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60c ■ AUG. 1967

Radio-Electronics

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HUGO GERNSBACK, Editor-in-chief

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COMMUNICATIONS

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Receiver Project

CB
Troubleshooter's
Casebook

Checking CB Frequency

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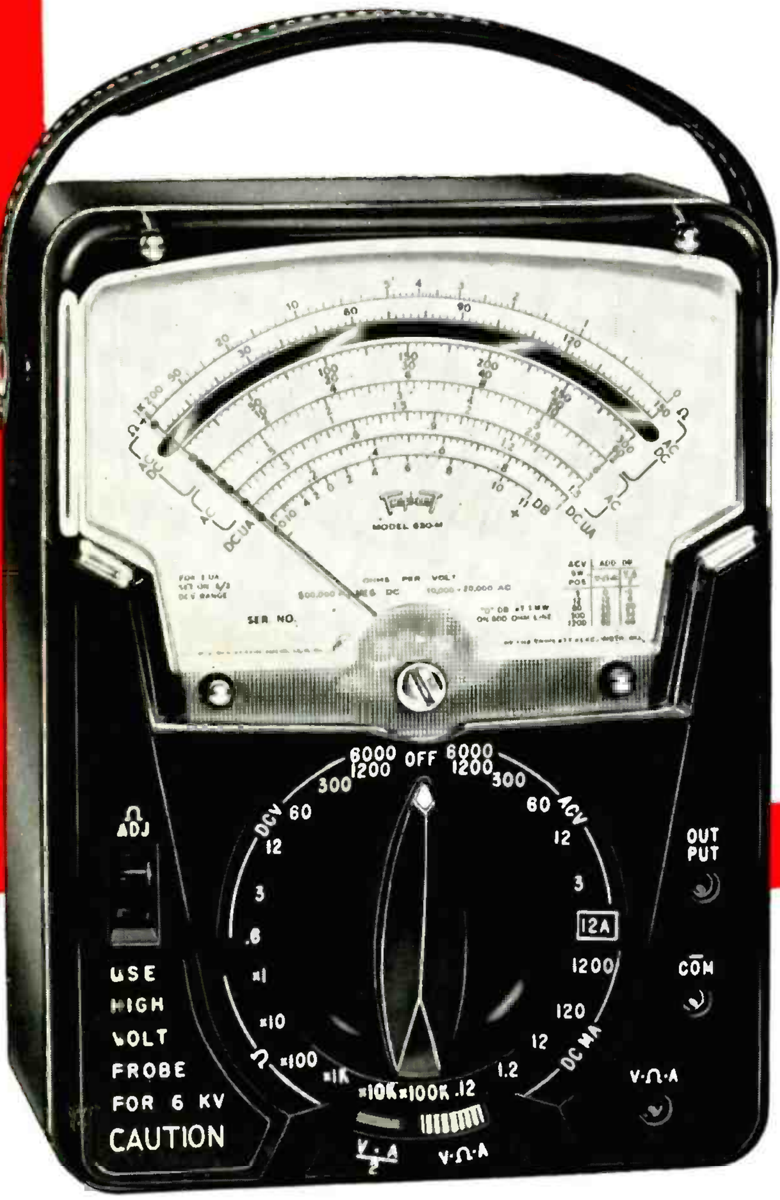

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EDITORIAL

FCC, CB and the Public

Recently, the Federal Communications Commission proposed basic changes in the Citizens band. It appears to me that these proposals (which were reported in our News Briefs column in the June and July 1967 issues) make sense. They seem a continuation of the Commission's efforts to clean up the CB mess.

Unfortunately, the FCC apparently doesn't have the resources to police CB effectively. Anyone who listens to the 27-MHz channels for even a short time can hear the attitude of many CB licensees; there is little fear of being caught violating FCC rules, so there are many violations.

Until a few years ago, it was difficult for the Commission to keep broadcast stations within the rules. Why? All the FCC could do to a radio or TV station was revoke its license. It was like having only one penalty for speeding—a life sentence. How often would such a penalty be used?

Congress recently gave the FCC a system of fines which could be levied against broadcasters. For a minor technical violation, the penalty might be $50. For a prolonged and serious breach, it might be $5,000. What's important is that the Commission was given the tools with which to work.

Now the time has come for Congress to give the FCC the money to hire more personnel. If the rules are to be enforced, this can be done only by additional inspectors, monitors, and field engineers. With the present FCC budget, rule enforcement is spotty and CB licensees know it. They know the Commission must police *all* radio services—from broadcasting to taxicab radio, from satellites to ship-to-shore.

Ideally, we are all good citizens who obey the law—and the FCC rules. Realistically, there are always those few inconsiderate individuals who blindly or deliberately violate the law—and FCC rules. The more they are allowed to get away with it, the more tempted we all are to cheat just a little. Eventually the whole thing gets out of hand, and you have a mess—like CB today. Laxity in rule enforcement doesn't do anyone any good.

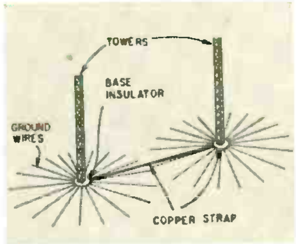
When Congress enacted the Communications Act and created the FCC, public service was the keynote. To allow the greatest public service on the Citizens band, the FCC must be able to enforce the rules adequately. The FCC needs more people; it needs more money to hire those people. Only Congress can appropriate that money. I think it should.

—Thomas R. Haskett

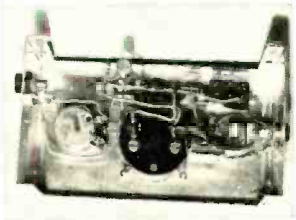
Radio-Electronics

August 1967 VOL. XXXVIII No. 8
Over 55 Years of Electronics Publishing

p 38—SIGNAL SLICER

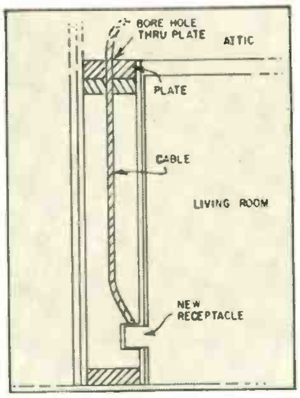


p 47—NO-TURN ANTENNA



p 60—MEASURE RF

p 54—MIX YOUR MIKES



p 42—CABLE THE HOUSE

p 67—TECHNICIAN'S LUCK

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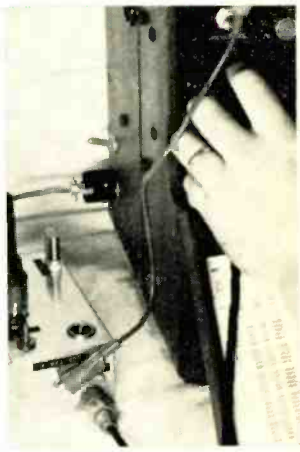
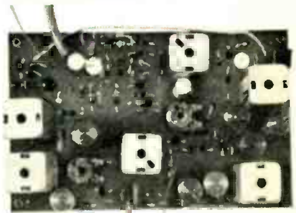


p 50—CB transmitters must be frequency-checked from time to time. This construction project lets you use a surplus BC-221 with increased accuracy for 27-MHz transmitter testing.

ADD STEREO



p 32—Got a mono FM tuner? Want wall-to-wall sound? Make this adapter and relax in two-channel bliss.

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NEWS BRIEFS

MONO DISC TO FADE

For several years—since the introduction of the stereo LP—most music has been available in both mono and stereo recordings. A nuisance to manufacturers, the dual-release practice may be on the verge of extinction.

EMI, the giant British-based producer of electronics and records, announced this summer that they were discontinuing the production of mono classical LP's (in favor of stereo only). Three American firms—Columbia, Mercury and RCA—are in the process of eliminating the price differential between stereo and mono versions of their recordings.

If and when mono records are eliminated, it would seem wise to produce all phonographs with stereo cartridges. Thus stereo discs could be played by everyone, even though in some cases both channels might be paralleled through a single amplifier.

NONINDUCTIVE TUNING

Integrated circuits have made possible microminiaturization of electronics circuits. But LC tuning networks are still physically bulky. One new method of achieving resonance was discovered recently by Westinghouse Molecular Electronics Div. It's a tiny transistor that can be voltage-tuned to resonance.

The solid-state device is made with a cantilever gate electrode over an MOS transistor. The lever is fine-tuned by a polarizing voltage. Input signals must be of the proper frequency to get through the device, which is essentially a tiny bandpass filter. It is currently being made in the 3- to 100-kHz range.

LASERS AND MEDICINE

A blind person may soon be able to use the purest kind of light to help him find his way. Scientists at RCA Laboratories in Princeton, N.J., have constructed a cane with two semiconductor lasers which locate obstacles in the user's path. The laser beams are reflected from points ahead of the sightless person, as shown in the photo. Upon bounceback, the beams activate photoelectric cells which trigger into vibration two pins in the cane handle.

An intervening object interrupts the laser beams, stopping the vibrations. The blind person can literally "feel" his way.

Cane developer William J. Hannan says that the infrared injection laser beams are produced by gallium arsenide diodes. Each diode is pulsed 20 times a second, 80 nsec at a time. The cane is still developmental and has limited usefulness at present.

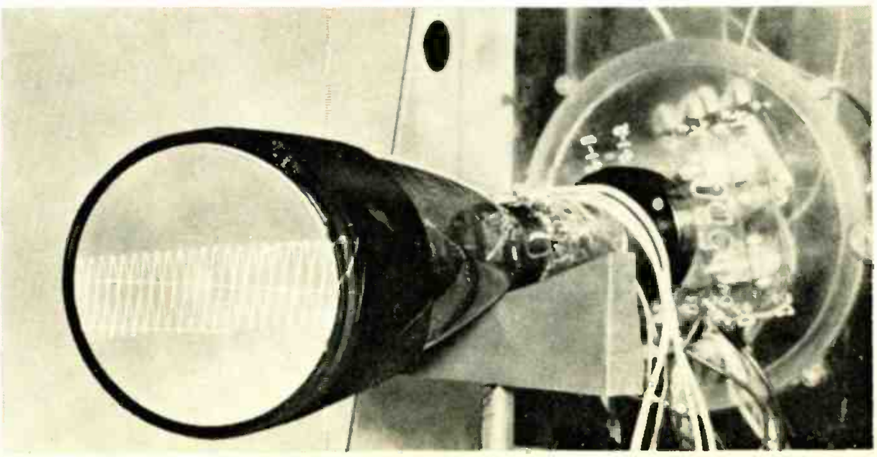
Meanwhile, a number of authorities are calling for stricter safety around lasers. It has been known for some time that even split-second exposure to a laser beam can cause blinding and permanent burns of the retina. Recent laboratory experiments have proved that lasers can produce fatal hemorrhages in the brains of mice. Currently several states, the Defense Department and the US Public Health Service are investigating hazards that may threaten workers using lasers.

TV DEVELOPMENTS

During May and June new developments in TV popped up all over the place.

Solid-state color: Modular semiconductor color receiver is now on the market. The set—produced by Motorola—has a 23-inch (viewable diagonal) CRT, IC's, and only two vaccum tubes—the kinescope and the HV rectifier. Circuit consists of 10 plug-in modules, each carrying one-year warranty. Out of warranty, modules will be replaceable for $15 each. Meanwhile Sony Corp. has demonstrated a prototype model of a personal color receiver with a 7-inch (viewable diagonal) screen. CRT is a three-gun Chromatron and is the only vacuum tube in the chassis. The 18-lb set is expected on the market in 1968. (Speaking of the Chromatron, a single-gun version has been successfully adapted by engineers in France for use with that country's SECAM color-TV system.)

The $50 TV: Will we have a video version of the standard ac-dc table radio? Maybe—now that General Electric has developed a receiving tube kit and basic circuit for a 12-inch (viewable diagonal) receiver. Kit consists of 4 Compactrons and 1 miniature tube which perform all functions except



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those of the tuner. Circuitry has been reduced to the bare minimum, using single-tube oscillators and a high-gain, single video i.f. amplifier.

One gun, two colors: A new CRT is made with two phosphor layers on the screen, separated by a barrier layer. By switching the final anode voltage, the beam can excite either phosphor, displaying either or both of two colors. Sylvania engineers devised the new tube for commercial, industrial and military applications—anywhere simultaneous display of two different data is desired.

Small-screen US color: It's not in receivers yet, but RCA has begun production of a new rectangular, rare-earth phosphor picture tube measuring 14 inches (viewable diagonal). Such a medium-sized CRT makes possible easily portable color receivers.

Tiny black-and-white: By using a 1-inch CRT and an integrated circuit, Sony has developed a prototype 2-lb personal TV. Set is not yet available.

One-man TV station: The man in the photo is taking a video picture, transmitting it to a nearby mobile truck via the transmitter on his back, and receiving instructions through another rf

channel. He can leave the camera and it may be operated by rf remote control from the truck. Portable camera/transmitter (which weighs 54 lbs) was produced by CBS Laboratories.

X-ray TV callbacks: The high-voltage supply in a television receiver can produce X-rays; unless certain precautions are taken by the manufacturer, such X-rays may cause harm to viewers. These precautions are designed into the chassis in almost every case. In May, however, G-E's quality control section found that some of their large-screen receivers were emitting soft X-rays slightly above the acceptable limit. The company then began a call-back program (at their expense) to replace the HV regulator and readjust the power supply. G-E emphasized that radiation level, while above the acceptable limit, was *not* high enough to harm viewers. Furthermore, the rays were emitted towards the floor, not towards the viewers. Receivers were also checked by Consumers Union (the independent research and testing organization which publishes *Consumer Reports*). Their findings confirmed G-E's, that radiation was not at a harmful level.

$500 home color recorder: It may be feasible within a couple of years, and is made possible by the development of a different type of tape transport. Newell Associates has worked out a different system of tape handling which removes tension and makes high speed possible without danger of breakage. This means fixed heads, high tape speeds, video bandwidth, and ultimately a less complicated machine.

Microwave/video pictures for pilots: No, they don't watch old movies while flying the airliner. System—called Microvision—uses microwaves to scan a runway and deliver a picture to a TV screen in the cockpit. Thus pilots can land even in thick fogs. New all-weather landing system was developed by Bendix and is now undergoing flight tests.

Image enhancer: Space-relayed TV pictures are often fuzzy, so CBS Laboratories devised a way to sharpen images. Ultrasonic delay lines in the equipment retain video information long enough for each point to be compared with surrounding points. Contrast is then emphasized and noise information eliminated. Using this technique, networks and stations can now clean up noisy pictures.

Multiplex TV with printed copy: An experimental system is currently under test by RCA which would transmit fixed-image information during the vertical blanking period. As in the facsimile method, RCA's system would scan print or pictorial matter at the transmitting station. At the home re-

Radio-Electronics

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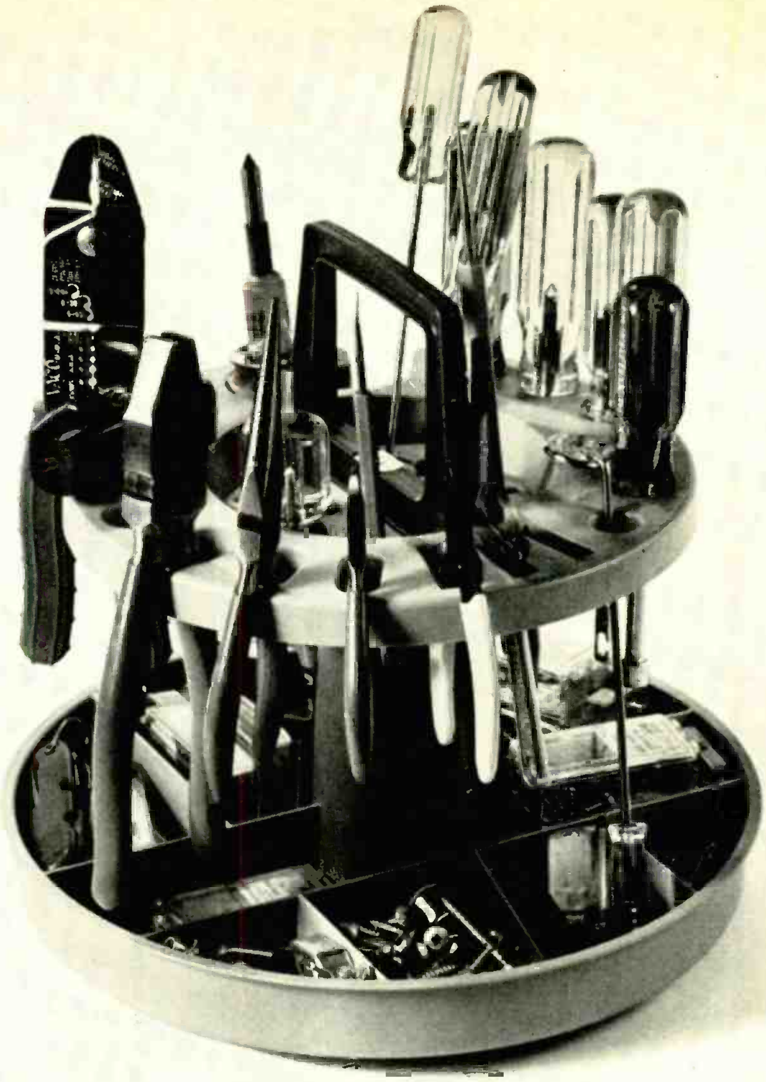

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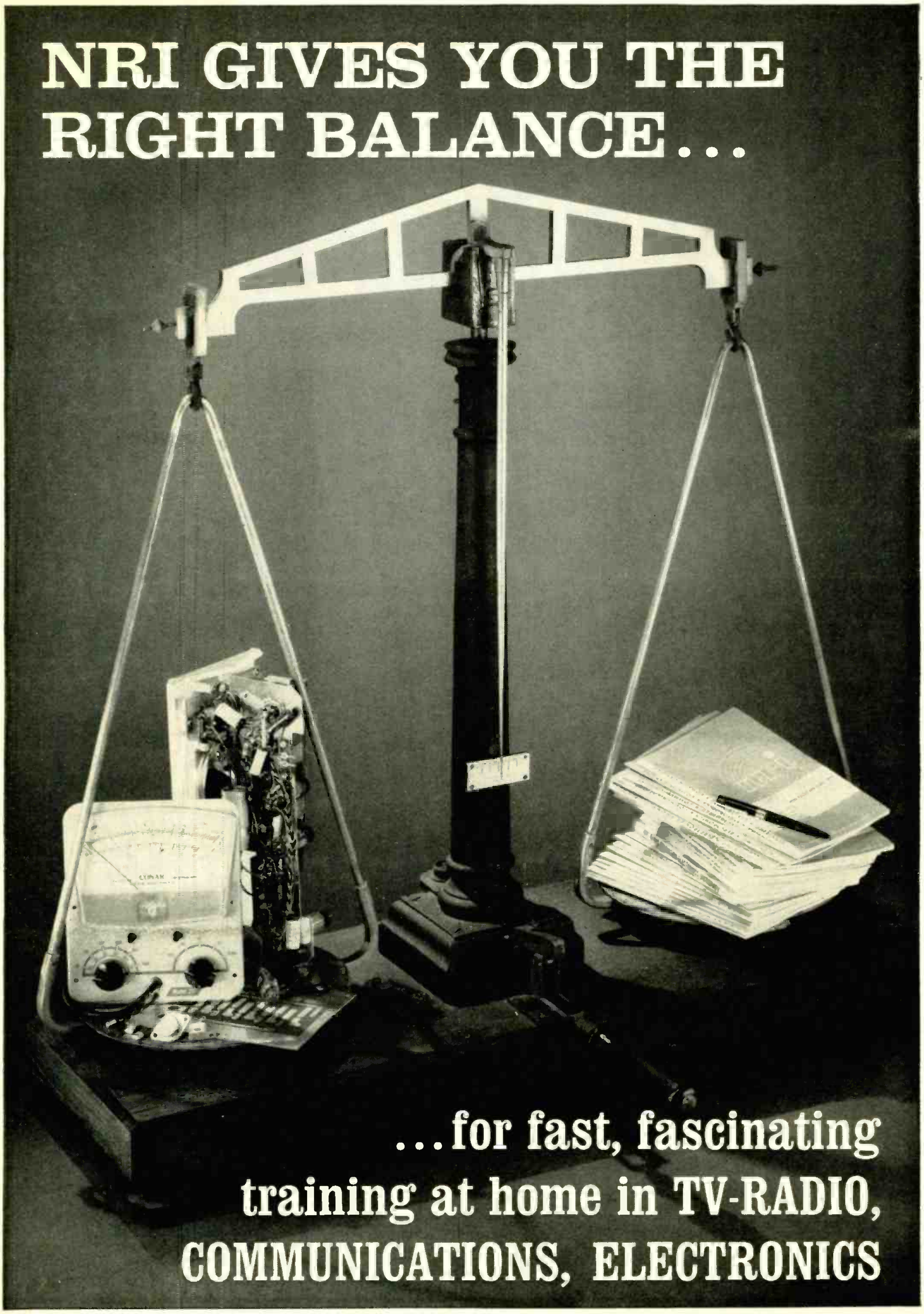
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L. V. Lynch, Louisville, Ky., was a factory worker with American Tobacco Co., now he's an Electronics Technician with the same firm. He says, "I don't see how the NRI way of teaching could be improved."

G. L. Roberts, Champaign, Ill., is Senior Technician at the U. of Illinois Coordinated Science Laboratory. In two years he received five pay raises. Says Roberts, "I attribute my present position to NRI training."

Ronald L. Ritter of Eatontown, N.J., received a promotion before even finishing the NRI Communications course, after scoring one of the highest grades in Army proficiency tests. He works with the U. S. Army Electronics Lab, Ft. Monmouth, N.J. "Through NRI, I know I can handle a job of responsibility."

Don House, Lubbock, Tex., went into his own Servicing business six months after completing NRI training. This former clothes salesman just bought a new house and reports, "I look forward to making twice as much money as I would have in my former work."

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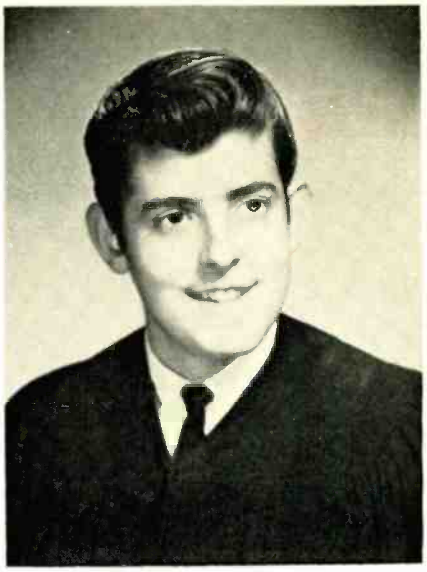
NEWS BRIEFS continued

ceiver, an adapter would produce a printed copy (see photo) utilizing an electrostatic printing process currently used by office copying machines. RCA has applied to the FCC for permission to conduct an on-the-air test in New York City.

GERNSBACK SCHOLARSHIP AWARDED

The 1967–68 Hugo Gernsback Scholarship awarded annually to a New York University student was won this year by William Conis. The $1,000 grant is presented to a student chosen by NYU's College of Engineering faculty.

Conis is a Manhattan native who says he ". . . spoke only Greek till the age of six since no one at home could speak English." He completed high school in three years and was named valedictorian of his senior class. At NYU he chose to major in electrical engineering and was tapped for Eta Kappa Nu (the electrical engineering honor society). Currently vice president



of the campus chapter of IEEE, Conis has been on the Dean's Honor List since he enrolled at NYU. Upon graduation in 1968, he hopes to specialize in solid-state or communications work.

20-YEAR BATTERY

The massive power blackout of November 1965, which paralyzed New York City and many nearby areas, taught one lesson: Everyone should keep flashlights and battery-operated radios on hand for such emergencies. Because batteries eventually deteriorate—even when unused, you may not be quite sure those standby cells have any life left in them.

The 1.5-volt alkaline cell shown in the photo has been designed to last 20 years if not used. Developed by Mallory and designated a "reserve" battery, the cell will be furnished to the user in a standby condition. When you need to use it, you turn the top cap, releasing liquid electrolyte and activating the cell. Not yet on the market, the battery will initially be made in D-size, and will be priced slightly higher than regular alkaline cells. END

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Correspondence

EDITORIALS DRAW COMMENTS

Dear Editor:

Your April editorial "The Hands That Feed ETV" deserves complimentary comment.

Two points especially: Concerning sets which do not function without the skilled hands and knowledge of the electronic technician, dead electronic equipment can be embalmed for all time.

The second concerns the so-called "exposes." If those who guide the programs of ETV would look into other fields of business—not overlooking the professions—they could find dishonesty that would make the TV man a pygmy by comparison.

Your closing thought about the "bitten hand" is apt; what is more to the point, yet, is the mutilated spirit and morale of those dedicated men whose characters are blackened, and which requires a long time to heal. I have winced more than once when a customer makes a crack about the repairman, and I wonder how bright his own halo might be.

HOWARD WOLFSON
Secretary, ARTS, Illinois, Inc.

Dear Editor:

I read your editorial in the April 1967 issue, where you mentioned a shortage of TV technicians. I would like to know where you and a few others get your information.

I am a journeyman TV technician. I have asthma and decided in January to find something where the climate was more agreeable. I was in five western states and found the same conditions in all. Right now I am thinking strongly of leaving the TV service field after 10 years experience because of what I have found every place I looked.

My first stop was in the San Francisco area. Union scale was $4.25 an hour but all I could find was outside service openings—not a single bench job in the area.

I found openings in almost every smaller town, but each required a 6-day week with wages ranging from $85 to $125. How can a man raise his family decently on that? Only a few places

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An important footnote: There is no time limit to our warranty! If an E-V microphone should fail, just send it to us. If there's even a hint that our workmanship or materials weren't up to par, the repair is no charge — even decades from now! Fair enough?

*Patent No. 3,115,207

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did I find a union and then with few members.

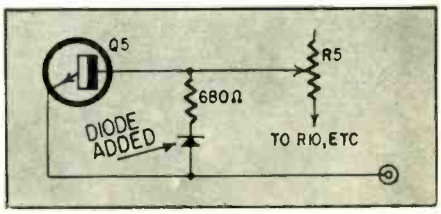
If there was a real shortage of technicians, conditions would be a lot better. As things stand now, I may let my First-Class Phone License expire and go into construction work.

S. GENE BENEFIELD
Tacoma, Wash.

REGULATED SUPPLY

Dear Editor:

I recently constructed the "All-Silicon Regulated Power Supply" from the June 1966 issue. To my chagrin, the initial "smoke test" ended with a burned-out 2N3053 (Q5). Careful checking of the wiring disclosed no error so I inserted another 2N3053. This time the supply performed well on "hi" range, but after a few minutes on "lo," Zap! went the 2N3053 again.



Some measurements and cerebral exercise showed that when the output control (R5) is adjusted for full output, the base–emitter of Q5 is reverse biased by an amount equal to the Zener voltage (D7) minus the IR drop across resistor R10. In the "lo" range position (with full output setting of R5), the drop across R10 is approximately 5 volts which places the base–emitter junction at 7 volts (reverse bias). The RCA data for the 2N3053 gives a maximum rating of 5 volts for reverse bias.

A simple remedy is to connect a silicon diode (similar to D6) and a 680 ohm, ½ watt resistor to the base–emitter of Q5 as shown.

ARTHUR G. BURNS
Tarrytown, N. Y.

SIMPLE SHUTTLE

Dear Editor:

I'm writing in regard to the article "Simple Winding Aid for Toroids" (March 1967, page 81). Rather than go to all the trouble of making one, it is much easier to use a double-end open-end wrench. They come in all sizes and most hobbyists and professionals have them in their tool kits.

H. MORRILL
Phoenix, Ariz.

END

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In the Shop . . . With Jack

By JACK DARR

> This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.
>
> If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

Judging from letters in my mailbag, some people have trouble getting normal range out of their CB transmitters. With a 5-watt rig, range isn't much, and proper setup and adjustment are very important.

A common problem is downward modulation. Normally, the rf amplitude should *increase* with modulation; if it goes down, you've got troubles—also far less transmitting range.

How to tell whether it goes up or down?

Here's a simple but effective way to measure the amplitude of the transmitted rf signal (Fig. 1). All you need is a pickup rod a few feet long, a general-purpose diode, and a meter. You can use a vom or vtvm, or even a 0–1-mA meter. The pickup rod must be 8 or 10 feet from the CB antenna, and don't let anybody stand between the two. This system will give you good coupling, and when you turn on the transmitter without saying anything, you'll read the value of rf being radiated.

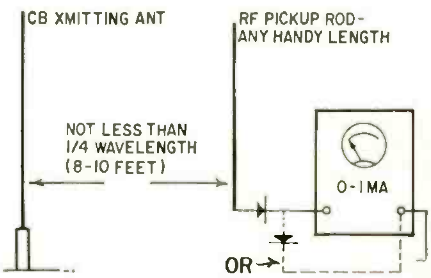

Fig. 1—How to measure the rf signal.

Now, when you modulate this rf energy, you *add power*. In an AM transmitter, about half the output power is in the modulation. Fig. 2 shows how this works with signal voltages as you'd see it if you put a scope on the antenna. The 50-volt audio signal adds to the 50-volt rf, for a total of 100 volts peak. This is voltage; because $P = E^2/R$, the power increase is 22% with 100% modulation.

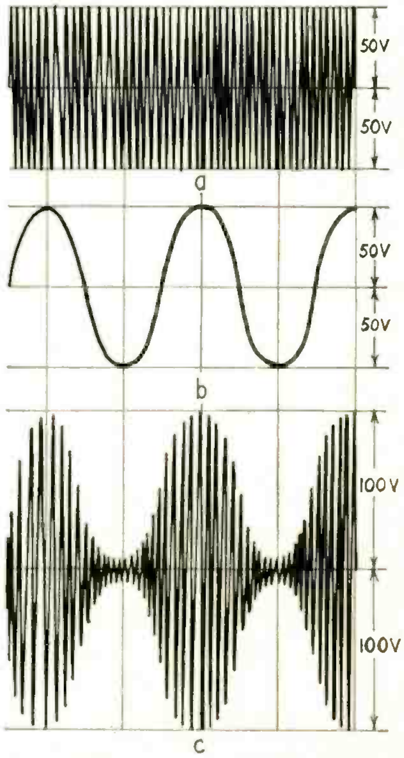

Fig. 2—Unmodulated rf (a) adds with audio (b) to produce modulated rf (c).

In the CB transmitter the audio circuit consists of the mike, voltage amplifier and modulator stage. It is usually capable of supplying 5 watts of audio power to the final, which is what's needed for full modulation.

What is there in the rf circuit? An oscillator feeds rf to the power output or final stage. This is followed (Fig. 3) by a tuned pi network for tuning and loading and a pi-network filter to keep the harmonics out of Uncle John's old TV set next door (we hope!). With 5 watts dc plate input and an efficiency of 70% at best, there is a *potential* 3.5-watt rf output. Can you actually *get* 3.5 watts of rf?

That depends on how well the final stage is tuned, on how well the antenna

continued on page 26

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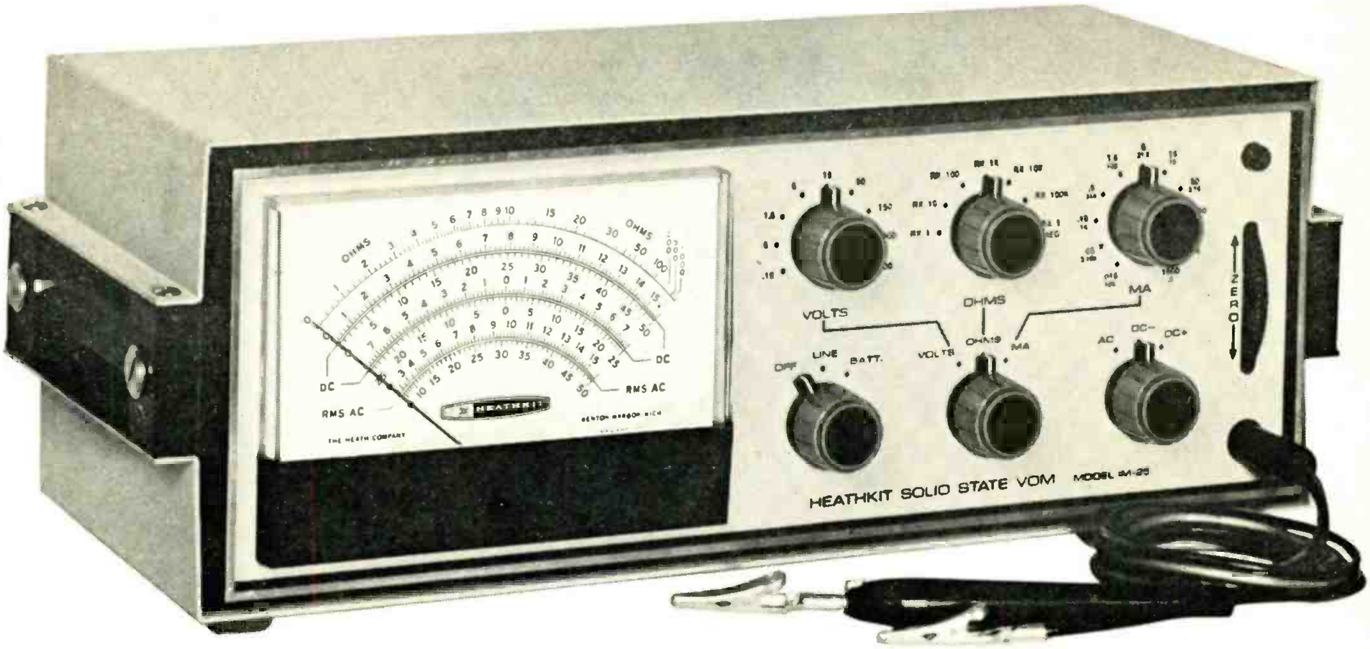

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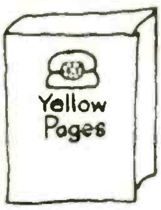

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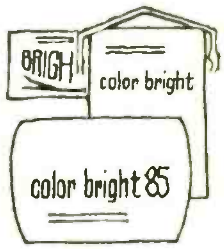

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and transmission line are matched to the rf output, *and* on how well the antenna was installed!

The output power of any amplifier stage depends on how well it is matched to the load. Check the antenna (load) and coax to make sure they are 50 ohms and properly coupled.

If everything is working normally, when you push the transmit button and whistle into the mike, you'll see the meter reading *increase* by about 25%. It makes no difference what the actual meter readings are, only what percentage of increase there is.

Suppose the reading drops—say from 1 to about 0.75. Trouble! This is downward modulation, and it means that you are *losing* power instead of gaining it with modulation. A scope would show how power is being lost (Fig. 4).

What's happening? Audio is simply overpowering the weak rf output, and trying to drive it into negative output (which isn't too likely!). So, for certain parts of the cycle, there is no rf power output at all. This produces audio distortion in the received signal; the tone gets very squawky.

Downward modulation has to occur in the rf final stage. That's the *only* place the output can change. Output goes down if the antenna is mistuned or an incorrect load (antenna) is used. Since the audio modulation level can be considered as fixed, the only cure for downward modulation is get the rf level up to where it ought to be.

For most efficient power transfer (highest rf output) the antenna must be tuned and loaded correctly. You start by tuning the plate tank circuit to resonance (the TUNE adjustment in Fig. 3). You can use a field-strength meter and tune for maximum rf output; or you can hook a dc milliammeter into the plate current. The peak on the FS meter and the dip in plate current should be *at the same* setting of TUNE. That's the first step.

Now, with maximum rf current circulating in the plate tank coil, you need to get it to the antenna with the

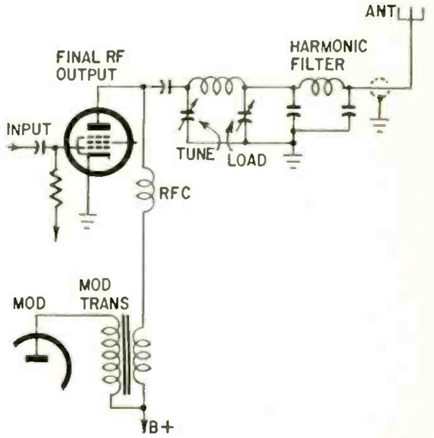


Fig. 3—You'll almost always find the cause of downward modulation in this circuit.

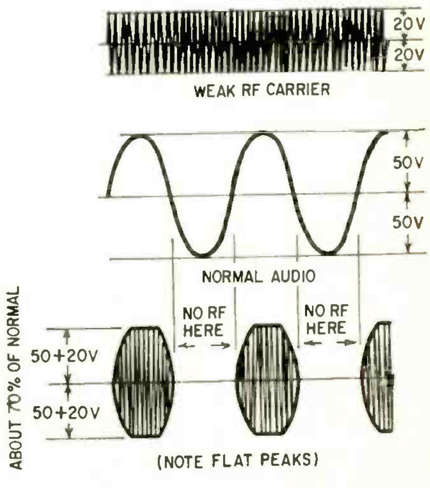


Fig. 4—A weak rf carrier swamped by audio produces downward modulation.

least loss; this is what the LOAD adjustment is for. (Since the antenna inductance and capacitance are fixed, you have to adjust the *transmitter* circuits to match the antenna.) Once again, adjust for maximum reading on the field-strength meter, indicating increasing rf power output.

As you adjust LOAD, you'll see the plate-current reading rise from its "dipped" value. You're taking power out of the circuit, so you have to raise the current; power means current times voltage. As you increase loading, the plate dip will become shallower until at full output it may be barely visible. It must still *be there*, however, when the plate-tank tuning is varied.

If the plate tank is *not* at resonance, you'll have an out-of-phase condition, and lose rf power. The plate circuit will not deliver maximum rf power to the antenna, and you'll have improper modulation.

If you want to see these patterns, or use a scope for tuning-up adjustments or modulation tests, be sure to feed rf directly to the vertical plates of the scope CRT. Don't try to go through the vertical amplifiers of the scope. Even a "wideband" scope won't carry the 27-MHz rf signal very far! Since you won't be able to use the scope vertical gain control, you'll have to adjust image height by altering the length or spacing of the rf pickup.

If you follow this method of tuning up, and make darn sure the antenna *is* correctly installed, you'll get the maximum "talk-power" out of any CB transmitter. Not only does this insure maximum range, but it makes the signal far more readable by eliminating overmodulation distortion.

If you still have downward modulation, this indicates one or more of the following troubles:

1. Insufficient grid drive to the final amplifier. This can be caused by a detuned oscillator or buffer stage or a weak oscillator or buffer tube.

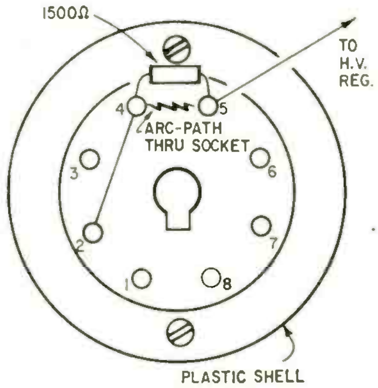
2. Insufficient grid bias on modulated stage. Check grid and cathode resistors for correct value.

