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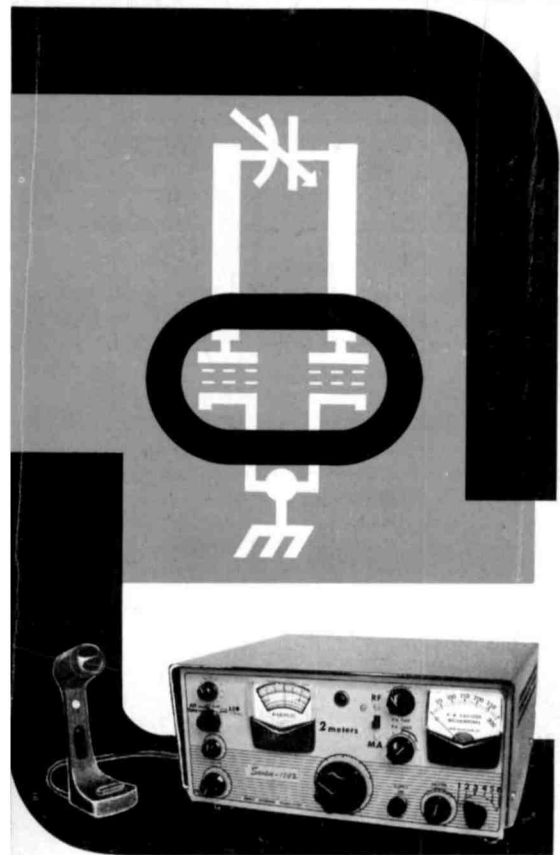
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# ham radio

MAY 1968

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- converting the Swan 120 to two meters

6

# Order Waters fine ham gear *direct*



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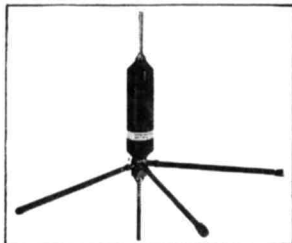
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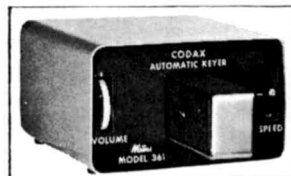
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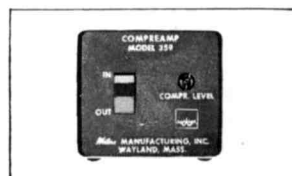
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# Some comments from warranty cards by owners of

## DRAKE TR-4 SIDEBAND TRANSCEIVERS



"The TR-4 is the best rig I have ever known to be made. Glad to own one."

Dan Tangorra, WA7FWH  
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"Finally got what I wanted!"

Ronald E. Lyons, WB2BQX  
Oakhurst, N. J.

"A superb piece of equipment, no comments necessary."

C. G. Noakes, G3UHR/V02  
Labrador City, Newfoundland

"Great rig—First contact was an ON5 in Belgium."

Bill Busse, WA9TUM  
Mt. Prospect, Ill.

"Best gear I have had the pleasure of working with. Receiver is exceptionally sharp and stable."

Albert V. Mitchell, WA9BUP  
Jeffersonville, Ind.

"Nothing to comment, except that my TR-4 is a real jewel, and I am very satisfied with it. I would like to receive the catalogue of your products."

Joe Braz Ribeiro, PY4UK  
Monte Carmelo (MG) Brazil

"A very F.B. piece of equipment. Audio very nice, especially on SSB, which is rare."

Thomas F. Totten, Jr. WB2GZR  
Saratoga Springs, N. Y.



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Orlando Escudero O., CE-3-OE  
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Wayne M. Sorenson, WAØETL  
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"Have had Drake 2-B for three years. Knew that TR-4 was same Good Stuff."

Charles E. Bishop, WA8FTT  
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Daniel N. Hamilton, WA4WXQ  
Ashland, Va.

"Why not build a good 6 Meter SSB & AM Transceiver . . . hurry up, I'm waiting."

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Charles E. Boschen Jr., WA4WXR  
Ashland, Va.

"I'm sure this, like the other Drake equipment I have, is the finest money can buy. YOU MAY QUOTE ME ON THAT."

C. E. (Ed) Duncan, WA4BRU  
Greenville, S. C.

"I'm a real happy man with it. Does a real good job of getting thru."

Jerome D. Lasher, W2RHL  
Hamburg, N. Y.

"Replaces my TR-3."

D. G. Reekie, VE 6 AFS  
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"Finest performing gear I have ever had the pleasure of operating."

Milton C. Carter, W2TRF  
Lakewood, N. J.

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Milton C. Carter, W2TRF  
Lakewood, N. J.

"Well pleased."

Rev. James Mohn, W3CKD  
Lititz, Pa.

"I am delighted with Drake gear. This is the second of your transceivers for me. I have used a TR-3 in my car for about 2½ years—only trouble: replacing a fuse!"

Guy N. Woods, WA4KCN  
Memphis, Tenn.

### "Ask the ham who owns a Drake TR-4"

... or write for details ...

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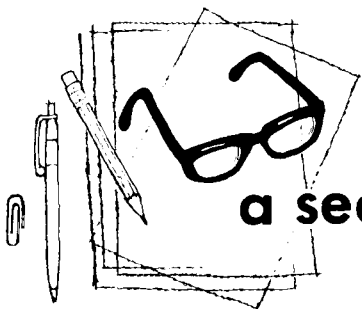
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## a second look

by jim  
fisk

How do you sell ham radio? How do you bag it and tag it and interest a customer in buying it? How do we get new hams? I wish somebody would come up with the secret; I've been looking for it for a long time and really haven't found a satisfactory solution. One thing I do know, before you sell it, you have to advertise it; and advertising means publicity.

The biggest thing that ham radio needs today is publicity. Good publicity and lots of it. There are lots of easy ways to do this and some take little effort.

As an example—have you noticed the many signs along the highways saying, "We monitor channel 9"? Amateur radio clubs should do the same type of thing. This is a small matter, but if you had a sign saying: "Attention amateur radio operators—we monitor 7255 kHz," it would help visiting hams. At the same time, it would publicize amateur radio.

I think it's pretty obvious that citizens band has stolen a lot of the glory of ham radio over the past four or five years. Many of the youngsters who would normally be interested in hamming have gone the easier route to CB. Most Americans have heard of citizens band and know something about it, but I wonder how many know of amateur radio? I think you would be quite surprised if you ran a poll.

Amateur radio gets its biggest publicity boost when hams furnish communications during times of disaster and catastrophe. But there are lots of other occasions when ama-

teur radio is equally useful. The occasions don't reach the national import of the Alaskan earthquake or the large Southeastern and Caribbean hurricanes, but nevertheless, amateurs can and do furnish a very good communications service in times of public need.

Perhaps the best example of this is the West Coast Amateur Radio Service (WCARS). This group, started about five years ago, monitors 7255 kHz daily with a roll call at noon-time. WCARS enjoys a large membership and through the work of its publicity chairman, Ed Gribi, WB6IZF, news releases appear in the California, Oregon and Washington papers quite frequently.

For some reason, amateurs in other parts of the country have not picked up the idea. However, Dave Flinn, W2CFP, has volunteered to start an East Coast net. He will monitor 7255 kHz each noontime and asks that anybody on the East Coast who can hear his signal check in with him. Perhaps the East Coast group will grow to the extent that WCARS has.

In a recent letter to me, Dave indicated that he would like to start the ball rolling along these lines, but that he doesn't want to duplicate the efforts of any other amateur. If you have started a public-service net, or know of anyone who has, please let Dave know so he isn't duplicating someone else's efforts. Perhaps with an East Coast net, as well as WCARS, amateurs in other parts of the country who are out of the range of WCARS and W2CFP will start their own nets.

WB6IZF told me recently that the WCARS net often gets into the inland states during the evening hours on 7255 kHz. If we can get amateur public service nets started in other parts of the country, we can develop a *liaison* between these nets on some other frequency band.

What better way to obtain publicity than to provide a public service? It's just the kind of thing that newspaper reporters and radio announcers are looking for. Interestingly enough, on New Years Day, net control of WCARS took roll call just to see how many amateurs would check in; almost 100 amateur stations were monitoring the frequency. During working hours, of course, there are not that many stations listening to 7255, but, nevertheless, there are always a few mobilers or retired persons at home who are able to pass traffic.

One member of WCARS is WA6PCY, a member of the California Highway Patrol. John has a mobile station mounted in his patrol car for immediate liaison with other WCARS members.

If you're interested in forming a public-service net and are not within range of W2CFP or WCARS, why not write to WB6IZF. I'm sure Ed would be more than happy to give you the necessary details for forming an amateur-radio service group. Ed has been busy for the past several months sending out WCARS publicity releases with the result that it is quite widely known in the western part of the United States.

If you're like me, you'll have the receiver turned on while reading the mail and not actually operating. This is ideal when you're doing a home construction project, cleaning out the shack, or making out QSL cards. As long as you're reading the mail, you might as well do it for a worthwhile purpose.

With amateur radio service nets throughout the country, there would be thousands of amateurs tuned to 7255 kHz any time of the day or night, 365 days a year. In addition to helping the general public in times of emer-

gency, it would be very helpful for mobile hams who run into trouble on the road. It's always nice to know that you have a friend that you can rely on just by pushing the mike button.

In addition to the frequency-monitoring signs and public-service nets, there are other ways to get in the public eye. How about a weekly amateur-radio column in the local paper? Most newspapers have space that needs to be filled. If you can't write the material yourself, there must be a member of the local club who can.

There are a lot of interesting things going on in amateur radio that the general public would be interested in. There have been a number of news stories concerning phone patches to Viet Nam, slow-scan television transmissions to Antarctica and amateur radio on board the Queen Mary's last voyage, just to name a few.

Once the stage is set with a human-interest story, the skillful writer can throw in some sales pitches for amateur radio. What other hobby can you think of allows the bed-ridden and handicapped to stay in touch with the world? What other hobby can provide a training ground for electronics engineers and technicians? What other hobby is as many-faceted as amateur radio? What other hobby can promote as much international friendship and understanding as amateur radio?

There are a lot of potential amateurs out there that just need to be sold on the idea. After they're sold, it's up to us to help them along. What's simple for the old timer is complex to the newcomer. When a newcomer asks you a question, try to give him a straightforward answer. Help him find those hard-to-get parts. Open up your junk box and give him some of that stuff you've been saving for twenty years. You can't make him into a ham, but you can certainly help him along the right path. It's time we got off our haunches and made amateur radio grow.

**Jim Fisk, W1DTY**  
**Editor**

# RELIABILITY

# QUALITY

# VALUE



## SWAN 410C FULL COVERAGE EXTERNAL VFO

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

**\$115**

## DUAL VFO ADAPTOR

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

**MODEL 22 . . . . \$25**



## MARS OSCILLATOR

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

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

## SWAN 500C SSB-AM-CW TRANSCEIVER

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

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

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

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

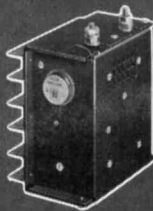
Voice quality, performance and reliability are in the Swan tradition of being second to none.

**\$520**

## SWAN 117XC MATCHING AC POWER SUPPLY

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

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## SWAN 14C DC CONVERTER

Converts the above 117XC A.C. power supply to 12 volt D.C. input for mobile, portable, or emergency operation.

**\$65**

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



# POWER

# VERSATILITY



## SWAN MARK II LINEAR AMPLIFIER

Two Eimac 3-400Z Triodes provide the legal power input: 2000 Watts P.E.P. in SSB mode or 1000 Watts AM or CW input. Planetary vernier drives on both plate and loading controls provide precise and velvet smooth tuning of the amplifier. Greatly reduced blower noise is provided by a low RPM, high volume fan. Provides full frequency coverage of the amateur bands from 10 through 80 meters and may be driven by any transceiver or exciter having between 100 and 300 watts output.

**\$395**

## MARK II POWER SUPPLY

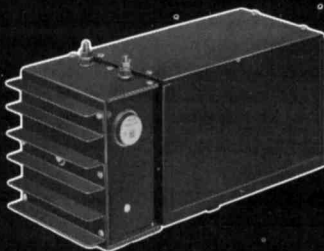
May be placed beside the Mark II, or with its 4½ foot connecting cable, may be placed on the floor. Silicon rectifiers deliver 2500 volts D.C. in excess of 1 ampere. Computer grade electrolytic filters provide 40 mfd capacity for excellent dynamic regulation. A quiet cooling fan allows continuous operating with minimum temperature rise, thus extending the life and reliability of all components. Input voltage may be either 117 or 230 volts A.C.

**\$235**

## PLUG-IN VOX UNIT

Plugs directly into Model 500C, and may also be used with Model 350C and other Swan transceivers.

**MODEL VX-2 . . . . \$35**



## SWAN 14-117 12 VOLT DC SUPPLY

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

**\$130**

## SWAN 350C SSB-AM-CW TRANSCEIVER

Our improved standard 5 band model, now in production and still only . . .

**\$420**

Illustrated on these pages is a complete Swan amateur radio station, one of the finest money can buy. Starting with the powerful 500C and an AC power supply, you are immediately on the air with a big, high-quality signal. Thanks to the excellence of the high-frequency crystal lattice filter, made especially for Swan by CF networks, you will have one of the cleanest and most readable signals on the air, as well as outstanding receiver selectivity and sensitivity. The various accessories from the Swan line may be added at any time, providing greater operating pleasure and performance. The tremendous acceptance of Swan products by radio amateurs throughout the world is most gratifying to all of the people at Swan. It is our continuing policy to offer the finest communications equipment we know how to design and manufacture, with quality control, craftsmanship, and service that is second to none.

73



# SWAN

ELECTRONICS

OCEANSIDE, CALIFORNIA

A Subsidiary of Cubic Corporation



## converting the Swan 120

### to two meters

With increased  
ssb activity on two  
meters, this transceiver  
should be a popular unit  
for mobile  
or fixed  
operation

Del Crowell, K6RIL, 1674 Morgan Street, Mountain View, California

**My first vhf conversion** of a Swan 120 was a unit that I put together for six meters.<sup>1</sup> It worked so well I bought another single-band Swan transceiver for this conversion to two meters. This conversion results in a complete ssb/a-m or CW transceiver with good sensitivity and selectivity. The transmitter puts out about 40 watts on ssb or CW using the original power supply.

#### receiver

The modifications to the receiving section are quite similar to the six-meter model. I used the same front-end design, changing the tank circuits to tune 144-147 MHz. The cascode rf amplifier works as well at 2 meters as it did on six; it exhibits low noise figure and more than adequate gain. The mixer also provides very good results on two.

The incoming rf signal is picked off the final plate circuit and fed into the cascode preamplifier through a 2.2 pF capacitor. This simplifies the problem of what to do about

transferring the antenna from transmit to receive. The original 6BA6 rf amplifier is completely disconnected; the new front end feeds directly into the 12BE6 mixer.

An agc circuit is incorporated with separate rf and audio gain controls. With this circuit, the audio level is held constant with very little popping and distortion. During round-table QSO's, the rf gain can be turned up with good results with both weak and strong signals.

## transmitter

The new two-meter transmitter circuit uses the original 12BY7 driver stage as the second mixer. L3 is relocated to form a 14-MHz bandpass coupler with L4. Spacing the two coils one inch apart provides the correct amount of coupling for tuning between 14.20 and 14.35 MHz.

Local oscillator injection is fed into the cathode of the 12BY7 across the original 100-ohm resistor. I removed the original bypass capacitor and connected a length of miniature coax between the local-oscillator output and the 12BY7 cathode. A center-tapped coil in the 12BY7 plate circuit provides two-meter tuning and permits matching to the grid of the new 12HG7 two-meter driver.

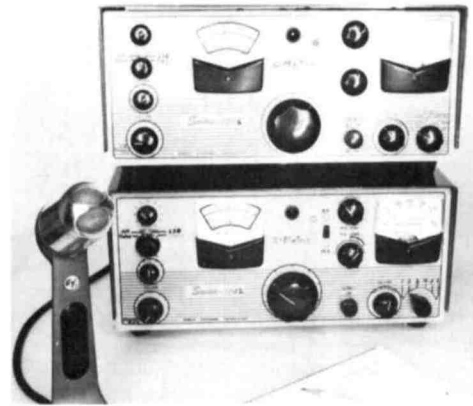
A 130-MHz trap reduces the amount of local-oscillator signal feeding into the driver. The 2.2-pF capacitor is connected to one side of the final tank and is fed to the rf stage through the final compartment wall. No an-

tenna switching is necessary; all switching from transmit to receive is accomplished by the original bias method.

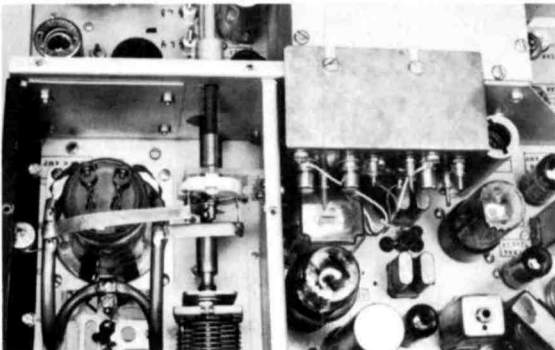
The 12HG7 is a rugged version of the 12BY7 with a higher plate-dissipation rating. When operated in Class AB<sub>1</sub>, it provides plenty of output to drive the final. A series-tuned coil in the 12HG7 plate circuit is used with an adjustable capacitor to provide balancing. The 12HG7 tank circuit is tuned with a variable capacitor ganged to the mixer plate capacitor. This arrangement provides a single control for retuning when you change frequencies.

The two-meter output stage uses a 5894 operating in class AB<sub>2</sub>. Static cathode current is adjusted to 50 mA. Ninety watts PEP input

**Two converted single-band Swans: one for the six, the other for two.**



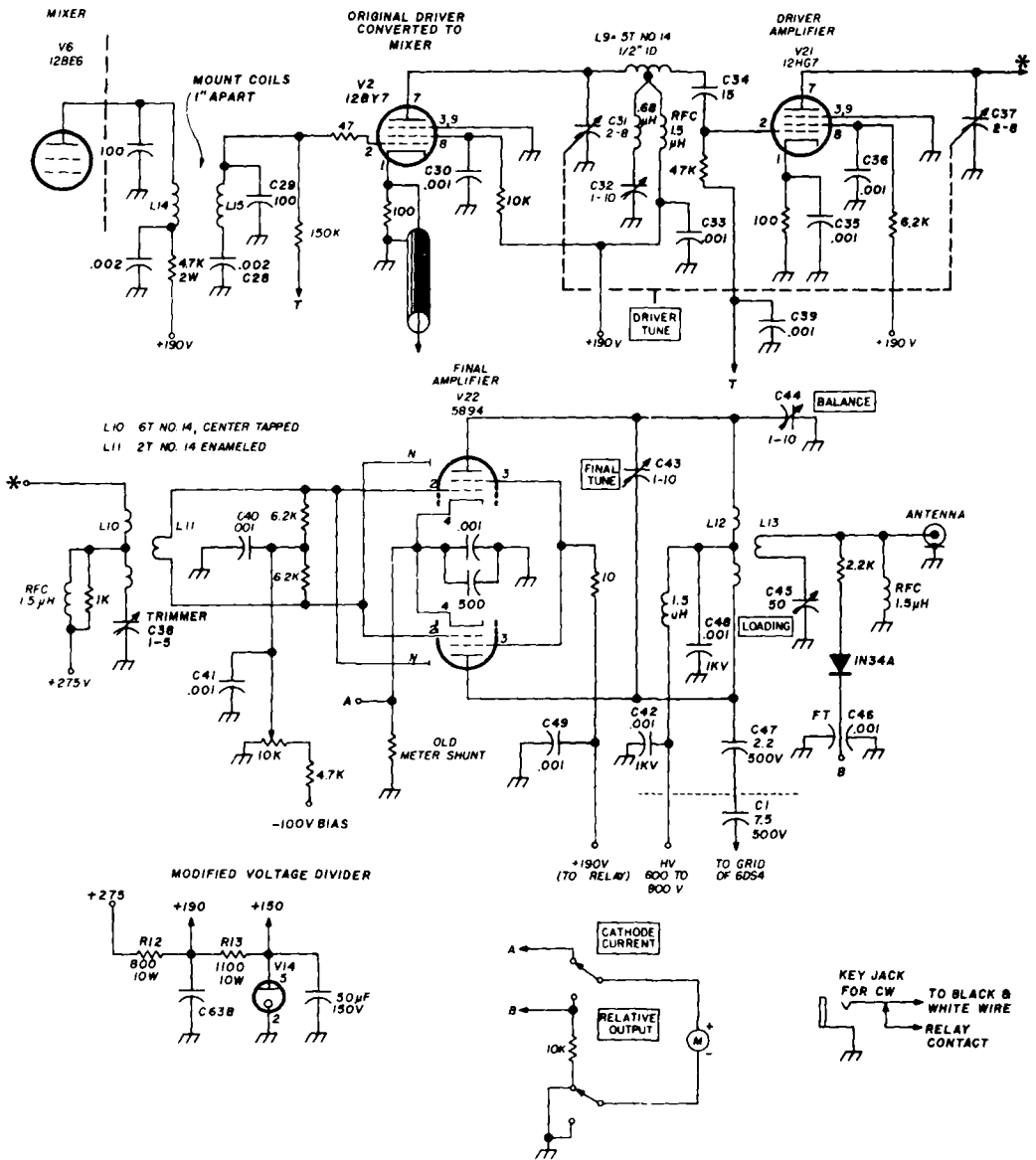
**Top view of the modified Swan 120 showing the final-amplifier compartment and new converter chassis. The plate-balancing capacitor (C44) is to the far left next to the plate line.**



produces over 40 watts peak output. Link coupling is used to couple the driving power from the 12HG7 into the 5894 grids. This is a simple and effective scheme for matching into the 5894 at 144 MHz.

Although I didn't neutralize the 5894 at the beginning, I found that the final could be made to take off with a mismatched load. In addition, maximum output power didn't peak simultaneously with the plate current dip (a good indication of unstable conditions). Cross neutralization—a pair of insulated wires from the grids, crossed and extended up through the socket beside the 5894 plates—stabilizes everything very simply.





C31, C37 1.5- to 10 pF air variable. Johnson 9M11 or 160-104.  
 C32, C44 10-pF piston capacitor.

C43 10-pF air variable. Johnson 7J12. Spread rotor plates for wider spacing.

fig. 3. Transmitter schematic. The rf chokes are Ohmite Z-144's (1.5-1.8  $\mu$ H). The voltages shown were measured at full drive on transmit with a Simpson 260 (through an rf choke). L14 and L15 are the original L4 and L3 respectively.

The original Swan cathode meter was modified by removing the 300-mA shunt from inside the case. Use care! The shunt is connected across a DPDT slide switch mounted on the front panel near the meter. With this arrangement, relative rf output or cathode current can be selected as desired.

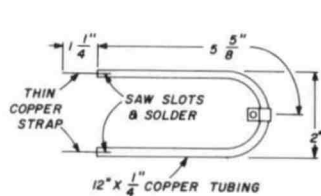
### local-oscillator chain

Local-oscillator injection is provided by a transistor crystal oscillator operating in the 43-MHz range. In this circuit, the crystals operate in the series mode, but if other types of crystals are used, the VFO calibration can be readjusted slightly to correct for any fre-

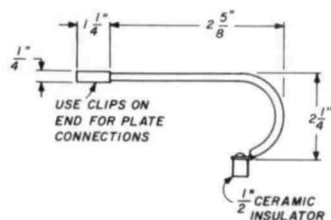
quency differences. A six-position switch provides six 150 kHz sections in the 144- to 148-MHz range. The dc power for the oscillator is

fed to the injection signal to each mixer cathode.

fig. 4. Construction of the final-amplifier inductor and output coupling link. First bend the tank lines as shown in A, and then bend as shown in B. Thin, 1-1/2" long strips are soldered on the ends for connection to the 5894 plate pins. The output link is made from number 12 bus wire.



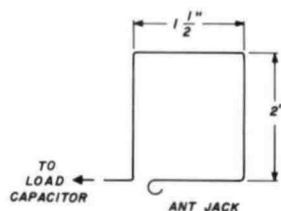
A  
TOP VIEW



B  
SIDE VIEW

supplied from the +150-volt supply by a dropping resistor and a 15-volt zener diode.

The triode section of a 6EA8 is used as a times-three multiplier, and the tetrode section, a 130-MHz buffer-amplifier. This tube provides plenty of injection for both transmit and receive; the screen resistor is selected for the desired injection level. Coupling is provided by a 1.0-pF capacitor to the receiving mixer and a 2.2-pF capacitor to the transmit-



Under the chassis. The new crystal oscillator and switch are in the upper right-hand corner. Tubes, from top to bottom, are 6EA8, 12HG7 and 5894.



## chassis modifications

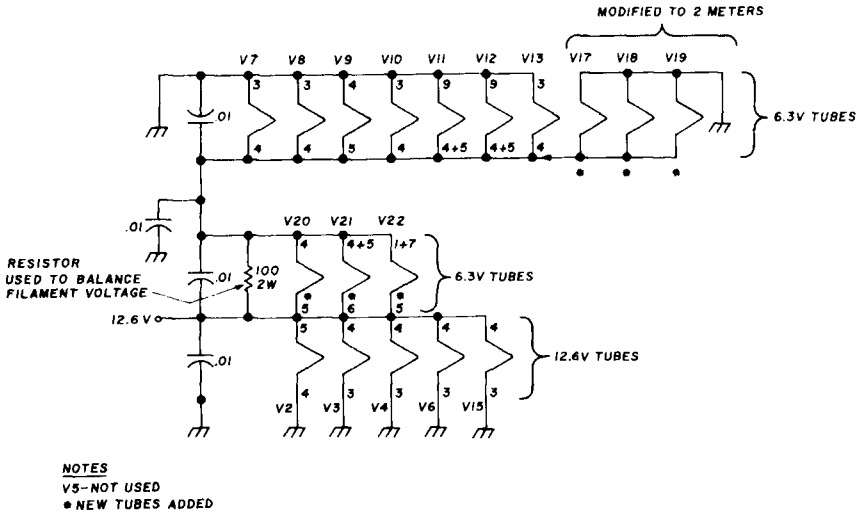
Before you can start the two-meter conversion, you have to take a few things out of the Swan 120:

1. Remove the front panel by removing knobs, control nuts, etc., and disconnect the meter and dial light.
2. Disconnect the wires going to the final amplifier tube socket and identify each one as you remove it. Pull the wires back through under the chassis.
3. Remove the final-compartment cover and shield, including the back panel of the transmitter.
4. Disconnect and remove all the parts in the final compartment.
5. Disconnect and remove the parts associated with the driver plate and final grid circuits.
6. Disconnect the parts from the 6BA6 rf amplifier (V5), and remove the tube.
7. Remove the switches on each side of the driver control; the on-off switch position is

used for the new rf gain control, and the tune switch is replaced by the new crystal switch. A new volume control with a built-in switch provides power-supply switching.

is drilled so it fits snugly around the capacitor shaft; a 1/4-inch panel bearing is installed in the original driver tuning control hole on the front panel to prevent any shaft wobble. You

fig. 5. New filament circuit for the two-meter Swan.



8. Check the chassis to make sure that the areas to be modified are ready for drilling.

Refer to the layout drawing and the photographs to locate all the holes that have to be drilled and punched. Careful layout and drilling is required to make sure all the parts fit properly, particularly the crystal sockets. After the holes are drilled, clean out the chips and filings before installing any new parts. The holes for mounting the terminal strips may be left until the major parts are in place.

### assembly and wiring

Refer to the photos and drawings to determine the correct position for the major parts and check them temporarily before you wire them into place. First, install the crystal sockets next to the 6EAB and 12HG7 sockets. The double capacitor used for mixer and driver tuning should be assembled to the capacitor bracket and installed temporarily while you're wiring the new circuits.

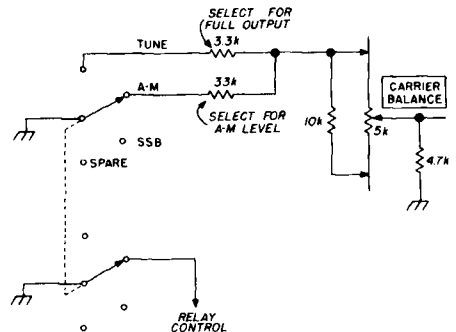
A flexible coupling and hollow shaft are connected to the driver capacitor. The shaft

can locate the various terminal strips by referring to the photos; use the smallest ones that will do the job.

The components associated with the transistor crystal oscillator are wired to a terminal strip right next to the crystal sockets and coil. Voltage for the crystal oscillator is provided by a resistor, zener diode and filter capacitor mounted on spare terminals on the voltage-regulator socket.

Use a shielded-type nine-pin socket for

fig. 6. The function switch for the two-meter Swan uses a double-pole, four-position rotary switch.



the 6EA8. The 12HG7 socket is a flush-mount type installed from underneath the chassis; a shield can't be used because of the 12HG7's large envelope. A Johnson 122-101-100 socket is used for the 5894 power amplifier. Because of the size of the 5894, this submount-type socket must be used. It works very well and leaves clearance room at both the plate and grid ends of the tube. It also provides good ventilation.

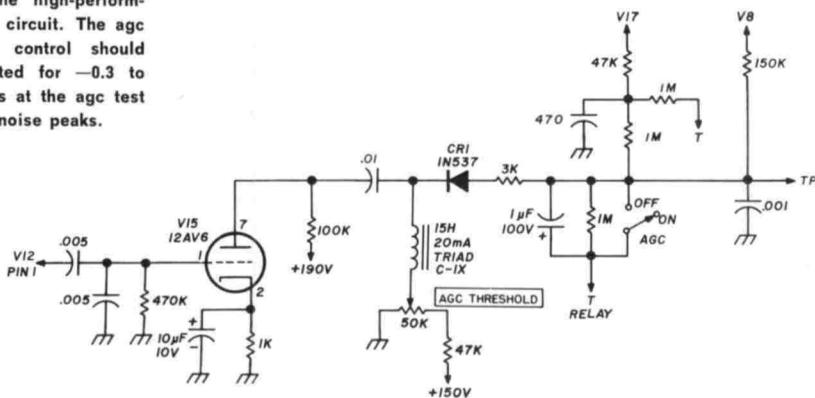
The capacitors I used for coupling between stages were surplus ceramic units, but any

The 1.5- $\mu$ H chokes can be Ohmite Z144's or any small-size 1.2- to 2.0- $\mu$ H chokes. The choke used in the 130-MHz trap has to be very close to the inductance indicated on the schematic. The best approach here is to wind a coil, temporarily connect it across the variable capacitor and grid dip it to 130 MHz before installing it permanently.

