60c ■ APR. 1967

Radio-Electronics

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HUGO GERNSBACK, Editor-in-chief

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Electronics Test Air War Tactics
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40th Birthday of TV!

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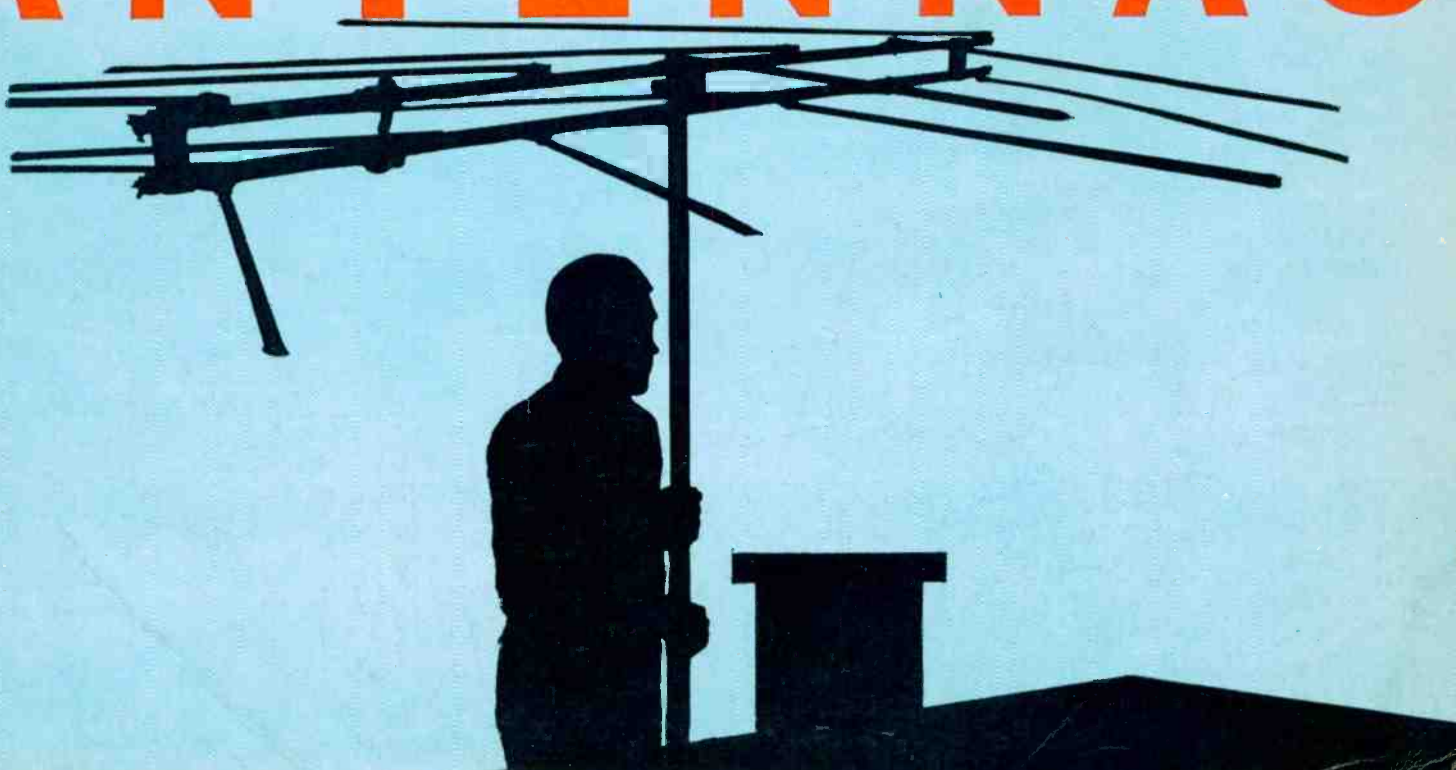

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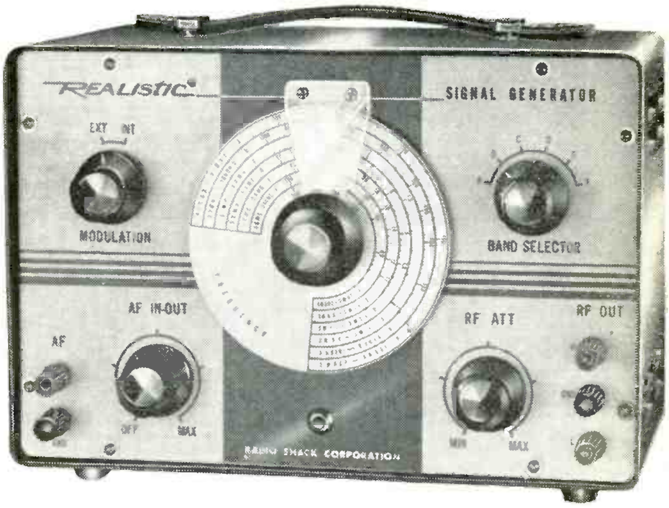

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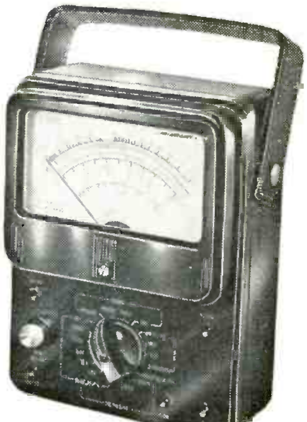

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FROM THE EDITOR

The Hands That Feed ETV

THE electronics industry is full of topics for heated discussion these days. One lively subject is educational television (ETV). Almost everyone agrees it has endless possibilities, but no one has decided yet how to support this academic orphan. After financing comes the question of what needs ETV can fulfill. Academic, certainly; cultural, hopefully; social, necessarily; and possibly even entertainment. But there are opportunities beyond the obvious.

Educational TV is inescapably tied to electronics. Electronics-trained engineers and technicians operate and maintain the studio, transmitting, and relaying equipment. Service technicians keep the receivers, distribution systems, and monitors working in home and school. Degree engineers plan, design, and oversee the manufacture of both transmitting and receiving equipment and of the test instruments used to maintain them. Without electronics, and engineers and technicians trained in electronics, educational television couldn't even exist.

One consideration, then, that should be a part of all ETV planning is how to develop and keep an adequate force of competent engineers and technicians —enough hands to keep the knobs turned and the joints soldered and the picture tubes glowing. Without these skilled professional hands, ETV's existence will be less than easy—no matter how thorough the financing. Unless transmitters function, there's no signal. Unless TV sets at home and school are working, there's no use for a signal; who'd watch it?

Educational TV hasn't devoted much apparent planning to this portion of the academic job. There are three important educational services that ETV is peculiarly well equipped to offer. In their own interests, ETV-industry leaders should look into these services seriously.

The first is consumer education—teaching owners of TV sets and other home electronic devices how to care for them and how to find good service when trouble pops up. Some inept "exposé" programs recently have contributed more confusion than help (because of technical inaccuracy and misleadingly incomplete reporting). What set-owners need are a few accurate and constructive programs. So far, I've neither seen nor heard of a program that shows a TV owner how to find a competent technician; instead, they try to show how to avoid frauds, and they haven't even accomplished that. If the ETV industry wants to see consumer and school receivers kept in top operating order, it's time to start using the same teaching tactics used for other subjects. Scare tactics are doing more damage than good.