3. High-impedance power supply. Check output filter capacitor. Replace with a larger value if necessary to eliminate the trouble.

Burned-up socket

The HV rectifier socket in this Zenith color chassis burned up, but I can't see why! I replaced it, and the set works fine. What happened?—P.M., Detroit, Mich.

The 1,500-ohm resistor in series with the HV lead opened. This resistor is tied across plus 4 and 5 on the socket;



so, the HV simply jumped this gap and kept on! In a little while, the heat caused by the arc burned the socket up. The diagram shows how it works.

Remote volume control in car

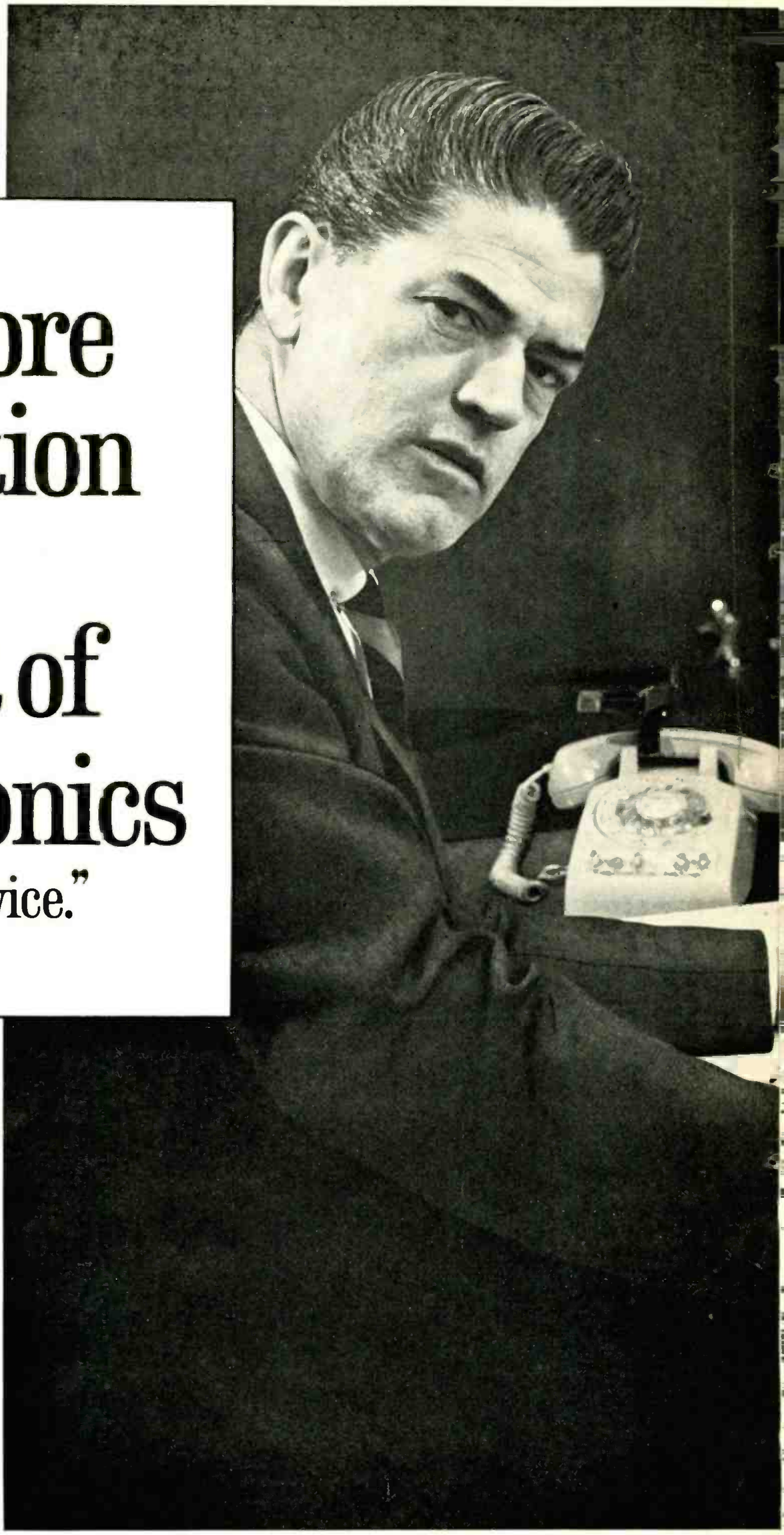
I've mounted my transistor car radio in the trunk; I have a remote-control gadget for tuning, but I'm having trouble working out a suitable remote volume control.—D. G., Montreal, Canada

Having a transistor output stage, you can't fool around with simple pot-type controls, for you'll get into trouble with output transistors. The best kind of remote control is an L-pad, of the same impedance as your speaker, whatever it happens to be.

In your set, it's a 3.2-ohm voice coil, which is unusual in transistor radios, but handy. You can get several kinds of L-pads in 4-ohm sizes. They are used with hi-fi systems, where they control the volume while maintaining a constant impedance across the audio line at all times. END

"Get more education or get out of electronics

...that's my advice."



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NAME________________ AGE______

ADDRESS________________

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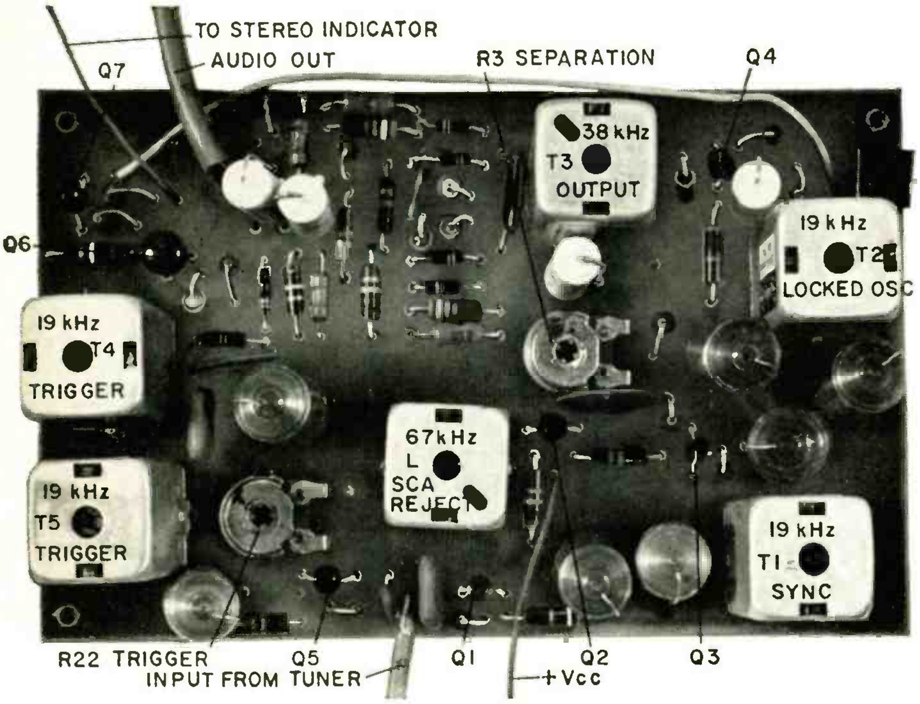
TYPE OF PRESENT WORK____________ ☐ G.I. BILL

I am interested in ☐ Electronic Engineering Technology
☐ Space Electronics ☐ Nuclear Engineering Technology
☐ Industrial Electronics for Automation
☐ Computer Systems Technology

APPROVED FOR TRAINING UNDER NEW G.I. BILL

A Modern FM Stereo Adapter



By KENNETH F. BUEGEL

THIS STEREO FM DEMODULATOR IS DEsigned around recent silicon planar transistors and uses high-stability polystyrene capacitors. It is compatible with any detector output level between 0.3 and 5 volts peak to peak. Separation on a properly constructed unit will exceed 30 dB from 50 Hz to 14 KHz, and 40 dB from 100 Hz to 10 KHz.

Many stereo listeners are puzzled when a good stereo adapter added to a previously satisfactory tuner fails to produce adequate separation. Often the trouble lies in unexpected areas. When you've been intelligent and careful in connecting the adapter to the tuner, and the antenna installation isn't faulty, what else could be wrong?

In almost every instance I have investigated, the problem was caused by restricted tuner bandwidth, which causes a distorted response in the 23–53-kHz subcarrier range. Many otherwise fine

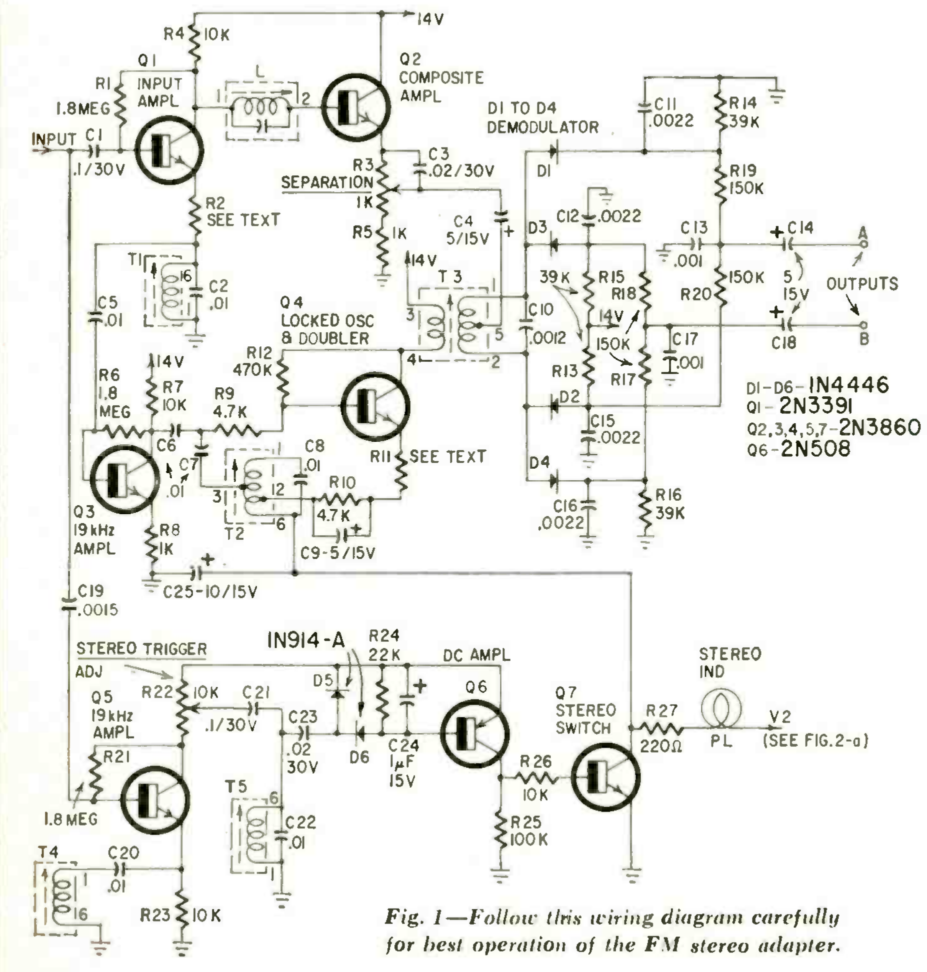


Fig. 1—Follow this wiring diagram carefully for best operation of the FM stereo adapter.

PARTS LIST

C1, C21—0.1 μF, 30V, ceramic
C2, C5, C6, C7, C8, C20, C22 — .01 μF, polystyrene
C3, C23—.02 μF, 30V, ceramic
C4, C9, C14, C18—5 μF, 15 V, electrolytic
C11, C12, C15, C16—.002 μF (Sprague 192P or equivalent)
C13, C17—.001 μF (Sprague 192P or equivalent)
C10—.0012 μF, polystyrene
C19—.0015 μF, disc ceramic
C24—1 μF, 15V, electrolytic
C25 — 10 μF, 15V, electrolytic
Capacitors specified as polystyrene are Mallory type SX, listed on p. 293 of Allied's catalog 260 (1967 general catalog)
Ceramic capacitors can be Sprague's low-voltage type, although higher-voltage capacitors are of course equally usable.
D1-D6—1N4446 (G-E) (1N914A is also usable)
Q1—2N3391 (G-E)
Q2, Q3, Q4, Q5, Q7—2N3860 (G-E)
Q6—2N508 (G-E)
PL—16-volt indicator lamp (15–20 mA) (Sylvania 16CSB—p. 316 of Allied catalog 260)
R1, R6, R21—1.8 megohm
R2, R11—see text
R3—trimmer resistor, 1,000 ohms (Mallory type MTC-4)
R4, R7, R23, R26—10K
R5, R8—1,000 ohms
R9, R10—4,700 ohms
R12—470K
R13, R14, R15, R16—39K, 5%
R17, R18, R19, R20—150K, 5%
R22—trimmer resistor, 10K (Mallory type MTC-4)
R24—22K
R25—100K
R27—220 ohms
All resistors ½ watt, 10% unless otherwise specified
T1, T2, T4, T5—19-kHz tank (J. W. Miller 1354-PC)
T3—38-kHz output transformer (J. W. Miller 1355-PC)
L—series bandpass filter (J. W. Miller 1352-PC)
For construction on chassis instead of etched circuit board, order Miller units without PC suffix

tuners may have this defect. It is possible to compensate for it.

This decoder incorporates just that kind of compensation. The schematic is in Fig. 1. Input stage Q1 has adjustable gain to match different tuner output levels. Because of heavy feedback the input impedance is high enough to allow direct connection to a vacuum-tube tuner without heavy loading. The value of R2 is selected during alignment.

L is the SCA (Subsidiary Communications Authorization) rejection filter, which, with the well-balanced output detectors, keeps SCA program matter inaudible. Emitter follower Q2 sends composite audio at low impedance to the center tap of T3, a 38-kHz doubler in the collector of Q4. The pilot signal developed across T1 is amplified by Q3 and synchronizes the 19-kHz locked oscillator, Q4.

Q5 selects and amplifies the 19-kHz pilot signal. R22 is the trigger adjustment, which sets the level of pilot signal required to switch the adapter to stereo reception. D5 and D6 charge C24 with rectified pilot signal until Q6, a dc amplifier, is forward-biased.

Q6 drives Q7 into saturation, which lights lamp PL and brings the lower end of T2 to ground potential. Under these conditions Q4 oscillates and T3 provides the switching signals to the output detectors. Diode pairs D1-D3 and D2–D4 will conduct alternately at the 38-kHz switching rate and channel left and right components of the signal applied to T3 centertap to correct outputs.

During monaural reception, when no pilot signal is present, Q7 will be cut off and its collector at supply potential. A slight reverse bias will prevent oscillation in Q4. There is now a path through D1, D2, R13, and R14; thus the monaural signal applied to the center tap of T3 appears at output A. A similar path exists for the same signal to appear at output B. The de-emphasis networks precede output jacks.

The decoder circuits draw about 8 mA from a 14-volt supply. PL's current is 20 mA from a slightly higher potential. If it is not convenient to draw this much current from an available source, the regulated supply shown in Fig. 2 will power the decoder.

When constructed on an etched circuit board, the complete decoder, including required bottom clearance, fits in a space 3¾ x 6 x 2 inches. Since the unit is extremely stable and won't need constant adjustment, it can be tucked away in an unused cabinet corner. If you decide on chassis construction, a recommended size is 7 by 9 inches. This provides room for the power supply, terminal strips, transistor sockets, etc. If you plan to build on a chassis instead of on a circuit board, be certain to order

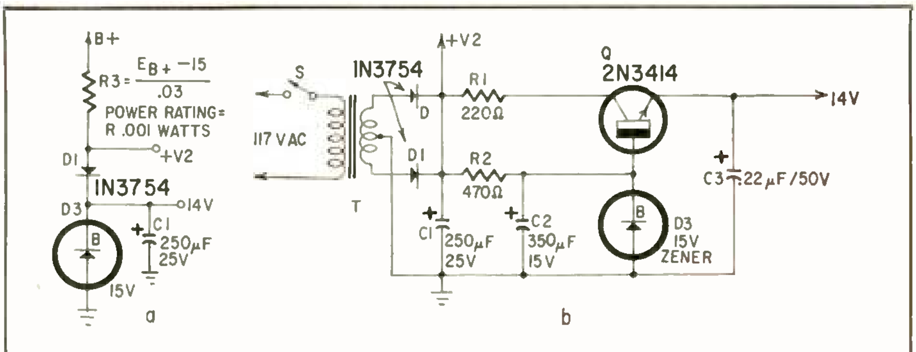


Fig. 2-a—Regulated power takeoff for using the demodulator with a tube-type tuner. b—If you don't wish to draw power from a tuner, this power supply will perform well.

Parts list for Fig. 2

C1—250 µF, 25V, electrolytic
C2—350 µF, 15V electrolytic
C3—0.22 µF, 50V, paper, Mylar or ceramic
D1, D2 — 1N3754 (RCA) or equivalent 100V silicon rectifier
D3 — Zener diode, 15V, ¾ or 1 watt (Motorola 1N4744, International Rectifier 1ZF15T10 or equivalent)
Q—2N3414 (G-E)
R1—220 ohms
R2—470 ohms
T—filament transformer, 117-volt primary, 26.5-volt ct secondary, 0.6 amp (Knight 54 A 1476, Triad F-40X or equivalent)

the transformers without the PC (printed circuit) suffix.

In mounting parts to the wiring board, first install the transformers, then R3, R22, all other resistors and capacitors (except R2 and R11), and finally the transistors and polystyrene capacitors.

The first step in alignment is to measure the multiplex output level of the tuner with an oscilloscope. Use the highest peak-to-peak reading as a reference. Use an input level, from an audio generator to the decoder, of 25% higher than this reference level. (Use any convenient frequency in the audio range.) Choose a value for R2 between 3.9K and 12K (larger input, larger value) which allows undistorted reproduction of the input signal as seen on a scope at the emitter of Q2.

Next insert a 67-kHz signal (this should be accurate) and tune L for *minimum* signal at Q2's emitter. Insert a 19-kHz signal at one-fourth reference level and tune T1 for *maximum* voltage across its winding. Reduce the input signal and tune T4 and T5, with R22 at maximum, for maximum voltage across R24. During tuning reduce the input level until the voltage across R24 starts to decrease; at this point the tuning effect is most pronounced.

Tack in a 470-ohm resistor for R11 and temporarily ground the collector of

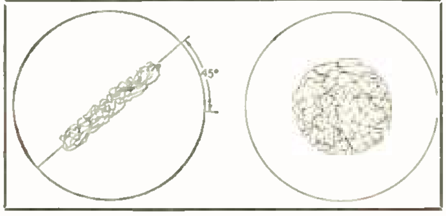


Fig. 3-a—Poor stereo separation; b—good separation; scope at adapter output.

Q7. Tune T3 for maximum amplitude of the 38-kHz waveform at Q4's collector. Then tune T2 until any jitter in the waveform disappears, indicating synchronization with the input signal. Continue to retune T1, T2, and T3, while reducing the input level, until the oscillator is synchronized with a 19-kHz input signal at least 26 dB (one-twentieth) below reference.

Select a value for R11 between 200 and 1,000 ohms that provides maximum undistorted 38-kHz output. Too low a value will give lower-amplitude switching voltages and reduced separation. Adjacent cycles of the switching waveform will not have identical height (this is normal) but should be within 20%.

If you have access to a stereo multiplex generator, remove the ground at Q7's collector and inject a composite signal at reference level. Set R22 to place Q7 in saturation and adjust R3 for maximum separation.

If such a generator is not available, you can run through the procedure just described with the decoder connected to a tuner receiving a stereo transmission. Connect a potentiometer (about 100K) to the tuner output to allow the input to the decoder to be reduced during alignment.

After preliminary adjustment remove the potentiometer from the circuit. Connect outputs A and B to the vertical and horizontal inputs of a scope. Tune to a station known to be transmitting a stereophonic broadcast. Adjust R22 until PL lights. The scope pattern will probably resemble Fig. 3-a. Adjust R3 until the scope display looks like Fig. 3-b. A slight touchup of T1 and resetting of R3 will result in best separation. If the separation seems poor, try another stereo station or broadcast. END

Stereo FM Stations

In the US and Canada the number of FM stations broadcasting in stereo continues to grow. More than 700 currently air two-channel programs at various times of the day. This list includes all known stations. Some may be heard in towns other than those shown.

ALABAMA

Albertville	WQSB-FM	105.1
Andalusia	WNBX	98.1
Birmingham	WCRT-FM	96.5
	WSFM	93.7
Dothan	WOOF-FM	99.7
Florence	WJOI-FM	107.3
Huntsville	WAHR	99.1
	WNDA	95.1
Mobile	WKRG-FM	99.9
	WLPR-FM	96.1
Monroeville	WMFC-FM	99.3
Montgomery	WAJM	103.3
	WFMI-FM	98.9
Muscle Shoals	WLAY-FM	105.5
Selma	WHBB-FM	100.1
Tuscaloosa	WACT-FM	105.5
	WTBC-FM	95.7

ALASKA

Anchorage	KAMU	102.1
	KNIK-FM	105.5

ARIZONA

Phoenix	KHEP-FM	101.5
	KMEO	96.9
	KNIX	102.5
	KOOL-FM	94.5
	KRFM	95.5
Tucson	KSOM	92.9

ARKANSAS

El Dorado	KELD-FM	103.1
	KRIL	99.3
Fayetteville	KNWA-FM	103.9
Fort Smith	KMAG	99.1
Hot Springs	KGUS-FM	97.5
Jonesboro	KBTM-FM	101.9
Little Rock	KARK-FM	103.7

CALIFORNIA

Alameda	KJAZ	92.7
Bakersfield	KGEE-FM	101.5
	KIFM	96.5
Berkeley	KPAT-FM	102.9
Carlsbad	KARL-FM	95.9
Coachella	KCHV-FM	93.7
Escondido	KOWN-FM	92.1
Fresno	KCIB	94.5
	KFRE-FM	93.7
	KXQR	102.7
Garden Grove	KTBT	94.3
Lodi	KCVR-FM	97.7
Long Beach	KNOB	97.9
Los Angeles	KBBI	107.5
	KBIG-FM	104.3
	KCBH	98.7
	KFAC-FM	92.3
	KFMU	97.1
	KFOX-FM	100.3
	KMET	94.7
	KPOL-FM	93.9
	KRHM	102.7
	KXLU	89.1
Los Banos	KLBS-FM	95.9
Los Gatos	KLGS	95.3
Marysville	KRFD	99.9
Monterey	KMBY-FM	96.9
Newport Beach	KOCM	103.1
Oceanside	KUDE-FM	102.1
Palm Springs	KDES-FM	104.7
Patterson	KOSO	93.1
Redondo Beach	KKOP	93.5
Riverside	KDUO	97.5
Sacramento	KCRA-FM	96.1
	KFBK-FM	92.5
	KHIQ	105.1
	KSFM	96.9
Salinas	KSBW-FM	102.5
San Diego	KBBW	102.9
	KFMX	96.5
	KGB-FM	101.5
	KLRO	94.9
	KPRI	106.5
San Fernando	KVFM	94.3
San Francisco	KABL-FM	98.1
	KBRG	105.3
	KFOG	104.5
	KGO-FM	103.7
	KKHI-FM	95.7
	KMPX	106.9
	KPEN	101.3
	KSFR	94.9
San Jose	KEEN-FM	100.3
	KSJO-FM	92.3
San Luis Obispo	KSBY-FM	93.3
San Rafael	KTIM-FM	100.9
Santa Ana	KWIZ-FM	96.7
Santa Barbara	KGUD-FM	99.9
	KMUZ	103.3
Santa Clara	KREP	105.7
Santa Maria	KXFM	99.1
Stockton	KUOP	91.3
Tracy	KSRT	100.9
Tulare	KDFR-FM	106.7
	KGEN-FM	94.9
Turlock	KOSO	93.1
Ventura	KUDU-FM	95.1
Visalia	KONG-FM	92.9
Walnut Creek	KDFM	92.1
Woodland	KATT	102.5

COLORADO

Boulder	KRNW	97.3
Colorado Springs	KPIK-FM	94.3
Denver	KFML-FM	98.5
	KLIR-FM	100.3
	KOSI-FM	101.1
	KTGM	105.1
Fort Collins	KFMF	93.3
Loveland	KLOV-FM	102.3
Manitou Springs	KCMS-FM	102.7

CONNECTICUT

Bridgeport	WJZZ	99.9
Brookfield	WGHF	95.1
Fairfield	WSHU	91.1
Hartford	WHCN	105.9
	WTIC-FM	96.5
Meriden	WBMI	95.7
New Haven	WNHC-FM	99.1
	WYBC-FM	94.3

DELAWARE

Wilmington	WDEL-FM	93.7
	WJBR	99.5

DISTRICT OF COLUMBIA

(Washington)	WASH	97.1
	WGAY	99.5
	WGMS-FM	103.5
	WMAL-FM	107.3

FLORIDA

Belle Glade	WSWN-FM	93.5
Boca Raton	WWOG	99.9
Bradenton	WBRD-FM	103.3
Clearwater	WTAN-FM	95.7
Cocoa	WEZY-FM	99.3
Cocoa Beach	WRKT-FM	104.1
	WXBR	101.1
Coral Gables	WVCG-FM	105.1
Crestview	WAAZ-FM	104.9
Daytona Beach	WNDB-FM	94.5
Fort Lauderdale	WFLM	105.9
	WMJR	100.7
Fort Myers	WINK-FM	96.9
Fort Walton Beach	WFTW-FM	99.3
Gainesville	WRUF-FM	103.7
Jacksonville	WIVY-FM	102.9
	WJAX-FM	95.1
	WKTZ-FM	96.1
	WQIK	99.1
Marianna	WTOT-FM	100.9
Miami	WGBS-FM	96.3
	WIOD-FM	97.3
	WWPB	101.5
Miami Beach	WAEZ	94.9
Milton	WXBM-FM	102.3
Orlando	WHOO-FM	96.5
Palm Beach	WWOS	97.9
Panama City	WMAI-FM	107.9
Pensacola	WPEX-FM	94.1
St. Augustine	WFOY-FM	97.7
St. Petersburg	WTCX	99.5
Sarasota	WSAF-FM	102.5
Stuart	WMCF	92.7
Tallahassee	WBGM	98.9
	WFSU-FM	91.5
Tampa	WFLA-FM	93.3
West Palm Beach	WPBF	107.9
Winter Haven	WXKL-FM	97.5

GEORGIA

Albany	WGPC-FM	104.5
	WJIZ	96.3
Americus	WDEC-FM	94.3
Athens	WGAU-FM	95.5
Atlanta	WKLS	96.1
	WLTA-FM	99.7
	WSB-FM	98.5
Carrollton	WBTR-FM	92.1
Columbus	WRBL-FM	102.9
Cornelia	WCON-FM	99.3
Gainesville	WDUN-FM	106.7
Griffin	WKEU-FM	97.7

La Grange	WLAG-FM	104.1
Milledgeville	WMVG-FM	102.3
Moultrie	WMTM-FM	93.9
Rome	WRGA-FM	102.3
	WROM-FM	97.7
Savannah	WTOC-FM	94.1
Valdosta	WGOV-FM	92.9

HAWAII

Honolulu	KAIM-FM	95.5
	KPOI-FM	97.5

IDAHO

Boise	KBOI-FM	97.9
Idaho Falls	KID-FM	96.1
Lewiston	KOZE-FM	96.7

ILLINOIS

Aurora	WMRO-FM	107.9
Bloomington	WJBC-FM	101.5
Champaign	WLRW	94.5
Charleston	WEIC-FM	92.1
Chicago	WEFM	99.5
	WFMT	98.7
	WKFM	103.5
	WLS-FM	94.7
	WMAQ-FM	101.1
	WSDM	97.9
	WXRT	93.1
Crete	WTAS	102.3
Decatur	WSOY-FM	102.9
East St. Louis	WMRY-FM	101.1
Elmwood Park	WXFM	105.9
Joliet	WJOL-FM	96.7
Loves Park	WLUV-FM	96.7
Mattoon	WLBH-FM	96.9
Peoria	WMBD-FM	92.5
Pittsfield	WBBA-FM	97.7
Quincy	WGEM-FM	105.1
	WTAD-FM	99.5
Rockford	WROK-FM	97.5
Rock Island	WHBF-FM	98.9
Springfield	WFMB	104.5
	WTAX-FM	103.7

INDIANA

Columbus	WCSI-FM	101.5
Evansville	WIKY-FM	104.1
Fort Wayne	WKJG-FM	97.3
	WPTH	95.1
Greenfield	WSMJ	99.5
Hartford City	WWHC	104.9
Indianapolis	WFMS	95.5
	WIFE-FM	107.9
Kendallville	WAWK-FM	93.3
Kokomo	WKMO	93.5
Lafayette	WASK-FM	105.3
Marion	WMRI-FM	106.9
Peru	WARU-FM	98.3
Plainfield	WJMK	98.3
Richmond	WKBV-FM	101.3
South Bend	WNDU-FM	92.9
	WSBT-FM	101.5
Terre Haute	WTHI-FM	99.9
	WVTS	100.7
Vincennes	WAOV-FM	96.7

IOWA

Ames	WOI-FM	90.1
Cedar Rapids	KHAK-FM	98.1
	WMT-FM	104.5
Des Moines	KDMI	97.3
	KWDM	93.3
Dubuque	KDTH-FM	105.3
Fort Dodge	KWMT-FM	94.5
Iowa City	KXIC-FM	100.7
Sioux City	KDVR	97.9
Waterloo	KXEL-FM	105.7

KANSAS

Dodge City	KGNO-FM	95.5
Emporia	KVOE-FM	104.9
Kansas City	KCJC	98.1
Lawrence	KANU	91.5
	KLWN-FM	105.9
Leavenworth	KCLO-FM	98.9
Newton	KJRG-FM	92.3
Scott City	KFLA-FM	94.3
Wichita	KCMB-FM	107.3
	KQTY	101.3

KENTUCKY

Ashland	WCMI-FM	93.7
Lexington	WVLK-FM	92.9
Louisville	WHAS-FM	97.5
Owensboro	WSTO	96.1

LOUISIANA

Alexandria	KALB-FM	96.9
Baton Rouge	WJBO-FM	102.5
Oe Ridder	KDLA-FM	101.7
Hammond	WTGI	107.1
Houma	KCIL-FM	107.1
Lafayette	KPEL-FM	99.9
Lake Charles	KPLC-FM	99.5
La Place	WCKW	92.3
Monroe	KMLB-FM	104.1
	KNOE-FM	101.9
New Orleans	WDSU-FM	93.3
	WNNR-FM	97.1
	WWMT	95.7
	WWOM-FM	98.5
Opelousas	KSLO-FM	107.1
Ruston	KRUS-FM	107.1
Shreveport	KBCL-FM	96.5
	KWKH-FM	94.5
Thibodaux	KTIB-FM	106.3

MAINE

Brunswick	WCME-FM	98.9
Caribou	WFST-FM	97.7

MARYLAND

Baltimore	WAQE-FM	101.9
	WBAL-FM	97.9
	WFMM-FM	93.1
	WITH-FM	104.3
Bethesda	WHFS	102.3
	WJMD	94.7
Cumberland	WCUM-FM	102.9
Halfway	WHAG-FM	96.7
Salisbury	WBOC-FM	94.3
Takoma Park	WGTS-FM	91.9

MASSACHUSETTS

Boston	WBCN	104.1
	WGBH-FM	89.7
	WHDH-FM	94.5
Framingham	WKOX-FM	105.7
Lynn	WLYN-FM	101.7
North Adams	WMNB-FM	100.1
Waltham	WCRB-FM	102.5
Worcester	WSRS	96.1

MICHIGAN

Bay City	WBCM-FM	96.1
	WNEM-FM	102.5
Oetroit	WABX	99.5
	WBFG	98.7
	WDET-FM	101.9
	WDTM	106.7
	WGPR	107.5
	WJBK-FM	93.1
	WLDM	95.5
	WOMC	104.3
	WXYZ-FM	101.1
East Lansing	WSWM	99.1
	WVIC-FM	94.9
Flint	WGMZ	107.9
Grand Rapids	WFUR-FM	102.9
	WJFM	93.7
	WOOD-FM	105.7
Holland	WHTC-FM	96.1
Interlochen	WIAA	88.3
Kalamazoo	WSEO-FM	106.5
	WMUK	102.1
Marquette	WDMJ-FM	95.7
Midland	WQDC	99.7
Mount Pleasant	WCEN-FM	94.5
Saginaw	WSAM-FM	98.1
Saline	WOIA	102.9
Traverse City	WLDR-FM	101.9
	WTCM-FM	103.5

MINNESOTA

Anoka	KTWN	107.9
Golden Valley	KQRS-FM	92.5
Minneapolis-St. Paul	KSTP-FM	94.5
	KWFM	97.1
	WAYL	93.7
	WLOL-FM	99.5
	WPBC-FM	101.3
Rochester	KNXR	97.5
	KROC-FM	106.9
St. Louis Park	KRSI-FM	104.1
Willmar	KWLM-FM	102.5

MISSISSIPPI

Biloxi	WVMI-FM	106.3
Corinth	WKCU-FM	94.3
Forest	WQST	92.5
Greenwood	WSWG	99.1
Gulfport	WROA-FM	107.1
Hattiesburg	WFOR-FM	103.7
Houston	WCPC-FM	93.3
Jackson	WWHO	94.7
Kosciusko	WKOZ-FM	105.1
Laurel	WNSL-FM	100.3
Natchez	WNAT-FM	95.1
New Albany	WNAU-FM	103.5
Pascagoula	WPMP-FM	99.1

MISSOURI

Cape Girardeau	KZYM-FM	102.9
Crestwood	KSHE	94.7
Dexter	KDEX-FM	107.3
Joplin	KSYN	92.5
Kansas City	KCMO-FM	94.9
	KMBC-FM	99.7
St. Louis	KCFM	93.7
Sedalia	KSIS-FM	92.1
Springfield	KTXR	101.5

MONTANA

Billings	KURL-FM	97.1
Great Falls	KOPR-FM	106.3

NEBRASKA

Columbus	KJSK-FM	101.1
Lincoln	KWHG	106.3
Omaha	KOIL-FM	96.1
	KOWH-FM	94.1

NEVADA

Las Vegas	KORK-FM	97.1
	KRGN	101.9
	KVEG-FM	92.3
Reno	KNEV	95.5
	KSRN	104.5

NEW HAMPSHIRE

Mount Washington	WMTW-FM	94.9
Nashua	WOTW-FM	106.3

NEW JERSEY

Atlantic City	WFPG-FM	96.9
Dover	WDHA-FM	105.5
Long Branch	WRLB	107.1
Paterson	WPAT-FM	93.1
Princeton	WPRB	103.3
Trenton	WBUD-FM	101.5
	WTOA	97.5

NEW MEXICO

Albuquerque	KHFM	96.3
	KRST	92.3
Hobbs	KHOB-FM	95.7
Los Alamos	KRSN-FM	98.5
Roswell	KBIM-FM	94.9
Santa Fe	KSNM	95.5
University Park	KRWG	91.7

NEW YORK

Albany	WHRL-FM	103.1
Babylon	WGSM-FM	94.3
Binghamton	WNBF-FM	98.1
Buffalo	WADV	106.5
	WDCX	99.5
De Pew	WBLK-FM	93.7
Elmira	WENY-FM	92.7
Garden City	WLIR	92.7
Ithaca	WVBR-FM	93.5
Jamestown	WKSN-FM	101.7
Lake Success	WTFM	103.5
Middletown	WALL-FM	92.7
Mount Kisco	WRNW	107.1
New York	WABC-FM	95.5
	WCBS-FM	101.1
	WKCR	89.9
	WNBC-FM	97.1
	WNEW-FM	102.7
	WNYC-FM	93.9
	WOR-FM	98.7
	WPIX-FM	101.9
	WQXR-FM	96.3
	WRFM	105.1
Patchogue	WPAC-FM	106.1
Plattsburgh	WEAV-FM	99.9
Riverhead	WHRF	103.9
Rochester	WBBF-FM	92.5
	WCMF	96.5
Schenectady	WGFM	99.5
Syracuse	WONO	107.9
	WSYR-FM	94.5
Troy	WFLY-FM	92.3
Utica	WRUN-FM	104.3
	WUFM	107.3

NORTH CAROLINA

Black Mountain	WMIT	106.9
Burlington	WBBB-FM	101.1
Charlotte	WBT-FM	107.9
	WSOC-FM	103.7
Fayetteville	WFNC-FM	98.1
Greensboro	WMDE	98.7
	WQMG	97.1
Greenville	WNCT-FM	107.7
Hickory	WHKY-FM	102.9
	WIRC-FM	95.7
Jacksonville	WXQR-FM	105.5
Leaksville	WLOE-FM	94.5
Raleigh	WPTF-FM	94.7
Reidsville	WWMO	102.1
Statesville	WFMX	105.7
Washington	WITN-FM	93.3
Williamston	WIAM-FM	103.7

NORTH DAKOTA

Fargo	WDAY-FM	93.7
Grand Forks	KVBC-FM	94.7

OHIO

Ashtabula	WREO-FM	97.1
Cambridge	WILE-FM	96.7
Canton	WCNO	106.9
	WHBC-FM	94.1
Cincinnati	WAEF-FM	98.5
	WCXL	105.1
	WKRC-FM	101.9
Cleveland	WCLV	95.5
	WDOK	102.1
	WHK-FM	100.7
	WNOB	107.9
	WZAK	93.1
Columbus	WBNS-FM	97.1
Elyria	WBEA	107.3
Fairfield	WCNW-FM	94.9
Findlay	WFIN-FM	100.5
Kettering	WVUD-FM	99.9
Mansfield	WVNO-FM	106.1
Medina	WDBN	94.9
Middletown	WPFB-FM	105.9
Port Clinton	WRWR-FM	94.5
Portsmouth	WNXT-FM	99.3
	WPAY-FM	104.1
Salem	WSOM-FM	105.1
Springfield	WBLY-FM	102.9
Toledo	WCWA-FM	104.7
	WSPD-FM	101.5
Urbana	WCOM-FM	101.7
Wooster	WWST-FM	104.5
Youngstown	WBBW-FM	93.3

OKLAHOMA

Lawton	KLAW	101.5
Midwest City	KXLS-FM	92.5
Oklahoma City	KFNB	101.9
	KOCY-FM	96.1
	KOFM	104.1
	KYFM	98.9
Stillwater	KOSU-FM	91.7
	KSPI-FM	93.9
Tahlequah	KTLQ-FM	101.7
Tulsa	KOCW	97.5
	KRAV	96.5

