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ham radio

magazine

APRIL 1969

**transmitting
mixers** for
**six
and
two
meters**



**7
mhz**

page 8

this month

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- clippers and compressors 24
- high-frequency antennas 28
- slow-scan television 38

there's a reason for the S/Line's reputation

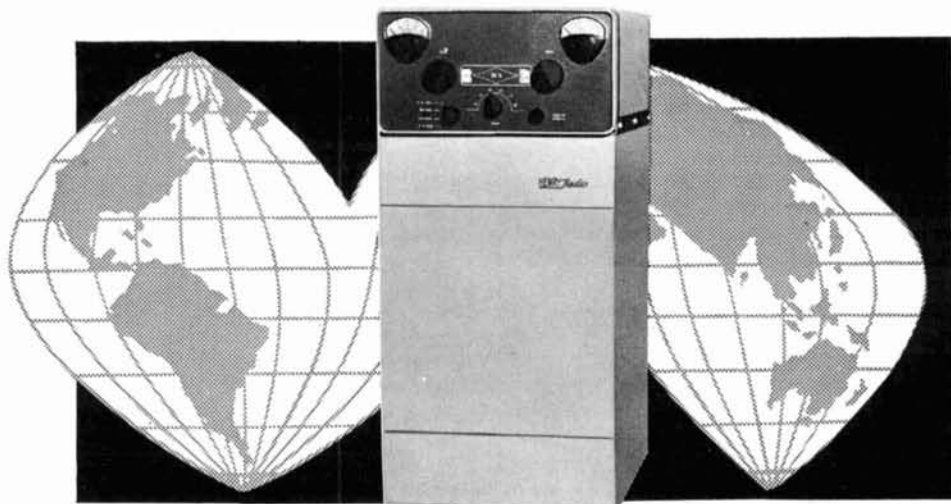
The main reason is performance. Amateurs around the world praise the S/Line's clean, strong signal. But there are design reasons, too. The S/Line is an engineered system. Each unit augments the others to provide single sideband operation at its best.

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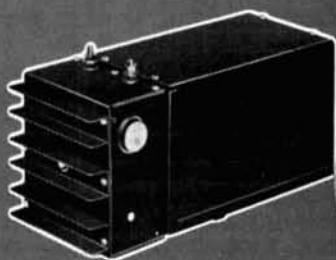
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WHO OWNS ONE**



april 1969

volume 2, number 4

staff

editor

James R. Fisk, W1DTY

roving editor

Forest H. Belt

vhf editor

Nicholas D. Skeer, K1PSR

associate editors

A. Norman Into, Jr., W1CCZ

Alfred Wilson, W6NIF

James A. Harvey, WA6IAK

art director

Jean Frey

publisher

T. H. Tenney, Jr. W1NLB

offices

Greenville, New Hampshire
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Telephone: 603-878-1441

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a second look

How often do we hear that ham radio is becoming an old man's hobby? We aren't attracting youngsters into our ranks at the rate that we should; the total count in most lower license categories is actually dropping. We need young people in amateur radio for many different reasons. Their enthusiasm and inquisitiveness have been responsible for much in the past and activities which tend to fall to our younger colleagues have been very important in continuing government support. Our hobby is well known as a technical training ground and obviously the younger people gain the most. If amateur training can start future engineers and technicians on their way, we are all gainers. In times of emergency the backlog of technically trained radio operators has always been an important national asset, but if this pool is all over 40 it is of far less value.

We need people who are willing to move quickly into new ground. Recent years have seen things such as the OSCAR program, Project Moonray and moonbounce. Who knows where we may head next? We'll need to be fast and adaptable, however, if we're to hold our vhf and uhf allocations against the communications technology of the 70's and 80's; and we had better have the manpower to do it!

But I think there is something of even greater importance here: youth has that wonderful energy which can accomplish so much when properly directed. We can always use this boost. New questioning of old ideas? It won't hurt us. The worthwhile traditions will survive while the outmoded will be replaced with more timely approaches. Remember that our hobby was started by young men who were willing to try something new.

Many factors have slowed the influx of newcomers to our ranks. The ease of getting on the air via CB has taken recruits; our recent political dissensions have surely cost us

members. However I expect that we have been the biggest problem ourselves. I have been dumbfounded to meet would-be hams who have been unable to find any local help in obtaining a ticket and getting on the air. Some have actually been turned away by local hams and clubs. Unbelievable, but unfortunately, true.

What can we do? Lead the way. Invite those young neighbors over and show them what it's all about; explain your equipment; let them have a shot at the mike. Let them know that the welcome mat is always out and that they are really wanted in amateur radio. If you have a local club, talk up a recruiting and training program. You'll be the winner as you get some of the most enthusiastic members you ever had.



Left to right: WA6ONZ, WN7LIX and KØTFL.

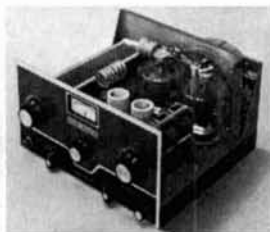
The picture shows Buzz MacDonald, WN7LIX, being awarded a Mosley Tri-band beam by Jack Mosley, KØTFL, of Mosley Electronics, Inc., and a Tri-Ex tower by Clyde Blyleven, WA6ONZ, from the Tri-Ex Tower Company. What for? Because WN7LIX was the youngest licensed ham (age 9) at the SAROC convention in Las Vegas last January.

We can't all give away beams and towers, but some of your old equipment mixed with a bit of patience and encouragement could go a long way towards giving our hobby a real boost.

Skip Tenney, W2NLB
Publisher



**Two will get you
two thousand.**



2000 watts PEP
input to a pair of Eimac
high- μ power triodes is
yours... continuous, 24
hours a day, day in and day
out. No intermittent "30 sec-
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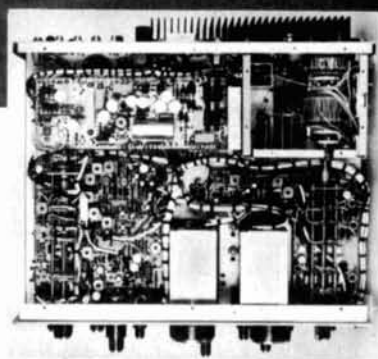
Swan chose two heavy duty
3-500Z Eimac power triodes for
their new Linear Amplifier because
these rugged, low cost power grid
tubes are ideal for cathode-driven
grounded-grid service, providing a
power gain of up to 20 in linear
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Listen on the bands. The out-
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- COMPLETE COVERAGE OF 160 through 10 meter ham bands in full 1 MHz ranges
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- ELECTRONIC IF SHIFT to slice away QRM at a touch.
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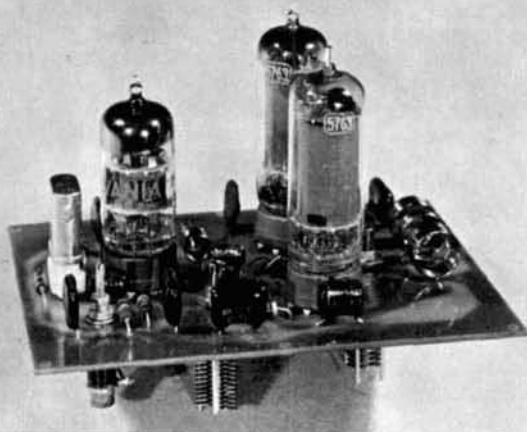
- RUGGED CONDUCTION - COOLED P.A. for a cool 300-plus watts input even on CW and FSK.
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heterodyne transmitting mixers

for
six
and
two meters

All you need is an
80- to 10-meter exciter
to participate
in the fun
on the vhf bands
with these
transmitter converters

D. W. Bramer, K2ISP, 45 Thayer Road, Fairport, New York 14450

The two units to be described were designed primarily to get the average high-frequency (80-10 meter) enthusiast off to a good start on the vhf bands with minimal cost and effort. They also provide interesting and straightforward construction projects for those amateurs who, despite all the easy approaches, respect ham radio as a technical avocation. Today's ham who knows his way around is sure to get more out of his hobby than the purchaser of commercially available boxes. Collect the necessary parts, put one or more of these units together with your own hands, adjust them properly, and you're off with tremendous satisfaction to explore the exciting world above 50 MHz.

Both units are of readily duplicated printed wiring board construction. Each is capable of producing about one watt of ssb or CW output, either directly to an antenna or as input to a higher-power linear amplifier.

The 50-MHz satisfies the objective of using almost any existing 80-10 meter transmitter as a basic rf source to generate signals at vhf, while retaining the operating convenience of the low-frequency equipment, such as vfo, upper or lower sideband selection, vox, PTT and break-in CW. It does so by accepting 7-MHz input and heterodyning it to the six-meter band.

Seven MHz input was selected because there are numerous single- and tri-band transceivers available, especially on the used market, at low cost. Also, this band represents a good compromise between receiver stability and freedom from undesirable transmitting-mixer output products.

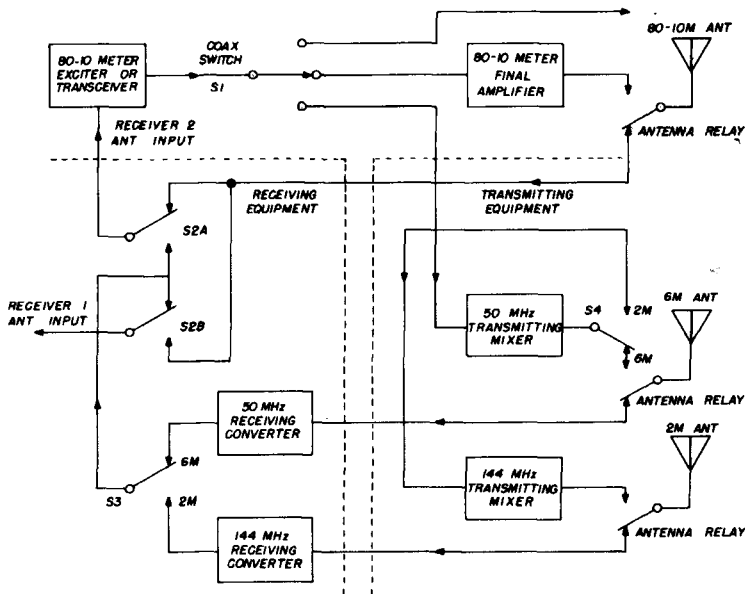
Unlike the six-meter unit, the two-meter mixer accepts a higher input frequency of 50 MHz. It will, therefore, produce two-meter output when driven by six-meter input. Hence, the six-meter mixer unit may be used directly to excite the two-meter mixer. You might then assemble the six-

newcomer in understanding just what vhf heterodyne transmitting mixers are and how they may be effectively integrated with existing equipment. It may even stimulate some thinking on the part of "mister experienced" toward more sophisticated or improved station arrangements. Muting bias and relay control lines are not shown, but are discussed briefly later on.

50-MHz circuit design

The six-meter mixer unit, **fig. 2**, starts out with a conventional triode oscillator; followed by a tetrode buffer amplifier; both

fig. 1. Typical hf/vhf rf switching system. Note that with the vhf converter output switched to receiver 1, the high-frequency antenna is automatically switched to the transceiver (receiver 2) by S2.



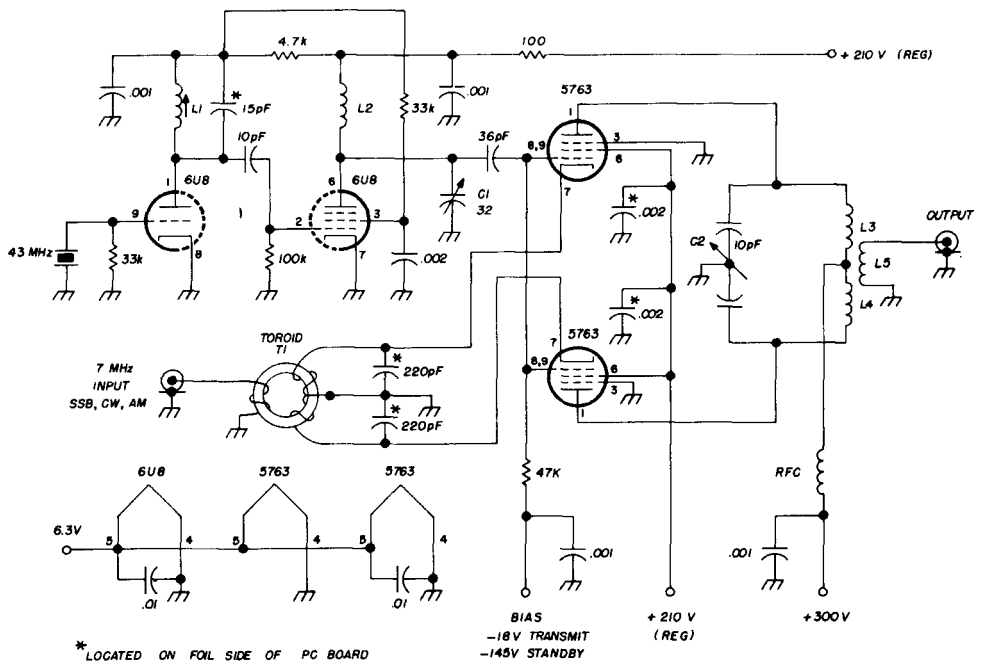
meter unit first and consider the two-meter unit project later on.

station layout

Although many amateurs tend to concentrate on a single band and/or mode of operation, there's much to be said for station versatility. With some foresight in station planning, the hf/vhf enthusiast can incorporate several bands and modes with little difficulty, thus taking full advantage of existing 80-10 meter gear and newly added equipment. **Fig. 1** outlines a typical combination hf/vhf station, showing major rf paths and switching. While this block diagram is fundamental, it will aid the

stages use halves of a single 6U8. Oscillator output at 43 MHz is lightly coupled to the buffer, which reduces pulling effects. The buffer operates straight through on 43 MHz with its output capacitively coupled to mixer grids.

Two 5763 pentodes operate as a push-pull balanced mixer, heterodyning 43-MHz oscillator injection with 7-MHz input for an output at 50 MHz. Note that the 5763 control grids are driven in parallel, while the plates are in push-pull. This cancels the undesirable 43-MHz output product, because in-phase plate currents are produced at each end of the balanced tank circuit. Output at 43 MHz would otherwise



- * LOCATED ON FOIL SIDE OF PC BOARD
- C1 32-pF variable (E. F. Johnson 160-110)
 - C2 10-pF butterfly (E. F. Johnson 160-211)
 - L1 9 turns no. 24 AWG, close wound on 1/4" diameter slug-tuned form
 - L2 9 turns no. 20 AWG, air wound, 1/4" diameter, 3/8" long
 - L3, L4 7 turns no. 20 AWG, air wound, 1/2" diameter, 9/32" long
 - L5 4 turns no. 20 AWG, air wound, 1/2" diameter, 1/8" long
 - RFC Ohmite Z-50
 - Xtal 43-MHz third overtone (International Crystal type FA5)
 - T1 toroidal transformer (see fig. 3)

fig. 2. Schematic diagram of the six-meter transmitting mixer.

be prevalent due to its proximity to the output passband of the 50-MHz tuned circuit.

Forty-meter excitation is applied in push-pull to the 5763 cathodes. A miniature toroidal transformer with center-tapped secondary derives push-pull cathode drive from the unbalanced link-coupled input. Shunt bypass capacitors of 220 pF from each 5763 cathode provide a low-reactance ground at both 43 and 50 MHz. These present a high reactance at 7-MHz and, therefore, have negligible effect on the broadband toroid transformer input. The 50-MHz output is link coupled from the push-pull tank coil.

High-voltage supply requirements are +210 V regulated at about 20 mA and

+300 V at 50 mA maximum. The +210 V may be obtained from two series-connected OB2 regulator tubes. Filament voltage is 6.3 Vac at 1.95 amperes. Under transmit conditions, mixer control-grid bias must be held at -18 V and switched to -145 V for muting during receive or vox dropout periods.

50-MHz mixer construction

An etched circuit board measuring 4 by 5 inches serves as a chassis for the six-meter unit.* It should be made from 1/16-

* Complete circuit boards etched, solder-tinned, and drilled are available from Stafford Electronics, 427 So. Benbow Road, Greensboro, North Carolina. Order: 6M-11 (six meters) and 2M-11 (two meters); prices: \$4.10 and \$5.75 each respectively.

inch thick epoxy copperclad stock. Three 0.104-inch-diameter holes are drilled along each longer board edge for mounting purposes. Drill two holes of the same diameter for the crystal socket. Tube socket holes are 0.067-inch diameter. The two miniature variable capacitors require 1/4-inch holes, while the slug-tuned coil-form hole is 11/64-inch diameter. All remaining holes may be drilled 0.040-inch diameter for coil, resistor, and capacitor leads.

Wire size and turns data for all coils are listed; L2, L3, L4 and L5 must be tight wound, using a mandrel of slightly less diameter than the coil size. A drill bit is handy for this purpose. Coils are then assembled to the PC board and coated with clear nail polish, or other dope, to retain mechanical stability. Details for the toroidal input transformer are given in **fig. 3**. It, too, is held in position on the PC board by its own leads.

Miniature 50-ohm coax such as RG-174/U is recommended for rf input and output connections to reduce stress on PC board copper strips. While this coax has adequate power capability, it should be used only for very short runs to avoid loss at 50 MHz.

Five capacitors, with short leads, are soldered to the foil side of the board. These consist of two 0.002- μ F 5763 screen bypass capacitors, two 220-pF 5763 cathode bypass capacitors, and one 15-pF oscillator plate tank capacitor.

Tube sockets are all 9 pin and should be the low-loss mica-filled type designed for 1/16-inch thick PC board mounting, such as Cinch-Jones type 9 PC or equivalent. Component location may be determined quite easily by examining the photographs and the schematic. The entire PC board should be cleaned of rosin after soldering.

Full size printed-circuit-board layout for the six-meter converter.



adjustment and operation of the 50-MHz mixer

Using a grid-dip oscillator, preset the oscillator coil slug and buffer stage plate variable capacitor for a resonance of 43 MHz. Preset the mixer plate butterfly variable for an output tank resonance of 50 MHz. Insert a 43-MHz third-overtone crystal, apply 6.3 Vac filament power, and temporarily connect +210 V to oscillator and buffer amplifier stages through the 100-ohm decoupling resistor. Quickly adjust L1 for oscillation and L2 for maximum output, as indicated on the grid-dip meter, which has been switched to its wavemeter operating mode. Optimize crystal oscillator operation by turning the L1 slug until oscillation ceases, then turn in the opposite

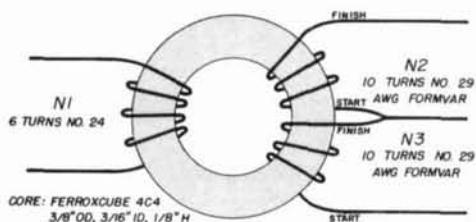


fig. 3. Toroidal input transformer for the 6-meter transmitting converter. Both the primary and secondary windings are wound around the full circumference of the core. Windings N2 and N3 are wound in the same direction. Start of N2 is connected to finish of N3 to form center tap. Toroid core is Ferroxcube 4C4, 3/8" OD x 3/16" ID x 1/8" high.

direction until the circuit just snaps into oscillation.

Now connect the -18-volt bias, +210-volt screen, and +300-volt plate supplies to the 5763 mixer stage. A small plate current should be evident, measured in series with the +300 volt supply line. Readjust buffer tank L2 for maximum mixer plate current. This should read about 15 mA. Check system stability by removing the 43-MHz crystal. Mixer plate current should drop to near zero. Reinserting the crystal should promptly restore the 15-mA current.

When the system responds properly to the setup procedure, you're ready to produce 50-MHz output from 7-MHz input. If more than one watt of drive is available (and it usually is), a pad must be connected between the low band transmitter and toroidal transformer input link. In my case, an 5B-101 was used as an exciter. This produced about 100 watts output on 40 meters and is probably typical of most exciters. A suitable pad for this power level is shown in fig. 4.

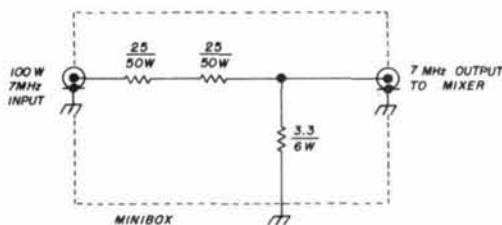
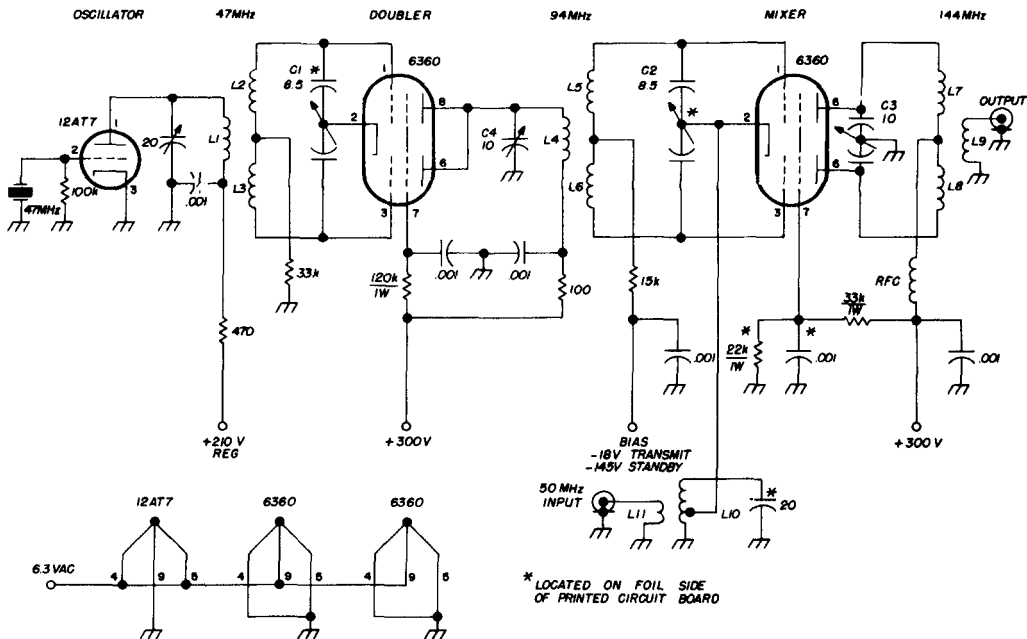


fig. 4. A 100-watt pad for 7-MHz mixer drive. 25-ohm resistors are Ohmite type 210-50; 3.3-ohm resistor is three 10-ohm, 2-watt resistors in parallel.

With all supply voltages applied and the 40-meter source connected, carefully increase 7-MHz drive until the wavemeter, held close to the push-pull mixer plate tank, indicates 50-MHz output. Peak the butterfly variable capacitor for maximum output. Again, check stability by reducing 7-MHz drive. The 50-MHz output should correspondingly decrease.

Connect a dummy load to the output link. With the load applied, tune the butterfly variable for maximum output, as indicated on an in-line forward power meter. Increase 7-MHz drive until no further increase in 50-MHz output occurs. Peak excitation on ssb should be limited to a level slightly below the above condition to resolve maximum output consistent with maximum linearity.

Connect your antenna, tune in a station, and establish contact. You'll be amazed at the results with only one watt output.