## receiver section

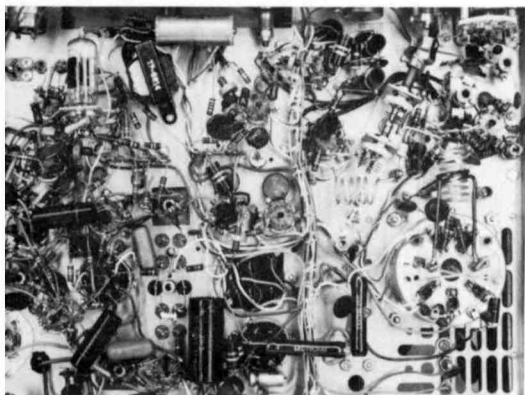
Since the original 6BA6 rf amplifier is not used, it is removed along with the rest of the

fig. 7. The high-performance agc circuit. The agc threshold control should be adjusted for  $-0.3$  to  $-0.4$  volts at the agc test point on noise peaks.



good quality discs or micas will work quite well. All bypass capacitors are disc ceramics. Air-wound coils are made from number 12 bare wire formed around a 1/2-inch dowel.

**Below-chassis wiring.** The 5894 final and 12HG7 driver are to the right; the tube in the upper left is the voltage regulator.



stage. A new front end is built on a brass subchassis and mounted on the VFO housing as shown in the photographs. A small coax cable is used to connect the output from the bandpass coupler to the grid of the 12BE6 mixer. The capacitance of this cable is used to tune coil L7.

The incoming 144-MHz signal is picked off the final plate tank. By using the original feed-through terminal, I eliminated any antenna relay and simplified the transmit/receive switching operation.

## other changes

An agc circuit, similar to the six-meter model, was also used in this unit. A new audio gain control is also used. Several .001 capacitors are used to bypass points in the transceiver to prevent audio feedback caused by two-meter rf.

Bypass capacitors were connected between



V11, pins 3 and 8, and the chassis. They were also used across several B+ points. The bypasses used on V11 are a must to prevent rf energy from being picked up by the long cathode leads; this causes rf feedback into the microphone amplifier.

### adjustment and operation

Check all the receiver circuits to make sure they are properly wired. In addition, a quick check with an ohmmeter should be made before applying the power. Check all

Side view showing the local-oscillator tube and crystal sockets. The 12HG7 driver, is just behind the 6EA8 oscillator.

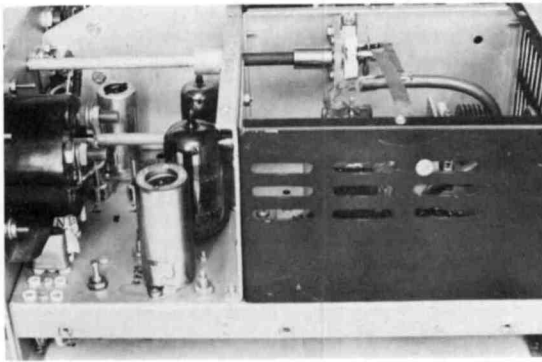
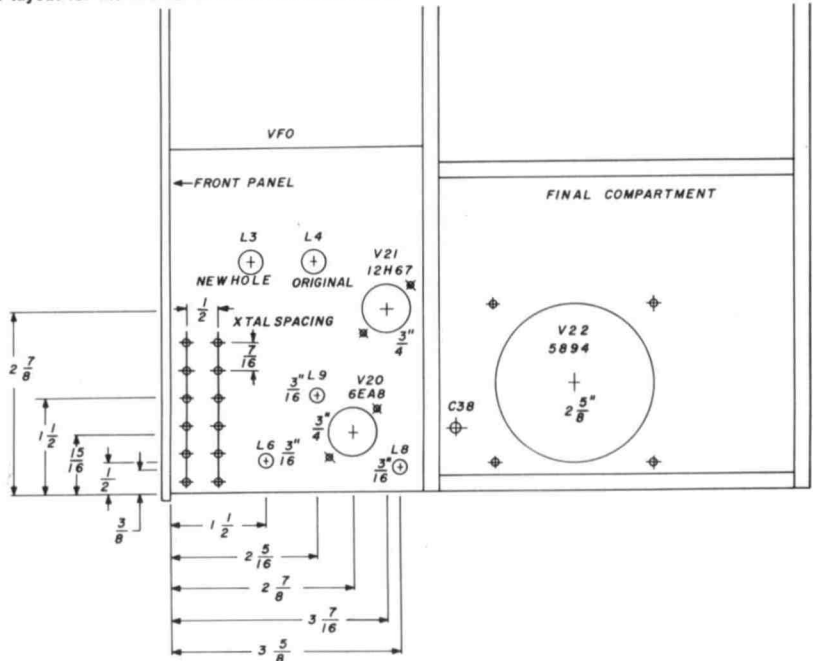


fig. 8. Chassis layout for the two-meter Swan 120 conversion.



the coils to be sure they are adjusted close to their operating frequency. After power is applied, check the test points for correct voltages. Adjust the crystal oscillator, tripler and local-oscillator-chain amplifier for maximum output with the grid dipper in the diode position.

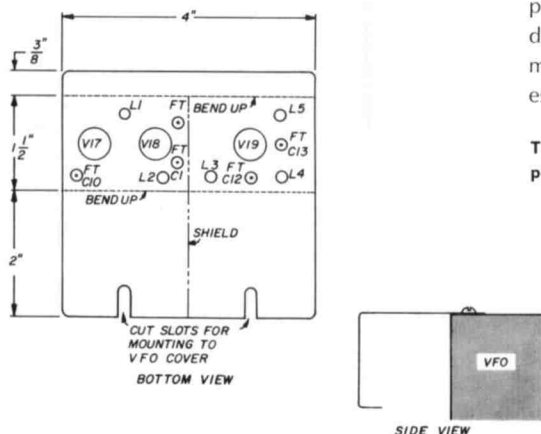
Adjust the new two-meter front end before mounting the chassis on the VFO housing. Adjust the bandpass coupler for flat response over a 150-kHz range. The two-meter coils have to cover a larger portion of two meters.

### transmitter adjustment

Preset all the coils to the desired frequency with a grid-dip meter, apply power, and after warmup, turn the transmitter on. Connect a 50-ohm load to the antenna connector and adjust the carrier-balance control for maximum injection. Peak all the controls for maximum output power. Next, with the VFO dial set in the center of its range, peak the 14-MHz bandpass coupler (L3 and L4) for maximum signal level. Adjust the driver-balancing capacitor for maximum output while simultaneously adjusting the driver control; this sets the tracking of the mixer and driver-plate circuits.

Neutralization of the final stage is done after disconnecting the B+ and screen voltage from the 5894. With full drive applied, adjust the crossed wires next to the plates for lowest signal feedthrough at the antenna jack. These stubs may have to be cut and formed for best results (be sure to insulate

fig. 9. Construction of the chassis for the 144-MHz converter.



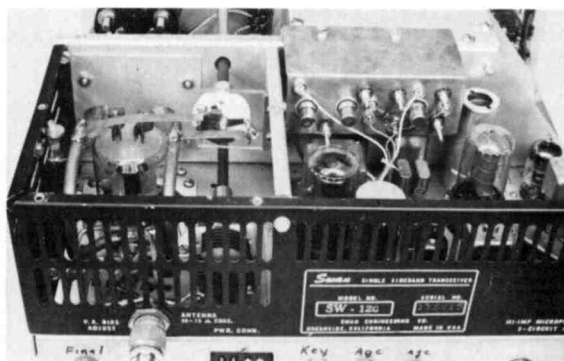
them with spaghetti). You may have to re-neutralize after making the rest of the PA adjustments.

After the screen voltage and B+ have been re-connected, install the cover, insert carrier,

and bend the antenna link for maximum output power. The plate-balancing capacitor must also be adjusted for highest output level. To obtain the correct drive levels, you may have to repeak all the driver circuits. The voltage readings marked on the schematic will help to determine if these circuits are working properly.

Adjust the 130-MHz trap with a grid dipper set in the diode position; couple the dipper to the driver coil and tune for maximum, then adjust the trap capacitor for low-est output at 130 MHz.

The agc bias control and voltage test point are located on the rear deck.



If you're interested in a particular section of the two-meter band, final adjustments can be made for optimum performance on that section. Be sure you recheck all the adjustments after the covers are installed.

The output meter shunt resistor is adjusted for center scale at 40 watts into a 50-ohm dummy load—10k ohms is about right.

## operation

If you change your operating frequency by more than 150 kHz, you must repeak the transmitter controls. When you switch from 144 to 145 MHz, the power output will be low but you can still make contacts. Since the first tuned circuit in the receiver is also the final plate circuit, you'll notice a slight reduction in sensitivity unless the 5894 plate circuit is peaked up, but for local reception it isn't required.

After the driver and final circuits are tuned for maximum output, the microphone gain

### parts list

- 1 7-pin socket (Johnson 122-101-100)
- 1 9-pin ceramic tube socket with shield
- 1 9-pin ceramic tube socket, flush mount
- 12" 1/4" copper tubing
- 15" Miniature 50-ohm coax (RG-174/U)
- 8 1/4" slug-tuned ceramic coil forms
- 6 ceramic crystal sockets
- 1 DPDT slide switch
- 1 small single-pole, 6-position rotary switch
- 1 500k potentiometer with switch
- 1 12HG7 tube
- 3 6DS4 tubes
- 1 6EA8 tube
- 1 5894 tube
- 1 1N34A diode
- 1 2N3564 transistor
- 1 12- to 17-volt zener diode
- 1 100- $\mu$ F, 20-V electrolytic capacitor

control should be adjusted so that voice peaks result in 35 to 50% of the maximum 5894 cathode current.

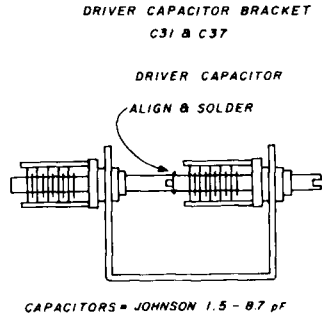
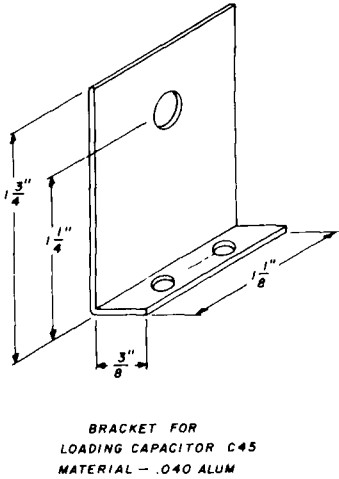
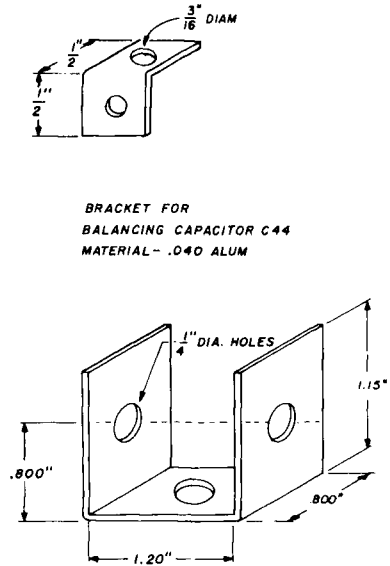
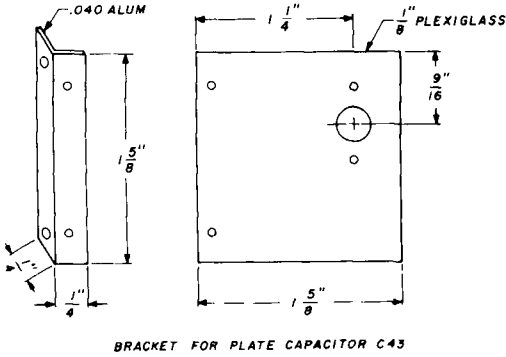
### final comments

I spent a lot of time trying different circuits and layouts, and after a lot of experimanta-

tion was made to a Swan 120, Swan 175 and 140 transceivers could also be used if you make the necessary changes in the mixing circuits.

Since I completed this conversion, I have worked stations up to 200 miles away on two meters. I can change frequencies from one

fig. 10. Construction of the various capacitor-mounting brackets and assembly of the driver capacitor from two Johnson 8.7 pF air variables.



tion, the conversion described here is the most simple and best performing I could obtain. The transistor crystal oscillator is very stable, even during mobile operation.

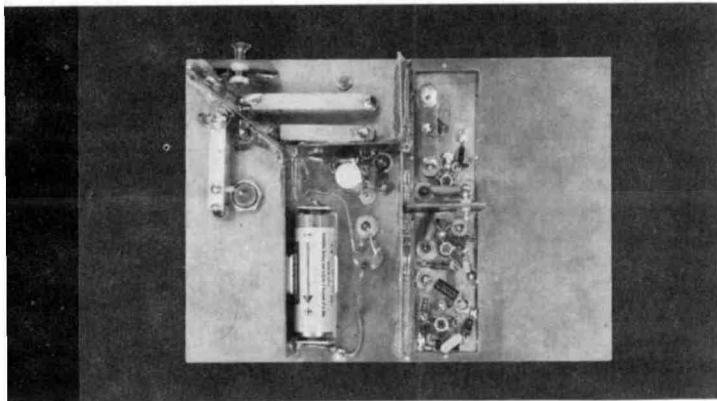
This conversion is only recommended for the more experienced home builder. It can be reproduced quite easily, but don't take any short cuts or make any parts substitutions. And, although this particular conver-

section of two to another, tune up and be ready to transmit in a matter of seconds. We need more ssb on our vhf bands, and this conversion is a good way to do it for 144.

### references

1. D. Crowell, K6RIL, "Converting the Swan 120 to 6 Meters," 73, June 1967, pp. 28-34.

ham radio



Inside the low-noise 432-MHz converter.

## low-noise 432-MHz fet converter

A high-performance  
converter for 432 MHz  
with excellent  
cross-modulation  
and  
gain characteristics

Bob Kolb, WA6SXC, 1300 W. Oak Street, Fullerton, California 92633

The availability of moderately-priced field-effect transistors with low noise figures in the vhf region has prompted a number of amateurs to design preamps for existing converters. The complete 432-MHz converter described here is a high-performance unit consisting of a single-stage rf amplifier, a multiplier chain and a mixer with a 28-MHz i-f.

The neutralized rf amplifier has 15-dB gain as shown by the scope trace. The 3-dB bandwidth is 10 MHz and the 1-dB bandwidth, 5 MHz. The rf amplifier uses the flat-pack 2N4417. The mixer, a 2N4416, operates at pinch-off, so it doesn't provide any conversion gain. However, this mode of operation offers excellent cross-modulation characteristics which are sorely needed in southern California where radar interference is a problem.

The 2N4416 is the same device as the 2N4417 rf amplifier, but it's mounted in the familiar TO-18 can. The multiplier uses a 101-MHz CR56/A crystal available from JAN Crystals\* followed by two doublers to pro-

\* JAN Crystals, 2400 Crystal Drive, Fort Myers, Florida 33901

duce 5 mW at 404 MHz. All bipolar transistors in the oscillator/multiplier circuits are 2N918's.

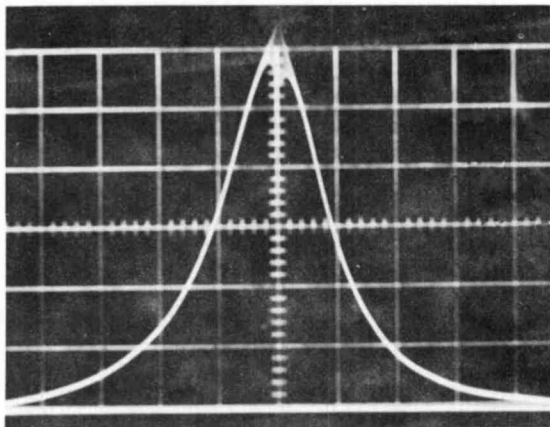
The net gain of the converter is only 12 dB. However, this is sufficient to overcome the noise figure of most high-quality amateur-band receivers. The signal-to-noise ratio is significantly better than my old two-stage 2N2857 preamp which measured 4.5-dB noise figure the last time I checked.

### construction details

The circuit is quite simple and easy to construct. The chassis is made from 1/16-inch epoxy-fiberglass printed-circuit board. The dividers are 0.9-inch high and the entire converter can be mounted in a 1-inch deep aluminum chassis. The board size shown in the drawings is 5 by 7 inches with a 2-1/4 by 5-inch section left for an internal power supply. The local-oscillator multiplier chain was constructed on a 1-1/4 by 5-inch board and tested independently.

This modular construction has a number of advantages, some of which will be noted in the tune-up section. For one thing, each

**Gain-bandwidth characteristic of the rf amplifier. The horizontal scale is 5 MHz per division; vertical scale is approximately 1 dB per division above the center graticule, which represents 12-dB gain.**



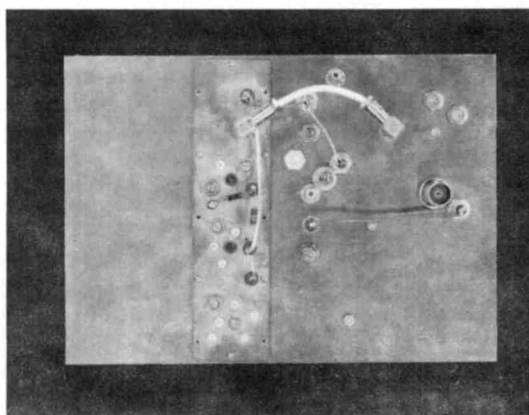
portion of the converter can be individually checked for performance. Furthermore, the local oscillator can be easily replaced by a different frequency unit if you want to change i-f's.

Use a large alligator clip to heat sink the Johanson capacitors when soldering to them. They're constructed with 570°-F solder and are easily damaged by medium-power soldering irons.

L1, L3, L4 and L5 are made from 0.020-inch thick by .250-inch wide copper shim stock. Brass or beryllium copper may also be used. Each of these inductors is mounted 0.3 inches above the chassis and supported by the low-pass filters (LPF's) and capacitors as shown in **fig. 3**. The mounting of L5 is shown in **fig. 3B**.

The 2N4417 rf amplifier is mounted with

**Top view of the 432-MHz converter.**



the gate lead soldered to the top of C1, the drain lead to the top of C2 and the source lead to the grounded standoff terminal 0.3-inch high. Don't bend the source lead and solder it to the shield. The ceramic-glass seal won't take the thermo-mechanical strain; this advice comes from costly experience. **Fig. 4A** shows this mounting from the source side looking along L1. **Fig. 5** shows the FET and transistor connections.

The manufacturer of the FET recommends the use of a **Miller 4403** 0.99- to 1.5- $\mu$ H variable inductor for L2, but don't mount the form on a grounded surface. The slug must **not** be grounded; if it is, neutralization is next to impossible! Furthermore, L2 should be mounted on the drain side of the shield and the neutralizing capacitor on the gate side. Drill a small hole through the shield and remove a 1/8-inch circle of copper around it to



X-acto knife, flow solder over that area, and use the knife to lift the copper while it's still hot.

Note that the base divider is mounted on top of the local-oscillator board. Feedthrough capacitors may be substituted for the low-pass or feedthrough filters called out, but look out for self-resonances at 432 MHz. If feedthrough capacitors are used, connections in the dc power lines should be made through 10- $\mu$ H rf chokes. BNC connectors can be used for all coaxial jacks, but J2 must be repositioned midway between L3 and L4, and J3 moved to the right of L5.

noticed that most solid-state amateur converters suffer from insufficient local-oscillator injection; on the other hand, too much local-oscillator power degrades noise figure. Note that minimum sensitivity can vary as much as two S-units with a 20-dB change in local-oscillator power.

The generator I used had only +10 dBm available. I would expect the curve to rise slightly as the local-oscillator power increases. At this point noise figure would be severely impaired. Local-oscillator injection into the source circuit usually requires even more power. By tapping local-oscillator pow-

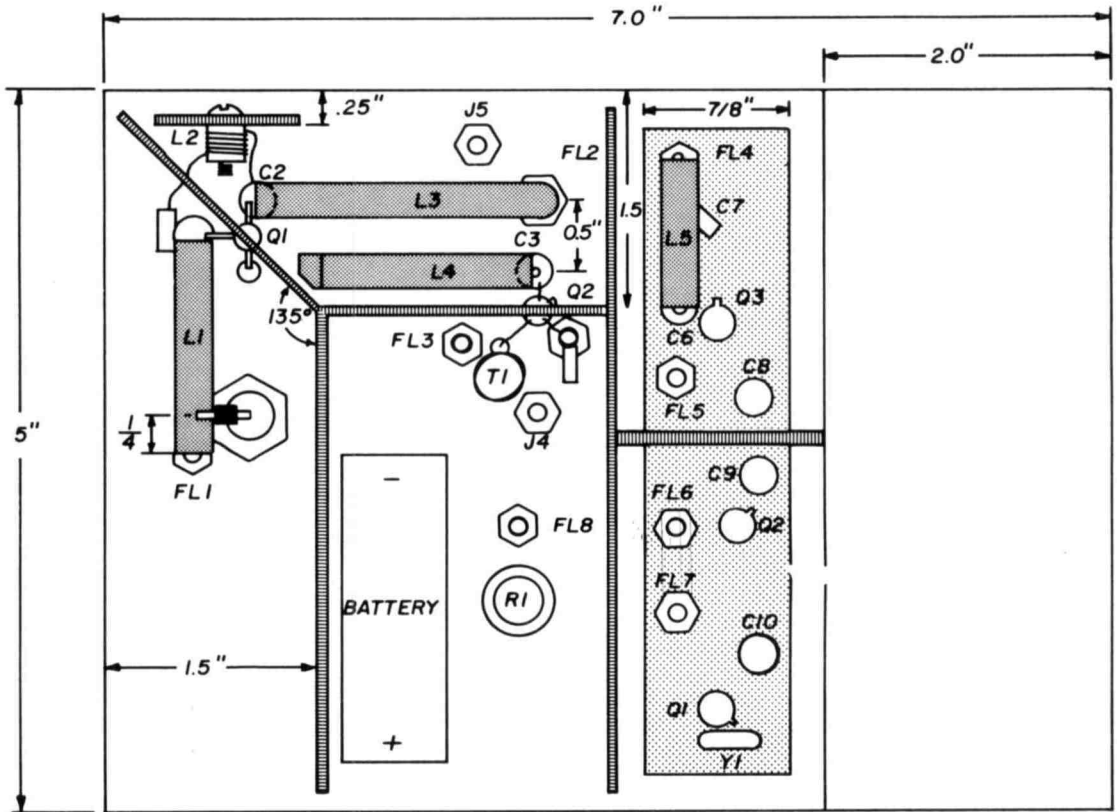


fig. 2. Layout of the low-noise 432-MHz converter. Double-sided copper-clad board is used for the chassis as well as the shields.

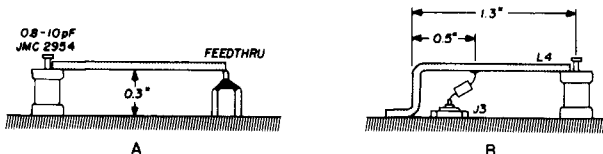
The tangential sensitivity (minimum discernible signal) versus local-oscillator injection power is shown in fig. 6. This data was taken with a 50-ohm source applied to J2 and the power level varied in 1-dB steps. I have

er into L4 you get a good match to the local-oscillator circuit while isolation between the local-oscillator and i-f is enhanced by the portion of L4 that is in series between the local-oscillator input and the i-f output.

## tune-up procedure

You can tune up the local oscillator with any rf-sensing device such as a detector probe for a VTVM or grid-dip meter in the diode mode. The choice of a 101 MHz crystal eliminates the possibility of tuning the local oscillator to the wrong harmonic or the develop-

fig. 3. Inductors L1, L3 and L5 are shown in A. L4 construction is illustrated in B.



ment of birdies due to nearby harmonics. It can be tuned up on the bench using a 51-ohm resistor as a load.

## the rf amplifier

To adjust the rf amplifier, connect an antenna or 50-ohm load to J1. With plus 15 V applied, adjust R1 for 5 mA of drain current ( $I_D$ ) measured at the dc input to L3. The voltage on L1 should be approximately  $-0.5$  V. Remove the connection at J1 and note any change in current. If the drain current changes, L2 must be adjusted. Apply a signal to J1 and monitor the output of the rf amplifier at J2 (local oscillator removed). Alternately adjust C1, C2, C3 and L2 for maximum signal with no change in current ( $I_{DQ1}$ ) while J1 is open circuited. When  $I_D$  remains steady with J1 open, and the amplifier is tuned for maximum signal, it is properly neutralized.

Do not attempt to neutralize the rf amplifier by adjusting L2 for minimum signal feedthrough without B+ applied. The B+ changes the junction capacitance of the FET and detunes the circuit. Small changes in B+ don't shift the bandpass significantly, but in areas where commercial power voltages vary considerably, it's a good idea to regulate the B+ to the rf stage with a 15-V zener diode.

Fig. 7 shows the method I used to determine converter sensitivity. Noise figure was calculated at 3.1 dB based on a 250 kHz i-f bandwidth for the HP417. **Minimum Discernible Signal** with 50% modulation was  $-125$

dBm or approximately  $0.1 \mu\text{V}$ . I attempted to measure MDS with the HP608C at 0 dBm with precision step attenuators in series with the input. However, this approach was abandoned because the unshielded converter picked up radiation from the generator when the attenuators were increased beyond  $-65$  dBm.

fig. 4. Method of installing the 2N4417 rf amplifier (A). The support for L2 is shown in B.

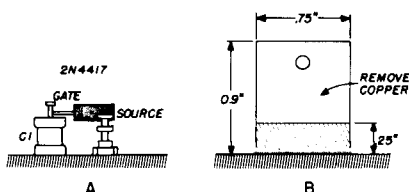


fig. 5. Transistor base diagrams.

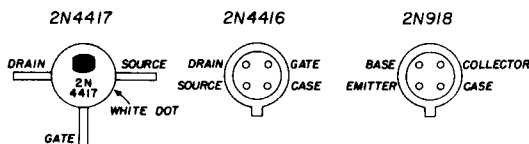
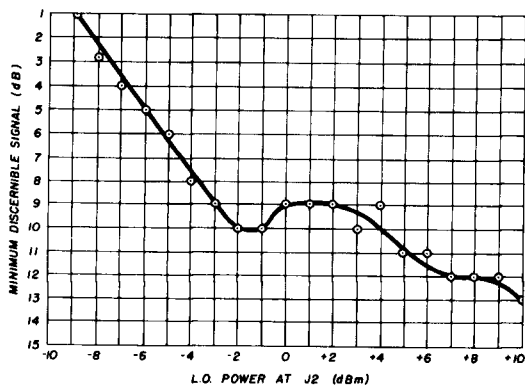


fig. 6. Minimum discernible signal vs. local-oscillator power for the 432-MHz converter.



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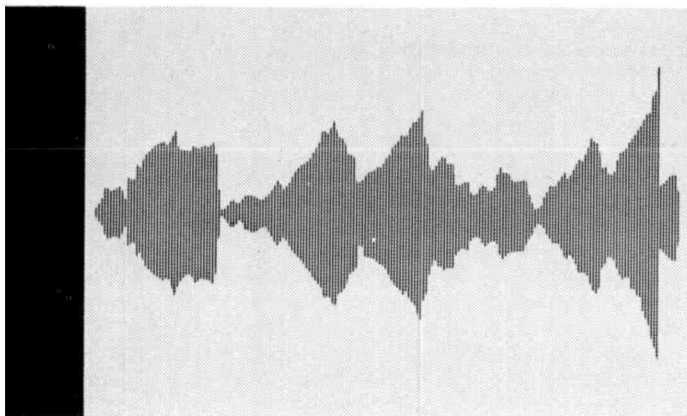
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# generating ssb signals with suppressed carriers

The  
inside story of  
the  
balanced  
modulator

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

The first step in forming a single-sideband signal is the generation of what is called a double-sideband suppressed-carrier or **dsb-sc** signal. Some form of filter then removes one sideband completely. It takes a special kind of modulator to create the sidebands and eliminate the carrier, and the one used most is called a **balanced modulator**.

## balanced modulators

A modulator is nothing more than a special mixer for mixing the voice signal with the carrier. With ordinary amplitude modulation, the mixing creates sideband frequencies equal to the sums of and differences between the voice modulation and the carrier—and, of course, both original signals remain in the output, too. The circuit that produces a suppressed-carrier signal must form the sidebands exactly the same as an ordinary a-m modulator and yet eliminate, as completely as possible, the carrier against which the voice modulation beats to create the sidebands.

First, then, to make it easy to understand the principles of carrier-suppressed modulation, let me explain a way to feed a carrier signal into a modulator circuit in such a way

that the circuit is controlled by it and yet the carrier itself does not appear in the output. **Fig. 1** shows how this works.

Look at **fig. 1A** first. In this arrangement, the rf signal is fed to V1 and V2 in parallel. In other words, when the grid of one is on its positive rf half-cycle, so is the grid of the other. As is usual in amplifiers, each tube inverts the signal.

Look what happens when the outputs of the two tubes are connected in push-pull. The output of V1 is a negative half-cycle, and is applied in one direction through the transformer. The output of V2 is also negative-going, but it is applied in the opposite direction through the transformer.