OREGON

Eugene	KFMY	97.9
	KWFS-FM	96.1
Portland	KOIN-FM	101.1
	KPFM	97.1
	KXL-FM	95.5

PENNSYLVANIA

Allentown	WFMZ	100.7
Altoona	WFBG-FM	98.1
Boyertown	WBYO-FM	107.5
Braddock	WLOA-FM	96.9
Chambersburg	WCHA-FM	95.1
Ebensburg	WEND-FM	99.1
Ephrata	WGSA-FM	105.1
Erie	WWYN-FM	99.9
Hanover	WYCR	98.5
Harrisburg	WTPA-FM	104.1
Johnstown	WJAC-FM	95.5
Lancaster	WGAL-FM	101.3
Lock Haven	WBPZ-FM	92.1
Oil City	WDJR	98.5
Philadelphia	WDVR	101.1
	WFIL-FM	102.1
	WFLN-FM	95.7
	WHAT-FM	96.5
	WMMR-FM	93.3
	WPBS	98.9
	WPEN-FM	102.9
	WQAL	106.1
Pittsburgh	KQV-FM	102.5
	WKJF	93.7
	WYDD-FM	104.7
Reading	WRFY-FM	102.5
Red Lion	WGCB-FM	96.1
Ridgway	WKBI-FM	94.3
Scranton	WWDL-FM	104.9
State College	WMAJ-FM	103.1
	WRSC-FM	96.7
Tyrone	WGMR-FM	101.1
Warren	WRRN	92.3
Wilkes-Barre	WYZZ	92.9

PUERTO RICO

Aguadilla	WABA-FM	100.3
Arecibo	WNIK-FM	106.3
Mayaguez	WKJB-FM	99.1
Ponce	WLEO-FM	101.9
	WPAB-FM	93.3
Rio Piedras	WFID	95.7
San Juan	WIAC-FM	102.5

RHODE ISLAND

Providence	WBRU	95.5
	WCRQ	101.5
	WHIM-FM	94.1

SOUTH CAROLINA

Beaufort	WBEU-FM	98.7
Columbia	WCOS-FM	97.9
Conway	WLAT-FM	104.1

Florence	WJMX-FM	103.1
Greenville	WMUU-FM	94.5
North Charleston	WKTM	102.5
Seneca	WBFM	98.1
Spartanburg	WSPA-FM	98.9

SOUTH DAKOTA

Sioux Falls	KELO-FM	92.5

TENNESSEE

Brownsville	WBHT-FM	95.3
Chattanooga	WDEF-FM	92.3
	WDOD-FM	96.5
Clinton	WYSH-FM	104.9
Greeneville	WOFM-FM	94.9
Humboldt	WIRJ-FM	102.3
Kingsport	WKPT-FM	98.5
Knoxville	WEZK	97.5
Manchester	WMSR-FM	99.7
McKenzie	WKTA	106.9
Memphis	KLYX	101.1
	WMC-FM	99.7
Morristown	WMTN-FM	95.9
Nashville	WLAC-FM	105.9
	WNFO-FM	103.3
	WSIX-FM	97.9
Sevierville	WSEV-FM	102.1
Tullahoma	WJIG-FM	93.3

TEXAS

Abilene	KWKC-FM	105.1
Amarillo	KVII-FM	94.1
Austin	KHFI-FM	98.3
	KTBC-FM	93.7
Beaumont	KTRM-FM	95.1
	KLVI-FM	94.1
Big Spring	KFNE	95.3
Brownwood	KFRN-FM	99.3
Bryan	KORA-FM	98.3
Clear Lake City	KMSC	102.1
Dallas	KBOX-FM	100.3
	KIXL-FM	104.5
	KRLD-FM	92.3
	WRR-FM	101.1
El Paso	KTSM-FM	99.9
Fort Worth	KCUL-FM	93.9
	KFJZ-FM	97.1
	KXOL-FM	99.5
	WBAP-FM	96.3
Gainesville	KGAF-FM	94.5
Highland Park	KVIL-FM	103.7
Houston	KBNO	93.7
	KFMK	97.9
	KLEF	94.5
	KODA-FM	99.1
	KQUE	102.9
	KRBE	104.1
	KXYZ-FM	96.5
Longview	KLUE-FM	105.7
Lubbock	KBFM	96.3
	KLBK-FM	94.5
	KSEL-FM	93.7
McAllen	KQXX-FM	98.5
Odessa	KWMO	99.1
Port Arthur	KFMP	93.3
San Angelo	KWLW	93.9
San Antonio	KEEZ	97.3
	KITE-FM	104.5
	KITY	92.9
	KMFM	96.1
Sinton	KTOD-FM	101.3
Texarkana	KOSY-FM	102.5
Victoria	KTXN-FM	92.1
Waco	KEFC	95.5
Wichita Falls	KNTO	95.1

UTAH

Ogden	KBOC	101.9
Salt Lake City	KLUB-FM	97.1
	KSL-FM	100.3
	KSOP-FM	104.3
	KWHO-FM	93.3

VIRGINIA

Harrisonburg	WSVA-FM	100.7
Lynchburg	WWOD-FM	100.1
Martinsville	WMVA-FM	96.3
Newport News	WGH-FM	97.3
Norfolk	WTAR-FM	95.7
	WYFI-FM	99.7
Petersburg	WSSV-FM	99.3
Richmond	WFMV	103.7
Roanoke	WSLS-FM	99.1
South Hill	WJWS-FM	105.5
Suffolk	WXYW	92.9
Winchester	WHPL-FM	102.5

WASHINGTON

Aberdeen	KDUX-FM	104.7
Bellingham	KERI	104.3
Bremerton	KBRO-FM	106.9
Edmonds	KGFM	105.3
Richland	KCYS	95.1
Seattle	KBBX	98.9
	KETO-FM	101.5
	KIRO-FM	100.7
	KISW	99.9
	KIXI-FM	95.7
	KLSN	96.5
Spokane	KDNC-FM	93.7
	KHQ-FM	98.1
	KTWD	105.7
Tacoma	KLAY-FM	106.1

WEST VIRGINIA

Beckley	WBKW	99.5
Bluefield	WHIS-FM	104.5
Charleston	WKNA	98.5
	WVAF	99.9
Martinsburg	WEPM-FM	97.5
Morgantown	WAJR-FM	101.9
St. Albans	WKLC-FM	105.1
Wheeling	WTRF-FM	107.5

WISCONSIN

Delafield	WHAD	90.7
Eau Claire	WIAL-FM	94.1
Green Bay	WBAY-FM	101.1
Janesville	WCLO-FM	99.9
La Crosse	WWLA-FM	93.3
Kenosha	WAXO	96.9
	WLIP-FM	95.1
Madison	WHA-FM	88.7
	WISM-FM	98.1
	WMFM	104.1
	WRVB-FM	102.5
Manitowoc	WKUB-FM	92.1
Marshfield	WDLB-FM	106.5
Milwaukee	WAWA	102.1
	WFMR	96.5
	WISN-FM	97.3
	WTMJ-FM	94.5
Oshkosh	WOSH-FM	103.9
Platteville	WSWW-FM	99.3
Sauk City	WVLR	96.7
Tomah	WTMB-FM	98.9
Two Rivers	WTRW-FM	102.3
Waupaca	WDUX-FM	92.7
Wausau	WSAU-FM	95.5
West Bend	WBKV-FM	92.5

WYOMING

Cheyenne	KVWO-FM	106.3

CANADA

ALBERTA

Calgary	CHFM-FM	95.9
Edmonton	CFRN-FM	100.3
Red Deer	CKRD-FM	98.9

BRITISH COLUMBIA

Kamloops	CFFM-FM	98.3
Penticton	CKOK-FM	97.1
Vancouver	CHQM-FM	103.5
	CKLG-FM	99.3
Victoria	CFMS-FM	98.5

MANITOBA

Brandon	CKX-FM	96.1
Winnipeg	CJOB-FM	97.5
	CKY-FM	92.1

NEW BRUNSWICK

St. John	CFBC-FM	98.9

ONTARIO

Cobourg-Port Hope	CHWC	103.1
Hamilton	CHML-FM	95.3
Kingston	CKWS-FM	96.3
London	CFPL-FM	95.9
Ottawa	CFMO	93.9
Port Arthur	CKPR-FM	94.3
Sault Ste. Marie	CJIC-FM	100.5
	CKCY-FM	104.3
Sudbury	CKSO-FM	92.7
Toronto	CHFI-FM	98.1
	CHUM-FM	104.5
	CJRT-FM	91.1
	CKFM	99.9
Windsor	CKLW-FM	93.9

QUEBEC

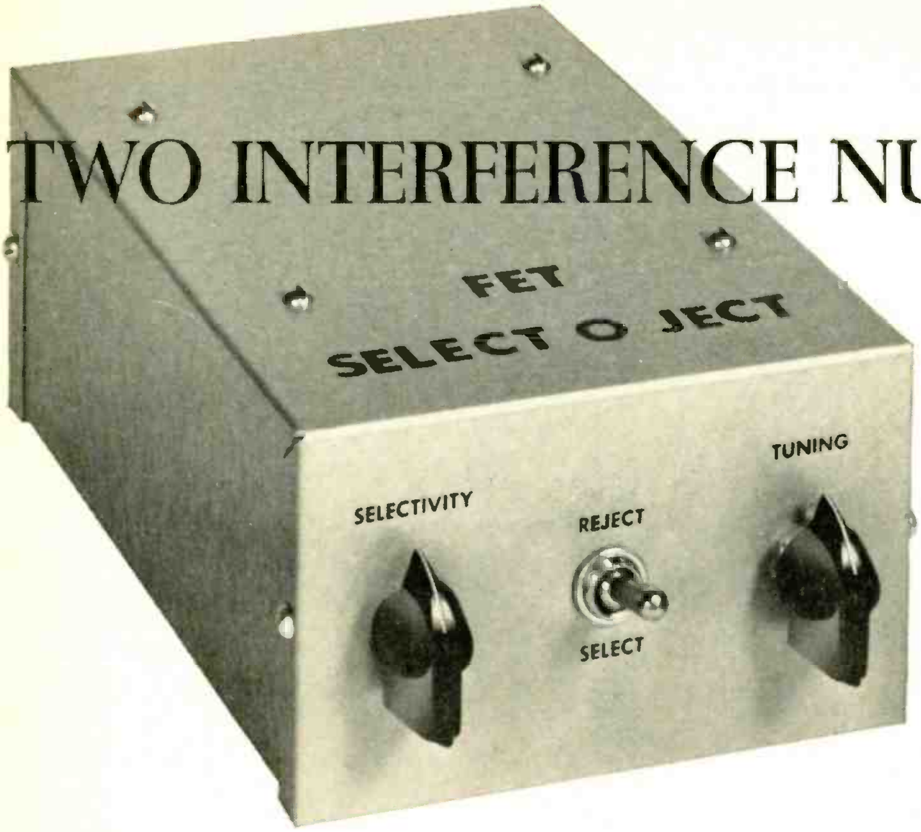
Montreal	CFCF-FM	92.5
	CJFM-FM	95.9
	CJMS-FM	94.3
	CKGM-FM	97.7
Quebec	CHRC-FM	98.1
Rimouski	CJBR-FM	101.5
Ste. Anne de la Pocatiere	CHGB-FM	102.9
Sherbrooke	CHLT-FM	102.7
Verdun	CKVL-FM	96.9

SASKATCHEWAN

Saskatoon	CFMC-FM	103.9
	CJUS-FM	89.7

END

TWO INTERFERENCE NULLERS



By JACK ALTHOUSE and OTIS VAN HOUTEN

IN COMMUNICATION RECEIVERS (CB, commercial two-way, SWL or amateur) heterodyne interference from undesired signals is a constant problem. Here is a pair of construction projects, both solid-state, and each with its own solution to the problem.

Selectoject

Devised some years ago, this circuit was named for what it does: select, oscillate, or reject. It works in the audio section of the receiver, where it can (a) select a narrow band for amplification, rejecting all others, or (b) reject only a narrow slice of frequencies.

In the *select* mode, shown in Fig. 1, a selected frequency is boosted. The first phase shifter operates only at the desired frequency, while the third shifter (or inverter) works at all frequencies. Because of the feedback loop, the selected frequency is shifted 360° (180° by each inverter) and added to the input. The combined signal at that frequency has a greater amplitude (adjusted by the SELECTIVITY control) than the original. Since all other frequencies are only shifted 180°, they tend to partially cancel out.

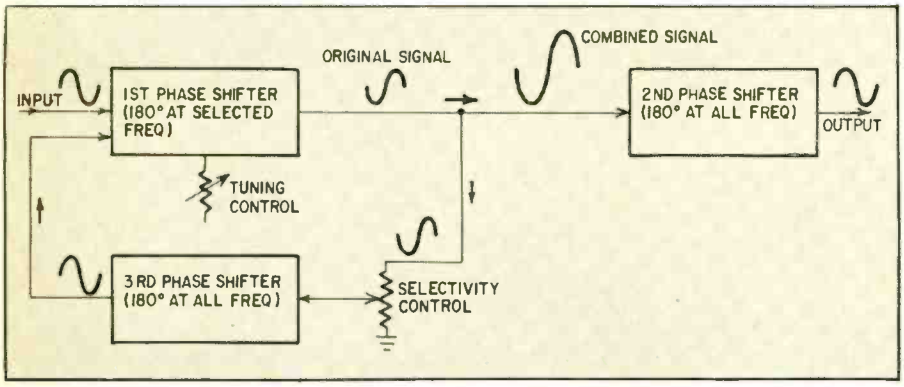


Fig. 1—When operating in the "select" mode, the Selectoject uses positive feedback to increase the amplitude of the desired narrow band of frequencies fed to the output.

In the *reject* mode (shown in Fig. 2) the selected frequency is split into two channels. The second and third shifters give all frequencies a 180° shift, but the first inverter gives the selected frequency an additional 180°. When the two channels are combined, the selected frequency cancels out.

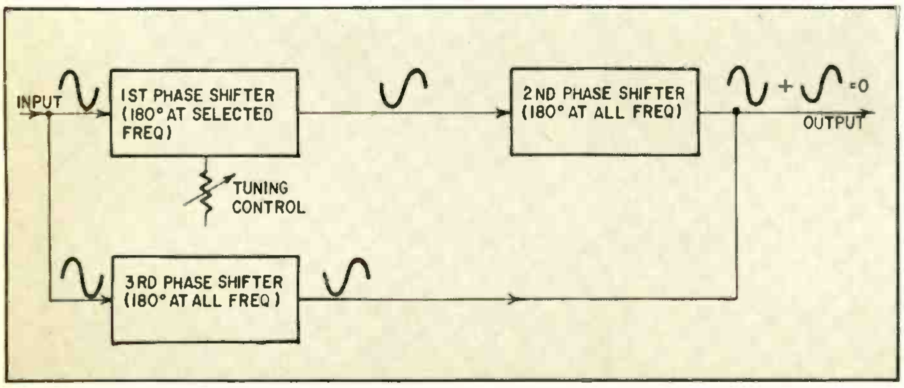
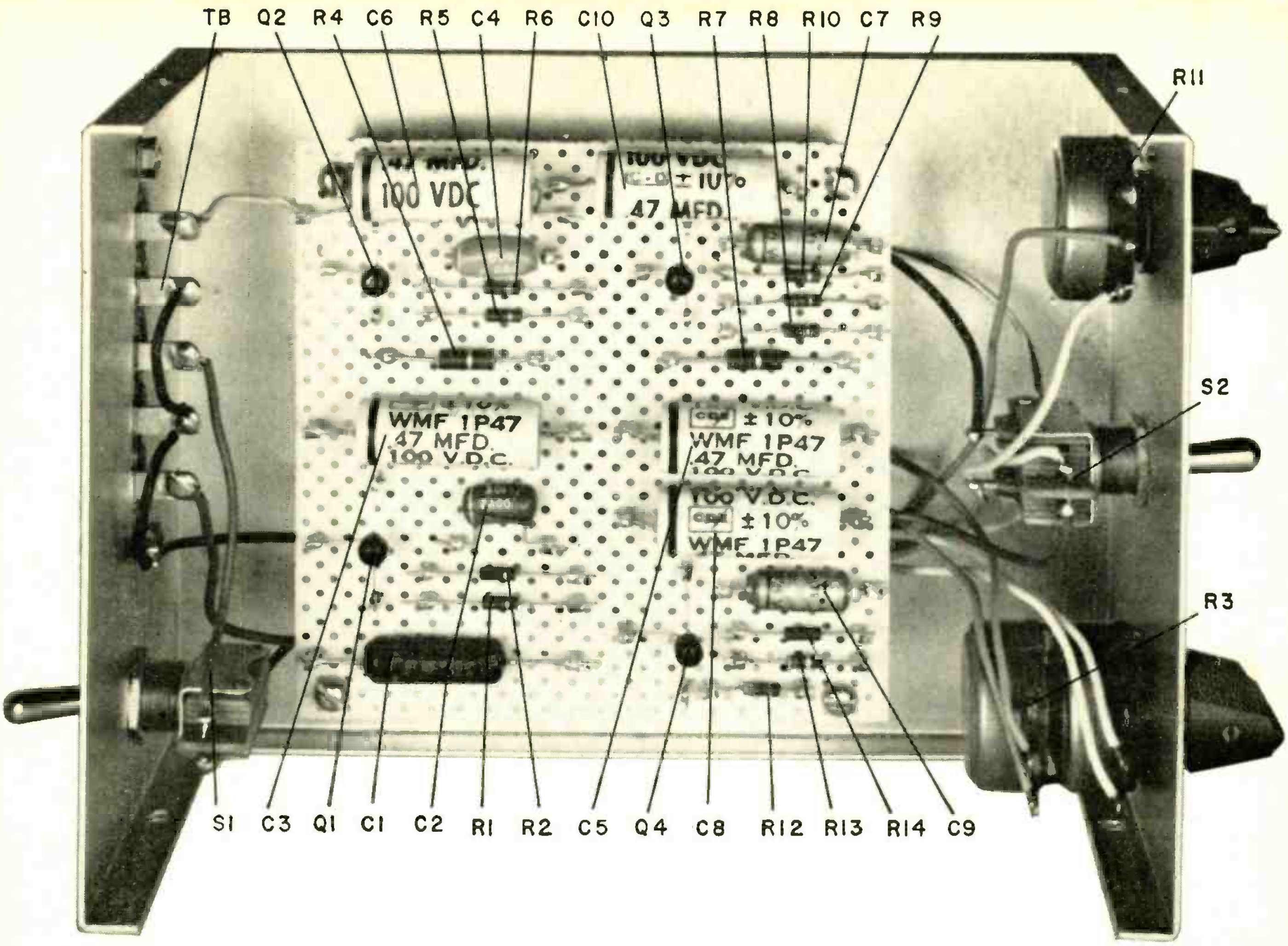


Fig. 2—The Selectoject can also reject a narrow frequency range. This is accomplished by inverting part of the signal so it cancels itself. Other frequencies are unaffected.

To make the circuit oscillate, it's only necessary to place it in the *select* mode and increase feedback until it equals the input. At this point the unit becomes a perfectly good audio oscillator for testing.

This Selectoject uses FET's, which are ideally suited for phase inverters. Not only are they made in both p- and n-channel types, they are high-impedance devices which will match most existing receiver circuits.

Fig. 3 is the schematic of the Selectoject. To maintain symmetry, you should use matched pairs for R1–R2 and R5–



Selectoject Parts List

C1—.01 μF, 200 volts
C2, C4—.0022 μF, 100 volts
C3, C5, C6, C8, C10—0.47 μF, 100 volts
C7, C9—10 μF, 10 volts, electrolytic
Q1, Q2, Q3, Q4—2N4360 FET, Fairchild (send post card to Marketing Services, Fairchild Semiconductors, 313 Fairchild Drive, Mountain View, Calif., and request name and address of your nearest Fairchild stocking distributor)
R1, R2—2,200 ohms (matched pair)
R3—dual pot, 500K audio taper
R4, R7—2.2 meg
R5, R6—2,200 ohms (matched pair)
R8—1,000 ohms
R9, R13—220 ohms
R10, R14—2,200 ohms
R11—pot. 1 meg, audio taper
R12—4,700 ohms
All fixed resistors ¼ watt
S1—spst toggle switch
S2—dpdt toggle switch
Miscellaneous—5-terminal strip, 4½ x 4½-in. perforated board, 7 x 5 x 3-in. metal box, terminals and spacers for board.

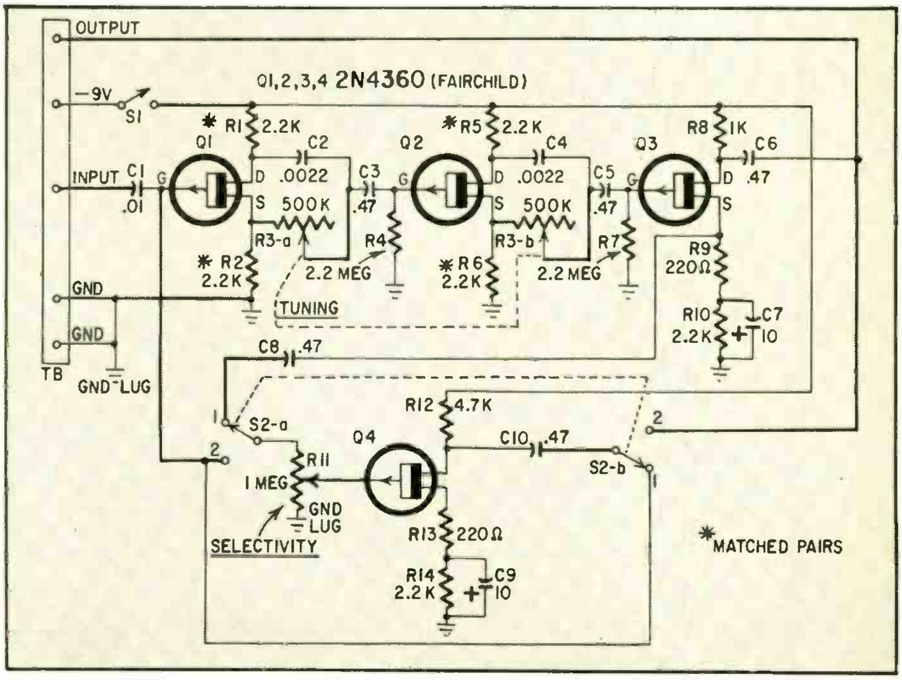


Fig. 3—FET Selectoject circuit is obviously much like the old vacuum-tube version. Heavy lines are those wires which join the perforated board to the case components.

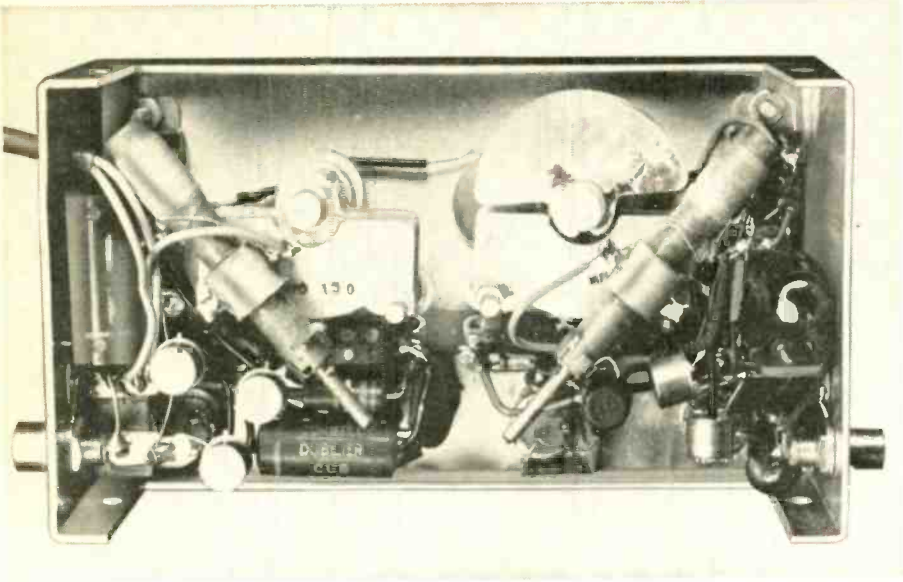
R6. You can buy 1% resistors, or use an ohmmeter to select close pairs from a number of 2,200-ohm units.

The easiest way to build the Selectoject is to mount and wire the components on the 4½ x 4½-inch perforated board as shown in the photo above. But drill mounting holes both in the board and in the 7 x 5 x 3-inch box first. Wires from the board to the panel components are drawn in heavier lines in Fig. 3.

FET lead arrangement is shown in Fig. 4-a, while 4-b shows how to bend the leads for board mounting.

The battery isn't shown in the schematic, for you may want to power your unit from an external source. There is room in the box, however, to mount a

TWO INTERFERENCE NULLERS



One author built two Q multipliers in a single case, to have double nulling capability.

Front view of the completed twin Q multiplier (Peak or Nuller) receiver accessory.

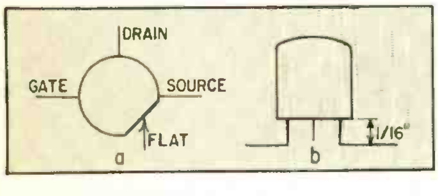


Fig. 4-a—You'll find the FET lead coding easy to make out, but there's one thing you won't believe. It makes no difference if drain and source leads are interchanged! b—To facilitate mounting on the perforated board, bend FET leads like this.

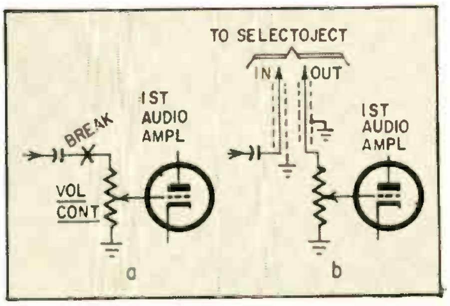


Fig. 5—Follow these steps to connect Selectoject to audio section of receiver.

9-volt transistor battery. As the Selectoject draws only about 4 mA, a zinc-carbon type (NEDA 1604) should last about 48 hours. A mercury battery (NEDA 1604M) will be good for two or three times that.

This device is made to work into a high-impedance receiver audio section, and should be connected as shown in Fig. 5.

In practice, you'll find it easiest to reject a single heterodyne with the TUNING control. SELECTIVITY controls the amount of null or boost. If an interfering signal produces a fundamental and harmonics, you'll probably get best results in the *select* mode, tuning for best signal-to-noise ratio.

Q multiplier

Another way of getting rid of heterodyne interference in a receiver is by varying the Q of the i.f. circuit. For instance, the Colpitts oscillator of Fig. 6, when connected in a receiver i.f. stage, will vary the selectivity depending on the position of R3.

With R3 set for zero resistance, maximum positive feedback occurs and the circuit oscillates at a frequency determined by L, C1, C2 and C5. Under this condition, the Q of the LC tank is almost infinite, producing high gain around the selected frequency. The effect in the receiver is the same as rejecting all other frequencies. By adding a third transistor, the circuit can null out a narrow frequency range.

The frequency of the *peak* or *null* can be varied over a 25-kHz range centered on 455 kHz. *Peak* bandwidth is adjustable from 1 to 20 kHz, while *null* bandwidth can be widened to eliminate most typical voice signals. The entire circuit can, depending on control settings, provide voltage gains from 5 to 10.

Refer to Fig. 7 for circuit function. The input is isolated from the receiver by R1, and the output is similarly isolated by its connection to the feedback-stage (Q2) emitter. This makes cable connections to the receiver uncritical.

In the *peak* mode, the i.f. input signal is applied to a voltage divider consisting of R1 in series with the parallel combination of R2, the input impedance of Q1, and the resonant impedance of the tank. At the tank's resonant frequency (f_R) the input impedance of Q1 is high due to the bootstrap feedback connection through R3. But at frequencies other than f_R, circuit impedance is much less, as is developed voltage.

Emitter follower Q2 isolates the input and output stages, and the output is taken from the collector circuit of Q3.

In the *null* mode, the signal from output amplifier Q3 is fed back to the input tank. This negative feedback

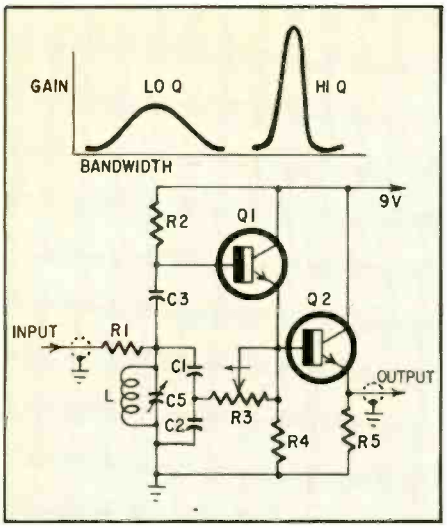


Fig. 6—A Colpitts oscillator can be used as a Q multiplier in a receiver i.f. stage.

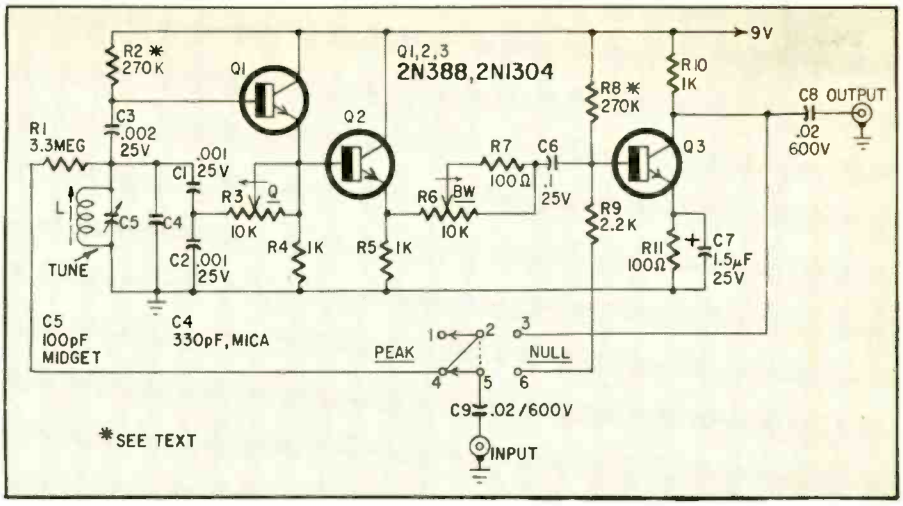


Fig. 7—Complete schematic of the solid-state Q multiplier. For greater flexibility in interference rejection, you may want to build two and put them in series. You'll then be able to cut through much hash by nulling out two signals, and copy cleaner signals.

causes gain to be very low at f_R, producing a notch (or null) in the i.f. response curve.

Construction requirements aren't critical, with two exceptions: R2 and R8, nominally 270 K, should be chosen to drop half the supply voltage to the respective bases of Q1 and Q3. The transistors may be npn's like the 2N388, 2N365A or 2N1304. Specifications should be at least the following: f_{ab} 5+ MHz, E_{ce} 20+ volts, P_c 100+ mW, h_{fe} 100+.

As shown in the photo, you can build the Q multiplier with point-to-point wiring in a small box. (The model shown is actually two separate Q multipliers in series, which permits more effective deheterodyning.) Or you may prefer a perforated board. Be sure the tank circuit components are rigidly mounted in a box with tight corners, for proper shielding.

Signal connections are shown in Fig. 8. Remove the agc connection to the i.f. transformer, and ground the bottom of the winding. Then add a 470K resistor from the last i.f. grid to the agc line just disconnected. Use shielded cable to connect the Q multiplier to the *in* and *out* points shown in Fig. 8.

If you wish, you may use a 9-volt battery to power the system (as mentioned above). To avoid the nuisance of changing batteries, you can alternatively steal the approximately 20 mA needed (for the twin version) from the receiver audio output stage, as illustrated in Fig. 9. Dc cathode voltage should be in the range of 8–13. The effective power-circuit resistance of the twin Q multiplier is about 450 ohms, so you can substitute the circuit for an existing output-stage cathode resistor in the range of 400–500 ohms. If your receiver uses

Q Multiplier Parts List

C1, C2—.001 μF, 25 volts
C3—.002 μF, 25 volts
C4—330 pF, mica
C5—100 pF, midget variable
C6—0.1 μF, 25 volts
C7—1.5 μF, 25 volts, electrolytic
C8, C9—.02 μF, 600 volts
L—40 to 300 μH variable (J. W. Miller 2002, or equivalent)
Q1, Q2, Q3—2N1304 (see text) or equivalent
R1—3.3 meg
R2, R8—270K (see text)
R3, R6—pot. 10K linear taper
R4, R5, R10—1,000 ohms
R7, R11—100 ohms
R9—2,200 ohms
All fixed resistors ½ watt
Miscellaneous—input and output phono jacks, aluminum case, tie strips, shielded cable.

another value, you'll have to shunt it with an added resistor to equalize the load. Be sure to use a cathode bypass electrolytic of about 50 to 100 μF at 25 volts—add one if not already present.

To align the circuit, apply a 455-kHz signal to the input jack. With C5 (the TUNE control) in the middle of its range and the switch set to PEAK, adjust L for maximum output. Be sure the Q and BW controls are at midrotation, with Q set just below oscillation point.

In operation, the TUNE control adjusts the position or frequency of the peak or null. The bandwidth control sharpens or broadens, and the Q control adjusts the height or depth of the peak or null. For initial adjustment, tune in a signal on the receiver with the switch in the NULL position and the TUNE control detuned. Turn the bandwidth control to maximum clockwise position and rotate the Q control until you hear a squeal in the speaker—indicating oscillation. Now turn the Q control counterclockwise until oscillation just stops. The Q control is now properly adjusted.

So there you are—take your choice, get out that soldering tool, and start your way toward slicing out interference! **END**

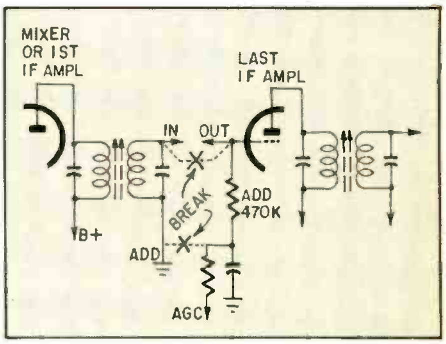


Fig. 8—Q multiplier connection to receiver.

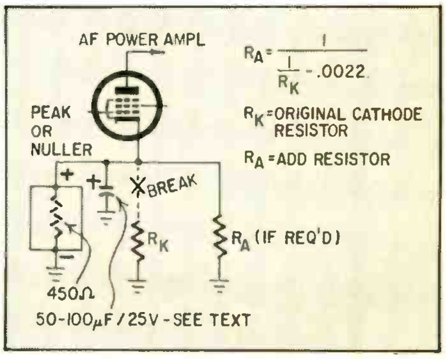


Fig. 9—How to steal power for the Q mult.

IN'S AND OUT'S OF LEAD-INS

They're only pieces of wire, but they carry that all-important signal

By EDWARD A. LACY

AN ANTENNA FARM ON THE OUTSIDE of your vine-covered cottage may result in a jungle of lead-in wires inside its walls. For whether you have TV, ham, SWL, Citizens-band or FM antennas (some poor souls have all of these!) the antenna lead-in presents a problem: How do you get the thing into the house neatly, efficiently and safely?

Some would say, "Just drill a hole in the wall and pull it through." Many installations plainly follow this direct approach.

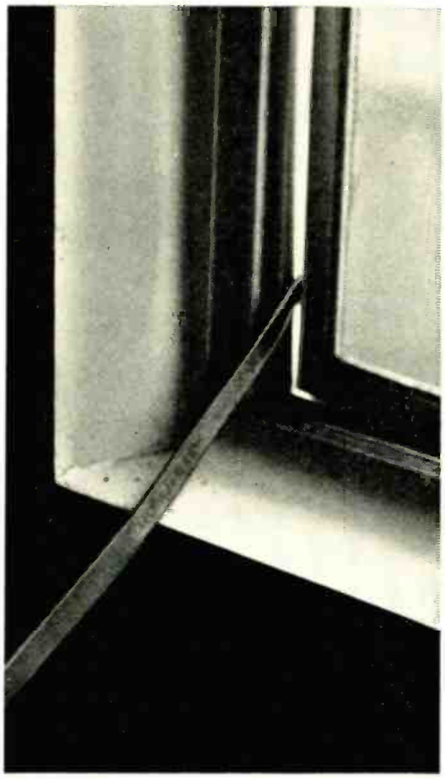
Unfortunately, this simple method usually looks atrocious (especially if you are living in rented quarters). It's inconvenient to disconnect or service, and it may be unsafe according to the National Electrical Code.

There are simple, straightforward procedures to fit most lead-in problems, however, plus new hardware to make the job easier. By following a few simple fundamentals, you can please your wife, get the best possible signal in and out of the house, and not electrocute your children and pets in the process.

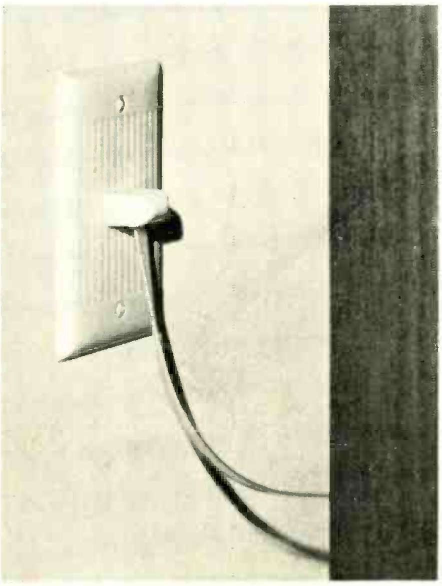
Let's follow your lead-in from the antenna to your equipment. We'll assume that you have made good mechanical and electrical connections at the antenna, there is no mechanical strain on the connections, and all connections have been made as weatherproof as possible. Weatherproof coax connectors by covering with silicone grease and all other connections by wrapping well with plastic tape or covering with a weatherboot.

If you have mast-mounted equipment—preamplifiers or matching transformers, for example—make sure you leave a drip loop (a U-shaped piece of the lead-in) to keep rain from running into your equipment. If you have an antenna rotator, leave enough slack in the lead-in to permit rotation. Extra slack also may be useful should you want to bring the antenna down to your level when disconnecting the lead-in. Don't forget to ground the mast and fit an efficient lightning arrester to the lead.

We won't get into the controversy of coax vs twin-lead for TV here, except to say that coax is not nearly so critical to install, especially for color TV. If you *do* use coax for TV, get all-channel cable so you will be set up for uhf, regardless of whether you now have high-channel stations on the air in your area.



How not to route lead-in; the insulator wears through and the screen won't fit.



To move the TV and clean the rug, you simply unplug the lead-in at the wall box.

No matter what type of lead-in you use, *do not* run it above or below power lines. Mount and restrict the lead-in so it can swing no closer than 10 feet to wires carrying more than 250 volts; no closer than 2 feet to wires carrying less than 250 volts. If no more than 150 volts are involved, you can run the lead-in within 4 inches of the power line, provided all lines are mounted securely to preserve the minimum permanent separation.

With coax or shielded twin-lead, you can tape it to the mast about every 6 feet with plastic tape. This will keep it from blowing in the breeze and eventually breaking because of vibration. With oval or all-weather twin-lead (no more flat twin-lead, please!), use plastic clips or all-polyethylene-head standoff insulators every 6 feet down the mast and across the roof of your quarters. Note that suitable types of twin-lead are too rigid to be twisted as was required for flat line.

For transmitting antennas, if coax is not used, mount the lead-in at least 3 inches away from the outer wall of the building, using nonabsorptive insulated supports.

