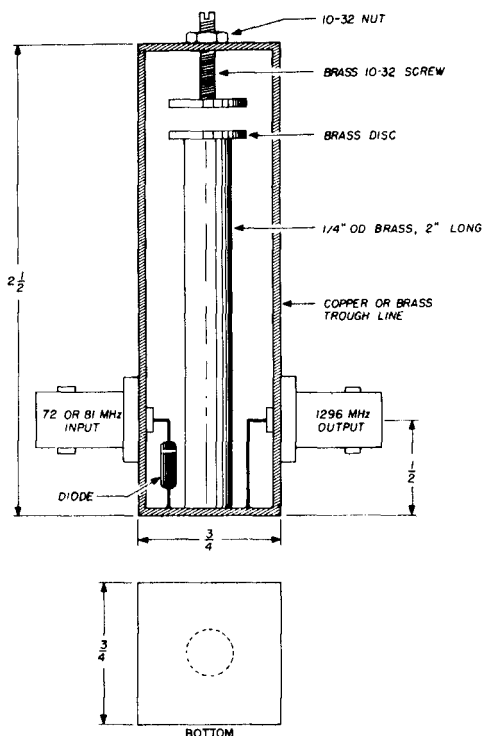


fig. 4. 1296-MHz weak-signal source uses 72-MHz injection and diode frequency multiplier. Diode may be a varactor, 1N914, 1N916 or 1N82. Input is link coupled to crystal-controlled oscillator.

Repeat all capacitors, and apply 9 volts to the preamplifier while adjusting collector current for maximum gain with lowest noise. Do not exceed 6 mA collector current. My V766B preamplifier worked best at 3.5 mA.

When tuning up (or using) the preamplifier do not allow the transistor to go into oscillation (as evidenced by sharply increased collector current) for more than a very short time or the transistor will be destroyed. The input and output networks are essentially pi networks but can be tuned to other modes. The function of these pi networks is to provide the transistor with a proper match; if the input of your converter is not close to 52 ohms you may need a 3-dB 52-ohm pad between the preamplifier and converter.

Final tuneup must be accomplished with the antenna connected to the input

terminals. Put the 1296-MHz signal source near the antenna and connect the transmission line to the amplifier. Tune in the signal and repeat all adjustments for best signal-to-noise ratio.

If you happen to purchase a particularly "hot" V766B transistor you may have trouble with oscillations, although this is very rare. However, if you do have oscillation problems, replace the collector rf choke with a 1000- or 2000-ohm, 1/4-watt resistor; this will reduce the Q and gain of the stage.

summary

With this new low-noise transistor many serious 1296-MHz enthusiasts believe now is the time to discard the cranky parametric amplifier—the so-called advantages are hardly worth the added effort and complexity of the paramp. As W21MU said recently, in relation to this 1296-MHz preamplifier, "We have entered a new era in EME for the amateur."

references

1. A. Katz, K2UYH, "A 1296-MHz Preamplifier—That Works!" *QST*, November, 1967, page 32.
2. D. Vilardi, WA2VTR, "Two-Stage Transistor Preamplifier for 1296 MHz," *QST*, December, 1968, page 40.
3. "The Radio Amateur's Handbook," ARRL, 1970, page 414.

ham radio



DEITCHUKIC

"Boy, you're in for the surprise of your life when you get out of here!"

HAL DEVICES



**HAL 311BC
ELECTRONIC
KEYER
\$53.00**

THE most versatile keyer available. Send for full details on the HAL 311BC and the complete line of HAL electronic keyers. There is a model to fit your requirement and budget from \$16.50 to \$53.00. Shipping extra. Available in kit form for even greater value.



**HAL
TOUCHCODER II
KIT
\$55.00**

HAL TOUCHCODER II KIT \$55.00

Complete parts kit, excluding keyboard, for the W4UX CW code typer. All circuitry on one 3 x 6" G10 glass PC board. Plug-in IC sockets. Optional contest ID and RTTY features available. New keyboard under development.

HAL DIP BREADBOARD CARD

Drilled G10 glass PC board accepts 6 16 pin DIP IC's in plug-in sockets. Each IC pin fanned out to two pads. Plugs into standard 22 pin edge connector (.156" finger spacing). \$5.50

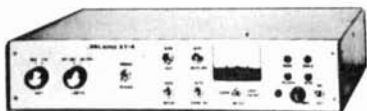
DOUBLE BALANCED MODULATOR KIT

For the DBM in March 1970 Ham Radio 7/8 x 2" drilled G10 glass PC board 4 HP-2800 hot carrier diodes matched by HAL. 2 Indiana General CF102-Q1 toroids. Wire and instructions included. \$6.50

HAL 25KHz MARKER GENERATOR

Generates 50 KHz or 25KHz markers from 100 KHz oscillator (not supplied) Drilled 1 x 2" G10 glass PC board Strong markers to 148 MHz. Divides any signal up to 2MHz by 2 or 4. \$4.25 kit form.

Hot Carrier Diodes: HF20K	90C	12/\$10.00	matched by HAL	4/\$4.25
Linear IC's:	SN7209N	\$1.00	SN7209L	\$1.25
	SN7210N	\$1.25	MC1429G	\$3.75
	MC1496G	\$3.25	MC1590G	\$5.60
Digital IC's:	74L91A	60C	74L92	90C
MRTL:	MC890P	\$2.00	MC880P	\$3.50
	MC724P, MC725P, MC730P, MC732P	\$1.75	MC704P	\$3.30
	MC9760P	\$5.45	MC771P	\$1.75
TTL:	7400P, 7401P, 7402P, 7410P, 7420P, 7430P			65C
	7404P, 7405P, 7440P	75C	7441AP	\$3.90
	7442P, 7495N	\$4.00	7472P	\$1.20
	7475P	\$2.75	7490P	\$2.50
FETs:	40673 MOSFET	\$1.60	MPF102 JFET	60C
TOROIDs:	Indiana General CF102-Q6, CF102-Q1, CF101-Q2		2N3819 JFET	55C
	CF102-Q3	\$1.25	FERROXCUBE FERRITE BEADS	10/\$1.25
CINCH IC SOCKETS	8-ICS, 14-DIP	80C	16-DIP	75C



HAL MAINLINE ST-6 RTTY TU

Complete parts kit for the W6FFC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. \$135.00 kit. Wired units available.

Shipping extra. Write for full details.



**HAL RT-1
TU/AFSK
KIT
\$51.50**

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch.

High and low impedance audio output. Price \$45.00. Shipping extra. Write for full details.

HAL Designer Cabinet for the above \$6.50. 3 pole Butterworth filter drilled PC board \$3.00.

HAL MAINLINE ST-5 RTTY TU

ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. \$50.00. Less boards, meter & meter components \$37.50. Boards only \$6.00. Shipping extra.

HAL MAINLINE AK-1 AFSK OSC

HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. \$27.50. Board only \$4.00. Shipping extra.

HAL ID-1 REPEATER IDENTIFIER

TTI logic. Power line frequency counter for 3 minute or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details.....\$70.00 Kit.

ORDERING INFORMATION

Postage is not included in the prices of HAL products. Please add 50¢ on small parts orders, and \$2.00 on larger kits. Shipping is via UPS when possible, and via insured parcel post otherwise. Please give a street address. Catalog of all items 24¢ postage.

HAL DEVICES, Box 365H Urbana, IL 61801

determining power dissipation ratings of transistors

The power dissipation
of a transistor
depends upon the size
and efficiency
of the heat sink —
here's how
to determine
practical power ratings

Have you ever ruined a transistor by operating it in excess of its rated temperature? Or have you ever bought a transistor with a large dissipation rating simply because you weren't sure whether a smaller device could withstand the power requirement? If you have, then this article is for you. I will discuss how to keep a transistor below its maximum temperature, and you will find that in some cases a device rated at 100 watts may be good for only a fraction of that much power.

safe operating area

The data sheets of most power transistors provide a safe-operating-area graph. Fig. 1 shows such a graph for an imaginary transistor capable of dissipating 100 watts. As shown on the graph, the maximum voltage which may safely be applied to this device is 40 volts; maximum current is 10 amps. The space enclosed by the black line represents the safe operating area — that is, the values of current and voltage at which the transistor may be operated without exceeding its maximum dissipation capabilities. Any value of voltage and current within the enclosed area may be safely applied to the transistor.

For example, the intersection of 4 amps and 20 volts lies within the line, indicating that the device may be used at these ratings without damage. On the

Jim Nyffeler, WN9CGW, RR 3, Bluffton, Indiana 46714

other hand, the intersection of 5 amps and 30 volts falls outside the enclosed area, indicating that the transistor, when operated at these values, will be generating more heat than it can dissipate, and will likely be destroyed.

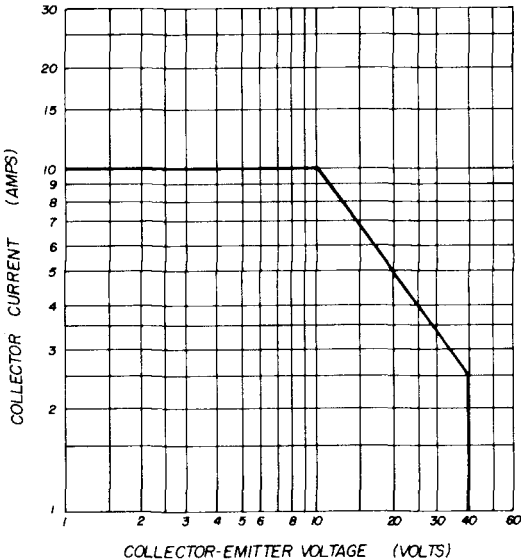


fig. 1. Typical safe-operating-area graph. The 100-watt transistor may be safely operated at any voltage and current values under the heavy line.

thermal resistance

The above explanation may seem very straight forward but unfortunately complications arise. Another factor, called *thermal resistance*, must be included in any calculations concerning a transistor's dissipation abilities. Thermal resistance is the resistance material offers to the conduction of heat. When used in conjunction with semiconductors, it is expressed in degrees centigrade per watt ($^{\circ}\text{C}/\text{W}$). This means that for a specific number of watts dissipated, the temperature of the semiconductor will rise a definite number of degrees C above the ambient temperature.

It is possible to calculate the thermal resistance between the junction and the case (θ_{JC}) of any transistor if its power rating and its maximum permissible operating temperature, $T_{\text{J(max)}}$, are known.* These values can be found on the data sheet.

To find θ_{JC} for the 100-watt demonstration transistor, we will assume a metal-encased silicon unit. For such a transistor, $T_{\text{J(max)}}$ would be 200°C . The thermal resistance may be found from the following formula:

$$\theta_{\text{JC}} = \frac{T_{\text{J(max)}} - T_{\text{A}}}{P_{\text{D}}} \quad (1)$$

where T_{A} is the ambient temperature, P_{D} is the power rating of the transistor, and θ_{JC} and $T_{\text{J(max)}}$ are as explained above.

Inserting the values given for the 100-watt transistor at 25°C ambient:

$$\theta_{\text{JC}} = \frac{200 - 25}{100} = 1.75^{\circ}\text{C}/\text{W} \quad (2)$$

For a given temperature, the thermal resistance of the semiconductor determines the maximum power dissipation.

Before the transistor can be used, an additional thermal resistance, between the case and the ambient environment (θ_{CA}) must be known. This is because the heat generated at the semiconductor junction can only be transmitted through the case and must be dissipated into the surrounding environment whether it's air, a heat sink or a liquid coolant.

To determine θ_{CA} , you must know how the transistor is to be mounted. If the transistor is mounted in free, still air with no heat sink, θ_{CA} will be quite high and the power capabilities of the device will be greatly curtailed. The amount of power that may be dissipated with no heat sink depends on the junction-to-ambient thermal resistance, θ_{JA} . This factor can sometimes be found on the

* This value can also be found on the data sheet, but the reader should understand how it was obtained.

data sheet, and when used in eq. 3 below it can be used to determine the maximum power that may be applied without a heat sink:

$$P_{D(\max)} = \frac{T_{J(\max)} - T_A}{\theta_{JA}} \quad (3)$$

values for the 100-watt transistor:

$$\begin{aligned} \theta_{JA} &= 3^\circ\text{C/W} + 1.75^\circ\text{C/W} + \quad (5) \\ &0.4^\circ\text{C/W} = 6.15^\circ\text{C/W} \end{aligned}$$

Hence, it is seen that the θ_{JA} of the complete assembly is 6.15°C/W . If this

table 1. Thermal resistance of typical heat-sink materials.

material	size (inches)	thermal resistance ($^\circ\text{C/W}$)	remarks
finned heat sink	3x4x1½	3	bright aluminum
finned heat sink	3x5x2½	1.5	anodized aluminum
finned heat sink	5x5x4½	0.5	anodized aluminum
chassis	2x3	11	unfinished aluminum
chassis	5x3	6.5	unfinished aluminum
chassis	7x5	4.5	unfinished aluminum
chassis	10x5	3.5	unfinished aluminum
chassis	12x10	2.5	unfinished aluminum
mica washer	—	0.4	with thermal compound

In the case of the 100-watt transistor used as an example, maximum dissipation would be approximately 5 watts.

However, if a heat sink is used the resistance to heat flow will be greatly reduced. Since heat sinks vary greatly in their ability to conduct heat, table 1 has been included to give you an idea of typical values of thermal resistance. In addition to the heat sinks listed in the table, several chassis are also included since they are often used as sinks.

Assume that the first heat sink in the list, rated at 3°C/W thermal resistance, is to be used with the 100-watt transistor. To find the total thermal resistance between the semiconductor junction and the ambient, it is necessary to know the thermal resistances of the heat sink, the transistor and of any insulating washers used between the transistor and the sink:

$$\theta_{JA} = \theta_{JC} + \theta_{SA} + \theta_{CS} \quad (4)$$

The thermal resistance of a mica insulating washer is 0.4°C/W . Inserting the

value is inserted into eq. 3, you can determine the maximum power that can be safely applied to the transistor:

$$P_{D(\max)} = \frac{200 - 25}{6.15} = 34 \text{ watts} \quad (6)$$

In this arrangement the maximum power that can be dissipated by the transistor is only 29 watts. To safely apply more power to the device you must use a larger heat sink, or the sink must be cooled with forced air. If you try to dissipate more power than that calculated without additional cooling, the transistor will be destroyed.

You may ask why a semiconductor is rated at 100 watts when it cannot practically dissipate that much power. The answer is simple: Transistor manufacturers, having no idea of the specific type of heat sink to be used, publish the maximum power that the unit can dissipate when used with an *infinite* heat sink.

pulse operation

If a power pulse is momentarily ap-

plied to a transistor, higher dissipation is possible. Fig. 2 shows a second safe-operating-area graph on which several dark lines are drawn. The line labeled dc is the maximum power-dissipation limit. If, for example, the demonstration transistor experiences stress for only 1 millisecond it

The case temperature may be found from:

$$T_C = P_{DC} (\theta_{CS} + \theta_{SA}) + T_A \quad (8)$$

where P_{DC} is the steady state value of power being dissipated by the transistor prior to the application of the pulse, θ_{CS} is the thermal resistance of the insulating washer and θ_{SA} is the thermal resistance of the heat sink.

As an example, assume that the 100-watt transistor, using the heat sink discussed previously, is dissipating 10 watts just prior to the application of a 1-millisecond pulse. From eq. 8 (at 25°C ambient)

$$T_C = 10(3 + 0.4) + 25 = 59^\circ\text{C} \quad (9)$$

Inserting the result into eq. 7 gives:

$$P_D(\text{pulse}) = \frac{200 - 59}{0.58} = 243 \text{ W}$$

The transistor can withstand 243 watts for a period of 1 millisecond. Wattage ratings for other pulse widths are found in a similar manner by substituting the desired values.

pulse-train dissipation

Since mathematical calculation of permissible power becomes rather unwieldy for repetitive pulses, at least one manufacturer, Motorola, has included graphs specifically for this purpose on his data sheets. As a result it is quite simple to find the maximum power dissipation for a wide range of pulse widths and for various duty cycles. A normalizing factor is obtained from the graph and multiplied by the dc value of θ_{JA} . The resultant factor may then be used in eq. 3 to determine maximum power dissipation.

references

1. "The Semiconductor Data Book," 4th edition, 1969, Motorola Semiconductor Products, Inc., p. AN-16.
2. "RCA Power Circuits Manual," 1969, Radio Corporation of America, p. 71.
3. "RCA Transistor, Thyristor, and Diode Manual," 1969, Radio Corporation of America, p. 202.

ham radio

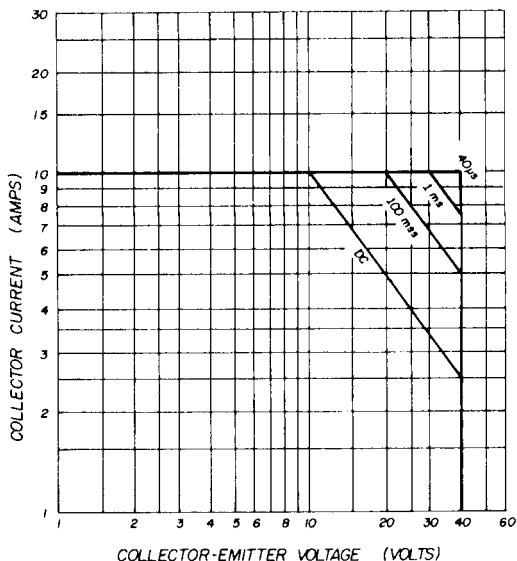
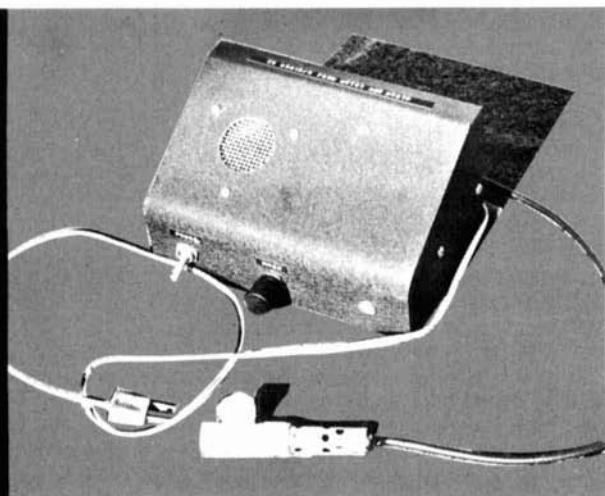


fig. 2. Safe-operating-area graph for single non-repetitive pulses.

can be seen from the graph that the device can dissipate 300 watts. Since the transistor is operated at three times its rated power the thermal resistance θ_{JC} , for a 1-millisecond pulse is reduced by a factor of 3 to 0.58°C/W. However, this holds true only if the transistor case is at a temperature of 25°C prior to applying of the pulse. For other case temperatures the following formula is needed:

$$P_D(\text{pulse}) = \frac{T_{J(\text{max})} - T_C}{\theta_{JC}(\text{pulse})} \quad (7)$$

where T_C is the case temperature and $\theta_{JC}(\text{pulse})$ is the pulse thermal resistance as calculated above.



transmitter-tuning unit for the blind

The Noise Maker
is an aural tuning meter
that allows
a blind person
to tune his rig
for maximum output

Don C. Miller, W9NTP, Waldron, Indiana 46182

Slow-scan television enthusiasts have a saying, "Hams should be seen as well as heard." I am an active slow scanner, but I was forced to admit one morning on 20 meters that this might not always apply, and in special circumstances, "Hams should be heard and not seen."

For many months several of us in the ninth call area have maintained contact with each other on the 20-meter band while driving to work on a newly built interstate highway. This highway provides superior radiation capabilities due to the excellent ground plane effect of the metal reinforcing in the concrete pavement. During this period of time W9TCT, myself and others were joined by a fixed station in the immediate area, K5MIB/9.

Wes soon told us that he was blind and that he lived in the area only during the winter months. Working Wes became routine, but his signal varied in strength from week to week and sometimes from day to day. It eventually occurred to us that this variation was due to the fact that his transmitter was not properly

tuned after moving from different parts of the band. When we inquired how he tuned his rig we were told that hams in

the area occasionally dropped in and peaked the final.