- C1, C2** miniature 8.5-pF butterfly (E. F. Johnson 189-253-5)
- C3** 10-pF butterfly (E. F. Johnson 160-211)
- L1** 8 turns no. 20 AWG Formvar, air wound, 3/8" diameter, tightly wound (note position relative to L8 and L9 in photograph)
- L2, L3** 11 turns no. 20 AWG Formvar, air wound, 3/8" diameter, tightly wound
- L4, L5, L6** 5 turns no. 16 AWG tinned copper wire, air wound, 3/8" diameter; turns spaced one-half wire diameter
- L7, L8** 4 turns no. 16 AWG tinned copper wire,

- air wound, 3/8" diameter; turns spaced 1 wire diameter
- L9** 2 turns no. 16 AWG tinned copper wire, air wound, 3/8" diameter; spaced 1 wire diameter
- L10** 9 turns no. 20 AWG Formvar, close wound on 1/4" diameter slug-tuned form, tapped 3 turns from cold end
- L11** 2 turns no. 20 AWG on cold end of L10
- RFC** Ohmite Z-144
- Xtal** 47-MHz third overtone (International Crystal type FA5)

fig. 5. Schematic diagram of the two-meter transmitting converter. Printed circuit boards are available for \$5.75.

144-MHz circuit design

The two-meter mixer unit uses one-half of a 12AT7 as a conventional triode oscillator, using a 47-MHz third-overtone crystal (fig. 5). Oscillator output is inductively coupled to the push-pull tuned grid circuit of a 6360 push-push doubler stage. With push-pull connected grids and parallel plate circuit, it doubles efficiently to 94 MHz, while canceling the 141-MHz third-harmonic product. Additional 144-MHz tuned circuits are therefore not required (as in other circuits) to reject 141 MHz

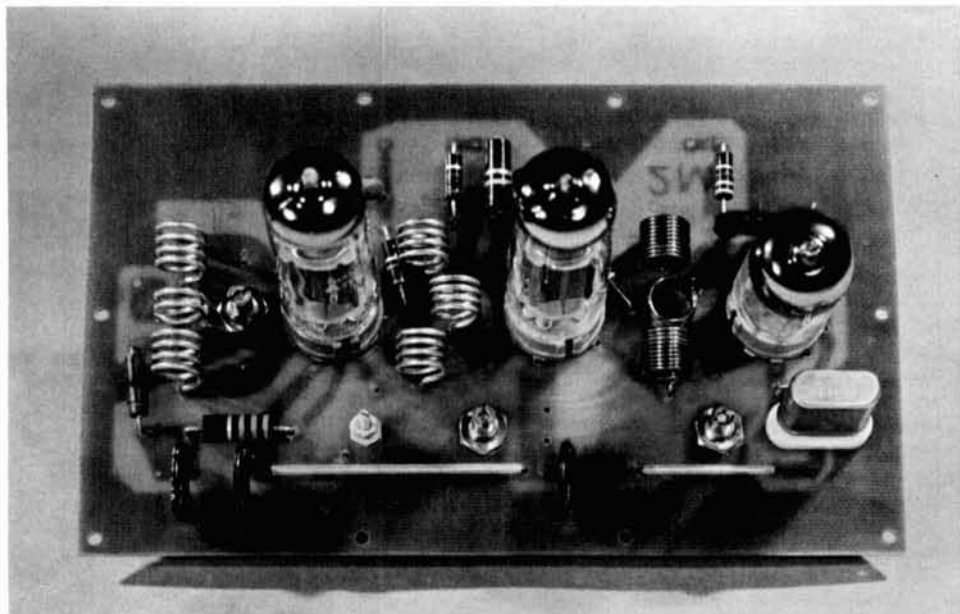
from the two-meter output passband. The 94-MHz mixer injection is inductively coupled to push-pull grids of another 6360 operating as a balanced mixer.

In contrast to the six meter unit, both grids and plates may be push-pull connected, because the 94-MHz injection signal is sufficiently removed from the desired 144-MHz output frequency. The 50-MHz excitation is applied through simple link coupling to a single-ended cathode input. Again, a push-push condition exists,

which cancels both 50 MHz and third-overtone 150-MHz products from the mixer output. A link is provided for coupling 144-MHz output to antenna or linear amplifier.

Power supply requirements are similar to those of the six-meter unit, being +210 V regulated at only 8 mA, +300 V at about

socket pin holes are 0.067-inch diameter. Holes for the three miniature variables are 1/4-inch diameter. Drill an 11/64-inch diameter hole for the slug-tuned coil form, centering it within the ring designated on artwork. Mounting holes for free-standing coils L4 through 19 are 0.066-inch diameter, while all remaining holes for L1,



110 mA maximum, and 6.3 Vac at 1.94 amperes. The same -18 V/-145 V bias is also used for transmit and muting. As a practical matter, the power supply should be capable of supplying both the six- and two-meter units.

144-MHz mixer construction

The etched circuit board for the 2-meter unit is slightly larger than that for the six-meter model, measuring 4 inches wide by 6-5/8 inches long. Again, 1/16-inch thick epoxy glass, copperclad material is recommended. Ten 0.104-inch diameter holes are drilled along the edges for mounting parts, four on each side and one on each end. The crystal socket requires two additional 0.104-inch holes. Tube-

L2 and L3, choke, resistors, capacitors, and filament jumper wires are 0.040-inch diameter.

Coils L4 through L9 are air wound, using wire diameter spacing between turns. L1, L2 and L3 are tight wound and secured with coil dope. Oscillator plate coil L1 is mounted vertically between L2 and L3 to optimize coupling. Several components, indicated with an asterisk on the schematic, are mounted on the foil side of the circuit board. PC type 8.5-pF variables are soldered directly to appropriate foil areas, using care to maintain physical balance at the push-pull grid circuits. The 20-pF capacitor is soldered directly across the slug-tuned coil-form end terminals.

A short length of RG-174/U 50-ohm coax

may be used for the 50-MHz input connection, but larger type RG-58/U is recommended for the output connection. Here again, avoid long runs, especially at 144 MHz. If long runs are required, step up to larger coax, using only a few inches of smaller cable for board terminations.

Examination of the photographs and the schematic will aid construction. Clean the entire board after assembly.

adjustment and operation of the 144-MHz mixer

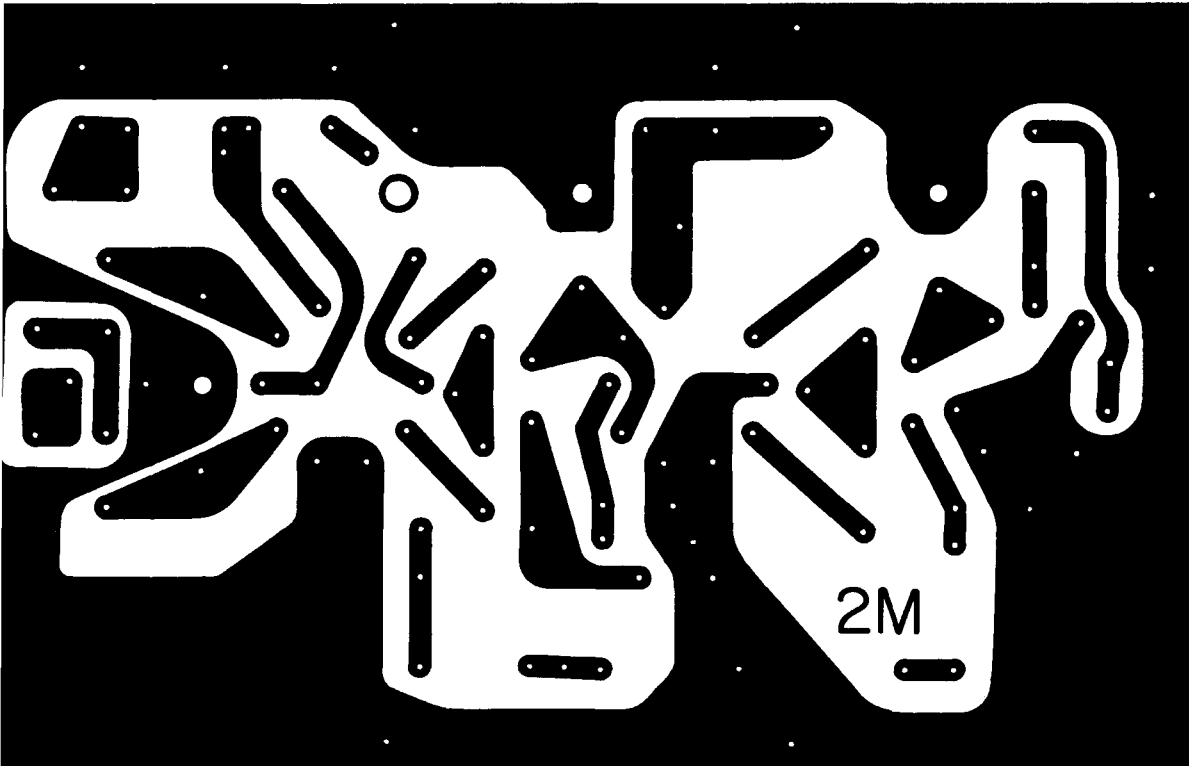
Preset the 12AT7 oscillator plate and 6360 doubler grid tank circuits to 47-MHz, using a grid-dip oscillator. These circuits are rather tightly coupled due to the proximity of their coils. Resonance of each circuit can be more readily recognized by temporarily loading the tank circuit **not under adjustment** with a 1000-ohm resistor. The unloaded circuit will exhibit a

higher Q and therefore resolve a more pronounced meter indication. The 6360 doubler plate and mixer grid tank circuits may be preset to 94 MHz, using the same procedure outlined above. Next, preset the mixer plate/output tank to about 145 MHz and the slug-tuned input coil to 50 MHz.

Insert a 47-MHz third-overtone crystal, apply 6.3 Vac filament power, and connect +210 V to the oscillator stage through the 470-ohm decoupling resistor. Adjust the variable capacitor quickly for 47-MHz oscillation, as indicated on a wavemeter. Next, apply +300 V to the 6360 doubler plates and screen grids. With the wavemeter set for 94 MHz, adjust the doubler plate variable capacitor for maximum indication. Readjust the doubler grid butterfly capacitor (on foil side of board) for maximum 94-MHz plate-tank output.

Temporarily connect a 4.7k-ohm resistor between the cold end of the 15k-ohm mixer

Full size printed-circuit-board layout for the two-meter converter.

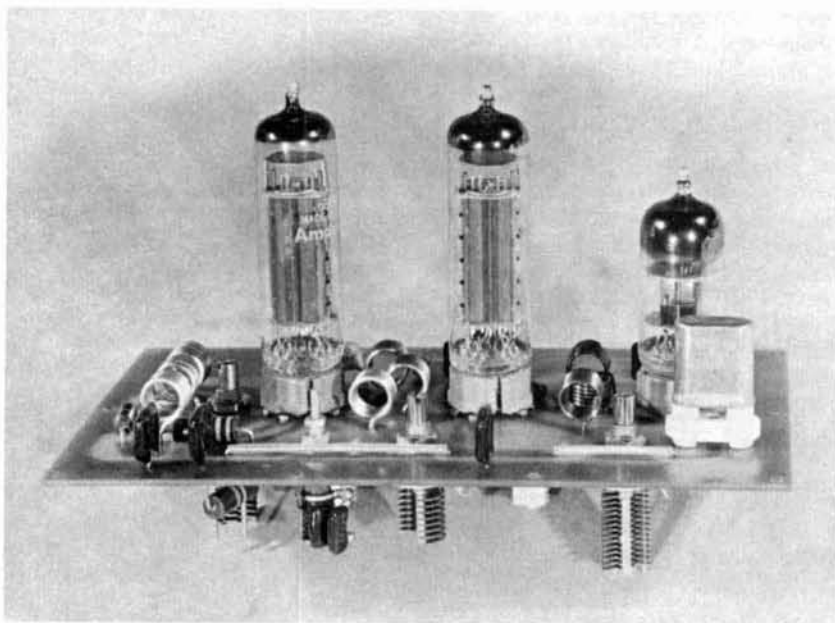


grid resistor and ground. Do **not** connect the +300 V plate/screen supply to the 6360 mixer stage at this time. With a vtvm connected between ground and the junction of the 15k- and 4.7k-ohm resistors, reconnect the +210 and +300 V supply to the oscillator and doubler. Carefully peak the doubler grid, doubler plate, and mixer grid variables for maximum negative voltage indication on the vtvm. Optimize crys-

inserting the crystal should promptly restore the 40-to 45-mA level.

A Heath Sixer (HW-29) makes an ideal 50-MHz source for driving the two-meter mixer board, especially during initial set-up and trial operation. (In my case, the output from a Gonset 6-meter Communicator was padded down to produce about one watt of drive.)

With all supply voltages connected, ap-



Two-meter transmitting converter.

tal oscillator stage operation by adjusting its plate tank variable until the circuit just snaps into oscillation as with the six-meter unit.

Remove the temporary 4.7k-ohm resistor, and connect all supply voltages, including -18-volt bias. The 6360 mixer combined plate and screen current should be 40 to 45 mA. If this current level is not achieved, carefully repeak all preceding tuned circuits for maximum mixer plate current. Check circuit stability by removing the 47-MHz crystal. Mixer plate/screen current should drop immediately to 4 or 5 mA. Re-

ply 50-MHz drive, and observe 144-MHz output with a wavemeter held close to the 6360 mixer push-pull plate coil. Peak the butterfly variable capacitor for maximum 144-MHz output. The 144-MHz output should disappear when 50-MHz drive is removed.

Connect a dummy antenna to the output link. With 50-MHz drive applied, tune the stage for maximum output, using an in-line forward power meter. The two-meter unit will produce a reasonably good a-m signal when driven directly by a Heath Sixer or equivalent. Connect the an-

tenna, call a local friend on the phone, and arrange to have him listen for the signal. If you have previously constructed the six-meter mixer unit, substitute its output for the a-m drive and get a report on two-meter ssb. You'll be pleased with the results.

notes

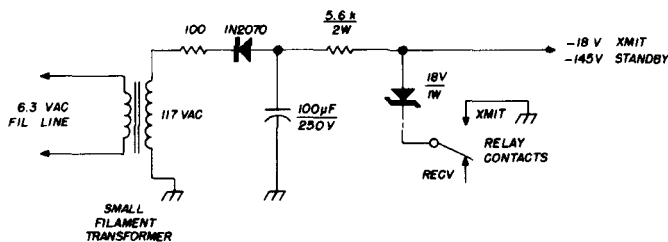
The value of adding a linear power amplifier stage between mixer output and antenna will soon be appreciated after initial experimentation with only one watt output. There are several constructional routes you might take. I assembled a com-

switch should be included in the six-meter model for shifting 50-MHz output either to the input of a linear amplifier, or to the two-meter mixer unit input. More elaborate switching could be used to apply only 6.3-V filament power to sections of the system in immediate use.

A simple bias supply (fig. 6) may be provided by connecting a small 6.3-V filament transformer backwards to the filament line and rectifying the 117-Vac output of the primary winding.

Relay contacts may be spare contacts on the low-band transmitter. When in nonenergized "receive" position, the zener

fig. 6. Bias supply for the two transmitting converters.



plete six- and two-meter unit, including a 100-watt linear amplifier stage for each band, on a single chassis. The chassis was then enclosed in a modern-styled cabinet that matched the color schemes of existing station equipment.

As an alternate solution, you could combine a single mixer PC board with a linear output stage on a chassis. An 829B makes an excellent amplifier when operated class AB₁ at +800 V plate, +210 V (regulated) screen, and about -22-V grid bias. Many simple 829B amplifier circuits are in vhf handbooks and magazine articles. A standard 3x5x10-inch chassis offers ample space for mounting the six-meter mixer and 829 output stage, while a 3x5x13-inch chassis would nicely support a two-meter version.

If eventual construction of both six- and two-meter mixer units is contemplated, a

is ungrounded and has no control, allowing the bias line to assume full -145-volt potential for muting. In "transmit" position, the relay contacts switch the zener circuit to ground, establishing proper -18-V operating bias level.


Although I chose 7-MHz input for the six-meter heterodyne mixer and 50-MHz input for the two-meter version, other frequency combinations are possible. It's only necessary to change injection oscillator crystal frequency and re-resonate oscillator and buffer (or doubler) tank circuits appropriately. As an example, consider 10-rather than 40-meter input for the 50-MHz mixer. The 28-MHz band has long been a favorite of vhf'ers, because it offers wider frequency coverage and reduced receiver feedthrough. In this instance, the crystal would be changed to 50-minus 28-MHz, or 22 MHz.* Oscillator/buffer stage plate circuits would then be tuned to the same frequency.

* Or, 50 MHz plus 28 MHz, 78 MHz, for better suppression of spurious signals. Editor



a programmable repeater identifier

You can
ragchew all day long
and let this
solid-state system
automatically
identify
your station



During the past year a number of people have offered ideas on the design of a CW code generator using transistors and logic circuits. There were two major drawbacks to the systems proposed. First, it was not possible to program the CW circuit to provide a variable format that could be changed easily; second, the construction of such a device required the builder to know how to design diode matrices or other more sophisticated circuits.

The devices described here eliminate all these undesirable characteristics and allow anyone to construct his own solid-state repeater identifier or CW code generator. I'll describe the complete repeater identifier, including its electronic clock and associated control circuit. Those who are interested only in the CW code generation technique may skip down to the part titled **memory planes**.

basic chassis

This is the main chassis of the unit shown in the photographs and in **fig. 1**. It contains the power supplies, card plugs, external connectors and interface circuits for interconnecting the cards. A 12-volt lamp and a push-to-test button are on the front panel. Jacks J1 and J2 are eight-pin octals that connect the repeater transmitter and command decoder.¹ K1 is a small 10k ohm sealed relay.

John Connors, W6AYZ, 920 Sir Francis Avenue, Capitola, California 95010

memory planes

These are Vector cards that store the morse code letters. They consist of numerous one-shots in series, each one triggering the next in line as shown in fig. 2. A diode attached to every other collector forms a keying line that turns the tone oscillator on and off. The amount of time the one-shot is off is determined by the time constant at its base. By varying the value of R, as shown in the CW generator drawing, you can select various band lengths.² The 1k ohm series resistors keep the gain of each stage down to prevent oscillation. The transistors should be npn silicons with betas of around fifty. While this sounds like a lot of transistors, bear in mind that the

longest calls, such as 'DE WA6XXX,' require only fifty-two transistors. In quantities the prices are quite reasonable.

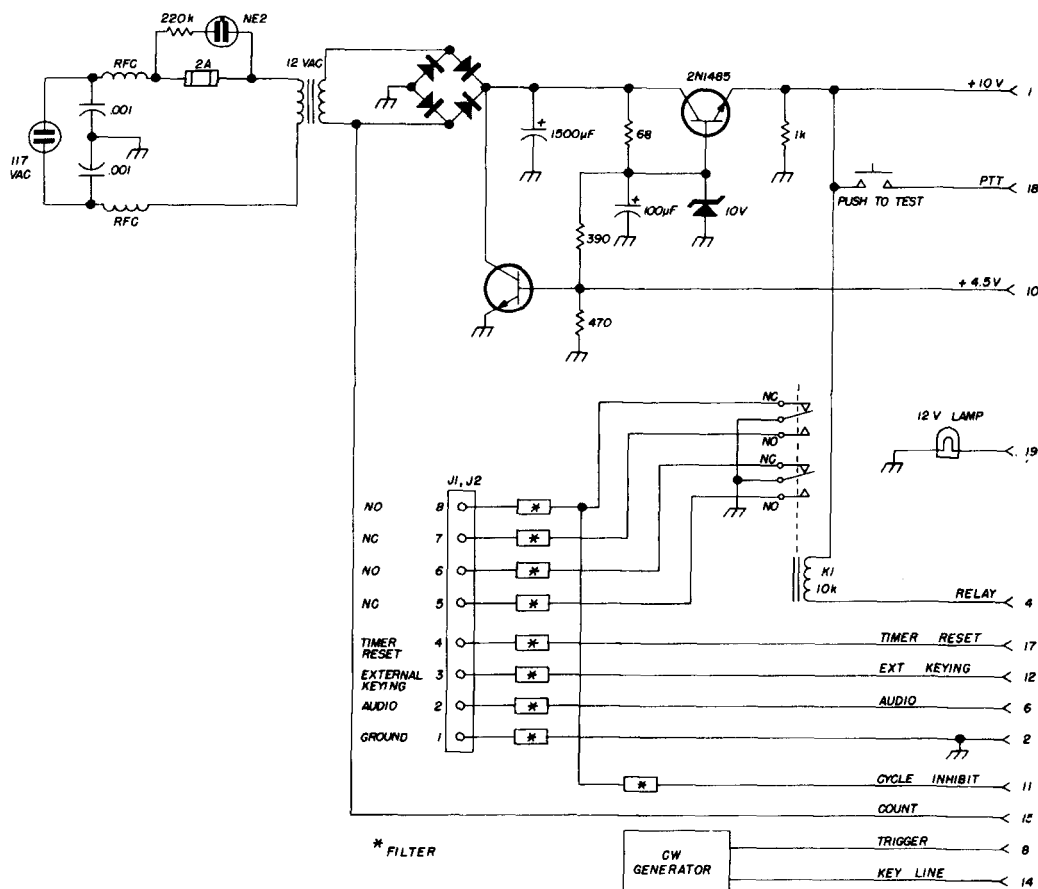
The big advantage is that by selecting the proper resistor values the code is chosen. The resistors could be mounted on a separate plug-in card and the code changed by changing cards.

logic plane

This card is the heart of the identifier. It provides all the control, audio, and keying functions. For clarity the schematic of this card has been divided into several sections. Each can best be understood by also referring to the block diagram (fig. 3).

The keying line output from the memory

fig. 1. Basic chassis contains the power supply, card plugs and interface circuits. Pins on the right mate with pins on the logic card.



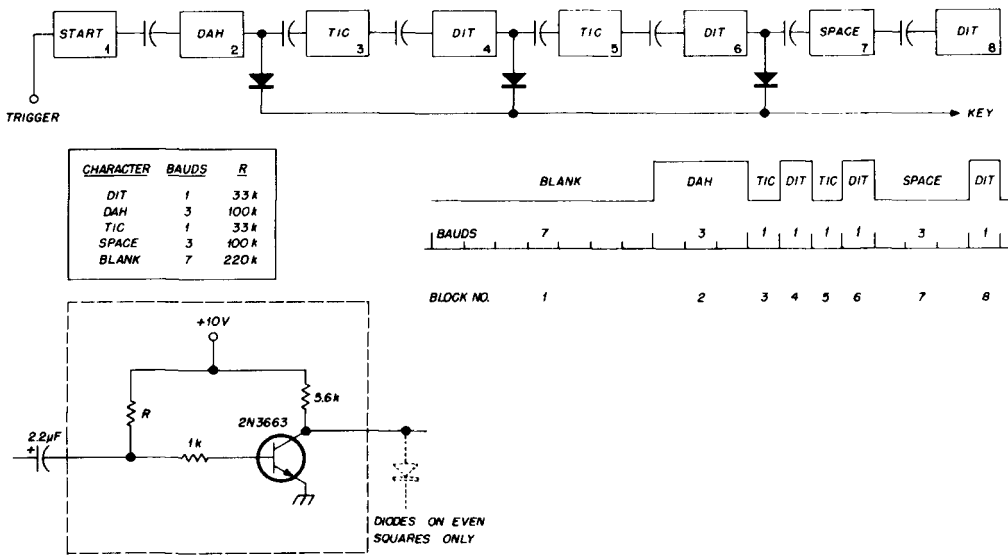


fig. 2. First eight stages of the CW generator or memory shown here generate the letters, "DE," as shown on the output wavetrain. Each of the boxes contains the simple transistor circuit shown. The length of the CW character generated by the circuit is determined by the size of the resistor R.