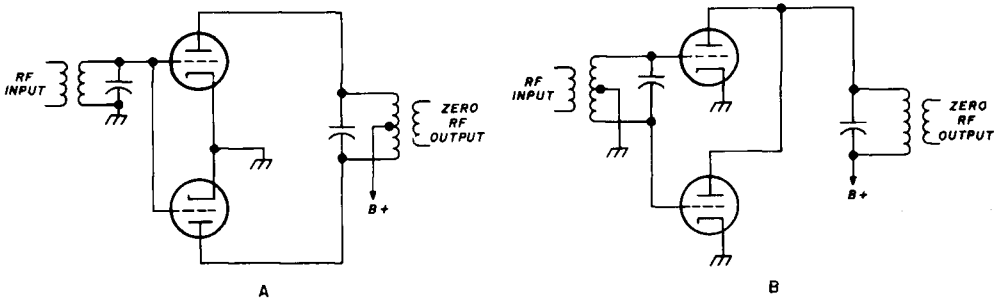
The result is cancellation in the transformer of the effects of either signal. If the amplifica-

tion of the two tubes is exactly equal, and the transformer itself is well balanced, there is total cancellation of whatever signal is applied to the grids of the two tubes.

parallel out also means cancellation of the input signal. If you're wondering why any purpose is served by feeding an rf signal into the stage only to have it canceled in the output, think about what happens whenever the tubes become unbalanced. Imagine that V1 in **fig. 1B** amplifies less while V2 amplifies more. One of the signals that appears in the parallel output will dominate the other, because it is stronger.

If the situation were reversed, with V2 amplifying more than V1, the unbalance would create a dominance of the opposite polarity. If something switches the amplification of the two tubes alternately up and down quite rapidly, the output signal varies back and forth at the same rate. The result is

**fig. 1. Cancelling the carrier signal: input in parallel, output push-pull (A); input push-pull, output parallel (B).**



tion of the two tubes is exactly equal, and the transformer itself is well balanced, there is total cancellation of whatever signal is applied to the grids of the two tubes.

Next, look at **fig. 1B**. If a signal is fed to this stage in push-pull, the half-cycles of rf sine wave drive one tube in one direction and the other tube in another. However, if the outputs of both tubes are connected in parallel, the positive excursion of one always cancels the negative excursion of the other.

For example, suppose the signal at the grid of V1 is on its positive excursion; the signal at the grid of V2, then, is on its negative excursion. As usual, each tube inverts the signal. The output of V1 is a negative half-cycle, and the output of V2 is a positive half-cycle. Since these are mixed in the same load, they cancel each other. Thus, push-pull in and

an output that is a rapidly fluctuating rf signal of first one polarity and then another.

Consider the same action in **fig. 1A**. With V1 conducting more than V2, the opposite signal components in the transformer are no longer equal, and a certain amount of rf output is coupled to the secondary. If V2 conducts more than V1, the unbalance is in the opposite direction. Again, if something switches this unbalance back and forth between the two tubes at a rapid rate, the output varies at that same rate.

**Fig 2A** shows a convenient method of varying the gain of the two tubes. What you see is the same circuit you saw in **fig. 1A**, but with a speech input transformer added in **push-pull**. It is easy to see that the push-pull speech signal can swing the amplification of the two tubes back and forth at an audio rate.

The tubes become alternately unbalanced at an audio rate, and rf shows up in the output—swinging back and forth from positive-going to negative-going output at the same rate. The effect is that the rf and speech signals are “mixed” and sidebands are created, yet the rf carrier signal itself does not appear in the output. The instant the speech modulation is removed, there is zero output from this balanced modulator.

**Fig. 2B** shows the principle applied to the circuit of **fig. 1B**. In this one, as you can guess if you now see the underlying principle of the balanced modulator, the speech signal is sent to both tubes in parallel. Since the tubes conduct alternately as far as rf is concerned, varying the gain of both tubes with the speech signal results in the same kind of amplification unbalance at an audio rate that was described in **fig. 2A**.

The result in the output is exactly the same. The carrier itself does not appear in the output; in fact, with no speech input, there is no output. When there is speech modulation, however, the output consists solely of sidebands created by mixing the speech signal with the rf carrier.

The pattern of operation here should be clear. In the balanced modulator, the rf signal is applied in one mode and coupled out in the other. That is, if rf is fed into the stage in parallel, it is taken out in push-pull. If fed in in push-pull, it is taken out in parallel. This is true of all balanced modulators; that’s why they suppress the rf carrier. The speech signal, on the other hand, is always applied in the same mode as the output is removed.

Balance is important. If either tube becomes slightly unbalanced, the carrier is then amplified constantly, even though slightly, by that tube. Many balanced modulators include a balancing adjustment which is set for minimum rf output with zero audio modulation.

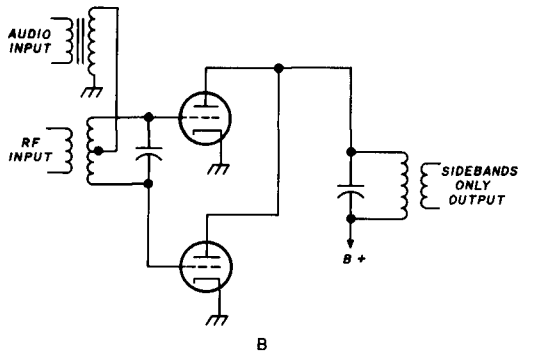
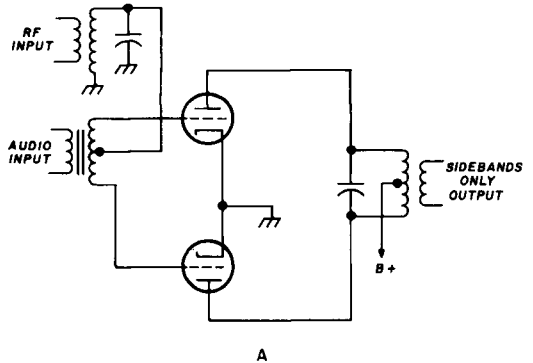
Now that you are aware of the principles involved, let’s examine some actual circuits. With your new understanding, you’ll find the circuits themselves are easy to figure out.

### diode balanced modulators

The simplest and least expensive balanced modulators generally use semiconductor diodes. They seem to be more stable than

tube-type balanced modulators, and are not prone to change characteristics over periods of time. Well designed diode balanced modulators provide about 40 dB of carrier suppression—more than tube types do (with the exception of the special beam-deflection-tube balanced modulator, which will be explained

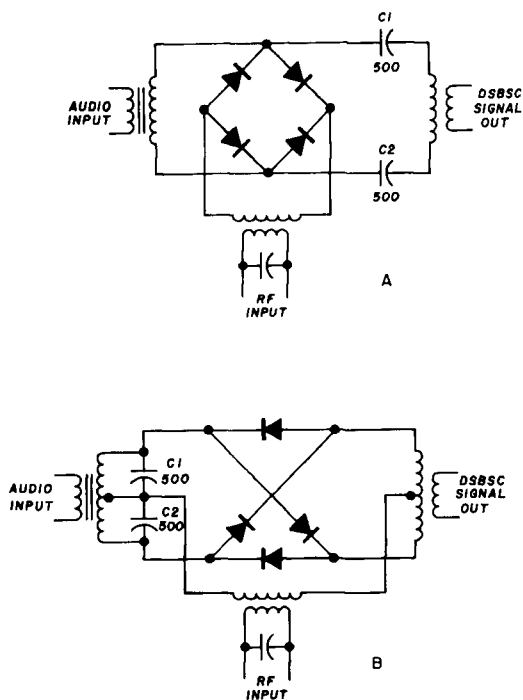
**fig. 2. Adding audio input for modulation: rf parallel, audio push-pull (A), rf push-pull, audio parallel (B).**



later). That means the power in the sidebands, at 100% modulation, will be at least 40 dB stronger than whatever carrier power slips through.

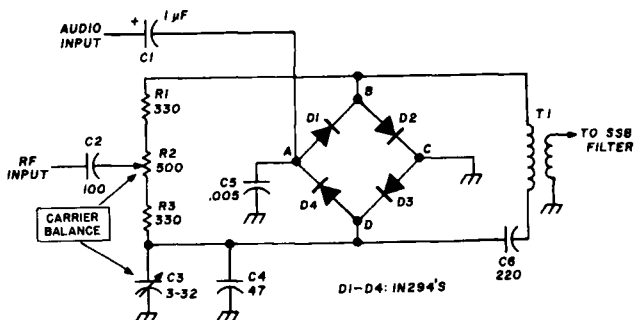
Two easy-to-understand diode balanced modulators are shown in **fig. 3**. At **3A**, you see the **bridge** type. In it, the rf and the speech signals are mixed in a four-diode bridge. Notice that, effectively, the principle of balanced modulators is adhered to. The speech signal is applied to the stage in the same mode in which the output signal is taken out.

fig. 3. Basic diode balanced modulators: bridge (A), ring (B).



The rf signal, on the other hand, is applied to the "balanced" corners of the bridge. One end of the rf input transformer is connected to the cathode of two of the diodes, and the other end is connected to the anodes of the other two. The result, of course, is that the rf signal is "shorted" to ground by the diodes except when there is speech modulation to unbalance their conduction. When that happens, the output becomes a double-sideband suppressed-carrier signal.

fig. 4. The most popular diode modulator used in ham transmitters.



## ring modulators

An improved version is shown in fig. 3B. It, too, uses four diodes—in a circuit called a ring. Better sideband signals are produced in the ring modulator than in the bridge-type. Again, the speech input is in the same mode as the output. The rf signal is fed into transformer center taps, so it is balanced with respect to the output.

Efficiency in the ring modulator is high, and the four diodes should be carefully matched. One way to check them is with an ohmmeter, by measuring their forward and backward resistances. All four should match within 2%—even better, if possible. If they aren't matched, a certain amount of the rf carrier will slip through. Furthermore, the sidebands themselves will be unbalanced, which will create distortion when you try to recover them at the receiver.

The purpose of the 500-pF capacitors in both modulators is to keep audio and rf separated except in the mixer diodes. The capacitors pass rf energy quite easily, but present a fairly high impedance to the speech signal. In fig. 3A, the sideband output transformer would act pretty much as a short circuit for the speech signals; instead, the capacitors keep them out and they are forced to go into the bridge.

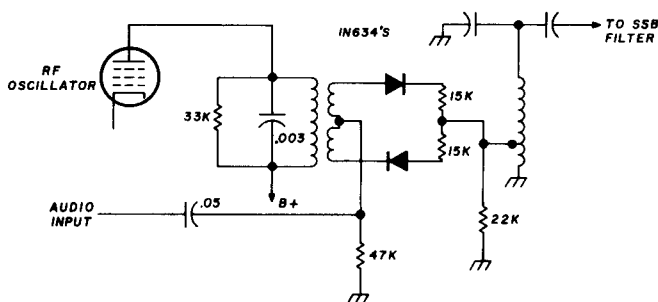
In fig. 3B, the two capacitors merely assure a low-impedance path for the rf signal in both directions to the ring circuit. The capacitors hardly affect the speech input signal at all, because of their low value.

About the most popular balanced modulator for ham equipment is the one shown in fig. 4. It is a variation on the ring circuit already described. Don't be confused by the

way it's drawn, because it isn't a bridge. You can tell it's a ring by the fact that the diodes all are in series with one another; in a bridge, there are always two cathodes together and two anodes together.

This circuit has some other peculiarities, because it is designed to eliminate the expensive input transformers. Furthermore, both the speech and the rf signals are fed into the ring diode circuit from stages in which one side is grounded. The thing to do, to understand this particular balanced modulator best, is to analyze the action on the rf carrier alone first, and then study the effects of unbalance created by the speech input signal.

fig. 5. Two-diode balanced modulator is one form of the ring-type.



The first thing to notice is that two corners of the ring are grounded as far as rf is concerned. Capacitor C5 keeps point A at rf ground; point C is grounded directly. That being the case, the rf signal is applied to the ring effectively in parallel. It goes in both directions through R1 and R3, from balancing potentiometer R2. When it reaches B and D it splits up, with both segments being shunted to ground through whichever diode happens to be conducting on that particular half-cycle or excursion.

The important thing is that, because of the way the diodes are connected in the ring, the rf signal is behaving **inside the ring circuit** almost as if it were in push-pull. From point B, it goes through D1 on one half-cycle, then through D2 on the next, seeking ground. From point D, it alternates going through D3 and D4. With zero input from the speech circuit, the rf signal is continually shunted to ground on both excursions by one or another of the diodes. The result is that no rf reaches the primary of transformer T1 and consequently there is no carrier output.

Next consider what happens when a speech signal is applied at point A. The capacitor there has little effect on the speech frequencies. Therefore, the path to ground for positive half-cycles of the speech signal is through D1 and D2. For negative half-cycles, it is through D3 and D4. The speech signal thus "turns on" these diode pairs alternately, at the speech-signal rate. You can see that the speech signal determines which diodes are conducting and which not conducting during a given half-cycle period.

As an example of the effect: when the speech signal is causing D1 and D2 to conduct, it has reverse-biased D3 and D4. Con-

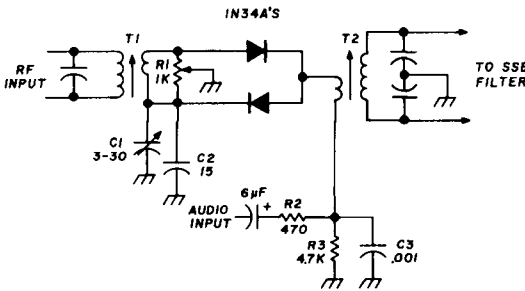
sider positive excursions of the rf signal (**many** rf excursions occur during each audio half-cycle). Their only possible paths to ground at that instant are through D2, which is made conductive by both the rf and the speech signal, and through D4 which is made conductive only by the rf signal. Obviously, the greater rf current flows through R1 and D2. Much less flows in R3 and D4, because conduction in that diode is opposed by the speech-signal excursion. For negative excursions of the rf signal, the path aided by the speech-signal excursion is through R1 and D1; the R3-D3 path is opposed because D3 is still reverse biased.

If you carry through the reasoning for both positive and negative speech-signal excursions, you'll see that the path for all rf signals is through R1 on positive half-cycles of the speech signal, and through R3 on negative ones. This unbalancing means that some of the rf is not canceled and causes rf current to flow in T1—first predominantly in one direction, then in the other. Since, during modulation, this unbalance is varying at the speech-

signal frequencies, the output is a pair of sidebands resulting from mixing the carrier and the speech frequencies; there is no carrier.

Capacitor C6 serves the same purpose it serves in the other circuits—to make sure only sideband signals reach T1; its value is such that it virtually blocks speech signals. C3 and C4 are balancing capacitors that make up for any stray capacitance in the stage; C3 is adjusted for minimum carrier output with zero modulation.

fig. 6. Simple two-diode balanced modulator is also ring-type.



### two-diode modulators

An exceptionally simple variation of the diode-ring balanced modulator is used in one transmitter. If you examine its circuit carefully (fig. 5), you'll see that all the requisites of a balanced modulator are there. The diodes are in series with each other, as in a ring circuit. The rf signal is fed to the modulator circuit in push-pull by the secondary of the input transformer, and the resulting sidebands are taken out in parallel via a tap between the two balancing resistors. The speech signal is

fed in parallel, being applied to the center tap between the two secondary windings of the input transformer.

With no modulation, each excursion of rf is applied to the diodes, but only the ones that make the top of the transformer secondary positive and the bottom negative can make the diodes conduct. Current then flows through the two balanced resistors. However, the output is taken off **between** the two resistors, so the voltages across the two resistors are in opposite phase with respect to ground, and they cancel. The result: no output. During the other excursion, there is no output because the diodes aren't even conducting.

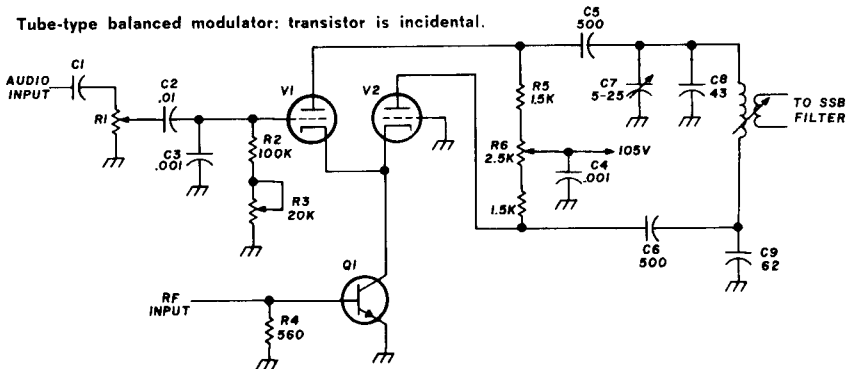
As the speech signal switches first one and then the other diode "on," the rf signal that is trying to flow in both diodes is either opposed or aided. The constantly shifting unbalance at the speech frequencies produces the sidebands at the junction of the two resistors, with the carrier suppressed.

Don't let the tap on the output coil confuse you. This one is strictly for matching the low impedance of this modulator to the higher impedance of the filter that follows.

There are other relatively simple two-diode ring circuits. One that has been popular in some home-brew rigs is shown in fig. 6. You don't need much explanation of this one; you can figure out its operation from your knowledge of this type of balanced modulator.

The rf is applied to the two-diode ring in push-pull. R1 can be adjusted for a "center-tap" ground that allows the speech to be fed in at a tap between the two diodes—therefore in parallel. The output is taken in parallel at the same point, through a coil which couples

fig. 7. Tube-type balanced modulator: transistor is incidental.



the sideband signals through a tuned secondary to the sideband filter.

C1 and C2 are the capacitance-equalizing part of the carrier-balancing network. Sometimes C1 is moved to the opposite end of the coil. R1 is of course the carrier-balancing potentiometer.

### tube-type balanced modulators

In fig. 7 is a tube-type balanced modulator used in at least one commercial ham transmitter. A transistor is used, too, but it is primarily an impedance-matching input device. The balanced modulator has the usual configuration. The rf is fed to the stage in parallel, to the two cathodes, and the output is taken out in push-pull.

R5, R6, and R7 make up a balancing network to equalize conduction of the two tubes. The speech signal must be applied in push-pull, which is accomplished by grounding the grid of one tube and feeding the signal to the grid of the other. This is, in effect, push-pull.

Operation of this circuit is very much like the one in fig 2A. The two 500-pF capacitors keep speech signals out of the output circuit. C7, C8, and C9 are the capacitance-balancing capacitors. C7, the adjustable one, may be at either end of the output transformer winding, depending on which position does the best job of suppressing the carrier. Capacitor C4 keeps the carrier-balance control slider at rf ground, providing the rf "center-tap" ground necessary to make the output circuit push-pull.

Pentodes may be used in place of triodes for this circuit. When pentodes are used, the rf signals may be fed to the control grids while the speech signal is fed to the screens. Speech and rf are in push-pull, and the outputs are paralleled. Fig. 8 shows an example of this particular hookup. The schematic is simplified to show merely how it works; the system is seldom used in commercial ham transmitters.

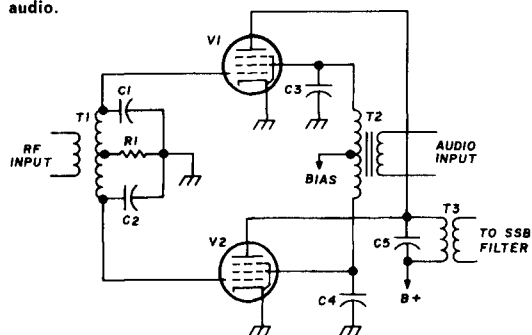
### deflected-beam-tube modulator

RCA has a tube, the 7360, that is designed especially for balanced modulators and balanced detectors. Its cathode gives off electrons that form a beam which travels between

two deflection plates toward two output plates. The schematic diagram detailed in fig. 9 looks pretty complicated, but it isn't if you keep the fundamentals you have already learned about balanced modulator operation in mind.

One big difference in this particular circuit is that it is self-oscillating. The carrier is generated internally. An external oscillator can be used, but there is little need, unless a separate oscillator is already part of another circuit. This one is a crystal-controlled Colpitts.

fig. 8. Pentode system uses screen grids to accept the audio.



The structure of the tube is such that the internally generated rf signal modulates the beam, but the beam doesn't strike either output plate. It goes right between them. So, you have that old familiar balanced-modulator characteristic: no rf-carrier output signal. You can call this type of carrier-signal injection parallel, since it has the capability of reaching either plate, as you will shortly see. The output, of course, is in push-pull.

The speech signal is applied to the deflection plates of the tube, **effectively** in push-pull. One of the deflection plates is at ground potential for audio signals—the 0.1- $\mu$ F capacitor does that job. The speech signal is fed to the other deflection plate.

The dc voltages on the two deflection plates must be equal when there is no speech input, so the rf beam misses both plates. That is done by a voltage-divider network across the 300-volt supply line, and the 5k potentiometer. Then, when speech modulation is applied to the deflection plates, the beam is pulled back and forth so it strikes the output

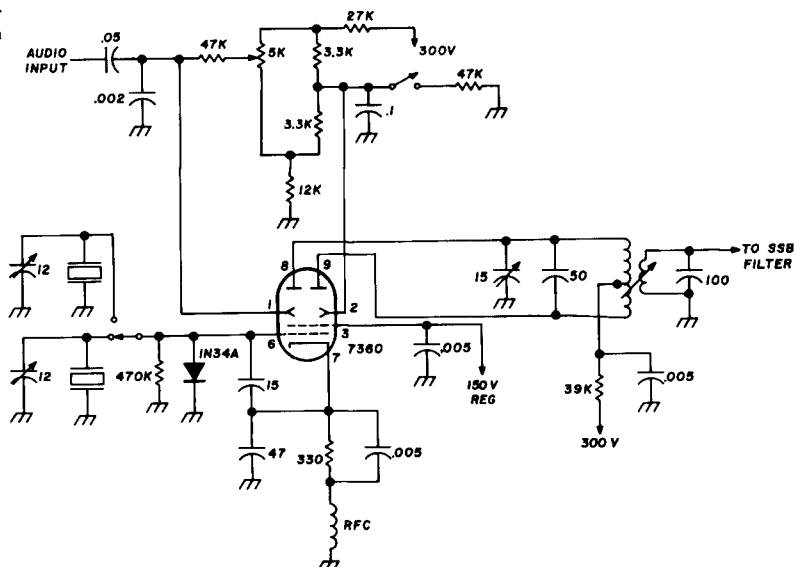


plates, first one and then the other, at an audio rate. The speech signal thus produces an output that contains only the sidebands.

The beam-deflection balanced modulator has several advantages. It is easy to adjust and doesn't require a lot of tricky balance

There you have the story of balanced modulators. Keep in mind the basics: the output mode is the opposite of the rf input mode, so the output will be devoid of the carrier frequency. The speech signal is fed to the stage so it can control gain, switch diodes,

fig. 9. Beam-deflection balanced modulator; tube is a RCA 7360.



adjustments—just one potentiometer. A regulated supply is a good idea for the screen grid, which acts as a sort of plate for the oscillator. The circuit is capable of at least 60 dB of carrier suppression. This is beyond the most stringent requirements.

or deflect a beam that already contains the rf. The result of this mixing of signals is an output that contains the sidebands produced by the mixing process, without the carrier.

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## two-year novice licenses

A number of rumors have been circulating around to the effect that Novice licensees who held a one-year Novice license which expired 22 November or thereafter, would receive a one-year extension to their license term. This is not true. According to the Federal Communications Commission in Washington, D. C., no extensions will be granted to Novice licensees because of the new two-year Novice-license term.

If you know any Novices whose licenses expired on or after 22 November 1967, check to make sure that they are not under the mistaken impression that their license has been extended for one year. If you hear other amateurs spreading this rumor, please tell them that there are no one-year extensions to Novice licenses. If they have any questions, have them check with their local FCC office.

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# folded mini-monopole antenna

Space problems?  
The mini-monopole antenna  
offers high performance  
and efficiency  
in a small package

William I. Orr, W6SAI, 48 Campbell Lane, Menlo Park, California

**Compact, low-frequency** antennas are characterized by low input resistance, high reactance, inherently high Q and low radiation efficiency. In addition to this melancholy catalog of features, the compact antenna requires a matching network to compensate for antenna reactance and to transform the input resistance to a value that is compatible with the transmitter. Unhappily, in most cases, the matching network inevitably introduces additional circuit losses. As a result, the performance of a compact low-frequency antenna system often leaves much to be desired.

## **the low-frequency whip antenna**

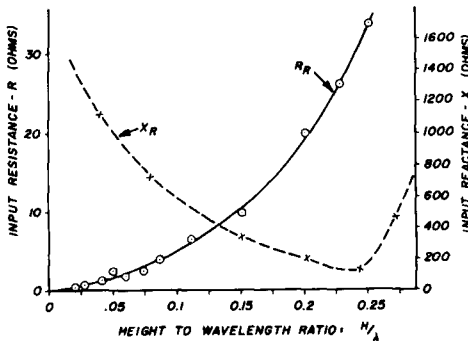
The size of an efficient low-frequency antenna presents a problem to the amateur whose backyard is small and hemmed in by telephone and power lines. In many cases, the only clear direction for an 80- or 160-meter antenna is **straight up**. Mobile operation poses much the same problem, with the additional handicap that vertical antenna height is limited to eight feet or so. Mobile

antennas and practical back-yard whip antennas of reasonable height are not noted for their efficiency; moreover, ground losses in the back-yard antenna and body losses in the automobile installation further compound the problem.

The input resistance of a simple whip antenna drops rapidly as the length is decreased below one-quarter wavelength (fig. 1). An ordinary quarter-wave whip has an input resistance in the neighborhood of 32 ohms or so, with minimal reactance.

At a length of 0.2 wavelength, the input resistance has dropped to about 20 ohms, and the reactance has risen to -200 ohms. When the whip length is further reduced to 0.1 wavelength (about 25 feet at 80 meters), the input resistance is only 4 ohms and the re-

fig. 1. Input impedance of whip antennas.



actance has sky-rocketed to about -600 ohms. Worse still, the eight-foot mobile whip has an input resistance of less than 0.4 ohm at 40 meters and less than 0.1 ohm at 80 meters.

In each case, the input reactance is extremely high—over -1000 ohms. Since the input resistance is extremely low, a considerable amount of current must flow in the antenna if any power is to be dissipated as radiation. In order to accomplish this, the reactance must be cancelled out by adding equivalent positive reactance (inductive) in the form of a loading coil to tune the antenna system to resonance.

The tuning network or loading coil adds the losses of the coil to that of the antenna. Even with a high-Q coil (say, 300 or so), the

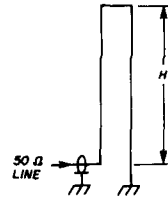
rf resistance of the coil is from 20 to 200 times the input resistance of the short whip, and, as a result, the greatest percentage of transmitter power heats up the coil instead of increasing the signal at the receiver of an eager listener. Antenna system efficiencies on the order of 0.5 to 2 percent are common in mobile installations, and you can expect efficiencies of 5 to 10 percent in short, loaded, back-yard whip antennas.

### the folded mini-monopole antenna

The folded mini-monopole antenna was developed in an attempt to obtain a portion of the impedance transformation within the antenna itself, eliminating the high losses of the customary matching network.<sup>1,2</sup>

The folded monopole is merely one-half of a folded dipole working against an image ground system as shown in fig. 2. Folded mini-monopoles less than a quarter-wavelength in height have been tested in the low-frequency region of 1.8 to 7 MHz in an attempt to devise a relatively efficient antenna system of reasonable size. The input impedance of a folded mini-monopole was measured on a vhf model and plotted in fig. 3. Both the resistive and reactive components of the input

fig. 2. The folded monopole antenna.



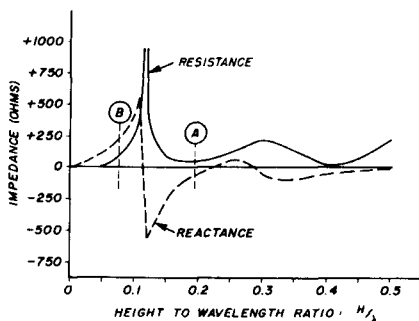
impedance vary sharply as the height-to-wavelength ratio is varied. The curves show several interesting input combinations which exist at discrete heights.

At a mini-monopole height of 0.19 wavelength (point A, fig. 3), the input resistance is about 50 ohms, with a reactance of -50 ohms. This is a reasonable value to feed directly with a 50-ohm line with no matching system; the SWR would be about 1.5:1. Not bad at all for a simple antenna! At a center frequency of 3.8 MHz, it would require a mini-monopole height of about 48 feet.

An even more compact mini-monopole may be constructed 0.075 wavelength high (point B, **fig. 3**). The input resistance of this antenna is about 50 ohms, with a reactance of +150 ohms. The positive reactance may be easily cancelled out by adding a series tuning capacitor. Happily, the tuning capacitor has much less resistive loss than even the best loading coil or matching network. For a center frequency of 3.8 MHz, the 0.075-wavelength mini-monopole is only about 19-feet tall.

This version of the monopole is very attractive for 160-meter operation. For a lower-band segment (1.8-1.9 MHz), the antenna height is 41 feet, while for the upper band (1.9-2.0 MHz), the antenna is 37 feet high. For 40-meter mobile operation, moreover, antenna height is about 10 feet—well within the capability of a modest installation since no center loading coil is required!

**fig. 3. Input impedance for folded mini-monopole antenna.**



### the 0.19-wave mini-monopole

Dimensions for the 0.19-wavelength mini-monopole antenna for 160, 80 and 40 meters are given in **fig. 4**. While the antenna itself presents a reasonable match to a 50-ohm line, you can accurately match the transmission line with an SWR meter by adding a very small, adjustable loading coil.