On one particular morning Wes was so

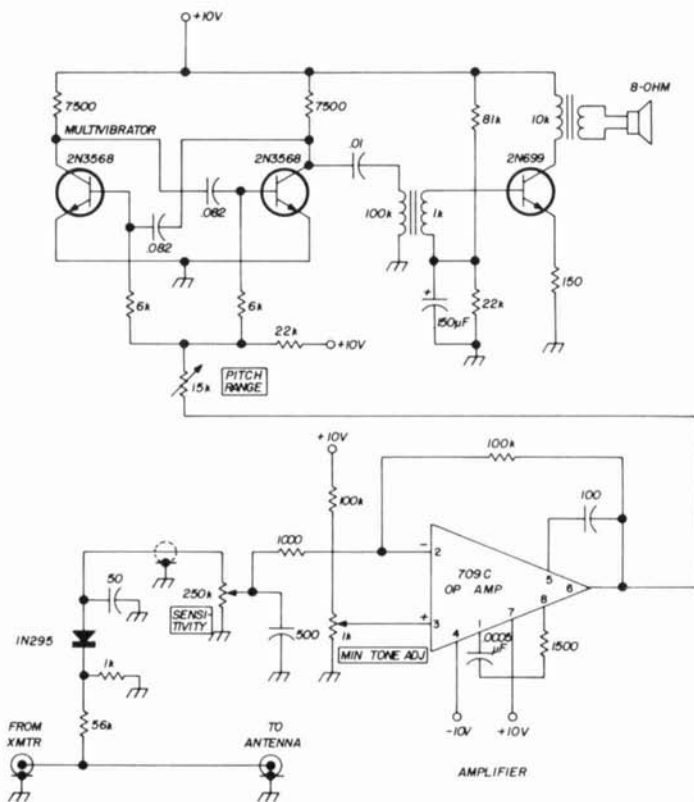


fig. 1. Schematic diagram of the aural transmitter-tuning unit.



Wes Bradley, K5MIB/9, tuning his Swan transceiver with the Noise Maker.

weak that his signal was barely readable just a few miles outside of town. W9TCT stopped in and tuned the rig for him. W9TCT and I felt that something had to be done, and decided that a simple device was needed to help Wes tune his rig to maximum output.

the circuit

Most slow scanners are familiar with the voltage-controlled multivibrator. The pitch of the oscillator can be changed over a rather wide range by providing a variable voltage to the base of the oscillator transistors. If the rectified rf current

from the output of the transmitter could be used to control the audio oscillator frequency a blind ham could easily tune his transmitter to maximum output by just listening to the highest pitch of the audio output frequency of the multivibrator. A simple diode output circuit and a 709C operational amplifier to supply the variable bias voltage were easily designed. A simple audio output transistor stage gave enough output to drive a small speaker.

theory of operation

The resistance divider consisting of the 56k and 1k resistors connected to the coaxial cable are adequate for power levels from 200 watts to 2 kW on all bands from 80 to 10 meters.

The gain of the 709C operational amplifier was set at 100. This amplifier has been compensated as recommended in the application sheets. A small voltage of about .01 volt is fed into the non-inverting input of the operational amplifier; this voltage provides the offset bias

over a small range by adjustment of the 15k pot. The lowest frequency is set by the small voltage fed into the non-inverting input of the 709C.

The multivibrator is conventional, and any npn transistors can be used. None of the components in this circuit are critical. The audio output stage uses a small imported high-impedance to low-impedance transformer to provide an impedance match between the collector of

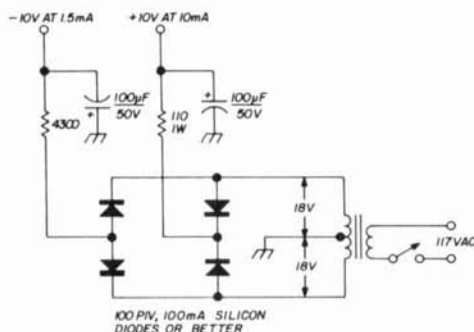


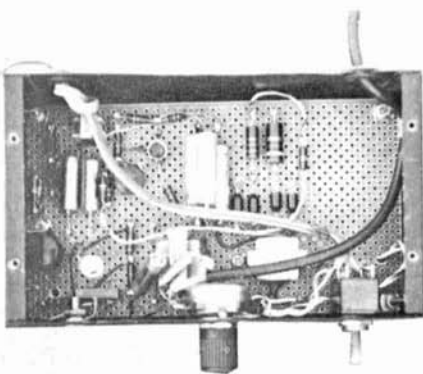
fig. 2. Power supply for the transmitter-tuning unit.

the multivibrator and the base of the audio transistor stage. The output circuit consists of a small output transformer and speaker to provide the audible output signal.

A center-tapped junk-box transformer was used for the power supply. The current drain is extremely small, and available parts from around the shack should work nicely. The complete circuit is shown in fig. 1. An Amphenol T-connector was used to provide the housing for the rf detector circuit shown in fig. 1. The Noise Maker was enclosed in a small sloping metal cabinet. The entire circuit was built on vector board.

In the photograph K5MIB/9 is happily adjusting his Swan 350 to maximum output. Strange as it might seem, several hams that have sight have asked for the circuit for their rigs. I am indebted to W9TCT for help and inspiration in the design and construction of the Noise Maker.

ham radio



Internal layout of the aural tuning unit. Component layout is not critical.

return of +1 volt for the base resistors of the multivibrator with no rf signal, telling the blind ham that the equipment is turned on.

The 709C amplifier has a positive swing of about +10 volts. The maximum pitch of the multivibrator can be changed



Ten-Tec RX10 communications receiver

A lot
of performance
in a small,
low-cost package

In these days of increasingly sophisticated and complex electronic communications equipment it is a pleasure to see a new product which fills an important need in a very simple and effective manner. The new Ten-Tec RX10 communications receiver is a natural for the beginner, or for the old timer who is looking for a good emergency receiver. The RX10 will give many hours of service from a handful of flashlight batteries.

In the Ten-Tec RX 10, direct conversion is used to provide complete coverage of the 80-, 40-, 20- and 15-meter amateur bands. The critical conversion stage uses an RCA 40604 dual-gate mosfet to provide low noise figure, high sensitivity and good overload charac-

teristics. The balance of the receiver is built around straightforward bipolar devices. An oscillator/buffer/multiplier section provides an appropriate injection signal to the 40604 mixer, while a filter and four-stage audio amplifier arrangement deliver a more than adequate signal to the headphone output.

An added feature is the cw practice oscillator that is included; this helps the beginner get going with his code-practice program. The receiver also includes a built-in 115-volt ac power supply for home use.

The RX10 receiver is quite stable. The manufacturer claims no more than 100-Hz drift from turn on, and our experience at *ham radio* backs this up. Just for fun we connected the RX10 to a HAL Devices ST-6 RTTY Demodulator and tuned it to a teletype signal on 20 meters. Much to our surprise and delight we were treated to nearly ten minutes of perfect "hands-off" copy before the station signed. And this was with a cold receiver!

Although no specific measurements were made, the sensitivity was very good on both the 80- and 40-meter bands; both 20- and 15-meter performance seemed to

Skip Tenney, W1NLB

BOOKS . . .

Radio Society of Great Britain publications

RADIO COMMUNICATIONS HANDBOOK — An outstanding technical guide to all phases of amateur radio. In 832 pages 20 complete chapters are devoted to such subjects as single side-band, antennas, mobile equipment, RTTY and much, much more. This excellent book has received wide acclaim on both sides of the Atlantic and belongs in your library . . . now. **\$12.95**

AMATEUR RADIO CIRCUITS BOOK — Completely revised — new edition. 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 \$2.50**

VHF-UHF MANUAL — G. R. Jessop, G6JP — Probably the most comprehensive work of its kind ever published. Covers everything from beginners to advanced material. **Only \$4.00**

AMATEUR RADIO TECHNIQUES — Third Edition — J. Pat Hawker, G3VA — Brand new edition — completely revised. A very complete collection of short articles and ideas covering many aspects of amateur radio. Includes new enlarged semiconductor section. 160 Pages. **Only \$3.75**

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. Whether you design, build or operate, this is a book you must have. **Only \$3.00**

Other Important Volumes

RADIO HANDBOOK — 18th Edition — How to design, build and operate the latest types of amateur transmitters, receivers, transceivers and amplifiers. Provides extensive, simplified theory on practically every phase of radio. 848 pages. **Only \$13.50**

ALL ABOUT CUBICAL QUAD ANTENNAS by W6SAI — Construction and tuning data. Multi-band Quads. Charts, drawings and photos for your Quad. Full complete data on homemade Quad antennas. The new X-Q Quad. **\$3.95**

VHF HANDBOOK by Orr W6SAI & Johnson W6QKO — 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! **\$3.95**

THE CARE AND FEEDING OF POWER GRID TUBES by Robert Sutherland, W6UOV — Just as the title says, a very complete rundown on the use of power tubes. Be sure to read this before you start work on your new linear. **Only \$3.95**

BEAM ANTENNA HANDBOOK by William Orr, W6SAI — New edition. Theory, design, construction, and the installation of rotary beam antennas! SWR data! Multi-band beams, 40 meter beams, 20 meter DX beams! How to make your beam work! 200 pages. **\$4.95**

NOVICE & TECHNICIAN HANDBOOK by W6SAI and W6TNS — All about amateur radio in non-technical language! How to learn the code. How to assemble your ham station. Transmitters! Receivers! DX! How to get QSL cards. **\$3.95**

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! **\$3.95**

comtec

Box 592 · Amherst, New Hampshire 03031

RX10 Specifications

Frequency range	3.5-4.0 MHz, 7.0-7.3 MHz, 14.0-14.6 MHz, 21.0-21.9 MHz
modes	upper and lower ssb, cw and a-m
sensitivity	less than 1 μ V provides readable signal
stability	less than 100-Hz drift; no warm-up
selectivity	2 kHz at 6-dB down
audio	3 volts across 1000-ohm load
antenna	50 to 75 ohms, unbalanced
power	115 Vac, 50/60 Hz, 1/8 A, or 12 Vdc, 35 mA
size	10-3/8" wide, 4-1/2" high, 6-5/8" deep; 2 $\frac{1}{4}$ pounds
price	\$59.95

offer more than satisfactory operation although it was a bit lower than on the lower bands. However, in all cases performance was well above the simple tube-type superhetrodynes which beginners have traditionally used.

Selectivity was also quite acceptable, even in the crowded 80-meter novice band. An audio filter with a 2-kHz bandwidth at 6 dB seemed to handle things quite well; in conjunction with the reasonably slow tuning rate for a simple receiver, it made it easy to find your way around. Of course, with the direct-conversion system you will hear the audio image of nearby stations, but in view of the excellent performance of this modestly priced receiver, I don't think this is an important consideration.

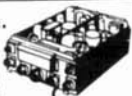
Please don't go out and buy a Ten-Tec RX10 for RTTY. However, I am sure that you will agree that for \$59.95 there is a lot of performance in this little package. Ten-Tec products are available from your local dealer or Ten Tec, Inc., Sevierville, Tennessee 37862.

ham radio

NEW G&G CATALOG! MILITARY ELECTRONICS

24 PAGES, crammed with Gov't Surplus Electronic Gear - the Biggest Bargain Buys in America! It will pay you to **SEND 25¢** for your copy - Refunded with your first order.

BC-645 TRANSCEIVER 15 tubes, 435 to 500 Mc. Easily adapted for 2 way voice or code on Ham, Mobile, Television Experimental, and Citizens Bands. With tubes, less power supply in factory cartons, BRAND NEW..... **\$16.95**



TRANSMITTER has 4 tubes: WE-316A, 2-6F6, 3-7F7
RECEIVER has 11 tubes: 2-9S5, 4-7H7, 2-7E6, 3-7F7
RECEIVER I.F.: 40 Megacycles
SIZE: 10-1/2" x 13-1/2" x 4-1/2". Shpg wt 25 lbs.

SPECIAL PACKAGE OFFER: BC-645 Transceiver, Dynamotor and all accessories, including mounting, UHF Antenna Assemblies, control box, complete set of connectors and plugs.
Brand New **\$26.95**

HEADSET

Low Impedance. With large chamois ear cushions. 4-ft cord and plug. Reg. \$12.50 **OUR SPECIAL PRICE..... \$2.95**
Above headset without ear cushions..... \$1.95
High Impedance adaptor for above..... 69¢



SCR-274-N, ARC-5 COMMAND SET HQ!

Freq. Range	Type	Exc. Used	Like New	Brand New
190-350 Mc.	Complete with Tubes			
5-9 Mc.	BC-453	\$16.95	\$23.50	\$27.50
1.5-3 Mc.	BC-455	\$14.95	\$17.95	\$21.50
	R-25		\$19.50	\$21.50
TRANSMITTERS. Complete with Tubes				
4-5.3 Mc.	BC-457	\$ 8.95		\$11.95
3-7 Mc.	BC-458	\$ 8.95		\$11.95
7-9.1 Mc.	BC-459			\$23.50

TG-34A CODE KEYS, self-contained, automatic, reproduces code practice signals from paper tape. 5 to 12 WPM Built-in speaker. Brand new with tech manual. takeup reel and AC line cord. ... **\$24.50**
Code practice tapes for above P.U.R.



BC-1206-C RECEIVER Aircraft Beacon Receiver 200 to 400 Kc. Operates from 24V DC 1.5A. Continuous tuning, vol control, on-off switch and phone jack. Very sensitive. Compact.
Complete with tubes, NEW..... **\$12.50**



BC-604 FM TRANSMITTER 20 to 27.9 Mc. Output approx 30 watts, 10 crystal controlled channels. Complete with tubes.
NEW..... **\$12.50**



ARC-811A Modern Q-5 Receiver 190 - 550 KHz **\$10.95**
ARC-822 540 - 1600 KHz Receiver with tuning graph **\$15.95**
R-4/ARR-2 Receiver 234-258 Mhz, 11 tubes, NEW **\$8.95**

EE-8 SIGNAL CORPS FIELD PHONES..... \$16.95
T-30 THROAT MIKE, NEW..... 59¢ USED..... 39¢
T-17 MICROPHONE, NEW..... \$8.50 USED, checked out \$4.95
BC-605 INTERPHONE AMPLIFIER, NEW \$3.45 EXC. USED..... \$1.95
TELEPHONE HANDSET, W.E. type..... LIKE NEW \$2.95
SCR-522 TRANSMITTER-RECEIVER, with 18 tubes, LIKE NEW \$32.50

BC-624 RECEIVER 100-156 Mc, with tubes, exc. used.... \$23.50
BC-625 TRANSMITTER 100-156 Mc with tubes, exc. used.. \$23.50
RAY-3 NAVY RECEIVER high freq. AM, like new..... \$ 9.50
TELEPHONE HANDSET, like new \$ 2.95
FULL WAVE SELENIUM RECTIFIER 110V @ 150 Ma, New \$.22

AM-300/AIC PUSH/PULL AMPLIFIER
4-tube PP power amplifier with dynamotor, works on 28 VDC. Automatic gain control.
Shpg wt 15 lbs. LIKE NEW..... **\$3.95**



FR MINIATURE CHOKE, hermetically sealed, rated 2 henries at 130 Ma. Upright mounting. Special Buy, NEW..... \$.29

AUTOMATIC BATTERY FILLER doubles battery life! Use one for 6V, two for 12V. Mounting bracket, instructions. NEW..... \$.69

MCELROY AUTOMATIC KEYS for keying transmitter or for code practice. Photoelectric cell & sensitive relay. Variable speed motor 110V 60 cy. Complete with tubes, EXC. USED **\$11.25**



BC-733 RECEIVER Receives radio signals being transmitted by US satellite on approx. 108 Mc. AM, crystal-controlled on 6 preset freqs. in 108.3 to 110.3 Mc range. Operates on 12/24 V DC & 220 VDC 80 Ma. Complete with 10 tubes. Can be converted to FM Receiver
80 to 108 Mc. Exc. Used..... **\$5.95**
BC-732A Control Box for above, NEW... 1.75



T-41 / APS - 18 TRANSMITTER ANTENNA UNIT designed for 115 V 800 to 1400 cps. Tubes included are two 15E and one 15K. Complete with shock mounts and blower motor. 7x8x18", NEW.... **\$8.95**



BC-223AX TRANSMITTER 25 Watt, CW, MCW, Voice, Crystal control on 4 pre-selected channels, range 2000 to 5200 Kc by use of 3 plugin units, included. Complete.
BRAND NEW..... **\$27.50**



APN-1 FM TRANSCEIVER 400-450 Mc. Freq. modulated by moving coil transducer. Easily converted for radio control or 70 cms. Complete with 14 tubes, dyn.
BRAND NEW..... **\$9.95**



AM-26/AIC PHASE INVERTER AMP.
4-tube pushpull power amplifier. Carbon mike input, hi-lo imp. output. Works on 24VDC. Easily converted to dandy 9-watt amplifier. Complete with tubes and dynamotor
LIKE NEW **\$5.95**



DUAL AMPLIFIER has two input circuits each feeding a single 6SN7GT twin triode amplifier. Complete with 115V 60 cy. power supply using 6X5GT rectifier. NEW..... **\$5.95**



IP-69A/ALA-2 INDICATOR 3" scope. Front panel controls: Vertical Pos., horizontal pos. intensity, focus, gain, width, center freq. Pan. Operates on 115 V 380 to 1000 cps.
Complete with tubes. LIKE NEW..... **\$27.50**



TG-5B TELEGRAPH SET for code communications or code practice. Portable, with hinged lid. Two or more units operate up to 25 miles apart. Bell call system, 1000 cycle howler, key, headpiece, canvas case, book.
Size 5-1/2x5-1/2x10". NEW..... **\$8.95**



CARTER GENEMOTOR Input: 5.9 VDC 32 Amps. Output: 405 VDC ,270 Amps. Fine for mobile ham gear. Built-in hash filter. NEW **\$4.95**



CARTER MAGMOTOR Input: 6 VDC 3.6 Amps. Output: 250 VDC .030 Amp.
#MA25035 NEW..... **\$2.65**



DM-34 DYNAMOTOR Input 14 VDC 2.8 Amps. Output: 220 VDC 80 Ma. Size 3" x 4-1/2" x 6-1/4". Wt. 5 lbs. NEW..... **\$4.45**



T5-126/AP RANGE CALIBRATOR TEST SCOPE Top quality 2" scope with all positioning, focus, gain and intensity controls. Complete with tubes and cables, NEW. **\$24.50**
Demilitarized, like new..... \$13.75



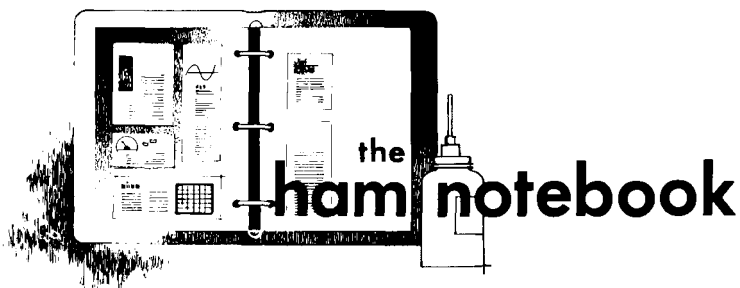
TELEPHONE TYPE RELAY
Made by J.H. Bunnell, has adjustable sensitivity. 150 ohm coil. NEW..... **\$3.45**



WILLARD 2-VOLT STORAGE BATTERY
Rated at 20 Amp.-Hours. Model 20-2. Rechargeable. Compact nonspill construction. Lightweight polystyrene container, 3x4x5 1/2". Shipped dry, uses standard electrolyte. Shipping Weight 3 lbs. NEW, each..... **\$2.79**



TERMS: 25% Deposit with order, balance C.O.D. -or- Remittance in full. Minimum order \$5.00 F.O.B. NYC. Subject to prior sale and price change
G&G RADIO ELECTRONICS COMPANY
45-47 Warren St. (2nd Fl) New York, N.Y. 10007 Ph. 212-267-4605



economical decade standards

Resistor decades are convenient for experimental use but are bulky and expensive, especially the higher-accuracy units. A more convenient and compact precision, direct-reading variable resistance may be easily assembled using the ten-turn potentiometers and dials now available on the surplus market. Pots with accuracies of 1% and 0.1% linearity are available – which is more than adequate for most applications.