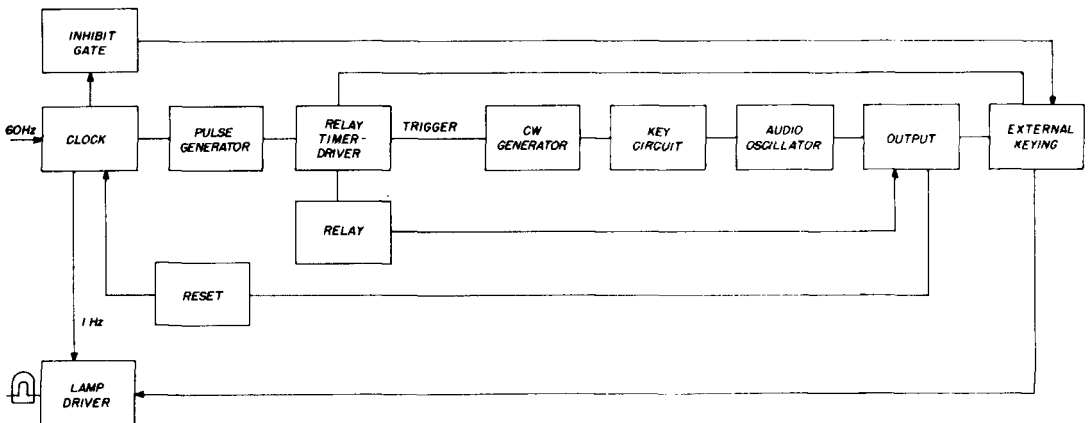
planes switches Q5 and Q6, which turn the audio on and off, fig. 4. Q1-Q4 make up a conventional oscillator. The 1k ohm potentiometer controls the output level. Sufficient audio power is available to drive almost any transmitter.

clock

The clock (fig. 5) establishes the ten-minute intervals necessary to fire the identifier. A 60-Hz, half-wave signal from one side of

the power supply rectifiers is squared by Schmidt trigger Q23 and Q24 and applied to the clock input. The clock divides the line frequency by 36,000 to produce one pulse every ten minutes at point B. Q18 is the reset transistor, which allows the clock to be synchronized to ten-minute intervals. By listening to WWV while holding pin 4 of the output plug to ground and releasing it on the time mark, you can set the clock to ten-minute intervals on the hour. Using a

fig. 3. Logic plane is the heart of the unit: circuits are shown in figs. 4, 5 and 6.





Plug-in cards for the identifier: two memory cards on the left generate Morse characters; logic card on right provides the control, keying and audio functions.

command from the command decoder allows the clock to be synchronized from a remote station.

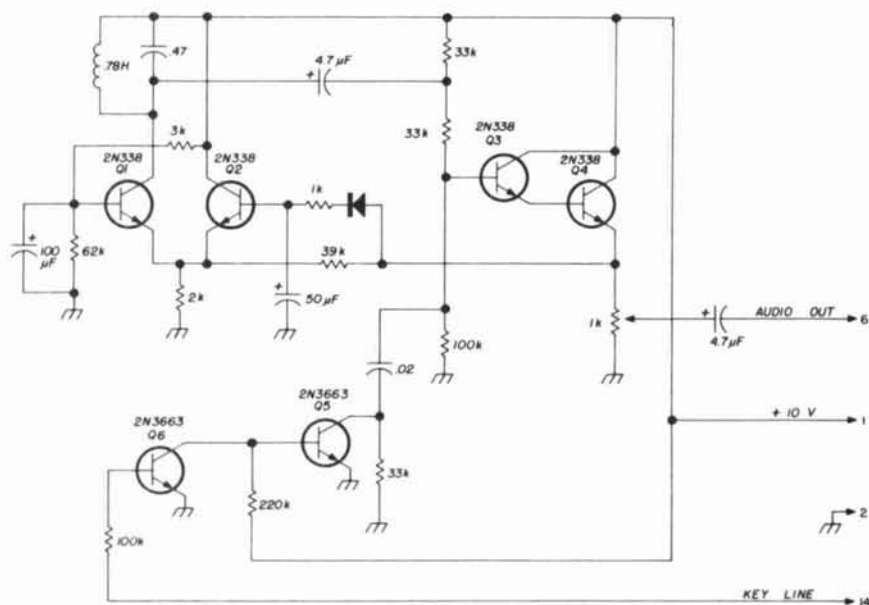
access-control gate

This circuit is shown in **fig. 6**. The output pulse, at ten-minute intervals, drives Q16, which turns on the relay timer/driver com-

posed of Q7-Q10. This closes the relay, which holds the transmitter on, and also provides the trigger pulse that starts the identification cycle. The one-second output from the clock is used to flash the lamp on the front panel at one-second intervals through Q11-Q13.

Point A is the takeoff for the one-second

fig. 4. Audio oscillator and keying circuit.

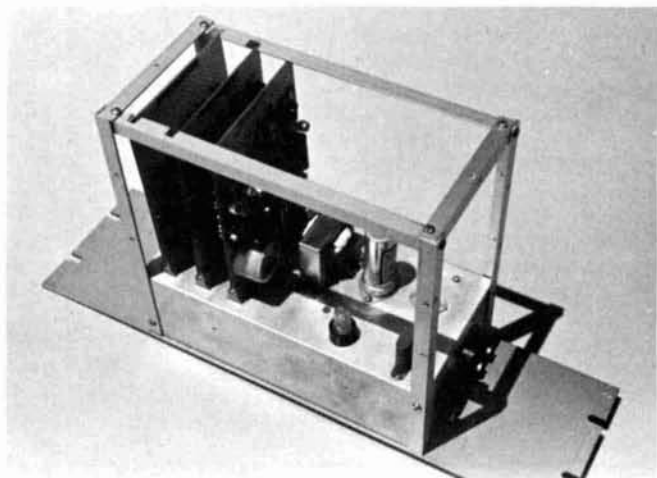


pulses. Q14 and Q15 are inhibit gates that prevent access to the trigger circuit from external sources such as the push-to-test button or the external keying input. There are only two times when it's necessary to prevent triggering the memory unit: first, when the identifier is cycling through its sequence and, second, when the identifier is approaching a ten-minute interval on its clock.

The diode from pin 11 of the card plug clamps the inputs during cycling. The four diodes attached to Q14's base resistor sample the clock and clamp the inputs ten seconds prior to clock firing. At the same time, this clock-inhibit signal holds the panel lamp on constantly as an external signal to alert an observer.

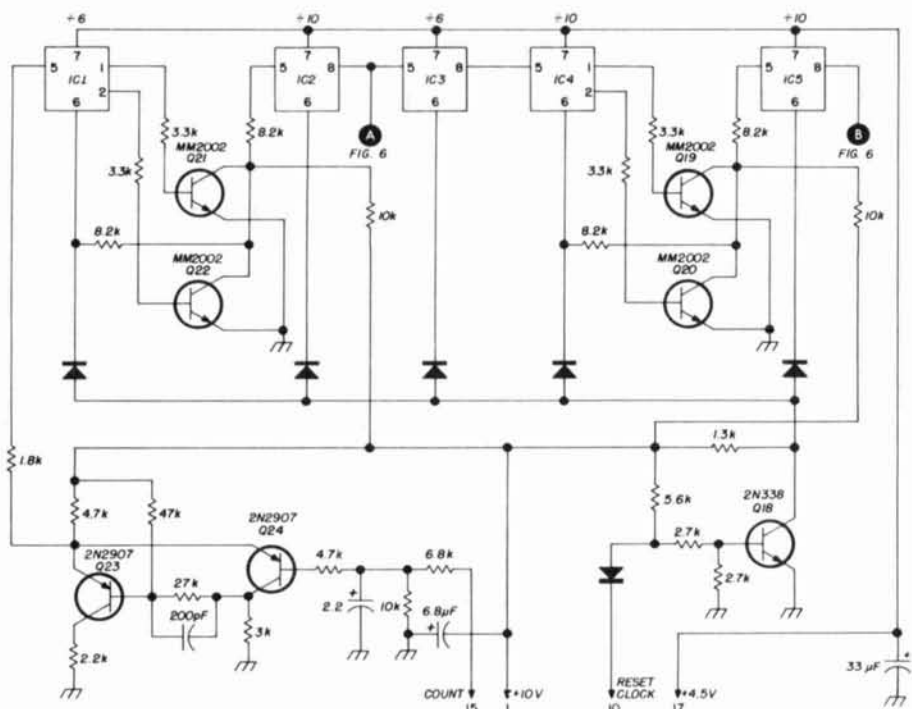
mechanical considerations

Repeater equipment requires a lot more attention to detail than most amateur equipment. It functions in a re-



Inside view of the CW identifier showing the three plug-in cards on the left and power supply to the right. The aluminum frame is made from do-it-yourself angle stock. BNC connectors are for audio and control functions.

fig. 5. Clock for the logic board derives its input from the 60-Hz line. Integrated circuits are Fairchild 995859's although other IC's may be used; divide ratios for each IC stage are shown.



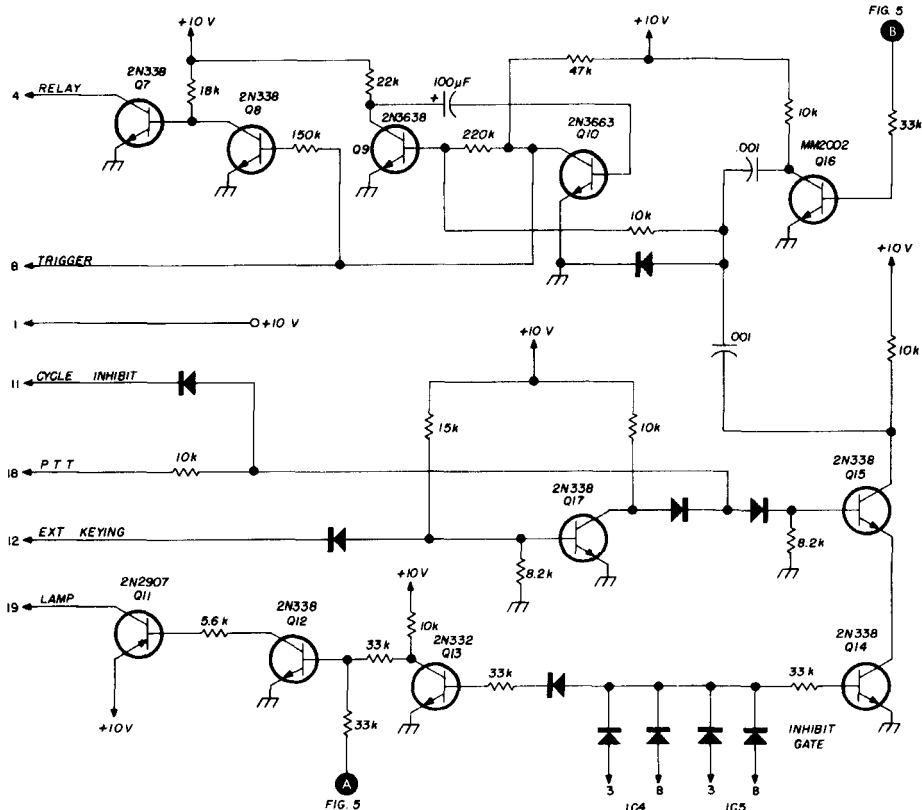


fig. 6. Access-control gate is used to start everything rolling at 10-minute intervals.

mote area where access is usually time-consuming and bothersome. The environment under which it operates is generally more hostile to solid-state equipment than a home or ham shack and often produces conditions totally unanticipated. For these reasons you should use care in constructing the identifier, and considerable attention should be paid to detail.

Numerous filter circuits are used to remove transients and rf, which would otherwise cause erratic triggering and operation. The photographs show the extent to which shielding was employed as a precaution against the intense rf fields from the repeater's transmitter. All input-output lines are filtered, including the 110-volt power line.

Extreme temperature variations are another problem more critical with transistorized equipment. Although this unit was

heated in an oven and cooled in a refrigerator to test its range of temperature tolerance, I recommend it be installed with adequate ventilation and with no heat-producing elements directly under it. The best method is to give it a rigorous test before installing it at your site.

Even after trying everything I could think of to make my identifier act up, something totally unanticipated forced me to go up to the site and get it for modification. All-in-all, however, the problems were minor and quite easy to correct. The unit functions quite well now and should be in service for a long time to come.

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2. "Keying Speeds," *Radio Amateur's Handbook*, ARRL, 1964 edition, p. 253.

ham radio

to clip or not to clip?

That's the
question—
and here
are some
provocative answers

E. H. Conklin, K6KA, Box 1, La Canada, California 91011

Some of the amateur phone signals indicate that speech compressors and clippers aren't necessarily the answer to good communication. This article attempts to demonstrate that, under certain controlled conditions, speech compression and clipping will increase the weaker voice components. It further shows that when these devices are not used properly, a penalty is incurred in the form of noise. Noise is defined as an extraneous by-product of radio transmitters that causes interference to other amateurs. Also, the article shows that if the peak power of ssb transmitters is limited with speech clipping, the amateur regulations can be violated by exceeding the legal average input power limit.

speech compression

Years ago, an aviation engineer in military service said that at least four aviators jumped out of their aircraft as a result of misunderstanding something said to them over a radio circuit. While this may not happen to amateur operators, the desire is great for intelligibility of signals at distant points.

Bell System engineers state that the dynamic range for voice communication is 20 to 30 dB. A considerable amount of the received intelligence depends upon the weaker parts of the voice wave. This range above the inherent circuit noise normally is necessary.

Several decades ago the **compandor** was developed to reduce this limitation. The compandor compresses the audiody-

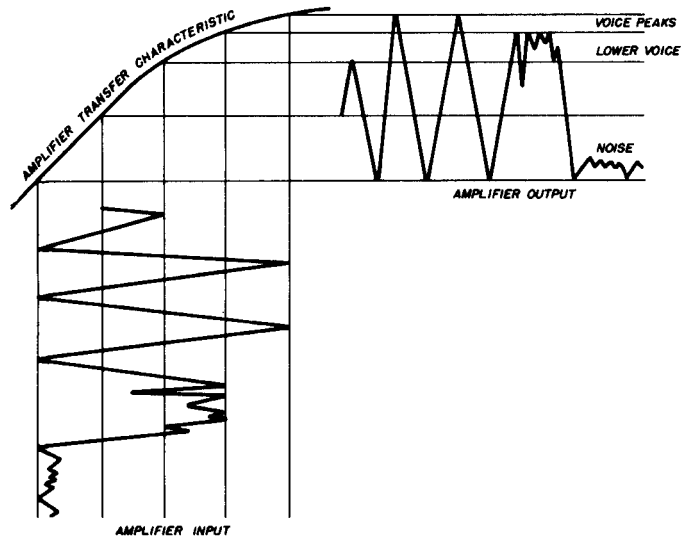
dynamic range before much noise is present and expands it again at the receiving end after transmission over a long circuit subject to noise. The combined action thus corrects most of the distortion created by the compression of the amplitude range at the sending end.

Compression of amplitude range might be pictured as in **fig. 1**. Here, an amplifier that is nonlinear above a point about equal to the lower amplitude components of the voice range will predistort and compress the range of the peaks above this level. The lower-amplitude components re-

Some form of indicator can be used, instead, to maintain a standard voice level.

One disadvantage of the integrated-waveform compressor is the tendency for hum, wind (breath) noises, blower, background noise and even tube noise to increase during pauses in speech.⁴ It causes some operators to hurry their speech, which is then difficult to interpret. This form of compression results in a sharply rising noise level after speech ends and before the VOX or push-to-talk circuit cuts off the transmitter. It often sounds like interference.

fig. 1. Comander performance, showing cycle compression of peaks.



main at the same level above the noise. This performance is not greatly different from filtered audio clipping, which attempts to do the same thing by clipping the peaks and then rounding them by filtering the high frequencies generated in the process. Either of these operates on a cycle-to-cycle basis.¹

Another type of compression is much more common. It operates on the integrated audio waveform principle, having an effect similar to automatic gain control. Its advantage comes from keeping the gain at some predetermined high level, even when the mouth is turned from the microphone. Its benefits are small.^{1, 2, 3}

single sideband

A peculiarity of ssb is that occasional peaks are generated.^{1, 3} The accepted theory is that, if these peaks are reduced in amplitude by rf clipping and filtering, they permit the audio level of the weaker voice components to be increased without greatly reducing the intelligibility, because the peaks contribute little to the intelligibility.⁵ At a distant receiver where the noise level may be close to that of the lower-amplitude voice components, intelligibility may have suffered considerably. An increase in audio may improve the reception more than distortion causes it to deteriorate.

This might be depicted as in **fig. 2**. The weaker voice components are in the noise at the distant receiver whereas with the same peak level, clipping may allow the weaker components to increase at the transmitter. Then they will be above the noise at the receiver.

local interference

This rationale overlooks the interference that may be generated locally, which may cover the entire band. Some amateur signals indicate that many transmitters

were modulated 100 percent with noise, after which the voice simply punched holes in this noise. A later inspection of a maintenance activity disclosed that the original Collins design was being produced by other manufacturers. The Collins technical note was not being distributed to all who should have it to prevent the accidental setting of the audio gain at a too-high level.

A later study of ground/air communications by the Naval Research Laboratory indicated aircraft radio sets were only 25 percent intelligible on the average, and de-

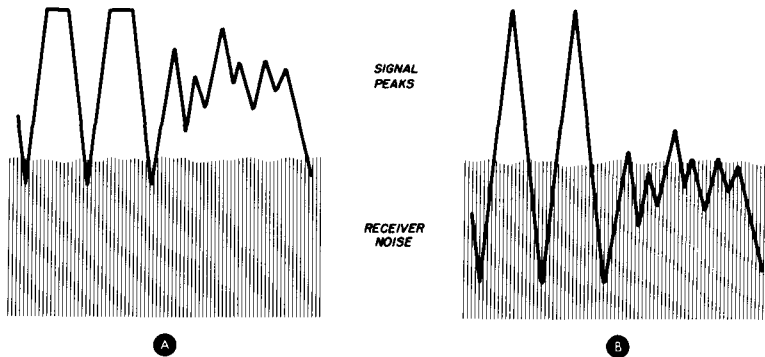


fig. 2. Signal received at a distant receiver when (A) clipping allows transmitter power on lower voice components to be increased, assuming that this brings the weaker parts of the voice above the noise. In B the receiver noise is above the lower voice components.

should not use either compressors or clipper, at least as they're used at present.

A local amateur told me, "If you don't use a clipper, you're not up to the state of the art." This latter term is used in section 97.73 of the amateur regulations: "The frequency of the emitted carrier wave shall be as constant as the state of the art permits." The implication is that not only shall the carrier wave frequency be as constant as the state of the art permits, but distortion products shall be eliminated in accordance with "... good engineering and good amateur practice" (from section 97.77).

intelligibility

During the invasion of Okinawa, I was impressed with the intelligibility of aircraft radio signals. A scope showed they

depended upon redundancy (familiarity with what probably would be said) for communication. This was largely due to the improper setting of the gain control, which produced excessive noise in the output. The report also showed the ground stations were only 50 percent intelligible during carefully controlled tests. To keep modulation at high levels, they were using compression plus some clipping. When this was turned off, the problem disappeared.

an example

When an amateur ssb signal swings an s-meter up, and the meter doesn't vary more than 20 or 30 dB between words, noise is being transmitted, which causes interference. This is not necessarily radiated beyond the passband of the trans-

mitter filter, but a noisy signal is being radiated that can interfere with the whole band locally, and with communication between other stations on approximately the same frequency.

Let's say X is talking to Y on low power, some distance away from Z, and not interfering with Z. But Z's noise may well prevent Y from hearing X. X's signal at Y might look like **fig. 2a** when Z is off, and like **fig. 2b** when Z is transmitting. This is not desirable and should be avoided as unnecessary to Z's communication.

Oscilloscope observation of some of the compressed or clipped signals shows that the voice is punching holes in the noise just as the Okinawa aircraft sets did nearly 24 years ago. Others are clean, allowing weaker signals to be heard through a louder one. Sometimes, a rare station stops transmitting, after which so many call him that the band sounds like escaping steam. This has been attributed to the large number of stations calling, but may well be the result of a single transmitter that's producing noise. A New Zealander once tried to describe this condition diplomatically to an East-Coast station one evening when a breaker said, "He sounds like a one-man pile-up!" At that, the ZL nearly blew a fuse!

peak power

Some operators are impressed with the higher average plate current that results from the use of a compressor or clipper, thinking that the higher current results from the voice. This isn't necessarily so. Also, the legal limit will be exceeded unless the power is reduced when this occurs. Tests with and without a clipper are difficult to control on a truly comparative basis, so a report of a better signal with the clipper may be only the result of an illegal power input.

A single sideband transmitter can put out considerable power without even moving the plate-current meter above the static level, because the meter time constant won't respond to transients (noise pulses and shot noise, for example). If a compressor or clipper causes the plate current

to rise without voice modulation, clearly the compressor or clipper is not operating properly and is modulating the transmitter with noise.

A single-sideband transmitter can put out considerable power even without moving the plate current meter above the static level. The meter may move as little as 6 dB from the static level to the point coinciding with 1kW output. Therefore, between words, the driving power should be far less than that which would just start to move the meter. If a compressor or clipper causes the plate current to rise without voice modulation, clearly the compressor or clipper is not operating properly and is modulating the transmitter **heavily** with noise.

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2. Wilfred M. Scherer, "The Waters Model 359 Compreamp," *CQ*, Vol. 21, No. 2, p. 43, February, 1965.
3. William Sabin, "RF Clippers for SSB," *QST*, Vol. 51, No. 7, p. 13, July, 1967.
4. Sydney H. Moate, "An Audio Peak Limiter for Voice Transmission," *QST*, Vol. 49, No. 8, August, 1965.
5. "RSGB Handbook," Third Edition, p. 278.

ham radio



"Why, hello Marilyn. Looks like you put on a little weight. How are the kids? Did my five-band DXCC plaque arrive yet?"

a survey of high-frequency amateur antennas

With special emphasis
on a new family
of antennas
that offers
superior performance
and wideband operation

Every amateur has different antenna needs, different facilities and a different pocketbook, so no one antenna will satisfy everyone. Indeed, it is the wise operator who considers many types of antennas before he decides what he is going to use. The chart in **table 1** was prepared as a guide to help you visualize some of the important differences between different types of antennas found on the amateur bands. Hopefully, it will help you make that all-important decision regarding your next sky wire.

bonadio antennas

You should be familiar with the first fourteen antennas on the chart, but the last four are new inventions* with some very interesting and exciting properties. Most antennas radiate basically along one vector. Exceptions include the Marconi, the quad and the rhombic; these have low- to medium-grade two-vector radiation. The Bonadio square-diagonal antenna radiates a high-grade two-vector wave. It does this by equally dividing the radiated energy into two identical members, 90° apart. The Bonadio box-diagonal antennas carry the idea one step further and divide the energy into four equal members 90° apart.

The Bonadio space-dimension antenna (**fig. 4**) completes the separation into idealized waves 90° apart. A logical presumption at this point is that such thin-

* The Bonadio square-diagonal antenna is protected by U. S. Patent 3,274,606. Patents are pending on the Bonadio box-diagonal and cube-diagonal antennas; Mr. Bonadio has applied for a patent on the space-dimension antenna. This protects the inventor against commercial infringement but does not prevent an amateur from building one for his own use. **Editor**

George A. H. Bonadio, W2WLR, 373 East Street, Watertown, New York 13601

ning of the radiation patterns is wasteful, but **results** do not confirm this. On band openings and closings, in fact, the extra wave vectors of the transmitted energy appear to be associated with the

performance I've experienced with them. The following reports are typical of the ones I receive when using Bonadio antennas, and suggest a number of unexplained factors. Just about all the aspects of my



W2WLR and the latest model of the space-dimension antenna.

signal being the first in **and** the last out. In addition, numerous spontaneous reports of less fading are logged. Comparisons with Yagis, quads and rhombics show more advantages at the more distant locations and the advantages seem to accumulate with each additional ionospheric hop.