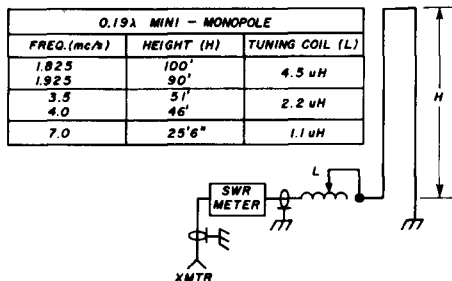
While a height of 90 to 100 feet may be prohibitive for 160 meters, you can see from **fig. 3** that the antenna may be shorter than the dimensions given in **fig. 4**, down to 0.15 wavelength or so, without appreciably affecting results. It is merely necessary to add inductance to the tuning coil (L) to compensate

for the restricted height. A minimum height of 80 feet is suggested for 160-meter operation, while half this would be suitable for 80-meters.

### the 0.075 wave mini-monopole

The 0.075 wavelength mini-monopole is a very interesting antenna; the dimensions for this mini-wonder are given in **fig. 5**. The chart

**fig. 4. The 0.19 wavelength mini-monopole.**



in **fig. 3** shows that this antenna presents an inductive component at the input terminals which can be tuned out with a series capacitance. For 160 meters, the over-all height is 40 feet or less, while for 80 meters the height is only 20 feet, or less. Since antenna height is only 10 feet on 40 meters, mobile operation is feasible. The series capacitor should be a transmitting type for moderate power levels, since the voltage across it is quite high.

### building a mini-monopole

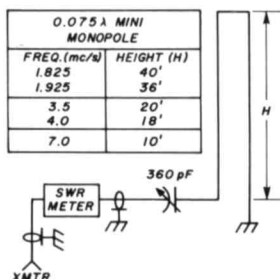
As with any antenna system, you must take care in building a mini-monopole or the advantages of the antenna will be offset by sloppy and inaccurate construction. For the 80- and 160-meter versions, the antenna may be built of aluminum tubing. Telescoping lengths of 1-inch and 7/8-inch tubing may be used if it's well guyed, or larger tubing can be used in a self-supporting arrangement.

The parallel tubes are strapped together at the top with a low resistance strap; a length of 1-inch wide aluminum strap is best. The spacing between the whips is not critical and may be from ten to sixteen inches or so. It appears that too-close spacing will inhibit

antenna operation and spacings of a few inches have provided puzzling results. Good, low-resistance connections between the sections of the antenna are mandatory, and liberal use of an aluminum anti-oxidizing compound such as Penetrox-A\* is recommended.

A good ground is required with both versions of the mini-monopole antenna. Multiple ground rods may be used, or a simple counterpoise system is suggested. A satisfac-

fig. 5. The 0.075 wavelength antenna.



tory counterpoise may be made up of two or more quarter-wavelength insulated wires running close to, but not on, the ground. Insulated hookup wire is satisfactory for this purpose and the clever amateur can disguise them by running them through bushes, along fences, or around the framing of the house.

The antenna is tuned by adjusting the series capacitor or inductor for minimum SWR on the transmission line. If you're an experimenter, you may want to change the height of the mini-monopole to drop the SWR to near-zero at your pet operating frequency. The rest of us lazy hams, like myself, will probably forego this instructive experience and work the antenna as is.

\* Penetrox-A is made by the Burndy Company and distributed through the General Electric Supply Company.

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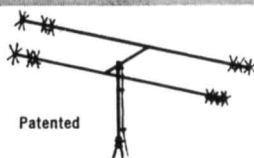
1. Giddis, "A Technique for Matching an Adjustable Folded Dipole," *IEEE Transactions on Antennas and Propagation*, May 1964.
2. King, "The Theory of Linear Antennas," Harvard University Press, Cambridge, Massachusetts, p. 341.

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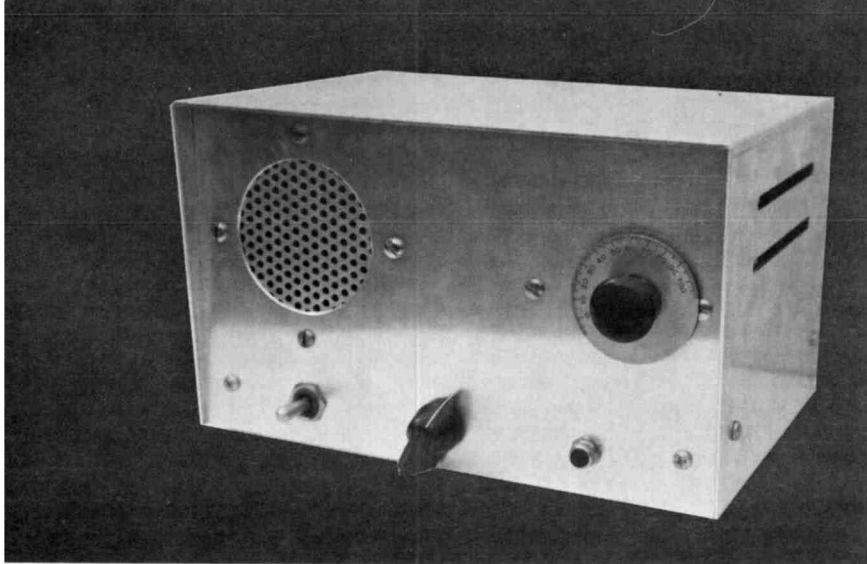
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Single Feed Line	52 ohm
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**162.55-MHz**

## **ESSA weather receiver**

**using IC's  
and  
FET's**

**A tunable vhf receiver  
of modern design  
using IC's,  
FET's  
and a  
crystal filter**

**Hank Olson, W6GXXN, P. O. Box 339, Menlo Park, California 94025**

In addition to low-frequency broadcasts of weather information for aircraft by the FAA, there are Environmental Sciences Service Administration (ESSA) broadcasts of surface weather information on 162.55 MHz (FM). Since these surface-weather broadcasts are primarily intended for ships and boats they are only available near navigable waterways. However, from the list of the ESSA stations given in **table 1** you can see that most of the country is pretty well covered. The broadcasts from these stations are continuous—by means of an automatic tape.

You can build a rather simple receiver for these weather stations by using some of the new semiconductor devices on the market. Integrated circuits cut wiring complexity, and field effect transistors and a crystal filter add performance features that can't be equaled—even by the multi-tube "kluges" in FM mobile service.

### **circuit**

A block diagram of the 162.55 MHz receiver is shown in **fig. 1**. Note the use of FET's in the front end; the rf amplifier and mixer are TIS34's. The use of FET's in these

two blocks of the receiver yields exceptional cross-modulation immunity. Another TIS34 is used for the local oscillator, but for a different reason—its inherent temperature stability over a bipolar transistor circuit.

The system bandwidth is established immediately after the mixer by a surplus 10.7-MHz crystal filter with a 40-kHz passband. Since the ESSA broadcasts are using FM with  $\pm 15$  kHz deviation, the 40 kHz passband of the crystal filter provides the required 30 kHz, plus 5 kHz “elbow room” on each side of the channel.

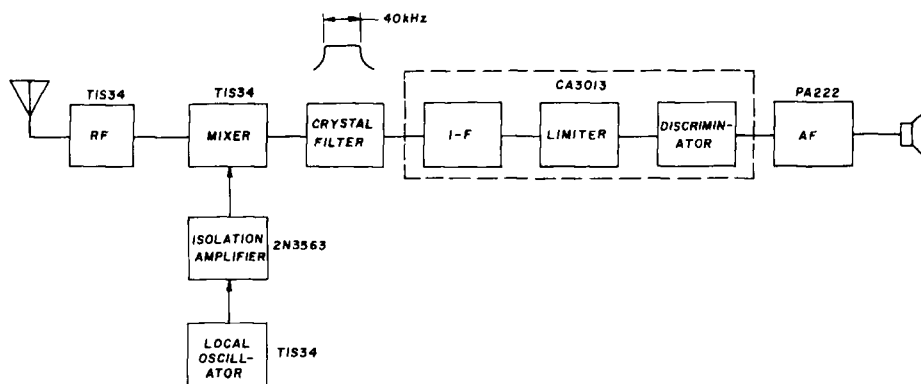
The i-f, limiter and discriminator consist of a single integrated circuit, an RCA CA3013. This ten-lead, TO-5 can IC has 75 dB i-f amplification and the discriminator diodes—all for \$2.75! The CA3013 is apparently the same IC that is being used as the sound i-f and detector in many TV sets. All you need to complete the detector is a discriminator transformer and a few peripheral resistors and capacitors. If you have trouble finding a CA3013, it could probably be replaced by the

Table 1. List of 162.55-MHz ESSA weather stations

Atlantic City, N. J.	KHB-38
Boston, Mass.	KHB-35
Bridgeport, Conn.	KHB-45
Charleston, S. C.	KHB-29
Chicago, Ill.	KWO-39
Corpus Christi, Texas	KHB-41
Galveston, Texas	KHB-40
Honolulu, Hawaii	KHA-99
Jacksonville, Fla.	KHB-39
Kansas City, Mo.	KID-77
Lake Charles, La.	KHB-42
Los Angeles, Calif.	KWO-37
Miami, Fla.	KHB-34
New Orleans, La.	KHB-43
New York, N. Y.	KWO-35
Norfolk, Va.	KHB-37
San Francisco, Calif.	KHB-49
Tampa, Fla.	KHB-32
Washington, D. C.	KHB-36

The receiver power supply is conventional, with a full-wave silicon rectifier, capacitive input and a dual regulator. Three voltages are

fig. 1. Block diagram of the 162.55 MHz ESSA weather receiver.



CA3014 or SK3022.

The audio section is similarly taken care of by an IC, the General Electric PA222. This chip, in a modified dual-inline package (DIP), provides 70 dB of open-loop gain and can put out up to a **watt** of audio. This amazing little af package fits into a standard 14-pin DIP socket, even though it only has 8 pins. The ninth (and largest) lead on the PA222 is a heat sink tab. It is soldered to a copper tab on the chassis.

supplied for this mixture of active devices: unregulated +18 and regulated +6 and +14 volts.

## construction

My receiver is built in an LMB W1C utility case which affords more than ample room. You could probably get the electronics in the smaller LMB W1A and still not be crowded. The i-f amplifier-detector section was built on a 2 by 2-1/2-inch piece of copper

laminates. I used this as I could easily solder down the IC bypass capacitors and maintain minimum inductance in all leads. This is very important, since the more casual construction I tried at first produced an oscillator! After all, we are fooling around with an awful lot of gain in a small package. The CA3013 simply won't forgive a sloppy layout.

Each of the .05- $\mu$ F bypass capacitors on pins 2, 3, and 4 are put in parallel with a 1000-pF standoff-type capacitor. In fact, the standard capacitors (which are soldered to the copper laminate) support the IC socket—a "spider" type, Nugent LP51710. Similarly, the .01- $\mu$ F bypass at pin 10 is in parallel with the 1000-pF feed-through capacitor bringing +6 volts in from the top of the chassis. While parallel-bypassing sometimes has its pitfalls, it was the trick that "calmed down" this IC. I made the discriminator transformer more-or-less as described in the RCA spec sheet for the CA3013 and CA3014.<sup>2</sup> The spacing between  $L_5 - L_6$  and  $L_7$  was not specified, so you can play around with it. I used about 3/4-inch.

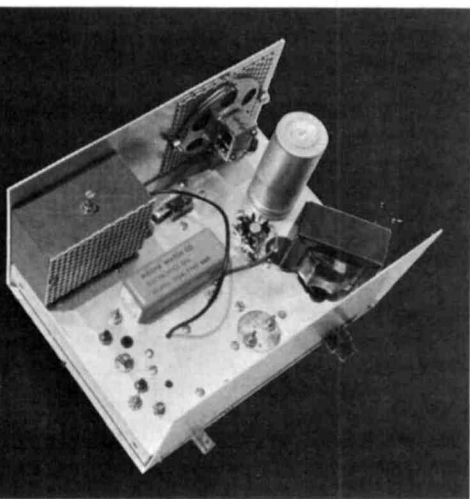
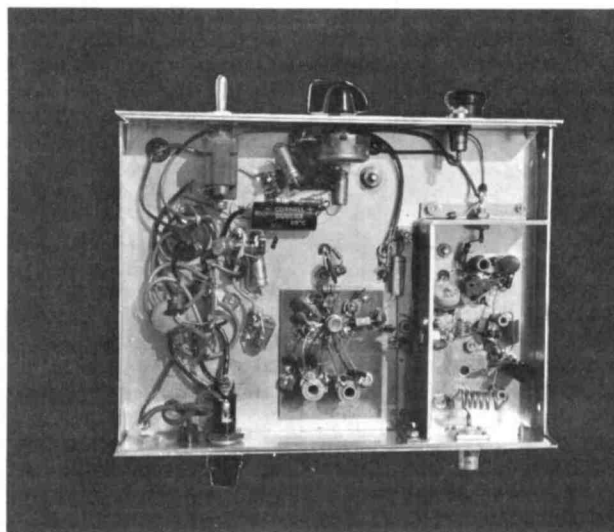
In addition, the PA222 is a high gain IC, and all the leads must be kept as short as practical. Since the PA222 has much less bandwidth than the CA3013, this job is a little easier. More details on the PA222 and how to use it are described in references 3 and 4.

**The vhf weather receiver. The tunable local oscillator is mounted on the box on the front panel just in front of the crystal filter.**

## local oscillator

I used a tunable local oscillator because it was simple; after all, that's what every hi-fi FM tuner on the market uses. Stability is further improved by using an FET in the LO. Local-oscillator power is extracted from the FET circuit at a 50-ohm tap on the oscillator coil. A 10-dB pad and a common-base amplifier isolate the LO from the mixer and allow injection into the mixer gate (in parallel with the signal), through a small capacitor (less than 1 pF). Local-oscillator energy is de-

**Below-chassis view of the receiver. The rf amplifier and mixer are located in the enclosure to the right.**



livered to the 2N3563 isolation amplifier through a 6-inch length of 50-ohm RG-174/U cable.

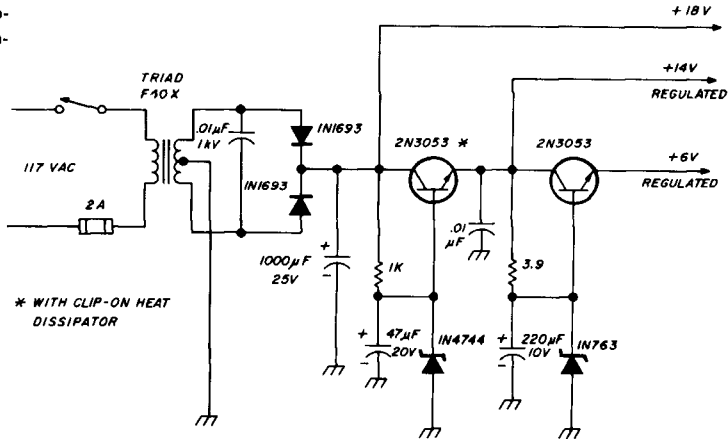
The LO is built in a 3 x 2-1/2 x 1-1/2 box made of copper laminate with a perforated aluminum cover. The LO box is quite rigid and is mechanically tied to the front panel of the receiver. Flexure between the front panel and the chassis doesn't change the LO frequency because the box moves with the panel.

Several points about this design deserve additional discussion. The rf amplifier and mixer are quite similar to the circuits in K6HMO's two-meter converter.<sup>5</sup> It may be possible to eliminate the 2N3563 isolation amplifier by injecting the LO at the source,





fig. 3. The power supply for the vhf weather receiver.

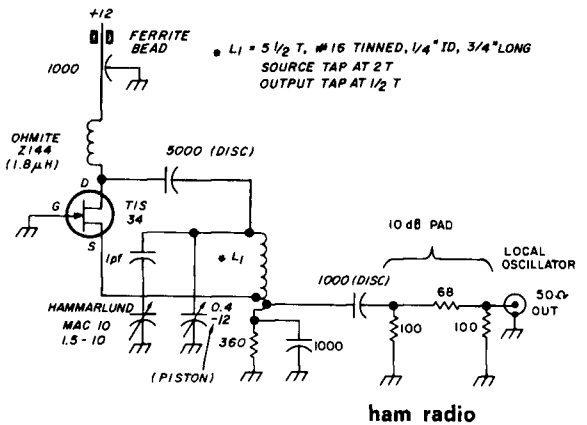


If you want to receive really weak signals, such as distant two-meter stations or mobile services (police etc.), it may be a good idea to use two TIS34 stages instead of just one. K6HMO's converter is designed that way. However, for the reception of KHB-49, San Francisco, some 20 miles away, this receiver is more than adequate in Palo Alto.

### References

1. C. Farrell, "Using Junction FET's As Oscillators," EEE's FET Applications Clinic, March 25, 1967, Section 4-1, published by Girard Associates, Box 404, Mt. Arlington, N. J. 07856.
2. RCA, "CA3013, CA3014 Specification Sheet," 92 CM, February 1966.
3. General Electric, "PA222 Preliminary Specification Sheet," 85.20, March 1967.
4. A. Petrie, "First Integrated Circuit Phonograph," Electronics World, December 1966, p. 28.
5. R. Friess, "A Low-Cost FET Two Meter Converter," 73, October 1966, p. 22.

fig. 4. With this tunable local oscillator, the receiver may be used for two meters and the various mobile services as well as the ESSA weather service. For single-channel reception, a crystal oscillator may be substituted as indicated in the text.



ham radio

## phone patch legality

The legal status of phone patches may be clarified and improved if the Carter Electronics Corporation succeeds in its case against three major telephone companies.

In 1965, the FCC advised Carter Electronics that its cradle-type Carter-phone patches were prohibited by Tariff 122. Carter filed an anti-trust suit against AT&T, the Associated Bell System and General Telephone. The Federal District Court requested a ruling by the FCC, which ruled that the Carterphone indeed vio-

lated Tariff 122, but that the tariff was an "unwarranted interference with the telephone subscriber's right to use his telephone reasonably in a way that is privately beneficial without being publicly detrimental."

The eventual result of this case may be that if a customer wishes to attach gear to his line, his telephone company will have to show cause for denial, a complete reversal of the present situation.

Jim Ashe, W2DXH

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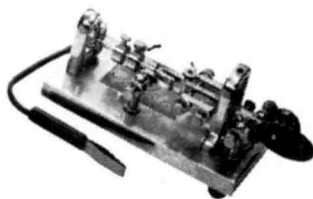
It's not that difficult! Just brush up on the code that got rusty while you were chatting on SSB. (One day a week on CW should soon have you in trim!) Then, crack the manual on the exam, and you'll be ready to meet your friends in the X bands.

73, *Bill Harrison, W2AVA*

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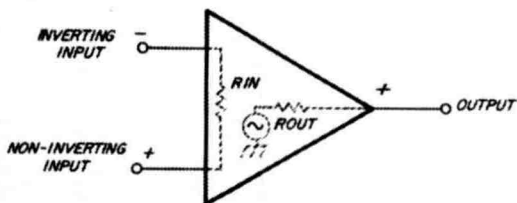


fig. 1. Basically, the integrated-circuit operational amplifier is simply an amplifying device with two inputs.

## amateur uses of the MC1530 IC

Although these circuits were designed around the MC 1530, other types of linear IC's may be used in similar circuits

In the past, integrated circuits have appeared as window dressing in some equipment when one or two transistor stages would have done the same thing at lower cost. However, the rapidly decreasing cost of IC's make them more applicable to many amateur uses. The Motorola MC 1530, a typical IC operational amplifier, can be used as an audio amplifier, audio compressor, i-f amplifier or oscillator with better results than several transistor stages.

The MC1530 is typical of a class of integrated circuits known as operational amplifiers. It is rather expensive, about \$15, but all types of surplus IC's are becoming available at prices ranging from one to three dollars. The applications described here are applicable to almost any operational-amplifier IC—as long as you consider the frequency range and power-supply requirements.

Operational amplifiers are essentially multi-stage transistor amplifiers wired so that the connection of external elements determines the frequency response and gain. By connecting external capacitors, coils, etc., IC's can be used as audio amplifiers, rf amplifiers or oscillators.

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

Normally, the operational-amplifier IC uses dc-coupled amplifier stages so no internal capacitors are required. The lack of capacitive coupling permits the amplifier to be used as a dc amplifier. In addition, the frequency range is not restricted by any capacitive-coupling effects.

Integrated circuits offer a number of advantages over conventional, discrete-component amplifiers. Perhaps the greatest advantage is the large amount of signal amplification available in a very compact package. The MC 1530, for example, provides a maximum signal gain of 74 dB, yet it isn't any bigger than a small audio transistor.

put and output terminals in the transistor circuits are separated by several inches. Good input/output shielding is imperative when you use IC's. The IC also has a frequency response beyond that of a simple transistor-amplifier stage.

The MC 1530 will operate from dc to well beyond 14 MHz. Proper bypassing is very important if you want to avoid spurious responses and oscillations. The application notes available from the IC manufacturer detail the circuit precautions that are necessary for stable operation; they should be followed closely. If you follow the manufacturer's recommendations, you'll find that IC's are more

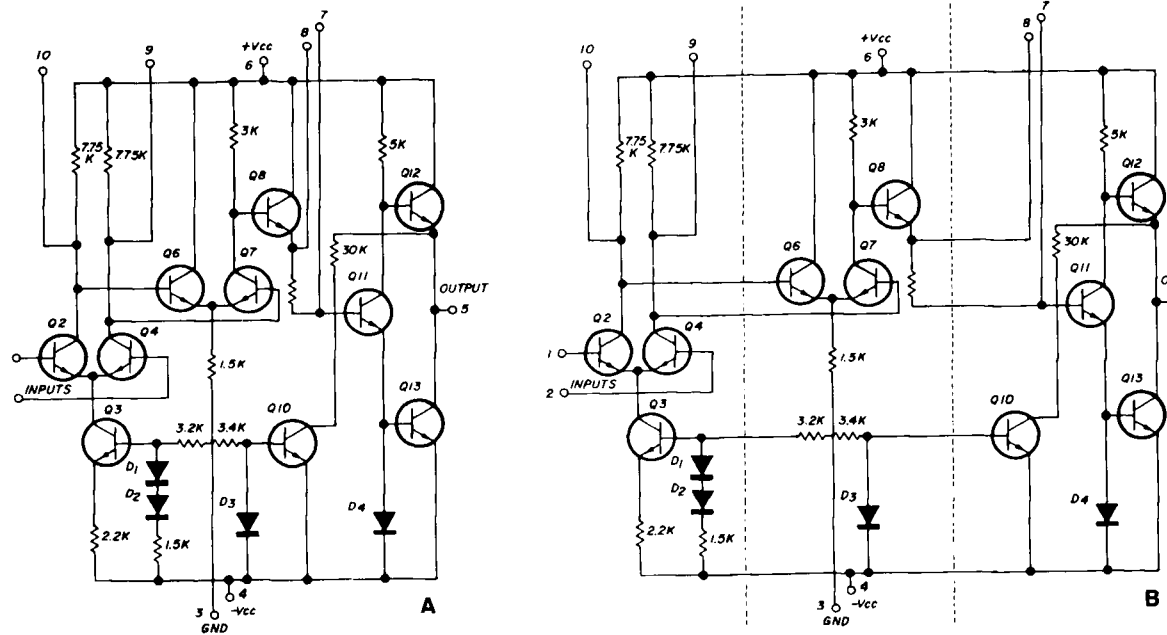


fig. 2. The complete internal circuit of an IC is rather complicated (A), but when it is broken into sections as shown in B, the circuit is much more straight forward.

temperature stability of integrated circuits is better than conventional transistor circuits because of the circuit configuration and construction.

The large amount of gain available in such a small package also indicates some of the problems it can cause. For instance, you must remember that you're dealing with a device with input and output terminals which are only separated by 1/4 inch. Although the gain provided by the IC is equivalent to a four- or five-stage transistor amplifier, the in-

stable and reliable than many conventional transistor amplifiers.

### the MC1530 operational amplifier

The best way to look at the MC 1530 is as the amplifying block shown in fig. 1. Maximum gain is 74 dB, and the frequency response is essentially flat from dc to 14 MHz. It has a high input impedance (about 50k ohms) and low output impedance (about 500 ohms). Two supply voltages are required—plus and minus 6 volts. Power-supply filtering

is about the same as that required for most transistor amplifiers. Maximum supply current is on the order of 10 mA.

Unlike conventional amplifiers, however, note that there is both a "non-inverting" and "inverting" input. The output signal is inverted (180° out of phase) when the "inverting" input is used. In other words, a positive-going input produces a negative-going output.

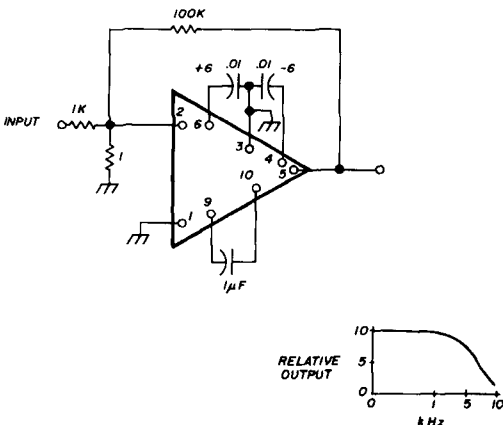
The output signal will be in phase with the input if the non-inverting input is used. If the two inputs are fed simultaneously, the phase and amplitude differences between the input signals govern the output-signal characteristics.

Although you can look at the operational amplifier simply as a compact amplifying device, it is better to understand what is going on inside. This is also helpful when you want to use the IC in a practical circuit.

The schematic of the operational amplifier shown in **fig. 2A** is confusing and it's difficult to distinguish between stage functions. However, if you divide the sections of the IC properly, as shown in **fig. 2B**, the relationships are not difficult to understand.

A description of the MC 1530 stages is informative, since it applies to many other operational amplifiers as well. In the input of the MC 1530, Q2 and Q4 form a differential-amplifier stage. If the base of either transistor is grounded, the output is inverted or non-inverted, depending on which transistor is grounded. If you use both inputs, the am-

**fig. 3. The high-frequency rolloff characteristics of this audio amplifier are determined by the capacitor connected between terminals 9 and 10.**

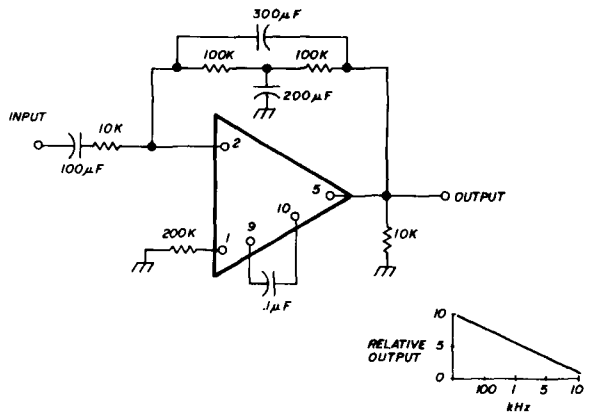


plified signal is the difference between the two inputs. This feature is used in the compressor circuit shown in **fig. 8**.

The input to the MC1530 can vary from several millivolts up to a maximum of 2 volts. A constant current source, Q3, is connected to the emitters of both Q2 and Q4. This stabilizes the input stage operating points.

The second differential amplifier, Q6 and Q7, is driven by Q2 and Q4. The output of this amplifier stage is single-ended, however, and taken from the collector of Q7 through an emitter-follower stage, Q8. Transistor Q11 functions as a voltage-level translator stage and is necessary because the amplifier stages are dc coupled.

**fig. 4. The IC integrator circuit provides constantly decreasing gain with frequency.**



In conventional capacitance-coupled amplifiers, the capacitors block the dc voltage from preceding stages so that the signal at the input of a stage swings around zero volts. This cannot be done with directly-coupled stages, so level translators are used to accomplish basically the same function. The three-volt offset (approximate) at the output of Q8 is shifted to zero volts by Q11; Q10 serves as a stabilized dc current source for Q11.

Transistors Q12 and Q13 form a conventional direct-coupled output stage. Terminal connections for the MC 1530 IC are fairly obvious from the diagrams in **fig. 2**. Terminals 7, 8, 9 and 10 are used for connecting external components between the internal stages of the IC so that you can control frequency response, gain and phase characteristics.

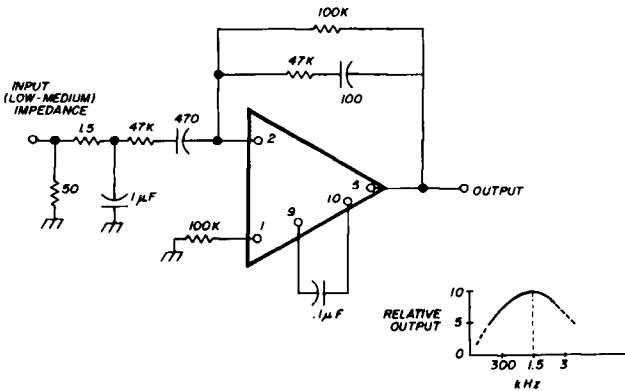
In a sense, working with an IC is like work-

ing with an amplifier where only the input/output, power supply and plate or load connections are accessible. It should be obvious that each connection has a purpose, and although all connections may not be used for any given application, you don't ground the unused pins! Some experimenters, who never bothered to understand the basics of IC circuitry, have done this with rather unusual and expensive results.

### applications

While all of the following circuits are designed around the MC 1530, most of them are suited to other integrated-circuit opera-

fig. 5. By adding additional components to the simple audio amplifier shown in fig. 3, both low- and high-frequency gain rolloff characteristics can be obtained.



tional amplifiers as well. Terminal connections will differ, of course, and you should consult the manufacturer's data sheet before using the device. Power-supply voltages are not exceptionally critical, but don't exceed the recommended values. Handle them like a transistor—but remember it doesn't take much overvoltage to destroy them in most cases. However, when they are used within their proper ranges, their reliability exceeds that of most discrete transistors.

### audio amplifier

A simple, low-level, high-gain audio amplifier is shown in fig. 3. Very few external components are required. With high-impedance microphones of reasonable output, this stage may be used as a microphone pream-

plifier or between a low-noise preamp and a high-level amplifier.