Potentiometer values in multiples of ten are used so that the selected resistance value may be read directly from the 10-turn dial by adding the proper number of zeros. Several potentiometer/dial units may be assembled in the form of the usual decade box.

The versatility of this arrangement may be expanded by bringing all three potentiometer terminals to binding posts on the front panel. With three binding posts continuously variable voltage dividers of accurately known ratio are conveniently available to the experimenter.

Gene Brizendine, W4ATE

*K. Macleish, W1EO, "A Frequency Counter for the Amateur Station," *QST*, October, 1970, page 15.

switching counter readouts

One of the more expensive parts of a frequency counter, or counter dial*, is the indicating or readout equipment. As a result many applications provide the readout for only three or four digits of the count. In some cases you might want to read kHz but not individual Hz; in other cases you may want to read kHz or Hz but not MHz.

One way to obtain a readout when needed, without providing more Nixie tubes and associated storing and decoding circuitry, is to switch the indicating system from one part of the counter to another so all digits can be read when required. This can be accomplished by switching half as many indicators as the available total of digits counted, or by having just one digital indicator which is switched from one digit to another. A

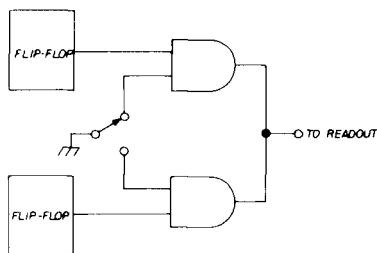


fig. 1. Using dual-input gates a readout can be switched to the Q output of either flip-flop to reduce cost. If the gates do not permit tying the outputs together, use steering diodes or a third gate.

rotary switch, with four double-throw contacts per decade, will do the job.

Digital logic handbooks often show a "data selector" circuit using a gate in each data stream with provision for applying a signal to select which data stream

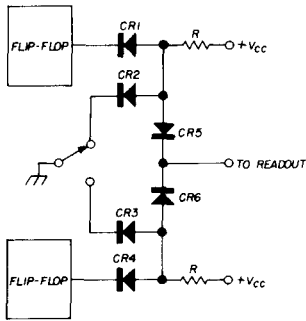


fig. 2. AND gates consisting of two diodes and a resistor can perform the switching between Q outputs, but require steering diodes CR5 and CR6.

appears at the output. Fig. 1 shows one way to do this when the gate design permits output ORing. It uses a dual-input gate for each flip-flop output, or four gates per decade. Four more gates may be needed for the alternate decade which might be switched to the readout. A single toggle switch is sufficient for all gates.

Since no operation is required of the later flip-flops when the earlier ones are connected to the readout equipment, half the gates can be eliminated. This can be done by providing *preset* or *clear* signals or removing the B+ from the later flip-flops which are not to operate the digital readout indicator. If direct interconnection of flip-flop outputs causes a problem, steering diodes can be inserted.

Surplus diodes and a few resistors can perform the gate functions if a steering diode is included between the gate and the digital readout. This diode prevents the two interconnected gates from operating as a single gate. Again, a single toggle switch is sufficient for all gates involved in the readout switching (see fig. 2).

In addition to other types of diode switching that probably can be worked

out to do the job at little cost, some other simplifications appear possible. One possibility is the elimination of one gate on the output of the tail-end flip-flops, turning these off by other means.

RTL and DTL flip-flops usually have their Q outputs connected to transistor collectors; the collectors are connected to +V_{CC} through a resistor. Shorting the output of these circuits may overheat the resistor (although it *can* be replaced externally to the IC. Putting +V_{CC} on the Q outputs can result in too much collector voltage on the transistors.

One simplification which I have not tried is shown in fig. 3. Diode CR1 forms a *one-input gate* when FF2, in an earlier position in the counter, is connected to the readout by the switch placing +V_{CC} on the resistor. Whenever FF2 is *high* there is little voltage drop across R, so the *high* passes through steering diode CR3 to

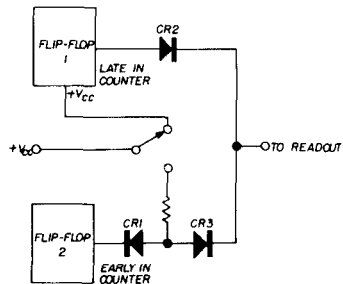


fig. 3. Simplified diode switching of readout when flip-flop 2 is earlier in the counter string than flip-flop 1.

the readout equipment. When FF2 is *low* the voltage from R goes into the flip-flop, creating a *low* input to the readout equipment. The other switch position puts +V_{CC} on FF1 and other tail-end flip-flops to be read out. This allows these flip-flops to operate, feeding the FF1 Q output through steering diode CR2 to the readout equipment. Diode CR2 prevents the voltage across the resistors from feeding back into the Q output of FF1 when FF1 is turned off by the switch. CR2 may not be necessary if the voltage on the Q output is not harmful when FF1 has no +V_{CC} supply.

Bill Conklin, K6KA

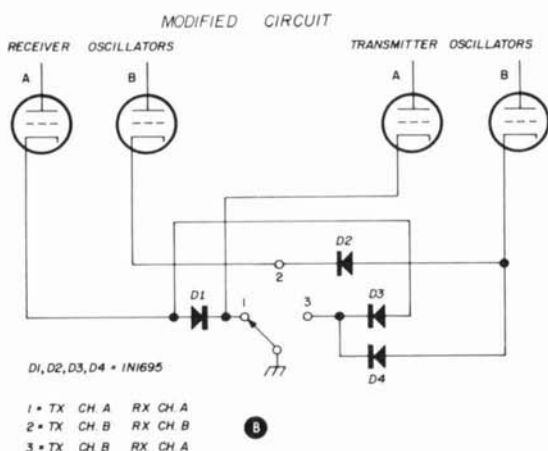
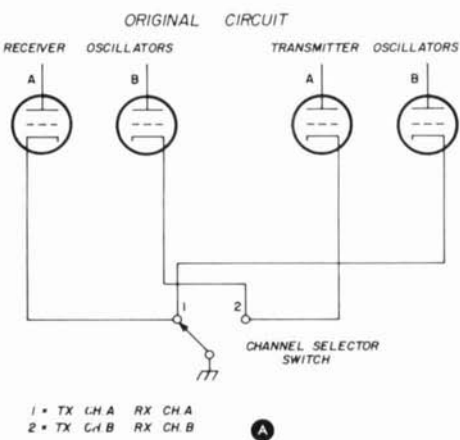


fig. 4. Method for increasing channel coverage in a typical fm oscillator circuit. Steering diodes, B, allow an extra transmit receive channel.

three channels from two

Many of the common fm mobiles are equipped for two-channel operation. However, with the different frequency combinations in repeaters using simplex, it might be necessary to transmit on channel B and receive on channel A (or vice versa). This can be accomplished easily with the addition of steering diodes (fig. 4). All you'll need are four diodes capable of carrying the current of the circuit and a single-pole, triple-throw switch. This system has been used in commercial applications for a private mobile system in this area.

The circuit shown in fig. 4B provides two simplex channels with a modified two-channel set. The idea for this application is from VE7BDY, to whom I'd like to express my thanks.

Vern Epp, VE7ABK

loose HW100 tuning knob

Many builders find that the main tuning knob on the HW100 is loose even though the dial mechanism is properly assembled and working well. The remedy is very simple.

Remove the tuning knob and place a washer on the end surface of the flexible

spline. The washer must have a hole large enough to pass the collar on the spline on the vfo shaft (see fig. 5); otherwise the knob will not fit. The added washer fills up the space between the spline and the inside of the knob, applying an outward force on the knob that keeps it from wobbling. With just the right washer thickness, and an even coating of silicone grease on both sides, the action is "silky" smooth. If the washer is too thick, the knob will either not go on, or tuning will be very stiff. Several very thin washers may be needed to get the right feel.

Al Lightstone, VE3EPY

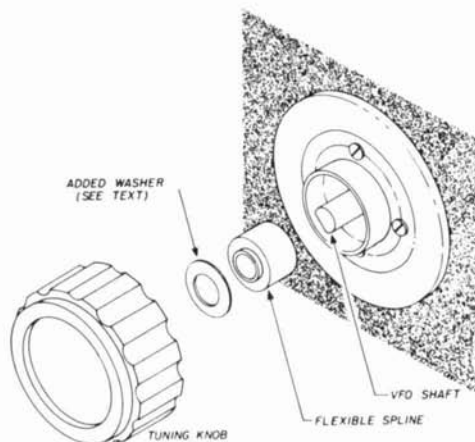
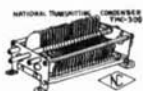


fig. 5. Remedy for loose tuning knob on the HW100.

BARRY



NATIONAL TMC-300, 300 pf, transmitting capacitor. .07" spacing.\$6.95



CRYSTAL OVEN: Maintains 2 type HC6/ μ crystals at 65°C. Requires 6.3 volts for heater.\$2.50

6.3 VAC @ 2A fil. xfmr. (115 VAC)\$1.95

833/833A tube socket. Johnson #212.\$12.95

HAMMARLUND 140 pf. MC 140M variable capacitor.\$1.75

T.M.C. RF SWITCH.# SW-206.\$3.95

DYCOMM "Block Booster" FM (2 mtr) amplifier, 50 watt output.\$89.95

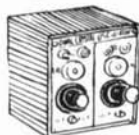
DYCOMM "Brick Booster" 2 meter FM amplifier, 12 watt output.\$69.95



30 AMP filament choke.\$8.90

COLLINS MECHANICAL FILTER, Type F250A-67, Center frequency 250kc, Bandwidth -6db is 6.7kc \pm 5%, Bandwidth @ 60db is 14kc, Resonating capacity 110 mmfd., Sig. input voltage from 0 to 5v RMS, DC voltage 300 volt maximum, Signal source impedance 50kc, Load impedance 50K Ohms.\$9.75

DYNAMIC MICROPHONE DESK/HAND SET. 28" Shielded Mike Cable terminates in an angle type PL55 Phone Plug. Microphone quickly removes from base. Attractive Beige Color. (Reg. net \$12.95). Mike and BaseOnly \$4.95



DUAL CRYSTAL OSCILLATOR. Use as a frequency source for alignment of receivers. I.E. 455KHz and 10.7MHz for FM, etc.\$25.00



230 VAC 3 ϕ primary 1750 VAC @ 2.5 amp per leg output.\$190.00 fob

30LI COLLINS Linear.MINT \$395.00

SILICON BRIDGE RECTIFIER. Tested at 6000 volts and 1 Amp. (4 separate rectifiers mounted on Nylon card.) 2 oz.Sale \$4.95

SILICON DIODES 1000 PIV @ 1.2 A.35¢ (ten for \$3.00; 100 for \$25.00)

COLLINS CHOKES: 4 Hy @ 500 Ma. 2.5 KV at 9.95; 12 Hy @ 500 Ma. 12 KV at \$9.95

WESTINGHOUSE OIL CAPACITORS — 4 Mfd @ 10,000 Volts at\$19.95

UCS-300  10 to 300 pf at 10KV.

JENNINGS UCS-300 VACUUM VARIABLE CAPACITOR. Capacity range: tunes from a min. of 10 pf. to a max. of 300 pf. Units are unused, "mint" condition, Lab-tested and certified O.K. in Aug. 1970. Without turning head at\$50.00 With turning head at\$66.75

HP-492A TWT AMPLIFIER, 4-8 GHz@ \$125.00

HP-430CR BOLOMETER BRIDGE, good @ \$89.95

HP-200AB AUDIO OSCILLATOR@ \$120.00

HP-X810B SLOTTED SECTION, good@ \$39.95

SPRAGUE 800 Ω 120W non-inductive\$1.95

DRAKE ML-2F FM MOBILE/BASE\$329.95

DRAKE TR-22 FM PORTABLE/BASE\$199.95

SRA-15 DELUXE KW ANTENNA COUPLER "Rolls-Royce" quality.\$95.00



TRANSCO SP4T SWITCH carries 2KW PEP @ 30MHz. Good to 3000 MHz. New, Sealed.\$17.50 Orig. cost approx. \$300. each.



VS-2 VACUUM RELAY. Easily Switches 2KW. Coil: 24VDC.\$9.95

EIMAC AIR-SYSTEM SOCKET. For 4-125A, 4-250A and 4-400A, and similar tubes. Supplied with screws and chimney hardware. Mfd. by Eimac. Type No. 4-400A/4000 (SK400). (Reg. price \$31.50) Special:\$14.95, for Socket

SK-406 Chimney (Reg. Stock) at\$6.50 each

JOHNSON 4CX250B AIR SYSTEM SOCKET \$8.50



4 GANG 250 pf. per section loading capacitor.\$3.95

8873, 8874 or 8875 NEW EIMAC\$37.00

IN STOCK, 6 separate single band liners, high power, home built, excellent cond. Call or write.

TEN-TEC SQUEEZE-KEYER KR5.\$34.95

B&W/Waters TPC-120 Transistor Power Supply. 120 Watt (12 V. Input) 500/250/660 Volts out at 120 Watt total. Brand new. (2 lbs.) Reg. \$57.80 Sale \$39.95

WATERS MODEL 346 Nuverter. 2 & 6 M VHF converter. New. Orig. \$175.00 net. Sale \$80.00

4" sq. PM Speaker, 4 Ω , 2 watts, new 90¢. 10 for \$8.00

RCA 1000.000 Khz CRYSTAL.Only \$3.50

COLLINS - 75A1 Receiver, 10-160 Meters\$210.00

COLLINS - 32V2 Xmtr, 10-160 Meters\$195.00

TMC — GPR-90 RDX w/TMC GSB-1 — (a \$2000. net value)\$695 combination

HP-415B SWR METER, good@ \$89.95

HP-5214L PRESET COUNTER, x1nt@ \$595.00

CASH PAID . . . FAST! For your unused TUBES, Semiconductors, RECEIVERS, VAC. VARIABLES, Test Equipment, ETC. Write or call Now! Barry, W2LNI. We Buy!

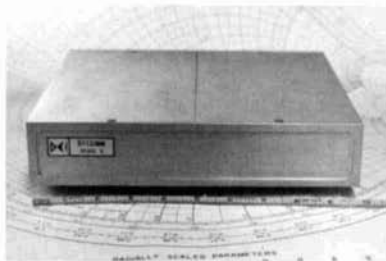
We ship all over the World. DX Hams only. See Barry for the new Alpha 70. (See front inside cover of this magazine.)

Send 35¢ for 104 page catalog #20.

BARRY ELECTRONICS
DEPT. H-6 — PHONE A/C 212-925-7000
512 BROADWAY, NEW YORK, N. Y. 10012

new products

dycomm solid-state fm repeater



The new Dycomm *Echo II* is the first commercially available repeater for amateur radio use. It is completely solid state, uses no relays, is ultra stable, portable and FCC type accepted. The *Echo II* is designed to withstand the most severe environment, features 12 to 15 Vdc operation, multiple channel operation and comes equipped with full input/output option capability.

The *Echo II* transmitter will operate into an open or short circuit or any other mismatch. Input and output impedances are 50 ohms; connectors are type-N UG-58/U (mate with UG-1185/U). The unit has built-in carrier-operated relay, metering terminations for rf output, limiter current and discriminator output. The second optional frequencies may be remotely selected (by terminal connection) for either transmit, receive or both. Local/remote-control point is provided

for local use as a transceiver so repeater may be used as a mobile or base-station transceiver. Guaranteed transmitter power output is 12 watts; typical output is 15 watts.

Useable *Echo II* receiver sensitivity is 0.2 μV ; sensitivity for 20 dB quieting is typically 0.4 μV . Desensitization is less than 0.25 μV with 200-kHz channel spacing (no cavities). With 300-kHz channel spacing desensitization is negligible. Current consumption on receive, 40 mA; on transmit, 1.5 ampere. Inter-modulation interference, 70 dB minimum; spurious response attenuated more than 60 dB.

The repeater may be controlled with positive power up/down, timer, tone-burst entry, audio identification, etc. The *Echo II* is priced at \$700 and includes two 6-dB antennas. For more information write to Dynamic Communications, Inc., Post Office Box 10116, Riviera Beach, Florida 33404, or use *check-off* on page 94.

rf detectors



The new Radiation Devices CRD-2 coaxial detectors provide an economical means for rf demodulation and voltage measurement or monitoring over the frequency range from 1 to 1000 MHz. Units are available with or without terminating resistors. Either point-contact or hot-carrier diodes may be specified, with positive or negative output polarity. Frequency response is within 0.5 dB to 500 MHz; ± 1.0 dB to 1000 MHz. Rectifica-

tion efficiency is greater than 65%; maximum input voltage, 3 volts rms with point-contact diodes, or 25 volts rms with hot-carrier diodes. Lower frequency limit may be extended by addition of capacitor to internal terminals. Furnished with BNC or type-N input connector. Priced from \$20 to \$25, depending on options. For more information write to Radiation Devices Company, Post Office Box 8450, Baltimore, Maryland 21234, or use *check-off* on page 94.

two-meter fm transceiver



The new *Gladding 25* two-meter fm transceiver features 6-channels with 25-watts output. Designed and built by Pearce-Simpson, the world's largest manufacturer of marine communications equipment, the *Gladding 25* fills the requirement for the amateur who wants high power and multichannel fm capability. Crystals are factory-installed for 146.34/146.94 and 146.94/146.94 MHz.

The solid-state receiver uses an fet front end and integrated-circuit i-f strip. An 8-pole crystal filter provides superior selectivity. The transmitter is all solid state except for the driver and power output stages; power output is 25 watts in the *high* position, 1 watt in the *low* position. Output is ± 5 kHz phase modulation with automatic deviation limiting. Harmonic and spurious emission is more than 60-dB down.

Receiver sensitivity of the *Gladding 25* is $0.5 \mu\text{V}$. Squelch is adjustable, $0.4 \mu\text{V}$ or less for 80% rated audio output. Audio power output is 2 watts (10% distortion).

Receiver spurious rejection is 60 dB or greater. Selectivity is ± 7.5 kHz at 6 dB down; ± 15 kHz maximum at 60-dB down.

Nominal supply voltage is 13.6 volts dc, negative ground. Current drain on receive is 400 mA; standby, 1.2 amps; transmit, 10 amps. An optional matching ac power supply is available. The *Gladding 25* comes complete with mounting cradle and push-to-talk handset. Price, \$249.95; accessory ac power supply, \$69.95. Special combination price, transceiver and ac power supply, \$299.95. For more information write to Pearce-Simpson, Division of Gladding Corporation, Post Office Box 800, Biscayne Annex, Miami, Florida 33152, or use *check-off* on page 94.

mobile antenna system

The Mosely *Rode-Master* is an all new amateur mobile antenna system that offers many significant money-saving options. The antenna covers 6, 10, 15, 40 and 75 or 80 meters with an adjustable vswr of 1.5:1 or better at any given frequency on each band. The *Rode-Master* features interchangeable coils for 10, 15, 20, 40 and 75/80 meters, and is power rated for 400 watts PEP ssb (200 watts a-m). The DX matching network is the reason Mosley can guarantee an adjustable vswr — the network is simple to install and operate the provides fine tuning on 20, 40 and 75/80 meters.

The upper mast section of the *Rode-Master* antenna doubles as a 6-meter whip, adjustable for the entire band. The telescoped whip-lock device permits precision tuning with little more than fingertip pressure. The antenna may be either bumper or trunk mounted, and includes break-over (hinge) for garaging or low overhangs. The antenna rotates 360° in the break-over position; this is convenient for coil insertion, antenna adjustments, etc. For more information, write to Mosley Electronics Inc., 4610 North Lindbergh Boulevard, Bridgeton, Missouri 63044, or use *check-off* on page 94.