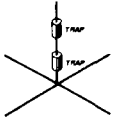
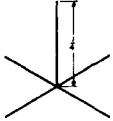
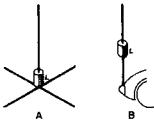
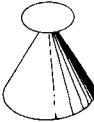
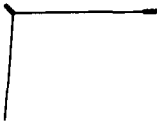
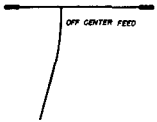
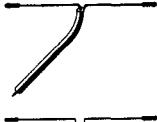
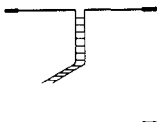
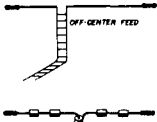
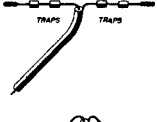

The performance of these antennas may be related to the three-dimensional nature of the ionosphere. The ionosphere **appears** to reflect two-vector waves with less fading and absorption than one-vector waves; furthermore, it seems to reflect three-vector waves with less fading and absorption than waves arriving along two vectors.

results

However, the main purpose of this article is not to try and explain how these antennas work, but rather to present the


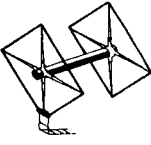
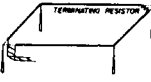
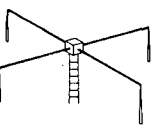
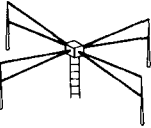
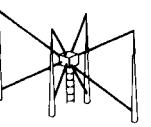
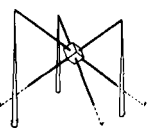
As you read through this article you will note a number of unusual and even unorthodox uses of the words "vector" and "wave." This is because of the apparent nature of these antennas. The author originally referred to the radiation patterns as two- and three-dimensional, but all antenna patterns have vertical height and horizontal width and depth, so I pointed out that a three-dimensional radiation pattern is not unique. The word "direction" could have been used, but many antennas are multi-directional or have several lobes, so this is not unique nor descriptive of what the author feels is happening. Finally, after much discussion, the word "vector" was chosen because it means, "along a single line." Please bear in mind that the author is not certain how these antennas work, although he has some ideas. Performance is what is important, and these antennas have that; we'll leave it to the antenna engineers and Maxwellian mathematicians to explain why the performance is there. Editor

table 1. Detailed comparison of 18 different high-frequency amateur antennas.

	type	ground wave	short skip	long skip	comparative cost	support points	ground system	short term fading	use for cb, tv fm, uhf etc.	feeder losses
	vertical trap	excellent	poor	good	medium	1	very important	very poor	very poor	low
	vertical 1/4-wave	excellent	poor	good	low	1	very important	very poor	very poor	low
	vertical, shortened and loaded	very good	very poor	fair	high	1	very important	very poor	very poor	low
	discone	excellent	poor	good	medium	1	part of system	very poor	very poor	low
	Marconi, long wire	good	good	fair	very low	2	modest	good	good	part of system
	Windom single wire	fair	very good	fair	low	2	modest	poor	fair	medium
	doublet, coax fed	good	very good	fair	low	2	none if high up	poor	very poor	medium
	doublet, open wire fed	poor	very good	fair	low	2	none if high up	poor	fair	very low
	doublet, Windom feed	poor	very good	fair	low	2	none if high up	poor	fair	low
	trap doublet	poor	very good	fair	medium	2	none if high up	very poor	poor	low
	inverted-V doublet	fair	very good	fair	low	1	none if high up	good	fair	low

optimum results on	tuning requirements	time to change pattern	pattern polarization	ground space not including guys	anti-QRM notch	anti-line noise ability	type
several narrow bands	fixed	—	vertical	ground radials	no	vertical trap	none
one band	fixed	—	vertical	ground radials	no	none	vertical 1/4-wave
one narrow band	special loading	—	vertical	ground radials	no	none	vertical, shortened and loaded
10:1 frequency range	none	—	vertical	circle	no	none	discone
any frequency with tuner	medium	hours	mixed	straight line	no	very poor	Marconi, long wire
one band	simple	hours	horizontal	straight line	no	poor	Windom single wire
one narrow band	none	hours	horizontal	straight line	no	fair	doublet, coax fed
any tuned band	modest	hours	horizontal	straight line	no	fair	doublet, open wire fed
any tuned band	modest	hours	horizontal	straight line	no	fair	doublet, Windom feed
several narrow bands	fixed	hours	horizontal	straight line	no	fair	trap doublet
narrow band	fixed	hours	mixed	straight line	no	poor	inverted-V doublet

table 1. Detailed comparison of 18 different high-frequency amateur antennas.

	type	ground wave	short skip	long skip	comparative cost	support points	ground system	short term fading	use for cb, tv fm, uhf etc.	feeder losses
	Yagi, 3 element	good	very poor	excellent	high	1	none	poor	very poor	medium
	quad, 2 element	very good	poor	excellent	high	1	none	very good	poor	medium
	terminated rhombic	fair	poor	superior	high	4	none	good	good	very low
	Bonadio square-diagonal	poor	very good	good	medium	2-4	none if high up	very good	excellent	very low
	Bonadio box-diagonal	fair	excellent	very good	high	4	none if high up	excellent	excellent	very low
	Bonadio cube-diagonal	excellent	excellent	excellent	very high	4	none if high up	excellent	excellent	very low
	Bonadio space-dimension	excellent	excellent	excellent	very high	3-6	none if high up	superior	excellent	very low

station and location are typical—140 watts (a-m), located in a built-up residential area, five-degree hill toward Africa—so the exceptional reports I get aren't from that department. The antenna in use when the following reports were received was a Bonadio box-diagonal antenna, elevated 5 to 9 meters (16 to 30 feet) above flat land.

K5MRU, 16 September 1967, "There must have been 15 stations in there calling me."

ON4XK, 16 September 1967, "There were many stations on your frequency."

ZE1BP, 26 September 1967, "You're on a par with any stateside signal in the last hour."

ZS6EB, 27 September 1967, "You're the **only** station we can copy," and four hours later, "Conditions no better than earlier; you're still 4 and 5." And on 5 October 1967, "First W2 heard this afternoon. There are no Americans; the band is no good at all. You're 4 and 6."

G3RXW, 16 October 1967, "About the only W on the band;" 40 minutes later, "I cannot hear any other American station."

optimum results on	tuning requirements	time to change pattern	pattern polarization	ground space not including guys	anti-QRM notch	anti-line noise ability	type
single band	fixed	seconds	vertical or horizontal	depends on support	excellent	excellent	3-element Yagi
single band	fixed	seconds	mixed	depends on support	excellent	excellent	2-element quad
3:1 frequency range	fixed		mixed	diamond acreage	no	fair	terminated rhombic
all above half-wave resonance	special tuner	immediate	vertical or horizontal	large	poor	good	Bonadio square-diagonal
all above half-wave resonance	special tuner	immediate	mixed	large	poor	good	Bonadio box-diagonal
all above half-wave resonance	special tuner	immediate	vertical or horizontal	large	poor	good	Bonadio cube-diagonal
all above half-wave resonance	special tuner	immediate	vertical or horizontal	large	good	very good	Bonadio space-dimension

F3EA, 17 October 1967, "Your signal is one of the very best I can hear on the band; very little QSB."

G3OSI, 20 October 1967, "When I heard you calling 'CQ DX,' you were the strongest on the band, but there is an ssb stronger."

Z51JH, 24 October 1967, while in a four-continent roundtable with G3HCU and the late ZL2UD, "This evening there is fading on all signals, but **not** on your signal, George."

From G3HCU, during the same roundtable, "George has a signal we classify as outstanding here in England."

Note that some stations are running up to 8 dB more power (kilowatt input), plus 10 dB or so for antenna elevations and up to 8-dB beam-antenna gain; this is more than 26 dB over W2WLR*—a 400:1 power ratio or more than four S-units. I

* And this does not include the theoretical 9-dB gain offered by single sideband.

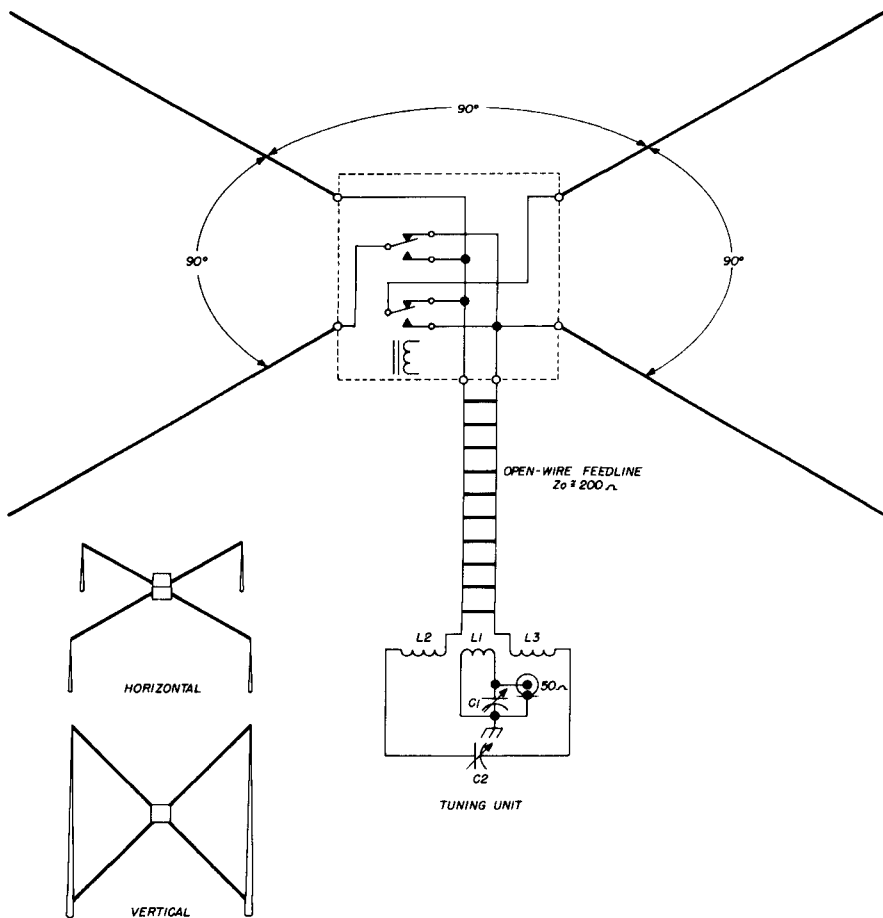


fig. 1. The square-diagonal antenna. The switching relay in the center is a modified dpdt unit; the special tuning unit is very important to proper antenna operation.

don't know what happened to the signal, but it is not happening at ground level; it must be happening in the ionosphere.

While splitting up antenna power three ways results in nearly 5-dB "loss" in the desired direction, it appears to mitigate fading depth by as much as 25 dB. Also, selective fading garble seems to be overcome by these antennas.

square-diagonal antenna

As the name implies, the square diagonal antenna shown in fig. 1 is laid out along the diagonals of an imaginary square. It can be mounted in the horizontal plane on four supports or in the verti-

cal plane on two poles. Both of these installations are shown in fig. 1. Each of the legs of the cross are exactly the same length and are made of number 8 aluminum ground wire or number 12 copper wire.

The relay in the center is a dpdt relay that has been modified for minimum lead length. The special antenna tuner shown in fig. 1 is extremely important to proper operation and must not be left out. The reactance of L1 and C1 should be equal to one-third the impedance of the coaxial feedline if they are in parallel (three times the impedance of the coax if in series).

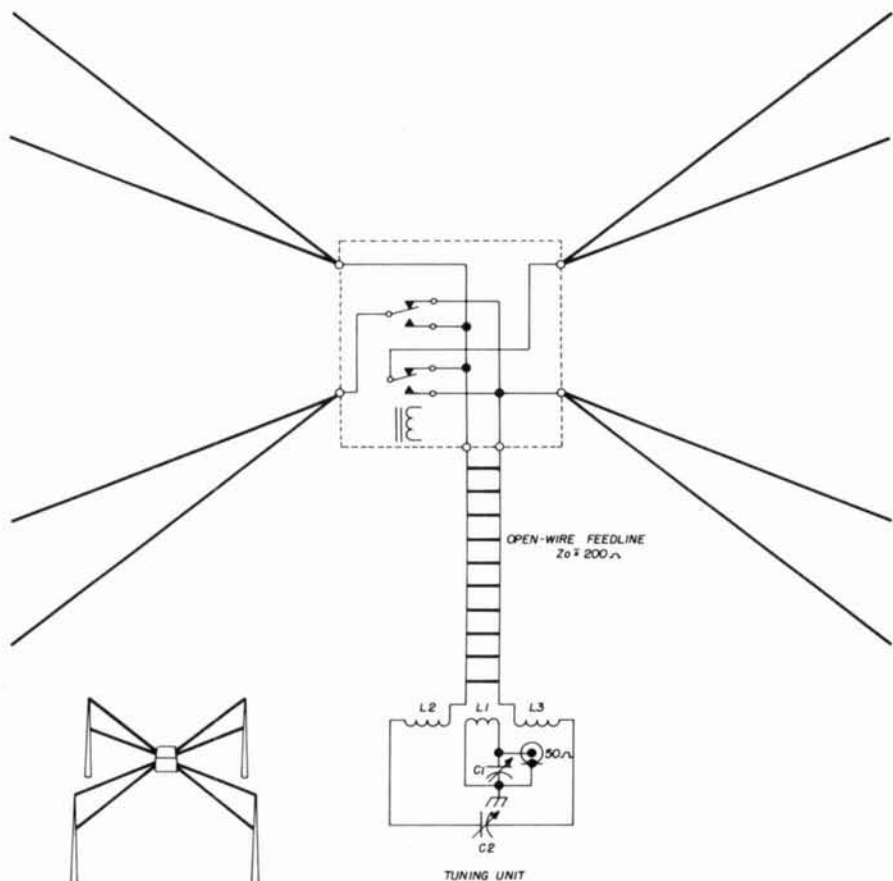
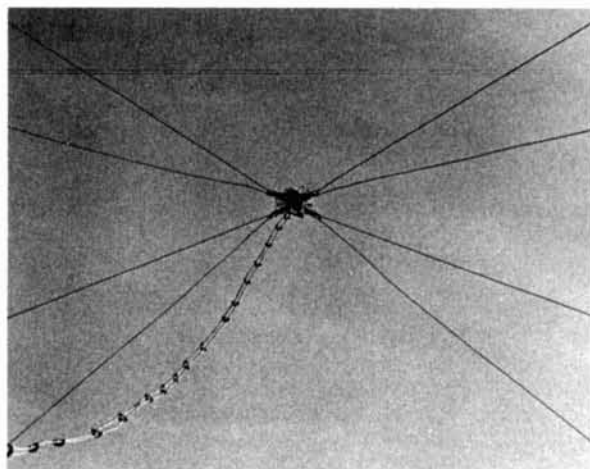


fig. 2. The box-diagonal antenna. The switching relay and tuning unit are the same as fig. 2.



Box-diagonal antenna.

The L1-C1 tuned circuit is grid dipped to the middle of the band before the coax cable is connected and **not** retuned. The reactance of L2 and L3 is three to five times the value of the impedance presented at the tuner by the open-wire feedline. If L1 is closely coupled to L2 and L3, an swr of 1:1 is an indication that the proper LC ratios have been used.

box-diagonal antenna

The box-diagonal antenna shown in fig. 2 is a natural development of the square-diagonal antenna. The special switching relay in the center and the tuning unit are the same as those used with the square-diagonal. The length of each

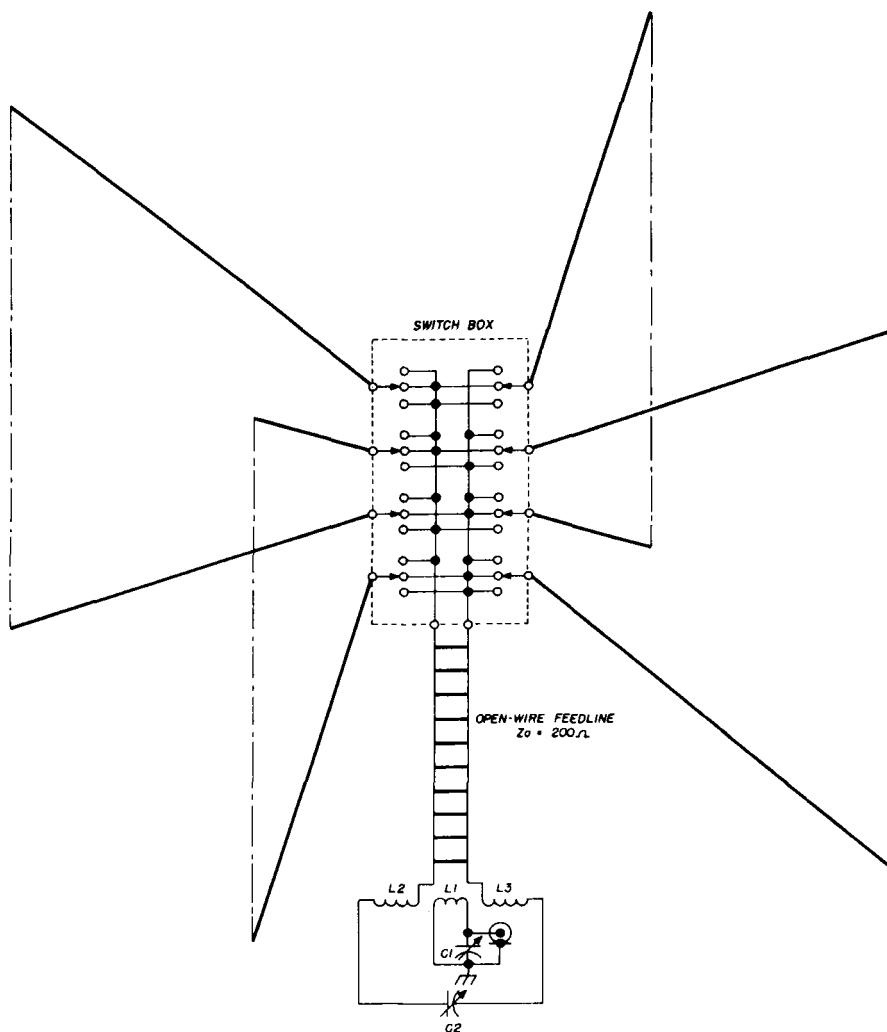


fig. 3. The cube-diagonal antenna. The element ends are located at the corners of an imaginary cube.

of the eight elements is exactly the same as before, and the vertical spread between wires on all four masts is identical. As you can see from **table 1**, this slight refinement in antenna construction results in improved signal reports—both close in and at long distance—as well as improved short-term fading performance.

cube-diagonal antenna

The cube-diagonal antenna shown in **fig. 3** is the result of efforts to further refine this family of antennas. The eight elements are exactly the same length and

are terminated in insulators located at the corners of an imaginary cube. This antenna is somewhat similar to the box-diagonal, but note that the switching relay in the center is much more complex than the relay used in previous designs.

If you trace out the switching positions of the relay, you will find that in the center or neutral position the four upper elements are fed against the four lower elements. In the lower position of the relay the front four elements are fed against the rear four; and in the upper position, the left elements are fed against the right.

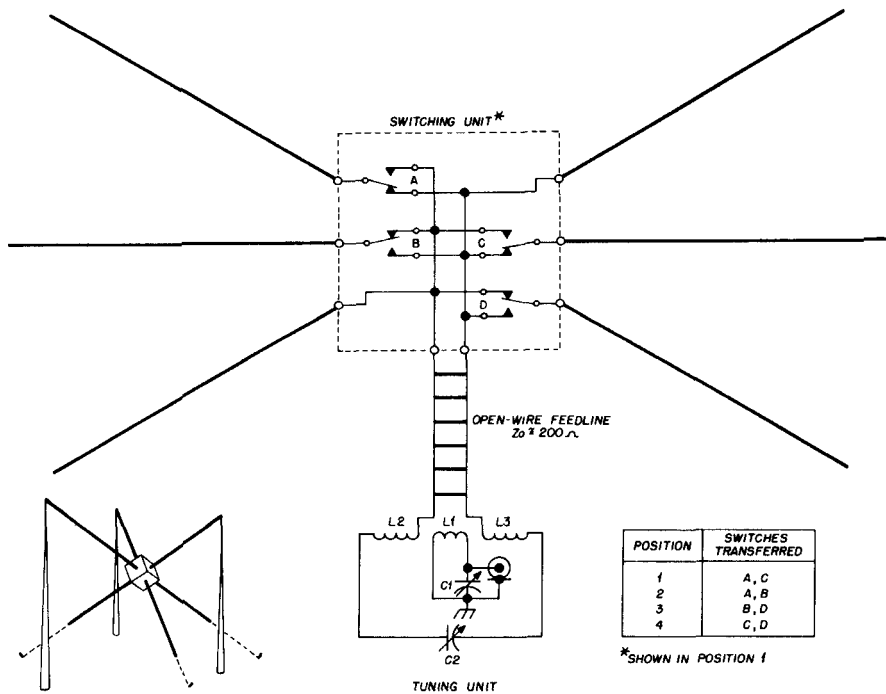


fig. 4. The space-dimension antenna; high performance with three support masts.

There was no commercial relay available to do this job, so a special unit had to be built.

space-dimension antenna

The space-dimension antenna shown in fig. 4 is the latest effort to improve performance and simplify construction. Only three vertical masts are required for this antenna, but it out-performs all of the other Bonadio antennas. All six elements of the space-dimension antenna are exactly the same length and constructed of number 8 aluminum or number 12 copper wire; all angles are either 90 or 180 degrees.

Four switching positions are required at the center of the antenna to provide one vertical and three horizontal polarization patterns while maintaining correct tuning and loading; if you trace out the switching logic, you'll see that three adjacent elements are fed against the other three. It would be possible to construct a single

remote-control switch to handle the complex switching chores, but the same results can be obtained with four spdt relays energized as shown in the table in fig. 4. The optimum elevation of the switch above ground is 20 meters (66 feet).

summary

Although these antennas have been in a continuous state of evolution since 1953, a lot of work remains to be done—experiments at different locations, performance tests at different frequencies and under different operating conditions, vhf and uhf tests to determine performance over line-of-sight paths—this is just a sample of the kinds of data that are needed. Construction of the antennas themselves is not difficult, although the complex switches and high-power-factor antenna tuners must be used for proper performance. Look for complete construction details in **ham radio** soon.

ham radio



**new solid-state
camera
and monitor
for
slow-scan television**

These new
solid-state designs
from Canada
use sampling techniques
to provide
slow-scan pictures
with fast-scan cameras

D. J. Watson and S. M. K. Horne, VE3EGO, Northern Electric Co., Ltd. Research & Developments Labs, P.O. Box 3511, Station C, Ottawa, Canada

The possibility of transmitting pictures has probably appealed to radio experimenters since the early days of radio. Hugo Gernsbeck featured the "teleautograph" on the cover of one of his early publications before 1910, and a cartoon in the May, 1921 issue of *QST* portrayed father tweaking the controls of his "radiotelescopograph." When practical (and realistically priced) hardware became available in the mid-1930's, radio amateurs were ready and the pages of *QST* were filled with technical and construction articles—so many in fact that some readers complained.

Many over-the-air friendships have been established between amateurs who have no idea what the other looks like, so the underlying interest in television should come as no great surprise. Unfortunately, normal fast-scan television requires wide bandwidths that are not compatible with our relatively narrow high-frequency allocations. However, slow-scan television—perhaps more properly called narrow-band image transmission—makes it possible.