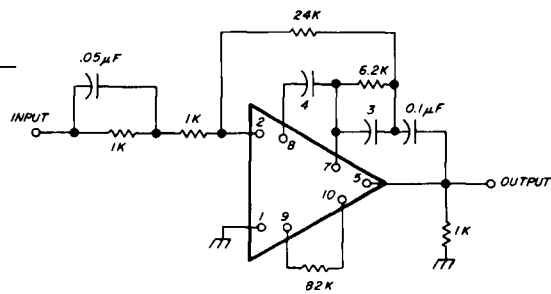
With the 1- $\mu$ F capacitor connected between terminals 9 and 10, the gain is constant from dc to about 1 kHz; the gain is about 20-dB down at 3.5 kHz. You can vary the value of this capacitor for the upper frequency where you want the gain to roll off. If a .01- $\mu$ F capacitor is used, for example, the gain will start to roll off just above 10 kHz.

### integrator

The integrator circuit gives maximum gain at the low frequencies and constantly decreasing gain with increasing frequency. This is in contrast to the previous circuit where gain is relatively constant up to the roll-off frequency.

In communications circuits, integrator circuits are usually used as low-pass filters. For instance, an integrator may be used after an audio-clipper stage to block the high-order harmonics which the clipping action generates. If they're not eliminated, they may overload later stages or produce audio distortion. The circuit in fig. 4 produces about 55-dB

fig. 6. This extremely broad-band amplifier works from dc to over 20 MHz.



gain at 100 Hz and drops linearly to 25-dB gain at 3,000 Hz and 10-dB gain at 10 kHz. This is a gain reduction of nearly 45 dB between a 100- and 10,000-Hz signal.

### bandpass audio circuit

By making a slight change in the external RC circuitry used with the IC shown in fig. 5, roll-off characteristics can be obtained which will favor the audio range from 300 to 3,000 hertz. With the values shown, the maximum gain of the amplifier is about 50 dB.

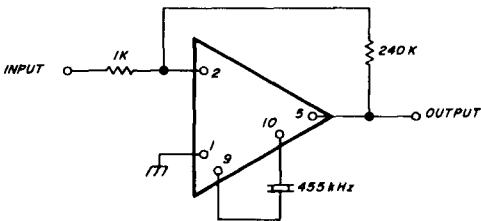
Gain peaks at about 1500 Hz and is 10 dB down at 400 and 4,000 Hz. With variable components, both the upper and lower frequency roll-off points can be adjusted.

### broad-band rf amplifier

With the proper external circuitry, the MC 1530 can be used as an extremely broad-band rf amplifier. The circuit shown in **fig. 6** provides a constant 20-dB gain from dc to 10 MHz and falls off to 15 dB at 20 MHz. This circuit may be used with various test instruments to extend their useful range or in such devices as broad-band monitors. You could even use it for additional i-f gain or as a broad-band rf preamplifier.

If the input and output circuits are tuned, the gain can be increased of course. As a

**fig. 7. A crystal-filter amplifier using the MC-1530.**



tuned amplifier, you should be able to obtain at least 50-dB gain at any frequency in the zero to 15-MHz range.

### crystal-filter i-f amplifier

**Fig. 7** shows how the MC 1530 can be used with a crystal to provide a high-gain, selective amplifier. This stage would be very useful in a receiver or transceiver to provide additional selectivity for CW reception. The gain of the circuit is more than enough to compensate for the attenuation introduced by the crystal. The circuit can be connected between the i-f stages in a receiver and directly bypassed (or a capacitor switched in place of the crystal) whenever the additional selectivity is not desired. If you want to be more elaborate, the single crystal can be replaced by a crystal filter.

The photograph at the beginning of the article shows how this circuit can be assem-

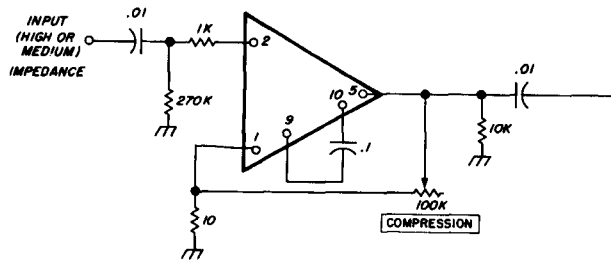
bled on a small piece of Vectorboard. The MC 1530 is practically lost when compared to the size of the crystal. The construction is typical of the circuits shown and demonstrates how compact circuits can be easily assembled.

### audio compressor/amplifier

By taking advantage of the fact that the two inputs to the MC 1530 produce both an inverted and non-inverted output, an extremely simple but effective compressor circuit can be developed. Although the circuit values shown in **fig. 8** are those which I found to be most effective for an audio compressor, there is no reason why compression action could not be applied to an rf stage by changing the capacitor values.

This circuit is relatively easy to understand. The input is directly coupled to the non-inverting input of the IC. A small amount of the output signal is fed through the 100k-ohm **compression** control and 10-ohm voltage divider to the inverting input (pin 1). The amount of feedback voltage is determined

**fig. 8. Simple audio compressor using the MC-1530. For minimum noise, this circuit should be preceded by a low-gain, low noise audio amplifier.**



by the value of the 100k pot and must be determined experimentally for the desired degree of compression. Tests I have made indicate that a compression range of at least 15-20 dB is easily attainable.

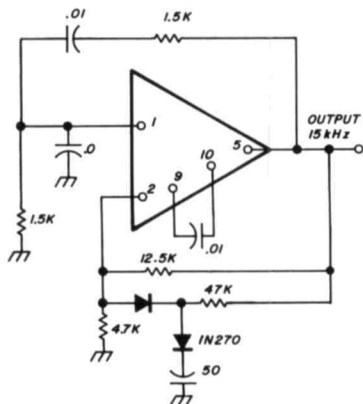
The capacitor between terminals 9 and 10 is used to provide a high-frequency roll-off at about 3,000 Hz to eliminate unwanted noise amplification. The value of this capacitor is not critical, but it should not be less than 0.05  $\mu\text{F}$  if the signal-to-noise factor of the amplifier is to be maintained at a reasonable level.



## audio/rf oscillator

Since the MC 1530 is a high-gain amplifier, there is no reason why it can't be used as an oscillator. Fig. 9 illustrates an MC 1530 oscil-

fig. 9. This 15-kHz sine-wave oscillator provides a very pure output waveform.



lator which uses both positive and negative feedback to produce a highly stable oscillator operating at 15 kHz. The output waveform is almost harmonic-free. By varying the RC feedback circuit connected between pin 5 and pins 1 and 2 and pin 2 and ground, you can build an oscillator from a few hundred Hz to several MHz.

Proper bypassing between pins 2, 9 and 10 and ground is necessary to prevent any spurious outputs. The frequency can be varied over a ten-percent range by varying either the resistive or capacitive element of the RC network between pins 1 and 5.

## summary

I have tried to demonstrate the extreme versatility of the integrated-circuit operational amplifier—from broad-band amplifiers to audio compressors and oscillators. It is only a matter of time before they are incorporated into commercial amateur equipment. In the meantime, you can use them to advantage to construct home-brew station or accessory equipment. The cautions are relatively simple and no more restrictive than those necessary with early transistors. The advantages are many—versatility, space and cost.

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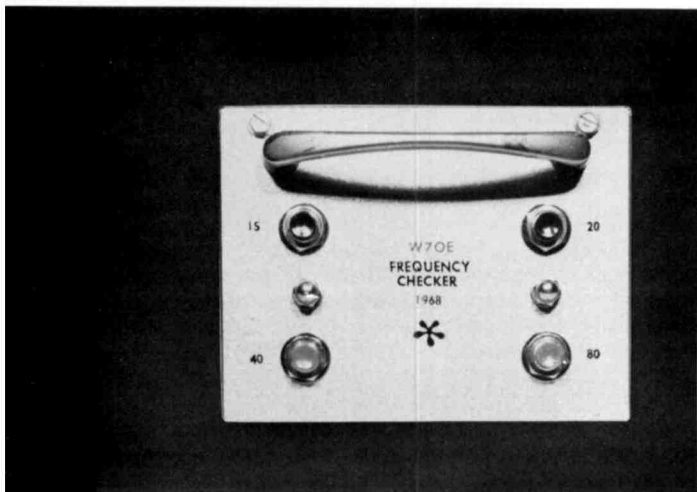
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The mini-spotter frequency checker. The handle is the antenna! Four push-button switches choose the desired output frequency.

## mini-spotter frequency checker

With this spotter  
you can hit your nets  
and schedules  
right on the nose

■ For the dedicated ham who likes spot-frequency operation for schedules and nets, accurate dial setting is a must. A stab in the dark with the VFO or a vague mark on the receiver tuning dial may give you an approximate setting, but you're going to have to dance around a few kilohertz either way to spot your man. There's an easier way—it will put you right on the button every time.

Maybe you work traffic nets—perhaps a frequent schedule with a friend in a distant state or across the pond. If you're right on frequency when the NCS or distant pal calls, it practically guarantees your QSO when band conditions are right.

I had the same problem not long ago; regularly scheduled operation with other members of the QRP Amateur Radio Club-International on designated club frequencies on 15, 20, 40 and 80 meters. It's common practice at schedule time to set the VFO dial where you **think** it should be, zero your receiver, and call your man. No go. Diddle the VFO a bit and try again. Maybe you catch him this time, more likely not. Try again! Ah, there he is; you finally hit him! Meanwhile,

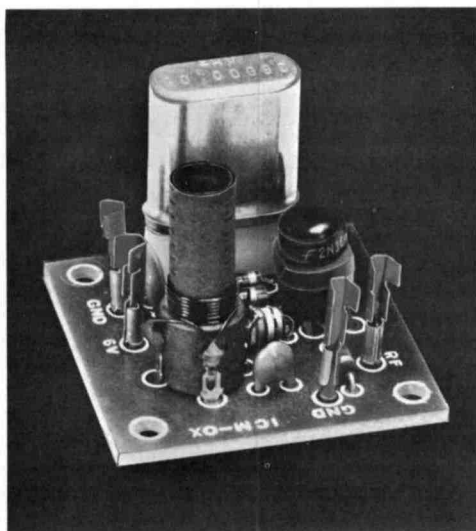
Howard S. Pyle, W7OE, 3434-74th Avenue, S. E., Mercer Island, Washington

you've been dancing around the receiver dial hoping he'll be calling you so you can zero in the VFO.

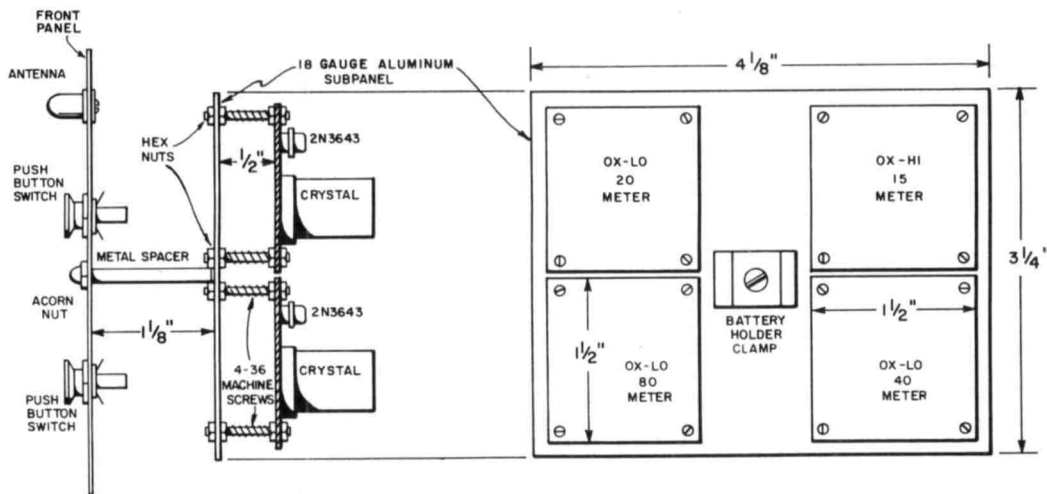
All that monkey business is childish. How much traffic do you suppose the commercials would move between ship-and-shore or point-to-point if they had to fuss around like that to find a guy who is supposedly right on the bottom?

I licked my transmitter problem by switching to crystal control for these contacts, leaving the VFO for casual excursions around the bands. The receiver relied on the crystal oscillator for a zero beat. However, the normal

**An International Crystal OX crystal-oscillator board.**



**fig. 1. Layout of the mini-spotter sub-panel.**



output from the crystal oscillator (final switched off) was too much for the receiver. Even with the rf gain backed down, the zero beat was too wide because of over-loading.

The solution was simple: a low-powered oscillator on each of the frequencies I was interested in spotting. Press a button for the selected frequency, zero in on the receiver and, if the transmitter is VFO controlled, you've got a perfect spotting signal on which to zero. Better yet, if you're standing by for a call on one of your spot frequencies, or if you monitor certain frequencies a good deal of the time, you don't have to keep the transmitter hot for occasional frequency checks. With this little frequency spotter just push the button and check your receiver zero at any time!

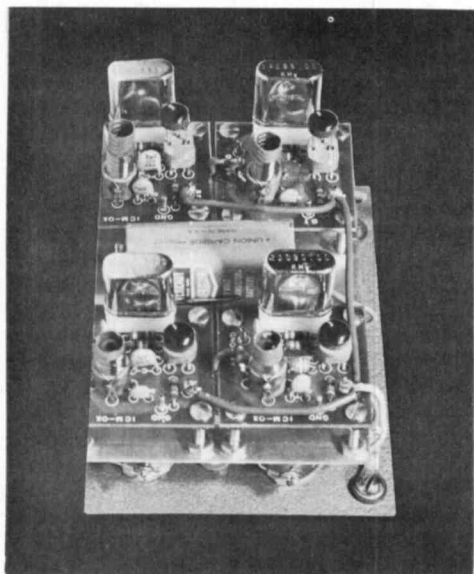
### crystal oscillators

I maintain spot-frequency schedules on four frequencies, so my little spotter is equipped with four separate crystal oscillators. You can cut this down or add more as you see fit. While it may sound costly to provide separate oscillators, actually it's not. Each oscillator cost me \$2.35; the cabinet and miscellaneous hardware were about \$3 more. Using crystals I already had on hand, the whole four-frequency business came out well under \$15! With less oscillators of course, the cost will be even less.

Each oscillator is one of the OX types recently introduced by the International Cris-

tal Company\*. These are supplied complete with the transistor, printed-circuit board, all components and hardware; everything you

**Internal layout of the mini-spotter. The battery is mounted in the center between the oscillator boards.**



need except the crystal. You can use one you already have or you can buy an EX crystal from International.

Assembling the kit is duck soup; I averaged 20 minutes for each oscillator including the soldering and cleaning off the resin residue! All the holes are drilled in the printed-circuit board and the position of all components is plainly labelled—you can't go wrong.

### construction

Each little oscillator is mounted with four corner screws (yes, they even come with the kit). I didn't want to "cheese-hole" the front panel with sixteen mounting holes and screw heads, so I used a piece of scrap aluminum for a subpanel to mount the oscillators on. This way, the subpanel was mounted to the front panel with only two screws. Spacers hold it one inch away from the rear of the front panel. The 9-volt transistor battery which powers all oscillators is mounted between the oscillators on the sub-panel with

\* International Crystal Company, Inc., 18 North Lee, Oklahoma City, Oklahoma 73102.

a small wiring clamp as shown in the photograph.

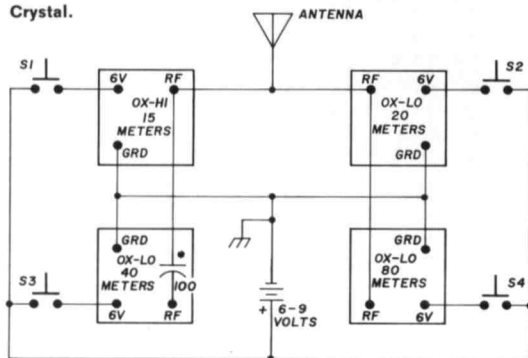
I housed the whole business in a Bud AU-1028\* 3 x 5 x 4-inch utility cabinet. If you use a different number of oscillators, you'll probably want to use a different cabinet.

Don't let the handle on the cabinet face fool you! Sure, it's a convenient way to move the little spotter around, but it is actually the antenna for the oscillator outputs! It's mounted to the front panel with shoulder-type insulating washers slipped over the mounting screws so that it doesn't make electrical contact with the panel.

The rf output terminals from the oscillators are paralleled as shown in the wiring diagram so there is no need for any switching. Pushing the selected frequency button simply applies a positive voltage from the battery to that particular oscillator. Its output then feeds the handle antenna.

Battery life is indefinite. I've used my spot-

**fig. 2. Wiring diagram for the mini-spotter. Each of the oscillator boards is an OX kit from International Crystal.**



ter for many months and it looks as though there are still years of soup left! The current drain is only momentary and is approximately 29 mils when a button is depressed.

There you have it, a frequency spotter that will put you right on the nose for schedules and net operations simply by pressing a push-button. This is about the handiest little gadget I have in my shack and I wouldn't be without it.

\* Gray hammertone, \$2.05 plus postage from Allied Electronics, 100 N. Western Avenue, Chicago, Illinois 60680. Order catalog number 42 E 8549.

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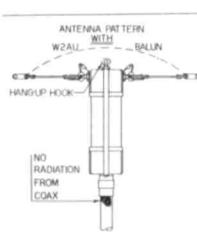
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# updating the BC-603 tank receiver

Here's how  
to breathe new life  
into  
an old receiver

Jim Harvey, WA6IAK, 1401 Enderby Way, Sunnyvale, California 94087

For three or four years I've been meaning to modify my old BC-603 to see if I couldn't put some life back into it. In the meantime, I have used it as a tunable i-f and demodulator for a number of vhf converters. When I bought it several years ago, it was in pretty sad shape—a previous owner had, among other things, tried to change the basic tuning range from 20 to 28 MHz to 50 to 54 MHz. This operation butchered up the rf and mixer-oscillator coils and removed one of the plates from the oscillator-tuning capacitor.

For some reason, the squelch circuit never worked reliably and the receiver was about as noisy as a one tube regen—it had little, if any, limiting. To top off this unhappy state of affairs, the sensitivity left plenty to be desired; at times it seemed to require a full volt to get full quieting.

After examining the existing circuit to see what would give me the most immediate improvement, I concluded it would be easier to rebuild the set than try to fix it. This also seemed to be the best way to increase overall performance.

There were other things about the receiver's condition that bothered me: aging resis-

tors that were probably noisy and scores of large mica bypass capacitors similar to ones which had caused me so much grief in other old gear. Finally, I wasn't very impressed by the 6J5/6AC7 tube lineup—not to mention the 6H6's which must have gone out with high-button shoes!

Rebuilding the receiver would not only eliminate these old parts, it would make it easier to include both a-m and fm capability. The decision to rebuild the BC-603 eliminates this as a modification article.

Instead, I will try to give you a few ideas and suggestions on rebuilding it. If a complete rebuild doesn't appeal to you, you may still get some good ideas; each part of the new circuit will stand on its own as a BC-603 modification.

## disassembly

The mechanical components, i-f transformers, rf coils and tuning assembly are well built. With some new capacitors and resistors, they are all used in the final receiver. The first task is to remove all the wiring. It isn't easy to start if your old BC-603 is still in working

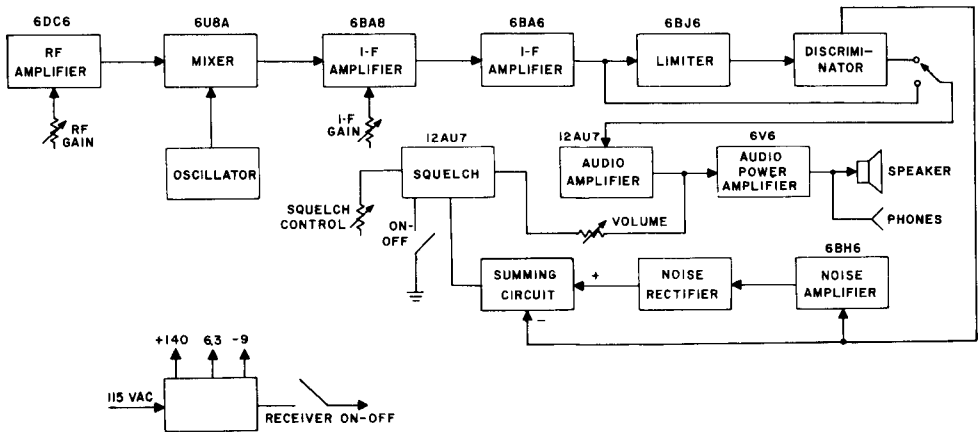
you're desoldering the old solder joints.

Remove all the octal tube sockets except the one near the front of the chassis right next to the jack for the front panel V9. Remove the phenolic strip along the side of the chassis near the demodulator, squelch and audio sections. Remove all the rf and i-f coils and set them aside; they will be modified before they are re-installed. I also took out the 2- $\mu$ F electrolytic capacitor near the front panel jack because I couldn't find any good use for it.

Since I didn't need them, I took out several other items to reduce weight:

1. The three bathtub capacitors on the side of the main-tuning-capacitor housing, C15, C23 and C24.
2. The metal cable guide that runs across the side of the chassis underneath the BFO and discriminator cans.
3. The multipin rear connector that I could never find a mate for (not the one to the dynamotor housing).
4. The antenna and ground jacks which stick out from the front of the chassis.

fig. 1. Block diagram of the updated BC-603.



order, as mine was. Once you've started, there's no turning back. The front panel is saved, wiring and all. Take out the screws holding it to the receiver chassis and set it aside until later.

A word of caution: if you have one of the BC-603's that was fungus proofed, don't breathe the fumes that are produced when

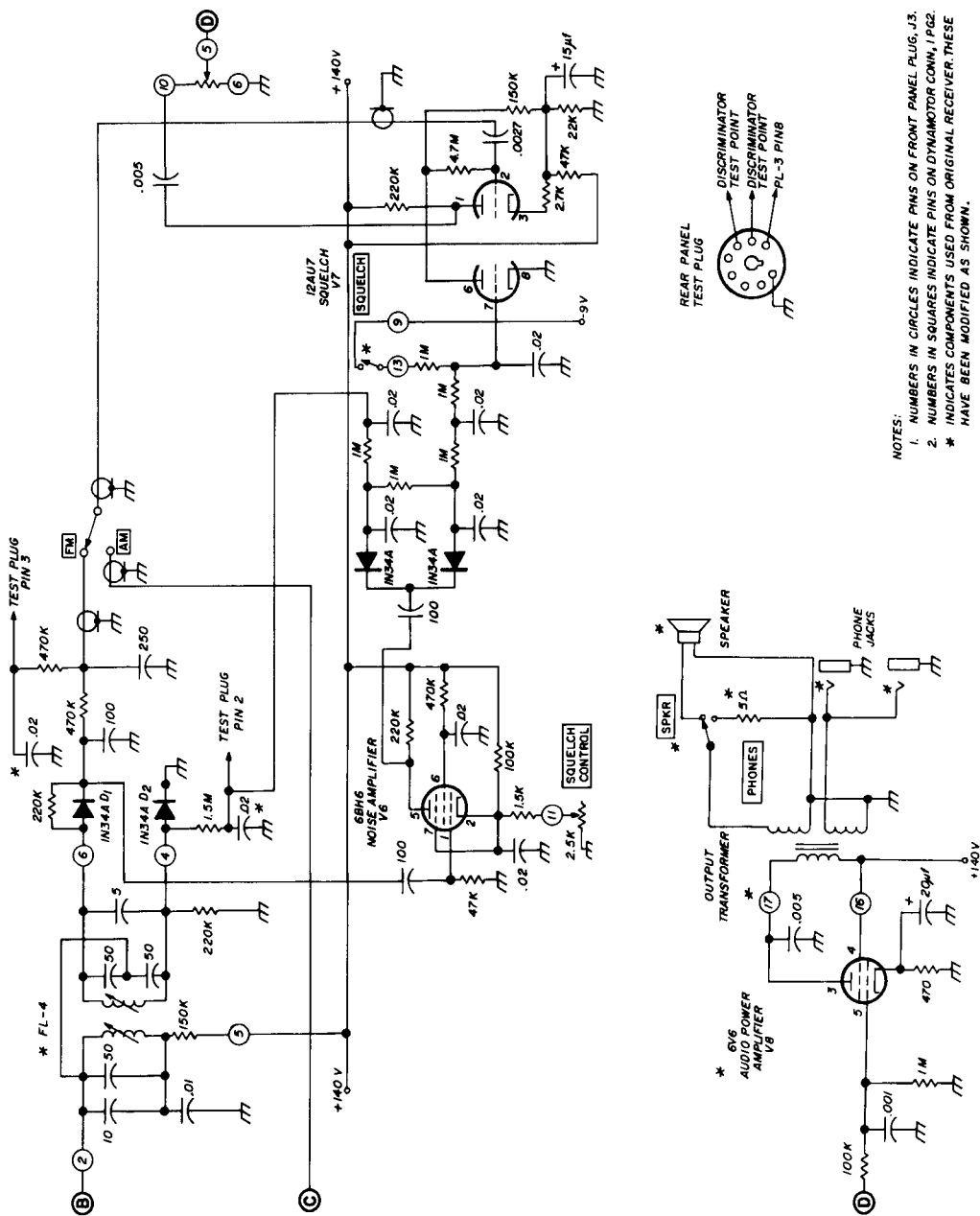
## construction hints

I won't attempt to describe every detail of how the receiver is built. I'll just describe the sticky areas that might hold up progress on the various stages during construction.

The mechanical work is very slight; this is one of the advantages of using an old receiver as a starting point. Mounting plates for the







- NOTES:
1. NUMBERS IN CIRCLES INDICATE PINS ON FRONT PANEL PLUG, J3.
  2. NUMBERS IN SQUARES INDICATE PINS ON DYNAMOTOR CONN, / PG2.
  - \* INDICATES COMPONENTS USED FROM ORIGINAL RECEIVER, THESE HAVE BEEN MODIFIED AS SHOWN.

fig. 2. Schematic diagram of the rebuilt BC-603.

smaller 7-pin and 9-pin tube sockets were cut from thin gauge aluminum with a pair of shears using the pattern in **fig. 4**. These adapter plates are installed in the holes left when the old octal sockets were removed. Use a ground lug under each of the screws that hold a plate to the chassis. If you do this on all of the plates, it will provide a convenient place for grounding things later on.

Install miniature 7-pin tube sockets in the chassis holes previously used by the rf amplifier (V1), first i-f amplifier (V4), second i-f amplifier (V5) and limiter (V6). Install miniature 9-pin sockets in the vacant 6AC7 mixer socket (V2) and 6V6 audio-output socket (V8).

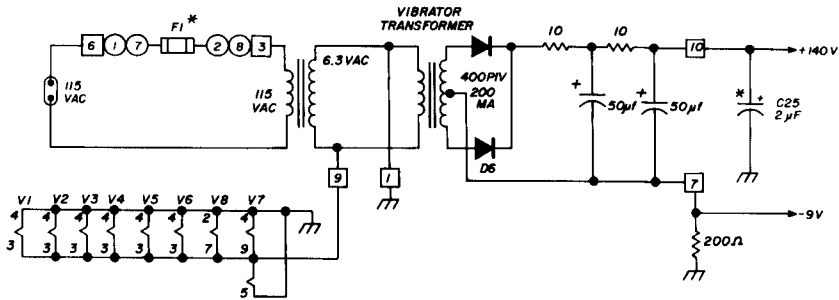
Several multi-lug terminal strips help to

## coil modifications

A block diagram of the finished receiver is shown in **fig. 1**. You can see from this diagram that the receiver is quite conventional. The rf stage is a low-noise 6DC6 semi-remote cut-off pentode. Both rf coil cans, LCU-1 and LCU-2, were modified as were the rest of the coils in the receiver. The schematic, **fig. 2** shows these coils in their modified configuration.

My BC-603 has a schematic glued to the bottom of the cabinet; I assume this was standard practice with these receivers so I will not present the old schematic here. Also, you don't have to have the original schematic

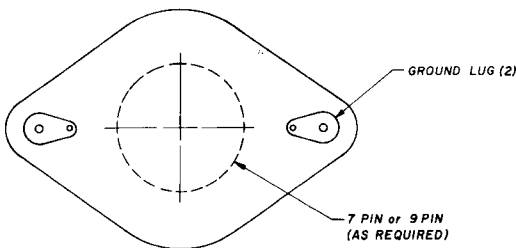
**fig. 3. Power supply for the BC-603 tank receiver.**



route B+ and heater voltage; they also support the discriminator and noise-amplifier diodes and other components. Other parts are either inside the cans, as shown on the schematic diagram, or tied directly to tube or coil pins underneath the chassis.

The important thing to remember is to keep all unbypassed signal leads as short as possible.

**fig. 4. Mounting plate for the new 7- and 9-pin miniature tube sockets.**



to construct this receiver. Just make sure that the coils are modified as shown in the schematic.

Except for the oscillator coil, all of the coils are easily removed from the cans. The oscillator-coil can is sealed and must be cut open near the bottom. Be careful—make a clean, straight cut, modify the coil as shown in the schematic, and resolder the can. I used the soldering attachment on a small butane torch to tin the can and to do the soldering.

## the new circuits

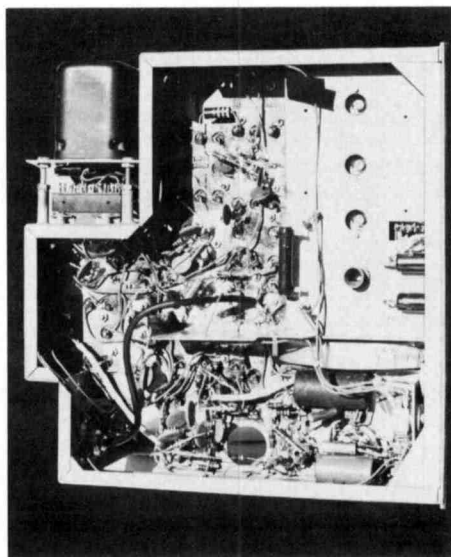
Not all receivers will have the same tuning range after you put in the new lower-capacitance tubes. The rf, oscillator and i-f sections must be tuned after completion. My unit covered 21 to 30 MHz with oscillator injection on the high side of the i-f by 2.65 MHz. This was a result of the missing oscillator-tuning capacitor plate mentioned earlier. No cou-

pling, other than inter-electrode capacitance, is required for good mixing action in the 6U8A. Most of the headaches of this mixer stage, and there were a few, were cured by a book on receivers.<sup>1</sup>

The two 6BA6 i-f amplifier stages are quite conventional and need no explanation. They worked the first time power was applied and have given no trouble since.