THE RADIO CONSTRUCTOR

Vol. 22 No. 11

JUNE 1969

THREE SHILLINGS

Top Band "Quartet" Transmitter



**NEXT MONTH
A MATCHING
TOP BAND
TRANSISTORISED
SUPERHET RECEIVER**



**Special
IN THIS ISSUE**

Automatic 400 Cycle Sine Wave Switch
Proper Continuity Leakage Tester

A New Magazine?

Not really. New in the U.S.A. perhaps, but very well known in Great Britain and now being offered to you here.

RADIO CONSTRUCTOR is almost exclusively construction material. Clearly written, concise articles give you full details on:

- Audio Construction Projects
- Receiver Construction Projects
- Transmitter Construction Projects
- Test Equipment Projects
- Radio Control Projects
- ... and much more

Try a subscription to this interesting magazine, we are sure that you will not be disappointed.

ONE YEAR SUBSCRIPTION — \$6.50

Write
RADIO CONSTRUCTOR
Greenville, N. H. 03048

Name

Address

City State

Zip

fm repeater identifier



Curtis Electro Devices has announced a completely solid-state fm repeater identifier designed to provide low cost, reliable call-letter identification in accordance with FCC regulations. The new unit, the ID-401, provides an audio tone output in the form of a Morse code identification (such as DE W1DTY) in addition to carrier keying. Identification is transmitted initially on repeater activation and subsequently every three minutes as long as the repeater is being used. A final identification is transmitted after repeater activity ceases. Contact closure in the repeater control circuitry initiates identification.

Relay contacts are provided to key the repeater carrier when necessary. Provision is also made to transmit a continuous audio tone on command, and an audible monitor may be switched on for convenience in set-up. A cw output mode is available for direct keying of transmitters used in vhf aurora and meteor scatter work and similar applications requiring periodic identification.

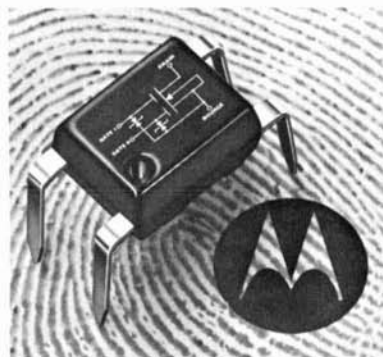
The compact unit, which uses 12 complex integrated circuits, is completely enclosed in a heavy metal case and requires 700 mA from a -12 to -24 Vdc supply. Code speed, interval length and tone pitch and volume are adjustable. Operating temperature range is -40° F to +140° F.

Code speed range of the ID-401 is 5 to 50 words per minute; interval time range is 1½ to 7 minutes. The capacity of the memory is 127 bits (one dot or one space = 1 bit). The unit has a built-in monitor speaker, and audio output of 0.5 volts p-p, 400 to 1500 Hz; the internal keying relay is rated at 2 amps, 500 volts,

100 volt-amperes.

Price is \$129.95, FOB Mountain View, California for the complete unit including a custom programmed memory. For more information, write Curtis Electro Devices, Box 4090, Mountain View, California 94040, or use *check-off* on page 94.

motorola mosfets



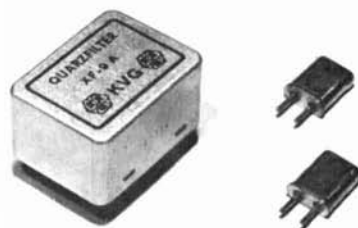
Three new dual-gate mosfets furnish low-cost high-performance amplifier/mixer applications in communications equipment, i-f strips and demodulators. The MPF120-122 are 50-cent range, plastic flat-pack cased devices with efficient agc control, low cross-modulation distortion, low feedback capacitance and high power gain plus gate diode protection. The MPF120 is an rf amplifier to 105 MHz with two separate channels. It provides excellent agc action, and a zener diode across the gate that shunts out voltage transients, adds reliability and stability.

The MPF121 is a vhf amplifier to 200 MHz. The MPF122 mixes rf with guaranteed frequencies of 104 and 244 MHz (optimum I_{DSS}). The new series of mosfets uses Motorola-developed silicon nitride passivation that ensures long-term stability under high-temperature and reverse bias conditions. Cross-mod for any of the devices is 1% (typical) with 100 mV of unwanted signal.

For more information, write to Motorola Semiconductor Products, Inc., Post Office Box 20912, Phoenix, Arizona 85036, or use *check-off* on page 94.

CRYSTAL FILTERS AND DISCRIMINATORS

by KVG of West Germany



9.0 MHz FILTERS

XF 9A	2.5 kHz	\$21.95
XF 9B	2.4 kHz	\$30.25
XF 9C	3.75 kHz	\$32.45
XF 9D	5.0 kHz	\$32.45
XF 9E	12.0 kHz	\$32.45
XF 9M	0.5 kHz	\$23.00
XL10M	0.5 kHz	\$59.95

10.7 MHz FILTERS

XF 107A	14 kHz	\$30.25
XF 107B	16 kHz	\$30.25
XF 107C	32 kHz	\$30.25
XF 107D	38 kHz	\$30.25

9.0 MHz DISCRIMINATORS

XD9-01	± 1.5 kHz	\$16.95
XD9-02	± 3.0 kHz	\$16.95
XD9-03	± 8.0 kHz	\$16.95

10.7 MHz DISCRIMINATORS

XD107-01	± 10 kHz	\$14.95
XD107-02	± 20 kHz	\$14.95

HC6/U CRYSTALS

XF 900	9000.0 kHz	\$2.75
XF 901	8998.5 kHz	\$2.75
XF 902	9001.5 kHz	\$2.75
XF 903	8999.0 kHz	\$2.75

ALSO:

DUAL GATE MOSFET CONVERTER FOR TWO METERS



Noise figure: 2. Excellent cross modulation and image rejection (116 MHz xtal oscillator.) IF 28-30 MHz. All inductors shielded.

Model DGTC 22. \$35.00

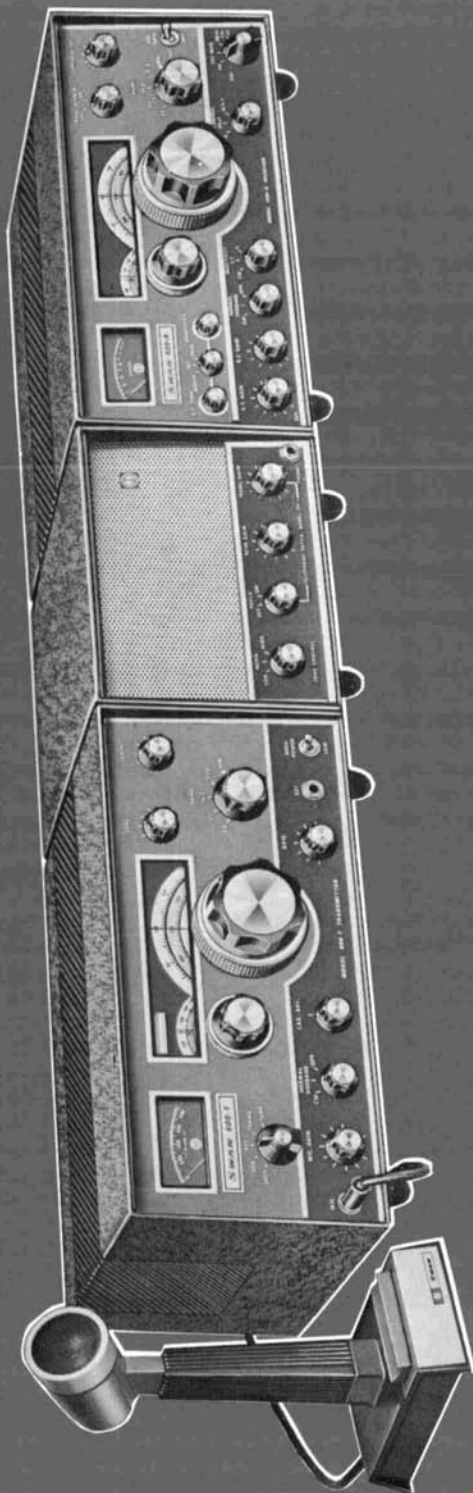
si

SPECTRUM
INTERNATIONAL
BOX 87 TOPSFIELD
MASSACHUSETTS 01983

THE SWAN TWINS



THE ULTIMATE IN VALUE ENGINEERING!



The remarkable success of the Swan transceivers has been based on our continuing policy of giving the amateur radio operator the best possible equipment at the lowest possible price. This is called "Value Engineering."

Now we at Swan have applied "Value Engineering" principles to the fabulous Swan Twins, and the results are truly remarkable.

With their superb selectivity, precision tuning, wide versatility, and natural voice sound, the Swan 600T and 600R offer you the complete amateur station, with more operating pleasure per dollar than any other equipment on the market, at any price.

We invite your comparison, and believe that you too will agree ... the Swan Twins are truly the ultimate in "Value Engineering."

SWAN FACTORY
305 Airport Road
Oceanside, Ca. 92054
Phone: (714) 757-7525



SWAN
ELECTRONICS
A Subsidiary of Cubic Corporation

EASTERN OFFICE
P.O. Box 2288
Ocean, N.J. 07712
Phone: (201) 431-0707

600R RECEIVER SPECIFICATIONS:

SSB, AM, CW Superheterodyne receiver. **FREQUENCY RANGE** with built-in tuning system:

3.4 to 4.4mc, 6.7 to 7.7mc, 13.8 to 14.8mc, 20.9 to 21.9mc, 27.5 to 30mc. With external tuner, Model 330: General coverage from 3 to 30mc.

With external crystal oscillator, Model 510X: 3 to 24mc, 10 crystal positions. These external oscillators plug directly into the 600R.

TUNING SYSTEM: The lower bands, 80 through 15 meters, are covered in 200 kc segments. 10 meters is covered in 500 kc segments. 100 kc and 25 kc crystal calibrator markers provide for highly accurate frequency readout on a large, easy to interpret dial.

Ultra smooth vernier tuning with large knobs gives you the incomparable feel of a Swan tuning system.

SENSITIVITY: Superior front end design gives you 1/4 microvolt sensitivity for 10 db signal plus noise to noise ratio at 50 ohms input impedance. At the same time, front end overload, cross modulation, image, and spurious responses have been reduced to "state-of-the-art" minimums.

R.F. SELECTIVITY: Antenna tuning circuitry in the 600R front-end provides continuous coverage from 3 to 30 mc. This is accomplished in 5 frequency ranges selected by the band switch: 3 to 5.5 mc, 5.5 to 10 mc, 10 to 16 mc, 16 to

24 mc, and 24 to 30 mc. Reception outside the normal VFO range of the receiver requires an external oscillator which can be the Swan 510X crystal controlled oscillator, or the Model 330 general coverage tuner. Either of these external oscillators plugs directly into the 600R.

Image rejection is a minimum of 55 db at 30 mc, increasing to better than 75 db at 3 mc.

I.F. SELECTIVITY: Swan's standard crystal lattice filter with 2.7 kc bandwidth, 1.7 shape factor, and ultimate rejection in excess of 100 db makes the 600R's selectivity superior to any other production receiver on the market.

With installation of the optional 16 pole crystal lattice filter (SS-16B), the 600R offers selectivity that far exceeds any receiver, at any price, anywhere! Selectivity then becomes truly

incredible, with a shape factor of 1.28 and ultimate rejection exceeding 140 db. Two additional crystal lattice filter options are available: One is a narrow band CW filter, the other is a broad band AM filter. There are provisions in the 600R for the installation of up to 3 filters, with front panel selection.

A.F. SELECTIVITY: Audio response of the 600R is 300 to 3000 cycles, ± 3 db, with 3 watts output to a 4 ohm external speaker. Headphone jack is provided with the speaker accessory unit.

An optional IC Audio Filter accessory is available for installation in the 600R. It provides a choice of either notching or peaking a selected audio frequency, and

greatly enhances both phone and CW reception.

I.F. NOISE BLANKER: (optional) Installs inside 600R. Extremely effective in suppressing impulse noises such as auto ignition interference.

EXCLUSIVE SINGLE CONVERSION DESIGN: with fewer spurious responses than multi-conversion designs.

HYBRID DESIGN: 7 tubes, 8 transistors, 12 diodes. Transistors used where they provide definite advantage. Tubes used where they still provide superior performance.

FULLY COMPATIBLE WITH 600T:

providing for transceiver operation as well as separate frequency control. Also CW sidetone and genuine CW break-in operation.

BUILT-IN AC POWER SUPPLY: for 117 volts, 50-60 cycles.

DIMENSIONS: 15" wide \times 6 1/2" high \times 12" deep. Weight: 23 lbs.

600R with standard 2.7 kc crystal lattice filter, less speaker..... **\$395***

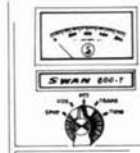
600R Custom with SS-16B super selective filter, I.F.Noise Blanker, and IC Audio Filter factory installed. Less speaker **\$560***

600T TRANSMITTER SPECIFICATIONS:

FREQUENCY RANGE: Full coverage of 10, 15, 20, 40 and 80 meters. Extended frequency coverage for MARS operation with plug-in crystal oscillator accessory, Model 510X.

TUNING: Internal VFO system is identical to that used in the 600R.

POWER RATING: 600 watts P.E.P. with a pair of 6KD6 power tubes. 500 watts CW, 150 watts AM, 100 watts continuous RTTY/SSTV.



PI-Network output for 50 or 75 ohm coax.

Suppression: Carrier 60 db down, unwanted sideband 50 db, third order distortion approx. 30 db.

Audio response:

± 3 db from 300 to 3000 cycles. CW Keying: Grid block, full break-in system. Includes sidetone to receiver.

INTERNAL POWER SUPPLY for 117 volts, 50-60 cycles.

DIMENSIONS: 15" wide \times 6 1/2" high \times 12" deep. Weight: 32 lbs. **\$495***

ACCESSORIES:

STANDARD SPEAKER

Has tone switch and headphone jack **\$18***

DELUXE SPEAKER (illustrated)

Includes Swan phone patch, tone switch and headphone jack **\$59***

I.F. NOISE BLANKER

Installs internally in 600R..... **\$79***

IC AUDIO FILTER

Installs internally in 600R..... **\$44***

OPTIONAL CRYSTAL LATTICE

I.F. FILTERS

600 cycle bandwidth CW Filter..... **\$20***

6 kc bandwidth AM Filter..... **\$22***

SS-16B Super Selective 16 pole.... **\$75***

PLUG-IN VOX FOR 600T,

Model VX-2 **\$29***

SWAN DESK MIKE Model 444 **\$25***

*Factory price.

DIODES

PIV	TOP-HAT		EPOXY MOUNT	
	1.5 AMP	1.5 AMP	3 AMP	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		.20	.40	.65
1000		.24	.48	.75

CAPACITORS

ALL NEW FULL AXIAL LEADS

1 Mfd @	25 Volts	5 for \$1.00
3 Mfd @	6 Volts	5 for \$1.00
5 Mfd @	15 Volts	5 for \$1.00
10 Mfd @	6 Volts	5 for \$1.00
30 Mfd @	15 Volts	5 for \$1.00
80 Mfd @	2.5 Volts	5 for \$1.00
100 Mfd @	15 Volts	5 for \$1.00
250 Mfd @	30 Volts	3 for \$1.00
500 Mfd @	25 Volts	3 for \$1.00
500 Mfd @	50 Volts	40¢ ea.
1000 Mfd @	12 Volts	3 for \$1.00
1500 Mfd @	25 Volts	2 for \$1.00
3000 Mfd @	16 Volts	2 for \$1.00

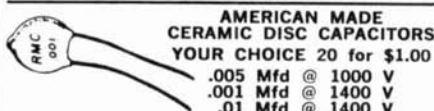


6 Foot Gray Line Cord. UL Approved. Very nice. 40¢ ea. ppd



CDE TYPE WMF MYLAR CAPACITORS
ALL 100 VOLTS

.033 Mfd @ 100 V	8¢ ea or 14 for \$1.00
.22 Mfd @ 100 V	10¢ ea or 12 for \$1.00
1.0 Mfd @ 100 V	25¢ ea or 5 for \$1.00



AMERICAN MADE
CERAMIC DISC CAPACITORS
YOUR CHOICE 20 for \$1.00

.005 Mfd @ 1000 V
.001 Mfd @ 1400 V
.01 Mfd @ 1400 V



DIPPED CAPACITORS
ALL 200 VOLTS
YOUR CHOICE 20 for \$1.00

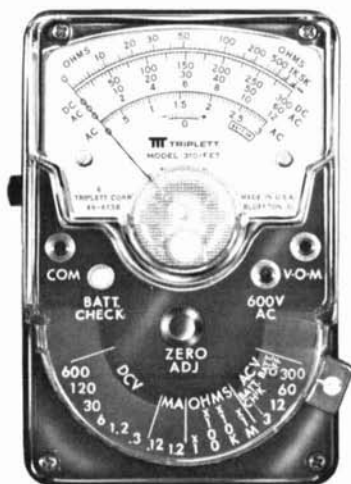
.033 Mfd @ 200 V
.02 Mfd @ 200 V
.22 Mfd @ 20 V

TI 1N914 Diode	16 for \$0.00 ppd.
1N4007 Diodes	28¢ ea. ppd.
Unmarked Germanian diodes, similar to 1N34.	25 for \$1.00; 100 for \$3.00
2N3055 Transistor	\$1.50 ea or 3 for \$4.00 ppd.

SEND STAMP FOR BARGAIN LIST
Pa. Residents add 6% State sales tax
ALL ITEMS PPD. USA

M. WEINSCHENKER K3DPJ
BOX 353 • IRWIN, Pa. 15642

fet vom



The Triplett model 310-FET vom is an all solid-state instrument that features 10-megohm input impedance. The battery-operated unit has a single selector switch and provision for attaching an ac clamp-on adapter. It has high sensitivity of 300 mV dc full scale for transistor bias measurements, and resistance measurements to 500 megohms. Open-circuit voltage is 1.5 volts on all ranges; maximum short-circuit current is 30 mA. Accuracy is 3% of full scale on dc, 4% of full scale on ac, and 3% of dc arc on ohms. The meter has a zero-center mark for null measurements, and a polarity-reversing switch for dc and ohms. Sixteen ranges include dc current to 1.2 mA, dc voltage to 600 volts, ac voltage to 600 volts and ohms to 50 megohms (center scale). Price is \$74.00 complete with leads, instruction manual and batteries from Triplett Corporation, Bluffton, Ohio 45817, or use *check-off* on page 94.

multi-tone repeater panel

Alpha Electronic Services has introduced a new, smaller 10-tone repeater control panel, the RCP-760. This unit is

especially designed for two-way radio repeater or shared repeater systems, where the high reliability of solid-state circuitry is required at low cost. The RCP-760 will respond to the receipt of any of up to ten tone frequencies by keying and modulating the transmitter with regenerated received tone. The desired tone frequencies are determined by merely plugging in circuit board modules; up to twenty combinations can be achieved by the addition of the RCP-769-1 accessory panel.

When ordered with at least one set of tone modules, the RCP-760 comes complete and ready to install. Built-in voltage regulation allows efficient operation over a wide range of input voltages (normal 12.6 Vdc). Dimensions are only 3-1/2 high, 3-3/4" deep, on a 19" panel. A 117-Vac Power supply is available.

For more information, write to Alpha Electronic Services Inc., 8431 Monroe Avenue, Stanton, California 90680, or use *check-off* on page 94.

communications ic

National Semiconductor has started production of an integrated circuit which may qualify as a general-purpose communications subsystem. The LM373, designed for a-m, fm and ssb applications, contains two amplifier sections (four gain/limiters), a gain-control stage, fully balanced fm and ssb detector, and an active a-m/ssb peak detector whose output matches the agc input characteristics. The bandpass characteristics can be shaped from audio to 15 MHz with a single external filter — crystal, ceramic, mechanical of LC. An LC tuned quadrature circuit gives 80-mV audio output for 75 kHz deviation at 10.7 MHz in a typical wideband fm application. In a-m operation typical sensitivity is 5 microvolts for 10 dB signal and noise. Price is \$4.85 each in small quantities. For sales information, write to National Semiconductor Corporation, 2975 San Ysidro Way, Santa Clara, California 95051.