When bringing the lead-in into the house, you can run it directly through or alongside metal pipes *if you use coax or shielded twin-lead.* Unshielded twin-lead, of course, must avoid such pipes if possible.

The only precautions necessary with coax: Don't crush it; don't pierce the insulation with staples, etc. Use hand-driven staples instead of a staple gun to avoid indenting the shield. Shielded twin-lead requires similar care.

Now, where should you bring the lead-in into the house? New hardware allows you to bring it in practically any place—the roof, eaves, window or window board, basement or foundation wall, even directly through the outer wall to the point where the lead-in will be used. Which method is best?

If one or more of your antenna outlets is to be mounted directly on an outside wall of your house, then it will probably be easier to bring the antenna directly through the wall using either a coax or twin-lead wall-through connector. You can, however, come up through the basement or crawl space and drill up through the floor for outside-wall outlets.

For all inside-wall outlets, come through the attic (by way of the eaves, ventilator or roof), through the basement (by way of a basement window or wall), or through the crawl space under the house (by way of a ventilator or the foundation wall) and then up (or down) the wall as needed. Don't plan on snaking a lead-in *down* an outside wall; insulation and braces make it too difficult a task.

Of these methods, the basement route is certainly the most convenient (unless you have a finished ceiling in the basement). You won't have to snake the lead-in down from the ceiling. For homes without a basement, the crawl space has the same advantage, too, if you care to brush aside the spiders and other denizens of the dusty, dark hole.

If none of these methods works, you can, as a last resort, bring the lead-in through a window pane or window board near your gear. This technique, however, is unsightly and it hampers or prevents normal opening and closing of that window. For transmitting antennas: If your lead-in consists of bare wire, you should bring it into the house at a point where a human cannot touch it. Rf burns are *dangerous and painful.*

Once you have determined the point of entry for your lead-in, bring it close to that point and form a drip loop. If you're using TV twin-lead, *do not* leave a full coil at this point (or any other point); it's murder for color! Strap the lead-in securely to the outside of the house so there will be no mechanical strain on the feedthrough connector.

Mount the lightning arrester close by, attach the antenna to it, and connect the appropriate ground wire. Arresters are not required for coax, if the outer shield is permanently and effectively grounded with an efficient grounding clamp. Note, however, that coax lightning arresters *are* made for Citizens-band and ham antennas. To protect shielded twin-lead from lightning, connect as shown in Fig. 1.

At this point, it's necessary to decide where to place the multi-set coupler if you have or anticipate having more than one TV. If one of your outlets is mounted on an outside wall, mount the coupler in a weatherproof box on the outside of the house. If the outlets are to be mounted on inside walls, or if you come up to an outside-wall outlet through the basement or crawl space, then you can place the coupler conveniently inside the house.

When installing coax, it is not necessary to use a bushing or feedthrough insulator to go through the wall, window or ventilation opening. If you wish, you can use a standard coax wall-through insulator (Fig. 2) which has a coax receptacle on the inside end. Twin-lead should be brought in through a feedthrough bushing or insulator (GC Electronics 1551 or Mosley 625 or equivalent, available with receptacle socket).

If you're not using coax for your transmitter, bring the lead-in through a drilled window pane or a rigid non-absorptive noncombustible insulating tube.

Once you have picked the feedthrough insulator, you can determine the size of hole you will need to drill.

To drill through masonry foundations, use extra-length carbide-tip drills. For wood foundations, use standard 18-inch electrician's drills. Both types are large enough to drill holes for coax, but the masonry bit is not large enough for bushings or feedthrough insulators.

To make masonry holes for bushings, start the hole with a carbide-tip bit, using a slow-speed drill if possible, and finish it with a regular star drill bit —a steel rod with a star-shaped point. Hold the star bit in one hand and strike a sharp blow with a hammer or mallet. Rotate the bit slightly after each blow. Since this is a hard, time-consuming job, try to go through a mortar joint, brick or cinder block instead of concrete, which is extremely difficult to drill through.

If possible, drill the hole so it slants down slightly toward the outside so rain won't run through the bushing into the house.

Instead of a star drill, you may use a large electric drill. Make certain the drill is grounded with a three-conductor wire and plug, since you'll probably be outdoors when using it.

After inserting the feedthrough (Fig. 2) or coax, make the hole water- and weather-proof by puttying it with a material such as General Electric's bathroom seal or ordinary caulking compound.

CAUTION

Do not drill into a wall or roof if you suspect there is an electric power line somewhere underneath. Several electricians, who should have known better, have been electrocuted this way.

Use protective goggles and work gloves when drilling or chipping masonry.

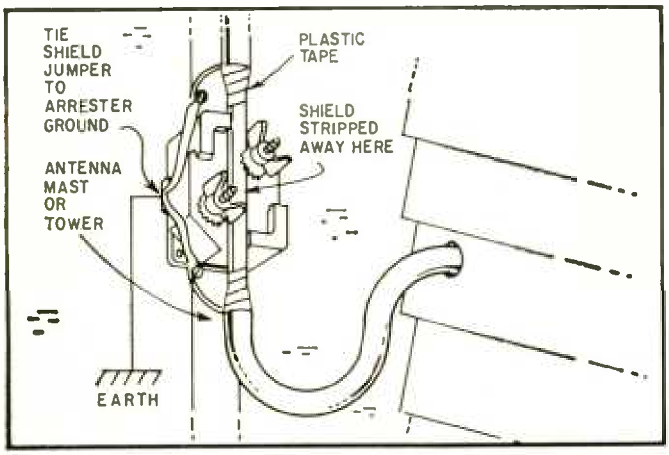


Fig. 1—Before routing cable or twin-lead inside a building, be sure to use some form of lightning arrester. Ground it well.

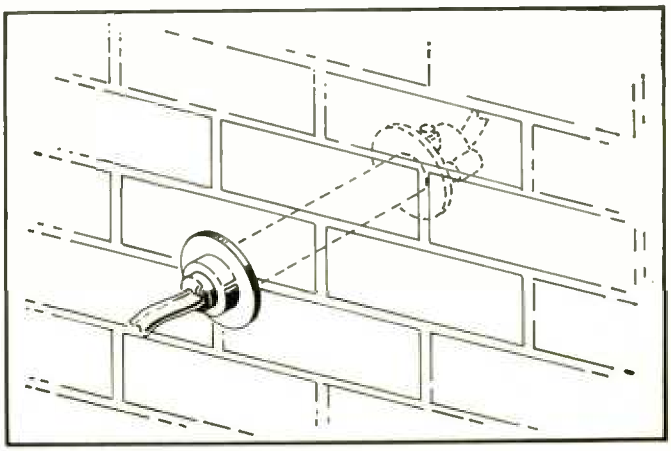


Fig. 2—You'll find that a wall feedthrough insulator is needed with twin-lead to protect and secure the body of the lead-in.

IN'S AND OUT'S OF LEAD-INS

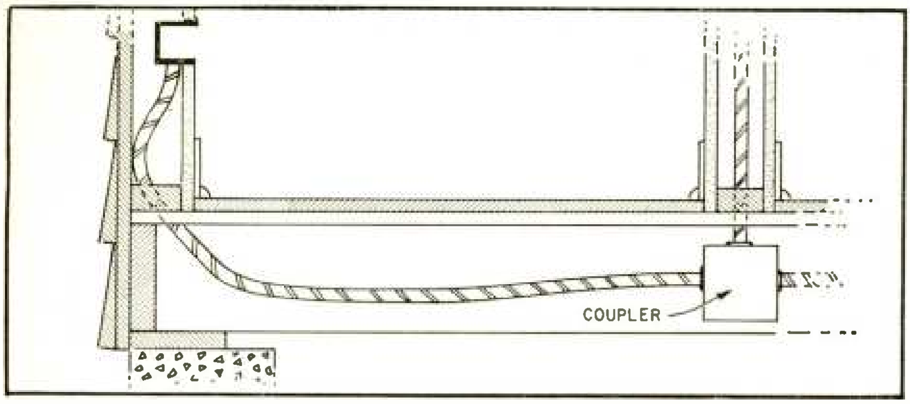


Fig. 3—Often you can make a neat job by routing cable between basement rafters (in other words, just below ground-floor level). Outlet boxes for the cable go in walls.

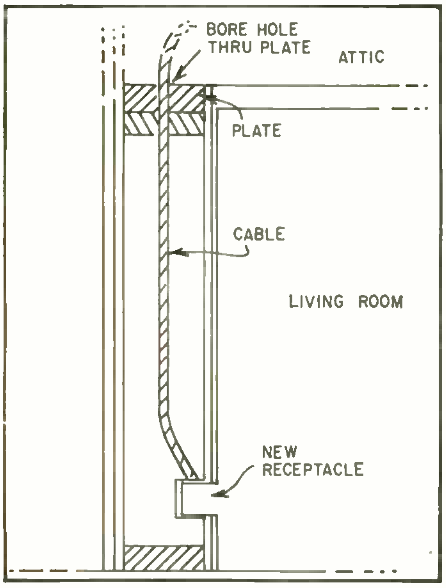


Fig. 4—Another way of running lead-in to a wall box is down through the attic.

To insert the lead-in through a feedthrough or a hole, *do not* strip the end of the lead-in until you have pushed it through.

Inside the house, mount any traps, filters, mixers, splitters, couplers, etc. you may have for TV or FM in a place convenient for adjustment and servicing, but not exposed to an undue amount of dust and moisture.

In running the lead-in to the outlets, remember: Do not run lead-in nearer than 2 inches to power conductors, unless the power conductors are in cable armor or unless they are permanently separated by a continuous and firmly fixed nonconductor such as flexible tubing or porcelain tubes.

Staple coax and shielded twin-lead on the inside of the house, using the same precautions as you did on the outside of the house. Standoff insulators are not necessary indoors; twin-lead can be held in place with plastic clips. Try to avoid long runs of unshielded twin-lead, and keep it away from plumbing pipes and metal-backed lath.

When using shielded twin-lead, maintain shield continuity by splicing a jumper across the cable shields when you encounter boosters, couplers, outlets, etc. It's easier to make these connections when you install the cable than to go back later to do it.

If you are running the lead-in underneath the floor, run it directly beneath the new outlet opening (Fig. 3) and drill a hole up through the subfloor and through the 2 by 4 plate on top of it. CAUTION: Be careful not to drill into a power line.

If you are running lead-in through the attic, carrying it directly to the point over the wall in which the outlet is to be mounted, then drill down through the ceiling plate (Fig. 4). If your outlet is next to a closet, it may be simpler to come down through the closet ceiling in a corner of the closet where the lead-in will not be obtrusive.

Now, come back up to the main floor and cut a hole in the wall large enough to mount plaster straps or mounting brackets. Mount the brackets. Attach the lead-in to the outlet plate, then attach the plate to the brackets.

As indicated in Fig. 5, there are several manufacturers who are now making 300-ohm and coax outlets as well as coax or twin-lead in combination with rotor outlets. *Avoid those outlets that combine ac power outlets with antenna outlets.* Most, if not all of these, do not conform to the National Electrical Code.

What should you do when you need outlets on two floors? You *can* bring a lead-in all the way from the attic through an inside wall down to the bottom floor, but it's a tricky business: You must remove the baseboard on the second floor and drill from the second floor toward the wall of the floor beneath. It's easier to run the second lead-in down the outside (or up the outside, depending on where your coupler is located) of the house.

Note that there are two types of antenna outlets: surface mounted and flush mounted. The flush-mounted type allows you to hide your wiring; of course, the surface-mounted type is easier to install.

If you are using coax for TV reception, you can use either a coax outlet or an outlet which has a 75- to 300-ohm matching transformer built in. If you are in a very strong signal area, unwanted TV signals can be received by the short length of lead-in that runs from the TV to the wall outlet. In such cases, use the coax outlet and mount the matching transformer on the back of the set. END

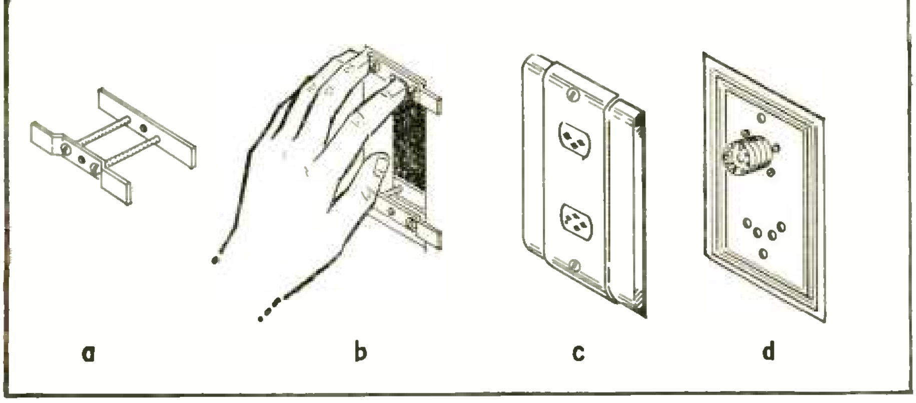


Fig. 5—How to install cable and twin-lead receptacles. Cut hole in wall, then use plaster straps (a) at top and bottom of hole (b). Receptacle panels attach to straps and are available in either twinlead (c) or coax (d) types. Some have antenna-rotator jacks.

Canada's First Satellite Station

By JAMES W. ESSEX

WITH THE DECISION OF CANADA'S Department of Transport (equivalent to the US's FCC) to build a satellite receiving station, the northland country is assured participation in the fast-growing chain of international communication satellites. A signatory to the International Agreement covering ownership and use of the system, Intelsat Canada has a 3½% ownership in the corporation which owns and operates satellites Early Bird, Lani Bird and Canary Bird. This percentage may be small, but it is significant as it places Canada fifth on the list of participating nations.

It's also worth noting that this northern neighbor of the US boasts one of three commercial satellite-receiving stations in North America, complementing the US stations at Andover, Me., and Brewster Flat, Wash.

The site selected for the station is on Canada's thinly populated eastern coast, not far from Halifax, Nova Scotia. Rising high above rocky terrain, the huge Dacron balloon which covers the antenna looms like a giant "puffball." Over 100 feet high, it's an impressive sight. Air pressure from five compressors maintains the form of the dome. The interior is completely unobstructed.

The town (Mill Village), near which the station was placed, is located about 85 miles southwest of the port city of Halifax. The site was chosen to provide a near-ideal proximity to Europe and Early Bird. The location also is remote from large built-up areas to minimize electrical interference. Adequate housing is available in the immediate vicinity, as are suitable power-line facilities.

In spite of the fact that signals from a synchronous satellite like Early Bird are virtually line-of-sight, the high frequency (4,000 to 6,000 MHz) and low power (3 watts) require an antenna having truly impressive gain and directional characteristics. The cost of this installation ($9 million Canadian) attests to the financial and physical difficulties involved in providing such an antenna. Manueverability—needed to accommodate the network of satellites that one day will circle the earth—also adds to the cost. Canada plans to be part of this world-wide network of orbiting satellites.

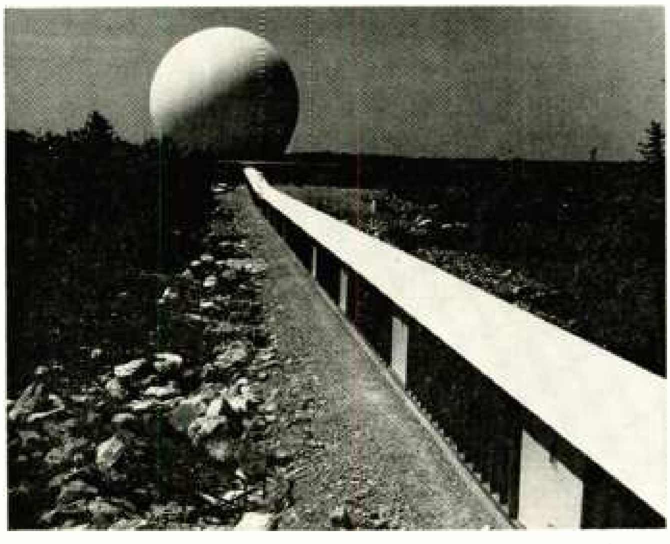
The Canadian parabolic dish can be constantly checked for precision by focusing it on a "man-made ground satellite." This signal source is actually a miniature version of the real one and is mounted on a steel tower 7 miles from the dish. When triggered by the giant antenna, signals are emitted in much the same manner as from the real satellite. With the exact range and bearing of the ground satellite known, the use of a boresight telescope allows operators to align the antenna visually by peering through an opening in the Dacron balloon covering.

High-gain parametric amplifiers having extremely high signal-to-noise ratios amplify the incoming signals. These sensitive circuits operate in a closed-cycle liquid-helium environment within 4.5° of absolute zero, a practice which minimizes random electron noise within the amplifiers. The low-level (−100 dB) signals are then converted to a 70-MHz intermediate frequency using a superheterodyne mixer. The 70-MHz signals are fed to the control room where they are further amplified.

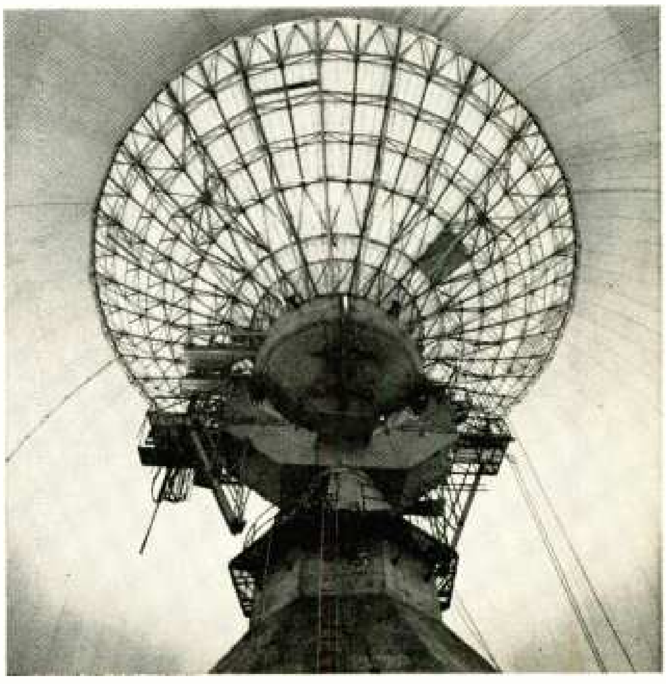
The antenna is used both for transmitting and receiving. A duplexer system is used for switching. Two modes of transmission are possible—SSB and FM—using two 10-kW transmitters operating in the range of 5,925–6.425 MHz. Other equipment associated with the antenna, including the transmitters, is housed within the dome.

A combination administration/control building is located 1,000 feet distant. Interconnecting electrical cables are housed in an above-ground tunnel that runs out to the antenna. After processing, signals from the site are fed into a microwave network with terminals in Montreal and Andover, Me. Remote control of the antenna also is possible from this building.

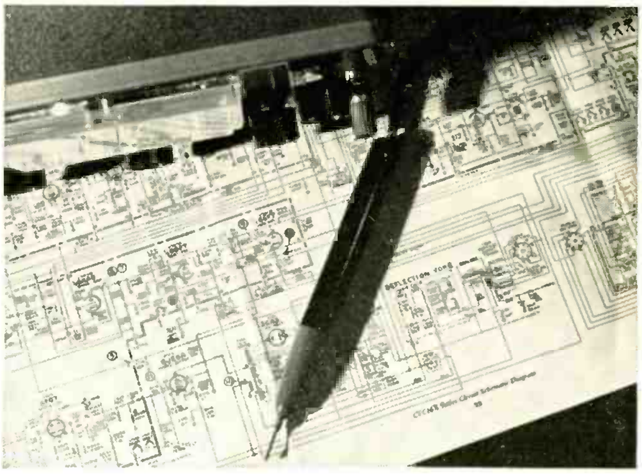
Operation of the station is the responsibility of the Canadian Overseas Telecommunications Corp. (COTC). About 40 persons, staff and scientists, are required to maintain its role in the international network. From the beginning, the station has been "commercial." Its future applications depend, not only on the proper assessment of present uses, but what is yet to be learned from satellite communication practices. END



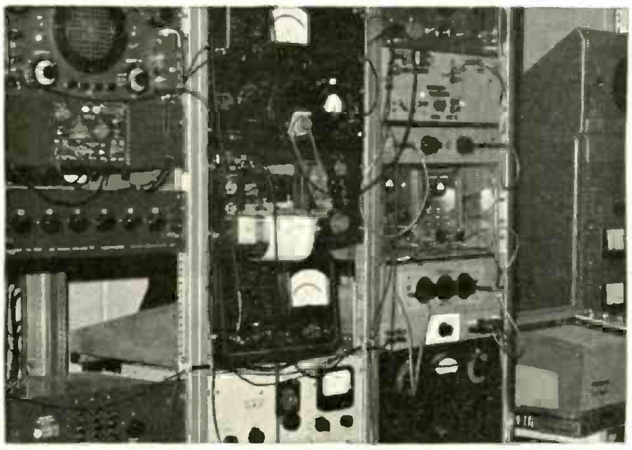
The satellite tracking antenna is housed inside the distant radome made of Dacron. The "bubble" is over 100 feet high.

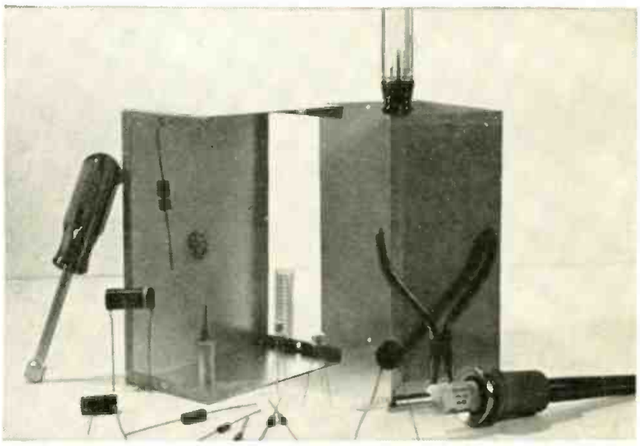


Inside the radome stands the giant parabolic antenna. Note the size of the access ladder near the base of the antenna.



Whatever your electronics interest,





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Radio-Electronics

Electronic Antenna Rotation

By RAY D. THROWER, WA6PZR

IN HAM-BAND, CB AND TWO-WAY COMmunication, a fixed antenna has one disadvantage—it can't be turned. This means it's nondirectional and unless most of your communication is in one direction you pick up undesired signals along with the desired ones. The answer to this problem, of course, is a beam, so you can null out interfering stations and get more gain in the desired direction (or directions).

Unfortunately, most low-frequency beams (80 or 160 meters) are large, expensive, and often objectionable to neighbors. Even at higher frequencies, beams are subject to mechanical problems, being exposed to the weather as they are.

Rather than physically turning the antenna, why not do the same thing electrically? Broadcast and commercial two-way stations have been doing this for years. Recently even some TV receiving and CB antennas have appeared using the same principle. The system is called a *directional array*, and consists of two or more vertical radiators or elements. Spacing and phasing of the two radiators are adjusted so that the rf fields add in some compass headings (thus producing greater signal) and cancel in others (thus producing lesser signal).

Basic DA operation

Fig. 1 shows three directional patterns you can obtain using two vertical radiators, a couple of hundred feet of transmission line, and some switches. Suppose you put up a tower or pole insulated from ground and used it as an antenna. The dashed-line circles in Fig. 1 show the pattern you'd get—a perfect nondirectional circle. Now suppose you put up another tower (you could actually use a flagpole or a telephone pole, and hang an insulated long wire off the side, just as long as the radiator is vertical). Space the second radiator 90 electrical degrees, or a quarter wavelength, away from the first.

First tie the transmitter to the first tower (let's call it X). Now tie the second (Y) in parallel, *but* insert enough additional line to delay the rf by 90 electrical degrees. The pattern you get is shown in Fig. 1-a, a cardioid with a sharp null in one direction and a large lobe in the opposite. Reverse the phasing and you will reverse the pattern, as in Fig. 1-b.

Add another 90° phase delay in the line to Y, or a total delay of 180°, and you'll have the pattern of Fig. 1-c, a bidirectional figure 8, with two sharp nulls at right angles to the lobes.

These are the three basic patterns that will be most useful in nulling out undesired stations and copying desired ones.

Antennas and ground system

There are steel or aluminum towers used for fringe-area TV reception which are reasonably priced and will do nicely as vertical radiators for low frequencies. For base insulators, you can buy ceramic cup types that electric power companies use on high-voltage line towers. You'll have to guy the towers, and break the guys with porcelain strain or egg insulators.

Alternatively, you can put up telephone poles or flagpoles and hang an insulated wire off the side as a radiator.

The two radiators should be equal in height. How high they are depends on how much money and guy space is available. Fig. 2 shows vertical-radiation patterns for four vertical radiators of four different heights, separately. At (a) a 270° tower has a great deal of high-angle radiation and only moderate ground-wave propagation. The 225° or ⅝-wave antenna at (b) has the theoretical maximum groundwave efficiency (good chiefly for local work, or long-hop DX), with only small lobes at skywave angles. The half-wave antenna of (c) has very little high-angle radiation and still a great deal of low-angle. Finally, the 90° or quarter-wave radiator of (d) is a fair compromise between high- and low-angle propagation.

Since the shorter towers cost less, the quarter-wave is probably the best bet, and you may decide to make do with even less. Don't try anything less than a 45° or eighth-wave height, however; it will be so inefficient your time and money will be wasted. Such short

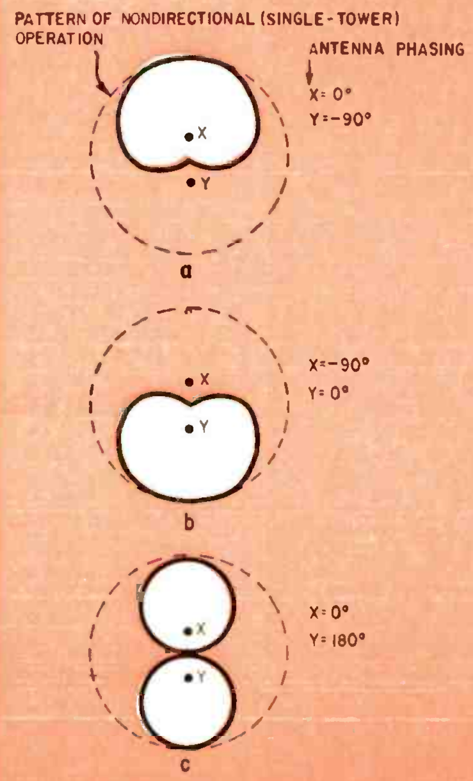


Fig. 1—Horizontal radiation patterns of two vertical antennas spaced ¼ wavelength and driven with phasings shown.

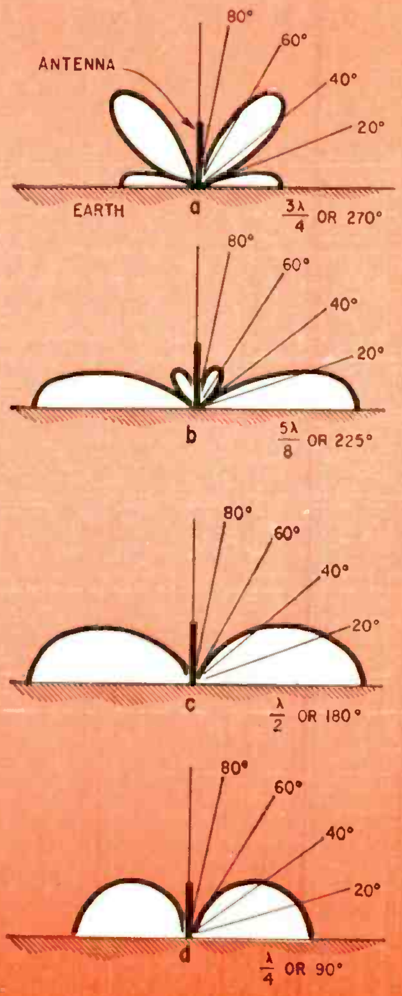


Fig. 2—Vertical radiation patterns of vertical antennas of several heights.

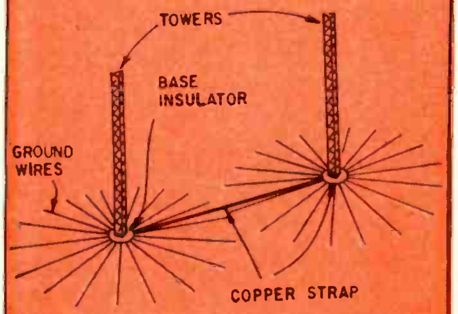


Fig. 3—A fairly good ground system.

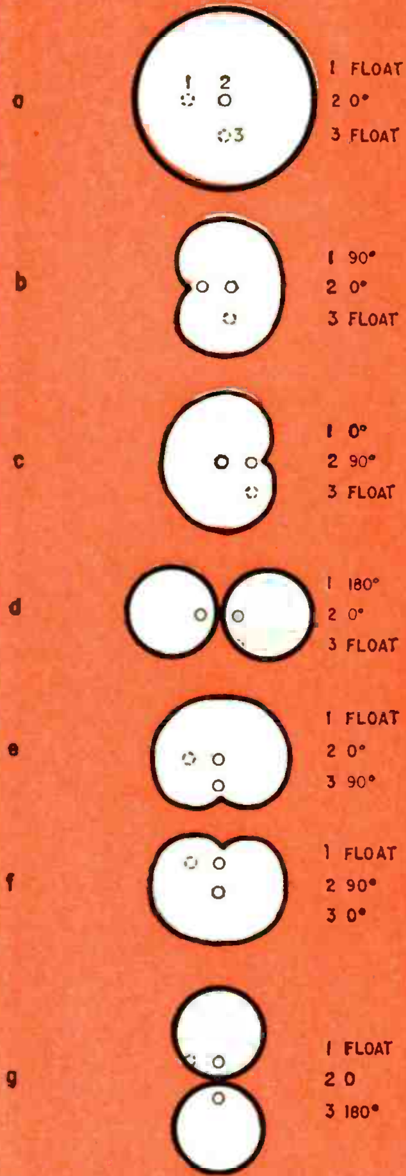


Fig. 4—By using 3 towers in an L-shaped array, you get these 7 patterns.

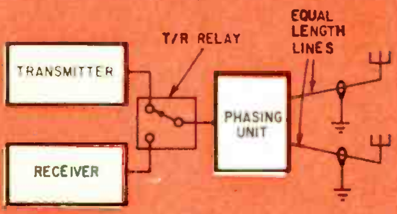


Fig. 5—How to connect phasing unit.

antennas have low radiation resistances and ground-system losses take most of the rf power. They also have lots of reactance and are difficult to match to transmitters.

The towers should be spaced 90 electrical degrees apart (a quarter wavelength). This is the best compromise between two undesirable extremes. Greater than 90° spacing produces a pattern with an increasing number of lobes and nulls. Closer than 90° spacing produces high mutual impedance between towers, which lowers radiation resistance and requires more rf driving current. Up go the losses and down goes the system efficiency.

If you don't plan to put a good ground system in, then don't bother to put up the radiators at all. As I said before, you'll be wasting time and money. The radiation resistance of an antenna is what the rf works into. But in a vertical radiator the ground system is the electrical return—the other half of the circuit—so the ground-system resistance is in series with the radiation resistance of the antenna.

A vertical radiator 54° (0.15 wavelength) in height has a radiation resistance of about 10 ohms. In Fig. 3 radial wires are laid in the ground extending outward from the base of each tower. Considering just one tower for a moment, if there are 120 radials each a quarter wavelength long, ground resistance will be about 1 ohm. Total system resistance is 11 ohms. If a 100-watt transmitter is connected, the ground system will take about 9 watts, leaving 91 watts for the antenna to radiate into space.

Suppose the ground system consists of merely a piece of pipe driven into the ground at the base of the antenna. Ground resistance would be about 50 ohms, for a total of 60 ohms. Assuming the same 100-watt transmitter, the ground-system loss would be 83 watts, leaving only 17 watts for the antenna.

If you can't afford to put a lot of copper into the ground, it's better to put shorter rather than fewer radials. Try for at least 15 or 20 equally spaced radials. Since you have few, they don't have to be so long—only about an eighth wave. Making them longer will have almost no effect.

As Fig. 3 illustrates, bond the radials to a ring of copper strap around the base of each tower. Connect the shield of the transmission line to the ring. Use a section of strap between the towers to tie the wire ends where they overlap. Use another strap to connect the two base rings together. Radial wires may be buried a few inches in soil (not deeper, though) or left on the surface if there's no pedestrian traffic.

Your operating frequency will determine the height of the antennas. For 160-meter (1.9-kHz) use, you'll probably want to use eighth-wave towers, about 65 feet high, since a quarter wavelength is 130 feet, and that kind of steel runs into money. Here are quarter wavelengths for other bands:

Band in meters	*Freq. in MHz*	*Approx.* $\frac{\lambda}{4}$ *in ft*
80	3.9	63
40	7.1	35
20	14.1	17
CB	27.0	9
10	29.0	8
6	50.0	5

Specify the center of the frequencies you operate on and use the following formula to determine *exact* antenna height and spacing:

$$\frac{\lambda}{4}\text{ (ft)} = \frac{246}{f(\text{MHz})}$$

At the higher frequencies—say from 27 MHz on up—it becomes quite simple to erect poles or tubular masts. Also, you can even use ground-plane antennas on a roof, but their operation will vary from those described here. This article concerns *only* vertical radiators with bases on the earth itself.

Choosing patterns

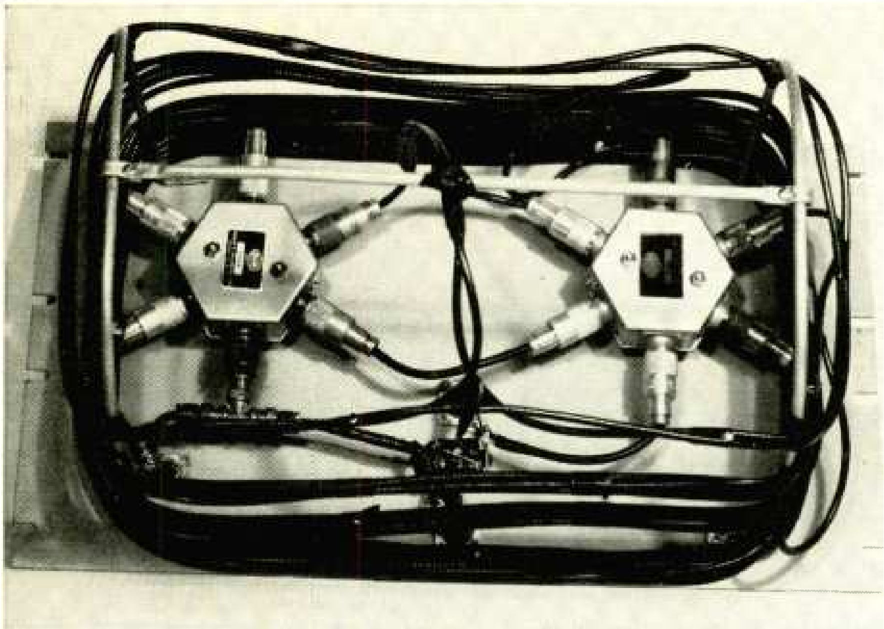
Decide how many and what patterns you want, for this will determine how many towers you must erect. With two radiators, you'll be able to get four useful patterns (more are available, but hardly worth the trouble). Three are shown in Fig. 1. The fourth (not shown) is nondirectional, obtained by driving only a single tower.

If you erect two radiators in a north–south line, signal lobes will be also north–south. How to get east–west lobes? Simple—put up a third radiator, making an L-shaped array, again using 90° spacing. By driving only two towers at a time you can shift patterns. Fig. 4 shows how.

The phasing unit

As Fig. 5 shows, the system for introducing phase delay is placed between the transmit–receive relay and the towers. The transmission lines from the phasing unit to the towers must be exactly equal in length, so no unwanted phase shift is introduced.

Circuit connections are shown in Fig. 6. All switches are coaxial. S1 and S2 must be switched separately by hand and must always be in equal positions. As shown, S2 allows tower 2 to float, while S3 connects tower 1 to the direct line from the transmitter, for nondirec-



While this isn't the unit described in the text, it shows switch and cable placement.

tional operation.

When S1–S2 are in position B, the first 90° delay line is put in series with the transmitter output and tower 2. This produces pattern C of Fig. 4. With S1–S2 in position C, both 90° sections of line are put in series with tower 2, producing pattern D of Fig. 4. S3 is used to reverse the cardioid pattern C to B.

S4 is optional but necessary if a third tower is used. Tower 2 becomes the center radiator, while towers 1 and 3 are alternately floated by S4, thus changing pattern orientation from east–west to north–south.

Components specified in the parts list will operate up to 1 kW and 100 MHz. Below about 150 watts *and* 5 MHz, you can save money by using RG-58/U and noncoaxial switches.

After you've decided the operating frequency, compute the 90° length, with the wavelength mentioned earlier. As an example, for 3.9 MHz, 90° is 63 feet. Multiply this figure by the propagation constant of the coax you're using. This constant is found in many engineering handbooks and also in cable manufacturers' catalogs. For RG-8/U and RG-58/U the constant is 0.66. Thus 63 × 0.66 is 41.6, or about 41½ feet.

The photo shows a slightly different system, but illustrates parts placement on the back of the cabinet front panel. Bolt a frame of tubing to the panel as a cable support. After you've cut the lines and attached connectors, form the cable into loops around the support frame and tape or lace them in position. Be sure to leave enough slack at the ends to reach switches and connectors. Don't force the coax into sharp bends or you'll change impedance and create a hot spot for arcover, as well as increase standing-wave ratio.

It's a good idea to place S1, S2 and S3 as close together as possible, so the coax between them can be very short. This prevents adding undesirable phase shift between radiators.

Tuning the system

Simply float tower 2, and load tower 1 to match your transmitter output as you normally would. Then reverse the procedure. One big advantage to using quarter-wave radiators is that reactance is practically zero. Radiation resistance of such a tower will be about 35 ohms. This is not a bad match to 50-ohm cable, since the ground resistance will be in series, and will probably be 5 to 25 ohms. When both towers are being driven in parallel the total resistance will be half that of each. This means when switching from non-D (nondirectional) to DA (directional array) operation you'll have to retune the transmitter output. Of course, if you never use non-D the resistance will remain constant. Even in the three-tower array no more than two towers are used at a time. You can, of course, add compensation—a dummy load resistor to be switched in place of the floated tower. This cuts radiated power in half, though.

Don't forget to use a lightning arrester at the base of each tower. Commercial models are available at parts houses. They are inserted into the feedline at the antenna base.