In 1957, Cop MacDonald, now WAØNLQ, became intrigued with the possibility of using a slow-scan technique for image transmission by radio. This method involves the use of television-type pickup and reproduction devices with slow scanning rates to produce narrow bandwidth video signals. In September, 1957, he started the design and construction of a low-cost slow-scan system for use with amateur phone equipment.³

The system required no greater bandwidth than normal voice communications and the signal could be transmitted and received with any equipment suitable for radiotelephone work. Ideally, the "cam-

Along with WAØNLQ, Don Miller, W9NTP, J. A. Plowman, G5AST, Louis I. Hutton, K7YZZ, and others did much to pioneer sstv development by proposing standards, writing technical and construction articles and interesting other amateurs in slow-scan work. A number of on-the-air experiments were conducted on the bands below 30 MHz under special temporary FCC authorization; similar arrangements were worked out with the DOT in Canada. In 1961 the ARRL requested the FCC to permit narrow-band picture transmissions in the phone portions of the 10- and 15-meter bands; in 1967 the FCC issued a Notice of Proposed Rulemaking that would



The authors via slow scan: Doug Watson. . .



and Syd Home, VE3EGO

era" could be plugged into the microphone jack of the ssb transmitter and a "monitor" plugged into the headphone jack of the receiver to convert a modern amateur radio rig into a two-way picture transmission facility.

authorize narrow-band picture transmission in the lower frequency amateur bands; this was eventually adopted effective August 30, 1968. The slow-scan frequency allocations for the United States and Canada* are listed in **table 1**.

Syd Horne, VE3EGO, built the camera and monitor described by Copthorne MacDonald in **QST**.^{5,6} After many months of work and planning, he exchanged pictures across the Atlantic for the first time with Art Backman, SMØBUO, in Stockholm.⁷ But before this important milestone could be achieved, in addition to constructing the cameras and monitors, permission had to

This article is an adaptation of an article that originally appeared in the January, 1969 issue of *electron*—the Canadian electronics magazine edited by Ernie Welling, VE2YU—and is presented here through the co-operation of Tomar Publications, Ltd.

table 1. Slow-scan television frequency allocations below 30 MHz.

United States ¹		Canada ²
present	22 November 1969	
3.800- 3.850 MHz	3.800- 3.900 MHz	3.725- 3.750 MHz
7.200- 7.225 MHz	7.200- 7.250 MHz	7.150- 7.175 MHz
14.200-14.235 MHz	14.200-14.275 MHz	14.175-14.350 MHz
21.250-21.300 MHz	21.250-21.350 MHz	21.100-21.450 MHz
28.500-29.700 MHz	28.500-29.700 MHz	28.100-29.700 MHz

1. Allocations limited to Advanced and Extra-class segments of the bands below 28 MHz.

2. Subject to revision on March 31, 1969.

be obtained from the licensing authorities in both countries to transmit sstv.

While operating with this equipment, Syd became aware of many of the operating restrictions that were imposed by existing equipment. He discussed the problem with Doug Watson and managed to get him interested enough in slow-scan tv to attempt a solid-state camera and monitor design incorporating features which would facilitate operation. The camera prototype was completed in June, 1968, and the monitor in October, just in time for a sstv demonstration at the first annual Radio Society of Ontario convention. With these new designs, the camera **samples** the output from a fast-scan picture source, producing pictures at the slow-scan rate.

the sampling camera

The camera uses a regular vidicon, such as the 7038, instead of the shuttered-mode Westinghouse 7290 vidicon required

* Earlier the Canadian Telecommunications Bureau had been requested to authorize Canadian amateurs to conduct slow-scan television experiments in portions of the high-frequency bands available to the amateur service. Following a study of viewpoints expressed by various groups, an amendment was made to the General Radio Regulations Part II under the Radio Act to authorize special experimentation. Under this authority, permission was granted to Canadian amateurs to experiment with sstv in the bands listed in **table 1**, subject to revision on March 31, 1969, the end of the current licensing year. The Telecommunications Bureau provided additional assistance by arranging to monitor and record the spectrum of a typical sstv transmission.

for the MacDonald camera. While 7038's have been used in modifications of the MacDonald camera, the low speed of the beam across the target area—of the order of 7.5 inches per second—results in very marginal performance of the vidicon. Therefore, it was decided to use the vidicon in the fast-scan mode and sample its output to synthesize slow-scan pictures.

table 2. The following sstv nets are in operation to promote slow-scan activity and help amateurs get started in sstv. The first two are primarily Canadian nets.

Tuesdays	2000 EST or EDT	3.740 MHz	Jack Barlow, VE3PW
Thursdays	2000 EST or EDT	14.180 MHz ¹	Syd Horne, VE3EGO
Saturdays	1900 GMT	14.230 MHz	Don Miller, W9NTP

1. listening for U. S. stations on 14.230 MHz.

The current sstv standards require the output to be equivalent to that from a 15-horizontal-line-per-second, 8-second-per-frame scanning raster. The easiest fast-scan raster to sample to obtain this output is 15 frames per second with a vertical frequency of about 3 kHz.

By displaying the fast-scan picture on an oscilloscope, rapid adjustment of electrical and optical focus, lighting and framing is possible, where previously up to eight seconds had to elapse before you could see the results of such adjustments. This is a tremendous operating advantage. The video path to the oscilloscope requires about 300 kHz bandwidth, but this only goes to the scope and a short length of shielded wire is adequate.

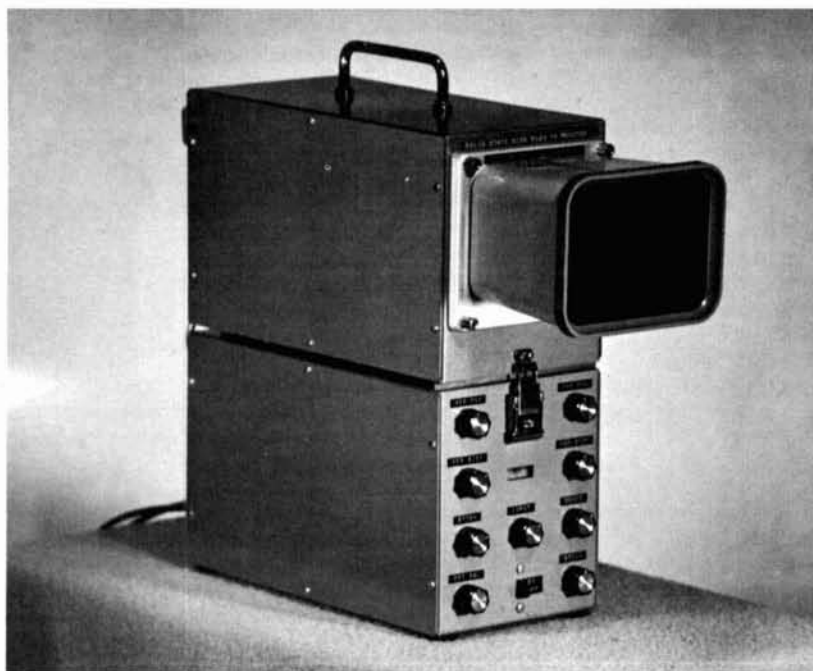
The fast-scan mode also permits the incorporation of automatic target control (atc) which automatically adjusts the target potential of the vidicon to compensate for changes in subject illumination. The time constants required to incorporate this in a slow-scan camera would render it useless, but with a 15 frames-per-second raster on the vidicon, compensation is achieved in approximately one second for a change of illumination greater than 100:1. The operating advantages of this feature are obvious.

Preliminary tests with the camera operating into a ssb transmitter drew the designers' attention to the danger of allowing the frequency-modulated subcarrier to exceed 2400 Hz. The filters of the transmitter wouldn't pass the higher frequencies, and the apparent signal dropout caused highlights to register as black on the receiving

operation is the optical focusing of the lens.

the monitor

A magnetically focused and deflected five-inch cathode-ray tube with a P7 phosphor was selected for the monitor (5FP7). This carries a number of advan-



Solid-state sampling slow-scan television monitor.

monitor; signal dropout also interfered with line and frame synchronization. A circuit was designed to detect frequency excursions beyond 2300 Hz and give an audible alarm whenever this occurs. The reference 2300-Hz signal used in this circuit is available with a flick of a switch so that its accuracy can be checked periodically.

The camera consists of two units each $3\frac{1}{2} \times 7 \times 8\frac{1}{2}$ inches. All dc voltages are regulated to minimize troubles due to hum and noise and line voltage changes. The only adjustment normally required in

tages for the solid-state approach as compared to a 5CP7A as used in the earlier monitor. The grid-cathode circuit of the 5FP7 can be, and usually is, at the grounded end of the high-voltage supply; this facilitates direct coupling which is almost a must for sstv work. The deflection coils are more easily driven by low-voltage solid-state circuitry than the deflection plates of an electro-static type tube. In addition, magnetically-focused tubes are characterized by a brighter image due to the geometry of the electron beam.

The specifications for the 5FP7 call for

a minimum of 4000 and a maximum of 8000 volts dc anode voltage; 6000 volts were used in this design. In an older monitor, there was raster distortion whenever the line voltage changed (e.g., whenever the refrigerator upstairs turned on). There was also a certain amount of high-light aberration due to the increase in deflection sensitivity as the high voltage dropped because of the high beam current during such highlights. An electronically-

table 3. Proposed slow-scan television standards.

Number of lines	120
Aspect ratio	1:1
Line frequency	15 per sec
Frame repetition rate	1 per 8 sec
Horizontal sync	1200 Hz for 5 millisecc
Vertical sync	1200 Hz for 30 millisecc
White frequency	2300 Hz
Black frequency	1500 Hz
Total bandwidth required	1100 Hz

regulated 6-kV supply that effectively cured these ailments was incorporated in the design.

Tuning an ssb receiver to provide intelligible reception of speech requires reasonably precise adjustment. The upward or downward shift of all frequencies due to slight mistuning is easily tolerated by the human ear. However, the reproduction of sstv images from the fm subcarrier requires the synch bursts to be within 50 Hz of 1200 Hz.

The fm demodulator designed for and used in this monitor was readily adapted to provide an output voltage proportional to the synch frequency. This is used to operate a tuning meter. A further step could be taken by controlling a variable reactance in the receiver circuitry to pro-

Unfortunately, it is impossible for the authors to provide more circuit or constructional particulars on the sampling camera and monitor until the proprietary designs of the Northern Electric Company are adequately protected. Hopefully they will be able to present the complete schematic and construction details as soon as the patent applications are filed.

Editor

vide afc which would automatically correct for the slight frequency drift usually encountered.

The Tektronix polaroid viewing hood shown in the photo effectively eliminates reflection of light sources in the viewing area by the crt face and the yellow filter used to eliminate the blue flash of the P7 phosphor.

The monitor is housed in two utility cabinets hinged together at the back so that the top unit containing the 5FP7 can be tilted for optimum viewing angle. The over-all size of the monitor is 6x14x12 inches.

summary

It is difficult to estimate the eventual impact of sstv on the amateur phone bands at the present time. However, a parallel can be drawn between the development and use of single sideband some 15 years ago and slow-scan television today. By overcoming many of the operating restrictions with the sstv sampling camera—along with the decided advantage of using readily available vidicons—it is reasonable to expect increased sstv activity in the future.

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\$3⁹⁵



OX OSCILLATOR

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\$2⁹⁵

MXX-1 Transistor RF Mixer **\$3.50**
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)



MXX-1



SAX-1



PAX-1



BAX-1

SAX-1 Transistor RF Amplifier **\$3.50**
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)

PAX-1 Transistor RF Power Amplifier **\$3.75**
A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw can be obtained depending on the frequency and voltage. Amplifier can be amplitude modulated for low power communication. Frequency range 3,000 to 30,000 KHz.

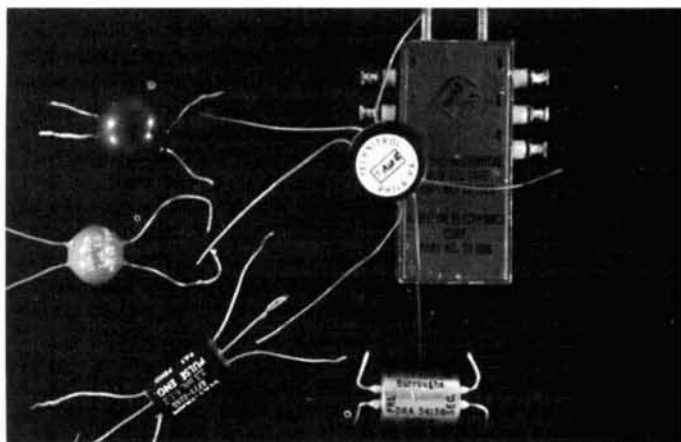
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General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL, Experimenter or Amateur.

Write for complete catalog.



CRYSTAL MFG. CO., INC.
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Pulse transformers for
blocking oscillators.



enter
the strange
but useful
blocking oscillator

Presenting
some facts and figures
on a versatile
yet simple
pulse generator

Hank Olson, W6CXN, P. O. Box 339, Menlo Park, California 94025

We are about to become acquainted with a singularly mischievous member of the oscillator family, whose apparent simplicity belies enough odd behavior to make the average electronic engineer weep all over his bagels.

The blocking oscillator is deliberately designed to produce nonsinusoidal waveforms; it usually produces pulses whose duration is short compared to pulse period (i.e., time between each pulse plus pulse length). While most oscillators are designed to have as low a feedback factor as possible (and yet remain self-starting), the blocking oscillator has a very large feedback factor. This, in combination with a low-Q tuned circuit, causes oscillations to build up rapidly, then die out for a time that's long compared to the pulse length (fig. 1). The transformer that is used with the blocking oscillator is not tuned except by stray capacitance, which usually assures the low-Q requirement.

how they work

Two forms of the blocking oscillator are in common use. The first is similar to the tuned-plate, tuned-grid or tickler-feed-back type oscillator. This is also shown in **fig. 1**. Of course, there is no "tuning," "plate," or "grid," so perhaps tickler-feedback is the better description. The second form is similar to the Hartley, as shown in **fig. 2**. Since only parasitic capacitance is used for tuning, the Colpitts form of circuit is not ordinarily used for blocking oscillators.

In **fig. 3** is a "real-life" blocking oscillator of the free-running tickler-feedback type. This astable circuit produces pulses whose pulse length is primarily dependent upon the inductance and resistance of the collector winding of the transformer, and whose repetition rate is primarily dependent on the time constant, RC. A detailed formulation of the design factors and their interrelation is given in reference 1.

Table 1 is a listing of the pulse transformers, recommended for blocking oscillator service, made by one transformer manufacturer.² Note that pulse length in-

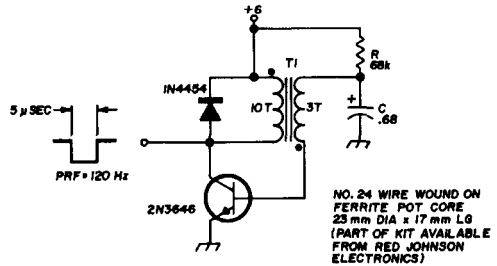


fig. 3. Blocking oscillator of the free-running tickler-feedback type.

creases with collector-winding inductance. Similar transformers are also manufactured by United Transformer Company and others. The turns ratio of the primary

fig. 1. Single-swing blocking oscillator waveforms are shown in A. The circuit in B is a solid-state tickler-feedback blocking oscillator circuit.

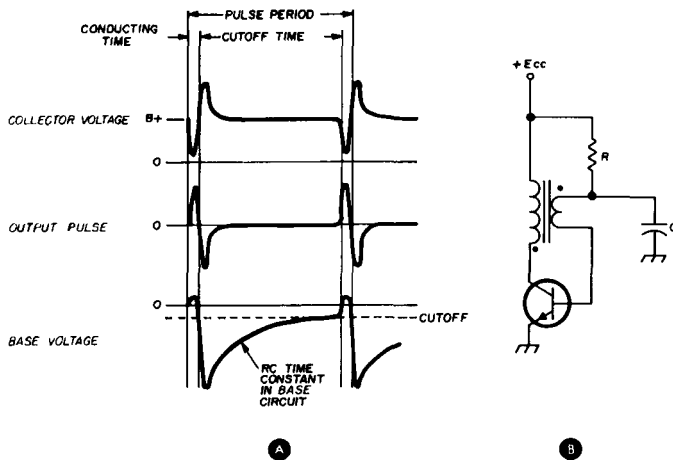
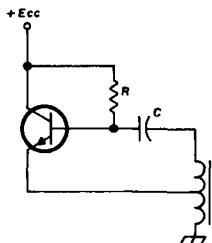


fig. 2. Hartley blocking oscillator circuit.



(collector) winding to secondary (base) winding is usually between 3 to 1 and 5 to 1. Linville³ has shown that, for bipolar transistor blocking oscillators, a 5-to-1 ratio gives the sharpest pulses.

Since most amateurs are not in a position to buy specially constructed pulse transformers, they must either make them

or use surplus types. However, rolling-your-own pulse transformer is really quite easy, now that ferrite cores are widely available. Because ferrite cores have such

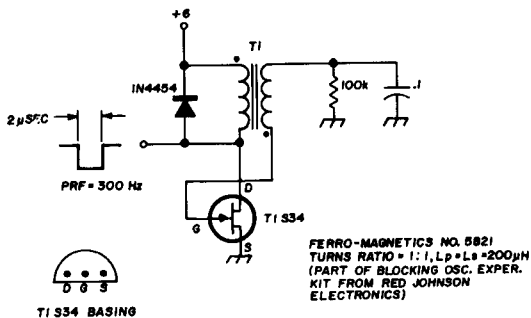


fig. 4. Blocking oscillator circuit that uses an fet with a tube-type pulse transformer.

high effective permeability, only a few hand-wound turns on a non-gapped core will provide enough inductance to produce a quite useful pulse width. Almost any of the closed-magnetic-path ferrite cores are adequate for pulse transformers, including pot cores, toroids, C-cores, E-I cores and U-I cores. The pot core used in fig. 3 is part of a "blocking oscillator experimenter kit." *

table 1. Pulse transformers for blocking oscillator service.

Pulse Eng. Catalog No.	Turns Ratio	Pulse Width (μ s)	Primary Inductance (mH)
2445	4:1:2	0.07 to 0.2	0.05
2444	4:1:2	0.1 to 0.2	0.1
2443	4:1:2	0.1 to 0.5	0.2
2671	4:1:4	0.1 to 0.5	0.2
2442	4:1:2	0.2 to 4.0	0.4
2672	4:1:4	0.2 to 4.0	0.4
2248	4:1:2	1 to 12	2.5
2673	4:1:4	1 to 12	3.0
2249	4:1:2	1 to 20	5.0
2250	4:1:2	1 to 50	10.0

* Available for \$2.00 from Red Johnson Electronics, 440 Pepper Avenue, Palo Alto, California 94306.

Most of the pulse transformers available in surplus are for the older tube-type blocking oscillators. The photograph shows a selection of these that were available in my local area surplus stores. The physical form of such small transformers seems to be quite distinct, and if you find one of these "gum balls," it is pretty likely to be a small pulse transformer.

The surplus tube-type pulse transformers can be used directly in bipolar transistor blocking oscillators, but the 1:1 ratio that most offer is too high to provide the best-looking pulses. But they can also be used

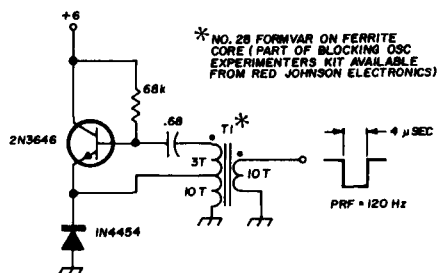


fig. 5. Hartley-type blocking oscillator.

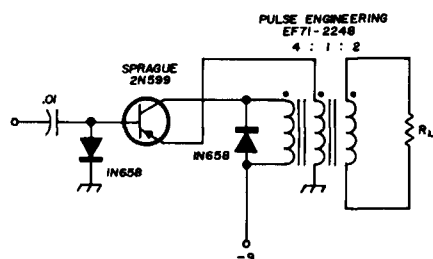


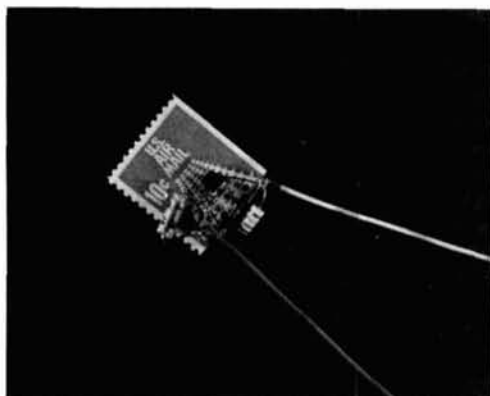
fig. 6. Blocking oscillator that is not free-running but is used as a one-shot.

in an fet blocking oscillator that is more nearly like the tube circuit for which they were designed, as in fig. 4.

When using an fet in a blocking oscillator it is best to use one that is de-

signed for switching, but such fet's are usually fairly expensive. The TIS34 (Texas Instruments) costs less than a dollar and has an $r_{ds(on)}$ of only about 200 ohms, and so this was the choice for fig. 4. The TIS34 is normally used for vhf rf amplifier

A circuit related to the blocking oscillator is shown in fig. 8. This circuit achieves the phase shift required for oscillation by means of a delay line. The waveform produced is a nearly square wave, whose period is twice that of the



Miniature blocking oscillator using the circuit shown in fig. 7.

service and has had wide acceptance in amateur two-meter service.

The circuits of figs. 3 and 4 are the free-running tickler-feedback type. Fig. 5 shows a Hartley-type blocking oscillator. Fig. 6 shows a blocking oscillator that is not free-running, but used as a one-shot. That is, the blocking oscillator produces one pulse for each trigger input. The circuit of fig. 6, by the way, is that recommended by Pulse Engineering to obtain the pulse widths specified using their transformers.²

integrated circuit pulsers

For those who favor an integrated circuit to produce pulses, because the IC is smaller and outwardly simpler, fig. 7 shows a circuit and picture of a blocking oscillator producing 100-ns pulses. Yes, friends, discrete circuits can be small, too. The ferrite core in this case is a ferrite shielding bead costing about 10c; the transistor is a Motorola plastic Micro-T at \$3.00. (A 2N3904 could be substituted at less cost if the small size isn't required.)

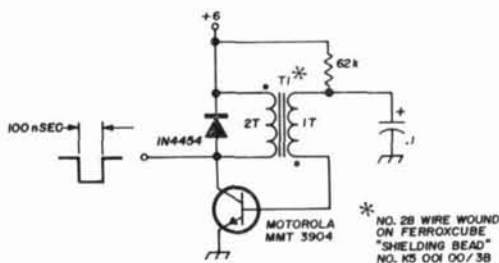


fig. 7. Miniature blocking oscillator circuit using a Motorola Micro-T transistor; completed circuit is shown in the photo.

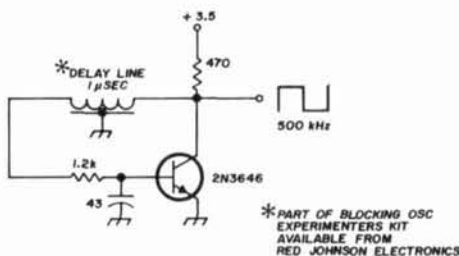


fig. 8. Circuit that achieves the phase shift necessary for oscillation from a delay line.

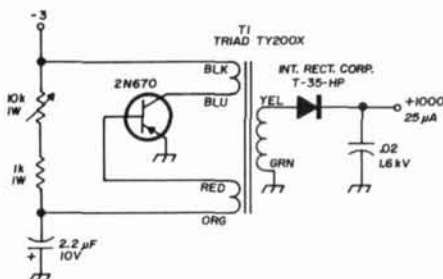


fig. 9. Blocking oscillator used in a high-voltage Geiger-counter power supply.

delay line. Since the ratio of pulse length to period is always fixed at $\frac{1}{2}$, this circuit is not as versatile as the blocking oscillator. However, for sheer simplicity this oscillator has few peers and can serve as a clock for RTL systems.