I wanted to cover both a-m and fm modes in my unit. The grid of the limiter tube is the a-m demodulator. Grid rectification due to the unbypassed 100k grid resistor provides very acceptable a-m detection. The fm discriminator transformer FL-4 is extensively

**Inside the rebuilt BC-603. The power supply is mounted in the old dynamotor space.**



cleaned up, and a more conventional circuit using 1N34A detectors is substituted.

### **sqelch and noise amplifier**

The sqelch circuit deserves some explanation. It may seem like a lot of trouble to go through, but it gives reliable results and really isn't as bad as it looks. The circuit is made up of a noise amplifier, a noise rectifier, and a keyer tube which turns the first audio amplifier tube on and off. When no signal is present, the noise at the output of the discriminator is filtered to remove any low-

frequency components and then amplified by the 6BH6 noise-amplifier tube; the noise is then rectified by the 1N34A's. This produces a positive potential, which, when applied through a summing circuit to the grid of the sqelch-keyer tube, half of the 12AU7, causes it to conduct heavily. With heavy conduction, its plate voltage is about 20 volts lower than its normal non-conduction voltage.

The plate voltage of the keyer tube is used to bias the grid of the other half of the 12AU7—the audio preamplifier. In the full-conducting state, the grid bias on the audio amplifier is approximately -20 volts with respect to its cathode. The tube is cut off in this condition, and the audio is sqelched.

When a signal appears in the bandpass of the receiver, the noise in the discriminator output disappears because of quieting, and the positive voltage which was being generated by the noise disappears at the summing circuit. At the same time, a negative potential is present in the secondary of the discriminator transformer across diode D2. This negative potential appears at the summing circuit and cuts the sqelch-keyer tube off. When the sqelch keyer is cut off, its plate voltage rises and turns on the audio amplifier stage. Voltage from a minus 9-volt bias supply can be switched from the front panel to cut the sqelch keyer tube off and effectively disable the sqelch circuit when desired.

### **power supply**

The power supply uses a 6.3-volt filament transformer and a 6-volt vibrator transformer. The 6.3 Vac supply runs all tube heaters and provides an input voltage to the 6-volt vibrator transformer. I used a surplus 6.5-volt filament transformer with an 8-amp rating.

You can find a vibrator transformer in almost any car radio, old mobile equipment or in the junk box, or you can buy a new transformer that has the output you need. However, make sure the transformer will fit in the available space and has sufficient rating.

The power supply is mounted on an aluminum plate which is supported by the threaded risers in the dynamotor housing as shown in the photograph. I used a TV cheater cord and receptacle for ac line voltage for easy re-

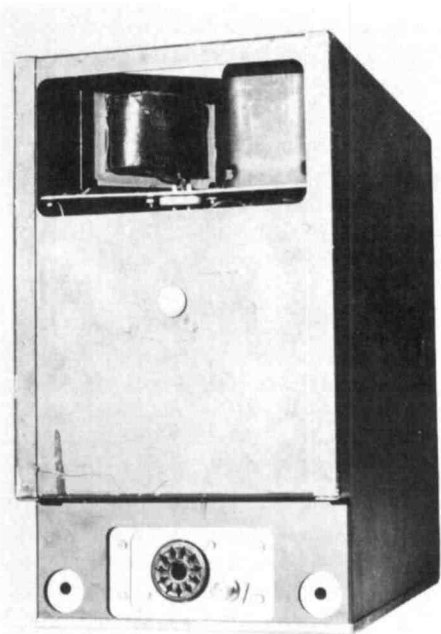
removal of the chassis from the cabinet. The power and switch leads are brought into the receiver through the existing Jones plug on the dynamotor housing. Pin numbers for the Jones plug are marked in the square boxes on the schematic diagram; I used the original BC-603 Jones plug, PG2.

The target voltage is 140 to 150 volts at 60 mA. The minus 9-volt bias is obtained through a 200-ohm dropping resistor in the power-supply return lead.

### front panel

Front panel wiring is essentially untouched. However, the tie point which connects the front panel squelch on-off switch, the volume, and the squelch controls to ground must be removed. Then the panel is wired for the front panel plug. The pin designations are shown in the circles on the schematic dia-

Back view of the reborn BC-603 with the cover on.

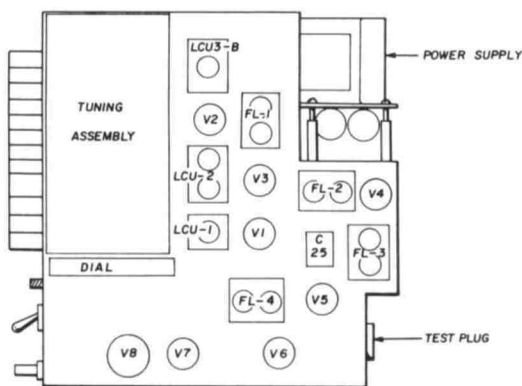


gram in **fig. 2**. The volume control and squelch pots were replaced with the values shown in the schematic.

The speaker in my receiver was bad and was causing distortion in the audio so I re-

placed it with a shallow 4-inch speaker. The heavy iron grillwork was taken off and replaced with a light aluminum grill made by bending some scrap aluminum in a vise and drilling a pattern of holes in it.

The rf and i-f gain control pots are installed side by side in the holes left by the removal



VIEW FROM RIGHT SIDE

of the antenna and ground posts. Small diameter pots must be used to allow clearance; I used a 7/8-inch diameter Centralab units.

### tracking adjustment and tune up

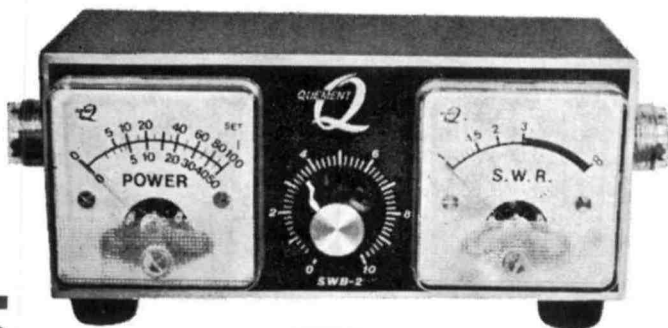
Tuning up a receiver is not an easy task without some test equipment. An rf signal generator, preferably one with an attenuator, that covers the i-f frequency of 2.65 MHz and the range from 20 to 35 MHz is almost a necessity. A VTVM or a sensitive, 50-microamp meter is also needed. To tune the i-f amplifier and detector stages, remove the 6DC6 rf amplifier, and disable the mixer oscillator by removing B+ from pin 4 of the oscillator can, LCU-3B.

Tune the signal generator to 2.65 MHz, couple it to pin 2 of the 6U8A mixer through a capacitor and tune FL-1, FL-2 and FL-3 by observing a peak indication on test-plug pin 1. Switch the meter to test-plug pin 2 and tune the primary of FL-4 for peak indication. Finally, switch the meter to pin 3 on the test plug and adjust the secondary of FL-4 for zero indication. These adjustments have some interaction so you'll have to go through this procedure several times. Reconnect B+ to pin

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4 of LCU-3B and replace the 6DC6 rf amplifier.

Set the oscillator frequency range 2.65 MHz higher than the received range. Tune the receiver to 21 MHz and adjust the oscillator coil slug until the oscillator frequency is 23.65 MHz. Set the dial to 30 MHz and adjust the trimmer capacitor, C1Dt for 32.65 MHz. Repeat these steps several times to insure proper tracking.

Put the meter on pin 1 of the test plug, set the rf signal generator at 21 MHz and plug it into the rf input jack. Tune the receiver to 21 MHz and adjust the coil slug of LCU-1 and LCU-2 for maximum indication on the meter. When tuning LCU-2, swamp the side of the coil not being tuned by connecting a .01  $\mu$ F ceramic capacitor and a 1k resistor in series and attaching it across the coil you want to swamp.

Change the signal generator and receiver frequency to 30 MHz and peak the indication using the trimmer capacitors C1At, C1Bt and

C1Ct. The adjustment of the coil slug and the trimmer capacitors at opposite ends of the tuning range will interact, so this procedure must be repeated several times to insure proper tracking.

## summary

It is not my intent to present a rigid set of instructions for building this particular receiver, but it gives you an idea of my approach to the problem. By starting out with all the difficult mechanical work completed, you are way ahead in any receiver project. There are a lot of surplus receivers on the market at very reasonable prices, and when they're fixed up and modernized, they will give many years of good service before the transistors and IC's move in.

## references

1. J. Kyle, K5JXX, "Receivers," 73, 1964.

ham radio

# aluminum's

## new face

Here are  
some helpful hints  
for cutting  
and finishing  
aluminum  
panels and chassis

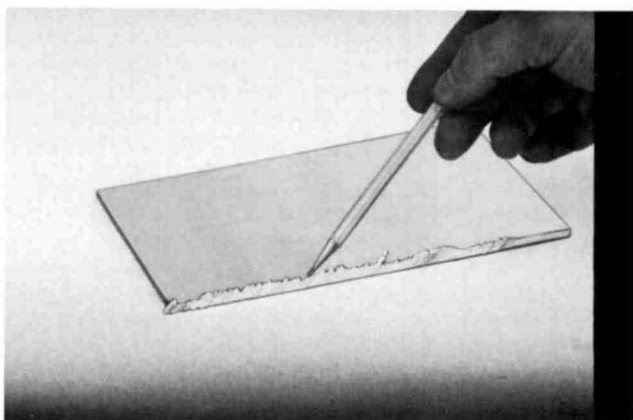
Are you proud of that new receiver or linear that you just built? Although it works well, its looks may leave a little to be desired! Painting aluminum panels flat black helps a little, but chips and scratches detract from the looks of an otherwise excellent product. Saw cuts frequently have to be smoothed with a file.

It used to take a lot of time to put a nice-looking finish on an aluminum panel, but with the simple techniques I discuss here you can get a professional-looking finish with minimum effort.

### cutting aluminum

You can save a lot of time and trouble by cutting sheet aluminum with a table saw. Hold an old candle or stick of paraffin against the edge of the saw blade just before making a cut. The wax lubricates the blade and prevents galling of the work due to aluminum build-up. Lubrication is the single most significant technique for producing a smooth, accurate saw cut. Watch your fingers

**Old Method . . . notice how the edge of the aluminum sheet has been galled by aluminum build-up on the saw blade.**



J. B. Hood and E. L. Klein, W4BRS, 6814 Criner Road, S.E., Hunstville, Alabama 35802

—stop the blade before applying the wax!

When you're cutting aluminum sheet which is 1/16th inch or thinner, it is a good idea to place a piece of masonite or plywood under the aluminum when running it through the saw. This supporting material is cut at the same time as the aluminum and the thin sheet is not bent down at the cut edge.

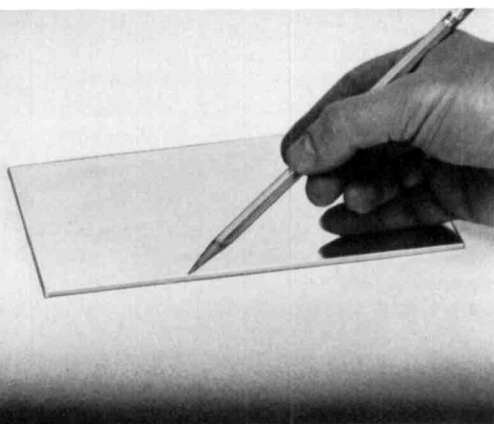
The type of blade used for sawing aluminum sheet is important. While a regular fine-tooth wood-type cross-cut blade works quite well, its life is limited somewhat. A non-ferrous metal-cutting blade is the best choice for cutting aluminum on a table saw. They are available from Sears for under three dollars.

Don't use coarse blades with tungsten-carbide inserts because they produce a very rough edge, especially on thin sheets. The same thing applies to hack saws and saber saws. A saber saw with a fine-tooth blade is very good for cutting thin aluminum, particularly when curves are desired. Also, if you use wax lubrication with these blades, very little, if any, filing will be necessary after you make the cut.

### surface finishes

Now, how about that surface finish? Would you like to improve it? A good paint job will go a long way toward improving the appearance of front panels. Aerosol spray cans are convenient to use and are available for primer paint as well as just about any type and color

**New Method . . . smooth, clean edges by lubricating the saw with an old wax candle or parafin.**



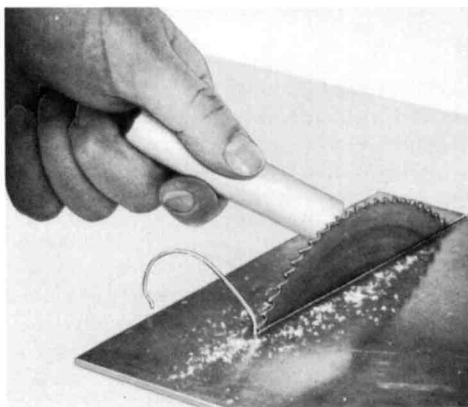
of finish coat. Many builders prefer flat black. After several coats are thoroughly dry, the flat-black surface should be rubbed with a soft cloth to provide a uniform sheen and minimize finger marks.

Bare surfaces, such as chassis and the backs of panels, can also be greatly improved in appearance after all the drilling is done. There are three very simple treatments for obtaining various surface effects—the brushed finish, orbital pattern and etched-satin finish. Each of them is very attractive on sheet aluminum.

### brushed finish

This finish is very popular on professional equipment. It is commercially produced with

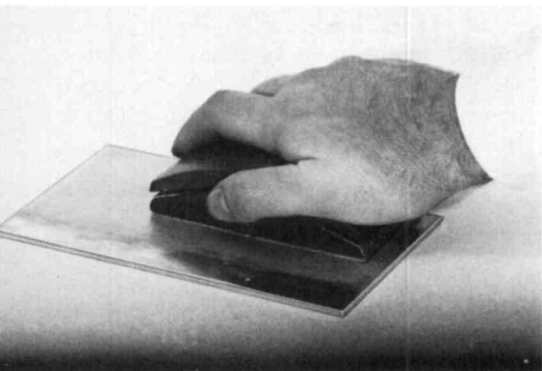
**A used candle, held to the saw blade just prior to or during a cut, provides the needed lubrication. Danger—stop the saw before putting the wax on the blade!**



a coarse, slow-turning wire brush; all scratch marks are parallel. All the amateur needs to simulate the brushed finish is a sanding block and a sheet of coarse sandpaper, preferably the type used for machine-sanding oak floors.

The coarse paper is moved back and forth in a straight line over the aluminum. A strip of wood clamped to the table as a guide makes sure that all the brush marks are straight. As the sanding progresses, the coarse grit should produce a series of tiny parallel grooves. Continue this back-and-forth movement until the entire surface has a uniform appearance.

You can simulate a brushed finish by using coarse sandpaper in straight parallel strokes.



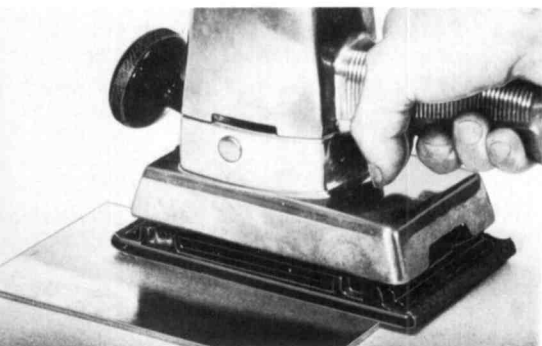
### orbital pattern

For this effect, you need some fairly coarse sandpaper and an orbital electric sander. Steady the piece of aluminum and sand it while moving the orbital sander around in a circular motion until the surface has a uniform pattern. If the piece of aluminum has a badly scarred surface, begin sanding with a much coarser grit than you use for the final sanding; reduce the coarseness until the desired finish is produced. For best results, use light pressure on the sander.

### etched-satin finish

For this treatment, you need a large plastic container, such as a dish pan. You also need

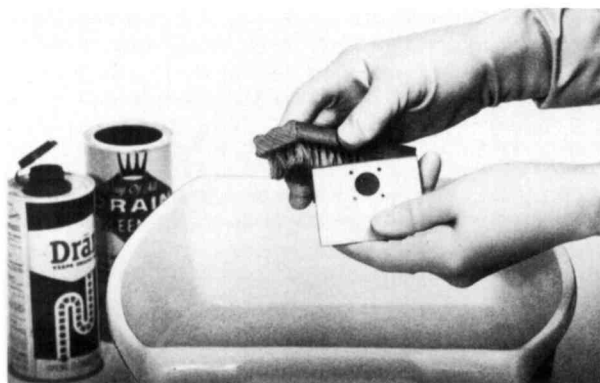
**An orbital surface pattern is obtained by using an electric orbital sander with medium-grade sandpaper. Light pressure produces the best cutting action.**



an alkaline chemical, a small scrub brush, a pair of rubber gloves and plenty of plain water.

The large container should be plastic. The alkaline chemical reacts with some metal pans and may damage the pan. Because of the fumes that are produced by this process, you should work outdoors or in a well-ventilated room. For the chemical solution, sodium hydroxide is mixed with plain water. If you

**Any one of several common household caustics can be used for etching aluminum parts to provide a satin finish. The brush removes oxides and enhances the etching action.**



can't find any sodium hydroxide, there are several brand-name household chemicals available that will do the job—Drano is one.

Before putting the aluminum in the chemical bath, remove any deep scratches with sandpaper, working from coarse through successively finer grits. Mix the chemical and water in the plastic pan. When the sodium hydroxide is dissolved, dip the aluminum into the solution. Scrub it vigorously with a small bristle brush to remove the aluminum oxide film. In a few minutes, the solution will etch a very fine pattern into the aluminum. When the pattern is uniform, rinse the panel thoroughly in cold running water.

None of these techniques require any special equipment, nor do they require a great deal of experience. The next time you build a piece of equipment, try one of them—your hand-crafted equipment will be something you can be proud of.

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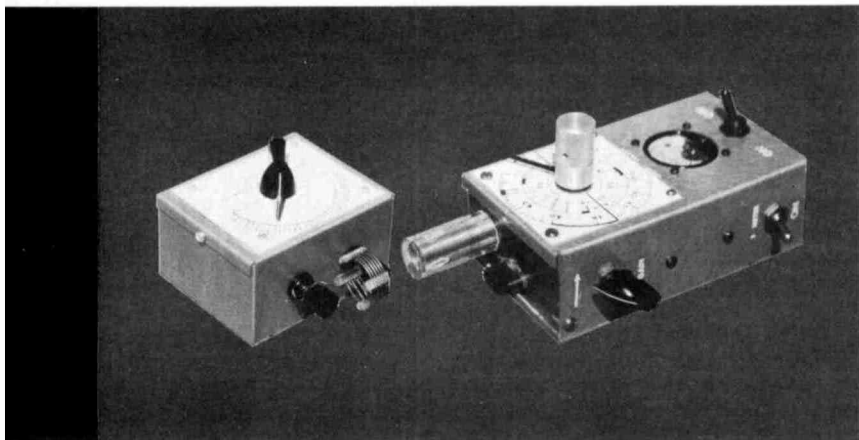
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## transistorized dipper

**without  
plug-in coils**

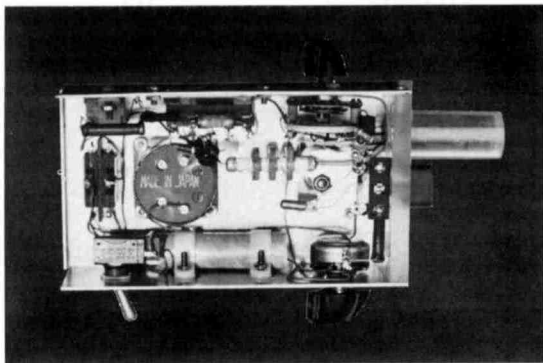
A handy instrument  
for measuring frequency,  
field strength,  
or checking crystals

It is often difficult to make transistor oscillators oscillate over wide frequency ranges. Dial calibration is also a real problem without expensive calibrating instruments and lettering sets. This article attempts to solve some of these problems, but you must use the same parts that I have, especially the coil and tuning capacitor.

One of the joys of this dipper is the convenience of band switching. There are no plug-in coils to worry about. Plug-in coils are a source of trouble when they wobble around in the socket and cause loose connections. Besides, they are often difficult to push in and take out.

This particular instrument functions as a dipper, a field-strength meter and crystal os-

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



cillator/checker throughout the 3.5- to 30-MHz range. To make it do all of this properly, you must follow the circuit and layout very closely. A 2N1742 transistor was chosen for the oscillator because of its high frequency response, but other types, such as the HEP 2, GE-9, TRO6 or JR30X will also work. If you're only interested in the lower frequencies, the RCA SK3008 does a nice job.

**The band-switching dipper may also be used as a field-strength meter or for checking crystals.**

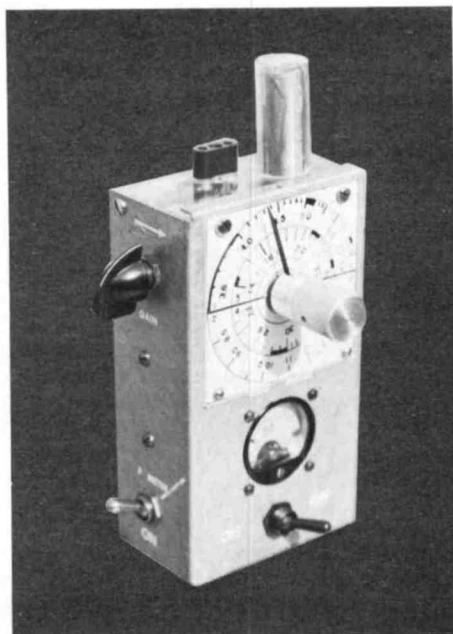
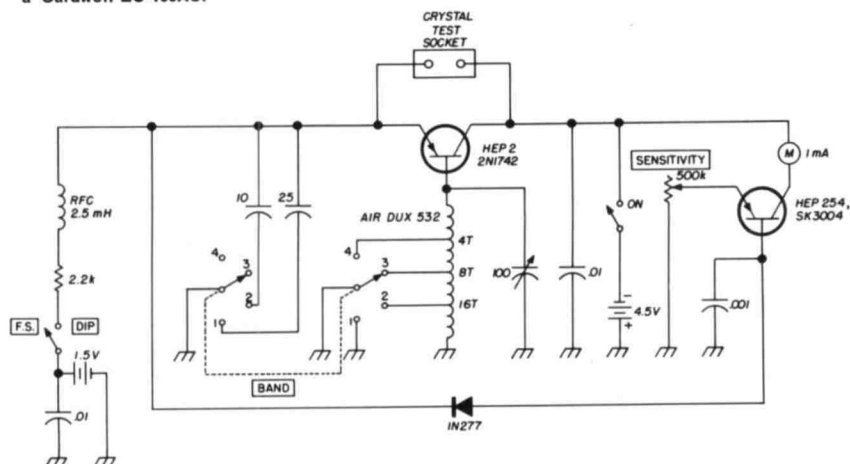


fig. 1. Schematic of the dipper. On Band 1, the entire Air Dix coil is used. The 100-pF variable is a Cardwell ZU-100AS.



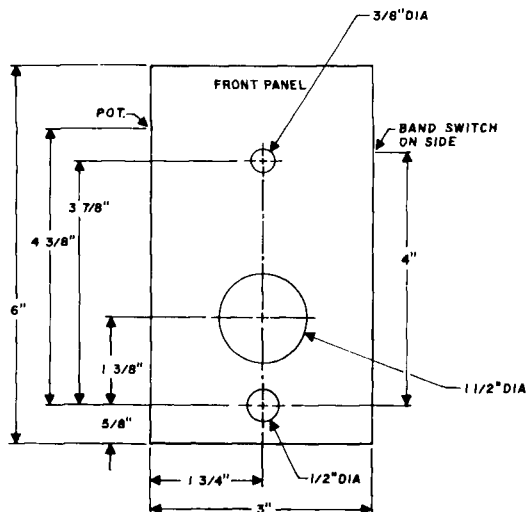
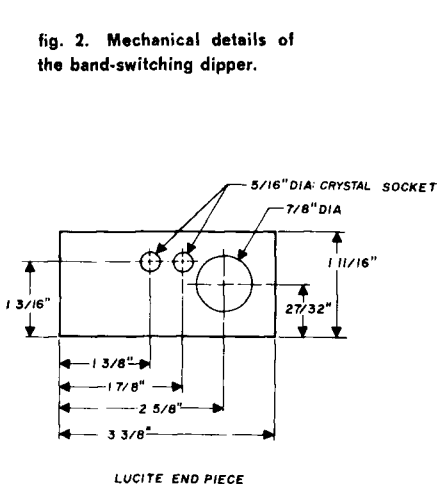
## construction

The entire bandswitching dipper is housed in a miniature LMB 138 chassis, 6-1/4 x 3-1/2 x 2-1/8 inches. As you can see from the photographs, nothing is particularly crowded. The meter is an imported 0-1 mA unit. If you use the same parts and layout I did, you can obtain reasonable accuracy with the same dial calibration—I can furnish glossy prints of the dial I used for 35c. Put a piece of sixteenth-inch clear plastic over the dial to protect it.

In this circuit, the transistor oscillates easier above 6 MHz, so you have to switch in various values of feedback capacitance on bands **one** and **two**. I did quite a bit of experimenting to set the values for these capacitors and to determine the type of coil. I recommend that you use Air Dux 532T for the coil. I tried the next larger size, but the oscillator wouldn't work on the 3.5-MHz band. On band **four** (22 to 40 MHz), the 2N1742 provides nearly full-scale deflection, while the SK3008 deflects the meter about one quarter. Almost any general-purpose audio NPN type will work in the meter-amplifier circuit.

When turning on the dipper, always put the sensitivity control to the off position to avoid pegging the meter needle; this is most critical on the 3.5-MHz band. Notice the 25-pF silver-mica capacitor used on the 3.5-MHz switch position. This value was required for oscillation on this band. The next band re-

fig. 2. Mechanical details of the band-switching dipper.



quired 10 pF, and the rest of the bands didn't need any additional feedback.

The best way to check for oscillation is to listen to a receiver or by putting a VTVM probe on the emitter of the 2N1742. If a large positive voltage is indicated, the circuit is not oscillating. Check this on band **two**. The meter may still deflect upscale even if the circuit is not oscillating. The meter amplifier can be checked by feeding an audio or rf signal into the 1N277—large enough to drive the meter-amplifier transistor.

If you use mercury cells for power, be careful to get the polarity connected properly. Above all, don't forget the .01- and .001- $\mu$ F bypass capacitors across the batteries; battery internal resistance may prevent oscillation. Ground the bottom of the coil; if it is left open, the stray capacity results in a tuned circuit, and the dipper will show a "false" dip.

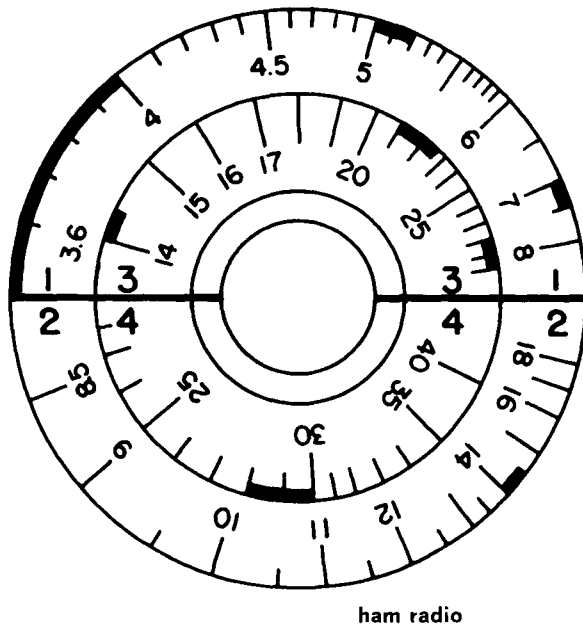
### operation

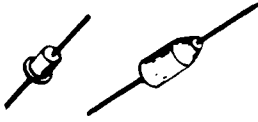
The single pole toggle switch in the battery lead is used for field-strength measurements. This switch converts the dipper into a field-strength meter for antenna measurements or transmitter tuning. When it is held close to an oscillator coil, it will indicate rf energy. The sensitivity control works in both positions—dipper or field strength. With the sensitivity turned up, the tank radiation from a 12-watt transmitter can be picked up three feet away.

In the dipper position, the dipper coil is placed near another coil and tuned through its range. When the dipper frequency is the same as the resonant frequency of the coil, the meter will dip to zero.

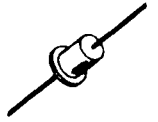
The distance you hold the dipper from a test coil depends on the selectivity of the coil and the frequency. For best results, use the minimum amount of sensitivity that is possible. Bandspread is sufficient, so a vernier dial is not necessary.

fig. 3. Full-size dial for the dipper.