INTEGRATED CIRCUITS FACTORY FRESH — NO REJECTS W/SPEC. SHEETS

FAIRCHILD — PHILCO — RCA MOTOROLA — NATIONAL NEW LOW PRICES RTL or TTL LOGIC

UL 900 Buffer	80¢	10/5.50
UL 914 Gate	80¢	10/5.50
UL 923 JK Flip-flop	\$1.50	10/8.50
MC 790P Dual JK Flip-flop	\$2.00	10/18.95
MC 890P Dual JK Flip-flop	\$2.00	10/18.95
MC 789P Hex Inverter	}	\$1.00 ea. 10/9.25
MC 724P Quad 2 Input Gate		
MC 799P Dual Buffer		

7400 Quad 2 Input NAND Gate	65¢	10/5.95
7404 Hex Inverter	65¢	10/5.95
7441A Decimal Decoder/Driver		
	\$3.50	10/29.95
7473 Dual JK Flip-flop	\$1.30	10/10.95
7475 Quad Latch	\$2.10	10/19.95
7490 Decade Counter	\$2.40	10/19.95
709 Op Amp	\$1.75	10/16.50
741 Op Amp	\$2.70	10/25.00
CA 3035 Linear Amplifier	\$2.25	10/21.95
14 Pin Dual Inline socket terminals	25¢	10/2.25
16 Pin Dual Inline socket terminals	30¢	10/2.75

NEW NATIONAL Long Life Nixie tubes NL 940S 0-9 with two decimal points	\$4.50 ea.	10/42.95
SOCKET for NL 940S	50¢ each	
100 KC CRYSTAL NEW	\$3.95	
Western Union facsimile machines, send and receive pictures and memos. Works on 115 v 60 cycles. Shipped with auto-start, auto-phase pos-to-pos, conversion instructions. 20 lbs.	\$19.95	

88 MH TOROIDS 10/3.00

DOOR KNOB CAPACITORS

600 PF - 12 KV	75¢
40 PF - 5 KV	50¢
50 PF - 7.5 KV	50¢



R & R ELECTRONICS
311 EAST SOUTH ST.
INDIANAPOLIS, IND.
46225

\$5.00 minimum order. FOB Indianapolis

June is antenna and tower month.

- HY-GAIN
- ANTENNA SPECIALISTS
- CUSHCRAFT
& NEW-TRONICS ANTENNAS
- CDE and
HY-GAIN ROTATORS
- ROHN TOWER

See or write us for your needs.

The midwest's newest
communications center.

COMMUNICATIONS WORLD, INC.
4788 STATE ROAD
CLEVELAND, OHIO 44109
(216) 398-6363

mosley two-meter antenna



The new omni-direction vertically-polarized *Diplomat 2* antenna from Mosley features low angle of radiation for maximum coverage. Gain is specified at 3.4 dB as compared to a $\frac{1}{4}$ -wave ground plane, and vswr is 1.5:1 or better. Input impedance is 52 ohms. The vertical element is made from high tensile strength aluminum; the base is high-impact polystyrene. The *Diplomat 2* is rated at 1 kW a-m or cw, 2 kW PEP ssb (input to the final amplifier). The base mounting fits up to a $\frac{1}{2}$ -inch mast. The *Diplomat 2* is available at your dealer for \$10.58; similar antennas for six and ten meters, the *Diplomat 6* and *Diplomat 10*, are \$21.75 and \$29.30 respectively. For more information, use *check-off* on page 94, or write to Mosley Electronics, Inc., 4610 North Lindbergh Boulevard, Bridgeton, Missouri 63042.

AT LAST -- A SPEECH COMPRESSOR THAT REALLY WORKS!



RPC-3M MODULE
(ONLY \$22.50)

- LOW DISTORTION CIRCUIT
- FULLY WIRED & TESTED NOT A KIT
- WORKS WITH PHONE PATCH
- INTERNAL UNITS & MODULES WORK MOBILE
- FULL WARRANTY — ONE YEAR
- INTRODUCTORY LOW PRICES
(Illinois residents add 5% Sales Tax)

Write for specifications
and information sheets
(free)

Demonstration Tape (cassette) available (\$2.00 deposit)



RPC-3C CABINET MODEL
(\$34.95)



RPC-3,3U INTERNAL UNIT
(\$24.95)

RP Electronics

BOX 1201H
CHAMPAIGN, ILL.
61820

new fcc form

Effective July 1, 1971, the Federal Communications Commission will accept for filing *only* editions of FCC Form 610, *Application for Individual Amateur Radio Station and/or Operator License*, dated July, 1970 or later. These forms are currently available. *No* applications on FCC 610 forms dated before July, 1970 will be accepted for filing after July 1, 1971.

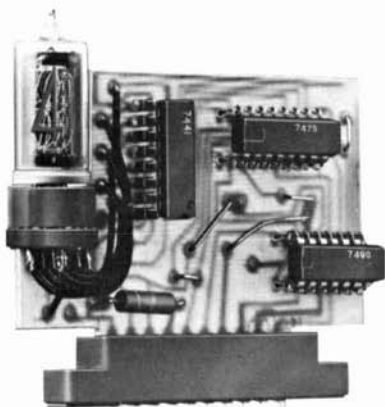
NIXIE READ OUT STAGE

"NEW TTL LOGIC"

AT A
LOW
LOW
PRICE

\$12⁴⁹
*see price schedule below

KITS ARE PURCHASED
AS LISTED



READ OUT STAGE SPECIFICATIONS

- NL 940s Read Out Tube with two decimal points supplied. (or equivalent).
- 2 x 3 etched and drilled glass epoxy printed circuit board.
- Accepts 10 pin PC board connector
- Voltage requirements 5 volts DC 80 ma for integrated circuits, 170 to 300 volts DC at 2 ma for the read out tube.
- 3TTL INTEGRATED CIRCUITS
- 7490 Decade supplies a BCD code output
- 7475 Quadlatch stores the count while the decade is re-counting not used in digital clocks (when quad latch is not used jumpers are required).
- 7441 Decoder Driver converts the BCD code to ten different signals needed to drive the read out tube.

BASIC KIT NX100

NL 940S nixie read out tube
NL 940S tube socket
7490 Decade
7441 Decoder/driver
Resistor
Etched and Drilled glass epoxy P.C. board

NX100-Q SAME AS NX 100
WITH ADDITIONAL QUADLATCH

DELUX KIT NX101

NL 940S nixie read out tube
NL 940S tube socket
7490 Decade
7441 Decoder/driver
Resistor
Etched & Drilled glass epoxy P.C. board
7475 Quad Latch
2 - 16 Pin I.C. socket assembly
1 - 14 Pin socket assembly
10 pin PC board socket

PLEASE ORDER BY
KIT NUMBER

QUANTITY	NX100	NX100-Q*	NX101
1 - 3	\$14.45	\$16.75	\$18.95
4 - 9	12.95	15.25	16.95
10 - up	12.49	14.75	16.45

*WITH QUAD LATCH
Completely guaranteed

**NX 101
NIXIE
READ OUT
STAGE
TTL LOGIC**

**ALL BOARDS
DIVIDE BY 10
OR
DIVIDE BY 6**

BY INTERCHANGING
OF 3 JUMPERS THE
P.C. BOARD IS
ADAPTABLE TO
DIVIDE BY 6 OR
DIVIDE BY 10.



R & R ELECTRONICS
311 EAST SOUTH ST.
Indianapolis, Ind. 46225

Radio

Expo '71

LAKE COUNTY ILLINOIS FAIR GROUNDS
JULY 10 & 11, 1971 - 8 am to 6 pm

THE LARGEST MEETING OF
RADIO ENTHUSIASTS IN THE MIDWEST

Displays - Technical Motion Pictures - Reserved
Space for Indoor Flea Market - Indian
Village and Dances - Amusement Rides
for the Kids - Practical Door Prizes
Camping Area - And Lots More

Halfway between Chicago and Milwaukee - Rts. 45 and 120

Tickets - \$3.50 for both days

Advance Sales - \$3.00 (Children under 12 - No Charge)

For advance sales, write to:

RADIO EXPO '71

Box 271

Northbrook, Illinois 60062

sponsored by the

CHICAGO FM CLUB



COMMUNICATE

with Stress Tested TRI-EX MW Towers

The MW series is a modular, all steel, crank-up tower, designed to support up to 9½ sq. ft. of antenna area. Its "W" bracing is exceptional with a minimum of torque and twist resistance. The MW's range up to 65' in height, nested down to 22'. Hinged base and wall bracket is included with your MW tower.

A unique feature of TRI-EX crank-up models is the die form guide that provides the spacing between sections, and makes one section slide into the other for extremely easy erection. Towers are available in 10' and 20' sections.

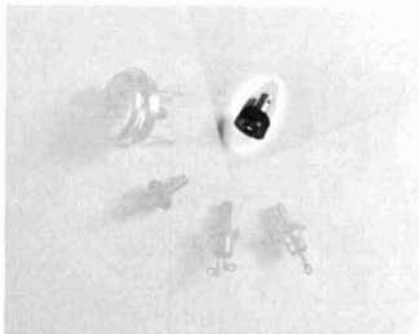
Give your Antennae their great opportunity! Mount them on a TRI-EX Tower.



ri-Ex. TOWER
CORPORATION

7182 Rasmussen Ave., Visalia, Calif. 93277

MEET THE STUD-NUT



Typical #10-32 threaded stud devices which can be mounted by the stud-nut shown at the upper right.

The stud-nut consists of an internally threaded, cadmium plated brass insert molded in a high-temperature, glass-filled nylon base. The unique patented design of the molded base insures perfect centering of the device stud for maximum voltage insulation and locking action. Thru holes are provided in the upper end of the metal insert for external lead connections.

PACKAGE OF FOUR STUD-NUTS — \$1.00 (Quantity Discounts Available)

SCF CORP., P. O. Box 999, Hightstown, N. J. 08520

Digital Frequency Meter



- Monitors your "transmitted" signal
- Measures kHz and MHz
- Operates with any exciter-transmitter (1 to 600 watts — up to 35 MHz)
- Large-bright "Nixie" display
- Now - 100 Hz (.1 kHz) Readout through 35 MHz

FM-6 Kit . . . \$119.50

(170 MHz Prescaler - \$45.00 extra)

Micro-Z Co.

Box 2426 Rolling Hills, Calif. 90274

radio amateur callbook

Radio Amateur Emblems engraved with your call letters.



Charm

- Gold
 Rhodium
 call letters
\$6.00 Ea.



Tie Bar

- Gold
 Rhodium
 call letters
\$6.00 Ea.



All illustrations are actual size.

Lapel Pin

- Gold
 Rhodium
 call letters
\$6.00 Ea.

Two or more emblems at the same time \$5.00 each.

Rush Order To: RADIO AMATEUR CALLBOOK, Inc.
 Dept. E. 925 Sherwood Drive, Lake Bluff, Ill. 60044

HAL DEVICES

FOREIGN HAMS DO YOU NEED AMERICAN CONSTRUCTION COMPONENTS?

Send us a list of your needs and we will give you a quotation on any standard American parts which you may require.

No longer need you avoid construction projects in Ham Radio or any other U. S. amateur publication because of hard to find parts. We'll find them and send them to you.

Send 4 IRC's for catalog.

HAL DEVICES

BOX 365 HF

URBANA, ILLINOIS 61801 U.S.A.

F.M. MOTOROLA GOVERNMENT SURPLUS



	Used	Re-Cond:
R-394 RECEIVER		
152-172 MC	\$14.95	\$22.50
T-278 TRANSMITTER		
152-172 MC	18.95	24.95
R-257 RECEIVER		
25-50 MC	19.95	
T-208 TRANSMITTER		
25-50 MC	29.95	
CY-938 CABINET	7.95	9.95
C-847 CONTROL BOX	8.95	12.95

Also — Power Supplies
 Amplifiers,
 Modules, Etc.
 Write — Dept. HR

Send For Our BIG CATALOG No. 71

FAIR RADIO SALES
 P.O. Box 1105 • LIMA, OHIO • 45802

NEED CRYSTALS?



We can supply crystals from 2KHz to 80 MHz in many types of holders.

SPECIALS

Color TV crystal (3579, 545KHz) wire leads	\$1.60	4 for \$5.00
100 KHz frequency standard crystal (HC 13/U)	4.50	
1000 KHz frequency standard (HC6/U)	4.50	
Any CB crystal, trans. or rec. (except synthesizer crystals)	2.50	
Any amateur band crystal in FT-243 holders (except 80-160 meters)	1.50	4 for \$5.00
80 meter crystals in FT-243 holders	2.50	

We have in stock over six million crystals which include types: CR1A/AR, FT243, FT241, MC7, HC6/U, HC13/U, HC25/U, HC18/U, etc. Send 10¢ for our 1970 catalog with oscillator circuits, listing thousands of frequencies in stock for immediate delivery. (Add 10¢ per crystal to above prices for shipment 1st class mail; 15¢ each for air mail.)



Special Quantity Prices to Jobbers and Dealers.

ORDER DIRECT with check or money order to

2400H Crystal Drive
 Fort Myers, Florida 33901

flea market



VHF NOISE BLANKER — See Westcom ad in Nov., Dec. '70 and Mar. '71 Ham Radio.

MUST SELL - T150 with new 6146A's \$45, Lafayette He 74 VFO 80-6 meters mint condition \$25, Lafayette He 35 6 meter transceiver, mike, crystal \$25. WA2UK1, 8337 256 Street, Floral Park, New York, (212) 343-5372.

ORIGINAL EZ-IN DOUBLE HOLDERS display 20 cards in plastic, 3 for \$1.00, 10 for \$3.00 prepaid. Guaranteed. Patented. Free sample to dealers. Tapabco, John K4NMT, Box 198R, Gallatin, Tenn. 37066.

ASK FOR FREE LIST of used Ham gear or for prompt personal attention on any new gear. Mail your order direct to VanSickle Radio, W9KJF, Indianapolis, Indiana 46205. 40 years experience.

■ **RATES** Commercial Ads 25¢ per word; non-commercial ads 10¢ per word payable in advance. No cash discounts or agency commissions allowed.

■ **COPY** No special layout or arrangements available. Material should be type-written or clearly printed and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** can not check out each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue. Deadline is 15th of second preceding month.

■ **SEND MATERIAL TO:** Flea Market, Ham Radio, Greenville, N. H. 03048.

THE ZERO BEATER AMATEUR RADIO CLUB will hold their annual Hamfest at the Washington, Mo. City Park on August 1st, starting at 10 a.m. Free Ham Gear Auction. Many fine Ham gear door prizes and free entertainment for the children and Y's.

WANTED. WALKIE TALKIE, hand held type, World War II vintage. Selwyn Luben, WOERF, 3641 Troost Avenue, Kansas City, Missouri 64109.

CONNECTICUT HAMS: Come and see all the goodies at Roger S. Miner Surplus Electronics, 246 Naugatuck Ave., Milford, Conn. 06460. Telephone 877-0555.

WANTED R390, R3C0A, R389, 51J4, 51S1, Racal, Nems, Clarke, Marconi receivers. SWRC, P. O. Box 10048, Kansas City, Missouri 64111.

WANTED: BULOVA ACCUTRON TE13 series clock. 1 1/2" diameter dial. Please give condition and lowest price. N. Ross, 1425 Walnut, Berkeley, California 94709.

FOR SALE — **KNIGHT T-150A** transmitter, 150 watts AM and CW, 80-6 meters, built-in VFO or crystal. Good condition. Also Eico 753 SSB and CW. Transceiver, does not operate, for parts or repair. Bill Jennings, 47 Allen Road, North Haven, Connecticut 06473.

THE SECOND ANNUAL MUSIC CITY HAMFEST will be held in Nashville, Tennessee on Sunday, June 20, at Edwin Warner Park Picnic Site #3. Lots of free parking, shelter and a playground for the children. Bring a picnic lunch, or food and soft drinks, ice cream, etc. will be available at the site. Main drawing will be at 3:30 p.m. Three main prizes plus many other prizes, with a special drawing for the ladies and favors for the children. Main prizes will be an HW 101, with power supply, an HA 460 Xceiver and a portable TV set.

EXCLUSIVELY HAM TELETYPE — 19th year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 30¢. \$3.00 year. Box 837, Royal Oak, Michigan 48068.

QSLs. SECOND TO NONE. Same day service. Samples 25¢. Ray, K7HLR, Box 331, Clearfield, Utah 84015.

YOU ALL COME TO International Independent County Hunters Convention in Kansas City, July 2, 3, 4, 1971. SASE to WA0SHE for information.

The LINCOLN, NEBRASKA AMATEUR RADIO CLUB will operate a special prefix amateur radio station using the call KQ0NEB. Operations will commence at 2100 GMT September 1, 1971 and will be continuous 24 hours a day through 0500 GMT September 9, 1971. Transmitters will be on 10, 15, 20, 40 and 80 meters, both CW and SSB. DX contacts will be QSLed via Bureaus. Stateside contacts must send cards with SASE to WOY0Y, Box 5006, Lincoln, Nebraska 68505. As with past operations of the Club, a special QSL card will be used.

MANUALS — \$6.50 each: R-390/URR, URM-25D, BC-639A, CV-591A/URR, TS-497B/URR, FR-5/U, TS-587B/U, UPM-45, SP-600JX. Hundreds more. S. Consalvo, 4905 Roanne Drive, Washington, DC 20021.

THE TWO RIVERS AMATEUR Radio Club will hold its annual hamfest July 18 at the Balcon Hotel grounds in McKeesport located 15 miles east of Pittsburgh. For information write Charles E. Thomas WA3MWM, 7022 Blackhawk, Pittsburgh, Pa. 15218.

TELL YOUR FRIENDS about Ham Radio Magazine.

HAMFEST: Indiana Radio Club Council's annual picnic Sunday, July 11th, LaPorte County Fairgrounds, LaPorte, Indiana. Large Flea Market with reserved locations available for large exhibitors and vendors on the Midway and Main Building. Mobile FM Clinic. Prizes. Tech Sessions. For flyer, write: Dave Osborn, K9BPV, P. O. Box 272, LaPorte, Indiana 46350.

75A2A MINT CONDITION \$200, 2 meter Gonset Comm. II \$50, SX-99 \$35, 10B with VFO \$50, 2 meter FM 80W base station \$50, 1-319-337-7114, K9EIF, 3305 Shamrock, Iowa City, Iowa 52240.

ELECTROSTATIC PHOTOCOPY SERVICE - 8 1/2 x 11 or 8 1/2 x 14 - any original - 1 to 10 @ .10¢ - 10 and on @ .08¢ - immediate postpaid return - complete drafting service also available. R. K. Wildman - 6142 Glenbrook Lane - Stockton, Calif. 95207.

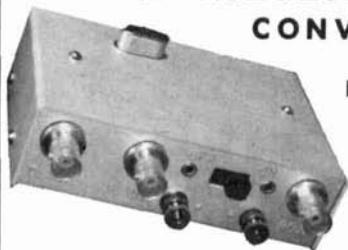
EVANSVILLE, INDIANA HAMFEST, 4H grounds (Highway 41 North 3 miles) Sunday, July 11, 1971, air conditioned, auction, overnight camping, ladies bingo, reserved flea market booths, advance registration. For flyer contact Morton Silverman W9GJ, 1121 Bonnie View Drive, Evansville, Indiana 47715.

SURPLUS CRYSTALS BLANKS: Range 4100-6800 kHz. 7200-8600 kHz. Assorted freq. our selection. 30¢/\$1. Nat Stinnette Electronics, Umatilla, FL 32784.

TOROIDs! Lowest price anywhere. 40/\$10.00 POSTPAID (5/\$2.00). center tapped, 44 or 88mhz. 32KSR page printer, reconditioned, perfect \$225. MITE UGC41KSR page printer, reconditioned, \$250. Mod28 Sprocket to friction kit, \$25. 28LBXD TD, \$70. 28LPR reper with gear shift, \$170. Model 15KSR, \$65. Matching RA87P.S. Unused, \$7. Lorenz 15KSR, \$75. Sync motors, \$7. 14TD, \$20. DPE punch, \$14. HP200CD Oscillator, \$95. R390/URR, \$550. 11/16" tape, 40/\$10.00. 33ASR, complete, \$700. Stamp for listing. Van W2DLT, 302H Passaic, Stirling, N. J. 07980.