The second important service open to educational television is a form of adult education. Technicians and engineers can be trained and upgraded by televised instruction. The shortage of technicians is so acute that not even the efforts of technical schools, high-school and college vocational classes, manufacturers' training sessions, and distributors' servicing clinics can produce as many skilled professional experts as are needed by ETV and the entire telecasting complex—transmitting and receiving. Only a mass medium can approach the job adequately, and ETV will be such a medium.

A helpful side effect from public airing of this kind of technical instruction on TV: Whoever of the TV public is interested can see the degree of training needed by a competent engineer or technician and could develop new respect for the individual so trained. Also, enough knowledge might rub off to develop a better-informed public, to the everlasting benefit of both the electronics industry and the consumer.

The third service ETV could perform is allied to the second. Programs could be designed and produced to attract young people to electronics careers. The engineers and technicians of the future are in school today. Besides offering actual training, ETV could build a better image of electronics as a field with professional stature instead of scaring students away from an "undesirable trade."

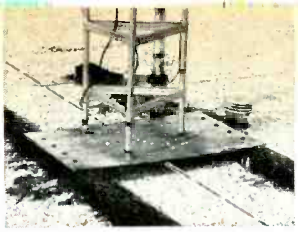
Educational TV has these obligations to the viewing public and to its own well-being. Much damage has been done already to the field of electronics through misapplied efforts to "clean up" the servicing industry, efforts publicized nationally by network and educational TV. The ends of both the consumer and the television industry can be better served by a sensible plan of education.

The hands that feed ETV are those of electronics engineers and technicians. They've been bitten severely. A serious education plan may be the salve to heal those wounds and attract enough future hands to give educational television the success it should deserve.

Forest H Belt

Radio-Electronics

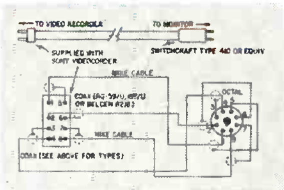
April 1967 VOL. XXXVIII No. 4
Over 55 Years of Electronic Publishing



p 53—ROOFTOP MOUNTS

p 51—FLIGHT TESTING

p 57—SOLID-STATE TALK



p 32—VTR ADAPTER

p 43—EASY COLOR SETUP

p 55—PIONEER VIDEO

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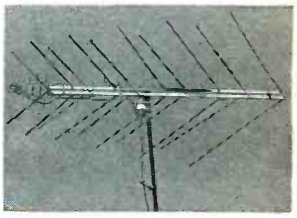
ANTENNA FEATURE



p 36—In weak-signal areas, a preamplifier at the TV or FM antenna can keep out much noise and deliver clean picture and sound. Several types of booster are available; learn to pick the right one for your location.

LIGHTNING BOLTS

p 40—When static discharges occur in the atmosphere, strange things happen. Sometimes fireballs are created, bouncing around the sky at tremendous speeds. Do they have anything to do with UFO's?

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Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

NEWS BRIEFS

PACIFIC SATELLITE IN REGULAR SERVICE

Commercial telephone (from AT&T) and commercial television service (from ITT and NBC) from the continental US to Hawaii and Japan via transpacific satellite began late in January. The Communications Satel-

lite Corp.'s second launch in its Intelsat II program achieved synchronous orbit and hovered about halfway between North America and Australia. The satellite—known colloquially as *Lani*, Hawaiian for bird—furnishes 6 voice circuits into Hawaii and 30 channels into Japan. Photo shows the "bird" before it left the nest. It was built for COMSAT by Hughes Aircraft Co.

(For more on this subject, be sure to read "COMSAT: Communication in the Space Age," in next month's RADIO-ELECTRONICS.)

ARE YOUR LIGHTS ON?

A motorist whose taillights are out is a hazard to himself and every other driver on the road. How to be sure you've still got some red showing unless you stop and get out of the car? Maybe a dash-mounted pilot lamp—except that the pilot could burn out apart from the taillight, which would be a nuisance.

Fiber optics has furnished a solution to the problem. Glass fibers that carry light the way a pipe carries water are the heart of the new system. A bundle of 30 glass fibers—each as thick as a human hair—is routed from each lamp in a car to the dash. Light travels along the fibers and produces a small pip on the dashboard monitor panel. Completely passive, the fiber bundle can't burn out. Whenever a headlight, parking light or taillight is on, the driver knows it. What's more important, he knows when they're *not* on and should be.

The system was introduced at the January meeting of the Society of Automotive Engineers by its developer, Mosaic Fabrications (subsidiary of Bendix Corp.).

SORRY, TIME'S UP!

Sometimes it seems like teenagers *never* get off the phone. Then there's the problem of employees who place personal calls on business telephones during working hours.

Now comes a solid-state device that limits phone conversations to a preset interval. The *Call Limiter* (trademark of Pulse Communications, Inc.) starts timing when a call begins. After 5 to 10 minutes of conversation (interval adjustable), a warning tone—1 to 3 seconds in duration—comes on the line. If the parties don't hang up, 2 or 3 minutes later the Call Limiter adds a continuous tone to the line, making any further conversation impossible.

The device is already being used in military and certain industrial applications. Once FCC tariff approval is given, the Call Limiter will be available to private telephone subscribers.

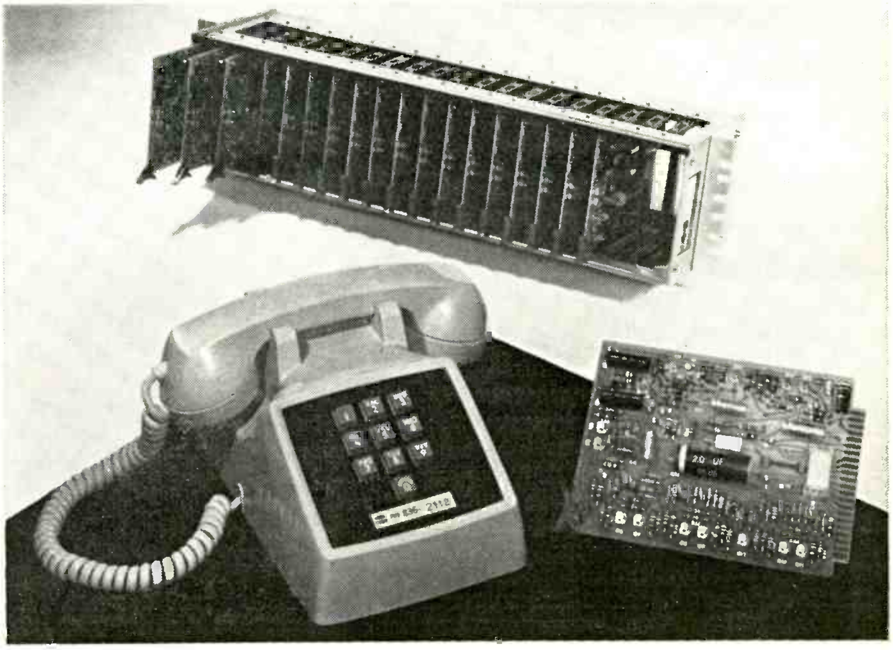
ALUMINUM OR COPPER?

Due to the present copper shortage, and the resultant price increase in copper conductors, aluminum wire is being used in many applications. Reynolds Metals Co. recently received an order for 70 miles of aluminum conductors for the Forrestal Building, now under construction for the Department of Defense. The Washington Hilton is also wired with this metal.

Aluminum seems a good substitute for copper in many noncritical applications. Possibly the only disadvantage is that aluminum has slightly higher resistance than copper—a ratio of about 1.7 to 1.