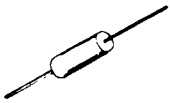


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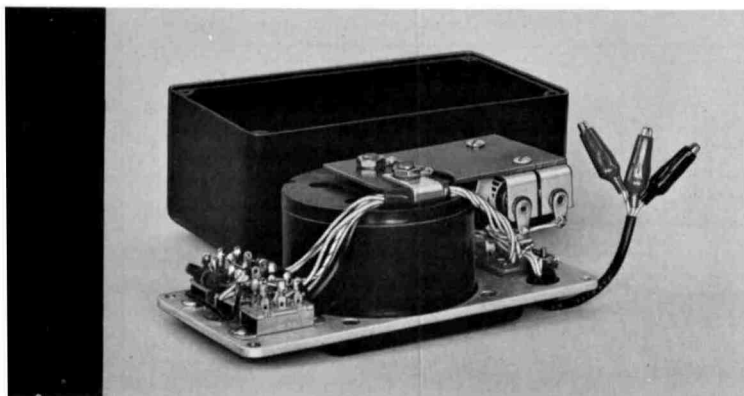
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Internal construction of the simple transistor checker.

# simple, low-cost transistor tester for checking leakage and gain

The construction  
of this tester  
will be paid off  
by the use  
of low-cost,  
surplus transistors

E. L. Klein, W4BRS, 6814 Criner Rd., S. E., Huntsville, Alabama 35802

More amateurs and electronic experimenters are using transistors today than ever before. They are available at relatively low cost. Indeed, the bargains advertised in the back of this magazine make these versatile and compact devices universally attractive to builders who used to depend on tubes for a myriad of electronic applications. Today, most ham shacks boast a collection of transistors neatly stored in their original cartons; but what about transistors which have been used in a breadboard or the bargains which can't be identified?

The answer is a simple and easy-to-use transistor checker. When he looks at the published characteristics of transistors, the average amateur is overwhelmed by the abbreviations used by different manufacturers and by a maze of interrelations between the transistor's three elements—emitter, base and collector. Usually, the electronic experimenter is interested in only a few basic factors:

- Is it a PNP or NPN?
- What is the relative emitter-collector leakage?
- What is the approximate gain under normal conditions?

The transistor checker described in this article is intended to provide instant answers to these basic questions. When these questions are answered, the transistor circuit builder knows that his transistor is "good". However, in some critical applications, individual selection may be needed, particularly in high-frequency circuits.

### circuit

You can see from the diagram in **fig. 1** that it's a simple circuit. Two sockets provide connections for the most commonly-used transistor configurations. As an additional convenience, a set of test leads lets you test transistors with other types of terminal arrangements. A double-pole, double-throw switch is included to reverse the emitter and collector terminals so that checker will take care of both PNP and NPN transistors. The 3-volt battery and 3.3k resistor provide emitter-to-collector current which is measured as "leakage" current on the 0-1 millimeter. By switching in either the 2.2k resistor

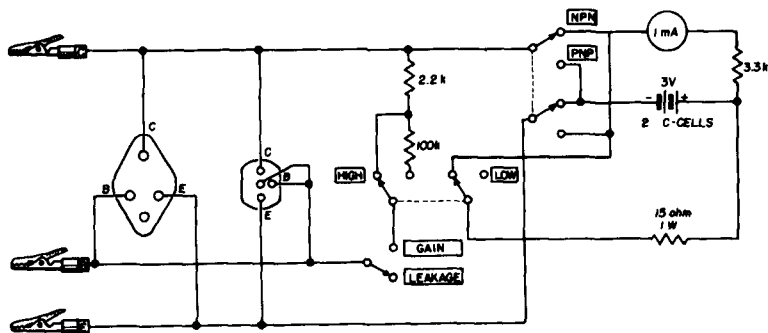
mits a heavier current to flow through the transistor without deflecting the meter off-scale. Secondly, this switch selects a lower value of collector-to-base bias resistor which is common for power-type transistors.

### construction.

I used a 5-3/4-inch bakelite instrument box for the case, but a mini-box or other home-made box will serve just as well. Because of its rigidity, 1/8-inch aluminum was used for the front panel. Since the 3-inch meter requires a hole which takes the greatest part of the panel width, this added rigidity is recommended. I used miniature slide switches due to their low cost, but regular toggle switches would be easier to mount in conventional round holes.

The two transistor sockets accommodate most transistors in use today. Smaller transistors of the TO-5 or TO-18 variety fit into the Elco 05-3304 socket, and power transistors of the TO-3 class are accommodated by the Cinch-Jones 2-TS1 socket. In the latter

fig. 1. Schematic diagram of the transistor tester. Mini-gator clips permit connections to transistors that do not fit the two standard sockets.



or 102.2k resistor (2.2k plus 100k), a nominal bias voltage is applied to the base terminal. Now the milliammeter reads a current which is representative of "gain". If you want to, you can put in a third switch position to measure the battery condition; in this case, a suitable voltage-dividing network must be included. An "off" switch is not used because no battery current can flow if a transistor isn't plugged in.

The "high-low" switch performs two functions. It shunts the meter and the 3.3k dropping resistor with a 15-ohm resistor. This per-

mits a heavier current to flow through the transistor without deflecting the meter off-scale. Secondly, this switch selects a lower value of collector-to-base bias resistor which is common for power-type transistors.

case, the collector terminal is not insulated from the panel with a mica washer. This permits a more convenient collector connection when testing power transistors. Miniature mini-gator clips are soldered to the ends of the three short flexible leads. Different colored insulating boots assist in identifying the emitter, base and collector leads; Brady wire labels with a bold E, B and C complete the identification job.

A 1/16-inch thick piece of phenolic, approximately 2 by 3 inches, is used to mount the dual battery holder (Keystone #140) to

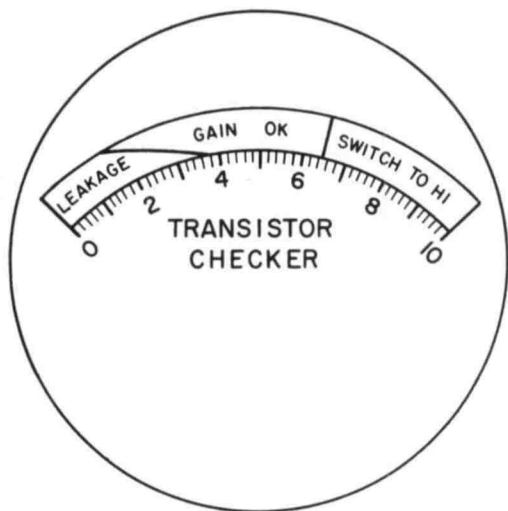
the meter terminals. The resistors used in the circuit are soldered directly to the switch lugs as shown in the photograph.

### meter face

Most meters can be disassembled by removing three screws from the back. Then you can remove the enamelled-metal meter face. Don't bend the needle or distort the hair spring when removing the meter face. It's a good idea to turn the meter face over and cement the new scale on the reverse side. Then the original scale is preserved in case you want to re-use the meter in some future job.

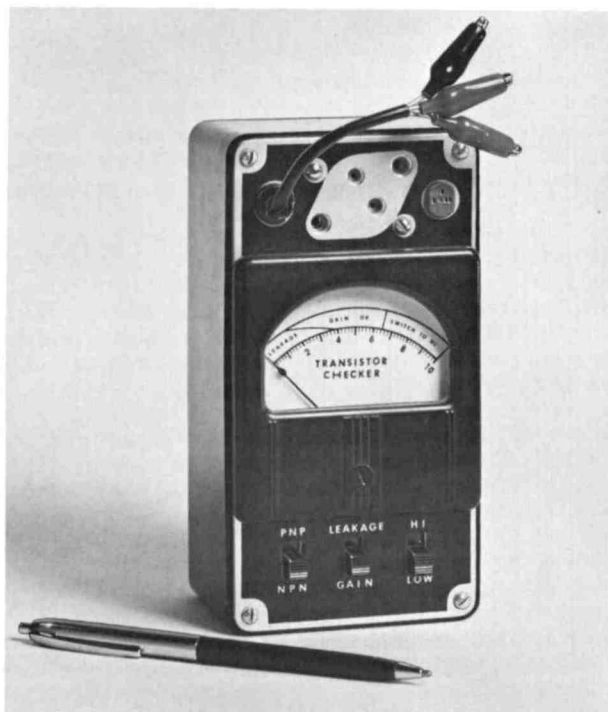
Calibration of the new scale is not particularly critical. You can cut out **fig. 2** and glue it on the metal plate or draw a new scale on good white paper stock with India ink. A very professional-looking scale can be made by first drawing the scale double-size and then reducing it photographically.

**fig. 2.** Full-scale layout of the new meter face for the transistor tester.



### panel construction

The master drawing for the panel nameplate is shown in **fig. 3A**. The transistor tester illustrated in this article boasts a unique photo-chemically produced nameplate using Scotchcal from Minnesota Mining & Manufacturing Company. A proper technical dis-



The simple, low-cost transistor checker—ready to go to work.

cussion of this fascinating material would demand a complete article. If you don't have access to professional nameplate fabricating facilities, you can use more conventional techniques for panel identifications such as decals or pressure-sensitive labels.

One word of advice—if a label is to be put on an aluminum panel, the surface should first be etched with **Drano** or otherwise worked to a uniform sheen with fine sandpaper or steel wool. A finish coat of clear Krylon will complete the job and give it long-term durability.

### operation

When you're testing a transistor of unknown type or quality, simply plug it into one of the two sockets. The leakage-gain switch should first be set to "leakage" and the high-low switch is set to "low". A defective transistor usually has a very high emitter-collector junction resistance. Therefore, a bad transistor will seldom cause excessive current to be drawn through the meter.



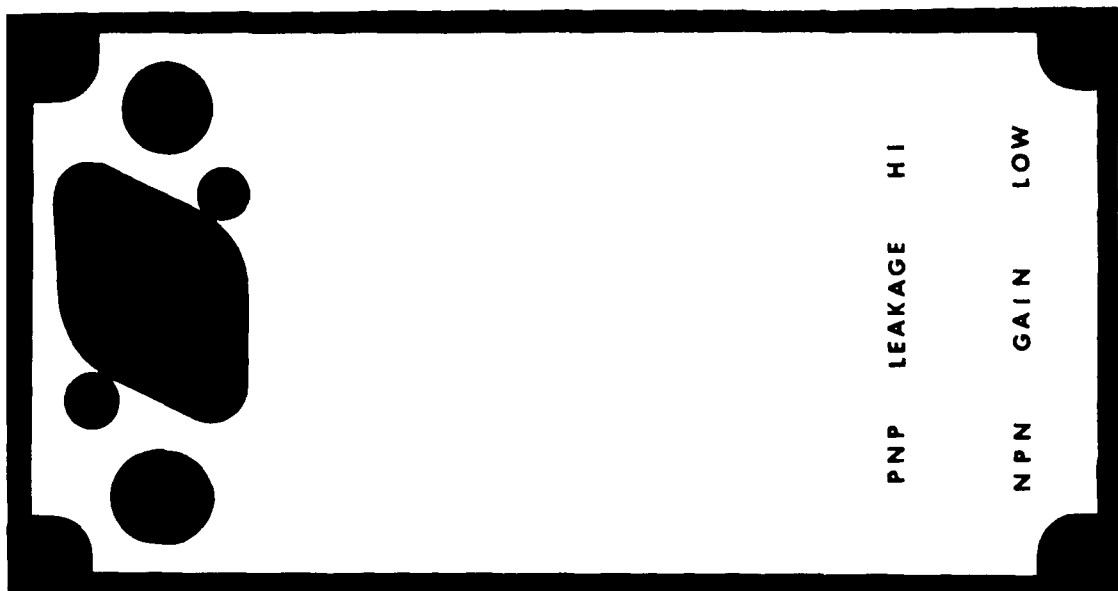


fig. 3. Full-scale photo master of the front panel for use with 3M Scotchcal. If you don't have access to photo-engraving, normal construction may be used with rub-on letters.

If little or no meter reading is evident, the transistor is either defective or the PNP-NPN switch is in the wrong position. Operate the switch; if a reading is now obtained, you have determined what type of transistor you have. If you still don't get a reading, the transistor is shot.

When switching from "leakage" to "gain", meter readings should fall into the "gain ok" area of the meter scale. The important thing to remember, however, is that with the same transistor, low leakage and high gain readings indicate merit. If the difference between the leakage and gain readings is small, you should consider the transistor to be below normal—a good candidate for the junk heap.

The absolute meter readings are not too meaningful if we wish to remain in the less

technical domain, which was the first condition of this article. However, the graduations from 0 to 100 were included on the new meter face as a convenience in recording relative values for different transistors within the same category or type number.

Generally, when power transistors are being tested, the "high" switch position is used. The "switch to high" notation on the meter face reminds the operator to change the position of the high-low switch.

When your transistor checker is all completed and functions as it should, it will prove to be one of your most handy instruments around the shop—it certainly is at W4BRS.

ham radio

## next month in ham radio magazine:

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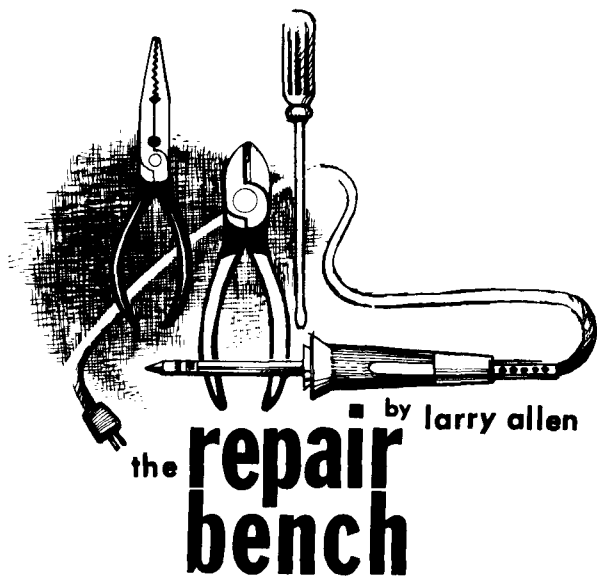
## signal injection in ham receivers

There's more than one way to skin a cat. And there's more than one way to track down trouble in a ham receiver in a hurry. Last month in this column I wrote about how to get your receiver back on the air fast by using a signal tracer. This month I'll explain another way—signal injection.

If you remember, the signal tracer lets you go through a set stage by stage, checking at each point for the signal. With signal injection, you don't even connect the antenna. Instead, you use a signal generator to put a signal into the receiver at various points, and you evaluate operation by whether or not the signal makes its way on through to the speaker. In most ways, signal injection is as effective as signal tracing. Often, it's even faster.

There are several different kinds of signals that can be used for injection. One is an audio-rate pulse produced by a very simple instrument called a harmonic generator. One example is a companion instrument to the pocket-type signal tracer I mentioned last month. It puts out sharply-spiked waveforms, generated at an audio frequency. The leading and trailing edges of the waveform are so sharp that the pulses are full of harmonics and can go through rf and i-f as well as audio stages. They can even shock-excite a tuned circuit into flywheel action. If you know the nature of the harmonic generator, you can use it throughout a receiver for signal injection. With a leftover transistor and a few parts, you can even build a little harmonic oscillator of your own.

Chief attractions of the small harmonic generator are simplicity and low cost. One alternative, which is more versatile yet more expensive, is the standard rf/af signal generator. With its audio and modulated rf outputs, you can inject exactly the correct signal for any stage in the receiver. The stability and accuracy don't matter unless you use the generator for alignment. For signal-injection troubleshooting, an inexpensive rf/af generator is adequate. The photo shows one of the better units, available in kit form. Several companies produce such instruments already



wired. They range in price from \$20 to well over \$100, depending on accuracy and stability.

You can even use a square-wave generator, because of the sharp rise and fall of its waveform edges. You see, a square wave at 1000 kHz contains a lot of harmonics that extend into the upper kilohertz and megahertz range. The result—and use—is similar to that described for the pulse-type harmonic generator.

### the method

There are two acceptable ways to use signal injection for troubleshooting. One is the divide-and-conquer method described last month for the signal tracer. You start about half-way through the set. If your tests tell you the trouble is in the front half of the set, you divide that in half and check again. You keep this up until you have isolated the defective stage or circuit. If the fault is in the last half, you divide that . . . and so on.

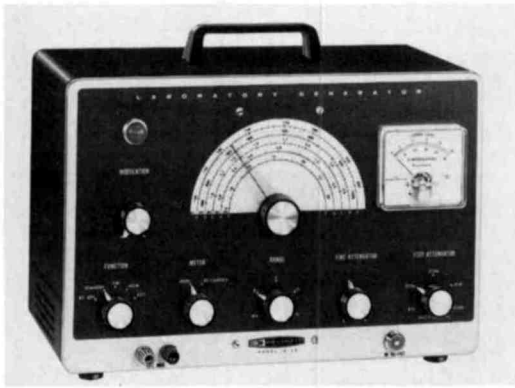
In the other system, you begin at the speaker and work your way back to the front end of the receiver. This is the method I prefer for signal injection, and it's the one I'll describe here. It's about as quick, and it has the added advantage of direct step-by-step logic. If you want to take shortcuts, you can easily skip a couple of stages, then back up if you find you've gone too far.

Turn the receiver on and let it warm up.

Turn the volume control to minimum, and disconnect the antenna. Set up the signal generator to give you only its audio output—not modulated, but audio alone. Connect the output lead of the generator directly across your speaker. The diagram shows this first test point as A. You may have to turn the output control of the generator wide open to get enough signal to hear clearly, but if you hear a signal, the speaker is probably okay. If there's no sound, the speaker is obviously bad.

Move the hot lead of the signal generator to point B, the plate of the audio output tube (or the collector of an output transistor). (Be

**A popular kit-type signal generator.**



sure there is a capacitor in series with the generator lead, so dc voltage won't burn out the attenuator in the generator; some instruments have a blocking capacitor built in.) You should still be able to hear audio signal in the speaker. What you're checking here is the output transformer. If you hear the sound, it is coupling energy to the speaker. If not, the transformer, or some connection between it and the speaker, is faulty.

Next, move to the grid of the audio output tube (or the base of an output transistor)—point C. The sound you hear in the loudspeaker should now be very loud. The audio signal is going through the output tube, which should boost it plenty. Probably, you'll have to turn down the generator to keep from rattling heck out of the speaker (or annoying anybody within earshot). If sound in the speaker is missing, or is not much louder than when the generator was connected to the

plate, the output stage is at fault. You can make parts tests with the generator (they'll be described later) or use dc voltage tests to pinpoint the trouble.

While the generator is still connected to the output grid, turn the output level down so that sound is just barely audible in the speaker. This will make it easier to evaluate the next test.

Connect the generator, still putting out an audio signal, to the plate (or collector) of the audio stage preceding—point D. This still feeds the audio signal to the grid of the output stage, but does it through the coupling capacitor. If that capacitor is open, the signal will disappear. If it is okay, you'll hear the audio signal in the speaker at about the same level you set it for before moving the connection.

Move the generator lead to the grid—point E. The signal you hear should be loud, because it now has the added amplification of the first audio stage. Again, you may have to turn down the output of the generator if the sound isn't louder than before, the stage isn't doing its job. The tube may be bad, or an operating voltage may be at fault. Use whatever method you like to troubleshoot within the stage, but signal injection tells you whether the stage is working or not.

If there are components between the audio-amplifier grid and the detectors of the set, you can move back along those with the generator. None of them should reduce the output sound very much from the level at the first audio grid. Be sure you consider the volume control setting. You turned it down at the start, and you'll want to check its operation by injecting the audio signal at point F and running the slider up and down. With the volume control full up, the sound should be exactly as loud as it was with the generator at point E. The same goes for signals injected at points G, H, I, and J.

Next, check the diode detector. For this, you'll have to reset the signal generator to produce a modulated rf signal. For the first test, frequency of the generator isn't important, but you may as well set it to the i-f of the receiver. Clip the generator output to a point just preceding the diode detector. This

may be across the secondary of the last i-f transformer, or at the plate of the i-f tube. In **fig. 1**, it's point K. Adjust the output of the signal generator for comfortable listening. Have the receiver audio gain (volume) turned up fairly high, but not high enough that you hear too much noise in the speaker with no signal injected. The setting of the rf gain control (if the receiver has one) doesn't matter at this point.

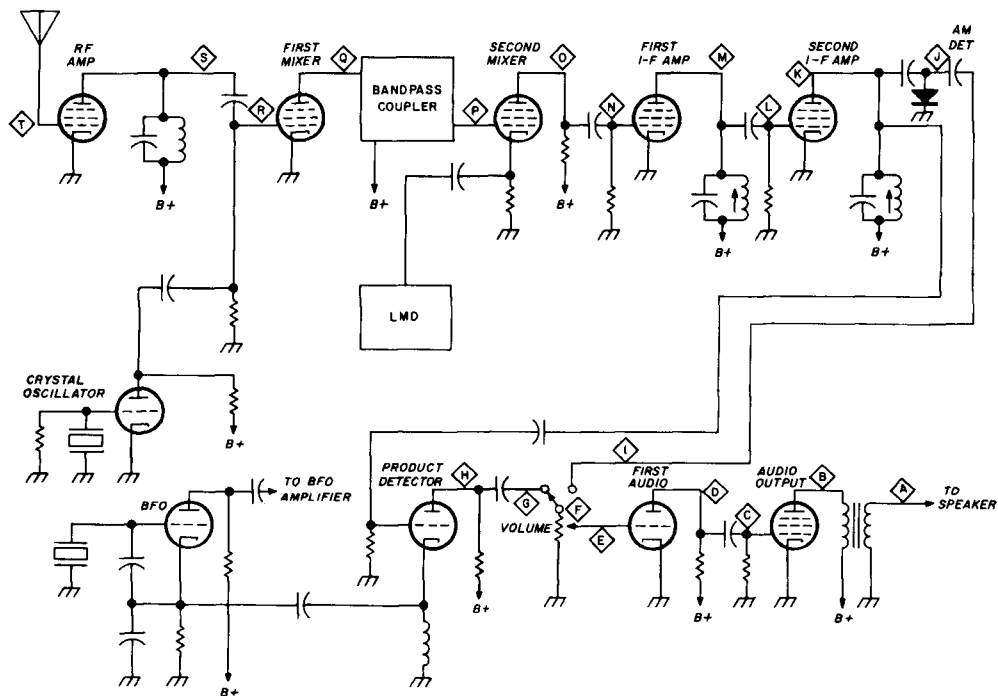
You can also, from this point on, stop using the loudspeaker as your indicator. A dc VTVM connected at the output of the detec-

is already there; disregard this step.)

Signal indication should change very little, if at all. If it does, the i-f transformer is not coupling the signal through as it should. If you're using the dc VTVM as an indicator, reduced signal is indicated by a lower dc voltage from the diode.

Before you move on back to the grid of the i-f stage (point L), reduce the output level of the generator until you just barely hear a sound in the speaker. Then, with the signal generator shifted to the grid (or base), the signal should get a tremendous boost, and

**fig. 1. Schematic diagram of a typical communications receiver. The test points are discussed in the text.**



tor diode makes a good one. Changes in signal level will show up as changes in the dc voltage at point J.

Adjust the signal level from the generator only high enough to cause a convenient, readable (or listenable) indication. Make sure the generator frequency dial is set for the i-f. Move the output lead back to the primary of the last i-f transformer, which is at the plate of the tube. (Where impedance coupling is used, as in the diagram, the generator lead

show a much increased output from the diode or the speaker.

By now you have gotten the idea of moving backward step by step through the stages. If the receiver is a multiple-conversion job, be sure to change the generator frequency as you jump from the plate of a mixer to the grid. In evaluating a mixer by this method, first make sure you have a good signal going through the rest of the set from the plate. Then, change frequencies and inject the sig-

nal at the grid.

If the oscillator is bad, you'll get little or no mixer output because, since you changed the generator's frequency, very little signal can get through the i-f's. If the oscillator and the mixer are working normally, you will get a signal output just about as strong from the grid as you got from the plate. If attenuation is noticeable, the mixer is inefficient.

Keep in mind that, in some sets, the stages preceding the second or third mixer are broadband i-f stages. This needn't be any problem. Just feed in a signal at any signal generator frequency that is within the pass-band of that particular i-f stage. **However**, remember that, if it's a stage that precedes the tuning section, you'll have to turn the station dial until the tunable oscillator is set to receive whatever frequency it is you are feeding into the i-f. It doesn't matter what the dial reads, since you're not checking calibration or anything like that; you just want to know if the stages are working. This is the way to tell.

Finally, you reach the antenna input—point T. If there is trouble in the set, somewhere along the way the signal will have grown distorted or disappeared. The trouble lies between the place where it was okay and the place it got bad.

### parts analysis by injection

You've already seen how signal injection checks the interstage coupling components. If your generator is reasonably accurate, you can even try out i-f transformer adjustments, just to see if they're working. If you find a lot of signal attenuation through an i-f strip, it might be well either to align the set or have it aligned by someone who has the equipment and knows how. (Next month I'll explain how **you** can.)

If you recall how to use a signal tracer for checking bypass components, you have probably figured out that you can do the same thing with a signal generator. Only the method of application is different.

For example, to test a bypass capacitor by signal injection, set the generator for whatever frequency the capacitor is supposed to eliminate. Connect the output of the signal generator across the suspected bypass capa-

tor. Unless you turn the generator output awfully high, you should hear no output in the receiver's speaker.

Here's a good way to gauge how much signal to use in a test like this: assume a bypass capacitor at the screen of an i-f amplifier. First connect the signal generator to the control grid of that i-f amplifier. Turn up the output of the signal generator barely enough for you to hear a weak signal in the speaker with the af gain control fairly well up. If you're using a dc VTVM as the indicator, use just enough signal to cause a definite reading. Now, without disturbing the output setting, move the signal generator lead to the screen grid. There should be virtually no output indication, either audibly or on the VTVM. Practically all the signal should be bypassed to ground. If not, the capacitor is faulty.

That takes care of practically all the components in the set. The signal injection technique has already checked out all the transformers, tubes, and coupling components. About the only thing left is filter capacitors, and they're always checked best by bridging a known good one across any suspected one.

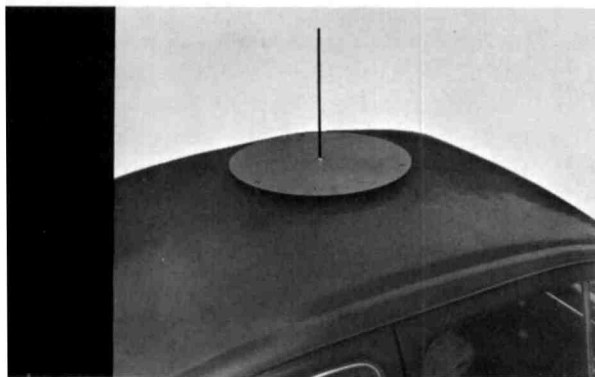
That's the story of signal injection. Next month I'll write about using the rf/af generator for alignment. Many of you have expressed the wish to align your own sets, and it really isn't too hard if you follow a few easy principles.

My mailbag was light this month, with little to pass along; I'm still waiting to hear from you. I'll be answering the best letters in this column.

**ham radio**

The **repair bench** is for you. Tell us about problems you have run into and solved, keeping your rig in peak shape. Questions you ask will be answered only if accompanied by a **copy** (not returned) of the full schematic diagram and a stamped, self-addressed #10 envelope. Larry will include some of the most interesting case histories in his column each month.

**Editor**



## two-meter mobile installations

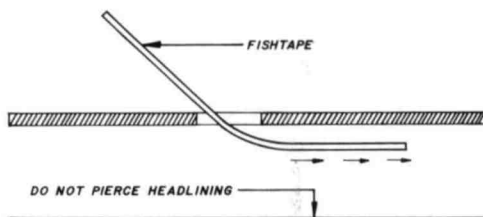
Here are some hints  
for two-meter mobile  
antennas, some without  
drilling a hole  
in the roof

E. H. Marriner, W6BLZ, 528 Colima Street, La Jolla, California 92037

There are many ways to mount a two-meter antenna on your car, and some are better than others. The best way is to punch a hole in the center of the roof, but not many hams have this sort of courage. Usually they look to other methods. Another way is to hold a vertical ground plane on the roof with a magnet as shown in the photo, or to fashion an antenna from an aluminum disk and hold it on with suction cups.

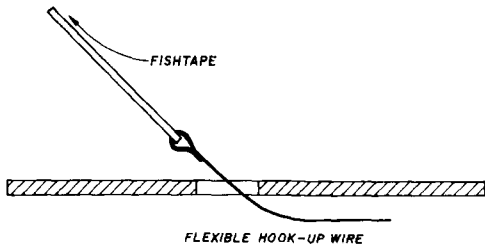
For those of you who **will** punch a hole in the car roof, there are several mobile antenna kits available for under \$10.00. The Antenna Specialist model ASPR-1L or the Motorola Mobile rooftop model TU-316-1L are both popular.

fig. 1. Step 2.



The Motorola antenna comes with coaxial lead-in cable and all of the hardware for a complete installation. The cable is installed inside of the car between the upholstery and the metal car body. In some cars the coax

fig. 2. Step 3.



can be pulled up to the top of the car by pushing a piece of stiff wire down between the body and the upholstery and fastening the coax to it. Installations may vary slightly with each car, but generally speaking, they are almost all the same.

### planning the installation

The installation procedure following is for a two-door passenger car. First, select a location for the antenna as near to the center of the roof as possible. When you install the lead-in cable, it should be kept as short as possible to minimize rf loss. Running the coax from the antenna diagonally to the right or left side of the trunk compartment will keep it short. You can probe the headliner with your fingers to make sure that all obstructions are avoided.

### installation procedure

When you have all the tools you need, you can start.

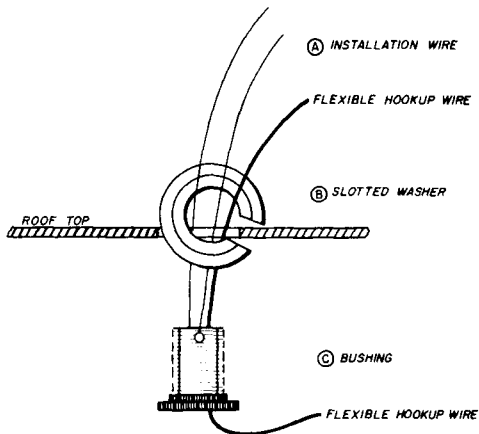
1. Locate the desired position for the antenna, mark it with the center punch and drill a 3/4" hole. Use a sheet-metal drill or hole saw. **Do not use a standard twist drill.** Be careful not to tear the headliner. Scrape the paint off the top of the car roof about 1/16" around the hole to provide a good electrical bond between the antenna base assembly and the roof.