It's not a good idea to switch patterns while the transmitter's on the air, for you can cause voltage surges across switches that may damage them or the coax. Kill the high voltage when switching. In the receive mode you'll do no damage by switching. In fact, the system patterns are just as valid for receiving, and that's where you'll find the real value of this array. When you reverse a null, away goes an interfering signal! Have fun with your directional system. END

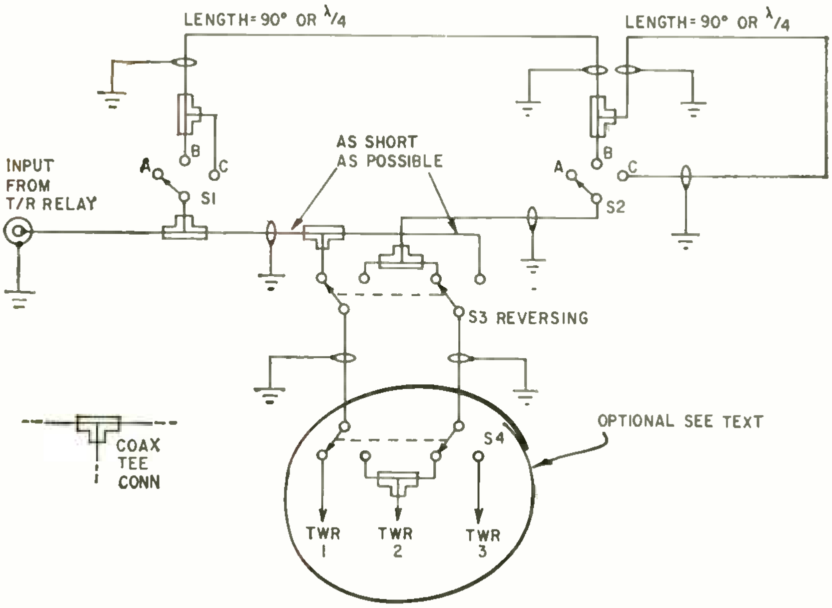
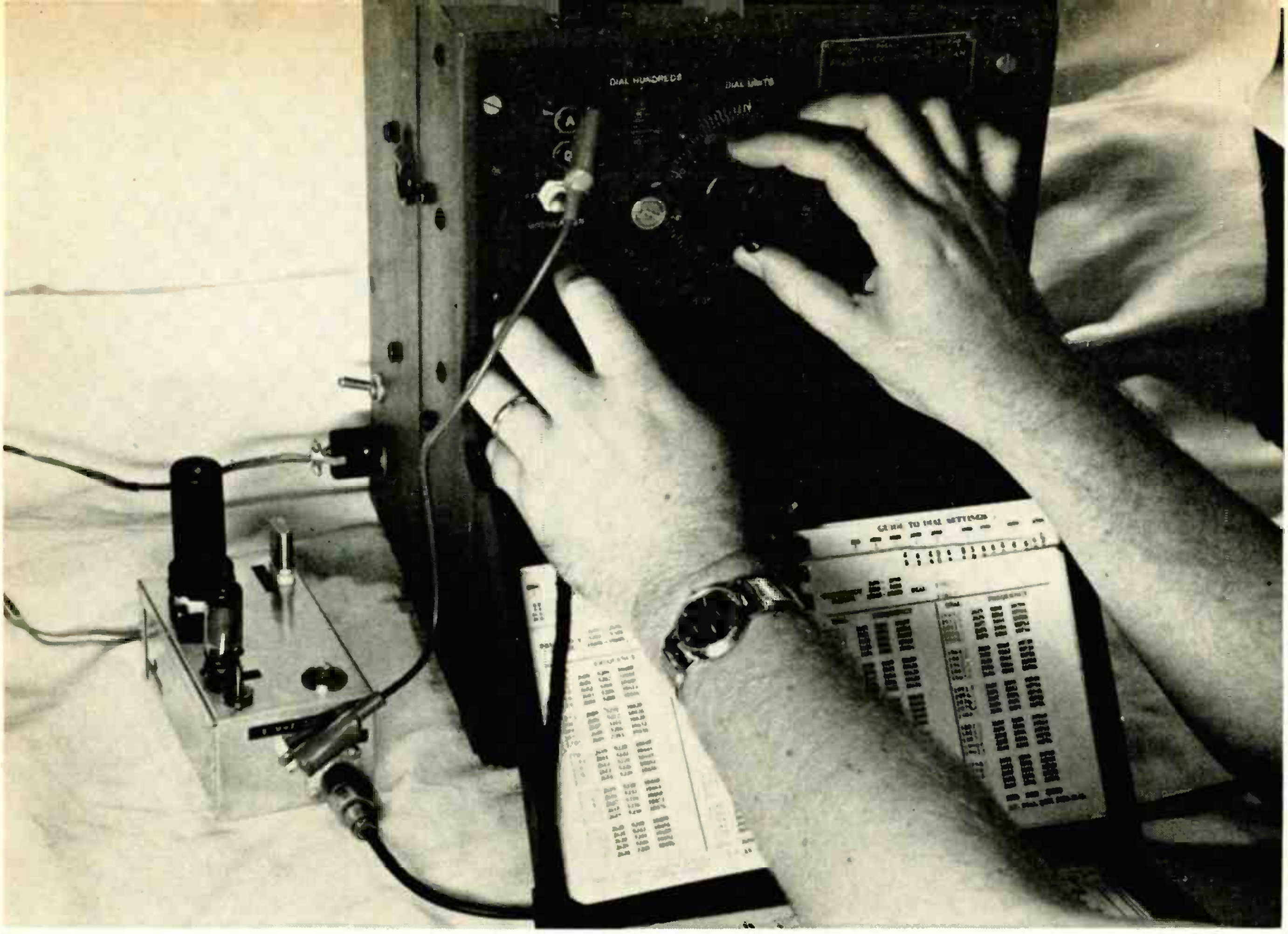


Fig. 6—Interconnections inside phasing unit. All wiring must be coaxial cable.

Parts List

- S1, S2—coaxial switch, sp3t, with uhf-type connections (Dow-Key DK78-3, or equivalent)
- S3 (and S4, if used)—coaxial switch, dpdt, with uhf-type connections (Dow-Key DK78-T, or equivalent)
- 6—tee connectors, uhf type, M-358 (Amphenol 83-1T, or equivalent)
- 27—coax plugs, uhf type, PL-259 (Amphenol 83-1SP, or equivalent)
- 3—coax receptacles, uhf type, SO-239 (Amphenol 83-1R, or equivalent)
- RG-8/U coaxial cable, as needed
- Panel and cabinet to fit cable lengths



Check CB Frequencies With BC-221 and a Converter

By RON GUNN

WITH THE CONVERTER AND THE INFORMATION in this article, you can measure Class-D Citizens-band frequencies on a surplus BC221 or LM frequency meter to an accuracy of .0015% or better, a maximum of 400 Hz. Other hf and vhf frequencies can be read off at the same 400-Hz accuracy with this technique. A little experimentation will demonstrate the actual limits over which you can have confidence in the readings. The trick is an easily built and inexpensive crystal-controlled converter, a principle used in the best receivers and frequency-measuring equipment. We'll also talk about the modification and use of the meter for maximum accuracy.

Nothing is more discouraging than having to turn down a job because you don't have the necessary equipment. Many technicians own a BC221 or LM, but dependable measurement of Class-D frequencies is not possible on the bare BC221. Its accuracy of .02% is four times the allowable 1,350-Hz limit on the band. That .02% is only 400 Hz at 2 MHz, though. The frequency converter you can build from this article accurately heterodynes the 27-MHz output of the Class-D transmitter to about 2 MHz so that you can get 400-Hz accuracy.

The converter

The converter consists of two parts (Fig. 1): a crystal-controlled oscillator and a pentagrid mixer. The fundamental frequency of the crystal oscillator is 5 MHz. This fundamental or its harmonics are beat against WWV at 5, 10, 15 or 20 MHz for calibration. A small trimmer is wired across the crystal so you can zero-beat the oscillator.

The plate circuit of the electron-coupled oscillator is set to the fifth harmonic of the basic frequency, or 25 MHz. The extreme stability of this oscillator under use is due to the very loose coupling to the mixer (5 pF), the fact that the plate circuit is tuned to a high harmonic, and the added isolation obtained by using an electron-coupled circuit.

A pentagrid mixer gives additional isolation between the transmitter signal to be measured and the standard oscillator. Any pulling of the oscillator would affect the frequency reading and must be avoided. In this circuit, keying the transmitter on and off does not change the oscillator–WWV beat by even 1 Hz.

A dummy load is included to take the transmitter output. A lamp is used to observe transmitter output during the frequency check. A sample of the signal is taken off through a 5-pF capacitor and goes to the pentagrid mixer.

The difference between the 25-MHz standard input and the 27-MHz transmitter signal is developed across the 2-MHz broadband tuned circuit in the mixer plate and is coupled through a high-voltage capacitor to the output feedthrough. A high-voltage capacitor is used to reduce the possibility of the mixer B+ getting to the user's hand! A clip lead goes to the BC221 input.

Using a 6AG7 for the oscillator seems somewhat like using a steam roller to squash a bug, but it is a dependable and sensitive oscillator. Very loose coupling can be used because only a small percentage of its power is required. Its high gain reduces crystal current, so drift in the oscillator frequency is minimized. Reasonable substitutes would be the 5763 or 12BY7.

Converter construction

The converter in the photos was built in a 5¼ x 3 x 2⅛-inch Minibox. There was plenty of room. Construction took a couple of hours and alignment, after a half-hour warmup, took but a few minutes.

Layout is not particularly critical, but don't mount the crystal too close to the 6AG7. Locate the crystal padder so it can be adjusted easily. The output circuit at 25 MHz must also be tunable while the converter is operating, though it will have to be set only once. Leads from connector J to the dummy load should be short to minimize radiation.

Frequency meter

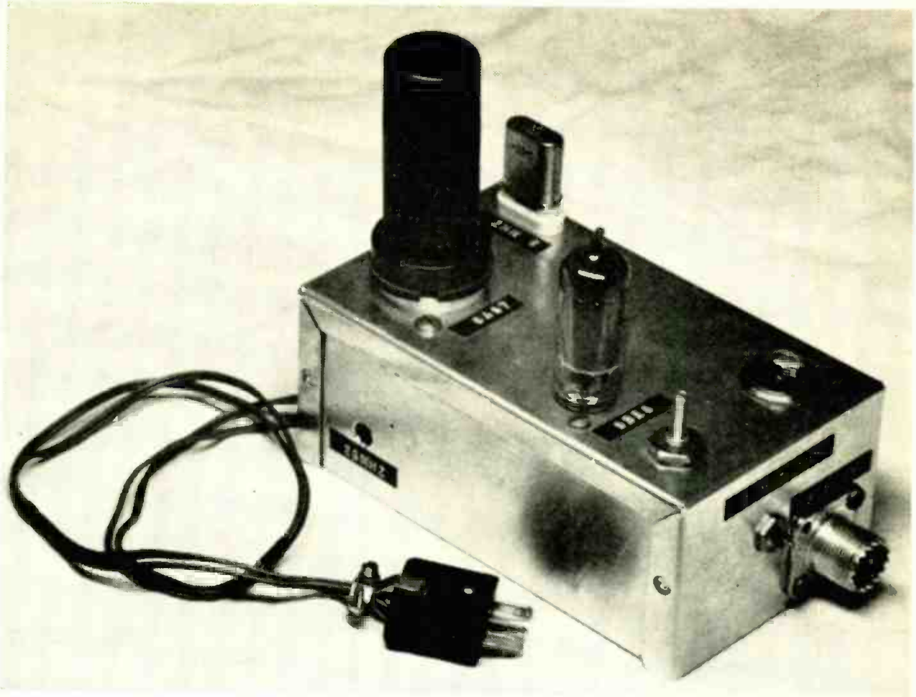
A well-calibrated BC221 or equivalent is the heart of this frequency-measuring setup. Be sure yours is in good shape before depending on it. A reasonable guideline is to allow less than one corrector division between check points. Even then, auxiliary checkpoints will have to be used, as explained further on.

Make sure that the coupling capacitor to the audio-amplifier grid is 0.22 μF or larger, as in Fig. 2-a. Many of them aren't. Parallel a 0.22-μF 200-volt paper capacitor with the existing one anyhow; it won't hurt and you do want to hear those low beat notes. Next, rewire the cathode of the audio amplifier as Fig. 2-a or 2-b. Now you *will* hear low beat notes.

Put in a three-conductor Jones plug as a power takeoff from the power supply to the converter. Include an spst switch in the B+ lead.

Converter setup and adjustment

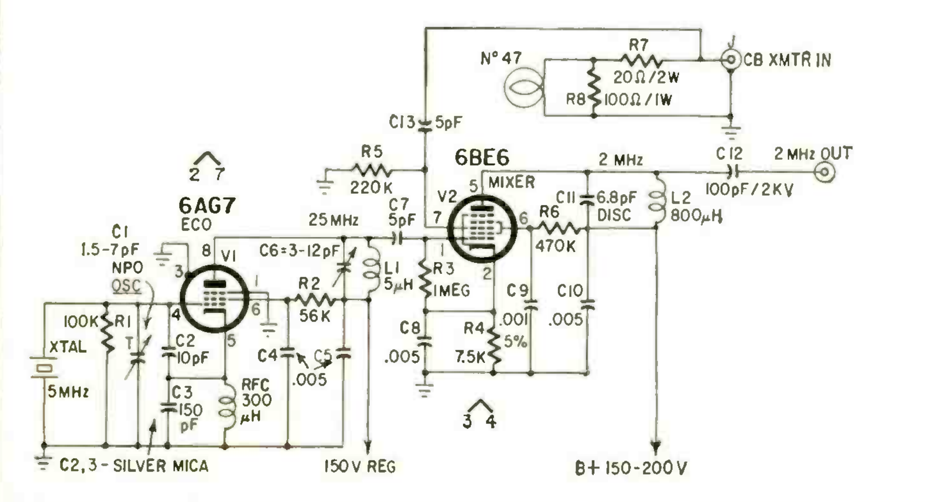
Warm up the meter and the converter for ½ hour or more. Set a nearby receiver on WWV. Zero the crystal oscil-



Converter you can build from this article is essential for upping accuracy of BC-221.

Converter Parts List

C1—ceramic trimmer, 1.5 to 7 pF, NPO (Centralab 822EZ or equivalent)
C2—10 pF, silvered mica
C3—150 pF, silvered mica
C4, C5, C8, C10—.005 μF, disc ceramic
C6—ceramic trimmer, 3 to 12 pF, NPO (Centralab 822FZ or equivalent)
C7, C13—5 pF, disc ceramic
C9—.001 μF, disc ceramic
C11—6.8 pF, disc ceramic, NPO
C12—100 pF, disc ceramic, 2 kV
J—type SO-239 coaxial female connector
L1—5μH (can be 14 turns Air Dux 832 or B&W 3016 coil stock)
L2—800 μH (J. W. Miller 4412 adjustable rf coil)
R1—100K
R2—56K
R3—1 meg
R4—7,500 ohms
R5—220K
R6—470K
R7—20 ohms, 2 watts
R8—100 ohms, 1 watt
All resistors ½ watt 10% carbon except as noted.
RFC—300 μH, rf choke (J. W. Miller 9350-20 or 70F334AI—listed in Allied Industrial Catalog)
V1—6AG7
V2—6BE6
XTAL—5-MHz crystal for 32-pF load, 25°C, with socket
No. 47 pilot lamp and socket
Two-piece aluminum case, 5¼ x 3 x 2⅛ in.



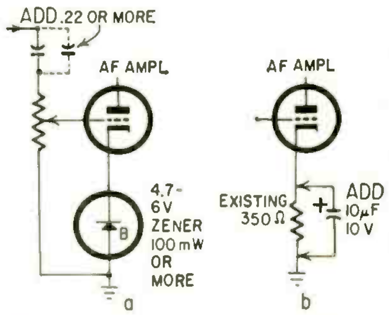


Fig. 2—See text for details on how to modify BC-221 audio stage.

Fig. 1—Converter schematic; 2-MHz output is via a test point.

lator and the frequency-meter 1,000-kHz oscillator to it. The switch in the converter B+ allows the converter to be turned off conveniently for zeroing the meter. Leave the WWV receiver on. It will serve to monitor the converter oscillator frequency.

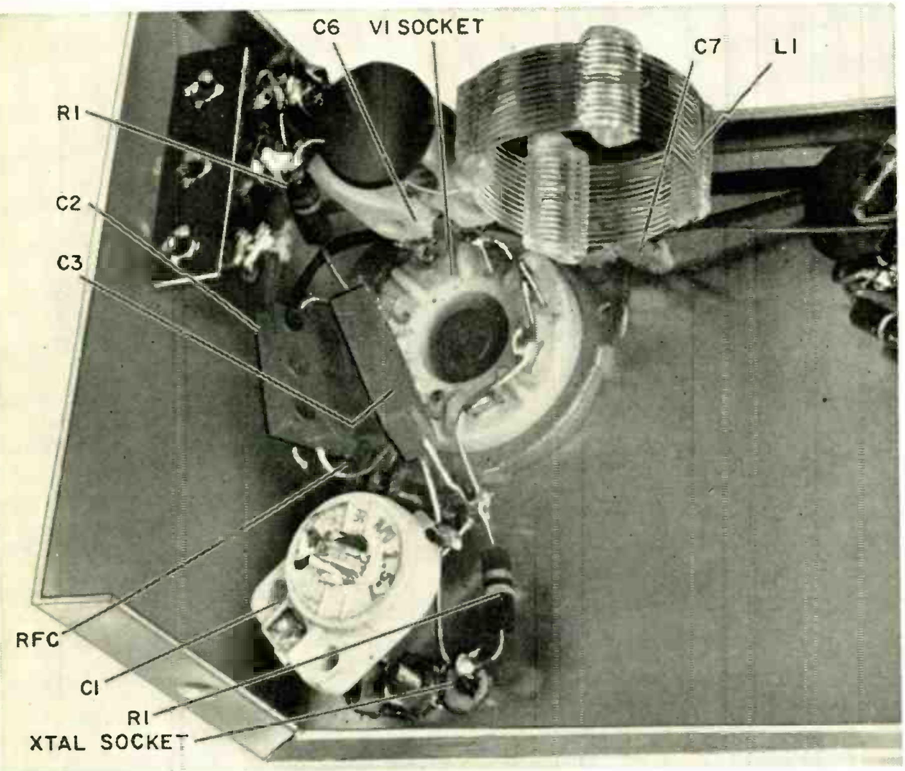
Now run a clip lead from the converter output to the frequency-meter input and run the CB transceiver into the 5-watt input connector. Put the transceiver on some intermediate channel, such as 11, and jot down the frequency (channel 11 = 27.085 MHz). Now subtract 25 MHz from this figure and, after calibrating with the corrector, set the frequency meter on this difference frequency (27.085 − 25.000 = 2.085 MHz).

The transceiver will hear a signal if everything is working properly. If there is no S-meter, connect a vtvm to the avc bus. Set the 25-MHz adjustment in the plate of the converter oscillator for maximum reading on the S-meter or vtvm. Then adjust the slug-tuned coil in the plate of the mixer for maximum signal. The converter is ready to use.

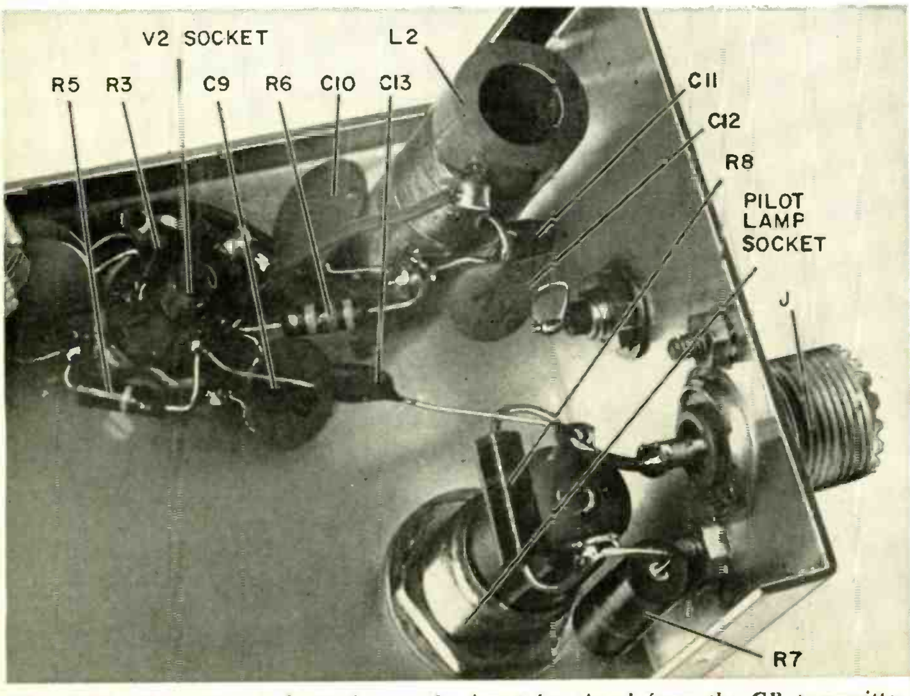
All 27-MHz frequencies will now come out accurately at 2 MHz. The table gives the channels and the frequencies they should read out at on the meter. Accurate channel-center signals of moderate strength are available for receiver calibration.

Channels 1, 2 and 3 are measured by taking the difference from 30 MHz. This inverts the readings. On these three channels a low reading on the frequency meter means the transmitter is high in frequency and vice versa.

Harmonics of the crystal oscillator can be tuned in at exact 5-MHz intervals to beyond 100 MHz. By adding another vhf tuned circuit in series with the 25-MHz plate circuit shown, the operating range could easily go past 150 MHz.



Closeup of 6AG7 electron-coupled oscillator stage with visible parts keyed to Fig. 1.



The 6BE6 mixer stage is located near the input for signal from the CB transmitter.

Meter operation

The BC221 frequency meter is originally calibrated with the corrector at one point. The readings in the book are not related to any one check point. You get best accuracy when you use the nearest one. The original checkpoints are too widely separated, even if the meter is acceptable as described earlier, for a 100–200-Hz tolerance in calibration to be maintained. Auxiliary checkpoints are required to reduce this span. The first two on the meter, for instance, are at 2,000 and 2,166.666 kHz, a span of more than 160 kHz. This is the range where we want 200-Hz or better accuracy of readings.

To improve accuracy in this range by a wide margin (the frequency may be off by 1 kHz or more if you use only the original check points), use the very good check point at 2,100 kHz and the very weak one at 2,050. For 2.035 to 2,065 (channels 7, 8 and 9) check the meter at 2,000 kHz, then tune to 2,050 to see if the beat note there is audible. If it is, zero it to reduce the calibration error at that point. For 2,075 thru 2,135 use the 2,100 check point, then shift to 2,166.666 to calibrate for 2,155 through 2,175.

Always use the closest check points and auxiliary ones as you go up. On my meter 2,000, 2,050, 2,100, 2,166.666, 2,200 and 2,250 are usable. On a reasonably good meter, the error will be less than 200 Hz. Mine held to less than 100 Hz on most channels when calibrated this way and checked on a digital counter (to the cycle!).

When you get the converter and frequency meter going, practice a while by reading signals off the air. If signals appear consistently high or low on a particular channel, especially when far from a check point, that part of the dial must be checked. Zero the corrector on the check point above the channel in question, then find out how many dial divisions of error there are at the check point below. If the error is too great, that part of the dial will require closer check points. These points are shown in the table.

Always go to the regular check point, then to the auxiliary check points shown. The reason is that many beats may appear in the range of the corrector. By using the regular check points first, the correct auxiliaries are within audible range and need be zeroed with the corrector only for accurate dial calibration.

Using the auxiliaries will always increase accuracy, but if your meter is reasonably good to begin with, your accuracy will be more than adequate. Read the auxiliaries as though they were signals, to see how close your meter is. If it is within a couple of hundred Hz, the auxiliaries need not be used unless a channel shows up very close to the edge. Now we have accuracy to burn!

Accuracy

Once you compensate for calibration error as described above, the greatest factor tending to throw off readings is under control. What else could go wrong? The BC221 manual mentions a few things that can be eliminated easily. If a 150-volt regulated ac supply is used, for instance, the 325-Hz allowance for low batteries is eliminated.

The manual also allows 250-Hz error for the 1,000-kHz standard being off. Checking against WWV at monthly intervals will reduce this error considerably. Checking the 1,000-kHz oscillator when the converter oscillator is checked (before each job) will eliminate it entirely.

Other maximum sources of error as listed in the manual are these:

1.	Small shocks	100 Hz
2.	Locking the dial	30 Hz
3.	Warming up	100 Hz
4.	Changing load on antenna post	50 Hz
5.	10% drop in battery voltage or 5° ambient temperature change	325 Hz

Items 1, 2 and 4 are things to think about when operating the meter. Items 3 and 5 are error-producing only as the frequency of the 1,000-kHz standard is affected, and apply primarily to field work. We are then left with the calibration error, which is slight near the check points.

There is a built-in limit to the calibration accuracy because the calibration book is good only to the nearest tenth of a division. The approximate separation between tenths is 50 Hz, so any point in the book may split this difference and be off by up to 25 Hz in either direction.

Given an accurate setting of the converter oscillator and the 1,000-kHz meter standard, the overall error of this setup is very small. You can make readings consistently to 100 Hz or less. This accuracy will decrease as you get away from the check points, depending on the meter. Know yours: with a poor one you might have to use all of the auxiliaries shown in the table to get acceptable accuracy.

Other applications

The principle of operation we've talked about applies to any other band as long as the 5-MHz oscillator harmonics are strong enough. Higher harmonics can be strengthened by adding another tuned circuit or by substituting a different one if you don't need the range around 25 MHz.

If more strength is necessary in the harmonic output, a varactor would undoubtedly help a lot, particularly at vhf. Zeroing the 5-MHz oscillator to WWV becomes critical at higher frequencies. A 50-Hz error at 10 MHz becomes 600 Hz at 120 MHz. Also, it is best to stick with the 2- to 4-MHz basic high range of the instrument, even though subtraction must be used on some readings. There are few birdies and misleading signals to cause confusion.

This setup is a real pleasure to use. It isn't tricky or temperamental. It can be reset to a previous setting within 50 Hz, and the absolute accuracy is not much worse than that near the check points.

Frequency certification and any transmitter adjustment that might affect the frequency can be done only by holders of an FCC First- or Second-Class Radiotelephone License. END

CB CHANNELS AND FREQUENCIES AS READ ON BC221

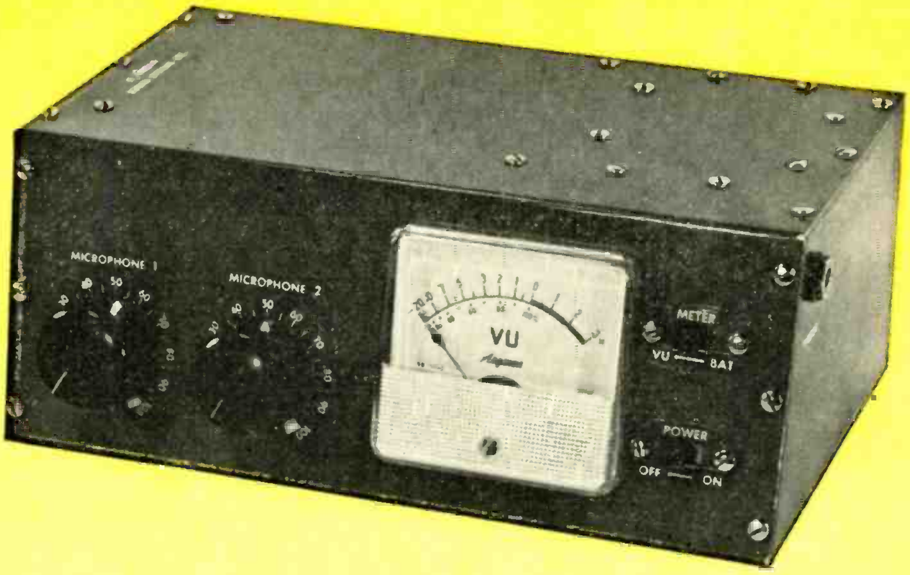
Chan	Freq (MHz)	Read at kHz	Check	Aux Check	Note
1	26.965	3,035			1
2	26.975	3,025			1
3	26.985	3,015			1
4	27.005	2,005	2,000		
5	27.015	2,015	2,000		
6	27.025	2,025	2,000	2,040	
7	27.035	2,035	2,050	2,040	2
8	27.055	2,055	2,050		
9	27.065	2,065	2,050	2,067	3
10	27.075	2,075	2,100	2,067	3
11	27.085	2,085	2,100		
12	27.105	2,105	2,100		
13	27.115	2,115	2,100	2,125	
14	27.125	2,125	2,100	2,125	
15	27.135	2,135	2,100	2,133	3
16	27.155	2,155	2,166	2,150	
17	27.165	2,165	2,166		
18	27.175	2,175	2,166		
19	27.185	2,185	2,200		
20	27.205	2,205	2,200		
21	27.215	2,215	2,200		
22	27.225	2,225	2,200	2,233	3
23	27.255	2,255	2,250		

Notes

1. Reading obtained by subtraction from 30 MHz. High meter reading means transmitter is low in frequency.
2. Calibrate with corrector at 2,000 kHz before moving to 2,050.
3. Auxiliary check point reading shown must be interpolated from calibration book.

Use the spaces under the frequencies given in the Read at kHz, Check, and Aux Check columns for writing in your own meter calibration points. This table then becomes a permanent reference for your own frequency meter.

There's not an audio man alive who won't find a use for one of these in the next few months! Try one yourself—and find out



Build An All-Transistor Mixer-Amplifier

By HARVEY INMAN

ALTHOUGH THIS MIXER-AMPLIFIER WAS designed for low-cost remote broadcast pickups, it has dozens of other uses in recording, broadcasting and public address. Even if you don't need a balanced 600-ohm line output monitored by a VU meter (which it has), you'll appreciate this amplifier's low output impedance. With it you can run long lines to the input of a recorder or amplifier with very little noise pickup or loss of high frequencies.

The mixer–amplifier can be built for less than $50 including meter and cabinet—much less if you can scrounge some of the parts or eliminate the meter circuit.

The amplifier's distortion is less than 1%. Its frequency response is within 1 dB from 50 Hz to 15 kHz. Noise is at least 50 dB below the output level corresponding to an input of −60 dBm. With good components and reasonable care in construction, you should be able to easily equal those specifications yourself.

Only two types of transistors were used in the completed design. Q1 through Q6 are pnp general-purpose replacement transistors (RCA SK3004). Q7 is npn (RCA SK3010). Similar general-purpose transistors are made by other major manufacturers and probably would give good results.

There are two input channels using high-level mixing. A master gain control was not considered necessary for a two-channel mixer and was omitted for simplicity and economy. For the same reasons, no input transformers are used. While input transformers allow the use of balanced microphone lines, good transformers are expensive and add nothing to the performance of a transistor input in most cases. If you want to add one, you can.

A low-impedance microphone will operate satisfactorily, and with low noise, directly into the transistors. The input impedance to the transistors is high enough to permit a microphone to work into an essentially unloaded input, as is recommended for most low-impedance microphones.

The input stages (Q1 and Q2) represent a compromise between low-noise operation and high-signal-handling capability. Besides lowering the gain, the unbypassed 100-ohm resistors in the emitter circuits raise input impedance, lower distortion, and let the transistors handle a larger input signal without overload.

The mixing circuit is very simple and effective. The mixing loss at maximum gain settings is very small with this type of circuit, and interaction between the two controls is only about 3 dB when a control is turned all the way open. This is apparent only when feeding in a steady tone and is not noticeable with normal program material. At normal settings of the controls, no interaction at all is apparent.

This type of gain control should be used only when feeding out of a circuit of relatively high impedance to prevent, among other troubles, a change in frequency response as the control is varied. The output impedance in this case is approximately the resistance of the 10,000-ohm collector resistors (R4, R10). The coupling capacitors (C3, C6) are in series with this impedance and the impedance looking into the pots. Their reactances are small enough to be negligible at the lowest frequency of interest.

Q3 and Q4 are conventional voltage-amplification stages. Emitter resistor R20 is bypassed at the higher frequencies to compensate for the declining high-frequency response of the output transformer. The low-end response was considered adequate without compensation. A higher-quality transformer would have made the high-frequency correction unnecessary, but the trouble of compensating the response was cheap compared to the price of a first-quality transformer. Again, if you wish, you may use one.

Q5 is a direct-coupled driver for Q6 and Q7. This stage must pass somewhat more collector current than the preceding stages to drive the output transistors with low distortion.

The output stage operates class-B single-ended push-pull. This type of circuit has several advantages over a transformer-coupled output stage for a high-quality amplifier. The output transformer for a conventional class-B stage must have very tight coupling between the two halves of the primary winding to prevent ringing when the current is abruptly switched from one winding to the other each half-cycle. In the single-ended push-pull stage, no such demand is made on the output transformer. The

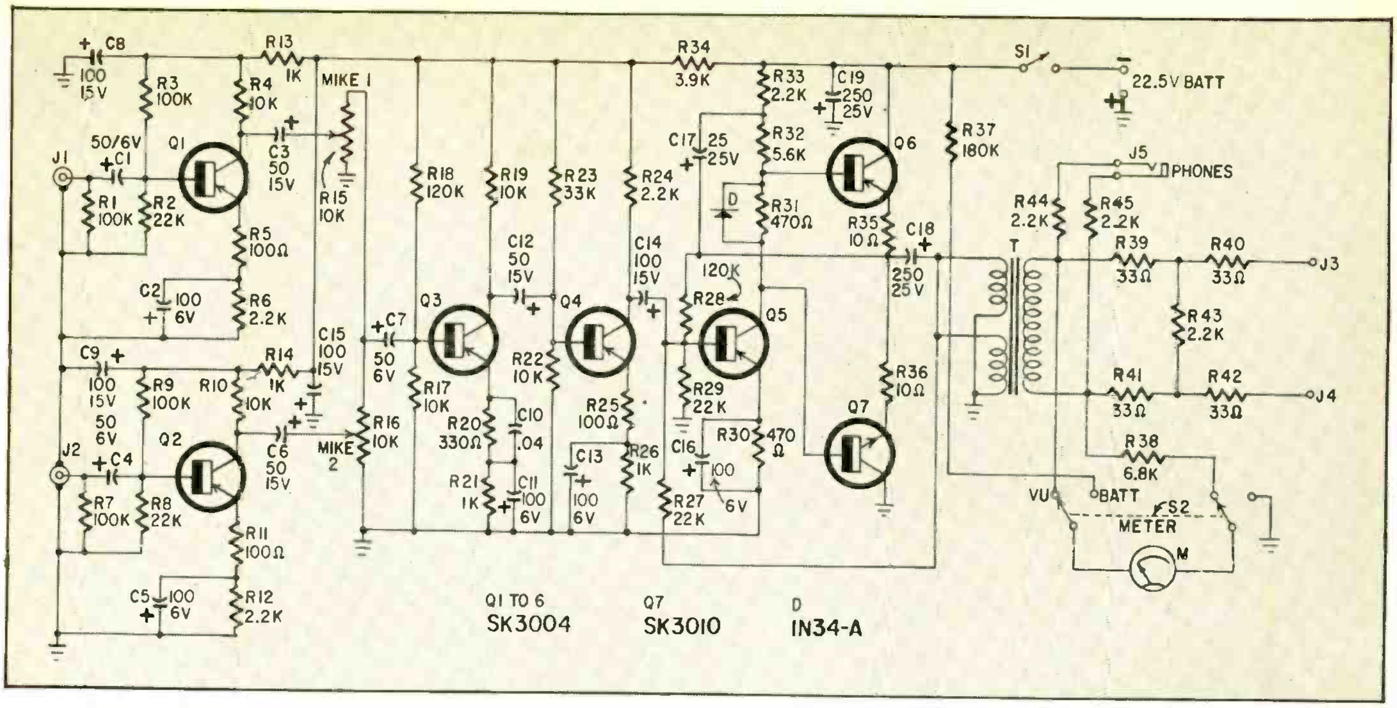
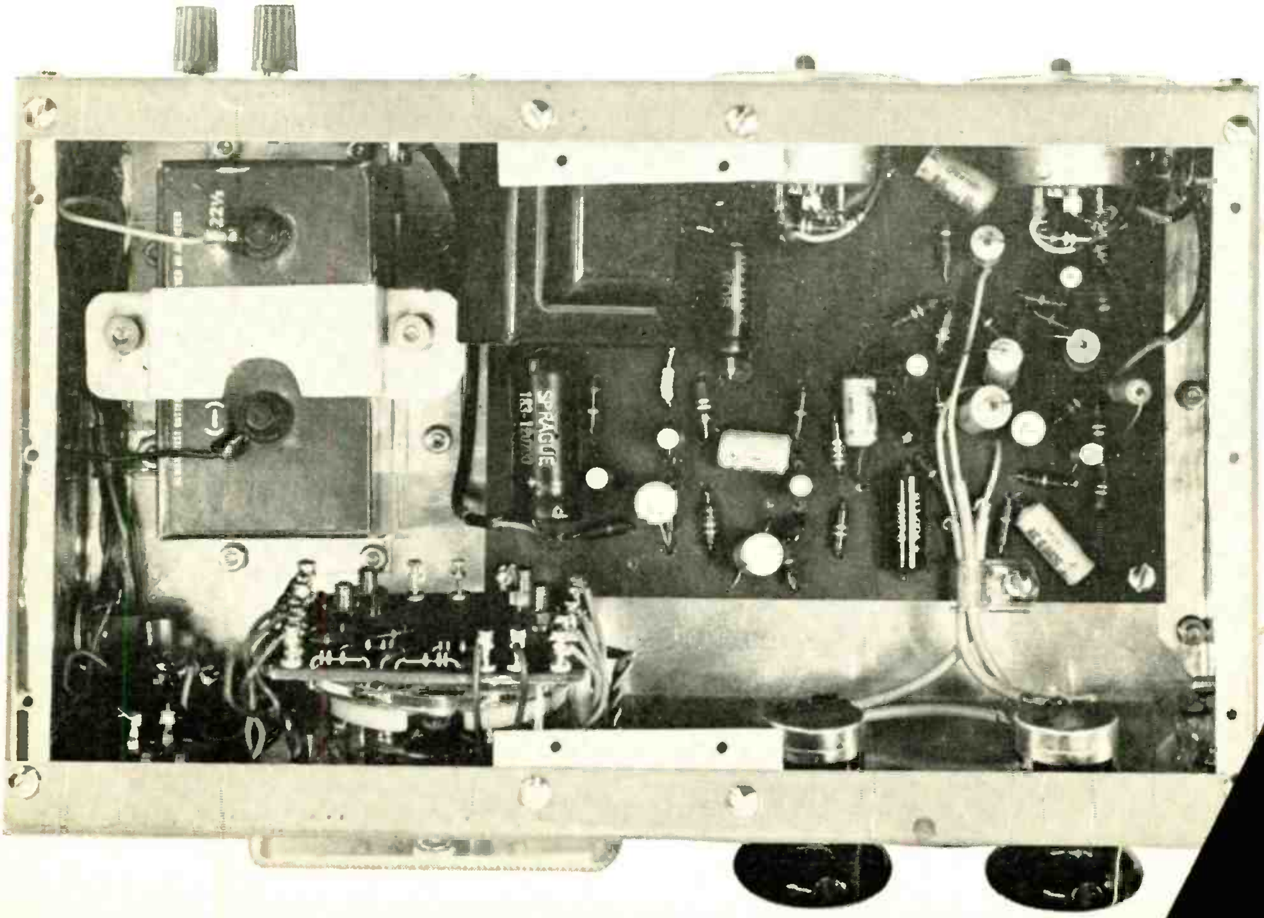


Fig. 1—Schematic of the battery-powered all-transistor mixer–amplifier. Use it for PA, recording, or general sound work.