TECHNICIAN TRAINING GROWS

To meet the demand for electronics service technicians, the National Electronic Associations, Inc., some time ago began an apprenticeship training project. The program was re-



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cently expanded and extended when the Dept. of Labor awarded a new contract to NEA. Cities where the project is now functioning include Detroit, Akron, Des Moines and Indianapolis. New divisions are being set up in Louisville, Wichita, Hartford, South Bend and Evansville (Indiana), and Columbus (Ohio).

The usual arrangement is for the apprentice to take 16 weeks of classroom study followed by 16 weeks of on-the-job training. The complete program covers a 4-year period.

WALKIE-TALKIE RULE CHANGE

The Federal Communications Commission is thinking of changing its regulations pertaining to license-free low-power transceivers operating in the 27-MHz Citizens band. These devices, which operate under Part 15 of FCC rules, are limited to 100 mW of power and may be operated by a person of any age. The Commission proposes to relocate such transceivers to a band in the 49-MHz region.

One reason for the change may be the recent wave of complaints from CB'ers about interference from children using walkie-talkies. CB stations (which are covered by Part 95 of the rules) must be licensed and such licenses may be granted only to a person 18 years or older. These stations must meet more rigid technical criteria than the Part-15 flea-power rigs.

If the walkie-talkies were shifted to 49-MHz, they'd have the band to themselves. Moreover, they wouldn't interfere with CB stations.

CORRECTION

There is a typographical error in the type number given for transistors Q1 and Q2 in the parts list and Fig. 3 of the article "Solid-State C-D Ignition Under $25" in the February issue. The correct type number for Q1 and Q2 is 2N3614. You will find this type listed at $1.40 each in Allied Radio and Newark Electronics Corp. 1967 catalogs.

TAPE FIGHTS DISC

Despite the controversy between four-track and eight-track prerecorded tape cartridges, industry leaders feel that music on tape can equal disc recordings in sales during 1967. Extensive promotion is under way and so far public acceptance of prerecorded tapes has been good.

What standards—if any—will be

Radio-Electronics

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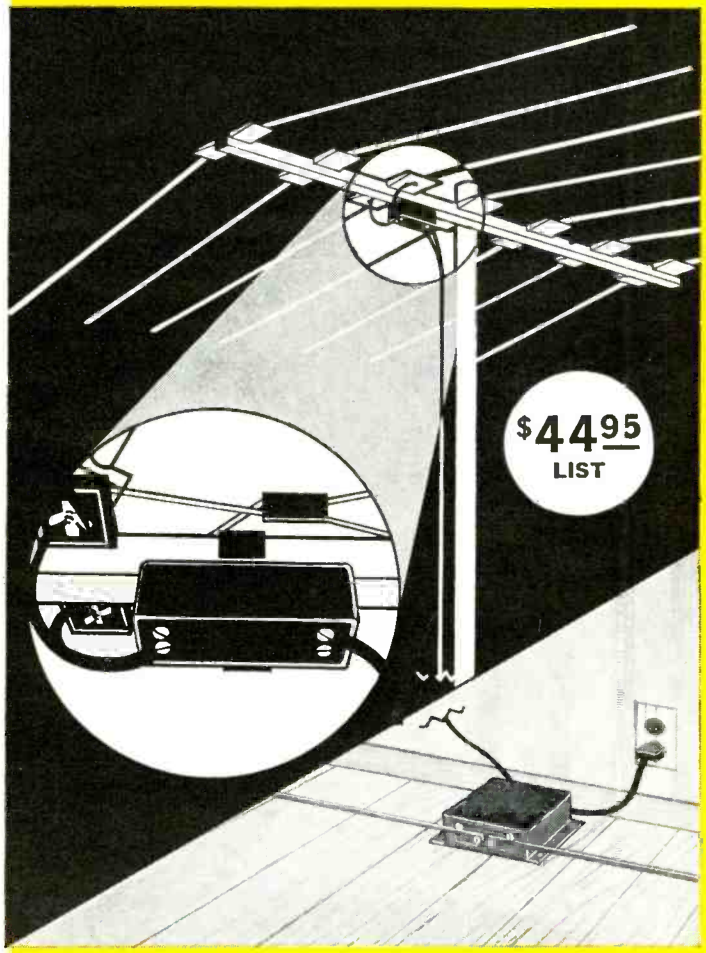

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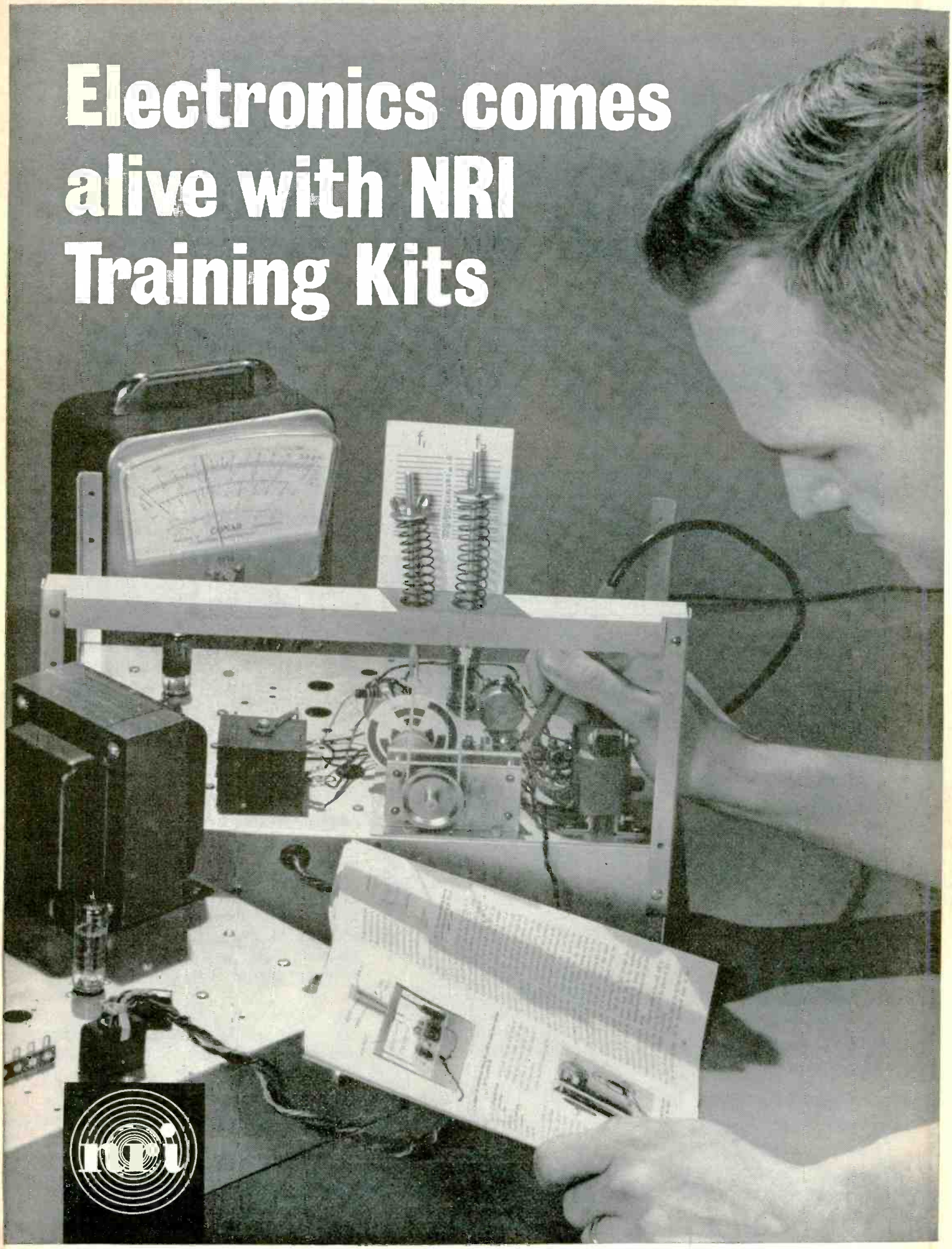
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11. ELECTRICAL APPLIANCE REPAIR— Learn to repair all appliances, including air conditioning, refrigeration, small gas engines. Leads to profitable part or full-time business.