2. Carefully route the electrician's fish-

tape through the mounting hole in the roof top. In some cases it may be necessary to remove the window trim from around the left or right rear window, and loosen the headliner along the top of the window.

3. Attach a length of #22 or #24 flexible wire to the end of the fishtape and pull the tape back through the antenna mounting

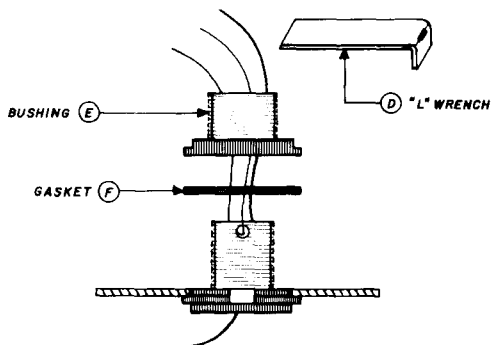
fig. 3. Step 4.



hole, leaving approximately 6" of flexible wire exposed at the mounting hole. Disconnect the fishtape.

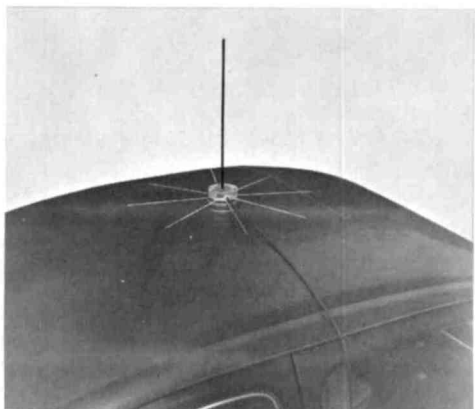
4. Attach the installation wire (A) to bushing (C), and pass the bushing over the end of the flexible wire and lower it through the

fig. 4. Step 5.



mounting hole. Pass the slotted washer (B) over the installation wire and the flexible wire, keeping the shoulder of the washer

This home made 2-meter ground plane is held on the car roof with a magnet.



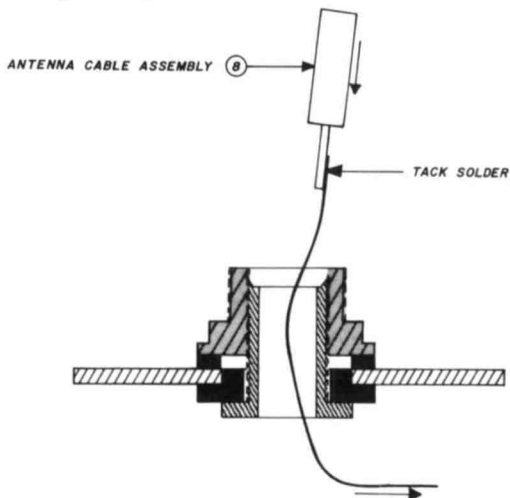
toward the top. Tilt the washer and pass the slot over the edge of the mounting hole. Push the washer through the mounting hole and onto bushing.

5. Put the gasket (F) (seam side downward) and bushing (E) over the end of the installation wire (A) and over the end of the "fish" wire. Pull the installation wire up until the washer is firmly seated in the mounting hole. Now, let the gasket drop into place over the bushing.

Put a little lacquer, glyptal or varnish on the threads of the bushing (E). Apply sparingly. Thread bushing E onto bushing C and tighten by hand.

Put the "L" wrench (D) in the slot in the

fig. 5. Step 6.

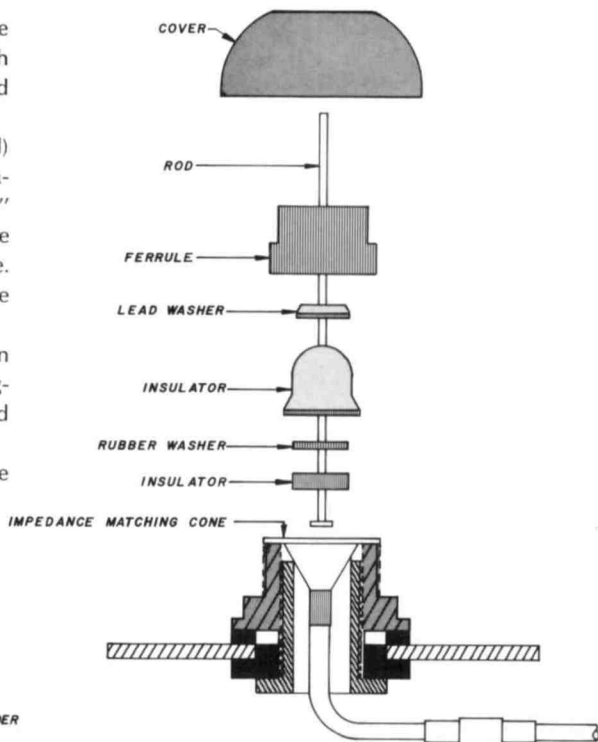


top of the bushing and securely tighten it using a 7/8" open-end wrench. Take out the installation wire by breaking it in the center and pulling out the two pieces.

6. Tack solder the unconnected end of the antenna cable to the upper end of the flexible wire and gently pull the lower end of this wire from the trunk or window frame until the curved tube on the end of the cable reaches the bushing (E). Work the curved tube downward onto the bushing until the impedance matching cone seats in the top.

7. Assemble the parts shown in fig. 6 onto the antenna rod in the order shown and pull

fig. 6. Step 7.



the rod up until the lead washer, insulators and rubber washer are drawn completely into the ferrule. Now apply a small amount of lacquer, glyptal or varnish to the threads of the bushing. Make sure you don't get any inside.

8. Thread the ferrule onto the bushing. Tighten it by hand, then back it off one full turn. Gently pull on the lower end of the



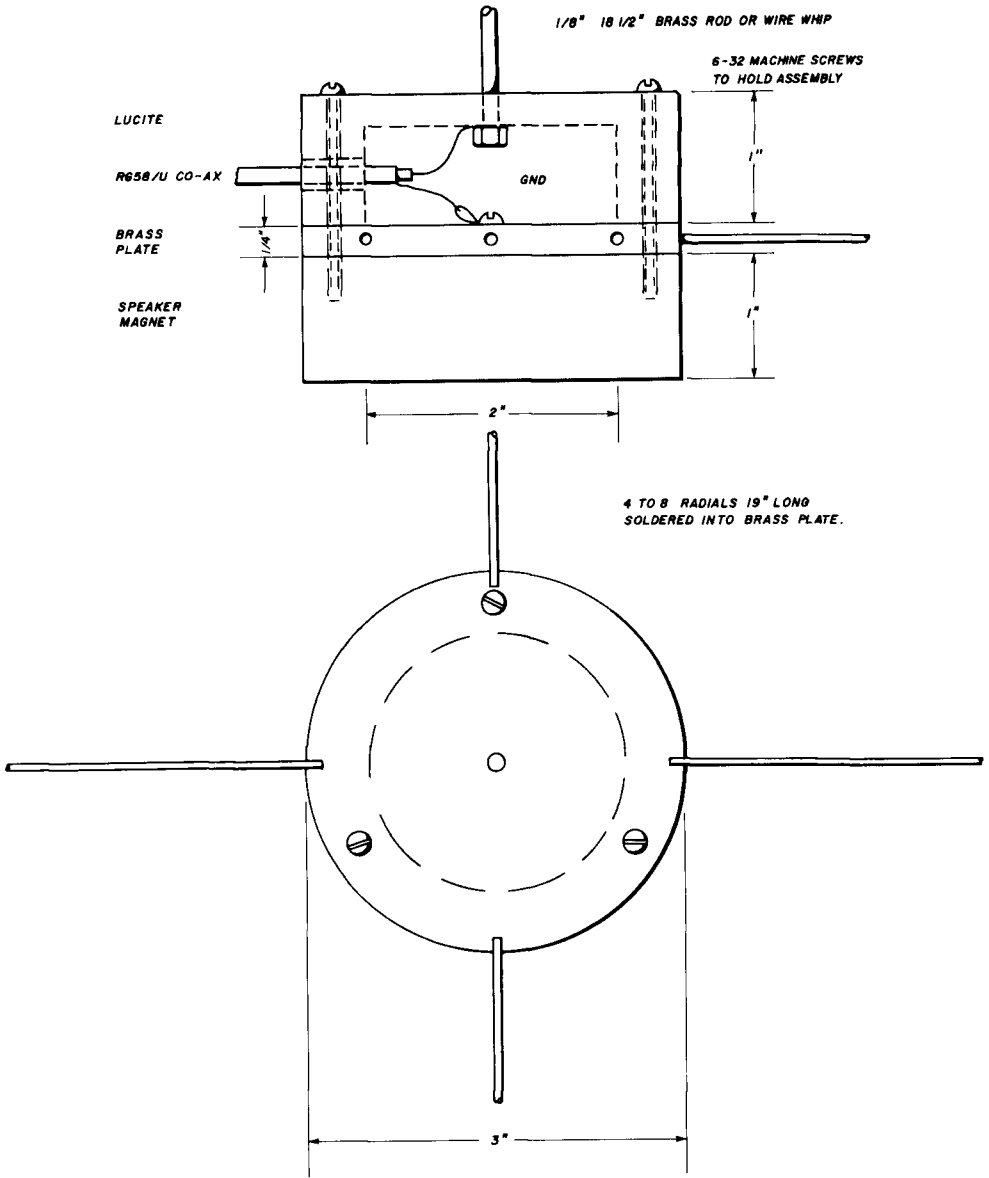
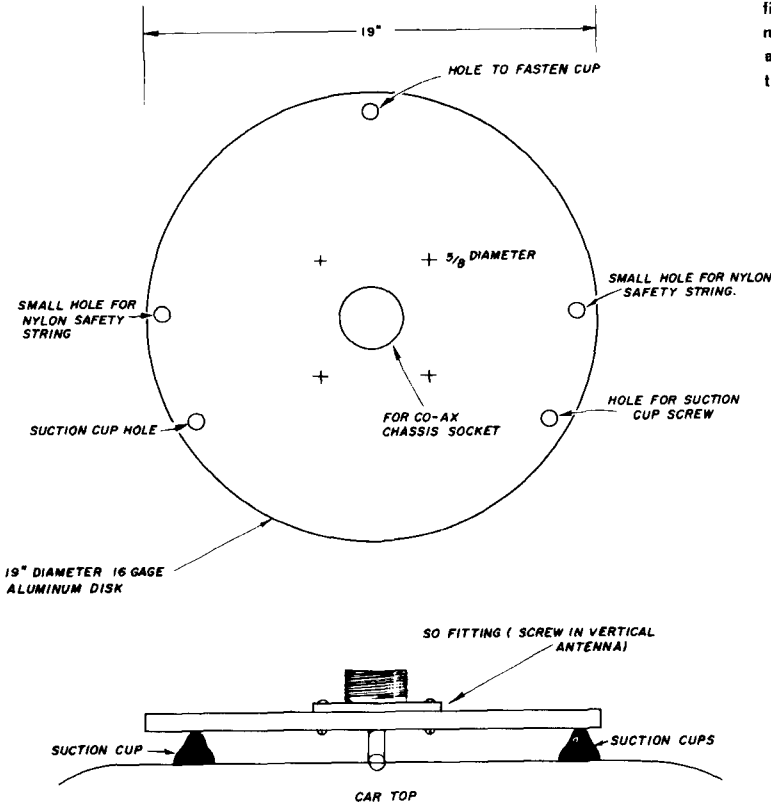


fig. 7. Holding a small 2-meter antenna on the car roof with a permanent magnet.

lead-in cable. This will cause the curved tube to swing into line with the lead-in, minimizing strain at the junction of the tube and cable. Tighten the ferrule using a 3/4" open-end wrench. Be careful. Don't tighten the ferrule too much—the antenna insulator will crack or break. Now put the ferrule cover in place.

9. If it has been necessary to remove the window trim, route the electrician's tape from the trunk compartment to the place where the antenna cable sticks out and attach the antenna cable to the fishtape; pull the tape back into the trunk compartment and carefully pull all excess cable into the trunk compartment. Cut the cable to the shortest

fig. 8. Two-meter mobile ground-plane antenna using suction cup mounting.



practical length that will reach the coaxial connector on your transmitter.

### mobile antennas without holes

Now, how about the fellow who doesn't want to punch a hole in the car roof? Well, you can buy a commercial antenna such as the Hy-Gain mobile HH2BA with a HMBA mast, or you can build your own mobile antenna. If you build your own antenna, it can be fastened to the car roof with a permanent magnet or suction cups from the local auto parts store.

Fig. 7 shows another mobile ground-plane antenna. This one is held on the car roof with a magnet from an old loudspeaker. A brass plate three inches in diameter is screwed to this magnet. The ground radials are soldered to the brass plate; four to eight are enough.

Fig. 8 shows how an antenna can be constructed from an aluminum disk and held on the car roof with suction cups. The same vertical which is used for a portable station can be used for the vertical part of the antenna or you can use a 19" piece of #12 wire.

ham radio

## ■ short circuit

There is an error in the schematic diagram of the discrete-component power supply on page 31 of the March issue. The supply will not regulate when connected as shown. The base of the 2N3053 regulator should be connected to the collector of the right-hand

2N3641, the base of the 2N4037 regulator to the collector of the right-hand 2N3644, not between the 5.1k and 1k voltage-dividing resistors as shown. Thanks to W1OOP and W6GXN for bringing this to our attention.

Editor



## **Radio Society of Great Britain Publications**

The various handbooks and publications of the RSGB have been well known in amateur circles for many years and have an excellent world-wide reputation.

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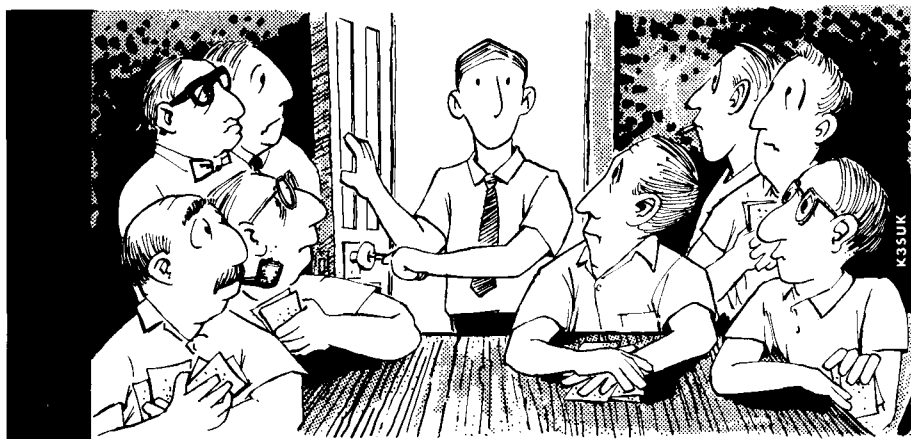
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## the secret society

What will  
you do when you  
confirm over  
300 DXCC  
countries?

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

Several months ago one of my very good amateur friends was passing through my section of the country. Since the welcome mat is always out, he didn't hesitate to stop by for a bit of Southern hospitality.

Jim works for an electronics firm and travels around the world, spending anywhere from a day to three months in any one place before he moves on. This brings him in touch with a great many amateurs, and he'll usually have an interesting story or two if I can get him going on the subject.

You all know how important DX has become in the last few years—DXpeditions, money for QSLs, pileups and publicity. When the DX fever hits, it's worse than the Asian flu! If there is a DX club in the area where Jim is staying, he gets in touch with some of the prominent members and attends a few meetings.

This story happened in Southern California. This makes everything very believable, because you know how things are out there as far as ham radio is concerned. One of the clubs Jim visited had some of the top DX'ers in the world. There were at least eight fellows who had confirmed over 300 countries. Naturally this had no small effect on their personality; their noses tilted a bit upward, among other things.

He was supposed to be in that part of the country for a few months, so the club loaned him a key to the club house so he could operate the station. One afternoon he managed to have a bit of free time, so he dropped by to see if 20 meters was open. He didn't expect to see anyone there, so he was a bit surprised to find the eight club members who had more than 300 countries. They weren't using the rig—just sitting around the meeting table. They stopped talking as soon as he came into the room.

Jim didn't give it much thought at the time, but about five days later, the same thing happened. The third time it happened he was sure that something was going on that he wasn't supposed to know about. They usually left as soon as he arrived, but on the third visit Jim found something on the floor—a QSL card. After a few minutes, when he finally realized what was going on, he had a good laugh.

The next week he found them all there and mentioned the QSL card. He was right, they did have something cooking among themselves. The card was from a commercial station in South America thanking one of the big DX'ers for his SWL report!

It seems that these fellows had just about worked every country in existence and just sat around the shack waiting for something to happen. One of them made a little one-tube superregenerative receiver and started to log foreign broadcast stations. Then he sent a report to them. He got more of a kick out of that SWL card than anything he had done in the past five years.

Before long, he and his select group of DX buddies were seeing who could get the most SWL cards using little one-tube receivers. Naturally, they couldn't let this get out or they'd be the laughing stock of the club. The little meetings they had were to compare their new SWL cards; Jim just happened to be there.

Jim and I can't tell you who these fellows are, and I'm sure they're not going to talk about it on 20 meters, but if you want a few laughs, the next time you work one of the big time DX'ers in W6-land, ask how Radio Peking is coming through these days!

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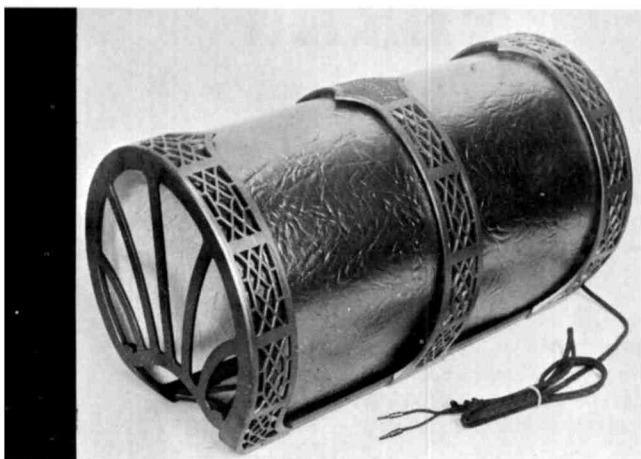
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## what is it?

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cold  
ham  
shacks

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

On November 3, 1925, Dr. Lee DeForest was granted a patent for a sound-reproducing device. At that time he was president of the Audalio Company, manufacturer of the speaker shown in the photograph. If you look closely, you'll see the name "Audalio" engraved on the center of the frame.

I got this speaker in a trade with a fellow member of the Antique Wireless Association who lives in Kentucky. He even threw in two bottles of "mountain tanglefoot" to boot! It's just as much a conversation piece as the speaker itself.

Since there are felt pads placed on the end and on the flat side, the speaker may be used in either the vertical or horizontal position. It is nineteen inches long, ten inches in diameter and uses a magnetic speaker unit. The coils were both open and I had to rewind them by hand. Most of the other parts of the speaker are made from white metal. Since it was 42 years old when I got it, you can imagine how much of the white metal was left in one piece. But, the best part of the whole project was, when all the repairs and replacements had been made, darned if it didn't work!

ham radio

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**RECEIVERS:** R-220/URR, R-388/URR, R-389/URR, R-390/URR, R-391/URR, R-392/URR, COLLINS 51J-3, 51J-4, URR-13, URR-27, URR-35, RAL.

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# new products

## EACO Lightning Arrestors



A novel ring gap is a feature of the new EACO Model 210 coaxial lightning arrestors. This type of gap is said to be self-correcting after a discharge of the type which would normally require replacement of point-type gaps. Zero insertion loss is claimed in a 50-ohm line, and the change in SWR cannot be measured at 150 MHz. The standard version has SO-239-type fittings, although other types are available. The Model 211 offers a loss-less electronic static circuit, but is limited to 50 watts of a-m power or 100 watts of ssb.

The Model 210 is priced at \$3.15 while the Model 211 is \$4.65. Available from the Electronic Applications Company, Route 46, Pine Brook, New Jersey 07058.

## DA Keyer



Omega Electronics has recently announced a new solid-state automatic keyer using integrated circuits, transistors and diodes, each where it will do the job best. It features "iambimatic" action (squeeze causes alternate dots and dashes), dot and dash memories, reliable long-life reed relay with heavy-duty 50-watt contacts and complete with built-in paddle. For maximum economy and low battery drain, milliwatt integrated circuits are used. Carbon batteries will last over fifty hours, or if preferred, the DA-3 option will provide operation from a 6.3-Vac supply.

The DA Keyer speed is continuously adjustable from six to sixty words per minute. The volume and tone controls for the built-in monitor are located on the rear panel. Jacks for an external paddle or straight key are also provided on the back. \$85 from the Omega Electronics Company, 10463 Roselle Street, San Diego, California 92121.

## Design Industries Operating Desk

A new entry from Design Industries will help to solve the ever-present problem of trying to keep an XYL and a ham radio station under the same roof. The Senator I and Senator II series of operating consoles have been designed to accommodate many of the popular receiver-transmitter and transceiver combinations. Room is also available for various



linear-amplifier combinations. If you have need for a custom-tailored installation, it can usually be worked into the *Senator*; the manufacturer will work with you to assure satisfaction.

Features include carpet rollers, an oil-dark walnut finish and removable front panel. The sides include storage and power-supply compartments and two letter-sized drawers. These consoles are designed so that when later equipment changes are made, it is only necessary to purchase a new front panel. The *Senator I* is \$295.00 and the *Senator II* is \$395.00 For further information write Design Industries, Inc., P. O. Box 19406, Dallas, Texas 75219.

## Raytrak AutoLevel



An interesting new volume compressor has recently been made available by the Raytrak Company. This device is compatible with ssb exciters in that it is not a clipping-type compressor. It uses a small incandescent lamp which is optically coupled to a photo-conductor (a light sensitive resistor) which regulates the output from the compressor. This approach allows a minimum of waveform distortion and insures a clean signal.

The *AutoLevel Volume Compressor* can provide up to 28-dB of compression. It is designed for use with either dynamic or crystal microphones and will operate on 115-volt ac power. Standard jacks are used and wiring permits push-to-talk operation through the unit. The price is \$87.50. The unit can be purchased from the Raytrak Company, 2111 Springhill Drive, Columbus, Ohio 43221.

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## comments

### Dear Jim:

I was going to write a book review type of article for the club paper; however, a good many copies of **ham radio** have found their way into the hands of our members. I haven't heard anyone knock it yet! This changed my mind about writing a review. Jim, if you can introduce a new publication into the ham-radio field and not have it lacerated, you and yours have a very bright future.

Most of your readers will admire the makeup and technical excellence of the magazine without realizing the endless thought and effort that went into your mid-wifery.

The content of the first issue is beyond reproach; you've set high standards for the future. Of almost equal importance however is the technical excellence of the magazine's production. One seldom sees better typography or printing. Your choice of a gothic type face is commendable and is especially appreciated by bi-focal wearers. Lastly, the schematics, technical drawings and cuts are beautifully sharp and crisp.

Congratulations, Jim, to you and your associates at **ham radio**.

**Ed Howison, WA8AXB**  
Editor, **CARASCOPE**  
Columbus Amateur  
Radio Association

### Dear HR:

Just received a copy of volume 1, number 1, and want to say how impressed I was—it has that fresh, clean look that's so hard to achieve in a new publication; and the layout, makeup and presentation are superb. Obviously, too, you are embarking upon a fresh, new approach to ham radio which has been needed for some time, and a standard of writing which should attract some competent professionals.

By the way, I would appreciate it if you could tell me just what type faces you use for the text and heads—I am an amateur printer as well as a radio ham. They are wonderfully modern and easy to read.

**Don Holm, W7PFL**  
Outdoor Editor,  
The Oregonian

*The text is set in 8-point Optima; the captions in 6-point Akzidenz Grotesk; and the heads, 14, 18- and 24-point Standard.*

### Dear HR:

Ham radio has a very refreshing and needed approach—a good technical magazine. Best of luck. . .

**H. W. Brown, W2OQN**

### Dear HR:

. . . Your approach to modern equipment is excellent. I have never understood ssb at all til I read the first issue and the excellent article on ssb theory.

**William E. Harris, W5TVN**

Dear HR:

If the next 12 issues are as interesting and refreshing as your first, you will be making a most creditable contribution to the published word on amateur radio state of the art...

John R. Esterly, W8RAK

Dear HR:

Congratulations! Your first issue is number one! Very fine articles, very well laid out, and very much needed. I hope that you will prosper in your labors and that the periods of difficulty will not weigh you down.

James R. Belt, Jr.

Dear HR:

...first issue looks great, keep up the good work.

George A. Wilson, Jr., W1OCP

Dear HR:

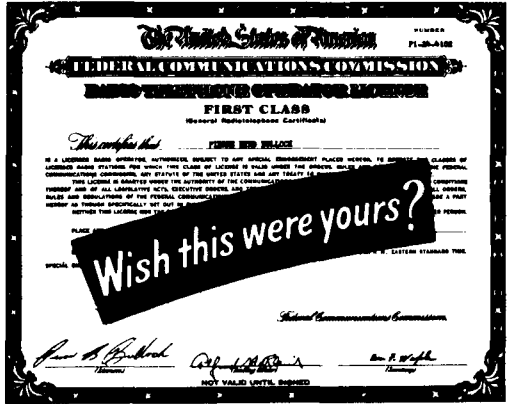
I just received your magazine in the mail today, and am writing this letter in haste. I am awaiting my General License and I am very anxious to "homebrew" my own ssb transmitter; in fact, all my gear. Mostly because I don't have the loot for an expensive appliance and because I would like to be able to say, "the rig here is homebrew," but unfortunately, I cannot find a reasonably presented article in any of the magazines on the market today—including yours. This is really frustrating. I guess I am going to give up looking.

When I saw the cover of your magazine I suddenly became excited when I saw the home-brew ssb exciter. The caption under the picture stated, "complete construction details"...you state that no tuning or alignment instructions are given, wow!... You must present the article in kit form with available templates at a small charge and parts lists, "available parts of course," and also, large photographs and total presentation in easy-to-follow kit form...

Kenneth D. Brown, WNØRXK

If we were to publish the ssb-exciter article in kit-form style, it would require the entire issue of the magazine. Obviously, this is impractical.

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**Dear Jim,**

I wondered where you had wandered. The answer is wonderful. Thank you very much for the sample copy of **ham radio**. How thorough and explicit your articles are. I couldn't wait to write a check and forward it to you for a year's subscription. Best of luck and success.

**Gerald "Doc" Feinberg, W1TXL**

**Dear HR:**

Congrats on the first issue of the new magazine. It's a real gem. It has opened the door for the return of ham technology long since gone from the scene. Heaven help the competition!

My best wishes for all the success in the future.

**Robert W. Stankus, K2DX**

**Dear HR:**

Thank you for copy of **ham radio** volume 1, number 1. The format is fine and I like the editorial philosophy.

I happen to hold original issue of **QST** December, 1915 and several others of the first year's issues.

**W. A. F. Pyle, W3WR**

**Dear HR:**

We took a swift glance through the new magazine and had to send you a little note of encouragement.

Will you have anything about RTTY? I am very interested in obtaining a printing model that can also be used to transmit. Any info concerning this phase of amateur radio would be greatly appreciated.

The sideband rig looks very interesting.

**Danel P. Keech, K1FKX**

*How about it RTTY authors? Let's have some good RTTY articles—my cupboard is bare!*

**Dear HR:**

Congratulations. The first issue is a real winner. Very glad to see you did not continue any of the articles on back pages. . .

**Tom Lamb, K8ERV**



Hello there. My name is Romey and I'm here to give you a preview of **STELLAR'S Suitcase Station**. It's just in the experimental stage now, but if you hams want it and will tell me what features you'd like in it, we plan to make it available as a package at a later date. If you send me your ideas, I'll see that you get a merchandise certificate for each one we use. Write me at Department H for further information. 73 es 88.



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**Dear HR:**

... I am most impressed with your first issue—the content is very good, but the type style and layout of the magazine is far superior to any other publication in the amateur-radio field—and, to most professional journals, I might add.

**Douglas E. Westover, K6TZX**

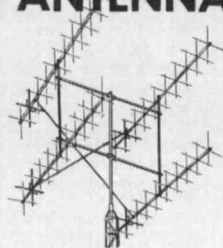
**Dear HR:**

Congratulations on the first issue of **ham radio**. Its format and layout are most attractive, the illustrations are of excellent quality and the printing is top grade. The contents are sufficiently diversified to provide something of interest to almost everyone. I have spent many years in the photographic illustration and advertising field, and I am sure that you are justifiably proud of your first issue. If the editorial policies of **ham radio** maintain the same high standards as its physical appearance, I believe its success is assured.

**W. G. Blankenship, Jr., WA4GNW**

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Write San Antonio Radio Club, 100 N. Winston Lane, San Antonio, Texas, 78213. (Include type of accommodations desired.)

See January and March QST for additional information.



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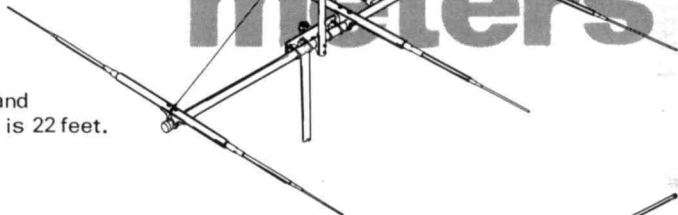


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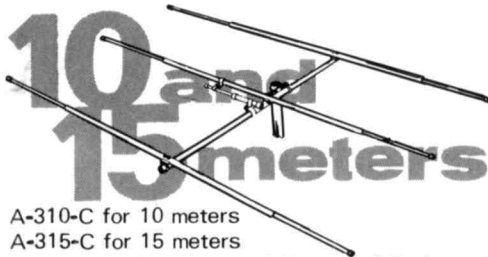
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