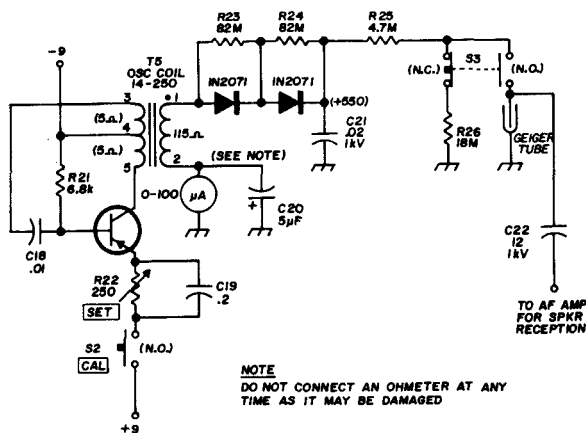


fig. 10. High-voltage Geiger-counter supply using a blocking oscillator.

applications

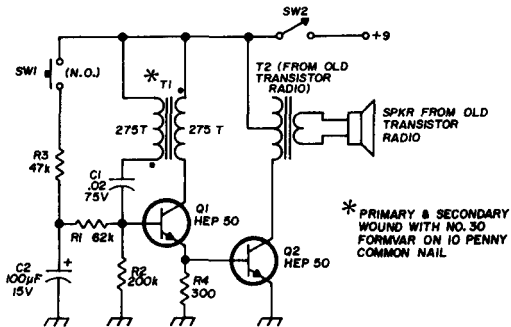
Aside from the obvious use of the blocking oscillator to produce short pulses for use in electronic devices such as tv sets and radars, there are a number of other applications. One very important use of blocking oscillators is in dc-to-dc converters. Since the blocking oscillator has such a low-duty cycle (i.e., the pulse length is short compared to the period) it is particularly suitable for converters requiring high-voltage, low-current output. Geiger counters are typical users of such converters. A circuit is shown in fig. 9. Another similar circuit is shown in fig. 10; this circuit is available from John Meshna for about \$5.00 as part of a surplus Geiger counter. Other blocking-oscillator-type dc-to-dc converters are contained in references 4, 5 and 6.

Another interesting use of the blocking oscillator is in electronic sirens. Such a circuit is shown in fig. 11.⁷ When SW1 is closed, C2 charges through R3, increasing the available base voltage of a blocking oscillator. This increasing voltage in-

creases the pulse rate of the blocking oscillator, while the pulse length stays more or less constant. When SW1 is opened C2 discharges through R1 and R2, causing the pulse rate to decrease again. The alternate, manual, closing and opening of SW1 produces a siren-like wail.

Other impulse-type services formerly using electromechanical contactors, such as electric auto fuel pumps and electric fence devices, are naturals for the blocking oscillator.⁸ The substitution of a blocking oscillator for arcing contacts in these services reduces radio frequency interference and increases reliability. All-in-all, a very nice cousin of the standard oscillator.

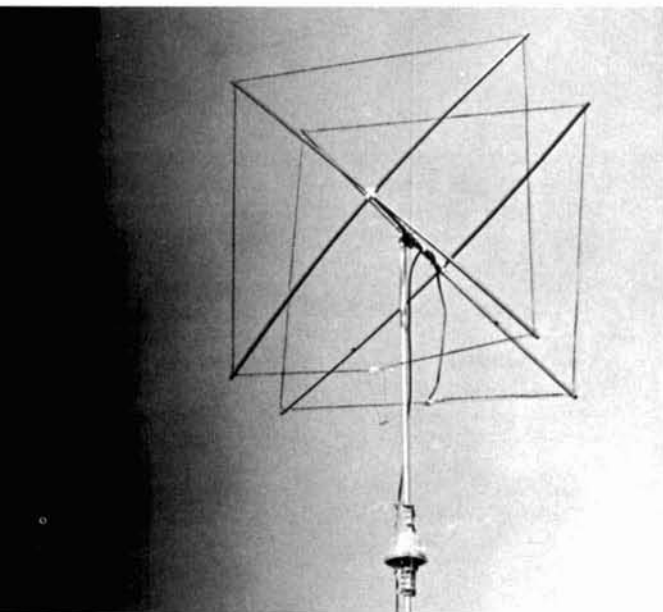
fig. 11. Electronic siren using a blocking oscillator; transistor Q2 is the audio amplifier.



references

1. "Handbook of Selected Semiconductor Circuits," *Buships NObsr 73231*, pp. 6-18 to 6-21 and 6-66 to 6-71.
2. *Pulse Engineering Catalog 206*, 1967, pp. 11-14.
3. J. Linville and R. Mattson, "Junction Transistor Blocking Oscillators," *Proceedings of the IRE*, November, 1955, pp. 1632-8.
4. "Transistors and Semiconductor Diodes," *RCA SCD-108A*, 1957, p. 31.
5. "Medium Power Germanium Transistor Power Supply Circuits," *Texas Instruments SC-1034*, October, 1960.
6. H. Olson, "A Self-Regulating DC to DC Converter," *73 Magazine*, May, 1966, p. 46.
7. "Hobby-Experimenter Projects Handbook," *Motorola HEP 400*.
8. "Motorola Semiconductor Circuits Manual," *Motorola*, 1964, pp. 7-31 through 7-34.

ham radio



an economy six-meter cubical quad

Here is
a directional antenna
you can build
for one buck
per dB of gain

Ev G. Taylor, W6DOR, 4100 Worthington Drive, North Highlands, California 95660

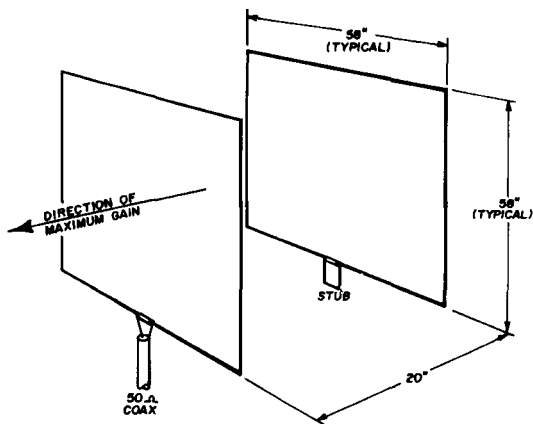
My first exposure to cubical quad antennas was right after World War II. A local amateur built one, and it worked very well. In fact he was doing as well as one of his ten-meter friends, who was using a three-element yagi. I built a quad also, then, but it didn't last long. I used a rather heavy wood and some dime-store shelf brackets; a Southern Indiana wind took care of it a few weeks after I put it up. Then I went back to yagis.

After several years and as many moves around the country, I finally settled in California, and I began to think seriously about the best antenna performance I could get for the least amount of money and labor. The quad won, and I must say Bill Orr's book¹ had a lot to do with it.

The six-meter quad I'm using now performs excellently and cost me about one

dollar per dB of gain. That's five dollars. If I use the gain figures you see in many ads for these antennas, then the cost would be something like fifty-eight cents per dB. That's because some of these ads base their claims on an isotropic reference source. This is engineering language for an imaginary point source stuck somewhere out in space where there aren't any path losses and other earthbound aberrations. But I can say one thing for certain: my quad works.

fig. 1. Layout of the economy six-meter quad showing the major dimensions. Both the driven element and reflector are made the same length to start; the reflector is tuned with the shorted stub.



materials

The secret weapon that beats the high cost of materials for this antenna is rigid plastic connectors. Of course, you must realize the antenna is designed for six meters, which means that physical lengths are small compared to 20 meters, for example. But if this six-meter antenna were scaled up in size to 20 meters, the cost certainly would be competitive with any commercial quad on the market.

A list of material you'll need is given in **table 1**. It is possible to shave costs even more if you've got a fairly well-stocked junk box and are resourceful. For example, you can apply the time-honored tech-

nique of boiling a two-inch piece of wooden dowel in paraffin for an egg-insulator substitute, or you could even use a piece of plastic water pipe, drilled at each end. There's no reason you couldn't use a length of mop handle for the boom; however, you would have to devise some method of fastening it to the crossarms other than threading it. With a little ham ingenuity, you could easily cut the material costs by one-third. Would you believe a high-gain, directional antenna for \$3.98 plus tax?

the crossarms

The material sources in **table 1** are suggestions of course. However, the plastic crossarms may be a little hard to find. They're made by Atlantic Research under the trademark G-S-R. My local source said they are rather uncommon and are made only by Atlantic Research, because patent rights haven't been issued to other plastics manufacturers. So if you can't locate any in your area, I've included the name and address of my source. These crossarms will accept 1/2-inch rigid plastic water pipe for the element supports, and the axial hole is threaded for steel pipe, which serves as the boom.

element supports

The plastic water pipe used for these parts comes in ten- and twenty-foot lengths. You'll need eight lengths, each 41 inches long. That's exactly 27 feet, 4 inches. I'd recommend buying one twenty-foot and two ten-foot lengths. Then you'll have a little extra material for insulators or other projects. This material is easy to work and has a good dielectric constant, at least up to the six-meter region.

elements

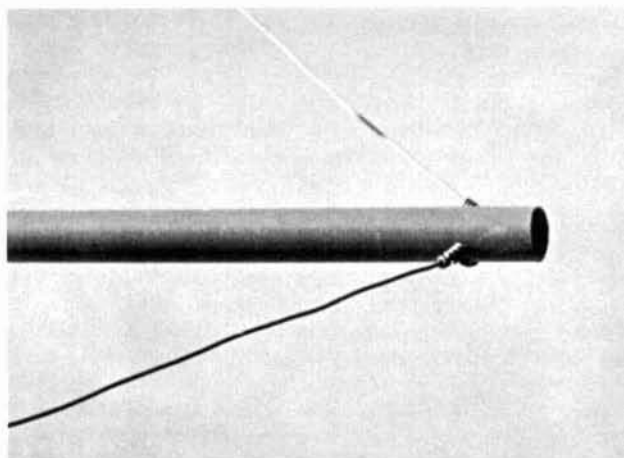
The sketch of **fig. 1** indicates that you'll need 38 feet, 8 inches of wire for driven element and reflector. Almost any type of wire can be used, but I recommend copper-clad steel. This wire is designed for antennas. It's a little more difficult to work with than pure copper wire, but it doesn't stretch. Another substitute is Sears' electric

fence wire. It costs about \$5.50 for a half-mile length of number 18 galvanized. Element diameter doesn't affect antenna bandwidth in a quad to any great extent, because the Q of a closed-loop antenna system is low. I've shown fifty feet of wire as the recommended quantity in **table 1**. This allows a little extra for the stub and fastenings.

construction

Assemble boom and crossarms first. The steel pipe boom should be threaded at both ends. If you decide to use a mop handle boom, it should be easy to force fit the wood into the plastic crossarms. I'm a great believer in epoxy. Although I didn't use a wooden boom, it should work all right if you use epoxy to weld boom to crossarms. It's a lot lighter in weight than the steel pipe, and it's free.

Drill holes for the wire in one end of each of the eight element supports. These holes should be located one inch from the end. Now insert the one-foot length of 3/4-inch diameter dowel into the element sup-



Attaching the wire elements to the support arms.

ports where they join to the crossarms. This gives added strength.

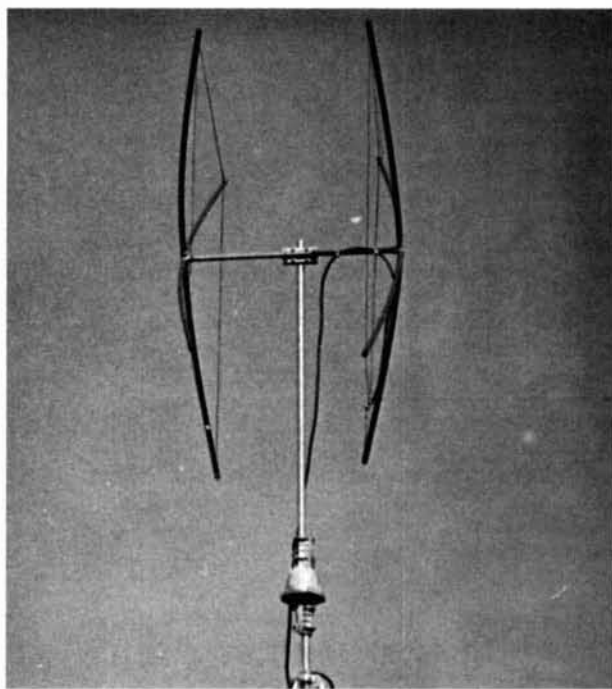
String the wire through the holes in the element supports and pull the wire up snugly. The element supports will then pull inward slightly. This adds to the stability

table 1. Material for the economy 6-meter quad.

part	material	quantity	suggested source or manufacturer
elements	no. 18 copperclad steel, or no. 12 AWG enamelled wire, hard drawn	50 feet	Junk box. (Alternate: Sears, Roebuck no. 18 electric fence wire; farm catalogue.)
element supports	plastic water pipe, 41-inch long by 1/2-inch	8 each	Lascopie 1/2-inch PVC 1220 or equivalent.
crossarms	plastic water pipe "side outlet cross"	2 each	E/Tronics, 7300 Worthington Drive, North Highlands, California 95660 Part no. 1764-1; \$4.00 for five crossarms.
boom	galvanized steel water pipe, 24-inch long by 1/2-inch diameter (see text)	1 each	Local hardware or plumbing supply (also see under "stiffener" below).
stiffener	wood dowel, one-foot long by 3/4-inch diameter	8 each	Mop handle, sanded and varnished (use marine spar varnish or epoxy).
hardware	egg insulators (2 each); Fahenstock clips (2 each); 6-32 cadmium-plated machine screw (1 each); flat washer (1 each); lock nut (1 each)		Local hardware supply (also see text).

of the whole affair. The assembly will then resemble a pair of back-to-back umbrellas.

Wrap six-inch lengths of wire around the elements as shown in the photo. An egg insulator serves as the termination for the driven element. The transmission line is soldered directly to the ends of the driven element. If you use coax cable, this means the center conductor and dielectric will be exposed to the elements. The best practice in a low-cost system like this is to give the exposed areas several coats of glyptal, Q-dope or any other good protective material.



side view of the economy quad.

There's no rf voltage at this point, but you'd be surprised what the transmission-line termination will look like in about six months if it's not protected. Be sure to allow adequate drying time between coats. Build up the protective coats gradually, then wrap the whole termination with Scotch number 33 electrical tape.

Dope the tape thoroughly in the same manner.

Another egg insulator terminates the reflector, with the wire extending ten inches beyond the insulator. This is the stub, which makes up the five- or six-percent extra length required for this element. Short-circuit the stub with two Fahenstock clips connected back-to-back with a 6-32 cad-plated machine screw, flat washer and lock nut. Don't use dissimilar metals for this hardware, or you'll never be able to find the hardware when you decide to disassemble the antenna. Electrolytic action will deteriorate the parts, especially if you live near the coast.

tune-up

With the dimensions given in **fig. 1**, the antenna resonant frequency is 50.15 MHz. This was determined with a Measurements Corporation Megacycle Meter (grid dipper). Tune the stub, by pruning the wire, to about five percent lower in frequency than the driven element.

performance

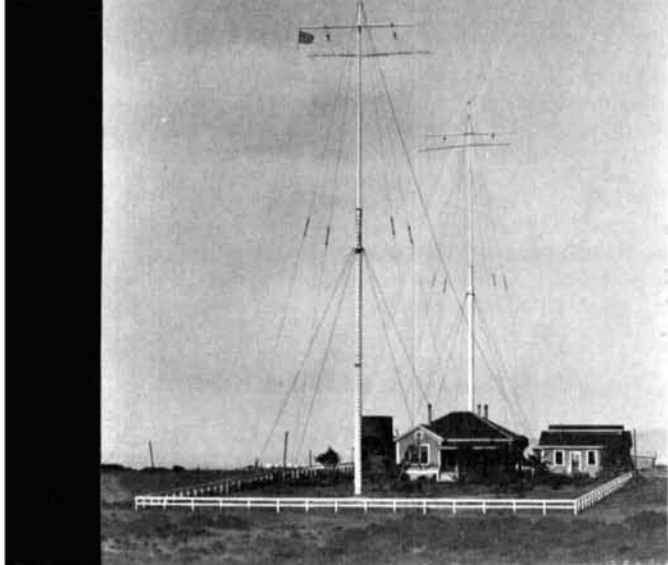
No antenna article seems to be complete without some report on performance, so I'll jump on the bandwagon with mine. Results to date have been quite good. A surprise opening in April 1968 netted 16 states in one weekend. With my Swan 250, contacts are being made almost every night with WA7GXM near Carson City, Nevada, with S-7 to S-9 reports. This is nearly 100 miles, over eight- and nine-thousand-foot peaks. Working the San Francisco bay area, 75 miles away, is a snap. And on April 1 and 29, 1968, I worked CE3QG during two F-layer openings with good results.

Perhaps a six-meter quad is the answer to the crosstown contacts that occur on twenty meters at the full legal power limit. Why support the power company? Come on up, the air's fine.

reference

1. Bill Orr, W6SAI, "All About Cubical Quads," Radio Publications, Wilton, Conn., 1959.

ham radio



Historical Collection, Union Title Insurance Company, San Diego, California.

wireless point loma

Want to reminisce
for a moment?
Then listen
to this old timer
recall the early days
of radio

IThe fog lifted early that morning of 12 May 1906. A young Navy Chief Radioman, R. B. Stuart, unfurled a bright new flag and ran it up the mast of a new wireless station atop Point Loma, California. Then he went inside the yellow cottage and pressed a telegraph key. With an ear-splitting, 500-Hz crash (500 cycles in those days), a whitish-blue spark jumped across the ten-inch gap, and the U. S. Navy wireless was officially on the air.

This station was one of many established on the West Coast for the Navy during 1902-1903. The call sign, TL (later to be changed to NPL), was familiar to radio officers on ships hundreds of miles at sea as they steamed up the Mexican Coast from Cape Horn. (The Panama Canal was still a dream then—the first ship went through in August, 1914.)

The romance of those early days of maritime wireless was recalled for local San Diego amateurs as Chief Stuart, an engineer with the Eleventh Naval District for many years, told his story when the U. S. Navy Electronics Laboratory groundbreaking ceremony occurred at the old Point Loma wireless-station site on 24 June 1949.

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

The old radio shack where Chief Stuart first put TL on the air was now a transportation office. The old Massie spark transmitter was gone, as were some of the more advanced transmitters that superseded it in later years. In the weeds around the old site you could still see remains of angle-iron anchors where the old towers once stood.

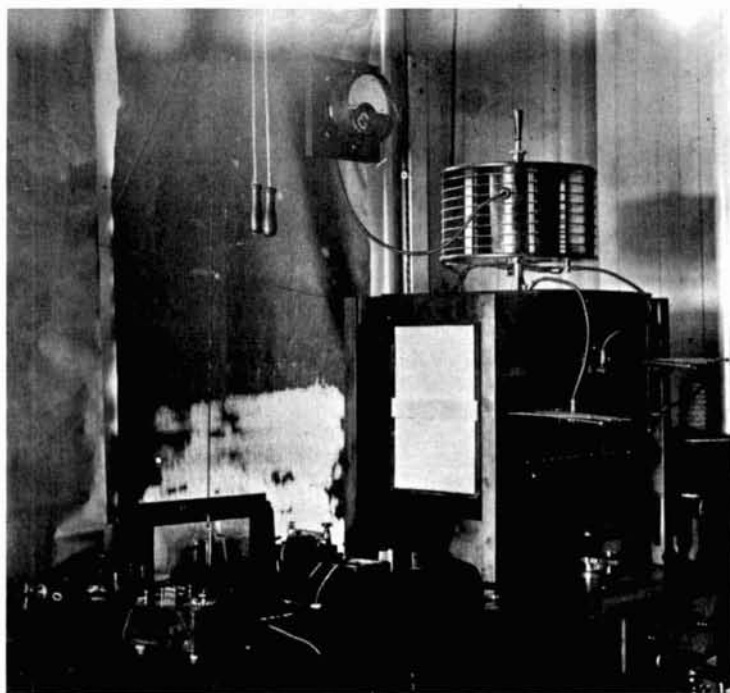
All was now gone except for the memories of the whining notes of rotary-gap transmitters, not-so-whining notes of non-synchronous straight gaps, and the sweet, dc whistle of the old Poulsen arcs. Sound maudlin and corny? Perhaps. But let me

the century to World War II, was a fellow with a unique talent.

He could sit in a stuffy, five-by-nine-foot shack on an old rusty coal-burning tub and copy press at thirty words per minute on a beat-up Remington (provided by the owners if they felt like it; else he used his own). At the same time, he could carry on a conversation with the mate about their plans when the ship anchored in Manzanillo, while listening with one ear for his call sign on the 500-kHz guard band. (Split phones, you know.)

If they were in a heavy seaway, the old kettle would list fifteen degrees, and his

Point Loma station about 1905 with a coherer on the left. There's a hot-wire ammeter on the wall in back of the oscillation transformer; the glass-insulated transmitting capacitor is below.



tell some of you youngsters with your solid-state receivers and strip-line devices about these radio operators in the early days of wireless.

the pioneers

A commercial radio operator working in the maritime service, from the turn of

bug would hang up on the dots, but Chief Stuart, at TL, couldn't tell the difference because the shipboard transmitter was being worked by a **radio operator**. It would have been great to use a mike and talk his message. Then he could have used that bug hand to pour his coffee and light his cigarette with the other. Yes, those fel-

lows were somewhat handicapped in those days. But they were radio operators...

As I said, all was gone when Chief Stuart told his story, as were most of the operators. Si Slocum, W6JH, passed away a few years ago, as did Chief Stuart. A few of the early operators are still around, though. One is Fred Nickel, W6CKZ, and Admiral Ellery W. Stone, USNR (Ret.) who, as a young Lieutenant in the USNR, wrote "Elements of Radio Telegraphy."

early detectors

Across the room from Ellery, as he wrote the book, were the old copper helix and the marble-insulated switch panels. His desk was probably not much different from the earlier ones, which held the coherer detector, operated by tapping its glass tube

Early Naval stations on the West Coast

NPA	Cordova, Alaska
NPB	Sitka, Alaska
NPC	Bremerton, Washington
NPD	Tatoosh Island, Washington
NPE	North Head, Washington
NPF	Cape Blanco, Oregon
NPG	Mare Island, California
NPH	Vladivostok, Siberia (temporary)
NPI	Farallon Islands, California
NPJ	Balboa, Canal Zone
NPK	Pt. Arguello, California
NPL	Pt. Loma, California
NPM	Pearl Harbor, Hawaii
NPN	Guam
NPO	Cavite, Philippines
NPP	Peking, China
NPQ	St. Paul, Alaska
NPR	Dutch Harbor, Alaska
NPS	Kodiak Island, Alaska
NPT	Olongapo, Philippines
NPU	Tutuila, Samoa
NPV	Seward, Alaska
NPW	Eureka, California
NPX	San Pedro, California
NPY	St. George, Alaska
NPZ	Puget Sound, Washington

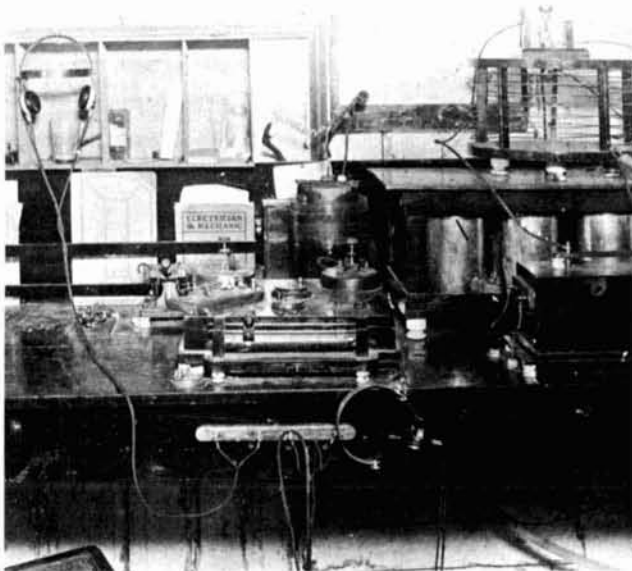
The call letters of Naval stations at yet an earlier period were:

TA	Cape Blanco, Oregon
TD	Tatoosh Island, Washington
TE	North Head, Oregon
TG	Mare Island, California
TH	Farallon Islands, California
TI	Goat Island, California
TJ	Pt. Arguello, California
TL (also TM)	Pt. Loma, California

with a doorbell clapper. This marvelous device would then uncohere the silver filings so the detector would receive again. It was a pretty slow business.