12. ELECTRONICS FOR PRINTERS — Operation and maintenance of Electronic equipment used in graphic arts industry. From basics to computer circuits. Approved by major manufacturers.

*You must pass your FCC License exams (any Communications course) or NRI refunds in full the tuition you have paid.

NEWS BRIEFS continued

adopted by tape companies is still a subject for speculation. There are four-track, eight-track, reel-to-reel and cartridge-loop systems. Perhaps we'll end up with something like the 33⅓–45-rpm compromise that's used in the disc industry.

MORE LOW-COST COLOR ON TAPE

Inexpensive color video recordings are possible with at least two brands of VTR's. Sony Corp. now markets an adapter for converting most of that firm's low-cost, helical-scan video recorders. Earlier, Ampex Corp. developed the first conversion of a relatively low-cost machine to color. (This unit was described in "A Portable Color Recorder," in last month's RADIO-ELECTRONICS.)

3-D HOLOGRAMS WITH ORDINARY LIGHT

The technology of making stereoscopic photographs is advancing rapidly. Using a laser to illuminate the scene—described in "Direct-View 3-D Images!" in our January 1967 issue—now appears to be somewhat old hat. A new technique, using a "fly's eye" lens and ordinary, noncoherent light, may make holograms possible for amateur photographers.

A hologram records all information contained in light waves from a scene. Where an ordinary photo records only light intensity, a hologram includes positional information. Thus a hologram appears to have depth and perspective.

The new process—developed by the research division of IBM Corp.—is illustrated in the photo. At center is the "fly's eye" lens, consisting of hundreds of tiny facets, each with a slightly different angle of acceptance from the others. The images surrounding the lens are but a few of the "pictures" formed of the same scene. Since each picture is shot from a slightly different angle, perspective information is preserved.

For playback (viewing the image), a laser is necessary at this stage of development. The beam is projected through the photo and another "fly's eye" lens, combining the multiple images into an image that has lifelike reality.

The drawing shows what the special lens looks like.

At the other end of the process, another firm has developed a hologram that is *viewable* with ordinary light. Jodon Engineering Associates has devised a method of producing holograms that can be observed when illuminated with a flashlight. The holograms are similar to color film transparencies.

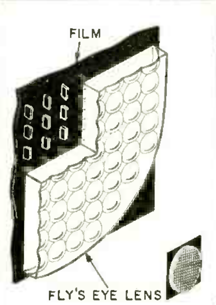
VAN DE GRAAFF DEAD

Another man whose name is an electronics byword is gone. Dr. Robert J. Van de Graaff died January 16 in Boston at the age of 65. In the early 1930's, he invented the particle accelerator which bears his name, and which has been used extensively since then in cancer therapy and nuclear physics research.

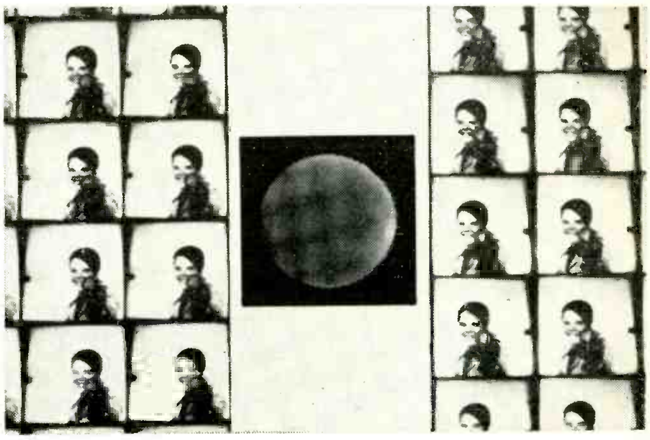
Van de Graaff was the recipient of many honors for his pioneer work in the field of high-voltage engineering. A physicist, he received BS and MS degrees from the University of Alabama, and a doctorate from Oxford University (England), where he was a Rhodes Scholar. He was a native of Tuscaloosa, Ala. END

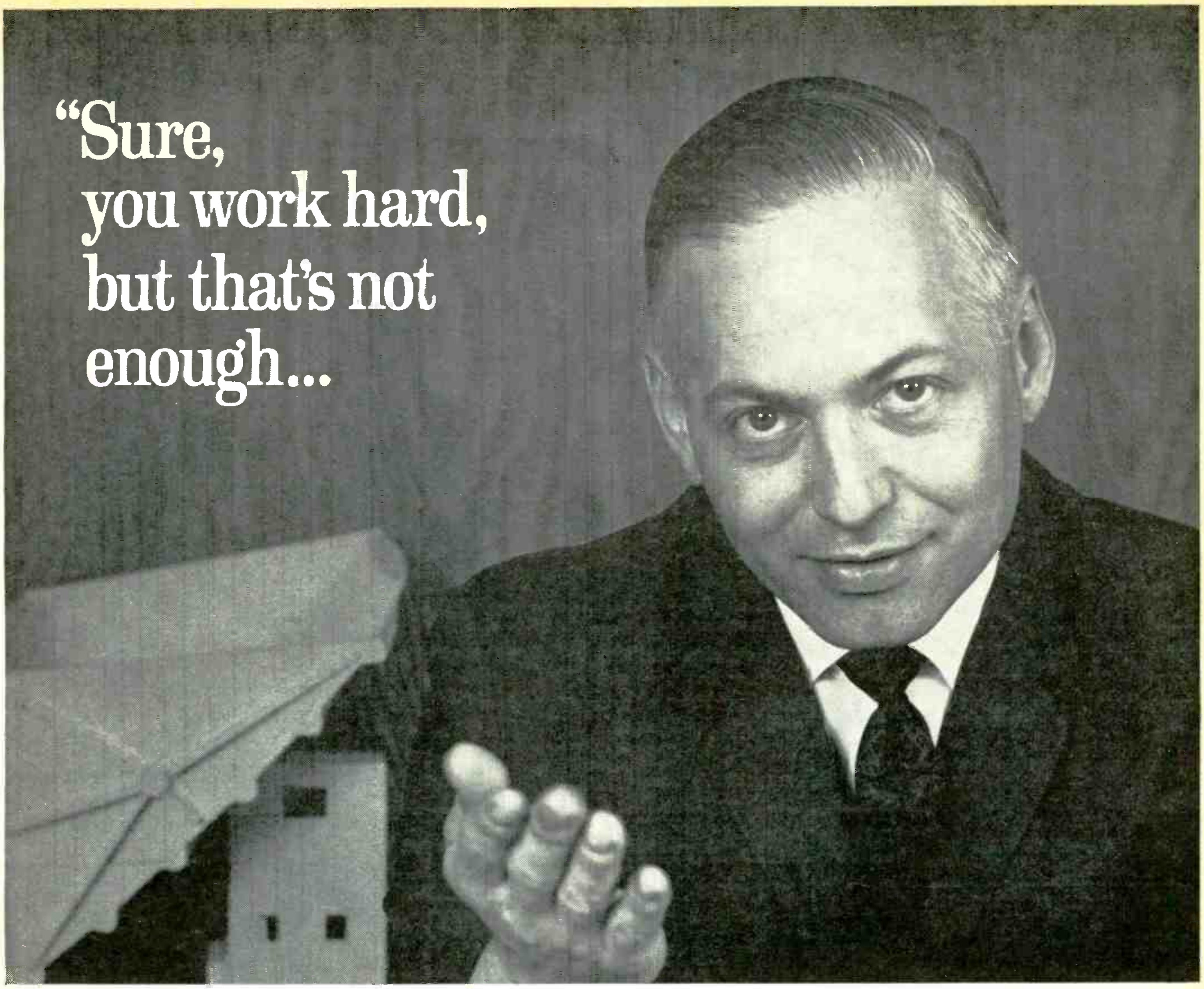
Driver-Reaction Tests
the reflexes of racecar drivers at the Indianapolis 500-Mile Speedway.
Read this special report in