C1, C4, C7—50 µF, 6 V, electrolytic
C2, C5, C11, C13, C16—100 µF, 6 V, electrolytic
C3, C6, C12—50 µF, 15 V, electrolytic
C8, C9, C14, C15—100 µF, 15 V, electrolytic
C10—.04 µF, paper or ceramic
C17—25 µF, 25 V, electrolytic
C18, C19—250 µF, 25 V, electrolytic
D—1N34A diode
J1, J2—microphone connectors (to match mike plugs)
J3, J4—binding-post terminals (2 required)
J5—headphone jack (single-circuit)
M—VU meter (Lafayette 99 C 5043)
Q1, Q2, Q3, Q4, Q5, Q6—SK3004 (RCA)
Q7—SK3010 (RCA)
R1, R3, R7, R9—100K
R2, R8, R27, R29—22K
R4, R10, R17, R19, R22—10K
R5, R11, R25—100 ohms
R6, R12, R24, R33, R43, R44, R45—2,200 ohms
R13, R14, R21, R26—1,000 ohms
R15, R16—10K audio-taper pots
R18, R28—120K
R20—330 ohms
R23—33K
R30, R31—470 ohms
R32—5,600 ohms
R34—3,900 ohms
R35, R36—10 ohms
R37—180K
R38—6,800 ohms
R39, R40, R41, R42—33 ohms
All resistors 10% tolerance, ½ watt
BATT—22½-volt battery (Eveready 763 or equivalent)
S1—spst slide switch
S2—dpdt slide switch
T—150-ohm to 600-ohm line-to-line transformer (SNC 1P161) see text.



two halves of each cycle are combined in the output stage itself, and a transformer is needed only for impedance matching or for feeding a balanced line. This will depend on your usage.

The stage operates as an emitter follower, with the advantages of low output impedance, low distortion, and better high-frequency response. Because of the built-in negative feedback, the output transistors do not have to be critically matched. This should make your job easier.

Any class-B stage must conduct a certain minimum resting current to prevent crossover distortion (a "jog" in the waveform where the signal is switched from one transistor to the other). This kind of distortion is especially objectionable. It is decreased here to a very small value by forward-biasing Q6 and Q7 for about 1.5 mA collector current. The bias is set by diode D, shunted by R31. The voltage drop across D does a good job of stabilizing the current of Q6 and Q7 with declining battery voltage and varying temperatures. This makes performance fairly constant in the field.

T is a multi-impedance transformer. A Stancor A-4350 may be substituted. Connect the primary for 125 ohms and the secondary for 500. Change C10 to .015 μF.

The negative-feedback networks are designed to allow the amplifier to be unconditionally stable. Feedback from the output stage is returned to the base of Q5 by two paths. Feedback through R28 tends to stabilize the voltage division between Q6 and Q7, as well as reduce distortion and lower output impedance. R27 supplies additional feedback and helps prevent a dropoff in low-frequency response caused by the increasing reactance of C18 at low frequencies. Positive feedback through C17 furnishes Q5 with a higher effective collector voltage under signal conditions. This greatly aids Q5 in supplying the ...ge swing necessary at full amplifier

... is a pad of about 2 dB in the ... prevent changes in load- ... the operation of the ...what larger pad is ...n feeding long ... seems ade- ... dB may ... be a ...al-

...it

...de in ...ne me- ... to have the proper damping and frequency response, it should be fed from a source resistance of 3,900 ohms. For levels higher than + 4 VU the meter multiplier usually takes the form of a T-pad. For this inexpensive meter, a single series resistor was chosen to make the meter read zero when + 4 dBm appears at the output terminals loaded with a 600-ohm resistor. Once again, a compromise has worked out fine in practice, but it is not recommended if you go to the expense of a standard VU meter.

The meter is also used to check the battery condition. When METER switch S2 is placed in the BAT position, the meter is connected to the battery through R37, which is selected to make the meter read zero with a new battery. Thus you have a quick check "on location."

After constructing the amplifier, make a few measurements to verify correct operation. The voltage at the junction of R35 and R36 should be half the battery voltage. A difference of a few tenths of a volt is nothing to worry about, but if the voltage is off by more than about 0.5 volt, change R28 to the next higher or lower standard value that you can obtain.

A radically different voltage at this point indicates a defective component somewhere in the output or driver stage. The measurements should be made with a new battery, since it is not possible to hold this optimum voltage division with a weak battery.

Measure the current drawn by the complete amplifier. Normal current is between 7 and 8 mA. The output stage should draw about 1.5 mA. Check roughly by first measuring the current drawn by the amplifier, then placing a temporary short across D and observing the decrease in current when the forward bias of Q6 and Q7 is thus removed. R31 should be decreased if the change in current is more than 1.5 mA. If the change is less than 1.5 mA, remove R31 entirely.

The signal-to-noise ratio was 57 dB with −60 dBm input from a 600-ohm source and the gain adjusted for +4 dbm output. When the gain was increased for +14 dBm output, with the input at the same level, the noise was 60 dB down. This indicates that a significant amount of the residual noise is generated in the stages after the mixers.

Maximum gain through each channel is about 80 dB, more than adequate for all normal use. The input stages are designed to handle microphone levels. If inputs other than microphones are used, it might be necessary to attenuate the signal before putting it into the amplifier.

Battery life with the specified battery should be well over 100 hours. The amplifier will still operate properly when the voltage has dropped to 15. At this point the distortion is still below 1%, and the gain drops only slightly.

The main portion of the amplifier was built on a 4- by 6-inch etched circuit board, and this method is highly recommended if possible. Copper-clad board and etchant solution are available from electronics mail-order houses; and the work is not difficult. The circuit pattern can be painted on the copper side of the board with a small brush and quick-drying lacquer. After etching, the paint is easily removed with lacquer thinner or speaker-cement solvent. You can also do a good job with perforated phenolic board.

The output pad, R37, R38, R44 and R45 were mounted on a second small board, which was drilled to mount on the meter terminals. The meter terminal nuts hold the board in place. The output transformer was mounted to the back of the cabinet.

No instability appeared, but as with any high-gain amplifier the input circuits should be well separated from the output.

I had a cabinet made of sheet aluminum. A small commercially made utility cabinet will serve just as well. A removable bottom plate allows access to the inside. The circuit board is mounted to the inside top of the cabinet on metal spacers. After cutting all holes in the cabinet, I spray-painted it and labeled the controls, switches and jacks with decals.

If you use the amplifier to feed a high-impedance (unterminated) load, connect a 620-ohm ½-watt resistor across the output terminals. The amplifier will work without it, but the VU meter readings will be different and the frequency response may be altered. Substantial runs of line (perhaps 100 feet or more) are usually possible with unshielded twisted-pair. If hum or radio-frequency interference is a problem, you will have to turn to shielded, two-conductor cable.

Carefully built and adjusted, this amplifier should give years of service with only occasional battery replacement. END

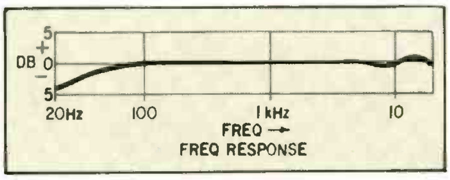
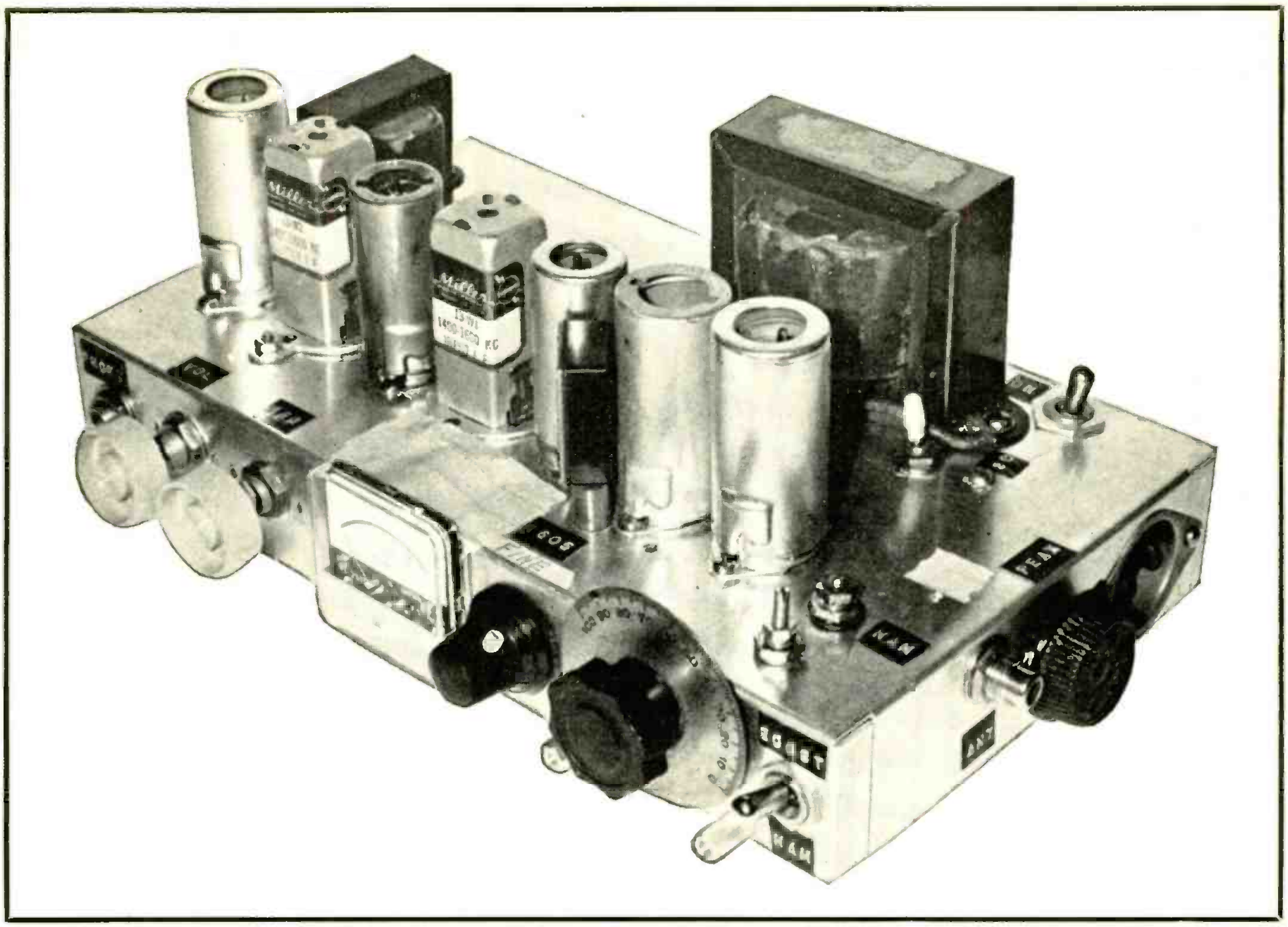


Fig. 2—Frequency response of amplifier meets broadcast standards. The 0-DB reference level is actually +4 dBm (+4 VU) measured at amplifier output.



Build Your Own Shortwave Receiver

Here's a good way to gain valuable construction experience in radio

By I. QUEEN

SHORT-WAVE LISTENING IS AN EXCITING and rewarding pastime. Because of the remarkably distant reception (DX) possible at the higher frequencies, stations from all over the world often are picked up even with simple receivers.

For short-wave listeners (SWL's) two major signal categories are of specific interest: international broadcasting and amateur transmissions. Broadcasting offers frequent news reports, interesting sidelights on far-away places, speeches made by heads of foreign governments, and symphonic concerts. Amateurs transmit their semi-personal messages to each other, some by code, some by voice. Something is nearly always doing on these bands. But, one thing that is not easy to find is product advertising!

Some time ago, I looked through several radio catalogs searching for a receiver for general short-wave listening. Since I already own a modern commercial set capable of picking up signals from almost anywhere in the world, the new set was to be used away from home for casual listening. Some receivers were for hams only, others for broadcasting only. Some had poor selectivity, others no provision for code listening. Some were simply too big or too expensive for a set to be used only occasionally.

Finding no unit that fulfilled my requirements, I resolved to build my own. After several preliminary models, the one described here evolved. Its cost is well under $50, and it offers four short-wave bands: 3.4–4.1, 5.8–6.8, 6.7–7.4 and 9–10 (all in MHz). The first and third are ham bands, 80 and 40 meters, respectively. The other two are popular international-broadcast bands. Actually, since the 40-meter amateur band is shared by broadcasters, there are three BC bands.

Selectivity is high, thanks to the double-crystal filter and two high-gain i.f. stages. Sensitivity is so great that a 4-foot wire antenna is sufficient to bring in signals from around the world.

Note that each band is limited in coverage; in fact, to 1 MHz or less. This is a distinct advantage. Relatively few of the short-wave frequencies are occupied by signals useful to SWL's. About 90% of the spectrum is filled with strange sounds—the buzzes and whistles of high-power telegraphy, teletype and experimental signals which cannot be deciphered by the average listener. The most interesting voice and code (CW) signals appear in compact bands like the ones mentioned.

An unusual feature of this receiver

is that it utilizes a method that doubles the number of bands without changing the oscillator circuit. In a normal superhet, the incoming rf signal is consistently below (or above) the local oscillator frequency. In this receiver, it may be *either above or below*, depending on how the antenna is tuned. The i.f. is about 1.6 MHz. If the signal-input antenna circuit is tuned 1.6 MHz *higher* than the local oscillator, we may tune one band of frequencies. If the input is tuned 1.6 MHz *lower* than the oscillator, we may tune another band.

Using this approach, only two oscillator ranges are required. One range, 5.0–5.7 MHz, is used to tune 3.4–4.1 MHz and 6.7–7.4 MHz, depending on whether the input circuit is tuned above or below the oscillator frequency. The second oscillator range, 7.4–8.4 MHz, tunes 5.8–6.8 and 9–10 MHz, depending on how the antenna circuit is tuned.

All that need be done is to peak up the antenna capacitor. This may be done either by listening to the noise background or, having heard a signal, by tuning the input circuit to maximum.

The relatively high i.f. (1.6 MHz) was chosen to minimize images. Transformers at this frequency are readily available.

Basic circuit operation

A short antenna (as noted previously, a 4-foot wire will bring in stations from all over the world) picks up the SW signals. L1–C2 resonates to peak them up and delivers them to the converter grid, where they are mixed with the signal from local oscillator V1-b. Switch S2 selects the amateur- or broadcast-band coils as desired. The HAM position covers 3.4–4.1 MHz, or 6.7–7.4, depending on the setting of antenna-input capacitor C2. In BDCST position, we may hear either 5.8–6.8 or 9–10 MHz.

When S1 is closed, part of L1 is shorted, and the circuit tunes from 5–10 MHz. For 80-meter coverage, the full 45-turn coil is required. A slightly larger antenna is recommended for this band.

The desired signal frequency is fed from the converter through the crystal filter at the input of the i.f. strip. One crystal is cut for a slightly different frequency from the other. The response of the filter gives sufficient selectivity for tuning code signals in a crowded band, yet it's broad enough to assure clear speech reception on AM and SSB.

The two i.f. stages are designed for high gain. Each is controlled by agc voltage. A tuning meter with a 0–1-mA movement is used in the plate lead of V3. The value of R13 is chosen so that M reads near full scale with no signal. About 2,000 ohms will be suitable in most cases. Use a 10K pot and adjust for full-scale meter deflection.

When a signal is tuned in, the agc voltage becomes more negative, reducing the plate current. The meter then indicates the lesser current. Moderately strong signals drop the needle to about midscale; very strong ones reduce the deflection nearly to zero. Besides being useful in tuning signals, the meter is a valuable aid to alignment.

Diode detector D1 rectifies the rf signal after it passes through the i.f. section. The detected signal is then fed directly to phone jack J2 or to the two-stage audio amplifier. There is sufficient gain here to bring nearly all signals to full loudspeaker volume.

CW signals are received by using regeneration in the second i.f. stage. Note that the suppressor of V3 is not grounded directly. Instead, a 2,000-ohm rheostat is included. As the resistance of R11 is increased, the stage regenerates. This is not as satisfactory an arrangement as having a separate bfo, but it works well enough to satisfy most SWL's.

Although we had not intended this receiver to receive SSB (single-sideband) signals, it can be done. Bring the i.f. stage to oscillation, then carefully adjust C10-b. This tiny variable capacitor works in conjunction with main-tuning capacitor C10-a. The fine-tuning capacitor is made from a 15-pF variable by cutting out all but two or three plates. The capacitance becomes so small that it can be used to fine-tune SSB stations. To get undistorted SSB signals, you must be able to vary the frequency over a very small range. With the aid of C10-b and a little care, you'll be able to tune sideband signals quite handily.

The power supply is conventional and supplies about 120 volts at 15 mA to the receiver. Hum is very low and will hardly be noticeable, even at full volume.

Construction

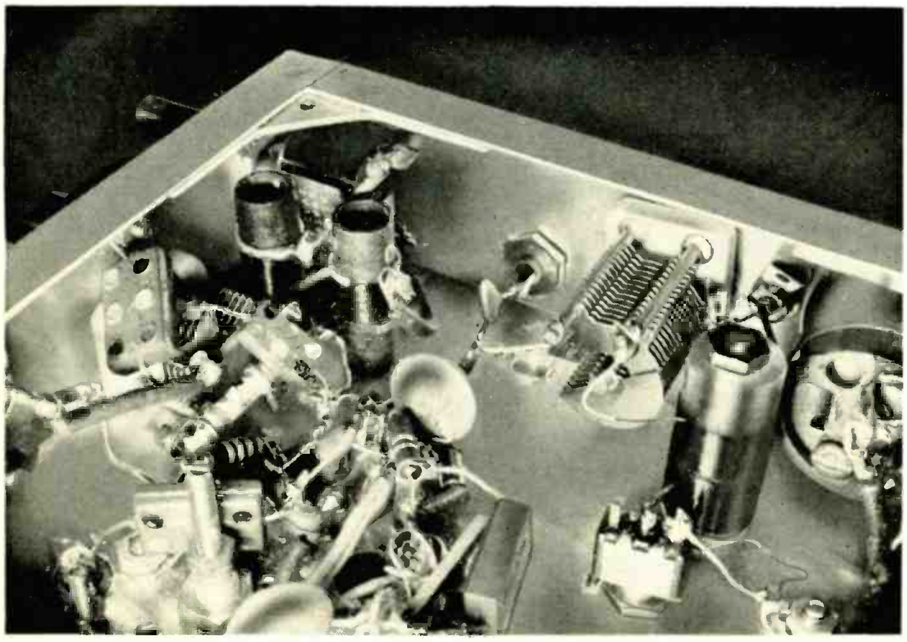
The receiver is built on an aluminum chassis, 9½ x 5 x 1½ inches. It is shallow enough so you can get your fingers and a soldering iron into it. All controls are on the front apron, except the ON–OFF switch, peaking (antenna) control and S1.

An important construction detail is the spacing between tube sockets and i.f. transformers, which are in a straight line across the chassis. The center of this line is 1⅝ inches from the front.

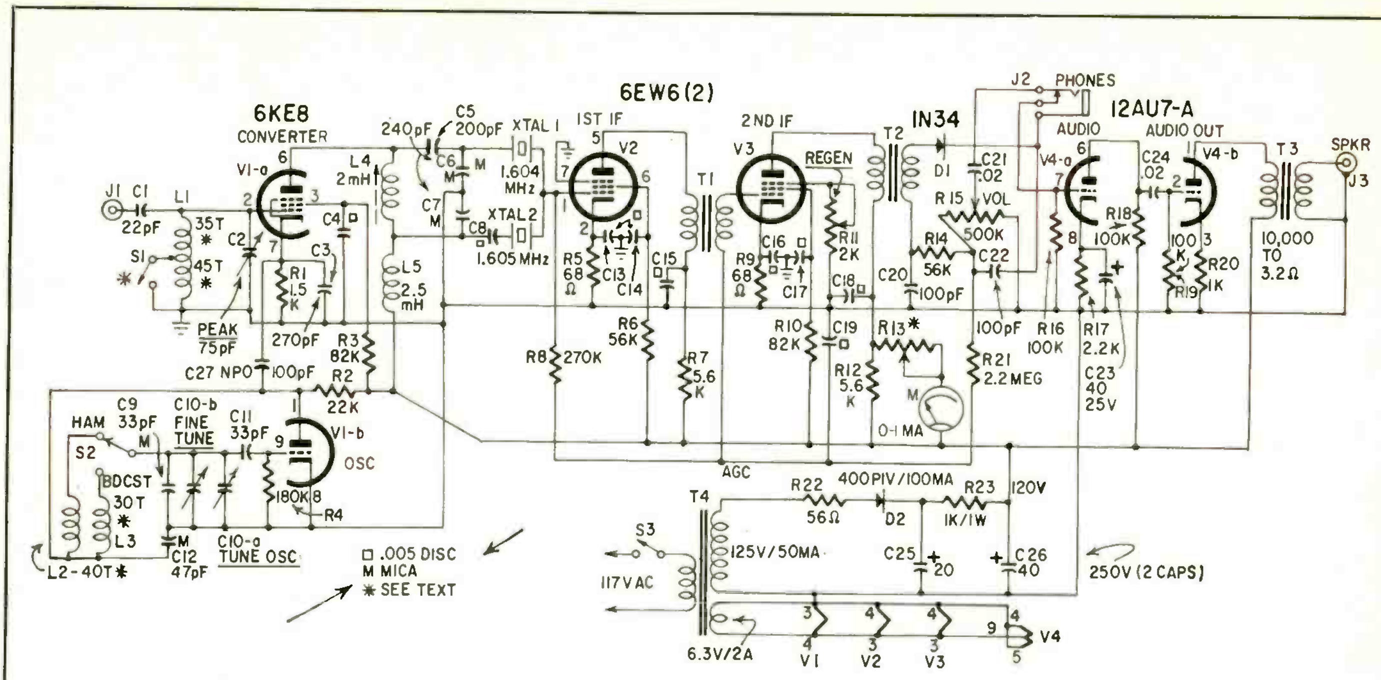
Looking down on the top of the chassis and measuring from the left-hand side of the chassis, we find the following dimensions to the *center* of each component:

V4 9-pin socket	¾ inch
T2 i.f. transformer	1⅞ inches
V3 7-pin socket	3 inches
T1 i.f. transformer	4⅛ inches
V2 7-pin socket	5¼ inches
L4 9-pin socket	6⅜ inches
V1 9-pin socket	7½ inches

L4 is a ⅜-inch diameter slug-tuned coil mounted with slug-screw down (un-



Front-end components are tightly, but carefully, placed to minimize stray pickup.



The receiver constitutes a fairly straightforward circuit. It's simple—only 4 tubes and 2 diodes.

PARTS LIST

R1—1,500 ohms
R2—22K
R3, R10—82K
R4—180K
R5, R9—68 ohms
R6, R14—56K
R5, R12—5,600 ohms
R8—270K
R11—2,000 ohm pot, linear taper
R13—10K pot, linear taper (see text)
R15—500K pot, audio taper
R16, R18, R19—100K
R17—2,200 ohms
R20—1,000 ohms
R21—2.2 megohms
R22—56 ohms
R23—1,000 ohms, 1 watt

Otherwise unmarked resistors are ½ watt

C1—22 pF, disc
C2—75 pF, air variable
C3—270 pF, disc
C4, C13, C14, C15, C16, C17, C18, C19—.005 μF, disc
C5—200 pF, mica
C6, C7—240 pF, mica
C9—33 pF, mica
C10a—main tuning, 50 pF, air variable
C10b—vernier tuning, see text
C11—33 pF, disc
C12—47 pF, mica
C20, C22—100 pF, disc
C21—.02 μF, disc
C23—40 μF, 25 V, electrolytic
C24—.02 μF, paper
C25—20 μF, 250 V, electrolytic
C26—40 μF, 250 V, electrolytic
C27—100 pF, NPO

T1—input i.f. transformer, 1.6 MHz (Miller 13 W1)
T2—output i.f. transformer, 1.6 MHz (Miller 13 W2)
T3—audio-output transformer, 10K to 3.2 ohms
T4—power transformer (Merit P 3045 or equivalent)
L1—coil, ½-in. diam, No. 30 enameled wire wound on polystyrene form, 80 turns, tapped at 35/45 point
L2—slug-tuned coil, ⅜-in. diam, No. 34 enameled wire, 40 turns
L3—slug-tuned coil, ⅜-in. diam, No. 30 enameled wire, 30 turns
L4—slug-tuned coil, approx 2 mH (Miller 4414)
L5—2.5 mH, choke

All coils are close-wound

XTAL1—1.604-MHz crystal (Texas Crystals)
XTAL2—1.605-MHz crystal (Texas Crystals)
Sockets for above crystals
V1—6KE8
V2, V3—6EW6
V4—12AU7-A
7-pin tube sockets and shields (2)
9-pin tube sockets and shields (3)
Power-line male socket
S1—spst
S2—spdt toggle
D1—1N34A
D2—400-piv diode, 100 mA
M—tuning meter, 0–1 mA (Lafayette 99R2513)
J1, J3—phono-type jacks
J2—headphone jack
Chassis, 9½ x 5 x 1½ inches
Hardware, knobs, terminal strips, lugs, etc.

der the chassis). It is housed inside a nine-pin tube shield which offers both shielding and mechanical protection. Discard the socket itself after separating it from the metal mounting. Using two screws, mount this base on the chassis, using as the center point a distance 6⅜ inches from the left-hand side of the chassis. The coil itself will be above chassis.

The tuning meter is 1½ inches in diameter, too large to fit on the front panel. Cut a square hole 1 x 1 inch on the top of the chassis, near the front. This allows the top of the meter to protrude above the chassis. Now, with a 1½-inch hole cutter, cut out the front apron. The meter will then fit on the front apron with only the top of it showing through the square hole.

Antenna (peaking) capacitor C2 is mounted on the right-hand side of the chassis near coil L1.

Keep rf and i.f. leads short, as usual; parts placement is not critical otherwise. The power supply is placed toward the rear of the chassis.

The crystal filter uses mica capacitors at C5, C6, C7. Use mica capacitors also for C9 and C12 in the oscillator section. A signal generator or grid dip meter will be helpful for aligning oscillator coils L2 and L3.

After you have listened for a while, you may wish to calibrate the main tuning dial. The 80-meter band will cover most of the dial. The 6-MHz band will be near the low end of the capacitor, and the 10-MHz band will come in near the high end. The 40-meter band will be received near the upper end of the dial.

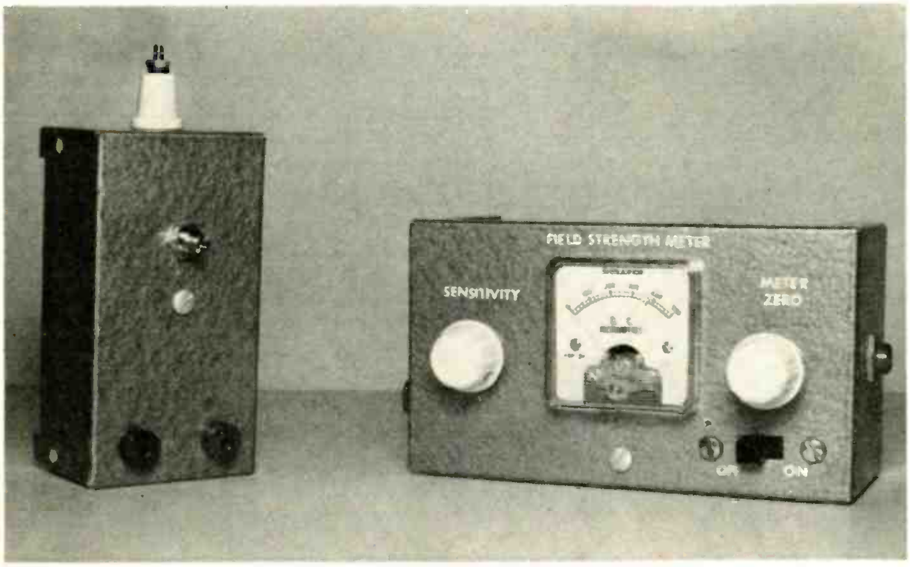
When properly tuned, there should be no instability on any band. Tune up the regeneration for maximum gain, but not too near the point of oscillation. If you are seeking CW signals, of course, you should go past the critical point.

Remember that the antenna circuit will tune either *above* or *below* the local oscillator frequency. If both are tuned near the same frequency, you may notice some instability, and the converter stage may oscillate. This improper tuning of the set should be avoided.

You will find you get remarkable results from this receiver on the bands for which it is designed. It is compact and light enough to carry with you on vacation or when visiting. And, when properly tuned, it will bring in stations from the far ends of the earth to provide many hours of interesting SW listening. END

Remote-Reading Field Meter

You say you can't see rf? Build this monitor and you'll be able to watch your transmitter output



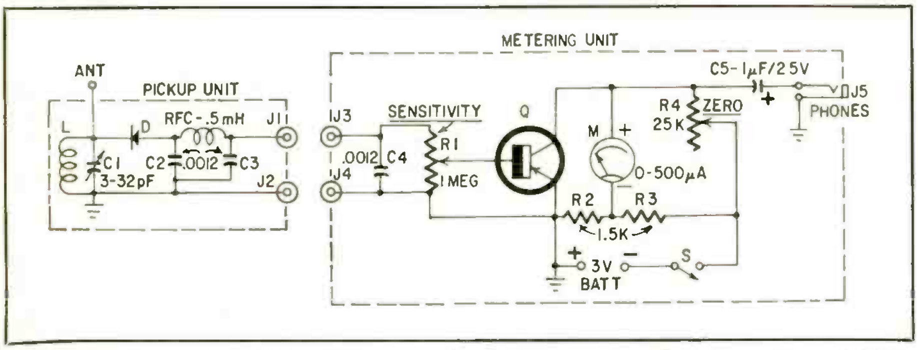
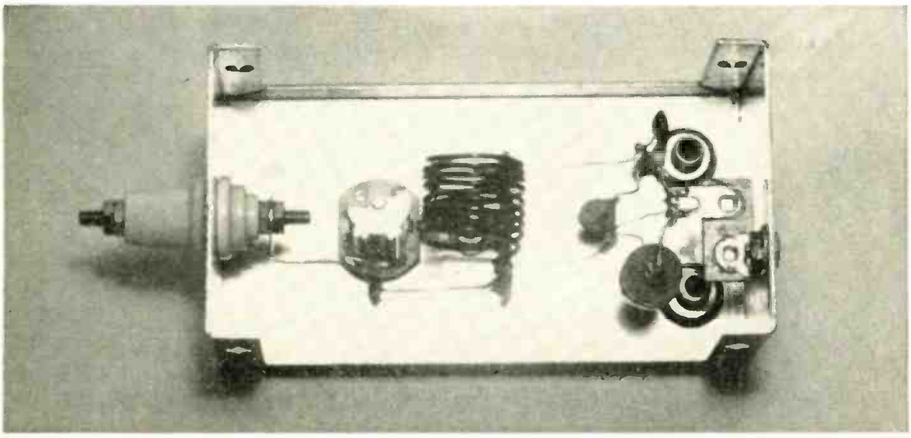


Fig. 1—Each section of the field meter should be constructed in its own metal box.



There's more than enough room inside the detector box for mounting all components.

By JAMES B. WHITE

EVERY GOOD TRANSMITTER OPERATOR IS interested in his radiated signal. Nothing is more evident as one listens to CB, ham or commercial two-way channels. Very often comparison checks are asked for, modulation reports are solicited and signal-strength measurements are noted. If you are going to operate any transmitter, you need a means of monitoring your signal every moment you are on the air.

This field-strength meter can be set up permanently to provide a visual report every time the transmitter is used. Mobile units can be checked in just a moment by having the operator key the mike. This meter is invaluable in the construction of beam antennas. Because of the remote-reading feature, you can put the detector out in the field while you watch the indicator by the antenna. This lets you check forward gain and front-to-back ratio.

The circuit

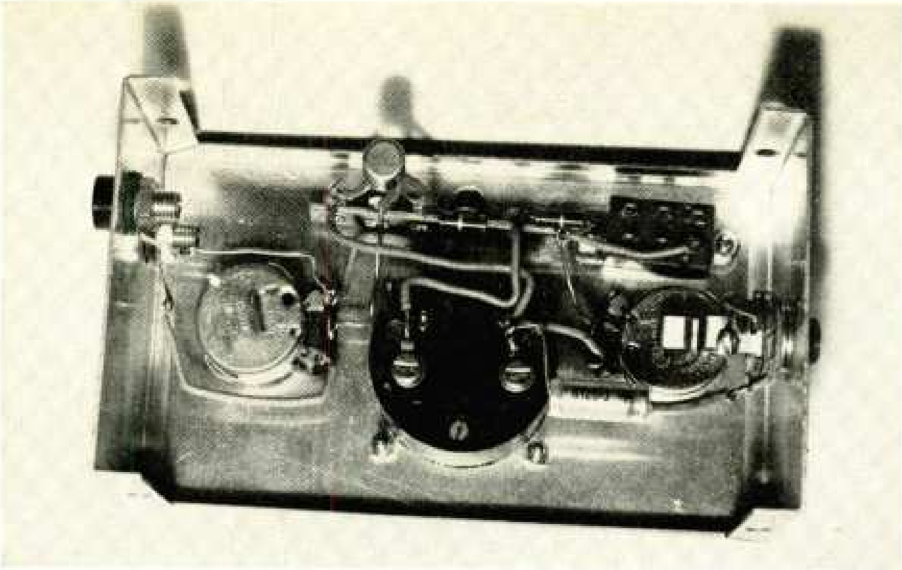
The field meter consists of two units, a detector and an indicator. The detector is the utmost in simplicity, containing only about a dozen parts. It's nothing more than a tuned circuit, which resonates at the transmitter frequency, and a detector diode. Rf is picked up by a whip antenna on a feedthrough insulator mounted on the case.

The indicator unit is only slightly more complicated; it is a transistorized voltmeter with two controls—SENSITIVITY (R1) and ZERO (R4). There's also a phone jack, to monitor detected audio. The power supply is simply two penlight cells (AA size).

Construction

Both units are housed in small aluminum boxes. Components are wired point-to-point and are self-supporting.

Locate and drill the mounting holes first. Be sure the jack holes are large enough to allow the insulating shoulder washers to fit. The black jack doesn't have to be insulated from the box, but the red one must be. The hole in the top of the detector box must be large enough to pass the feedthrough insulator. Be careful mounting the in-



For best (and easiest) results, use simple, point-to-point wiring inside indicator unit.

sulator; if you tighten it too much, you'll crack it.

The meter hole in the indicator unit will probably be a problem unless you have a socket punch the right size.

Try this: Scribe a circle 1½ inches in diameter and drill a series of ⅛-inch holes about just inside the circle. Keep them as close together as you can. Knock out the metal between the holes, leaving a ragged hole just under 1½ inches in diameter. This hole can be dressed off with a small round file. You can use the same technique to mount the power switch.

Next, mount and wire the components. Note carefully the meter polarity and wire it accordingly. Be careful with the diode and transistor. When you have completed all the wiring except the semiconductors, check your work carefully. Then wire in the diode and the transistor. Cut leads to a length that will allow ample working room. Slip a small piece of spaghetti over each lead. As you solder, be wary of too much heat. Use long-nosed pliers, with a rubber band around the handles, as a heatsink. Or try locking pliers.

With the two penlight cells connected you can check out the indicator unit. Turn the power switch on. The meter may go off scale to the left, or it may read to the right. Rotating R4 should zero the pointer. If it does, set the metering unit aside till later. If not, check your wiring.

The photographs show a CB channel coil soldered in place. This coil will also tune the 10-meter ham band. The other coil specifications are listed. The four low-frequency coils are regular TV peaking coils and rf chokes. The higher-frequency coil is hand-wound.

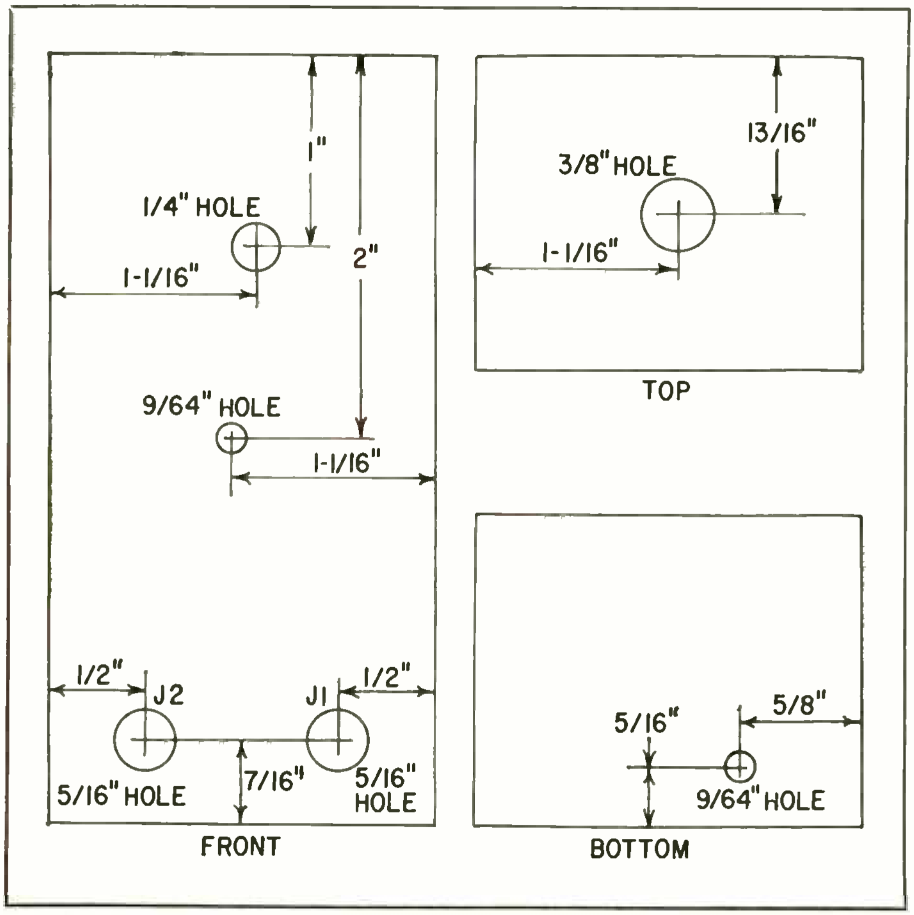


Fig. 2—Locate and drill holes as shown in the detector box. Ream edges smooth.

Using the meter

Connect the detector to the indicator, red jack to red jack, and black to black. Turn on the power and zero the meter with the ZERO control. Set SENSITIVITY so the arm of the pot is at chassis potential (should be maximum counterclockwise). Turn on the transmitter and advance SENSITIVITY until you get a reading. Tune C1 for maximum meter indication. Depending on transmitter rf power, you may or may not need a piece of wire connected to the feedthrough insulator. If the meter doesn't work properly, recheck wiring. If it does, you are ready to use the instrument.