Other detectors were the magnetic detector, (which had to be rewound ever so

In the early days, amateurs often worked Naval and commercial stations. Gene Skinner used this station in San Diego in 1909 under the call "ES" to contact Navy ships in Magdalena Bay 500 miles away.

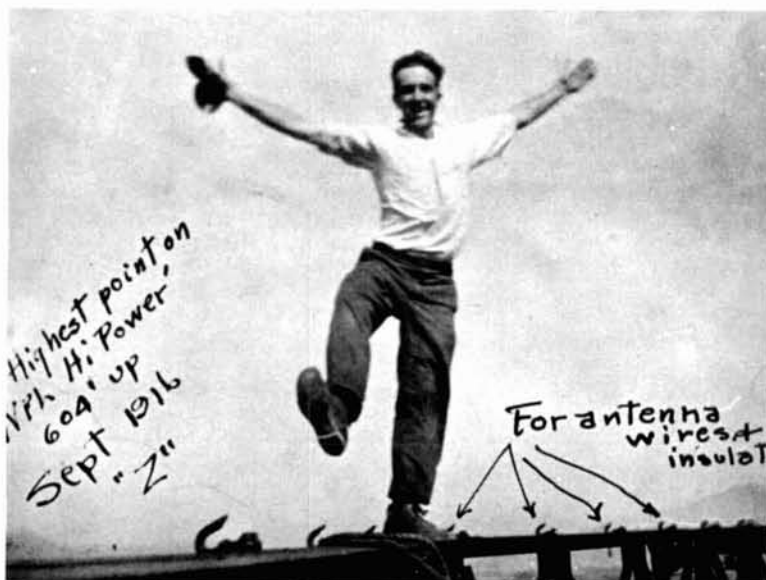


often), the galena, silicon, or carborundum. After every message the galena would become desensitized because of the local large currents produced by the transmitter. The operator would then have to feel around on the surface of the crystal with the cat-whisker for another sensitive spot. You can well imagine the experience of the midwatch operator, who had just arrived at the station, after winding his way up the muddy canyon road in a horse and buggy. He'd probably been on liberty down in the small community of Roseville where he'd had a few beers. He was shaking so badly from the effects of the beer and cold that he wasn't in any condition

to fuss around with any cat-whisker.

In those days the operators at TL did their own cooking, and many local residents lost chickens to night foraging parties from the station. In the daytime, the rabbit population of the Point would bounce out of sight as the operators with their shotguns approached, almost in the exact spot where Richard Henry Dana and a companion had hiked up over the point eighty years before.

Diego paper to the ships at sea, with "CQ de NPL-Press." Wireless operators on oil tankers, passenger ships and cruisers adjusted their cat-whiskers and began to copy the messages to put them in touch with the world. Point Loma's voice was available for both civilian and Navy traffic until 1915, when a German Telefunken transmitter was installed, and the old spark gap was silenced for all time, only to linger in the memories of many old-time



Joe Hallock, W7YA, Portland's now-retired FCC inspector standing on top of the 604-foot NPL tower in 1916.

the great white fleet

In 1908, NPL took part in wireless experiments with the Great White Fleet, which was sent around the world by Teddy Roosevelt. The Fleet had been working its way up the coast of Mexico to the coaling station at Magdalena Bay in lower California, and local amateurs competed with TL in contacting the ships. Dr. Lee De Forest was on board one of the ships, the USS Connecticut, the flagship. He had his audion-tube receiver aboard.

These early experiments with the USS Connecticut were soon forgotten as the station later was busy with its growing traffic, or was sending news from the San

wireless hams around San Diego who had hiked out to the station to watch.

Mr. Eugene Skinner remembers riding out to the station in 1909 on his motorbike after working TL on his spark rig. A couple of other early amateurs who used to contact TL were Harry Gough, K6AJ, and the late Carl Rogatsky, W6PG. These memories will probably bring letters from many of the old ops who listened to the sweet, 500-cycle note blasted through the air from the old Telefunken transmitter, which was installed in 1915 in Chollas Heights, east of San Diego.

ham radio

universal flea-power transmitter

With QRP societies claiming record memberships and ham magazines reporting flea-power DX over increasingly long expanses, many amateurs are tinkering with low-power circuits. The basic problem with most published designs is that the oscillator circuits are crucially dependent upon the L/C factors and related components.

The result is a circuit that will produce outstanding performance on 80 meters, but simply refuses to oscillate—without major circuit overhaul—on 160 or 20. The universal circuit illustrated in fig. 1 overcomes this long-standing obstacle to true amateur-band flexibility.

five bands

By creating a parallel resonance, fundamental mode, a simple transistor oscillator can be built which will perform reliably over the range from 1 to 21.5 MHz. If you add tuned circuitry at the frequency desired, you can be on any ham band in that range.

By using an extremely simple oscillator—with no tuning circuits—frequency drift due to aging and external ambient variations has been eliminated. The 22-pF variable stabilizes initial frequency shifts; it's a preset adjustment and doesn't have to be accessible from the front panel.

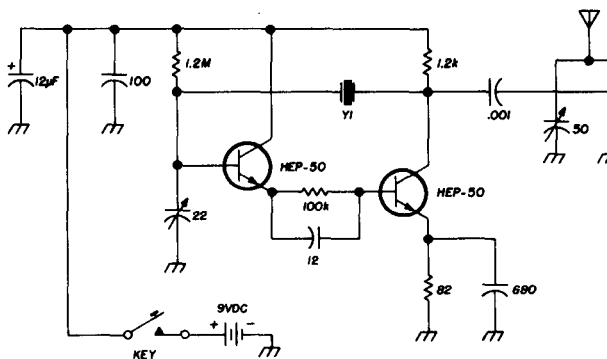
Similar in design to a Pierce oscillator with an emitter-follower inserted between the base of the second transistor and the crystal, the wide-band approach increases input impedance at the crystal input to the transistor. This impedance is normally quite low when compared with crystal

characteristics. As frequency increases, the two emitter bias circuits aid in reducing gain attenuation.

The only way this wide-band oscillator can be upset from the stability standpoint is if the battery supply voltage fluctuates (you can easily cure any problems here by inserting a zener diode).

Referring to fig. 1, note that the output

fig. 1. Circuit diagram for a flea-power transmitter for 160 through 20 meters.



circuit is tuned to 14 MHz. This is included here only for practical purposes. The tiny transmitter can be put on the air directly from this diagram—or you can adapt the output for any band you want.

Note that the transmitter is dependent on fundamental-frequency crystal oscillation. Doubling or tripling action is not recommended, unless a more elaborate output stage is added.

ham radio

Robert M. Brown, K2ZSQ, 5611 Middaugh Avenue, Downers Grove, Illinois 60515

a Great one from NRCI



New 500-Watt 5-Bander from NRCI

You can't buy a more potent package than the new NRCI NCX-500 transceiver. This versatile 5-bander is packed with the performance extras that give you the sharpest signal on the band, plus an enviable collection of QSL's. Check it out!

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- Rugged heavy-duty 6LQ6's.
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THE FT_{DX} 400 TRANSCEIVER

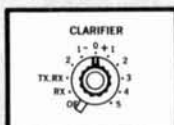
Conservatively rated at 500 watts PEP on all bands 80 through 10 the FT dx 400 combines high power with the hottest receiving section of any transceiver available today. In a few short months the Yaesu FT dx 400 has become the pace setter in the amateur field.

FEATURES: Built-in power supply • Built-in VOX • Built-in dual calibrators (25 and 100 KHz) • Built-in Clarifier (off-set tuning) • All crystals furnished 80 through the complete 10 meter band • Provision for 4 crystal-controlled channels within the amateur bands • Provision for 3 additional receive bands • Break-in CW with sidetone • Automatic dual acting noise limiter • and a sharp 2.3 KHz Crystal lattice filter with an optimum SSB shape factor of 1.66 to 1.

Design features include double conversion system for both transmit and receive functions resulting in, drift free operation, high sensitivity and image rejection • Switch selected metering • The FT dx 400 utilizes 18 tubes and 42 silicon semi-conductors in hybrid circuits designed to optimize the natural advantages of both tubes and transistors • Planetary gear tuning dial cover 500 KHz in 1 KHz increments • Glass-epoxy circuit boards • Final amplifier uses the popular 6KD6 tubes.

This imported desk top transceiver is beautifully styled with non-specular chrome front panel, back lighted dials, and heavy steel cabinet finished in functional blue-gray. The low cost, matching SP-400 Speaker is all that is needed to complete that professional station look.

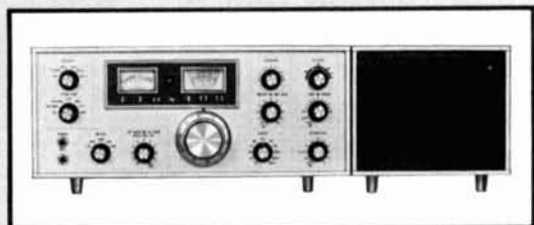
SPECIFICATIONS: Maximum input: 500 W PEP SSB, 440 W CW, 125 W AM. Sensitivity: 0.5 uv, S/N 20 db. Selectivity: 2.3 KHz (6 db down), 3.7 KHz (55 db down). Carrier suppression: more than 40 db down. Sideband suppression: more than 50 db down at 1 KHz. Frequency range: 3.5 to 4, 7 to 7.5, 14 to 14.5, 21 to 21.5, 28 to 30 (megahertz). Frequency stability: Less than 100 Hz drift in any 30 minute period after warm up.



CLARIFIER CONTROL—Does the work of an external VFO—allows operator to vary receive frequency 10KHZ from transmit frequency, or may be used as an extra VFO combining transmit and receive functions.



SELECT CONTROL—Offers option of internal or outboard VFO and crystal positions for convenient preset channel operation.



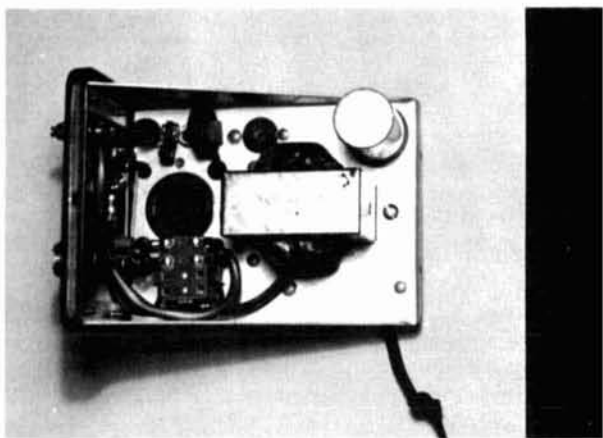
FUNCTION CONTROL—Selects crystal calibration marker frequency and desired transmit mode of operation.

FT DX 400 \$599.95 — SP-400 \$14.95



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— PROFESSIONAL EQUIPMENT FOR THE AMATEUR —



the ideal t-r switch

You can modify
any t-r switch
to provide
instant break-in and
best signal reception
at reasonable cost

Al Brogdon, K3KMO, RD 1, Box 390A, State College, Pennsylvania 16801

Two methods are in general use for providing an antenna in an amateur station installation. One is to use separate antennas for transmitting and receiving. Most amateurs interested in top receiver performance rule out this possibility, preferring instead to have the advantage of gain and directivity of their transmitting antenna for receiving. The other method is to use a single antenna for receiving and transmitting, and switch the antenna between receiver and transmitter with a relay or electronic transmit-receive (t-r) switch.

Both methods have advantages and disadvantages. For the cw operator, a t-r switch allows full break-in operation, which is necessary for traffic, net, DX and contest operating. If you've ever used full break-in, you can appreciate how nice it is to be able to monitor what's going on in the way of competition as you listen between code characters. But the t-r switch has one drawback. No t-r switch is as efficient as a direct connection between antenna and receiver. Many operators, therefore, compromise full break-in capability in favor of the best possible weak-signal performance and use an antenna changeover relay.

In this article I've presented the modification of a commercially available t-r switch to combine the advantages of elec-

tronic switching with those of an antenna changeover relay. The technique can be used with any commercial or homebrew t-r switch.

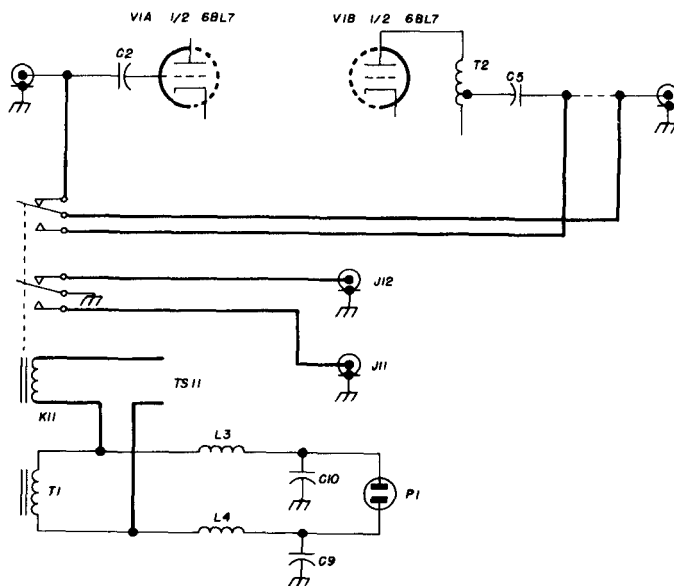
When I was faced with this choice, I wanted to have my cake and eat it, as usual, so I decided to combine the antenna relay with the t-r switch for the ideal combination of antenna changeover. The resulting improved t-r switch provides the capability of full break-in plus allowing direct connection of the antenna to the receiver.

the same, with only the mechanical considerations being different.

the change-over relay

The antenna changeover relay I used was a Potter and Brumfield KT11A, for 115 Vac operation. This dpdt relay has performed perfectly since its installation. One pole is used to switch the unbalanced coaxial feedline, and the other controls the transmitter. This provides a safety feature, because the transmitter can't be turned on until the relay removes the re-

fig. 1. Modifications to the Johnson t-r switch are shown by the heavy lines. Relay K11 is Potter & Brumfield KT11A (115 Vac).



the t-r switch

The switch I used for this application was the Johnson model 250-39 t-r switch. It is compact, reliable, and inexpensive and performs well. Furthermore, exactly the right amount of vacant space is available in the case to accommodate the antenna changeover relay, and just the right amount of space is on the front panel for the required new connectors.

I refer to this particular t-r switch in the following discussion, but any t-r switch, either commercial or homebrew, can be used. The electrical connections will be

ceiver input from the antenna feedline. The transmit switch operates the relay, one pole of which turns on the transmitter B plus.

construction

The changes to the Johnson t-r switch to add the relay are shown in fig. 1, with the modifications indicated by heavy lines. TS11 is a bakelite terminal strip, and J11 and J12 are RCA phono connectors. These carry control circuits, and any suitable substitute can be used. An spst switch connected to the terminals of TS11 is the

transmit switch. J11 provides the ground-to-transmit function to activate the transmitter.

If the transmit control for your transmitter requires this line to be off ground, then another terminal strip or an ungrounded connector can be used to carry this control line. J12 provides a ground on the receive function, which may be used to mute the receiver for phone operation.

connections to the station

To connect the t-r switch into your station, make the three coax connections (to receiver, transmitter, and antenna) as indicated on the t-r switch front panel. Connect the station transmit control switch to the terminals of TS11. Connect J11 and J12 as described for transmitter and receiver control. It's that simple; you're now ready to go.

operation

With the station-control switch in the standby position, the antenna is relay-connected to the receiver, and the transmitter is switched to standby by the same relay. This provides best weak-signal reception. When the station-control switch is in the transmit position, the receiver is disconnected from the antenna and connected to the t-r switch output. At the same time, the transmitter is relayed on, ready for full break-in operation.

The photo shows the inside of the t-r switch with the added relay and connectors. It makes a very neat package. If you prefer not to modify your t-r switch, an external antenna changeover relay can be wired to provide the same switching action. A Dow-Key model DK60-2C can be used, with the relay's auxiliary contacts wired for transmitter control in the manner described.

The cost of the relay and connectors for modifying the t-r switch comes to about \$4.25. The complete t-r switch described here can be duplicated as shown for a little less than \$35. It's a low price to pay for the versatility and good performance obtained.

ham radio

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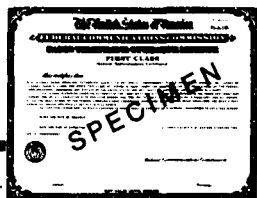
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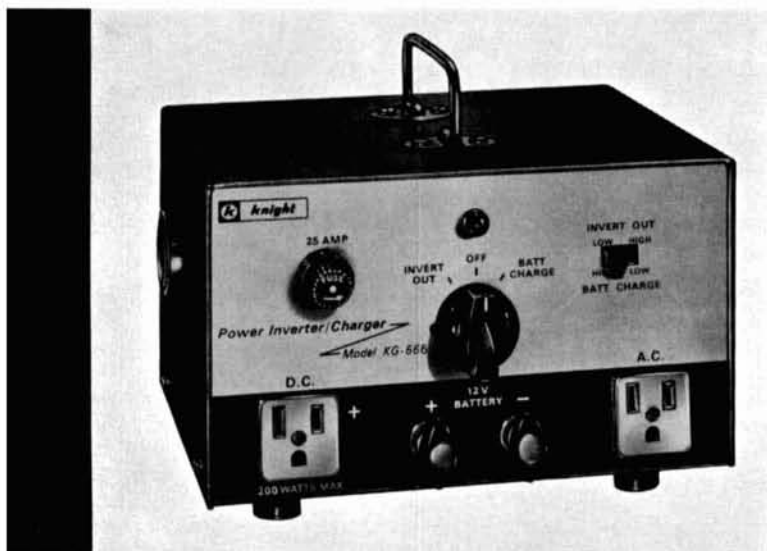
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knight-kit power inverter/charger

Most amateurs, when they want to operate mobile or portable, buy one of the accessory dc-to-dc converters that goes along with their transceiver. The price will vary all the way from seventy to two-hundred dollars, depending on the manufacturer and power output that is required. A dc-to-dc converter that is designed specifically for a piece of equipment is probably the best approach for **daily** mobile operation, but if you only mobile occasionally or operate portable only on field day, you probably are reluctant to spend the money for a dc-to-dc converter that more or less is limited to one particular piece of gear.

The KG-666 Power Inverter/Charger kit, manufactured by Knightkit, is the ideal answer to the amateur who only wants (or needs) to operate on battery power occasionally. When operated from a 12-volt battery, this unit will provide 200 watts of 110-Vac power. In addition, when you're not operating mobile or portable, the power inverter/charger can be used for powering soldering irons, drills or even television sets from a 12-volt battery; or it may be used as a battery charger with a self-regulating bat-

tery charge tapering from 6 amps. If 200 watts isn't enough to handle your requirement, two of the KG-666's may be connected in parallel. The ac output of the inverter is 55 to 65 hertz depending on load and battery voltage; the tapped secondary permits selection of 105 or 120 volts.

A simplified circuit diagram of the KG-666 is shown in **fig. 1**—the switch is in the inverter position. The switch across the transformer secondary selects either 105 or 120 Vac output. When the switch is turned on—with the unit connected as an inverter as shown here—the four 2N443 transistors are heavily forward biased by the 200-ohm resistor in the center tap of the transformer feedback winding. Since the transistors are not exactly matched, one of the parallel-connected sets will conduct slightly more than the other set, and will initiate oscillation. As soon as base current begins to flow through the feedback winding, the diode in the center tap of the feedback winding is forward biased, and reduces bias to a lower level.

The transistors are protected from switching transients by the 2- μ F capacitor and the

Jim Fisk, W1DTY, Box 25, Rindge, N.H. 03461

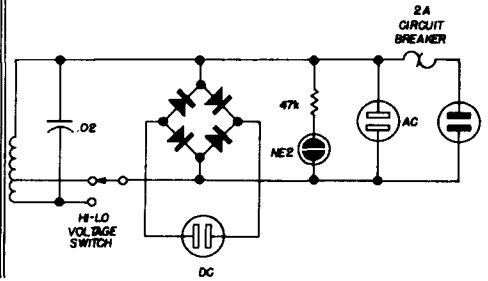
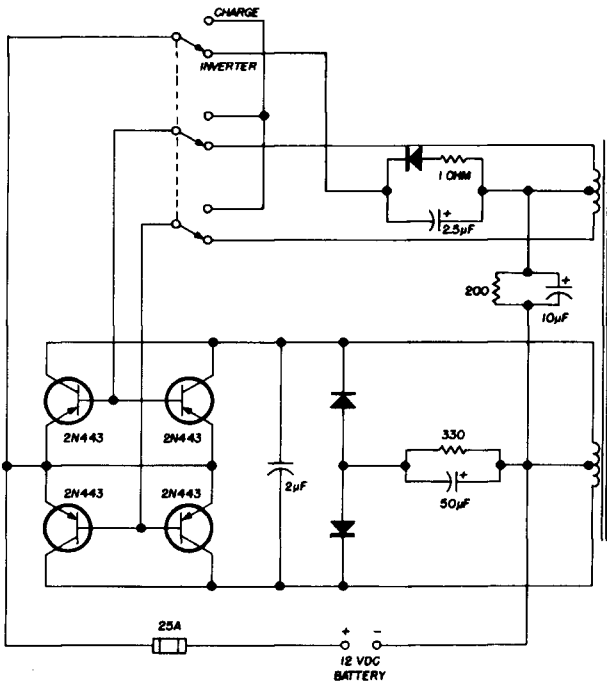
two back-to-back diodes connected across the primary of the transformer. In the diode despiking circuit, the 50- μ F capacitor is charged to the peak voltage across the winding, and the two diodes are reverse biased. Any transients that tend to exceed the voltage stored in the capacitor are short circuited through the diodes.

The square wave ac output of the inverter is converted to pulsating dc by the diode

circuit.

The KG-666 is extremely compact, measuring 8 inches wide, 4-3/4-inches high and 8 1/4 inches deep. Total weight is 8 pounds. Battery connections are provided on the front panel through two large thumb-screw terminals. Two standard ac outlets on the front panel provide either 115 Vac or Vdc.

If you are interested in a utility emergency power supply for your shack, the KG-666 is



Simplified schematic diagram of the Knight-Kit KG-666 Power Inverter/Charger kit.

bridge. This output is useful for equipment that does not operate efficiently from square-wave ac such as the universal motors commonly found in electric shavers and inexpensive drill motors.

When the inverter/charge switch is pushed over to the charge position, the feedback winding is not in the circuit anymore; 115 to 120 volts is applied to the input through a 2-amp circuit breaker. When the KG-666 is used as a battery charger, the inverter transformer is used as a stepdown transformer to 12 Vac. The base of each transistor is connected to its emitter through the inverter/charge switch and two transistors are used as diodes in each leg of the full-wave rectifier

worth looking into. It can be used to keep a large 12-Vdc automobile battery charged when 115-Vac power is available. If you should have a power failure, simply plug in your transceiver, transfer the switch to the inverter position and you can be on the air. At available full load—200 watts for the KG-666—the total load on your battery is about 20 amps. However, this assumes a constant load. With ssb or CW operation, the duty cycle is fairly low, so battery life should be relatively long. You should be able to estimate expected battery life depending on the transceiver you're using and the size and age of the storage battery.

ham radio

propagation predictions for april

During the past six months, amateurs in the Northern Hemisphere have enjoyed excellent daytime propagation on the higher bands (20, 15 and 10) and excellent nighttime conditions on the lower bands (40, 80 and 160). Ten has been open almost every day; absorption has been low enough that 20-meter contacts could be made over the pole to stations in the Northern Hemisphere almost any time (muf's permitting) during quiet magnetic conditions; noise levels have been low... it was too good to last.