May RADIO-ELECTRONICS



A multiple-image lens creates 3-D images on film.





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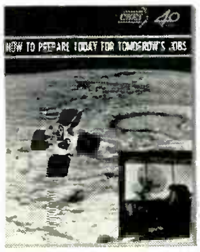

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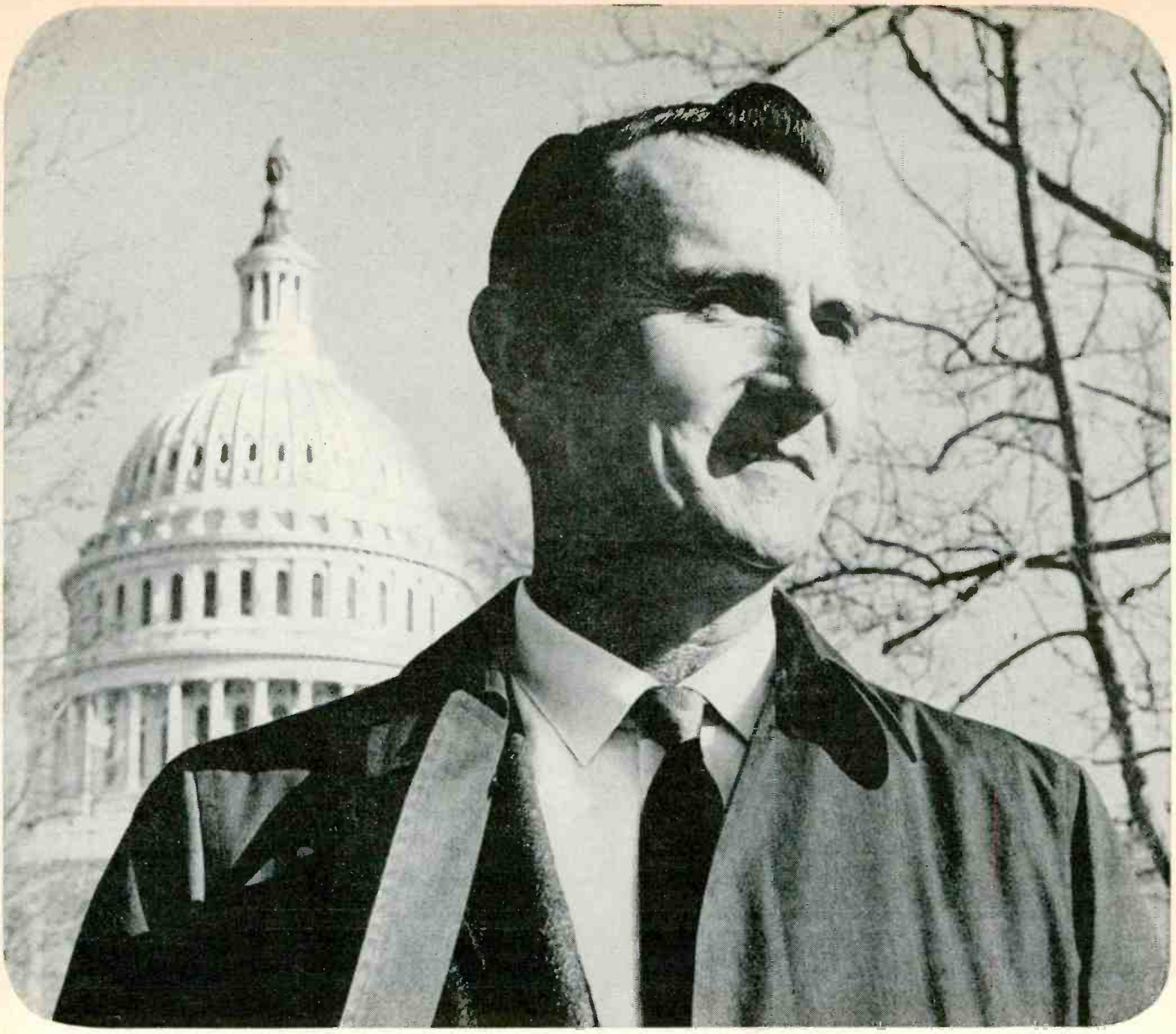

"When you're commissioned to do antenna installations for the Capitol

. . . Blair House, the Pentagon, Washington National Airport, Department of Justice, Federal Trade Commission, Federal Communications Commission, and the National Space and Aeronautics Administration Buildings, you can't take chances. That's why we install JFD television antennas exclusively," says JERRY PEAKE, of Jerry Peake Co., Inc., Washington, D.C.

"As the biggest professional antenna installing company around these parts, we can't afford to be No. 2. We've got to deliver top picture—VHF and UHF — for the dealers, retailers and department stores who rely on us to keep their sets sold and customers satisfied. Color, especially, must be natural and ghost-free. Only JFD LPV antennas come across with this kind of reception."

Jerry Peake Co., Inc., Washington, D.C., has installed over 185,000 antennas in the last 18 years in the Washington, D.C. area. He relies on both JFD LPV-CL Color Lasers and LPV-TV Log Periodics — like other professionals — to get performance people expect from a professional. Here's why:

☐ **W-I-D-E BAND LPV LOG PERIODIC DESIGN** delivers *more* gain, *higher* signal-to-noise ratios, *pinpoint* directivity that kills ghosts—VHF and UHF.

☐ **SHOWROOM QUALITY COLOR** — *flat* response across each channel. No "suck-outs" or "roll-off." *Out-performs* any other antenna in *color* or black and white — *keeps* customers sold.

☐ **CAPACITOR-COUPLED ELEMENTS** work on *both* fundamental and harmonic modes. *Entire* antenna (not just part of it as in other antennas) responds to *every* channel.

☐ **RUGGED NEW "FLIP-LOK" ASSEMBLY** snaps out elements — keeps them *tight* and right on target.