MECHANICAL FILTERS: 455 Khz. 2.1 Khz \$18.95. 300 Hz \$22.95. J. A. Fredricks, 314 South 13th Ave., Yakima, Washington 98902.

... THE BEST
**2 METER
 CONVERTER**



Model 407
\$42.95
 ppd.

144-146 MHz in. 28-30 MHz out
 or 146-148 MHz with a second crystal
 available for \$5.95 each

A full description of this fantastic converter would fill this page, but you can take our word for it (or those of thousands of satisfied users) that it's the best. The reason is simple — we use three RCA dual gate MOSFETs, one bipolar, and 3 diodes in the best circuit ever. Still not convinced? Then send for our free catalog and get the full description, plus photos and even the schematic.

Can't wait? Then send us a postal money order for \$42.95 and we'll rush the 407 out to you. NOTE: The Model 407 is also available in any frequency combination up to 450 MHz (some at higher prices) as listed in our catalog. New York City and State residents add local sales tax.

VANGUARD LABS

Dept. R, 196-23 Jamaica Ave., Hollis, N.Y. 11423

FREQUENCY STANDARD



Only
\$32.50
 (less batteries)
 POSTPAID USA

- Precision crystal
- Fully guaranteed

- Markers at 100, 50, 25, 10 or 5 kHz selected by front panel switch.
- Zero adjust sets to WWV. Exclusive circuit suppresses unwanted markers.
- Compact rugged design. Attractive, completely self contained.
- Send for free brochure.

**PALOMAR
 ENGINEERS**

BOX 455, ESCONDIDO, CA 92025

**A "broadband" isn't an all girl
 orchestra.**

ITS A BALUN FROM L.A. ELECTRONIX



Mod. LA-BN330

IMPROVE YOUR ANTENNA PATTERN
 AND REDUCE TVI.....FOR ONLY

\$11.77

SPECIFICATIONS

BANDWIDTH.....3 THROUGH 30 MH. CONTINUOUS
 VSWR.....1:1 WHEN TERMINATED WITH A
 BALANCED 52 OHM LOAD.
 POWER RATING.....1KW DC 2KW PEP
 IMPEDANCE RATIO.....1:1 AT 52 OHMS
 INPUT CONNECTOR.....SO-239
 OUTPUT CONNECTIONS.....STANDARD TERMINAL LUGS
 WEATHER PROTECTION.....INTERNALLY SEALED

• ORDER TODAY FROM •



Electronix Sales

23044 S. CRENSHAW BLVD., TORRANCE, CALIF. 90505

213-534-4456

HOME OF LA AMATEUR RADIO SALES

FM'ers
 Here is 13.6 Volt D.C.
POWER

For your Regency, Standard, Varitronics or similar 10 watt, solid-state FM transceiver.

100-130 volt 50-60Hz input

BLULYNE XP-500

13.6V Nominal at 2.5 Amp Transmit.
 14.0V Nominal at 200 Ma Receive.

A well filtered, regulated solid state power supply ready to plug in and use.

Only \$34.95

Check, money order or use your Mastercharge or BankAmericard.

BLULYNE ELECTRONICS CORP.

91 STATE STREET

NORTH ADAMS, MASS. 01247

413-662-2876

THE PINE RIDGE AMATEUR RADIO CLUB of Chadron, Nebraska will hold their seventeenth annual hamfest at Chadron State Park located 9 miles South of Chadron on Highway 385, Sunday, June 6, 1971. All amateurs and families welcome. Bring a covered dish and your own utensils. The Club will furnish soft drinks and coffee, no charge.

DON'T BUY QSL CARDS from anyone until you see my free samples. Fast service. Economical prices. Little Print Shop, Box 9848, Austin, Texas 78757.

SURPLUS MILITARY RADIOS, Electronics, Radar Parts, tons of material for the ham, free catalogue available. Sabre Industries, 1370 Sargent Ave., Winnipeg 21, Manitoba, Canada.

TELETYPE #28 LRXB4 reperfector-transmitter "as is" \$100; checked out \$175. Includes two 3-speed gearshifts. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

2 METER FM — standard SR-C826M \$339.95, Clegg 22'er FM \$369.95 includes mobile antenna. Send for specs. and information. H & H Electronics, 824 Read, Lockport, Illinois 60411.

PASS FCC Extra, Advanced, General Exams easily with simplified, economical books and code records. Free catalog. Ameco Publishing, 314H Hillside Avenue, Williston Park, N. Y. 11596.

WANTED: HEATHKIT PANADAPTER, any model or surplus 455 KHz model. Used Hy-Gain 14AVQ vertical antenna. R. J. Brubaker W0DYR, 3932 Charlotte, Kansas City, Missouri 64110.

PLAN AHEAD! June 19th & 20th, Colorado Springs, Antlers Plaza Hotel. 1971 ARRL Rocky Mountain Division Convention is coming! Pass the word! Contests - Prizes - Top Speakers - Wouff Hong. The biggest Ham event of the year! Watch for your pre-registration blank in the mail — take your vacation! Quit your job! GET HERE SOMEHOW!!

TOROIDS 44 and 88 mhy. Unpotted, 5 for \$1.50 ppd. W. Weinschenker, Box 353, Irwin, Pa. 15642.

QSL'S — BROWNIE W3CJI — 3111B Lehigh, Allentown, Pa. 18103. Samples 10¢. Cut catalogue 25¢.

WORLD QSL BUREAU — see ad page 88.

SALE: COLLINS 75A4 Receiver, mods per factory, filters, \$300.00; Heathkit SB610 Scope, \$60.00; HD15 Phone Patch, \$20.00; HM15 SWR Bridge, \$20.00; 14AVQ Antenna, \$25.00; Phasor 40 Antenna System, \$50.00. WB6TFO, 1682 Rainbow Drive, Santa Ana, CA 92705. (714 544-1208).

SELL OR TRADE for two meter equipment: Mobile six meter FM GE Progress Line Transistor Supply, 100 watt output. Very clean on 52.525. With manual, two frequency head, all accessories. Daniel Vernier, 19741 Broadacres, Mt. Clemens, Michigan 48043. 313-791-8364.

ZENITH Parametric Amplifier 1296MHz \$75; Alfred TWT amplifiers w/pwr 500-1000MHz and 1-2GHz \$45 each; Gertsch FM-4A (30 GHz capability) \$145; 432MHz 7034/4X250B amplifier \$75; UHF Products 432MHz transverter \$100; swap list VHF/UHF components SASE. W4AP1, Box 4095, Arlington, Virginia 22204.

JOHNSON VIKING 1 kilowatt amplifier - 80 thru 15 meters, SSB-AM-CW for sale or trade for SSB transceiver. Jack Hamilton, Route 1, Sylvester, Georgia 31791.

"DON AND BOB" NEW GUARANTEED BUYS. Dealer Tempo, Kenwood write specifications. Monarch KW SWR relative power dualmeter bridge 14.95; Amphenol PL259/S0239 3.90/10; Swan 1011 demos 399.00; Hy-Gain Hy-Quad 99.00; Ham-M 99.00; TR44 59.95; AR22R 29.95; write quote SPR4, GT550, Tri-Ex. Ray 6LQ6 3.50; Motorola HEP170 epoxy diode 2.5A/1000PIV 39¢; GE 3A/600V 33¢; transformer Stancor RT202 12-28V/2A 6.95; 8A. RT204 10.95; 12A. RT206 15.95; 6V-12V-28V/1A. 1.95; 1000KHz Knight crystal 9PIN 3.95; PB relay KHP17D13 4PDT/48V 1.95; 4 ft. test leads Simpson Triplett 1.49/pr; NE2U lamp 6¢ ea; Prices FOB Houston, GECC, Mastercharge, BAC. Quotes specific items. Service guaranteed. Madison Electronics, 1508 McKinney, Houston, Texas 77002. (713) 224-2668.

ATLANTA HAMFEST AND GEORGIA ARRL CONVENTION JUNE 12 & 13, 1971 LENOX SQUARE, ATLANTA, GEORGIA

The Atlanta Radio Club is pleased to announce the annual Atlanta Hamfest and Georgia ARRL Convention. Events unprecedented in history. Highlights will include:

- ARRL Forum
- Mars Meetings
- Manufacturer's Displays
- FM Technical Sessions
- Left Foot CW Contest
- Carnival for the Harmonics
- Gala Banquet and Dance Saturday Evening.

Prizes will be the largest and best ever!

YOUR CHOICE OF A COLOR-TV OR DRAKE TRANSCEIVER.

REGENCY HR-2
TEN-TEC RECEIVER
COMPLETE ANTENNA SYSTEM

A SURPRISE (A TRANSCEIVER THAT WE'RE OBLIGATED NOT TO DISCLOSE 'TILL SUNDAY, JUNE 13TH).

Reservations are available at the Roadway Inn, 3387 Lenox Road (261-5500). This fine motel is directly across from the Hamfest site. In fact, once you get to Atlanta, you won't need your car again.

For fun, fellowship and an all around good time bring the family. (Note the carnival, bowling and a fine selection of ladies prizes.) Join us in Atlanta, June 12 & 13, 1971, Lenox Square.

**FOR FURTHER INFORMATION CONTACT
WA4VWV, STEVE SMITH
5258 SEATON DR., DUNWOODY, GA.**

ALL SOLID-STATE SSB TRANSCEIVER —



\$195.00 . .

- Complete single-band SSB transceiver 4 to 5 watts PEP output 15, 20, 40, or 75 mtrs.
- VXO tuning up to 100 KHz or 2 fixed freq.
- Suitable for dry battery operation.
- Light weight, small size makes excellent portable - boat, aircraft, field or mobile.
- Contains 15 transistors, 1 MOSFET, 2 darling-ton amps., 1 I.C. and 17 diodes. Four-pole filter.
- Some options available to customer requirements.
- Furnished with spare switching and final amp. transistors, dummy load and extra plug.

JUSTIN, INC.
2663 NORTH LEE AVENUE
SOUTH EL MONTE, CALIF. 91733

2 METER FM



Standard's SR-C826M Transceiver

- 12 Channels (4 supplied)
- 10 watt power output
- Hot MOSFET receiver front end
- Low drain—all silicon semiconductors
- Full 6 month warranty

Complete, ready-to-go! Connect power and antenna and you're on the air! **Only \$339.95**

NEW! 25W. 851SH . . . only **\$449.95**
 3W./6 channel 811SH **199.95**

Send QSL or circle number for detailed brochure

ERICKSON COMMUNICATIONS

4657 North Ravenswood Avenue
 Chicago, Ill. 60640 (312) 334-3200
 a division of Carl E. Erickson Co.

WANTED! DRAKE T4X
REWARD: \$320.00
 trade allowance on new T4XB



• T-4XB TRANSMITTER •

Can be used with VFO of either R-1B or T-1XB for transceiving.

Mention this ad and we will pre-pay the freight to anywhere in the U.S.A.



L.A. Electronics Sales
 23044 S. CRENSHAW BLVD.
 TORRANCE, CALIFORNIA 90505



213-534-4456

USED TEST EQUIPMENT

All checked and operating unless otherwise noted, FOB Monroe. Money back (less shipping) if not satisfied.

Boonton 202D-175-250MHz sig gen	285
Boonton 207E-Univertor for sig gen	95
Fluke Monotronics 207-1 Precision VLF Receiver-Comparator transistorized	640
GR736 A-Wave analyzer	249
GR821A-Twin-T Imp. bridge	235
GR1603A-Z-Y bridge	176
Gertsch FM3/PS3 20-100MHz freq mtr	275
HP120AR-200kHz scope	135
HP175A-50MHz scope-main frame only	450
HP524B-10MHz freq counter	325
HP524B-W/plug-in to 100MHz	385
HP525A-10-100Mz plug-in for above	115
HP525B-100-220Mz plug-in for above	135
HP525C-100-500Mz plug-in for above	225
HP526B-Time interval plug-in for above	65
HP608A-10-500MHz stand sig gen	400
Meas 65B-75kHz-30MHz sig gen	265
Meas 82-20Hz-200kHz, 80kHz-50mMz stand sig gen	275
NE Eng 14-20C-10MHz freq counter (as is less time standard)	180
NE Eng 14-20C-complete, checked	295
NE Eng 14-20C-W/plug-in to 100MHz	355
NE Eng 14-21C-10-10MHz conv for abv	114
NE Eng 14-22C-100-220Mz for abv	135
NE Eng 14-24C-Time interval conv for abv	65
Tektronix 513D-20MHz scope	275
Tektronix 517A-Hi-speed scope	545
URM25E-10kHz-50MHz stand sig gen	215
USM24C-8MHz time base scope	125
USM50-22MHz time base scope	145
USM105A-Mil version HP160 scope w/dual trace plug-in	550

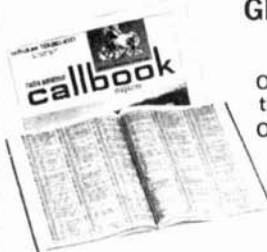
(Send SASE for complete list)

GRAY Electronics

P. O. Box 941 Monroe, MI 48161

Specializing in used test equipment

radio amateur callbook



GET YOUR NEW ISSUES NOW!

Over 285,000 QTHs in the U.S. edition **\$8.95**
 Over 165,000 QTHs in the DX edition **\$6.95**

NEW EDITION EVERY:
 MARCH 1 - SEPT. 1
 JUNE 1 - DEC. 1

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
- Prefixes by Countries!
- Zips on all QTH's!
- 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. E 925 Sherwood Drive
 Lake Bluff, Ill. 60044

KCOKC WILL BE HEARD on all bands for the period July 1st 1971 through July 5th 1971 GMT around the clock. KCOKC will be on 10, 15, and 20 meters beginning around 1300 GMT until late in the evening. Activity on 40 and 80 meters will probably begin around 2200 hours GMT until 1300 GMT the following day. However, activity will generally be on any band at any time that band is open. Activity is planned around the following frequencies: CW 3550, 7050, 14050, 21050, 28050; Phone 3880, 7205, 14205, 21280, 28600. For special QSL send SASE or 2IRCs to: KCOKC, P. O. Box 753, Shawnee Mission, Kansas 66201.

826 TUBES WANTED FOR CASH. Pay \$100. each for 445A WE Klystrons. C. Hutnan, 308 Hickory St., Arlington, N. J. 07032

THIRD ANNUAL HAM CAMPOREE — Florida Campgrounds, June 11-13. Contact WA4YNN or Brandon Amateur Radio Society, Box 828, Brandon, Florida 33511.

FOR SALE: 75S-1, 32S-1, 516F-2, \$700. MP-1, or 516E-1, \$100. 351D-2, \$100. 30L-1, \$350. 32S-3, 516F-2, \$650. P-150-DC (for SR150/SR160), \$50. Galaxy-300, PSA-300, \$185. Waters Nuverter, new, \$100. C. E. 100-V, manual, \$275. Waters Hybrid Coupler, model 3001, \$40. Motorola 80-D (low-band), with accessories, \$50. Capacitors, 2 ea 4 MFD/10KV, \$15 ea. Simpson #260 VTVM, factory-reconditioned, \$45. Telex headset, new, \$5. Filter F455Y-60 (for 75S-1/S-2/S-3), \$18. Messenger III, new, \$100. Transformers: 5VCT@30A, \$8; 6.3VCT@20A, \$7; UTC S-49, \$15; UTC S-57, \$4; UTC S-60, \$9; UTC S-63, \$7; Henry 2-K, \$500; 4-K, \$895. Collins 30S-1 (needs repairs), \$675. Antique HRO-5TA-1, 6 coils, \$100. Power supply 21VDC @ 12 amps, \$15. Collins 180T-2 Antenna Coupler (tune 31' whip 2-30 mhz with 1:1 SWR), \$225. SX-115, \$275. HT-32-B, \$275. BC-221, Lambda VR Supply, \$50. HW-32A, HP-23A, SB-600, \$150. 312B-5, cables, manual, \$275. 32V-2, \$145. 32V-3 (no cabinet), \$185. C. E. 20-A, BC-458 VFO, VOX, manual, \$100. Viking KW Match-Box, meter, \$135. Mobile Mount for SR-150, new, \$20. Heath KL-1 Chippewa Linear, with K5-1 supply, \$200. Swan SW-140, \$85. KWM-1, A. C., D. C., and Mobile Mount, \$325. Federal Receiver Model 123 (tunes 15-650 khz), \$50. James W. Craig, 29 Sherburne Avenue, Portsmouth, N. H. 03801. (603) 436-9062.

OLD TIME RADIO SHOWS. SASE. Box 724, Redmond, Washington 98052.

THE PENTICTON CIVIL DEFENSE Amateur Radio Club are pleased to announce their sponsorship of the annual International Okanagan Hamfest in co-operation with the clubs in Kelowna, Vernon and Kamloops. This centennial year, we plan to change the location to the Gallagher Lake Lodge and grounds of RR#2, Oliver, B.C. Dates July 24 and 25. Motels, trailer, tenting and camping space are all available, as well as shower, washroom, laundry, small lake and pool with crystal water. There will be a giant auction, transmitter hunt, contests and games for both young and old. Evening entertainment assured. A registration door prize value \$40-\$50 and big raffle prize value \$75-\$125. Admission for licensed OM's \$3.00, XYL's and YL's \$2.00, Family Ticket \$5.00. Registration begins 10:00 a.m. Saturday, July 24. For further information contact Denny Warner VE7ASY, Secretary, RR#4, Crawford Road, Kelowna, B.C., Canada.

FOR SALE: Drake 1-A, Heath HD-10 keyer, HG-10B VFO, HM-15 SWR bridge, Collins 353C-31 mechanical filter, plug-in adapter (3KHz BW), and never used 811-A with socket. No trades please. All other offers considered. R. O. Crosmer, 1241 1/2 Columbia, Orange, California 92668.

2m FM TRANSISTORIZED TRANSCIVER. Multi-channel 12 vdc/110 vac, 1-10W, \$170. D. Anderson, (213) 478-6738.

FOR SALE: Nixies, new, 0 to 9. B-5440, B-5991, \$5.00 each. H. P. 512A Freq. Converter 0-100 MHz; Hughes Memo-Scope 104; H. P. P.C. Mixers: Model 10534B 50K-150MHz; Philip Lupi, 1225 Hillside Place, North Bergen, N. J. 07047.

CINCY STAG HAMFEST: Attention hams: Mark this date, Sept. 26, for the 1971 Cincinnati 34th Annual STAG Hamfest, the one big STAG Amateur Radio event of the '71 year. Meet all of your friends here. More details later. W8DSR, Hamfest Secretary.

WIRED AND TESTED INTERDIGITAL PRE-AMPLIFIERS by CADCO

Factory wired and aligned 6, 2 and 1-1/4 meter state of the art ultra low noise Interdigital Pre-amplifiers and filters - as featured in February 1971 HAM RADIO!

INTERDIGITAL PRE-AMPLIFIERS

50 MHz Model IPA-50 \$29.00*
144 MHz Model IPA-144 \$29.00*
220 MHz Model IPA-220 \$29.00*

INTERDIGITAL BANDPASS FILTERS

50 MHz IS-BPF-50 \$19.00*
144 MHz Model IS-BPF-144 \$19.00*
220 MHz Model IS-BPF-220 \$19.00*

*Plus \$0.50 postage

Allow 3 weeks for receipt of order

BOB'S DISCOUNT ELECTRONICS

720 N Hudson, Oklahoma City, Okla. 73102

(405) 232-1384



CAMP ALBERT BUTLER INVITES HAM RADIO ENTHUSIASTS OF ALL AGES

TO TRY FOR YOUR

GENERAL CLASS TICKET

This Summer! Our 12th Season

STUDY INSTRUCTION
LEADING TO GENERAL ADVANCE
and AMATEUR EXTRA LICENSE

This co-ed Amateur Radio Camp, Y.M.C.A. owned and operated, can accommodate 60 campers. There is no age limit. We have had campers from 7 through 74 years of age. It is very helpful if you can copy 5wpm or have a Novice or Technician ticket but it is not necessary. Time is divided between radio classes in code and theory and usual camp activities, such as swimming, archery, riflery, hiking, etc. Golf privileges are included at the beautiful New River Country Club course.