Mount the detector as far as you can from the antenna to be checked. If you plan to use the meter for keeping a constant check on a base station, put the detector as far as possible from both antenna and transmitter. The location will be determined largely by the amount of wire you have and how big your lot is. The two units can be separated by several hundred feet.

A short pickup antenna must be connected to the antenna feedthrough insulator. Its length is determined by power and antenna-to-antenna spacing. Cut several pieces, try them, and use the one which causes the meter to read up scale, but not consistently off scale.

You'll find this field meter useful in observing day-to-day transmitter and antenna operation. If anything deteriorates—low line voltage, a weak output stage, or a shorted or open antenna element—you'll know it the next time you put the rig on the air. The meter is also handy in servicing transmitters because it lets you "see" rf.

(continued on page 66)

How to get into

One of the hottest money-making fields in electronics today–servicing two-way radios!

HE'S FLYING HIGH. Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. Read here how you can break into this profitable field.

More than 5 million two-way transmitters have skyrocketed the demand for service men and field, system, and R&D engineers. Topnotch licensed experts can earn $12,000 a year or more. You can be your own boss, build your own company. And you don't need a college education to break in.

HOW WOULD YOU LIKE to start collecting your share of the big money being made in electronics today? To start earning $5 to $7 an hour...$200 to $300 a week...$10,000 to $15,000 a year?

Your best bet today, especially if you don't have a college education, is probably in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc. and Citizen's Band uses—and the number is still growing at the rate of 80,000 new transmitters per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Many of them are earning $5,000 to $10,000 a year *more* than the average radio-TV repair man.

Why You'll Earn Top Pay

One reason is that the United States Government doesn't permit anyone to service two-way radio systems unless he is *licensed* by the Federal Communications Commission. And there simply aren't enough licensed electronics experts to go around.

Circle 24 on reader's service card

Another reason two-way radio men earn so much more than radio-TV service men is that they are needed more often and more desperately. A home radio or television set may need repair only once every year or two, and there's no real emergency when it does. But a two-way radio user must keep those transmitters operating at all times, and *must* have their frequency modulation and plate power input checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the available licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. A more common arrangement is to be paid a monthly retainer fee by each customer. Although rates vary widely, this fixed charge might be $20 a month for the base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 100 stations, averaging 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

Be Your Own Boss

There are other advantages too. You can become your own boss—work entirely by yourself or gradually build your own fully staffed service company. Instead of being chained to a workbench, machine, or desk all day, you'll move around, see lots of action, rub shoulders with important police and fire officials and business executives who depend on two-way radio for their daily operations. You may even be tapped for a big job working for one of the two-way radio manufacturers in field service, factory quality control, or laboratory research and development.

How To Get Started

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC Exam and get your Commercial FCC License.
2. Then get a job in a two-way radio service shop and "learn the ropes" of the business.
3. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move *out* and start signing up and servicing your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you $5,000. Or you may even be invited to move *up* into a high-prestige salaried job with one of the major manufacturers either in the plant or out in the field.

The first step—mastering the fundamentals of Electronics in your spare time and getting your FCC License—can be easier than you think.

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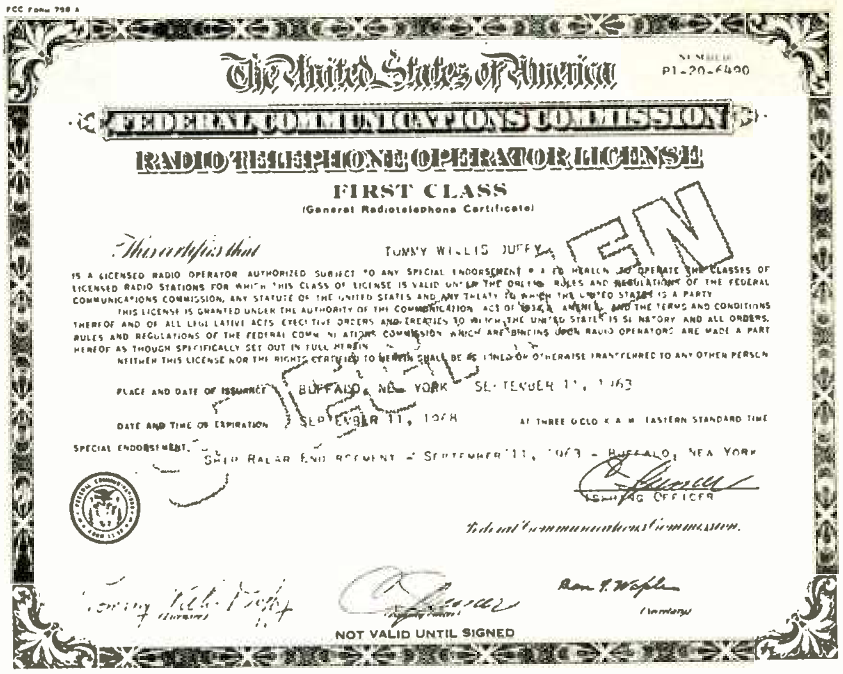
By the time you've finished your CIE course, you'll be able to pass the FCC License Exam with ease. Better than nine out of ten CIE-trained men pass the FCC Exam the first time they try, even though two out of three non-CIE men fail. This startling record of achievement makes possible the famous CIE warranty: you'll pass the FCC Exam upon completion of your course or your tuition will be refunded in full.

Ed Dulaney is an outstanding example of the success possible through CIE training. Before he studied with CIE, Dulaney was a crop duster. Today he owns the Dulaney Communications Service, with seven people working for him repairing and manufacturing two-way equipment. Says Dulaney: "I found the CIE training thorough and the lessons easy to understand. No question about it—the CIE course was the best investment I ever made."

Find out more about how to get ahead in all fields of electronics, including two-way radio. Mail the bound-in postpaid reply card for two FREE books, "How To Get A Commercial FCC License" and "How To Succeed In Electronics." If card has been removed, just send us your name and address on a postcard.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PARTS LIST

C1—air trimmer, 3–32 pF (E. F. Johnson 160-130 or equivalent)
C2, C3, C4—.0012 μF, disc ceramic
C5—1 μF, 25 volts, electrolytic
R1—pot, 1 meg, linear taper
R2, R3—1,500 ohms, ½ watt
R4—pot, 25K, linear taper
J1, J2, J3, J4—insulated banana jacks, 2 reo, 2 black (H. H. Smith 205 or equivalent)
J5—phone jack
Q—pnp general-purpose audio transistor (RCA SK3009 or equivalent)
M—meter, 0–500 μA (Monarch PMC-5S)
S—dpdt slide switch
RFC—rf choke, 0.5 mH (National R50)
D—1N34A general-purpose diode
BATT—2 penlight cells, 1½ volts, AA size
Detector box—metal, 1⅝ x 2⅛ x 4 inches (Bud CU2101A)
Indicator box—metal, 2⅛ x 5¼ x 3 inches (Bud CU2106A)
Miscellaneous—4 banana plugs to match jacks, phone jack, knobs, wire and screws, and 1 feedthrough insulator (E. F. Johnson 135-50 or equivalent)
Coil data (L):
3.0 to 5.0 MHz—73-μH peaking coil (J. W. Miller 6172 or equivalent)
4.2 to 7.5 MHz—36-μH peaking coil (J. W. Miller 6176)
7 to 14 MHz—10-μH rf choke (J. W. Miller 4612 or equivalent)
13 to 26 MHz—3.9-μH rf choke (J. W. Miller 4608 or equivalent)
25 to 55 MHz—10 turns No. 18 enamel wire, ¾-in. diameter, self-supporting

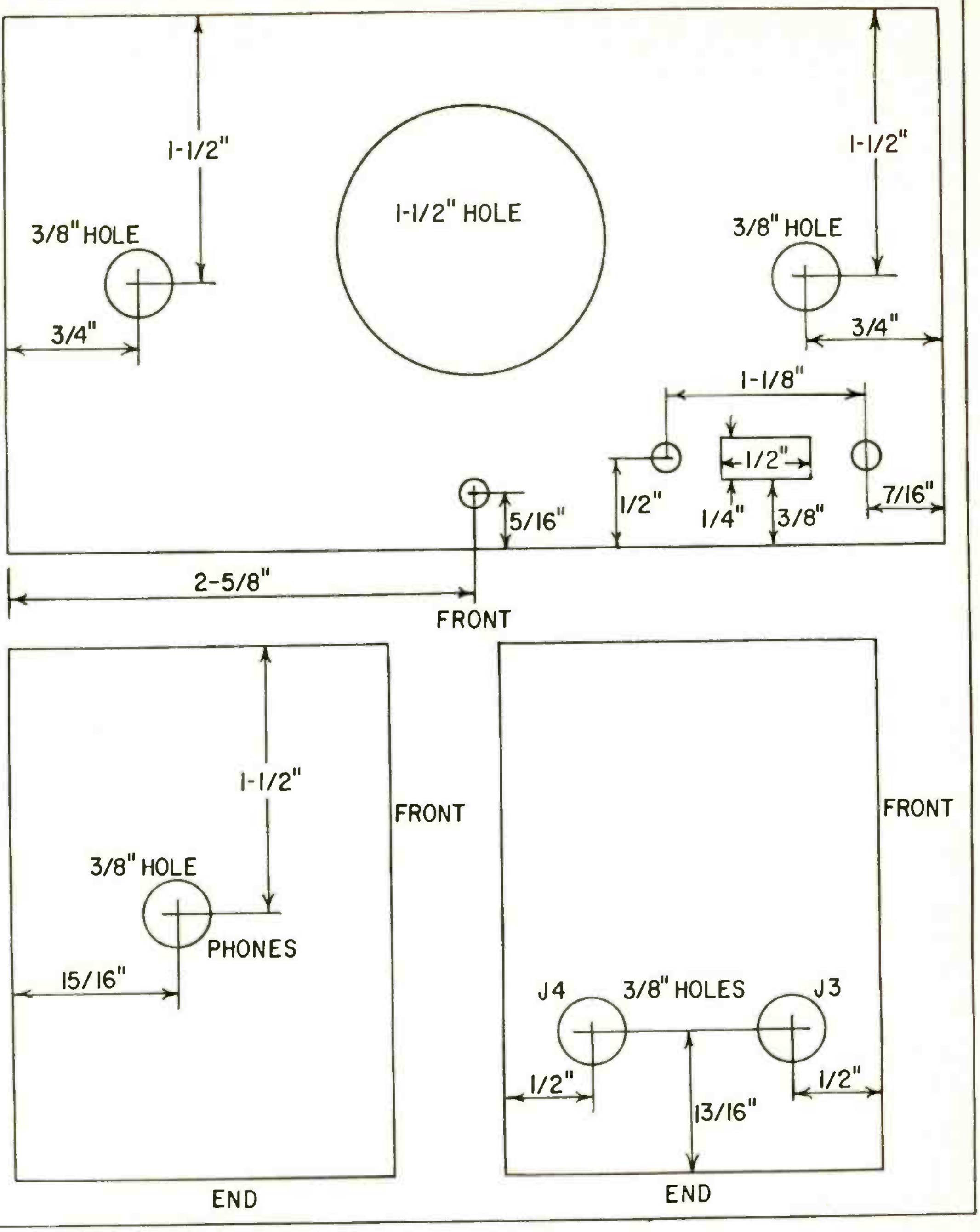


Fig. 3—Indicator box holes must be cut carefully, especially the large meter hole.

WHAT'S YOUR EQ?

Conducted by E. D. Clark

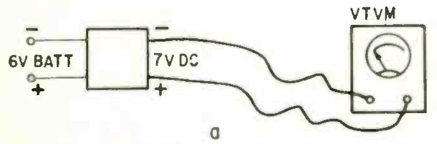
Two puzzlers for the student, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.

Answers to this month's puzzles are on page 93.

Voltage Booster

The black box contains a single, common electronic component. It is not



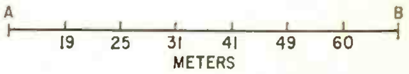
a

a battery, has no moving parts, and does not oscillate. What is it?

—*Richard P. Speck*

Shifted Tuning

The dial of a shortwave receiver is shown. A is the high-frequency end; B is the low-frequency end. When tuning from A to B, stations are received at



indicated frequencies. Yet when tuning from B to A, stations are shifted to the left. There is no slip or backlash. What causes the shift?

—*C. S. S. Shenoi*

Luck is a Lady

Story and cartoons by **FRANK SALERNO**

A LITTLE LUCK GOES A LONG WAY IN TV SERVICING. THERE come those trying times when all skill fails and we must pray for the deliverance of luck. And in our business we find ourselves praying more and more each day.

Take, for instance, the RCA KCS68C that I serviced recently. No picture. It didn't take long to see that the flyback transformer looked like a lump of coal. The customer told me that three flybacks had been replaced in this set in as many years and he begged me to find the cause of these costly breakdowns. I promised to do my best.

When I installed the new part in the shop, I gave the horizontal sweep section a complete voltage and current check. Everything looked fine. All voltages throughout the system checked good and 6CD6 cathode current was a respectable 120 mA. I set up all the sweep adjustments according to the manufacturer's recommendations, including horizontal width for slight overscan and linearity for minimum circuit current. So far as I could see, the receiver was in perfect shape and ready for delivery. But I wasn't pressed to return it, so I decided to cook it for a couple of days just to be sure.

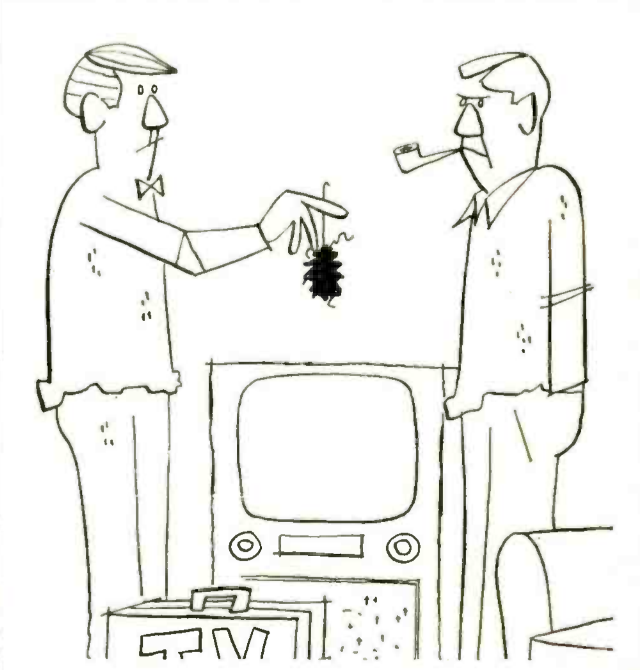
Next morning I was lucky enough to catch a test pattern on the air, which gave me a chance to make a few finer adjustments. Lucky for me because I noticed something that was not perceptible when I checked the set against a regular TV program the day before. I adjusted the circles to a ¼-inch overscan on each side, turned away to some other work. When I looked back 5 minutes later the pattern had stretched away out. This seemed odd. I cooled the set down and tried again. Sure enough, the same thing happened a second time. The picture came on normally and, within 5 minutes, began to expand. There was no blooming or loss of brightness—just a 2-inch stretch on each side.

I now had to reconsider a fact that had seemed peculiar to me when I had first noticed it, but since everything else had fallen so neatly into place I had mistakenly ignored it. While screwing the width-coil slug in from end to end on the day before, I found it gave me a large peak, a sudden dip and then another peak. We're all familiar with adjustable coils having two peaks. Although I had never known a width coil to have more than one, I passed this off as a first-time-for-everything kind of thing.

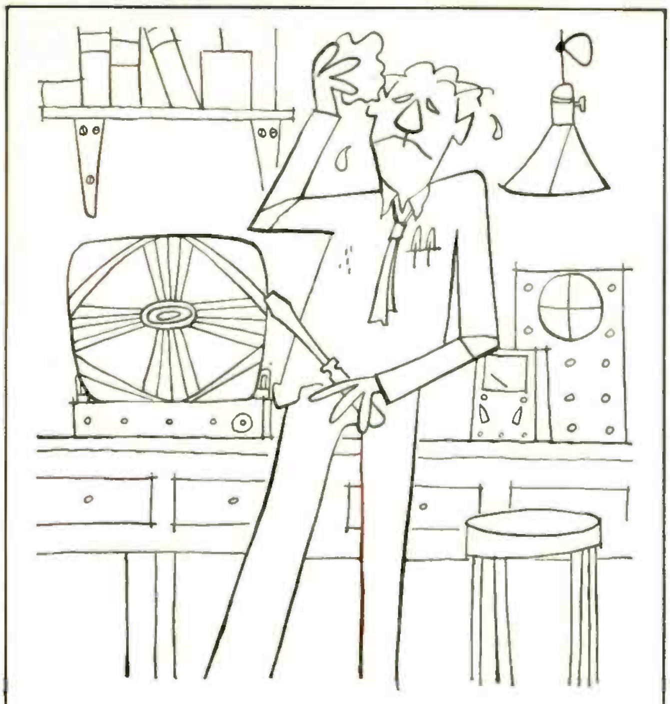
Now, in view of the new problem, I looked closer at the width coil. When the picture stretched out, it was easy to restore it to normal size by readjusting the width, but then the predictable happened. When the receiver was turned on from a cold start, the test pattern was 2 inches short on each side of the screen.

My first step, of course, was to try a new coil, but that didn't help. I checked all the capacitors in the width and yoke circuits but results were still negative. After hours of time-consuming tests I couldn't find any reason for the picture to behave that way. Actually, I could easily have got by with the condition had I delivered the receiver, because it was not noticeable on a regular TV program. But I was convinced that whatever was causing this unusual behavior was related to the high failure rate of the flybacks. I kept on looking.

It was at this point that Lady Luck stepped in and tapped me with a wonderful stroke—in disguise. As I tuned and retuned the width coil I found a new problem. I began to get flashover under one of the two 6W4-GT sockets. The way the chassis was lying, I couldn't see exactly where the arcing came from, but as I tuned the coil in and out, looking for that one reliable setting, the flashover would break out intermittently. For one brief moment the arcing sustained



The flyback was obviously burned out.

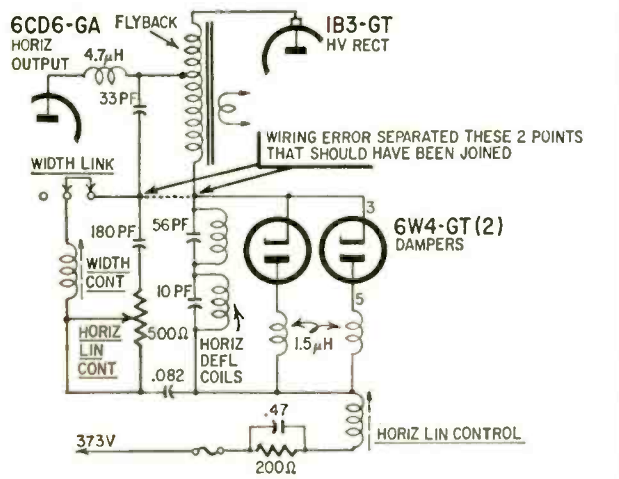


When I turned the set on again I was right back where I'd started.

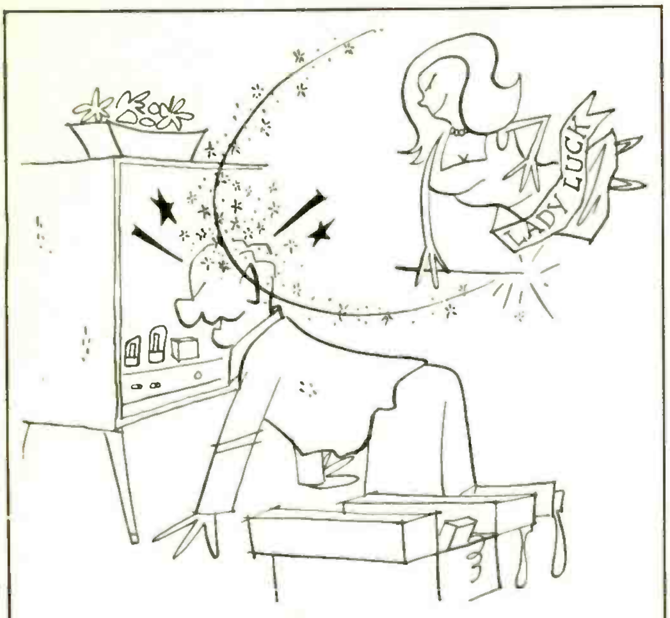
itself long enough for me to discover that I suddenly lost the double width peaks. I went from maximum to minimum inductance with the coil slug and got the normal minimum to maximum to size—without the dip!

It was time to find out just what was going on under that 6W4 socket. I opened up the high-voltage cage for a better look. There, between pins 2 and 3 of the socket, was a beautiful carbon path. Pin 2 seemed to be used only as a tie point for a capacitor and a wire, so I simply clipped the pin off the socket and taped it. When I turned the set on again, I was right back where I had started. The width coil got back its two peaks and its associated stretch problem.

But Lady Luck had flirted with me and I chased her. What had happened in that brief moment when the arcing



Somebody goofed on the production line.



Instantly, it happened!

sustained itself and the whole system snapped to normal? I read the schematic and I looked at the wiring. I looked at the wiring and I read the schematic. Very gradually the webs parted and the fog lifted. It all suddenly became clear. The wire and capacitor that had been soldered to pin 2 of the 6W4 socket and that had so obligingly arced over for me were supposed to be connected to pin 3, the damper cathodes. It was a wiring error right from the factory and had gone unnoticed all these years. The partial schematic shows how easily it defied discovery. Neither voltage nor resistance measurements could unearth it—only an amazing stroke of luck like a compassionate little flashover. When the wiring was corrected, the problem vanished.

Of course, Miss Luck has many varied ways of presenting her lovely self, and, Lord knows, she's always welcome.

An old customer of mine owns an F4632 Philco. He'd been having sound trouble with it for the better part of a year. The complaint had always been the same—volume would drop for a while, rise again, drop and rise. This might happen for a week straight and then not happen for a month. Every time I made a service call the set worked fine but, despite a whole new set of audio tubes, I continued to receive complaints. I finally took the chassis to the shop.

As you'd expect, the sound worked perfectly for 3 days. Out of sheer desperation, I replaced both the sound takeoff and sound detector transformers, checked the set out for another couple of days and delivered the chassis.

I was hoping for the best, to be sure, but I was worried. These repair jobs where nothing concrete is established hardly ever work out well. Nevertheless, I finished screwing down the back cover while listening to a program, still trying to find that one missing clue before leaving.

Instantly, it happened! The sound shot down and at last I knew why. It was while tightening the last screw that my hand brushed the rear-mounted TV-phono switch and the volume went down to a whisper. I merely touched the switch again with my forefinger and the volume shot up to normal. I sprayed some contact cleaner into the switch and the trouble was gone.

Once more, that ageless beauty, Lady Luck, saved the day and my sanity. END

A Cartridge and a Record to Test It
Shure V-15 Type II

Circle 23 on reader's service card

THE WORLD OF HIGH FIDELITY HAS always been one of JND's, as the psychologist would say: just-noticeable differences. They add up, of course; recorded music does sound a lot better now than it did 15 or 20 years ago, when hi-fi began being an industry.

Still, within any given year's worth of new products, it is usually impossible to point honestly to a particular component and say, "There! That one is worlds better than the others." This makes things difficult for the audio reviewer. The outcome is too often a nit-picking review that either discourses lengthily on altogether irrelevant matters like the finish of the tone-arm shell, or a review in which the lack of any discernible difference is painted over with a coat of adjectives.

Now Shure Bros. has brought out a new cartridge that once more represents a small improvement overall—but the improvement is definite and specific. This new pickup is a revised version of the respected plain V-15.

The design process for the V-15 Type II seems to have been about as scientific as cartridge design can be. Shure amassed a collection of records that had been found hard to trace—records that at some point caused the stylus to lose contact with the groove wall and produce very audible distortion. They found that these records had peak groove velocities beyond the ability of then-available pickups to follow. There was nothing actually *wrong* with the recordings; they just demanded too much. The maximum velocities on such records were determined and used as a design criterion.

Shure's engineers decided to build a cartridge that would trace grooves with such abnormally high peak velocities, instead of simply lowering tip mass and increasing compliance on the assumption that those are always Good Things to do.

It turned out that the interlocking of variables was so complex that calculating them was beyond practical limits of time and manpower. Shure used an analog computer to generate an electrical model (analog) of a proposed design. It thus became practical to vary parameters like tip mass, stylus velocity, compliance of the moving assembly, and so forth, without building an endless number of real cartridges. (There are easily a dozen interdependent variables, depending on what you count in and what you ignore.)

The result was the V-15 Type II, and it really works. To prove it, Shure produced a recording, called "An Audio Obstacle Course" ($3.95 postpaid from Shure Bros. Inc., 222 Hartrey Ave., Evanston, Ill. 60204). The record immediately aroused people's suspicions: how could they be sure it wasn't doctored to favor the new cartridge? Well, I have demonstrated to my own satisfaction that it's an honest job. I have played the Obstacle Course with the new Shure pickup and with others. I have also played "problem" recordings of music with the new pickup and with others, including Shure's older V-15.

The new cartridge definitely does trace high-velocity grooves better than anything else I've used. The improvement is most noticeable on recordings with much high-frequency percussive material: harpsichord, guitar and banjo, cymbal clashes and such; but it is clearly apparent also in music for brass instruments.

You can buy the record and try it for yourself. I won't dwell on what to listen for, since the printed matter with the record explains that very well. Most of the material on the record is brief musical passages played by various "difficult" instruments. The passages are repeated four times, each run 4 dB higher than the preceding one.

The highest-level passage cannot be traced by most cartridges without increasing the stylus force well above the specified figure. The sound becomes harsh and gritty, or there comes a knocking or chattering noise on top of the music, depending on the type of recorded material and on the degree to which the stylus fails to follow the groove. (Shure warns that the Obstacle Course should not be played more than 10 times with "ordinary" cartridges, else the high frequencies will be erased permanently. Lots of pickups shouldn't be used on this record at all.)

The sound of the V-15 II is clear and colorless overall, as good as any I've heard. That far, it isn't substantially different from a lot of other good pickups. Where it shines is on recordings that have much of the high-velocity material we've been talking about. Whether the new V-15 is worth the money ($67.50) to you depends on how fussy you are and how much you value your records. If you do own records that have stung you with harsh breakup noises at high levels, the Shure V-15 Type II may solve your problem.—*Peter E. Sutheim* END

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Circle 46 on reader's service card

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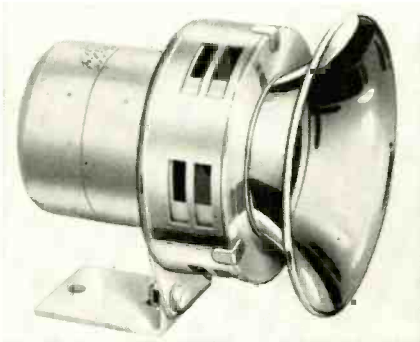
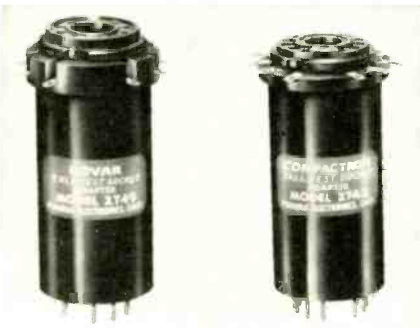


switch, lock cover, in-line fuse, 6 door switches, 2 switch brackets, wire, terminals, screws, instructions.—**Jubilee Mfg. Co.**

Circle 49 on reader's service card



TEST SOCKET ADAPTERS, *9-Pin Novar, model 2749; 12-Pin Compactron, model 2742.* For test measurements from tube sockets equipped with captive or telescoping tube shields. Adapters tall enough to rise above top of tube shields. *Model 2749,* $3.25, *model 2742,* $3.55.—**Pomona Electronics**

Circle 50 on reader's service card

AMATEUR-BAND COMMUNICATIONS RECEIVER, *Heathkit SB-301.* Covers 80- through 10-meter amateur bands for AM, CW, SSB and RTTY plus 15- to 15.5-MHz coverage for WWV reception. Automatic noise limiter. Front-panel switching. Crystal-controlled front

end. Linear master oscillator. Sensitivity, +0.3 mV for 10 dB signal-plus-noise to noise ratio. SSB selectivity, 2.1 kHz. Optional filters for AM and CW. 23 lb. $260—Heath Co.

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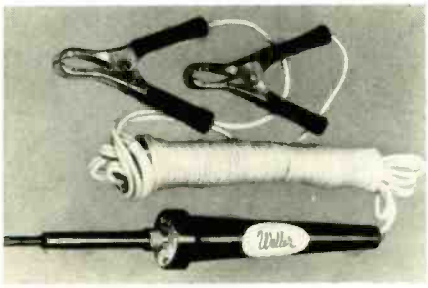

12-VOLT SOLDERING IRON, *model TCP-12.* Includes 12-ft power cord with battery clips, 700°F 3/16-in. screwdriver tip. Temperature control system minimizes battery drain.—Weller Electric

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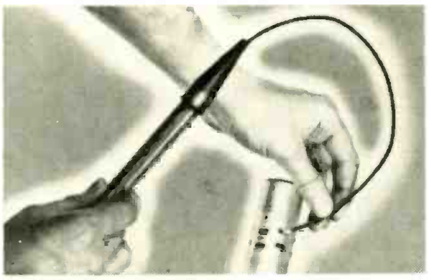

FLEXIBLE LIGHT, *Flexilight, No. 60,648.* Maximum bending radius of ¼ in. Plastic fiber light guide couples to a rotary-switch penlight. $2.75—Edmund Scientific Co.

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RECEIVER–TURNTABLE, *model SC 6.* Features AM, FM, FM/stereo with automatic switching circuit between FM and FM/stereo. Includes stereo headphone receptacle on front panel, tuning meter. Provision for tape recorder. Optional Lucite dust cover. $239.50—Harman-Kardon, Inc.

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AM/VHF-AIR BAND POCKET PORTABLE, the *Jetstream.* AM broadcasts plus 108–135 MHz for aircraft, tower and weather transmissions. 6 x 3½ x 1½ in. 1 lb. Ac adapter available. $21.95—Radio Shack

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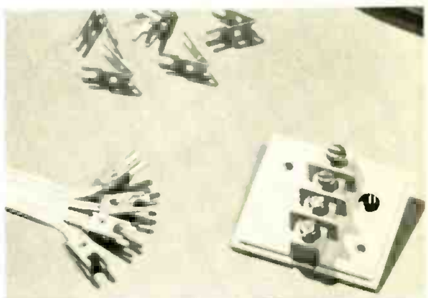

BARRIER STRIP CONNECTOR, *Scotchflex No. 515.* For use with *No. 500* flat cable in music, sound and low-voltage control systems. Foam adhesive backing. 4 openings. 10 per carton, 5 cartons per case.—Dept. EL 7-13, 3M Co.

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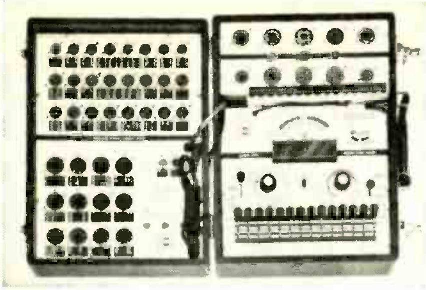

voltage transformer. Features grid-circuit, dynamic-mutual-conductance and cathode-emission tests. 13 x 9 x 7 in. 115 Vac. $198.50—Seco

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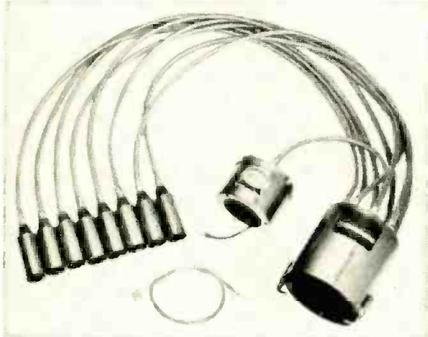

INTERFERENCE KIT, *model HH-8*. High-tension coil-to-distributor filter lead replaces existing lead. 8 filters snap in place between sparkplugs and leads. Moisture-proof, flashover-proof. $12.95.—Hallett

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COMBO ORGAN, the *Rheem Mark VII*. Portable stereo. Features psychedelic sounds, bass fuzz. Provision for 192 electronic sound combinations. 16-ft solo stop, bass keyboard coupler to 7 full octaves, multitone booster, full-range variable vibrato, *walking bass, bass boost*. $660—Rheem Musical Instruments

Circle 60 on reader's service card

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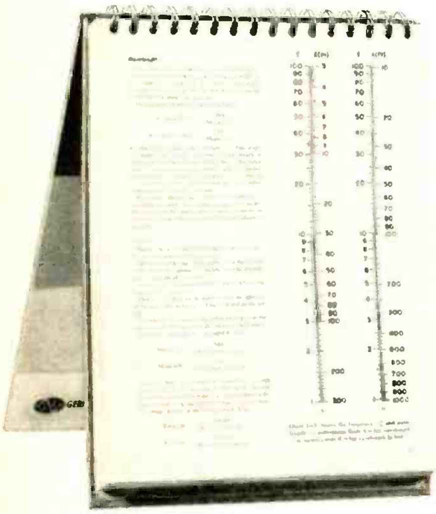

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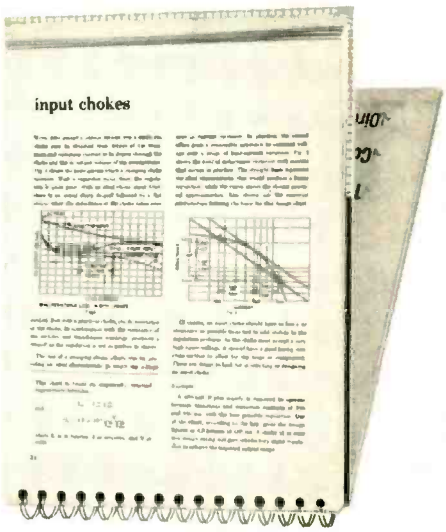

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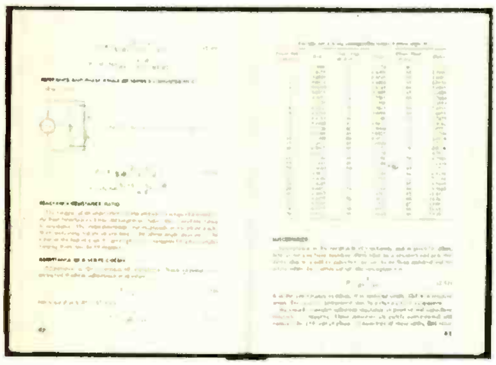

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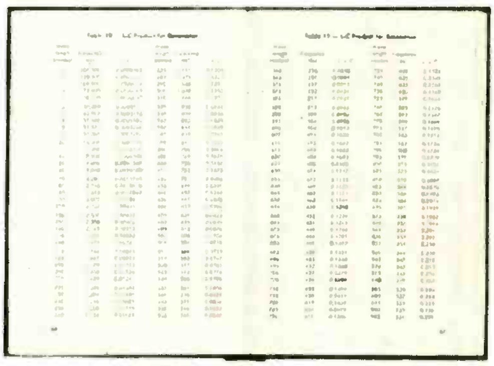

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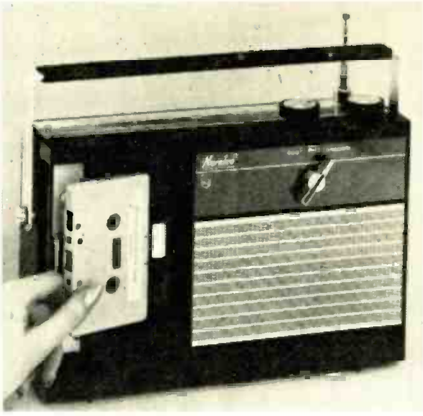

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NEW LITERATURE

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AUTOTRANSFORMER PRODUCT GUIDE. Illustrated. Describes standard and deluxe variable and isolated variable transformers.—**Staco, Inc.**

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1967 CATALOG. 52 pages. Lists 14,000 components. Includes batteries, flashlights, capacitors, controls, jacks, plugs, semiconductors, switches, circuit breakers, timers, vibrators. Section with performance charts, product diagrams, packaging and literature details.—**Mallory**

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CONDENSED CATALOG OF VECO THERMISTORS, VARISTORS, *No. MGP681*. Data include resistance-temperature characteristics, dissipation and time constants, electrical properties, dimensions.—**VECO** END

Circle 70 on reader's service card

MOSFET's AND IGFET's sound like Martian political parties or underwater monsters. But they're actually two new semiconductor devices. Everytime somebody invents a new transistor or diode, it seems harder to understand the name than to learn how the device works. Find out what MOSFET and other solid-state abbreviations mean **in September RADIO-ELECTRONICS.**

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MORE ABOUT HYDRONICS

The May 1967 issue of RADIO-ELECTRONICS carried an article by Jack Althouse entitled "Build Hydronic-Radiation Transmitter." Little is known about *hydronics;* Wallace Minto—who coined the term, claims it's a new form of communication different from radio. Jack Althouse then built a hydronic transmitting system which apparently works. How it works is still a controversial subject.

R-E reader Peter Lefferts wrote us, sugesting further hydronics experiments. He believes there may be another explanation for hydronic radiation (besides the "up–over–down" theory mentioned by Althouse). He has used "ground-conduction antennas" consisting of ground rods spaced up to 600 feet apart. Working from 5 to 76 kHz with a simple rf oscillator, he claims to have heard signals transmitted entirely through the earth. He also believes he heard a radio station over 1,000 miles away using this method.

Since Lefferts experimented with conventional transmitters, he concludes that conventional radiation was involved. He suggests the antenna created a magnetic loop effectively larger than itself. When the hydronic antenna is near water surface, the greatest effect is observed. Lefferts's theory: The water provides a *spreading conducting* path located in a vertical plane. The water then radiates like a large single-turn loop antenna. Water conductivity acts like a ground plane, and useful radiation occurs just above the surface.

Further, the spreading radio waves continue magnetically to induce circulating currents just under the water surface, and thus provide coupling back to the antenna. Lefferts thinks this explains how conventional radio waves are picked up by his conductive ground antenna. [*Underground antennas have been known for years to pick up signals from the broadcast band to at least the 80-meter ham band.*—Editor] He suggests the following experiments:

Loop antennas: Place the plane of the loop perpendicular with the water surface and parallel with the plane of the hydronic transmitter antenna plates. Connect the loop to a receiver and tune in the transmitted frequency, monitoring avc voltage with a voltmeter. If the magnetic-field and circulating-current theory is correct, you should observe an increase in received signal when the hydronic antenna is first dipped in the water.

Fluid effects: Some have suggested that hydronics is related to magnetohydrodynamics (or the current-induced motions of a conducting liquid). Two experiments could prove or disprove this theory:

1. Measure the velocity of propagation in water. You could do this by measuring the phase delay of a received signal by comparing it (on a scope) with the same signal as transmitted. If the propagation rate is found about the same as that for radio waves in air, this would seem to rule out water movement.