Seasonal changes begun last month should be complete by the end of this month. Accordingly, 160-meter maximum range predictions are being dropped in favor of 15 meters. Actually, a radio amateur with only modest equipment should be able to work anywhere in the world on 15 meters if the path is in sunlight and not within 30° of the North Pole. However, eventually even a 15-meter signal is absorbed, usually just after the first transit of the earth. The 15-meter range predictions are based on the same station parameters as 20 meters, 100 watts CW and a 6-dB gain antenna.

working through the twilight zone

The 15-meter band curves suggest the likelihood of round-the-world propagation (RTW), which may be more an annoyance than a useful propagation path. This is because some signal component with much less time delay is usually present,

and the combination usually has at least two components with relative delays up to 1/7 second, causing difficult copy. The muf over the entire path does not have to exceed the operating frequency, but the muf at the end control points does.

If you wish to verify the existence of RTW you should first find yourself a partner—unless you have two beams and a receiver which will recover in much less than 100 milliseconds. The two stations

Victor R. Frank, WB6KAP, 12450 Skyline Boulevard, Woodside, California 94062

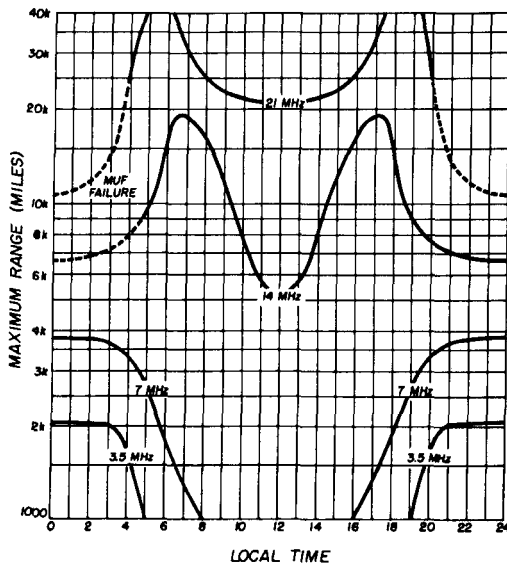


fig. 1. Maximum range vs local time for propagation to the north from mid-latitude United States (38° N).

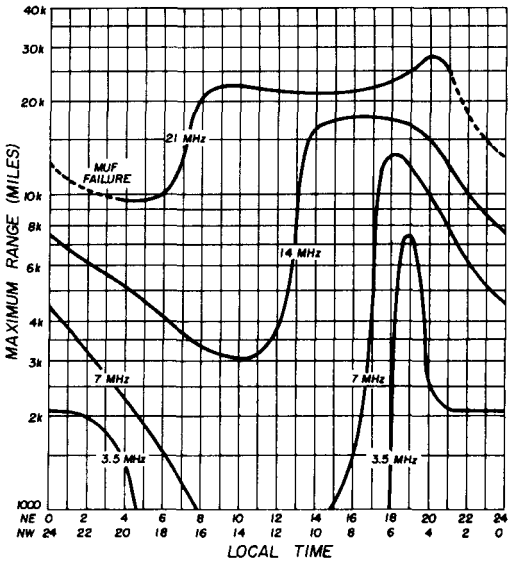


fig. 2. Maximum range vs local time for propagation to the northeast (top time scale) and the northwest (bottom time scale).

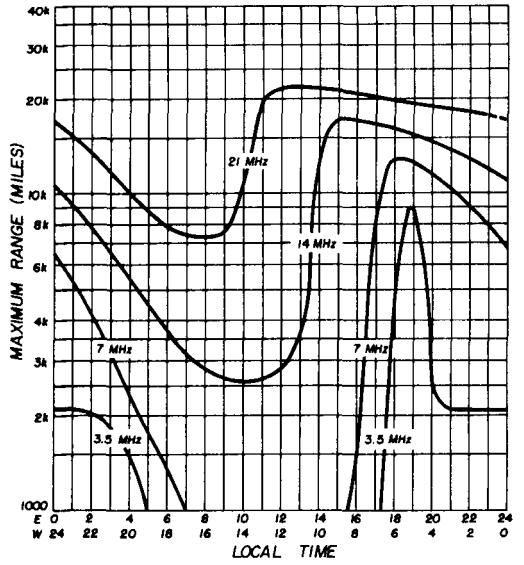


fig. 3. Maximum range vs local time for propagation to the east (top time scale) and the west (bottom time scale).

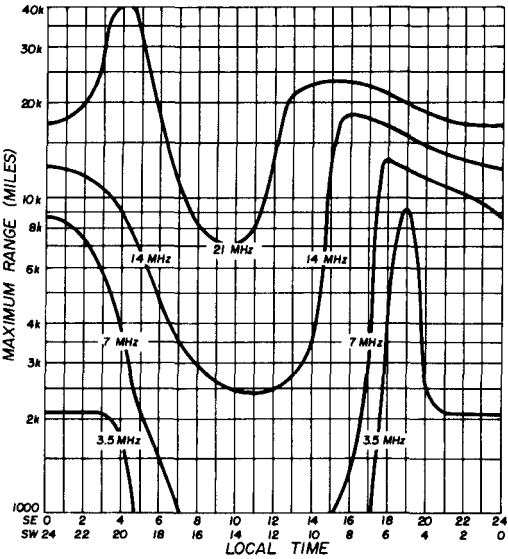


fig. 4. Maximum range vs local time for propagation to the southeast (top time scale) and the southwest (bottom time scale).

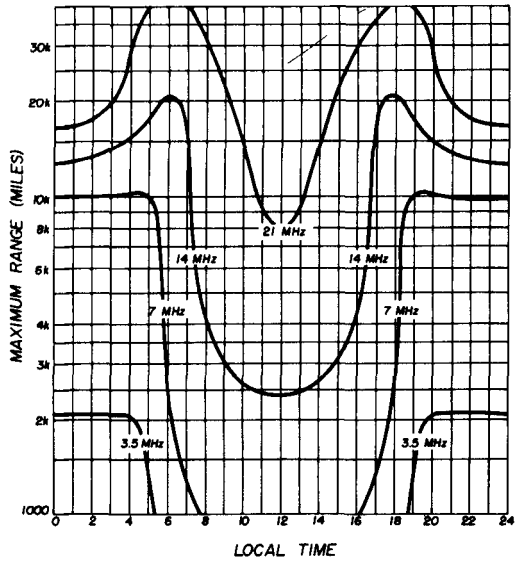
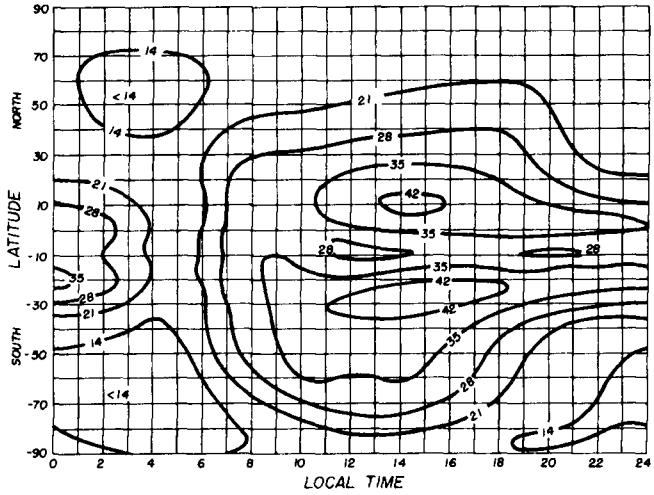


fig. 5. Maximum range vs local time for propagation to the south from 38° N latitude.

fig. 6. Time chart of predicted median muf for April 1969, centered on 90° W longitude.



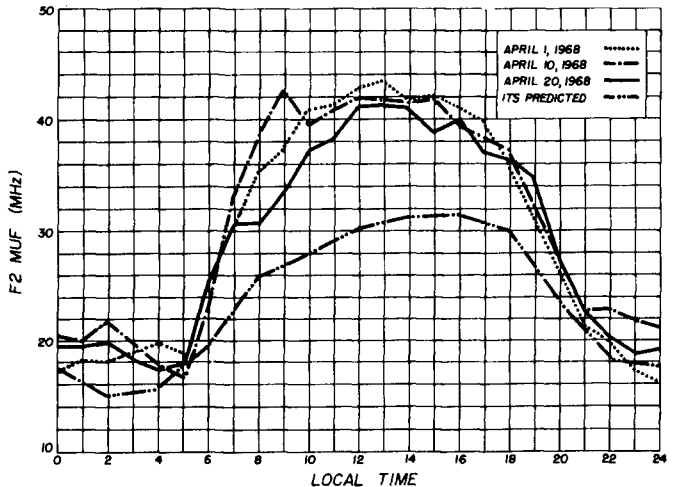
ideally should be within each other's skip zones (600 miles). Pick a time from the maximum range charts for the maximum distance in the direction (and reverse direction) you intend to work. Best RTW conditions usually exist near the dawn/dusk line (NW-SW near sunset, NW-SE after sunrise). The position of the twilight zone in the E-region is marked on each chart. The two stations should point their beams in opposite directions, and the station with the most power or noisiest location should transmit CW or ssb, and the other station should listen for an echo.

If the direct or scattered signal and the RTW signal are about the same amplitude, code copy at speeds much in excess of 15 wpm may be difficult. Listening to such a signal the first time is an eerie experience.

maximum usable frequencies

The predicted median F2-layer 4000-kilometer muf's for April 1969 are shown in the time chart of fig. 6, which is centered on 90° W. longitude. These muf's may be pessimistic if ionospheric soundings made last April at Point Arguello,

fig. 7. Muf vs time of day scaled from April 1968 vertical-incidence ionograms from Pt. Arguello, California.



California are typical of what can be expected this April. **Fig. 7** shows a comparison between muf's vs time of day scaled from Point Arguello ionograms on April 1, 10 and 20, 1968 and the median muf (4000) F2 predicted by ITS for the same point.

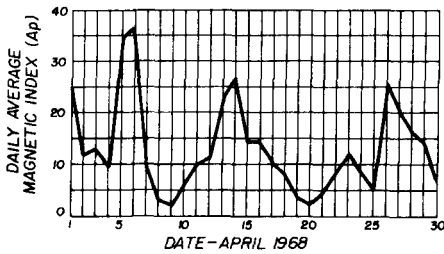
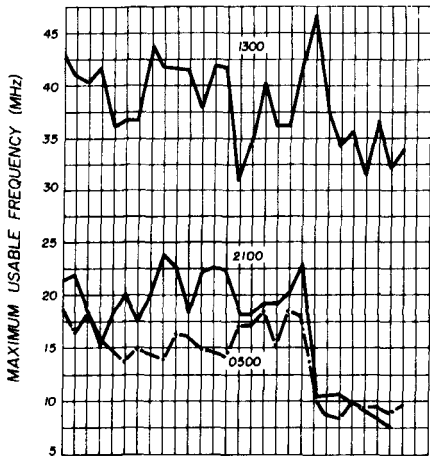


fig. 8. Muf vs day of month of April 1968 for hours of 0500, 1300 and 2100 local time scaled from Pt. Arguello ionograms.

A better idea of conditions that may occur during the month may be gained from referring to **fig. 8**; this graph shows the muf's at 0500, 1300 and 2100 local time for each day of April 1968 along with the daily average magnetic index, Ap. Magnetic storms occurred on April 1; 1300, April 5 (gmt) to 1800, April 7; 0400, April 12 to 2100, April 14; and 2100, April 25 to 1100, April 28. Interestingly enough, the storm with the highest magnetic index wasn't the one that affected propagation the most. From April 21 to 28, the bottom dropped out of the nighttime ionosphere.

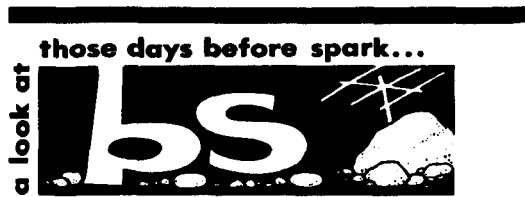
Sporadic-E and spread-F were prevalent. Vertical incidence critical frequencies were below 3 MHz during most of that period as early as 2100 local time.

I can't predict whether such a storm will occur again this April. However, ignoring disturbed days, two trends appear on **fig. 8**. The 1300 muf decreases throughout the month while the 2100 muf increases. Twenty meters will probably be open to somewhere 24 hours a day during quiet conditions.

vhf

Transequatorial (TE) 50-MHz evening openings should continue through the month. Some sporadic-E is likely near the end of the month. The Lyrids meteor shower is expected between April 19 and April 23. Long distance tropospheric ducting across the Gulf of Mexico is predicted for two meters and higher frequencies.

ham radio

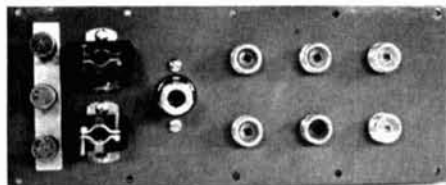


"I tried mobile once . . . yuh run into a lotta problems."

the ham notebook

coaxial feedthrough panel

Devising a simple and uncluttered method of bringing coax feedlines and rotor control cables into the shack is always a problem. After using a haywire lashup for years, I solved the problem neatly and efficiently with a small wall-mounted panel. Every wire except ac power is brought into the operating room through this panel.



The panel is made of 1/8-inch tempered masonite, 4 inches high by 9 1/2 inches wide. The coaxial feedthrough connectors are PL-258 straight adapters (Amphenol 83-1J) mounted snugly in a hole made with a 5/8-inch punch. Epoxy cement is applied around the connectors on the rear of the panel and will hold them in place forever if the epoxy is properly and thoroughly mixed.

The two Jones plugs which show in the photograph are used for control lines to antenna rotators; the small round plug is used for a remote swr meter. The metal strap is connected to a ground rod outside the house.

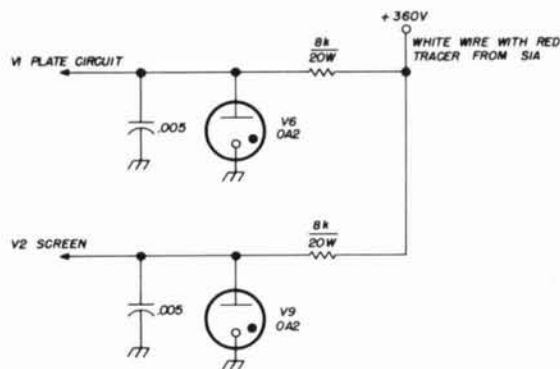
The panel may be painted with a spray can to match the decor or equipment. It is screwed to the wall over a 3 x 8 1/2-inch cut-out in the wall near the radio desk; the coaxial cable and rotator control leads pass through the wall partitions to the outside. This panel is rather elaborate since it has six antenna lines and two rotor lines, but a smaller one for a simpler setup could be installed over a standard ac wall outlet box.

Edwin W. Hill, W3URE

T150A frequency stability

If your Knight T150A transmitter is chirping or showing other signs of instability, look for trouble in the voltage regulation circuit. The original circuit uses a 4000-ohm voltage-dropping resistor for the OA2 VR tube; this allows excessive current through the OA2 and causes early breakdown, removing regulation from the vfo and following stage. In my unit there was a five-volt variation!

To correct the problem, remove the 4000-ohm, 20-watt resistor (R37) from its mounting hole and install a 7-pin miniature socket in its place for an additional VR tube (V9). Mount two 8000-ohm resistors vertically on top of the chassis near the VR tube socket and drill some holes in the chassis to accommodate wiring to them.



Connect the white wire with red tracer (formerly connected to R37) to a new terminal strip mounted under the chassis; run leads from this point to the two new resistors on top of the chassis. Now wire the two VR tubes as shown in **fig. 1**. Be sure to install another .005 μ F disc capacitor across V9. With these simple changes, you should have no further troubles with instability.

Al Mumby, WB2MCP

new products

signal/one



The new Signal/One CX7 communications package provides a number of operating capabilities heretofore unavailable in an amateur-band transceiver. This "integrated amateur station" package covers seven 1-MHz frequency bands in the 1.8 to 30 MHz range as well as receive-only on 50 to 51 MHz.

The CX7 is completely solid state except for the final power amplifier. The conventional frequency dial is replaced with an integral frequency counter that provides direct frequency readout with 100 Hz accuracy. Two permeability-tuned oscillators provide the 1-MHz tuning range with ample overlap on each band; the tuning rate is 25 kHz per knob revolution. The unit may be operated transceive with either vfo; on split frequencies using both vfo's; transceive on either vfo plus independent receive-only on the other; or transmit-offset transceive where the transmitter frequency tracks the receiver and may be instantly offset up to ± 5 kHz from the receive frequency.

Receiver sensitivity is better than 10 dB signal-plus-noise-to-noise ratio for $1/3 \mu\text{V}$ input at 29 MHz (2-kHz bandwidth). Excellent selectivity on ssb: 2 kHz at -6 dB and 3 kHz at -60 dB—is a result of two cascaded 8-

crystal lattice filters. Ultimate attenuation and image rejection are greater than 80 dB; i-f rejection is in excess of 60 dB and internal spurious are less than $1 \mu\text{V}$ equivalent.

The hang-type agc system results in less than 6 dB audio output change with signal levels from $1 \mu\text{V}$ to 100 mV. The hang time is selectable, 100 milliseconds or 1 second. The receiver exhibits good front-end dynamic range; a $10 \mu\text{V}$ desired signal is modulated less than 10% by an unwanted 10,000 μV signal 10 kHz away (modulated 30% at 400 Hz), or by a similar 100,000 μV signal removed 5%.

Passband tuning is accomplished by varying the actual i-f frequency up to 2 kHz above and below nominal; tracking error (received signal shift) is unmeasurable. The receiver also features dual receive—two receive channels usable separately or simultaneously with a continuously variable relative rf gain control. Either channel may be used for transceiving and the other for receive-only.

The transmitter section of the CX7 is rated at 300 watts PEP input with adjustable rf speech clipping for exceptionally good ssb performance; the transmitter will also operate on CW and fsk. The power amplifier stage is broadbanded for the amateur bands from 1.8 to 29.7 MHz so no tuning is required if the load swr does not exceed 1.5:1. For non-amateur frequencies or excessive swr's, an internal matching network may be switched into the circuit.

Other features of the new CX7 are a built-in noise blander with adjustable threshold, built-in electronic keyer for 5 to 50 wpm, built-in power supply for 115/230 Vac, push-to-talk or fast-attack vox, instantaneous break-in CW, fast key-up receiver recovery independent of agc hang time, and metering of rf clipping, drive level, plate and screen current and forward and reflected power. Optional accessories include CW and fsk filters, mobile mount and dc adapter, miniature mobile control head, station console and vhf adapter.

Price for the standard CX7 is \$1495. For more information, write to the Marketing Manager, Signal/One Division, 2200 Anvil Street North, St. Petersburg, Florida 33710.



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TNB-250 shown installed on Swan 250 by means of the pre-punched accessory holes.

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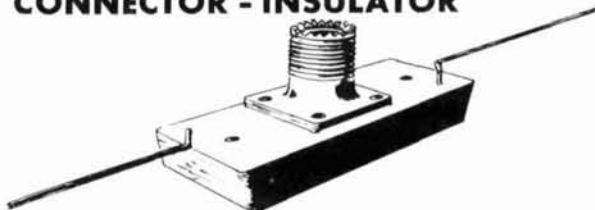
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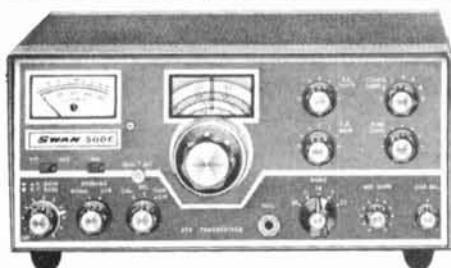
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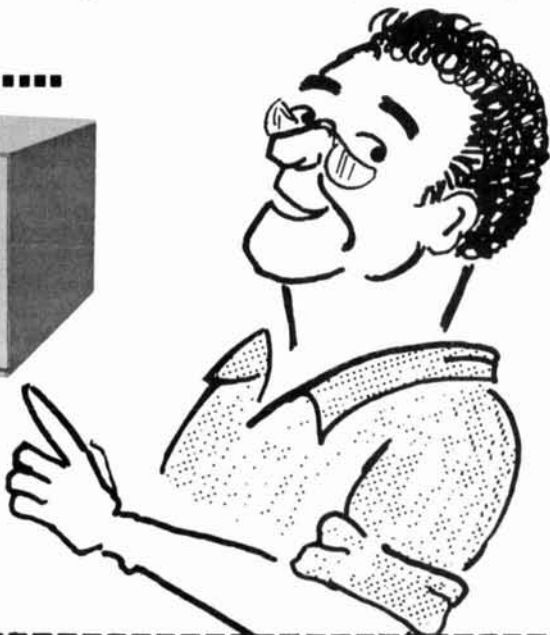
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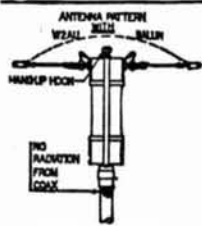
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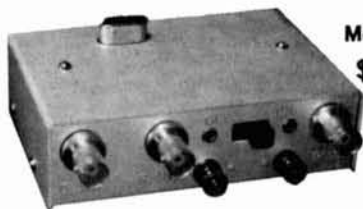
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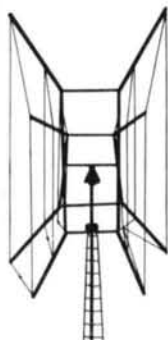
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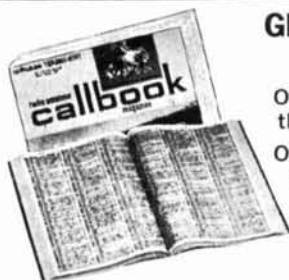
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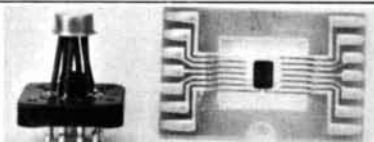
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CW TRANSMITTERS

Or A Plea To Some Manufacturers To Put Heft Back Into Their Products

Many amateurs are finding out that their recently purchased sideband rigs fail to perform adequately on CW. Some, not liking to operate with less than the best, confine their time to SSB. Yet CW, as a mode of communication, is hard to beat — and truly can be a ham's "best friend." This impasse is logically a reflection of the fact that SSB is what modern rigs are designed to do best — CW is something of an after-thought.

Yet the requirements of each mode, while differing in degree, are not that far apart — if only present day manufacturers would enlarge the copper and steel content of their power supplies. In the typical sideband rig today the power transformer weighs between 8½ and 11 pounds. Nonetheless, it is expected to sustain up to 500 watts of PEP input or 400 watts of CW input. Is it any wonder, then, that your CW performance leaves something to be desired?

This same problem is even easier to see when it comes to RTTY operation with your sideband rig. You simply can't cope with teletype. Your rig will either get too hot, or you will have to operate with scarcely any input at all. Manufacturers of commercial gear were quick to recognize the advantage of low duty cycle power requirements of sideband. Marked reduction in cube, weight, and portability were extolled as virtues. Decent regulation and CW keying characteristics were not considered important.

The plain fact stands that RTTY requires nearly 100% duty cycle, CW requires 45%, and SSB requires only about 12%. Albeit, we are not likely to repopularize AM on the HF bands, yet CW is here to stay, and efforts must be made to make A1 more attractive.

My motivation for these words is twofold. First, to cause some engineers in the throes of creating modern gear, to remember that you can't get "somethin from nothin." And, second, to suggest that one expedient answer is the tremendous amount of old traded-in gear that exists in dealers' stocks — gear that really works and is a pleasure to listen to and to operate. For instance:

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