JFD® LPV®

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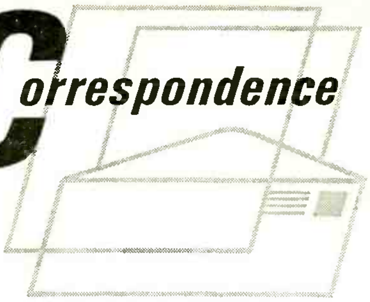
JFD International, 64-14 Woodside Ave., Woodside, N.Y. 11377 JFD Canada, Ltd., Ontario, Canada
JFD de Venezuela, S.A., Avenida Los Haticos 125-97, Maracaibo, Venezuela

Circle 14 on reader's service card

Correspondence



CASE OF THE MISSING ARTICLE

Dear Editor:

Am a regular subscriber to RADIO-ELECTRONICS and was for many years when it was named differently. But I received my February copy Friday and was very disappointed. In the January issue you have a notice of "an instrument you can build to identify and evaluate strange transistors." Then on your front cover of the February issue: "Identifying Transistor Characteristics."

But you cut the article completely. There must have been a good reason but it was very disappointing as I was looking forward to this article.

JOSEPH POWER
Philadelphia, Pa.

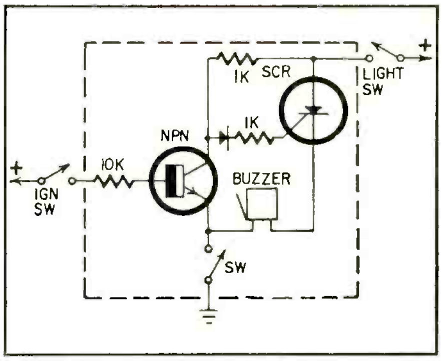
[We were redfaced and disappointed, too. As issue preparation got down to the last minute, we found a glaring problem with the unit. Even though covers were already committed, we killed the story rather than run a misleading version.

We hope the units in the March issue did the job for you. See "An Experimenter's Transistor Test Set" (page 57) and "Quick-Checker for Controlled Rectifiers" (page 70) in that issue.—Editor]

SWITCH FOR PMDVM

Dear Editor:

For the Poor Man's Digital Voltmeter (RADIO-ELECTRONICS, August 1966, page 30) I recommend the following switching system, using built-in guard rings to avoid leakage problems. The two probe sections should be on separate wafers or banks, each with its own ground section. The series input resistors go to contacts 1 through 6; they are the multipliers.



DAVID C. BELL
Auckland, New Zealand

THREE FOR THE MONEY

Dear Editor:

I read your editorial in the January issue (page 2). $752 for color? Baloney. A dependable set isn't worth more than $389.95. Why? I bought a Zenith black-and-white recently for $129.95. Exchanging black for red, then blue and yellow [sic] is extra. So, $129.95 for red, $129.95 for blue, and $129.50 for yellow [sic] equals $389.95 for color.

E. J. KUKLER
Tewksbury, Mass.

[And stereo FM should cost twice as much as mono FM?—Editor]

LIKES THE INDEX

Dear Editor:

I have been a subscriber to your magazine for years and I want to thank you for putting out a fine publication.

Your yearly index is a valuable feature and I want to express my preference for your switching back to the one annual index in the December issue. The semiannual index was fine, but it would have been better if the December issue carried the full annual index.

STEPHEN WIESNER
Cleveland, Ohio

NICAD INFO

Dear Editor:

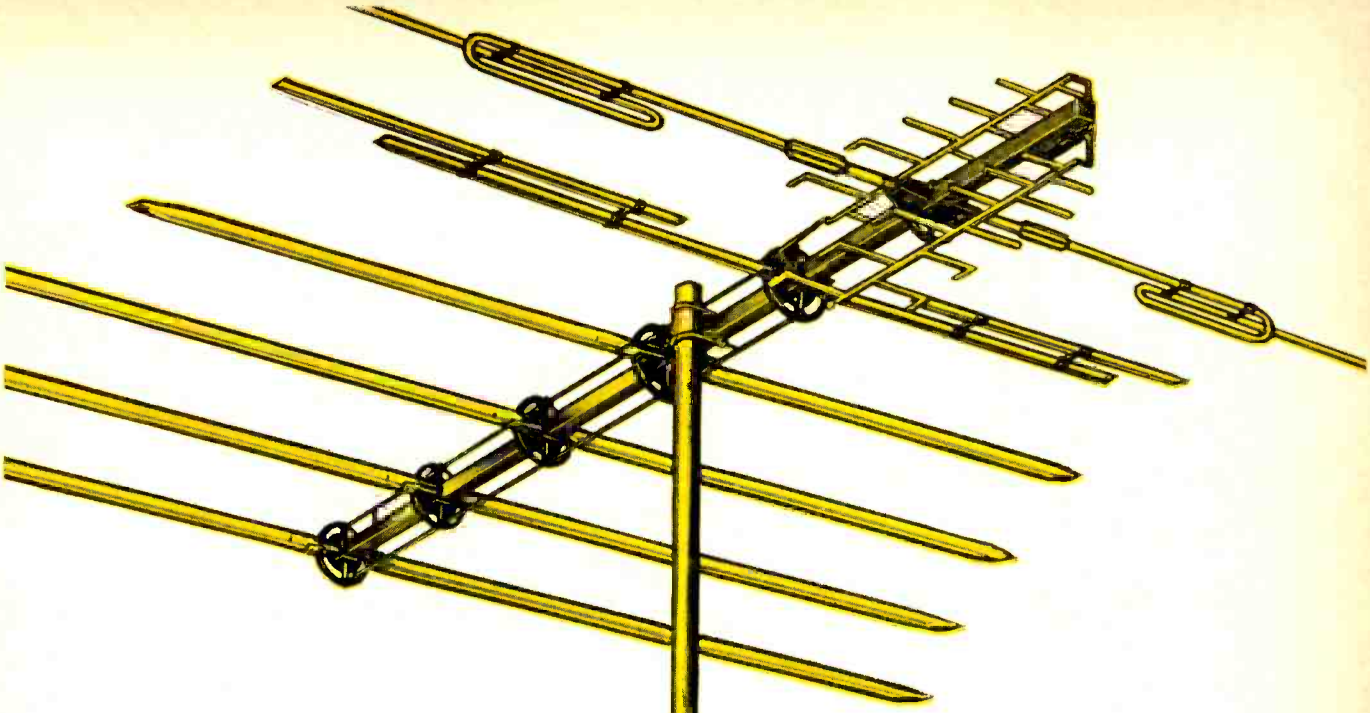
In your Battery Selection Guide which appeared (page 60) in the February issue, you omitted one of the most desirable characteristics nickel-cadmium batteries possess: a very flat voltage-discharge curve. Indeed, this is probably the cause for the erroneous statement that the batteries would be discharged to cutoff after two months on the shelf.

Your statement that they lose a certain percentage of their capacity per month on the shelf is certainly correct, but let's not confuse ampere-hour capacity with terminal voltage. A glance at the specification sheet of a Gould National size D NICAD shows that the cells lose about 25% of their capacity in one month, 50% of their capacity in three months, and 85% of their capacity in 5 months. This is ampere-hour capacity, not terminal voltage.

I found the rest of the article excellent; it provides information that up to this time has been difficult for the general public to obtain.

HARVEY ALTSTADTER
New York, N. Y.

END



Fill the "profit gap" with the new Jerrold VU FINDER T.M. 82-channel antenna

Now—the economical new Jerrold VUfinder 82-channel antenna provides the best possible 300-ohm all-channel color TV and FM reception. The VUfinder joins Jerrold's Coloraxial Pathfinder and Paralog-Plus antennas to give you another chance to profit on Jerrold reception quality:

- Sharp directivity eliminates color ghosts
- Flatness of ±1 db per channel assures greater color fidelity
- Color-distorting phase shifts are eliminated

The Jerrold VUfinder Antenna actually works on both high and low band channels simultaneously—making each element serve double duty. The models are short, easier to install, and offer less wind loading than ordinary antennas of comparable gain. And each antenna comes complete with a UHF/VHF frequency splitter for the back of the set.