Entire staff consists of licensed hams who are instructors in electrical engineering in some of our finest colleges and universities. Camp opens July 31st and closes August 14th. Tuition of \$200.00 includes all camp expenses: room, meals, notebooks, textbooks, and insurance. Send for our brochure.

C. L. Peters, K4DNJ

General Secretary

Gilvin Roth Y.M.C.A., Elkin, N. C. 28621

Please send me the Booklet and Application Blank for the Camp Albert Butler Radio Session.

NAME

CALL

ADDRESS

CITY STATE ZIP



**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 \$1.25

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 \$1.25

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 \$1.25

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 1/4" x 12" postpaid \$2.00

Complete reference library of maps — set of 4 as listed above postpaid \$3.50

See your favorite dealer or order direct.

WRITE FOR FREE BROCHURE! RADIO AMATEUR **callbook INC.**
Dept. E 925 Sherwood Drive
Lake Bluff, Ill. 60044

WORLD QSL BUREAU
THE ONLY QSL BUREAU to handle all of your QSLs to anywhere; next door, the next state, the next country, the whole world. Just bundle them up (please arrange alphabetically) and send them to us with payment of 4¢ each.
5200 Panama Ave., Richmond, CA USA 94804

ANNOUNCING A NEW DIGITAL KEYS
Featuring squeeze keying, dot-dash memories, transistor and relay output, variable pitch keying monitor with built in spkr, regulated power supply, 8 I.C., 5 transistors, 5 diodes, handsome cabinet and a warranty that is unequalled. Logic board and power supply monitor board can be purchased separately. Send for brochure.
BAKER & WINNAY
420 Maplewood Ave., Springfield, Pa. 19064

**SEE YOUR
DEALER FOR**



EQUIPMENT

NEW CATALOG AVAILABLE, WRITE:
AEROTRON, INC.
P.O. BOX 6527, RALEIGH, N.C. 27608

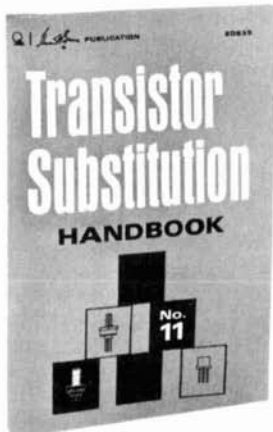
NEW!

1971 EDITIONS

Popular

HOWARD SAM'S

Handbooks



**TRANSISTOR SUBSTITUTION HANDBOOK
(11th Edition)**

by the Howard W. Sams Engineering Staff. This updated guide lists over 100,000 substitutions. Tells how and when to use substitute transistors. Also includes manufacturers recommendations for using popular replacement transistor lines. Computer-compiled for accuracy. 160 pages; 5 1/2 x 8 1/2; softbound.

\$2.25 Postpaid

**TUBE SUBSTITUTION HANDBOOK
(14th Edition)**

by Howard W. Sams Engineering Staff. The most complete, up-to-date DIRECT tube substitution guide available, including more than 12,00 substitutions for all types of receiving tubes and picture tubes. Instructions accompanying each section guide the reader in making proper tube substitutions and explain how to cross-reference between sections for other substitutes. 96 pages; 5 1/2 x 8 1/2; softbound.

\$1.75 Postpaid

Order these useful books today
from

book division



Box 592 • Amherst, New Hampshire 03031

SHACK CLEARANCE: Heath HW-20 Pawnee, 2 meter, excellent condx., \$90.00, Heath Tunnel Dipper, \$17.00, CV-253/ALR converter, 38-1000MHz; I.F. 30MHz, Vy gud \$40.00, Jennings UCSLPS-750, 750PF/5KV New, \$15.00, Jennings ECSC-30, 30PF/10KV New, \$10.00. Much more: RTTY, VHF, REPEATER GEAR, ETC. Send S.A.S.E. for list and photos. Gerry, K7UGD, 945 Cottage, Pocatello, Idaho 83201.

SWAN 500CX, 117XC, 14X, DC module, VX2 VOX. Excellent condx. \$495 firm. Bob Dufon, 4114 Northcote, East Chicago, Indiana 46312.

WANTED: CUSTOMERS: No experience necessary: Write or call "HOSS TRADER ED MOORY" for the best deal on new or used equipment: NEW EQUIPMENT: New ROHN 50 Ft. Foldover Tower Prepaid, \$219.00; Waters 334A Dummy Load/Wattmeter, \$135.00; Mosley A-203-C, 20 meter beam, \$112.00; Yaesu FVd400 VFO, \$79.00; GT-550, \$395.00; USED EQUIPMENT: Collins PM-2 AC, \$95.00; Drake TR-4, \$449.00; Drake RV-4 VFO, \$69.00; T4-XB, \$365.00; Ham M Rotor, \$85.00; Viking Valiant, \$135.00; R4-B, \$349.00; NCX-3, \$149.00; AUTHORIZED Dealer for all new Drake, Galaxy, National, Regency, Varitronics, Tri-Ex, Mosley, Hy-Gain, and many others: Moory Electronics Co., P.O. Box 506, Dewitt, Arkansas 72042. 501-946-2820.

OSCILLOSCOPE, 3", Military OS-34/USM-32. Compact modern styling. 4 MHz Vertical Bandwidth, 10-200,000 usec Sweep Time, Time Marker Generator and Voltage Calibrator are some of its features, \$95.00. Other scopes from \$45.00 to \$500.00. James R. Walter, 2697 Nickel, San Pablo, California 94806.

7289 (3CX100A5) ceramic replacement for 2C39A. Pullouts. Guaranteed. 3/\$10; 12/\$30, plus postage. Will trade for 2 mtr gear. W4SOD, Folly Beach, S. C. 29439.

SAROC 1972 — The Las Vegas FUN convention. January 6-9. Watch for further details. SAROC, Box 73, Boulder, Nevada.

CALIFORNIA VACATION, XYL and I want to trade houses, cars and ham rigs with ham near Boston or Washington for month of August. Write K6SN, 7551 Westlawn Ave., Los Angeles, Calif. 90045.

CALI VI PANAMERICAN GAMES Contest. Only Amateurs from the Pan-American countries. Contacts are valid on the 15, 20 and 40 meters bands. The objective will be to contact as many Pan-American stations as possible. Contacts with station HK5 CCP will give 20 points. Contacts with station HK5 VD will give 10 points. Contacts with HK5 stations will give 5 points. Contacts with other Panam-Stations will give 2 points. Contacts are valid with the same station on the three bands, but cross-band contacts or relays are not allowed. Single operator, single station, phone only. Start at 2400 GMT Friday, June 18, 1971 and it will end at 2400 GMT Sunday, June 20, 1971. Call and number exchange: The call will be "CQ Panamerican Games". The report will be a five digit number: signal report (RS) and a three digit numeral order: eg. 59018, 58132, etc. Logs: Separate sheets must be used for each band. The log must contain: date and GMT time, station worked, number given and received and the points credited. It must be specified if the station was AM or SSB. 20 points will be credited to the station that submits in his log the list of countries that will take part in the VI Panamerican Games and 10 more points to the station who fills in this information: geographic position of Cali, altitude above sea level, average temperature, population, date of foundation and the name of the founder. Logs must be mailed before August 31, 1971 to: Cali Concurso Panamericano (HK5 CCP), P. O. Box 6149, Cali, Colombia, Sur America.

QSO's EN ESPANOL and auf Deutsch on tapes and cassettes. 1 1/2 hour Spanish course \$11.95, 1 1/2 hour German course \$13.95. Manuals only, \$2.50 each. FOREIGN LANGUAGE QSO's, Box 53, Acton, Mass. 01720.

YOUR AD belongs here too. Commercial ads 25¢ per word. Non-commercial ads 10¢ per word. Commercial advertisers write for special discounts. For standing ads not changed each month.

TYMETER  **9:37**

CALL-IDENT

10-MINUTE STATION CALL REMINDER

24 HOUR CLOCK

#124
23⁵⁰



10-minute repeating timer buzzes warning to sign in your call letters. Walnut or ebony plastic case. 4" H, 7 3/4" W, 4" D. 110V, 60 cy. One Year Guarantee. Made in U.S.A.

At Your Dealer, or DIRECT FROM

PENWOOD NUMECHRON CO.

TYMETER ELECTRONICS

7249 FRANKSTOWN AVE

PITTSBURGH, PA 15208

LAST CALL!
AT THESE PRICES

Until June 15 Only

\$87.00	\$50.00
Two Element Quad	Extra Element
After June 15, 1971	
\$107.00	\$60.00
Two Element Quad	Extra Element

GEM-QUAD FIBRE — GLASS

ANTENNA FOR 10, 15, and 20 METERS.



Submit Payment with Order
Shipped Freight collect.

Price includes
Canadian Federal Sales Tax
or U.S. Customs Duty.

- KIT COMPLETE WITH**
- SPIDER
 - ARMS
 - WIRE
 - BALUN KIT
 - BOOM WHERE NEEDED

SEE OUR FULL PAGE IN MAY ISSUE

Buy two elements now — a third and fourth may be added later with little effort.

Enjoy optimum forward gain on DX, with a maximum back to front ratio and excellent side discrimination.

Get a maximum structural strength with low weight, using our "Tridetic" arms.



MANITOBA DESIGN INSTITUTE
AWARD WINNER

Structural Glass
LIMITED

Canadian Patent No. 794506
U.S. Patent No. 3532315

20 Burnett Avenue, Winnipeg 16, Manitoba, Canada

INSTANT CIRCUIT BOARDS!

NO ETCH • NO MESS • NO FUSS
INSTANT CIRCUIT BOARDS is a complete new system of component sub-elements and materials designed to work together to produce durable circuit boards. **CIRCUIT-STIK** eliminates all drilling, photo work, and etching. Just stick the pressure sensitive sub-elements down on pattern P Vectorboard. They stick down firmly, withstand soldering temperatures, yet can be picked up and moved for circuit changes. In fact, they make building pro-

jects with integrated circuits and transistors a real breeze. Sub-elements are available for 8, 10, an 12-lead IC's all transistors, dual in-line IC's, plus copper tape to complete the wiring. Other special sub-elements are also available. Three different assortments are available. The more expensive assortments contain more sub-elements of a type and a larger piece of board.

Assortment CS-20 \$5.50
 CS-30 \$7.95, CS-40 \$9.95

CONNECTICUT HAMS

Visit Roger Miner's Surplus Electronics, 246 Naugatuck Ave., Milford, Conn. Ph. 877-0555. Nights 7 pm to 10 pm and all day Saturday.

For Sale: Johnson Invader 2000 - \$500.00, Heath SB-200 - \$165, NCX-3 - \$175 w/ps, DX-20 - \$20.00, Super-Pro - \$100.00, Swan 250c w/ps - \$385.00, Collins 75S1 w/nbr - \$300.00, HEWLETT-PACKARD 202c audio osc. - \$30.00, 205ah audio osc. - \$40.00, 450a wide band amp. - \$20.00, 460b wb amp. \$25.00, 521 freq. counter - \$150.00, 522b counter - \$180., 415b swr meter - \$40. Thousands of parts. High power amp. parts, power supplies, etc., come see us.

The Roger S. Miner

SURPLUS ELECTRONICS COMPANY

246 NAUGATUCK AVENUE • MILFORD, CONNECTICUT 06460

DELUXE SPACE/ONE RTTY DEMODULATOR

Completely Solid State featuring the latest integrated circuitry — Choice of three shifts 850-170-425 — Choice of AM or FM operation limiter or limiterless — Sharp but-terworth bandpass input filters — Auto start — Anti space — Regulated power supply — Modern desk type gray hammertone cabinet 11 1/2 x 8 x 7 — Many extra features and controls — 90 day warranty.

SPECIAL INTRODUCTORY PRICE \$250.00 FOB

OPTIONAL EXTRA: J & J'S LOW DISTORTION HIGH OUTPUT AFSK GENERATOR AT AN ADDITIONAL COST OF \$75.00.



J & J ELECTRONICS
 CANTERBURY, CONN.

WE PAY **HIGHEST**
 PRICES FOR ELECTRON
 TUBES AND SEMICONDUCTORS

H & L ASSOCIATES

ELIZABETHPORT INDUSTRIAL PARK
 ELIZABETH, NEW JERSEY 07206

(201) 351-4200



ELECTRONIC FIRST ... THE PROFESSIONAL KEYSER

Check the Reviews

- QST, March 1971
- POP. ELECT., July 1970
- CQ, January 1971
- 73, January 1971
- Ham Radio, August 1970, December 1970, March 1971
- IC MEMORY FOR EK-39M now only \$39.95!!

CURTIS ELECTRO DEVICES

From your ham dealer or direct.
 Box 4090, Mountain View, California - 94040

A HANDSOME PAIR MATCHING BOUND VOLUMES and BINDERS

Binders \$3.95
 1969 & 1970 Bound Volumes each \$14.95

Order from
HAM RADIO MAGAZINE
 GREENVILLE, N. H. 03048

Semiconductor Supermart

• HEP • FAIRCHILD • RCA • MOTOROLA • NATIONAL

MOTOROLA HEP SEMICONDUCTORS

NEW FUNCTIONAL ICs

C6004 1-W Audio Power Amp	\$2.60
C6005 2-W Audio Power Amp	\$4.35
C6006 4-W Audio Power Amp	\$5.60
C6010 W'band Amp-RF-IF-Audio	\$1.59
C6001 FM IF Diff. Amp	\$2.09

JUNCTION FETS

HEP-802 N-channel RF	\$1.59
HEP-801 N-channel Audio	\$1.59

DUAL-GATE FETS

F2004 VHF RF Amp-Mixer	\$2.50
F2007 VHF RF Amp-Mixer; Diode Protected LOW- NOISE 2.6 dB at 200 MHz	\$1.65

HEK-3 RADIO AMATEUR KIT

Contains (2) HEP-590, (1) HEP-570 plus book w/10 Ham Projects. \$5.95

HEK-2 FET EXPERIMENTERS KIT

Contains HEP-801, HEP-802, HEP-50, HEP-51 and Instructions for 9 Projects. \$3.95

RF POWER FOR THAT FM XMITTER

HEP-75 P out 1 W	\$2.95
S3001 P out 5 W	\$3.75
S3005 P out 3 W	\$9.55
S3006 P out 10 W	\$19.90
S3007 P out 25 W	\$24.95
S3008 P out 1.5 W	\$2.18

POPULAR IC's

MC1550G	\$1.80
CA3028A	\$1.77
CA3020	\$3.07
CA3020A	\$3.92
MC1306P 1/4 W hi-gain audio power Amplifier	\$1.10
MC1350P IF amp, hi-gain 50 dB power gain at 60 MHz more at lower freq.	\$1.15
MC1351P FM IF amp quadrature detector	\$1.70
μ A703 RF amp	\$2.00
μ A723 Voltage regulator	\$2.50
MC1496 μ A796 Doubly balanced mod /demod	\$3.50

MOST MOTOROLA, RCA, & FAIRCHILD LINEAR IC's AVAILABLE... WRITE US WITH YOUR NEEDS.

TRANSISTORS

MPF102	\$.75
MPF105/2N5459	\$.96
MPF107/2N5486	\$1.26
MPF121	\$.85
3N140	\$1.95
3N141	\$1.86

MFE 3007 (replaces most dual gate FETs) \$1.98

MOST 2N, MPS AND OTHER MOTOROLA AND FAIRCHILD TRANSISTORS AND FETS AVAILABLE.

TOROID CORES

T 68-2 3 cores	\$1.00
T 50-10 3 cores	\$1.00
T 200-2	\$2.00
KW Balun kit includes core and wire	only \$3.50

Please include 25¢ for shipping
All orders shipped Air Mail

CIRCUIT SPECIALISTS CO.

Box 3047, Scottsdale, AZ 85257
FACTORY AUTHORIZED
HEP-CIRCUIT-STIK
DISTRIBUTOR

ANTENNA BOOKS

73 VERTICAL, BEAM AND TRIANGLE ANTENNAS

by Ed. Noll W3FQJ

$\lambda/4$ Verticals and Ground Systems

- 10-15-20 Vertical
- Base Loaded Vertical
- Phased Verticals
- Four Square Vertical
- Low Band Triangles
- High Band Triangles
- Triangle and Parasitics
- Turnstile Triangle
- Two-Element Antennas
- Yagi's
- Quads
- Horizontal Phased Arrays
- End-Fire Beams
- Broadside Arrays
- Tuners

PRICE \$4.95 (\$5.95 Foreign) 160 Pages

73 DIPOLE AND LONG-WIRE ANTENNAS

by Ed. Noll W3FQJ

- Basic Dipoles
- Novice Multi-Band Dipoles
- 20-40-80 Maypole
- Inverted Dipoles
- 3/2 Wavelength Antenna
- Inverted-Vee Long-Wires
- 10-15-20-40 Long-Wire Special
- Long Vee-Beam Antennas
- Inverted-Vee Trios
- Tilted Long Wires
- Rhombics
- 10-15-20 Rhombic
- End-Tuned Rhombic
- End-Fed Long Wire
- Line and Antenna Tuners
- Sloping Vee Beam

PRICE \$4.50 (\$5.40 Foreign) 160 Pages

TRIANGLE ANTENNAS
BOX 276 • WARRINGTON, PA. 18976

BRAND-NEW SOLID-STATE SCOPE BARGAINS:

We are now the Distributor for Leader Instr. Corp. **QUALITY-CONTROLLED** imports. Warranty is 2 years on parts, 6 mos. on labor. We pay shipping to your door at advertised prices! Here they are:

- LBO-301: 3" Portable, triggered, with both vertical & horiz. accurately calibrated. DC-7 MHz pass. 3 1/2 mv rms sensit. Swp 0.2 usec & up. 5"x8"x12", 14 lbs. 334.50
 LBO-501: 5", triggered, both vert. & horiz. accurately calib. DC-10 MHz. 7 mv rms sensit. Swps 0.2 usec & up. 11"x8"x17", 20 lbs. 339.50
 LBO-53B: 5" Vectorscope, DC-10 MHz. Hybrid solid-state & tubes. FET's eliminate display bounce from line transients. Clear Vector Pattern display. 11"x8"x17", 30 lbs. 229.00
 10X Probes for above: LPB-10X, each 15.90

SCOPES & COUNTERS AT LOWEST PRICES EVER!

All scopes checked for sweep, defl., good CR tube. OHC (Overhauled, Calif.) can be added at cost, grtd not to exceed \$75.00 per item. Some already OHC'd. Will send detailed specs on anything you ask about.

TEKTRONIX OSCILLOSCOPE BARGAINS:

- 503: 450 KHz pass X-Y Scope 395.00
 519: DC-1000 MHz real time, OHC'd 2750.00
 535: Blue, round-corner DC-11 MHz. .02 usec/cm & up. Calibrated Variable Delay. Already overhauled & certified 495.00
 535A: Later model, DC to 15 MHz, already overhauled and calibrated. 595.00
 541A: DC to 30 MHz, 20 nsec/div. and up 550.00
 545A: Same plus calib. variable delay 750.00
 RM45A: Same, for rack mounting 700.00
 RM545B: Rack-mtg 33 MHz pass, w/cabinet 875.00
 545B: Cabinet model 925.00
 564: Storage, with 3B3 and 2-trace 3A1, already OHC'd 1650.00
 570: Tube curve tracer 275.00
 575: Transistor curve tracer 675.00
 661: With 451 & 5T1A, 2-trace self-triggering sampling scope, DC-1000 MHz 850.00
 PLUGINS: 1A2: 2-trace 33 MHz, \$225. 3576: 2-trace sampler, \$275. B: 5 mv 12 MHz, \$40. CA: 2-trace 24 MHz, \$125. CA already OHC'd, \$150. 53/54D: 1 mv/cm, \$35. 53/54G: 20 MHz differential, \$50. G: \$60. L: 5 mv, 30 MHz, \$75. S: Diode recovery, \$175. 80,P80,5 atten., \$50. 82: \$350.