2. The hydronic antenna should be tried in salt-water-soaked earth. If transmission ranges are similar to those in water, as Lefferts suspects, then this suggests no fluid rf action.

Antennas: 1. Set up a hydronic transmitter and receiver with antennas in a single body of water and measure received signal strength. Then place the two antennas in separate, electrically isolated bodies of water the same distance apart (for instance, two tubs of water) and remeasure avc. If the magnetic-loop theory is correct, results should be similar.

2. Instead of running twisted wires to the antenna plates (as Althouse did), use separate wires run parallel and apart. This should increase loop size and transfer more signal. As the antenna plates are dropped deeper, the conductive-loop area should be greater and signal strength should increase, rather than decrease, (as Althouse found).

Shielding: 1. Will insulating the hydronic antenna reduce reception? If not, *why not*—since water presumably conducts the signal.

2. Will a conducting shield around the antenna reduce reception? For an antenna near the surface, must the shield be under the surface, above the surface, or completely surrounding the antenna?

3. If a conducting shield or plate reduces signal level, will a plate with holes in it (to allow water movement) also produce shielding?

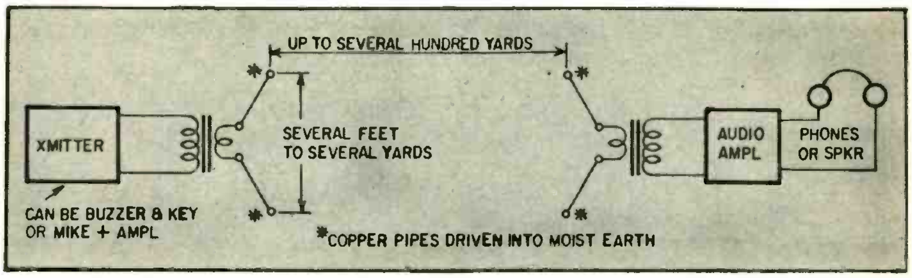
We hope some of you will try to answer the above questions. Let RADIO-ELECTRONICS know what you find out. Perhaps the hydronics mystery can be solved.

ANOTHER SUGGESTION

Dear Editor:

The hydronic radiation system described in your May issue sounds like it has a great deal in common with earth-conduction communication (see illustration), which to the best of my knowledge has little if anything to do with "electromagnetic and magnetohydrodynamic forces, characteristically propagated through a water medium. . . ." As usually attempted, earth conduction "radio" uses audio frequencies, although it would probably work with low- or medium-frequency rf.

It seems to me that when the propagation medium is some kind of electrochemically ionizable solution (such as water with some quantity of dissolved salts), there must be considerable plain old electrical conduction between the plates. There is also doubtless some capacitive transfer between transmitting and receiving antennas. I wonder whether the system would work equally well in distilled water, which ionizes only very weakly, and so is a relatively poor conductor, or in water with some nonionizing substance dissolved in it—like sugar, for instance? The question of how large a role electrical conduction and capacitance play in the transmission is not taken up in the article.



I think it is time to devise a series of experiments to separate, if possible, the effects of conduction, induction, capacitance and electromagnetic radiation in the hydronics scheme.

GEORGE MARTINSON
New York City

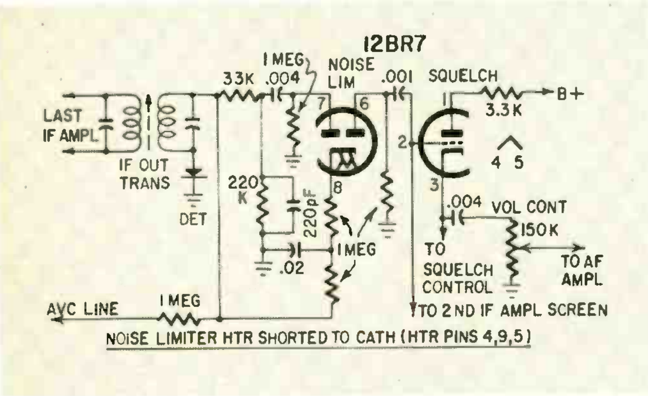
END

CB Troubleshooter's Casebook

Compiled by
Andrew J. Mueller

Case 1: Loud 60-Hz hum on receive with the volume control turned up. The hum disappears with the volume control turned down.

Common to: Olson Spotter 2

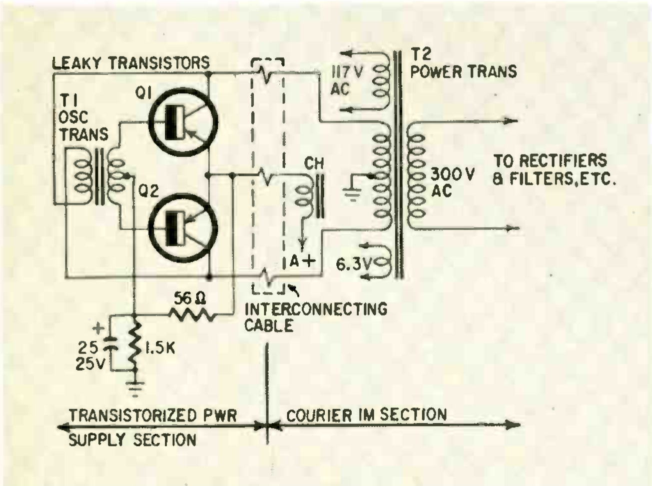


Remedy: Replace 12BR7 tube in the receiver.

Reasoning: This tube shorts from the heater to cathode in the diode sections. This feeds ac into the audio system when the volume control is turned up.

Case 2: When the unit is operated on 12 volts, it doesn't transmit but receives okay. This unit works perfectly on 117 volts ac.

Common to: ECI **Courier 1M** with TPS (Transistorized Power Supply).

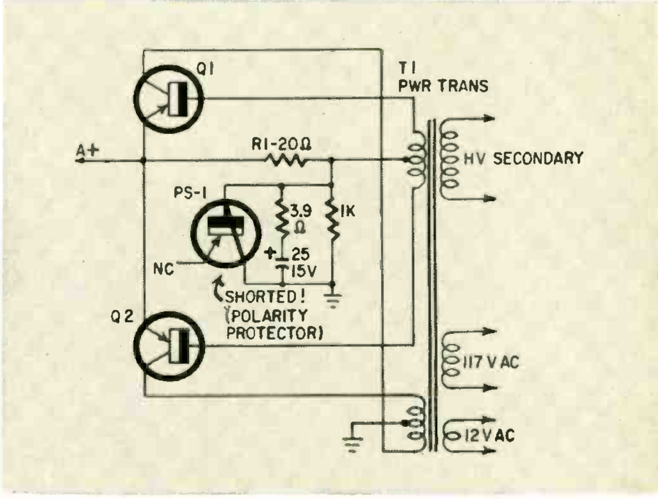


Remedy: Replace both transistors in the TPS.

Reasoning: The transistors are leaky. On receive, the set doesn't need as much B+ so everything operates normally. When the unit is switched to transmit, a heavier load is put on the power supply. This causes the transistors to stop oscillating; hence the unit goes dead on transmit but not on receive.

Case 3: Transceiver blows fuses on 12-volt operation, but works normally on 117 volts ac.

Common to: Pearce-Simpson **Companion I**

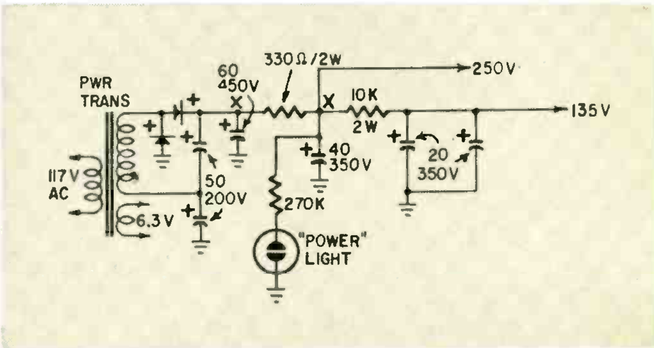


Remedy: Replace shorted polarity protector, PS-1.

Reasoning: When the unit is placed on 12 volts, the A+ line is shorted through R1 and PS-1 to ground. This is almost a dead short, which will blow a fuse. The unit will operate normally on 117 Vac because this part of the circuit is not used on 117-volt operation.

Case 4: Intermittent receive and transmit. The neon lamp goes off when the unit quits.

Common to: Heathkit **GW-10**

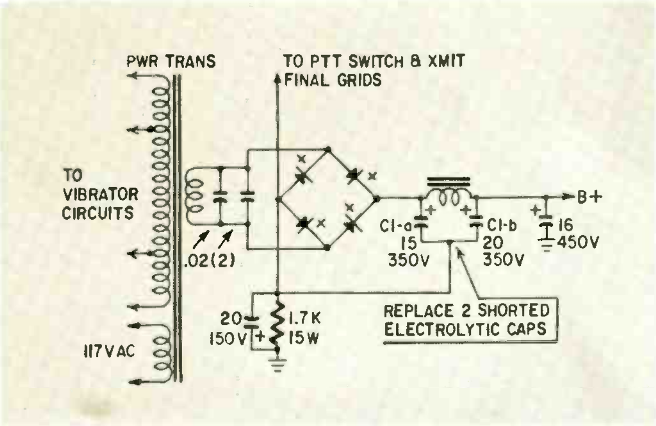


Remedy: Solder the loose connections at the points indicated by an "X" on the schematic.

Reasoning: Poor solder connections between the electrolytic capacitors and the 2-watt resistors cause this trouble. This is especially true with home-built kits. Due to the large wire size of the resistors and the many wires being soldered at these points, this spot is often not soldered, or very poorly so.

Case 5: Transceiver intermittently blows fuses on 12-volt operation. Okay on 117 Vac.

Common to: General VS-6

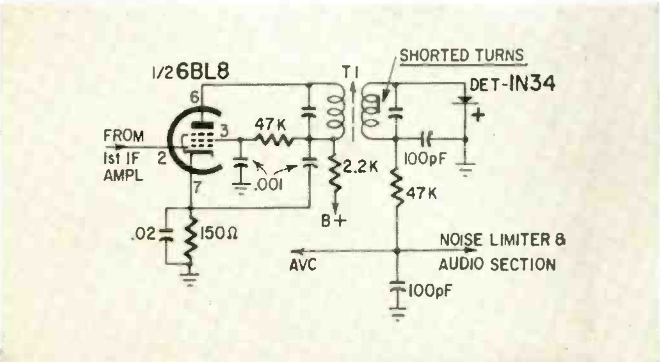


Remedy: Replace shorted filter capacitor C1-a, b and check the voltage regulator of the automobile. Reduce regulator output to 13.6 volts if you find the output too high.

Reasoning: High input voltages to the receiver from the auto will cause B+ voltage to become higher than the ratings of filter capacitor C1. Thus C1 breaks down and shorts. If this happens, check the generator output voltage before reinstalling the transceiver in the car.

Case 6: Weak receive but transmit okay.

Common to: Hallicrafter CB-7



Remedy: Replace last i.f. transformer, T1.

Reasoning: Shorted turns in T1 cause this problem. This action reduces circuit Q, killing almost all the signal. Trouble can be a tough dog to find. While the coil peaks normally, the output of this stage is very low. Hence you can be led to believe the trouble lies elsewhere. END

COMING NEXT MONTH

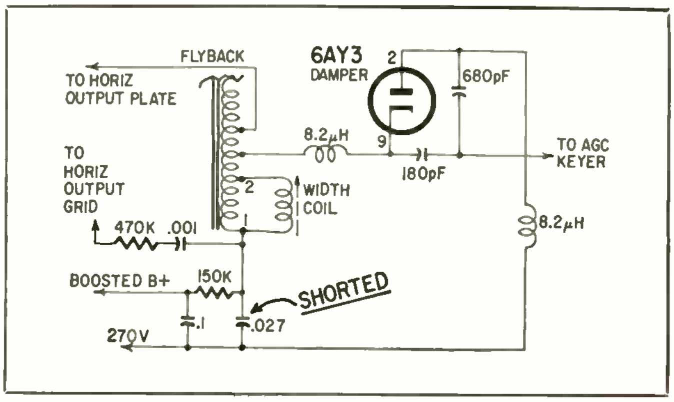
COLOR TV is an important part of electronics and is (a mystery) (not very clear) to me. I should (study color) (pick it up on the job). I don't like dull textbooks, so I will (forget about color) (read the easy-to-understand programed primer on color coming in September RADIO-ELECTRONICS).

CREATIVE SERVICING means you don't just start replacing components at random when troubleshooting electronics gear. Hit-or-miss is mostly miss—you waste time, do a poor job, and make less money. Why not take a few minutes to find out a logical and practical troubleshooting method? No matter how much electronics experience you have, you'll be interested in this article on logical servicing, in September RADIO-ELECTRONICS.

TECHNOTES

RCA KCS140—INTERMITTENT RASTER

When the set was first turned on the raster would come on and then fade away. All tubes checked good. With the 6AY3 damper tube out of its socket, the raster and brightness remained. But the width was pulled way in.



Checking the high-voltage and damper circuits, we found a shorted .027-μF in the bottom leg of the horizontal output transformer (see diagram). A new capacitor restored the raster to normal.—*Homer L. Davidson*

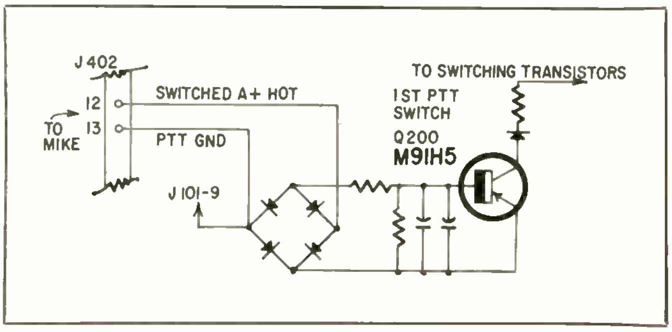
ADMIRAL COLOR REMOTE CONTROL

There have been reports of the on–off circuit being triggered when the COLOR button is pressed to *increase* color intensity. The trouble is caused by a gradual drift in the oscillator circuit in the remote control transmitter.

This can be corrected by simply touching up the setting of trimmer C12, located next to the transducer. See Admiral *manual S1043E* for complete alignment details—*Admiral Service News Letter*

MOTOROLA MOTRAN U51LLT

A car was brought in with the complaint of no squelch and no audio in the Motran U51LLT two-way radio. The red light on the control head came on when the mike button was pressed. The trouble was traced to the first ptt (push-to-

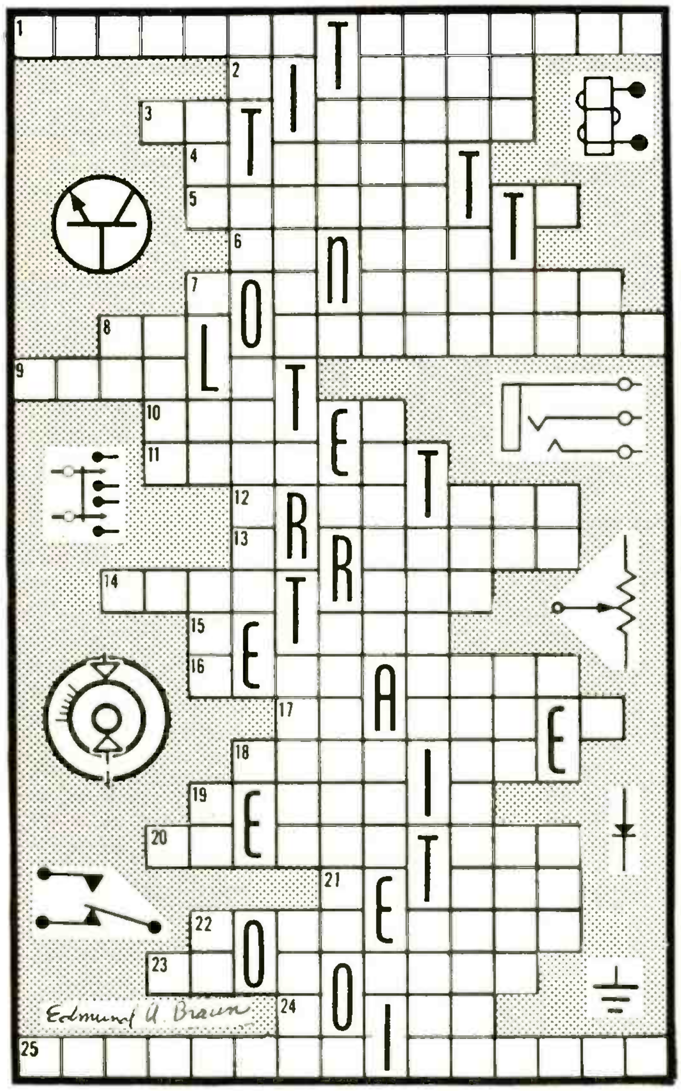


talk) transistor. It was shorted so it applied power to the power switching transistor. The transmitter was running continuously, with no indication that it was. The receiver is normally cut off in this state.—*Don A. Dudley* END

R-E PUZZLER

OHM-RUN HITTER? For a change of pace, try this only-across-word puzzle based on electronic terms. It shouldn't prove difficult except for someone who thinks "autodyne" means eating at a drive-in restaurant, or that "Wheatstone bridge" is a card game! Ready? Set? Go!

1 A type of radio receiver.
2 Alkaline metal used in construction of photoelectric cell.
3 Points of maximum displacement in series of standing waves.
4 Used to remove unwanted portions of printed circuit during fabrication.
5 Heavily varnished tubing used as insulation.
6 Tubular raceway for holding cables or wire.
7 A joining.
8 Instrument for measuring thousands of volts.
9 A type of antenna.
10 Unmodulated pattern found on picture tube face.
11 Any component of a vacuum tube.
12 Kind of insulating tape.
13 Device that protects circuits against lightning.
14 One of the essential components inside a vacuum tube.
15 Used to hold indexed rotary switches firmly in each position.
16 Grayish-white metallic element with many electronic applications.
17 Test instrument used to check electronic equipment or parts.
18 Two diodes in the same envelope.
19 Claylike substance which, after processing, is used as insulation.
20 Insulating medium between two plates of a capacitor.
21 Material introduced into a vacuum tube during manufacture for greater evacuation.
22 Process of joining two pieces of metal with heat.
23 The original model from which copies are made.
24 A union of two conductors.
25 Part of radio direction finder that determines the phase difference between two received signals.



Solution next month

NEW SEMICONDUCTORS, MICROCIRCUITS & TUBES

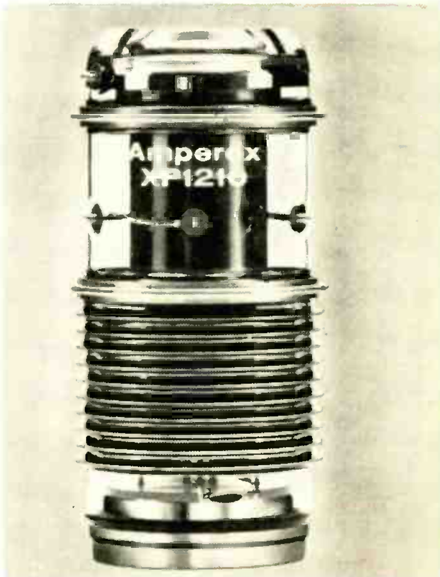
DO-IT-YOURSELF IC

Research laboratories and small companies can now carry out R & D projects involving IC's without having complete microcircuit manufacturing facilities at their disposal. This is made possible by Westinghouse's new Insta-Circuit monolithic silicon breadboard. All the customer has to do is to link the active areas of the tiny unit in various circuit combinations to suit his specific needs. The only equipment required is a wire bonding machine equipped with a microscope to facilitate connecting hair-thin gold bonds between various areas of the tiny silicon chip.

The Insta-Circuit breadboard contains 8 transistors, 44 resistors and 5 diodes—all within a chip no larger than the pupil of the human eye. It sells for $29.

PHOTOMULTIPLIER AND X-RAY TUBES

The XP1210 is a new tetrode focused photomultiplier tube capable of unusually fast response and high efficiency. Featuring a 2-inch cathode, the tube has the following typical parameters (voltage-dependent): electron transit time 18 nsec, rise time 0.6 nsec, collection efficiency 90% or better at 5,300 Å, luminous sensitivity (average) 60 μA/lumen, nominal gain 10^8 and nominal dark current 14×10^{-17} A/



cm^2. When operating at potentials up to 8 kV, the tube does not show tendency toward ionization or corona.

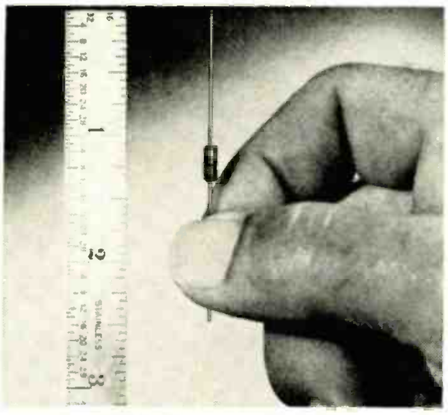
The FX-30 and FX-30M are the smallest flash X-ray tubes commercially available. The FX-30 envelope is 1⅛ in. in diameter and 2½ in. long. Overall length is 3⅜ in. The miniature version (FX-30M) is in a ½ × 1½-in. envelope and is 2 in. long overall.

Both tubes have a pulse duration of 100 μsec with a duty cycle of 1 pulse per 5 sec. Maximum plate voltage in air is 30 kV. Plate current is 1 A. Used in diagnostic studies of destructive weapons testing, stress-analysis equipment and similar applications.

Further information on these three tubes can be obtained from Amperex Electronics Corp., Hicksville, N. Y. 11802.

1-WATT ZENER VOLTAGE REGULATORS

The G3 through G12 make up a new series of 1-watt glass Zener diodes designed for regulator and other industrial and commercial applications requiring stable long-term operation. The small size (DO-7) makes this series especially suited for high-density packaging applications.



Available in a nominal Zener voltage range from 3 to 12 V and tolerances of 20%, 10% and 5%. The series is described in Bulletin C103 from International Rectifier, Dept. 781-C2, 233 Kansas St., El Segundo, Calif. 90245.

END

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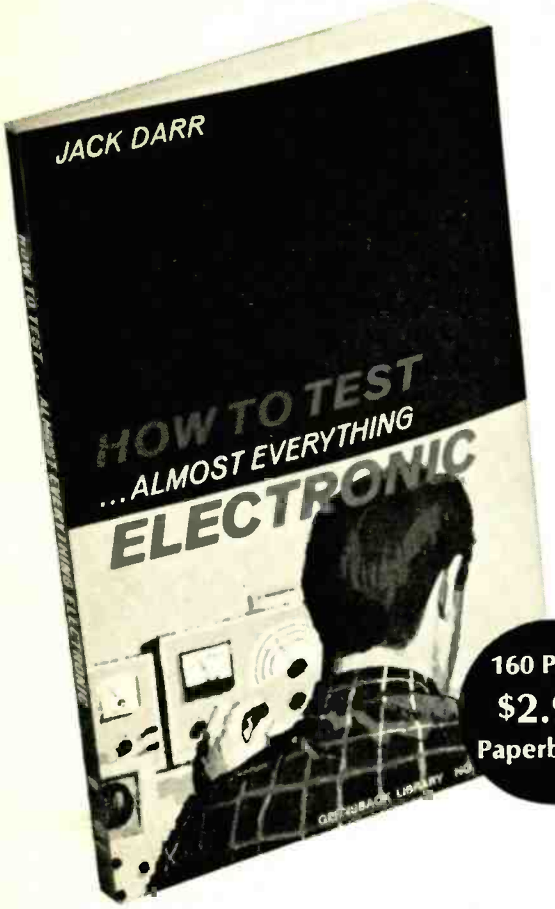

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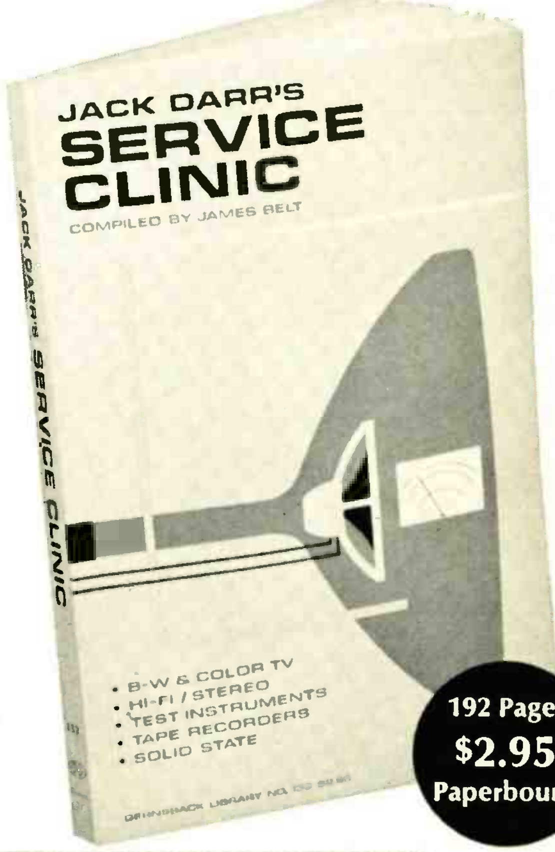

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JACK DARR'S SERVICE CLINIC

Compiled by James Belt. The most helpful material from RADIO-ELECTRONICS Service Editor Jack Darr's monthly "Service Clinic." Every chapter contains distillations of concise and witty instruction about testing and trouble-shooting, followed by actual reader questions and answers. Hundreds of questions selected for lasting usefulness and grouped under convenient categories for easy reference. Gernsback Library #133.

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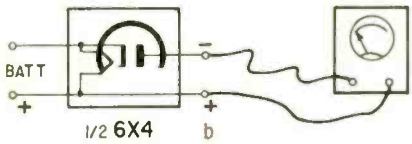
WHAT'S YOUR EQ?

These are the answers.

Puzzles are on page 66.

Voltage Booster

The box contains an ordinary vacuum tube. Electrons leave the hot cathode with enough energy to reach the plate even though it is slightly more



negative. In a triode, the grid, rather than the plate, should be used. Using a vtvm, cathode-to-plate voltages up to 2.5 may be obtained. This voltage drops rapidly with load, but short-circuit currents over 100 μA are normal.

Shifted Tuning

The gang capacitor has been lubricated with machine oil. Starting from A (unmeshed blades), the rotor blades are free and the capacitor functions normally. At B (meshed), the blades are in contact with the reservoir of oil. Due to surface tension, oil evenly spreads between rotor and stator plates, acting as a dielectric, increasing the capacitance. Hence station frequencies are shifted. When the gang is tuned back to A, the blades are again free and the oil seeps out, restoring normal capacitance. END

50 Years Ago

In Gernsback Publications
From August, 1917
Electrical Experimenter

Thunder-Storms and Lightning Rods

Women Radio Operators To Aid Uncle Sam

Unique Electrical Apparatus Reads the Mind

Details of a 20,000 Meter Undamped Radio Receiver

COLOR TV is an important part of electronics and is (a mystery) (not very clear) to me. I should (study color) (pick it up on the job). I don't like dull textbooks, so I will (forget about color) (read the easy-to-understand programed primer on color coming in **September RADIO-ELECTRONICS**).

NOTEWORTHY CIRCUITS

TRANSISTOR SLIDE CHANGER

A pause between taped commentary can be used to control your solenoid-actuated slide projector. You will recall this method was used in my "Silentac" electronic slide changer in the June 1964 issue. Here is a transistor version of the control circuit.

The circuit consists of two common-emitter ampliers operated without bias. The control relay is in Q2's collector circuit. A signal from the recorder's speaker terminals is fed to the base of Q1. When there is no signal from the recorder, capacitor C1 is charged to full supply voltage and Q1 and Q2 are cut off as a result.

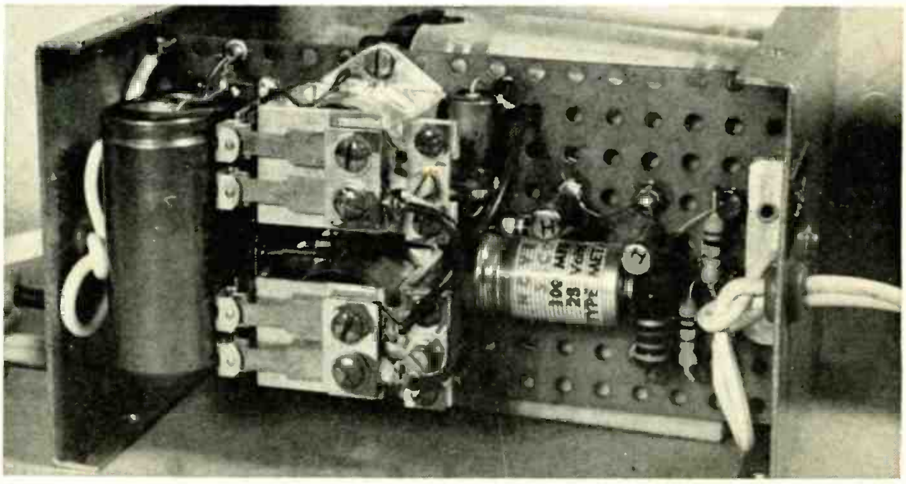
RY1 is not energized. Contact 1-2 of RY1 is closed, energizing RY2 and closing contact 5-6 on RY2; contact 3-4 of RY1 remains open. The control loop between terminals X and Y is normally held open by RY1 contact 3-4. The slide actuator is tripped by momentarily closing the loop.

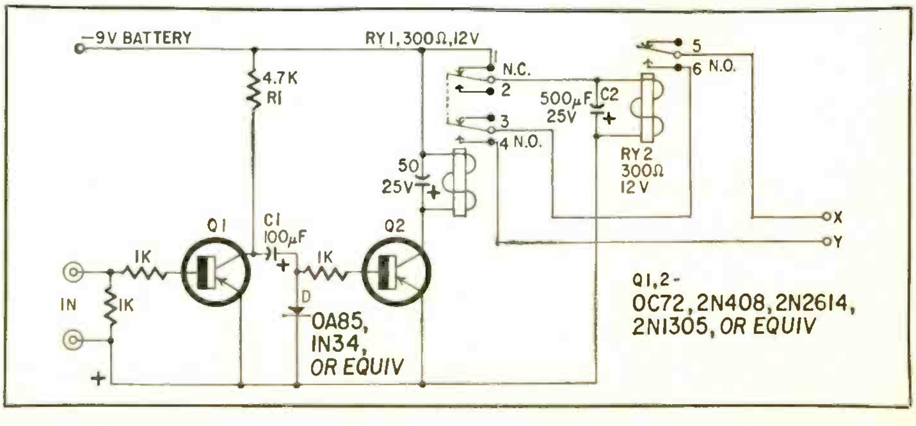
When the recorded commentary starts, Q1 saturates on negative half-cycles, drawing current through R1. This lowers the voltage on Q1's collector and permits C1 to discharge through diode D. The amplified signal drives Q2 to conduction, energizing RY1 to close contact 3-4 and open 1-2.

Although contact 1-2 is now open, RY2 remains energized for the period required for C2 to discharge through its coil. This delay is long enough to actuate the changer solenoid and project the first slide.

RY1 is energized and RY2 is not, as long as commentary continues. When there is a pause in commentary, C1 starts charging through Q2, keeping RY1 energized during the charging interval. When the pause exceeds a predetermined limit, Q2 cuts off and RY1 releases (drops out). Contact 1-2 closes, resulting in the sequence already described. When commentary resumes, a new cycle starts and the next slide is projected.

—*W. G. Landrieu* END





Solution to R-E Puzzler for July 1967

1 autotransformer
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3 electroacoustic
4 dopant
5 trinistor
6 additron
7 demodulation
8 transmitter
9 tertiary
10 padder
11 alligator
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14 thermionic
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16 chromaticity
17 toroidal
18 unidirectional
19 instability
20 concentric
21 substrate
22 actinium
23 oscillation
24 photovaristor
25 Intermodulation

Subtract 4 points for any part you didn't answer correctly. Perfect score is 100.
Your rating:

60-64 Fair
68-72 Fair to middlin'.
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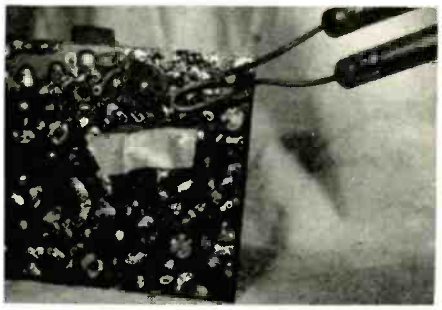
100 Perfect! Tell your wife to bake a cake and celebrate!

By Edmund A. Braun

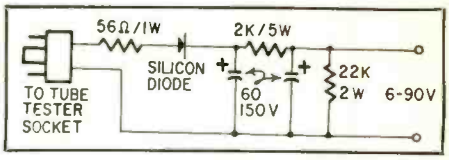
TRY THIS ONE

MASKING TAPE AS SOLDERING AID

Recently, while making a connection on a vertical printed-circuit chassis, molten solder flowed down and shorted several circuits. I've since found masking tape a simple solution to the problem.



Just stick it tightly over the foil areas directly under the area being repaired. This prevents molten solder from falling on and shorting other surfaces. *—Peter Legon*



BATTERY ELIMINATOR FROM TUBE TESTER

This kink is a real time saver when servicing tube-type battery portables. I use the filament-voltage output of my tube tester along with an outboard rectifier and filter as a B-battery eliminator. This saves time when the right battery is not available.

The diagram shows the circuit of the adapter. It supplies B+ voltages from 6 to 90. I adjust the output voltage with the filament-voltage selector. An octal tube base connects the adapter to the tube tester. You can connect the battery eliminator to the set through insulated clips or matching battery connectors.—*Oscar Blair* END

NEW BOOKS

ELECTRONICS DRAFTING WORKBOOK, by *Cyrus Kirshner and Kurt M. Stone. McGraw-Hill Book Co., 330 W. 42 St., New York, N. Y. 8½ x 11 in., 96 pp. Paper, $4.50*

Just what the name implies—a workbook. Page by page, the reader does his drawing right in the workbook. Can be used for self-study, although we feel its best use would come in connection with a suitable drafting textbook or with an instructor who can explain the assignments in a little more detail.

PRINCIPLES OF AERIAL DESIGN, by *H. Page. D. Van Nostrand Co., Inc. 120 Alexander St., Princeton, N. J. 5½ x 8½ in., 172 pp. Leatherette, $1.75*

Published originally in London by Iliffe Books Ltd., this is a book for post-graduate engineers. The majority of the book is deeply mathematical, but the last chapter on practical forms of antennas is exactly that—practical. Almost any high-school graduate can learn about aerials (antennas) from that section.

MICROWAVE VALVES, by *I. C. H. Dix and W. H. Aldous. Iliffe Books Ltd., Dorsett House, Stamford Street, London, S. E. 1, England. 5½ x 8½ in., 280 pp. Leatherette, $7.70*

On microwave tubes. Includes helix-type traveling-wave tubes of both low and high power. Also covers linear crossed-field tubes, cylindrical crossed-field tubes, amplicons and magnetrons. Has supporting math, but depends heavily on cross-sectional sketches and diagrams to get the principles across. Smoothly written, well indexed.

END

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600	.20
800	.25
1000	.50
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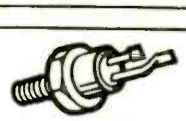
1800	1.20



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Circle 147 on reader's service card

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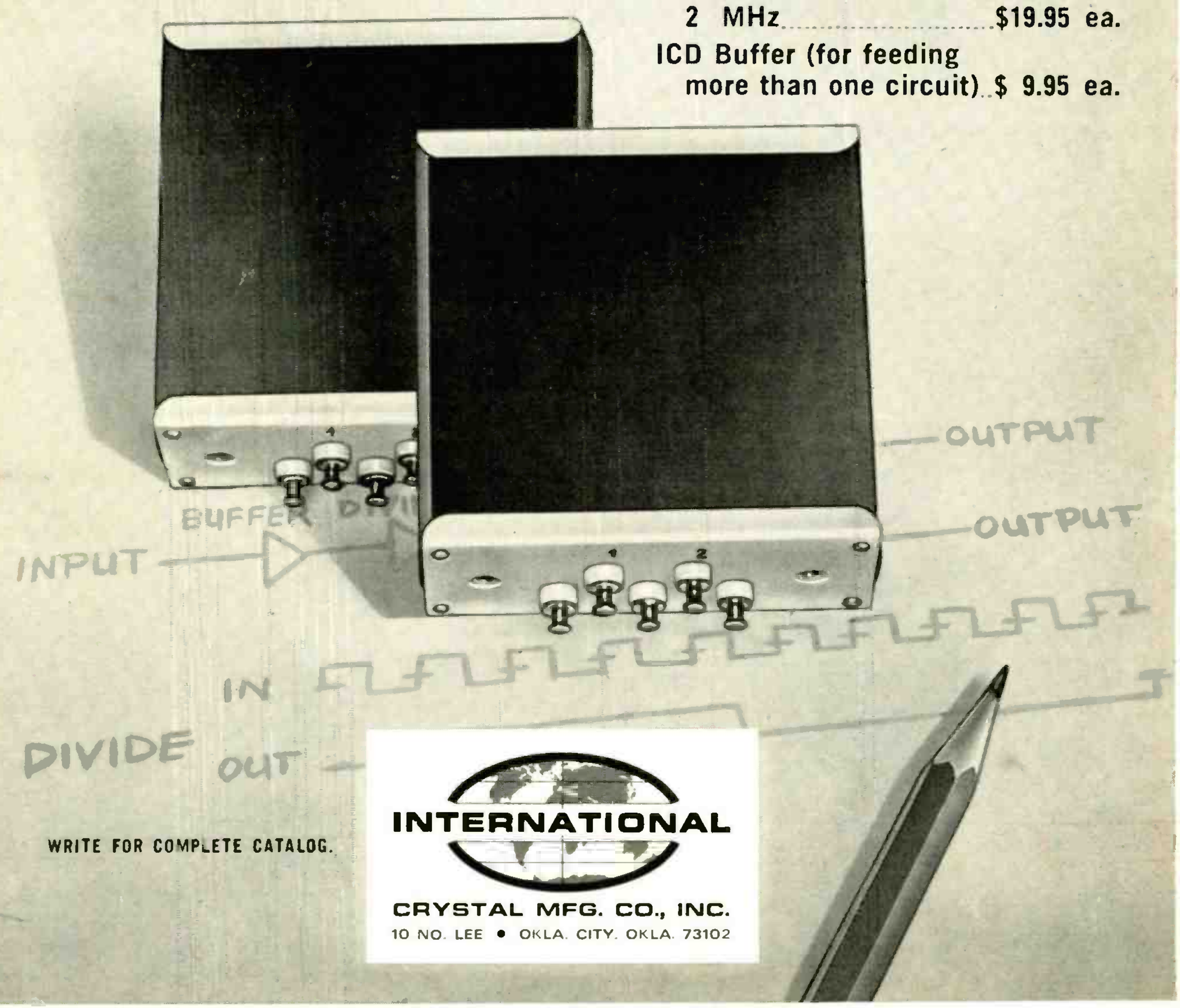

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