Focus on Jerrold. First with the finest products and profits. For details on the Jerrold VUfinder 82-channel antenna, see your Jerrold distributor.

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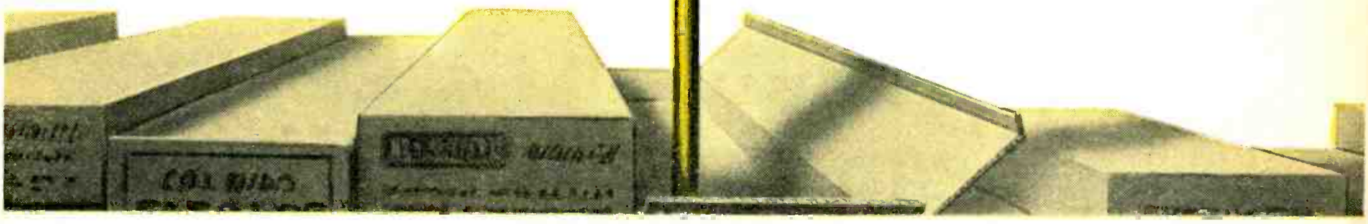
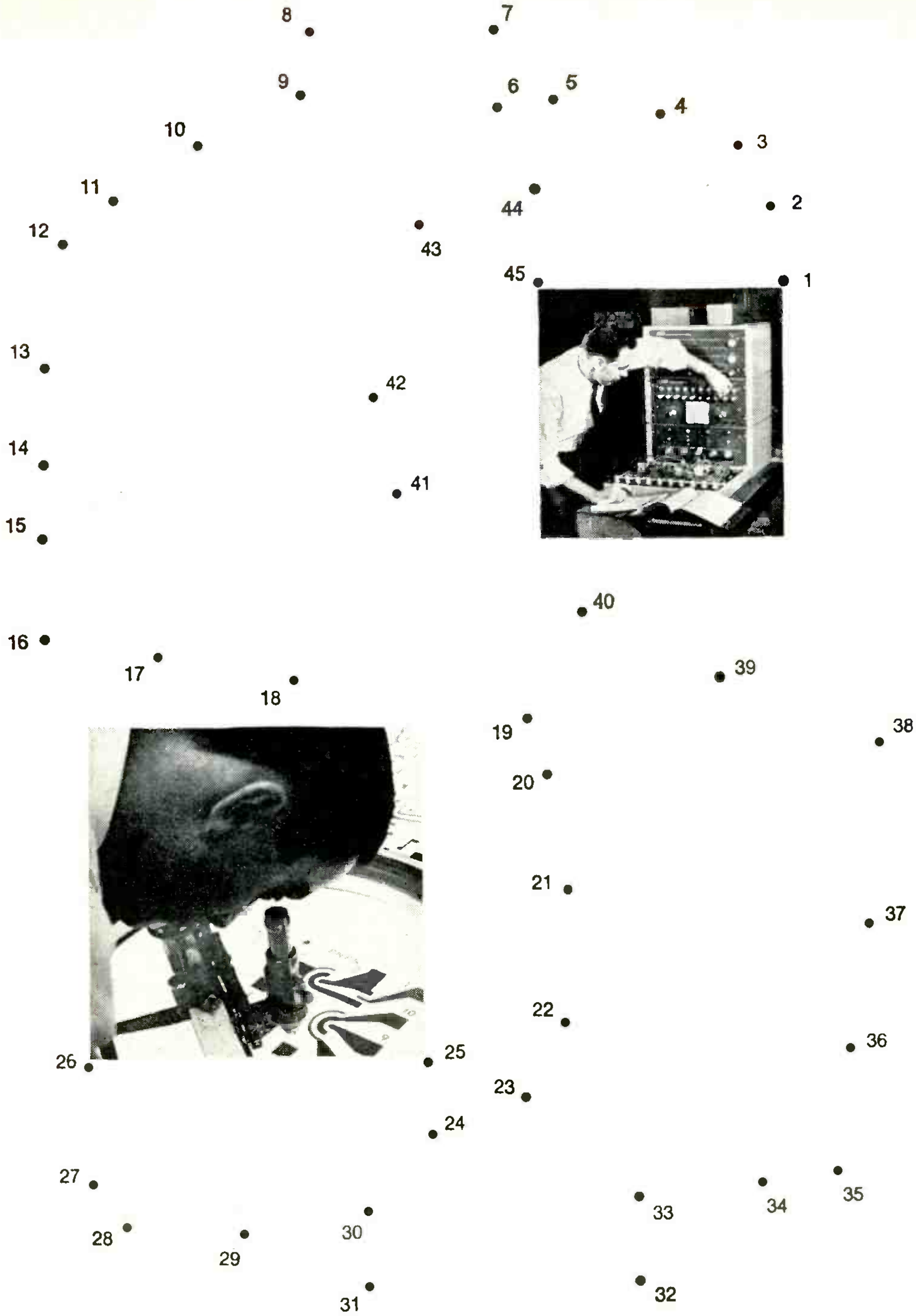


Circle 16 on reader's service card



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SERVICE CLINIC

In the Shop . . . With Jack

By JACK DARR

THERE HAS ALWAYS BEEN A GOOD DEAL of discussin' about antennas (and at times a good bit of cussin' as well). For what they're worth, here are the results of some actual tests and observations I've made over a period of quite a few years.

One: antenna height. The old theory says "The higher the antenna, the greater the signal pickup, in direct ratio." A good many years back, when TV first arrived in our area, I spent all summer cranking a test tower up and down. In each case, I made a height test before installing the antenna. I used a field-strength meter and the regular antenna. I ran it from 20 feet up to 50 and back again.

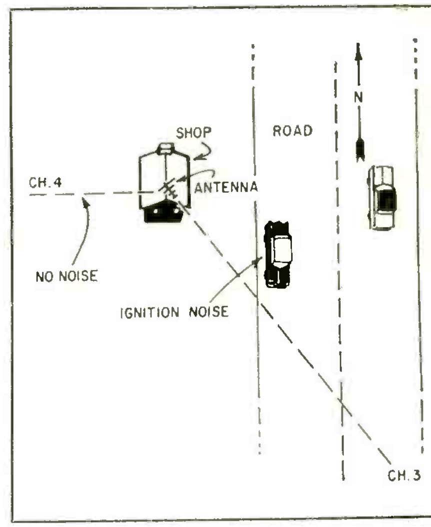
Oddly enough, I found that in our area, maximum signal strength was about 30 feet above the ground. Higher than that, there was a slight but measurable *loss*. I found no sign of layering of the TV signal at all. (Remember, this was vhf.) All over-the-horizon reception, too, I might add; the nearest station was 87 miles away beyond a lot of mountains, and the rest were even farther.

So, there went that theory. Another one went with it—the one about the TV signal not bending over the horizon. The optical horizon of all of our TV stations, on the towers they had then, couldn't have been more than 40 miles. But we got 'em, and got good pictures; still do.

By using high-gain directional antennas, we can get reception over distances that were thought impossible. The types used around here are all-channel vhf, mostly Yagis. Overall gain runs about 12-15 dB or higher. The sharply directional patterns are a great help in several ways. I have been able to pick up three stations on channel 4, for example, by simply turning the antenna!