HEWLETT-PACKARD SCOPE BARGAINS:

- 140A: With 1405A 2-trace 5 MHz & 1422A sweeper plugins & 2 probes. 600.00
 With 1402A 2-trace 20 MHz & 1420A sweeper, no probes 750.00

OVERHAUL & CERTIFIED COUNTERS

- Solid-State 220 MHz: CMC 737CU, 7 nixies, plus 525A & B. Light & compact. 750.00
 510 MHz: Substitute 525C for 525B, add 100.00
 10 Hz-15 GHz: Read freq. on 7 DCU's, no algebra! Beckman 7370/7580 combo. 950.00

AND PLENTY MORE! Ask for List #11a.

R. E. GOODHEART CO. INC.

Box 1220-HR, Beverly Hills, Calif. 90213
 Phone: Area Code 213, Office 272-5707

TELEGRAPHERS WANTED - For membership in Morse Telegraph Club, Inc.

Non-profit - Historical Fraternal

Dues \$2 per annum

Write: S. L. McLean, GS&T
 5125 Arvada Street
 Torrance, Ca 90503



KW BALUN KIT STILL ONLY \$5!

The AMIDON Toroid Balun Kit makes a modern, compact antenna transformer that can be wired for either 4:1 or 1:1 impedance ratio. The balun is ideal for use between a coaxial feedline and a balanced antenna. It reduces coax radiation and properly balances the energy for application to the antenna's feedpoint. The balun also acts as an isolation device and removes the capacity of the coax from the antenna which extends the low SWR frequency range of the array. Baluns made from this kit can be used to advantage on these antenna types: Dipole, Quad, Beam, Inverted Vee, Windom and Folded Dipole.

SEND FOR
 FREE FLYER!

AMIDON
 Associates



Pack & Post: 50¢

12033 OTSEGO STREET - NORTH HOLLYWOOD, CALIF. 91607

WE PAY CASH FOR TUBES

Lewispaul Electronics, Inc.
 303 West Crescent Avenue
 Allendale, New Jersey 07401



**MONARCH
 SWR AND
 POWER
 METER**

Reads output and reflected power simultaneously. May be left in line up to 2000 watts. Low insertion loss. Size 5x2x2. Good to 175 MHz.
PRICE \$14.95 Insured Postage & Handling \$1.50

MADISON ELECTRONICS SUPPLY

1508 MCKINNEY — HOUSTON, TEXAS 77002
 (713) 224-2668

ROTARY QSL FILE MODEL CB-8-H



Displays and protects QSL's in clear plastic pockets (3 1/2 x 5 1/2) included for 160 cards, holds up to 500 cards. Refills available. Rotates on base and a turn of knob brings new cards into view. Cards held securely without glue or mounting.

PRICE: \$9.00 ppd. U.S.A.
 Illinois residents add 5% Sales Tax

M-B PRODUCTS & SALES

1917 N. Lowell Ave., Chicago, Ill. 60639



NEW! REPEATER IDENTIFIER!

- The black box you've been asking for...
- YOUR MCW OR CW ID EVERY 3 MINUTES
- ALL SOLID STATE, -12 TO -28VDC
- 100VA CARRIER RELAY, AUDIBLE MONITOR
- MEETS FCC REQUIREMENTS, -40 TO +140°F

Complete, programmed (DE YOUR CALL), \$129.95 plus shipping (4 pounds)
 (Box 4090, Mountain View, California - 94040)

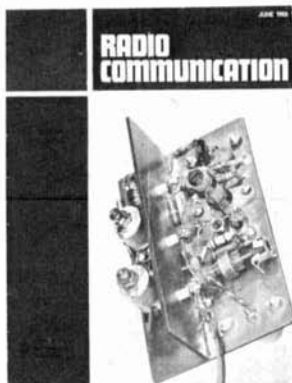
GURTS ELECTRO DEVICES

160 METER ANTENNA



MODEL 48MV MATCHBOXER WILL RESONATE ANY 40 OR 80 METER DIPOLE/INVERTED VEE ON 160 METERS **\$39.95** Ppd
 • Handles 250W PEP (140W DC)
 • Use coax or open feedline
 • Use with any SWR bridge
 • Made in USA—Guaranteed

TOP BAND SYSTEMS
 5349 Abbeyfield, Dept. 3, Long Beach, Calif. 90815



Many thousands of you have become very familiar with the various Radio Society of Great Britain books and handbooks, but very few of you are familiar with their excellent magazine, **Radio Communication**.

This is the oldest and most widely read British amateur radio magazine. Published monthly it provides complete coverage including such popular features as: Technical Topics, a monthly survey of the latest ideas and circuits, Four Meters and Down, a rundown of the latest in VHF and UHF and much more.

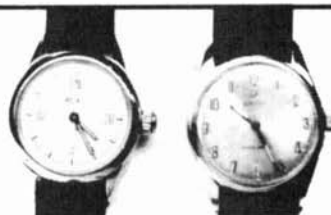
It includes numerous technical and construction articles in addition to a complete rundown on the month's events in amateur radio. Surely a most interesting addition to your amateur radio activities.

We can now offer this fine magazine to you along with the other advantages of membership in the RSGB (such as use of their outgoing QSL Bureau) for \$9.60 a year.

book division

comtec

Box 592 • Amherst, New Hampshire 03031



Genuine RCAF Watches
Gov't issue, used, guaranteed OK \$20. ea.
OMEGA models, only \$25.



Projection type decimal counting units 0-9 digits. From used eqpmt. \$6 ea

SOLID STATE LAMP DRIVER completely wired with plug for use with above DCU or any similar DCU. A \$50.00 value for only \$3.50



Wired memory from UNIVAC computer 2640 byte on plug-in board. Exlnt cond. \$10

DIP PACKAGE IC brand new 35¢ ea. or \$3.50/12. 7400-7401-7402-7410-7420-7430-7440-7451-7453-7454-7460 The following



are \$2.50 ea.

7441	— 2.00	7490	— 2.50
7447	— 1.00	7493	— 2.50
7475	— 2.50	74121	— 1.50

NIXIE — RAYTHEON CK 8754 5.00

FIBRE OPTICS the most comprehensive list of FO material available.. face plates, jewelry, light pipes, coherent peepscope, light sources, magnifiers, circle to line converter, lamp kits. • Send for special listing.

METAL LOCATORS, become a millionaire, find jewelry, gold, silver, lost treasures. • Send for special sheet.

Send **25¢** for Surplus Catalog..

JOHN MESHNA JR. ELECTRONICS
P.O. Box 62 E. Lynn, Mass 01904



FIRE & BURGLAR ALARMS

1971 Handbook & Catalog

Save
Hundreds
of
Dollars

Professional equipment from famous manufacturers. Easy step by step illustrated instructions, no special tools required. Save up to 75%. This handbook is a must for every homeowner and businessman. Just \$1 cash, check or M.O.

Write WJFT

ALARM COMPONENT DISTRIBUTORS

33 NEW HAVEN AVE., DEPT. HR
MILFORD, CONN. 06460

Advertisers check-off

... for literature, in a hurry — we'll rush your name to the companies whose names you "check-off"

INDEX

- | | |
|------------------------|-------------------------|
| —Aerotron | —Madison |
| —Alarm | —Meshna |
| —Alpha | —Micro-Z |
| —Amidon | —Miner |
| —Atlanta | —Morse Telegraphers |
| —Baker & Winnay | —Mosley |
| —Barry | —National Semiconductor |
| —Bob's | —Newtronics |
| —Blulyne | —Palomar |
| —Camp Butler | —Pearce-Simpson |
| —Circuit Specialists | —Pennwood |
| —Communications World | —R & R |
| —Comtec | —R-P |
| —Curtis | —Radiation |
| —Dycomm | —Callbook |
| —Ehrhorn | —Radio Constructor |
| —Eimac | —SCF |
| —Erikson | —Sentry |
| —Fair | —Spectronics |
| —Goodheart | —Spectrum |
| —Gray | —Structural Glass |
| —H & L | —Swan |
| —HAL | —Top Band |
| —Henry | —Tri-Ex |
| —International Crystal | —Triangle |
| —J-J | —Triplett |
| —Jan | —Vanguard |
| —Justin | —Weinschenker |
| —L A | —World QSL |
| —Lewispaul | |
| —M B | |

June 1971

Please use before July 31, 1971

Tear off and mail to
HAM RADIO MAGAZINE — "check-off"
 Greenville, N. H. 03048

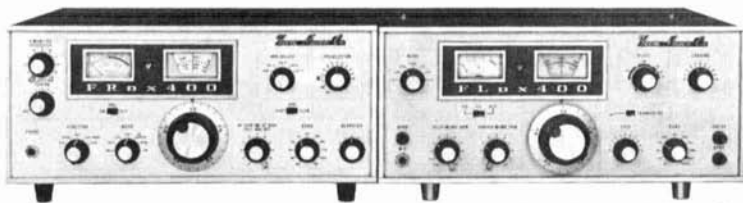
NAME.....
 CALL.....
 STREET.....
 CITY.....
 STATE..... ZIP.....

Advertisers iNdex

Aerotron, Inc.	88
Alarm Component Distributors	93
Amidon Associates	92
Atlanta Hamfest	88
Baker & Winnay	88
Barry Electronics	69
Bob's Discount Electronics	87
Blulyne Electronics Corp.	84
Camp Albert Butler	87
Circuit Specialists Co.	90, 91
Communications World, Inc.	78
Comtec Books	88, 93
Curtis Electro Devices	90, 92
Dynamic Communications, Inc.	48, 49
Ehrhorn Technological Operations	Cover II
Eimac Division of Varian	Cover IV
Erikson Communications	86
Fair Radio Sales	82
G & G Radio Electronics Co.	65
Goodheart Co., Inc., R. E.	92
Gray Electronics	86
H & L Associates	90
HAL Devices	55, 82
Henry Radio	2
International Crystal Manufacturing Co.	39
J-J Electronics	90
Jan Crystals	82
Justin, Inc.	85
LA Electronix Sales	84, 86
Lewispaul Electronics	92
MB Products and Sales	92
Madison Electronics Supply	92
Meshna, John, Jr.	93
Micro-Z Co.	82
Roger S. Miner	90
Morse Telegraphers	92
Newtronics Corp.	5
Palomar Engineers	84
Pennwood Numechron Co.	89
R & R Electronics	77, 79
R P Electronics	78
Radio Amateur Callbook, Inc.	82, 86, 88
Radio Constructor	72
SCF Corporation	81
Sentry Manufacturing Co.	1
Spectronics	95, 96, Cover III
Spectrum International	73
Structural Glass, Ltd.	89
Swan Electronics	27, 74, 75
Top Band Systems	92
Tri-Ex Tower Corp.	81
Triangle Antennas	91
Vanguard Labs	84
Weinschenker, M.	76
World QSL Bureau	88

Now you don't have to pay twice the price to get twice the rig.

Picture this pair in your shack. The Yaesu FLdx 400 transmitter and the FRdx 400 receiver. Loaded with power. Loaded with sensitivity. Loaded with features. Loaded with value. Read on, and discover how you can have the most up-to-date receiver-transmitter rig in the world... and at an unbelievably low price.



The FRdx 400 Receiver

Get a big ear on the world with complete amateur band coverage from 160 meters through 2 meters, including WWV and CB reception. Four mechanical filters do it—they provide CW, SSB, AM and FM selectivity. Separate AM-SSB-FM detectors are included, along with squelch and transmit monitor controls. Plus a noise limiter and a variable delay AGC. And a built-in notch filter with front panel adjust for notch depth.

The FRdx includes calibration markers at 100 KHz and 25 KHz, with accurate calibrator checks verified by WWV. A solid-state FET VFO for unshakable stability. And a direct-reading 1 KHz dial affords frequency read-out to less than 200 Hertz.

The FRdx 400 sells for \$359.95.

The FLdx 400 Transmitter

Here's how to set yourself up with dual receive, transceive or split VFO operation. The FLdx 400 with its companion receiver brings you the ultimate in operational flexibility. Flexibility like frequency spotting, VOX, break-in CW, SSB, AM and even an optional FSK circuit.

The completely self-contained FLdx 400 features a built-in power supply, fully adjustable VOX, a mechanical SSB filter, metered ALC, IC and PO. A completely solid-state FET VFO provides rock-solid frequency stability.

We rate the FLdx 400 very conservatively. That rating guarantees you 240 W PEP input SSB, 120 W CW and 75 W AM. The FSK option will go all day at a continuous 75 W. And you get full frequency coverage on all amateur bands—80 meters through 10

meters—with an optional provision for certain other bands that you can personally specify. For all that, you pay just \$299.95.



FL2000 B Linear Amplifier.

Ideal companion to the Series 400, this hand-crafted linear is another example of Yaesu's unbeatable combination of high quality and low cost. Designed to operate at 1500 watts PEP SSB and 1000 watts CW, this unit provides superb regulation—achieved by a filter system with 28 UF effective capacity.

Other features include dual cooling fans (one for each tube), individual tuned input coils on each band for maximum efficiency and low distortion, and a final amplifier of the grounded grid type using two rugged carbon-plate 572 B tubes. Ready to operate at only \$299.95.

SPECTRONICS WEST

Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST

Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

Please send new color catalog of all Yaesu products.

Enclosed find \$ _____

Please send model(s) _____

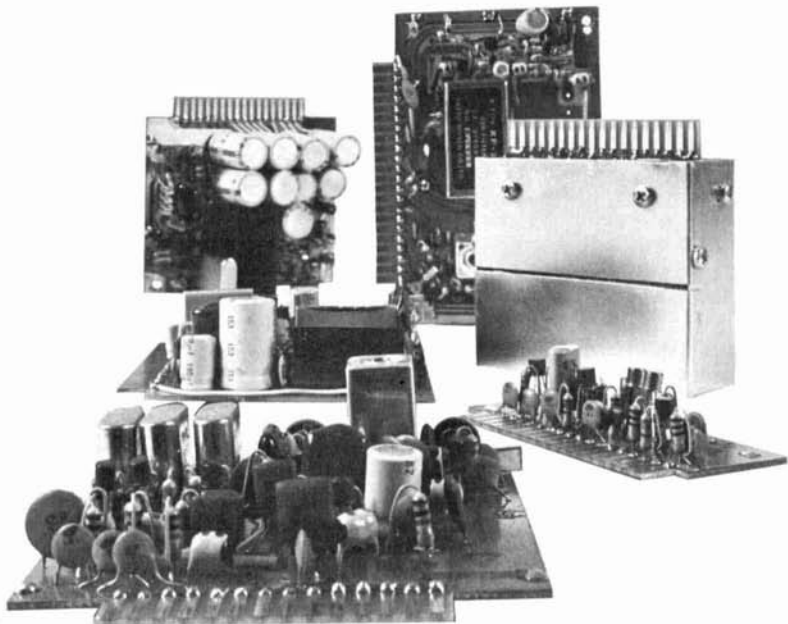
Name _____

Address _____

City _____ State _____ Zip _____

All prices F.O.B. Signal Hill, Ca.

Here's just half a dozen reasons why the Yaesu FT-101 is the world's best portable rig.

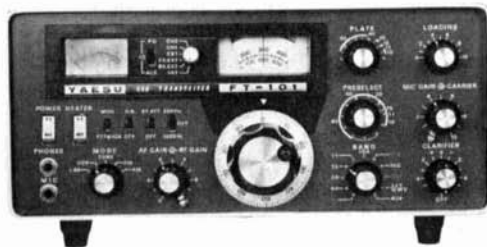


Those six computer-type plug-in modules hold most of the FT-101's 10 FET's, 3 IC's, 31 silicon transistors and 38 silicon diodes. Being solid-state, they're built to give you years of superior performance. But if any one of them ever gives you trouble, you simply mail it back to us for a factory-new replacement module.

Not that you should expect trouble. What you should expect — and what you get — is the most

The FT-101 is a thirty-pound package of DX punch, air-ready when you are, wherever you are. Just add an antenna, feed it 12 or 117 volts, and you're ready to work the world.

So sure are we of the 101's solid-state reliability, we guarantee it for one year from date of purchase. And we guarantee you that it will be a very good year... the first of many to come. The FT-101 — only \$499.95.



sensational portable rig ever offered to the American amateur. With features like these: a built-in VOX, 25 KHz and 100 KHz calibrators, the WWV 10 MHz band, a high Q permeability tuned RF stage and a 5 KHz clarifier. And 260 W PEP, 180 W CW and 80 W AM. With 0.3 microvolts receiving sensitivity — for a 10 db signal-to-noise ratio.

Not to mention a built-in 12 VDC and 117 VAC power supply. Plus an in-motion necessity — a noise blanker that picks out noise spikes, leaving only clean noise-free signal copy behind.

SPECTRONICS WEST

Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST

Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

Please send new color catalog of all Yaesu products.

Enclosed find \$ _____

Please send model(s) _____

Name _____

Address _____

City _____ State _____ Zip _____

All prices F.O.B. Signal Hill, Ca.

The Yaesu FTdx 560 is a great rig, but it's no bargain.

At \$450, it's a steal.

Considering all the FTdx 560 offers, you might think its \$450 price tag was for a kit. But it isn't.

You get a powerful, air-ready station. A handsome, completely hand-crafted transceiver that's fully guaranteed for one year.

You'll have maximum input of 560 watts PEP in the SSB mode or 500 watts CW. And except for speaker, mike and antenna, you'll have nothing else to buy. Power supply, WWV, calibrators, VOX, warranty and all the other items you usually have to pay extra for are included.

One more point: About 90% of the amateur stations in the Orient are Yaesu; in Europe, it runs about 80%. They're good. It is quite likely Yaesu is the best transceiver made anywhere in the world.

Send for our free information packet that tells the Yaesu story and gives you facts, specifications and schematics for the FTdx 560. The radio you can steal.



SPECTRONICS WEST

Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST

Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

Please send new color catalog of all Yaesu products.

Enclosed find \$_____

Please send model(s) _____

Name _____

Address _____

City _____ State _____ Zip _____

All prices F.O.B. Signal Hill, Ca.

EIMAC's new 8877 high-mu triode delivers over 1500 watts output at 220 MHz. (2000 watts output at 30 MHz is easy)

On your right is the new, rugged, ceramic/metal 8877 high-mu power triode by EIMAC. Another state-of-the-art tube. Only three and one-half inches high, this low-profile, heavy-duty tube has a plate dissipation rating of 1500 watts, a maximum plate voltage rating of 4000 and a maximum plate current rating of one ampere. In the HF region, typically, the 8877 coasts along at a continuous duty level of 3500 watts PEP input. A peak drive signal of only 65 watts is required. This impressive power gain is achieved with 3rd order intermodulation distortion products — 38 decibels below one tone of a two equal-tone drive signal.

This magnificent power triode is rated at full input to 250 MHz. The low impedance grid structure is terminated in a contact ring about the base of the tube, permitting very effective intrastage isolation to be achieved up to the outer frequency limit of operation. The close tolerance grid, moreover, is composed of aligned, rectangular bars to achieve maximum grid dissipation and controlled transconductance. This aligned grid, plus the

EIMAC segmented, self-focusing cathode provide low grid interception and the low grid drive requirement; both of paramount importance in the VHF region. Although primarily designed for superlative linear amplifier service demanding low intermodulation distortion, the 8877's high efficiency permits effective operation as a class C power amplifier or oscillator, or as a plate modulated amplifier. The zero bias characteristic is useful for these services, as plate dissipation is held to a safe level if drive power fails, up to an anode potential of 3 kV.

The sophisticated circuit connoisseur will appreciate the many advantages of this newly developed power tube. Write for detailed information. And remember — the 8877 is another example of EIMAC's ability to provide tomorrow's power tube today.

For additional information on this or other products, contact EIMAC, 301 Industrial Way, San Carlos, California 94070. Phone (415) 592-1221 (or call the nearest Varian/EIMAC Electron Tube and Device Group Sales Office.)