An antenna booster (or preamp) helps, too. However, no booster will *make* a picture. You've got to have a pretty fair, steady signal to start with. A booster with a good noise figure will clean up the signal and make it look much better. Late-model preamps, using transistors or nuvistors, have given very good results.

Two: ignition-noise pickup. I have what might be the ideal site for testing this; my shop's about 150 feet from a very busy highway. One of my stations is southeast, and I must aim the antenna diagonally across the road to get it. On this one, I get a good deal of ignition noise from old cars. However, watching another station straight west, with the antenna aimed directly away from the road, I get no ignition-noise pickup at any time.



Therefore, I would say that in this case, the noise is being picked up on the antenna itself. This, of course, is pretty much unavoidable, since you have to shoot at the station to get it! I ran a test on this last summer.

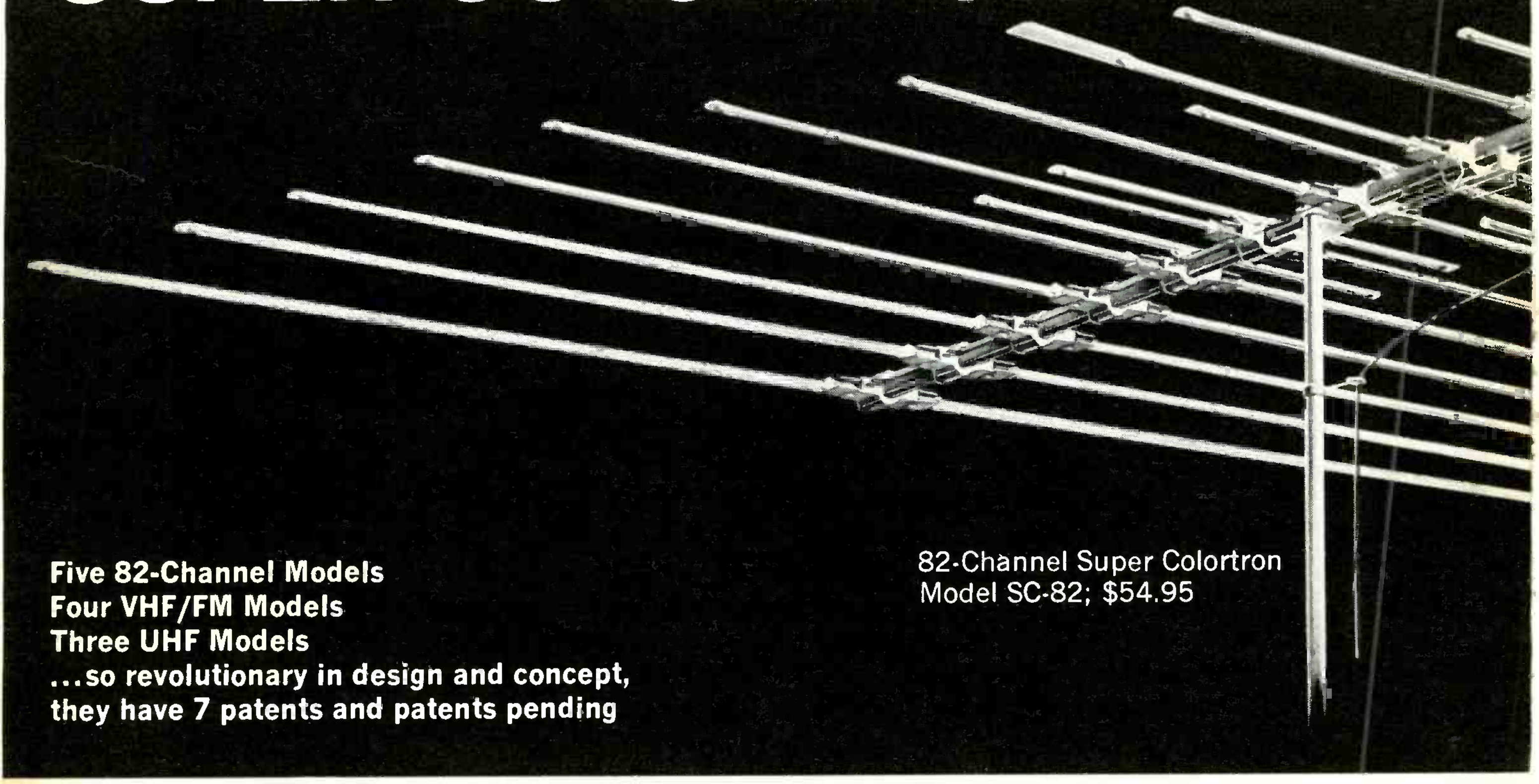
Having a spare test tower (used for antenna testing, naturally) sitting there, with a lead-in run all the way to the top, I tried something. I hooked this open-ended lead-in to the set, and watched for any sign of ignition-noise pickup. None. (No TV signal, either, for that matter, since all I had was about

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.

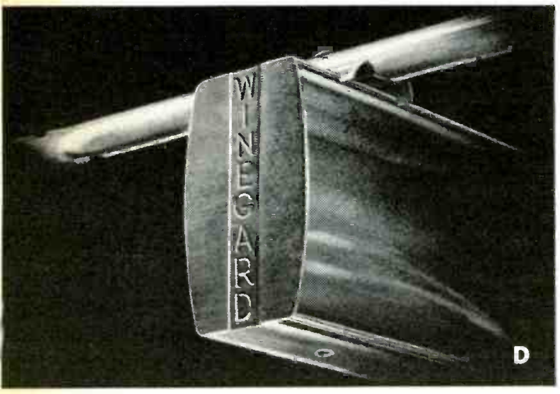
Circle 18 on reader's service card

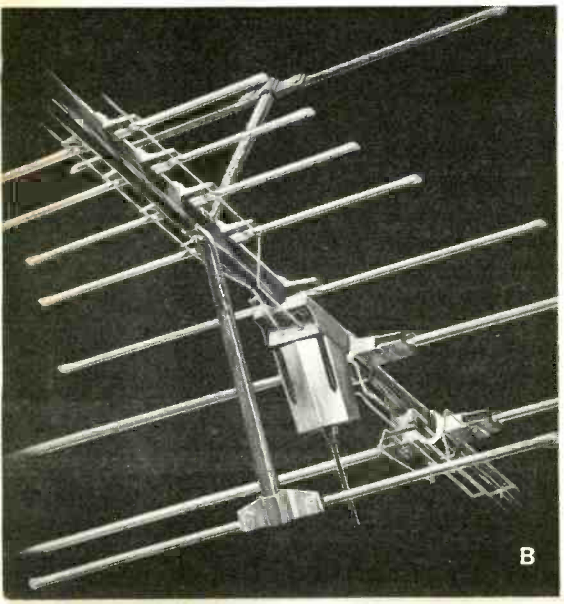
Winegard Introduces Super Compact Total Design Electronic SUPER COLORTRONS



Five 82-Channel Models
Four VHF/FM Models
Three UHF Models
...so revolutionary in design and concept, they have 7 patents and patents pending

82-Channel Super Colortron
Model SC-82; $54.95





The World's First Total Design Antennas

New antennas come and go. But there's never been an antenna like the amazing Winegard Super Colortron. 12 models in all—totally designed with more exclusive electronic, construction and performance features than all other antennas combined. It's taken us a while to create and develop and perfect the Super Colortron. But it was worth the time. See for yourself. Read about the Super Colortron's exclusive features. Then call your Winegard distributor. Or write for full color, 8-page brochure.

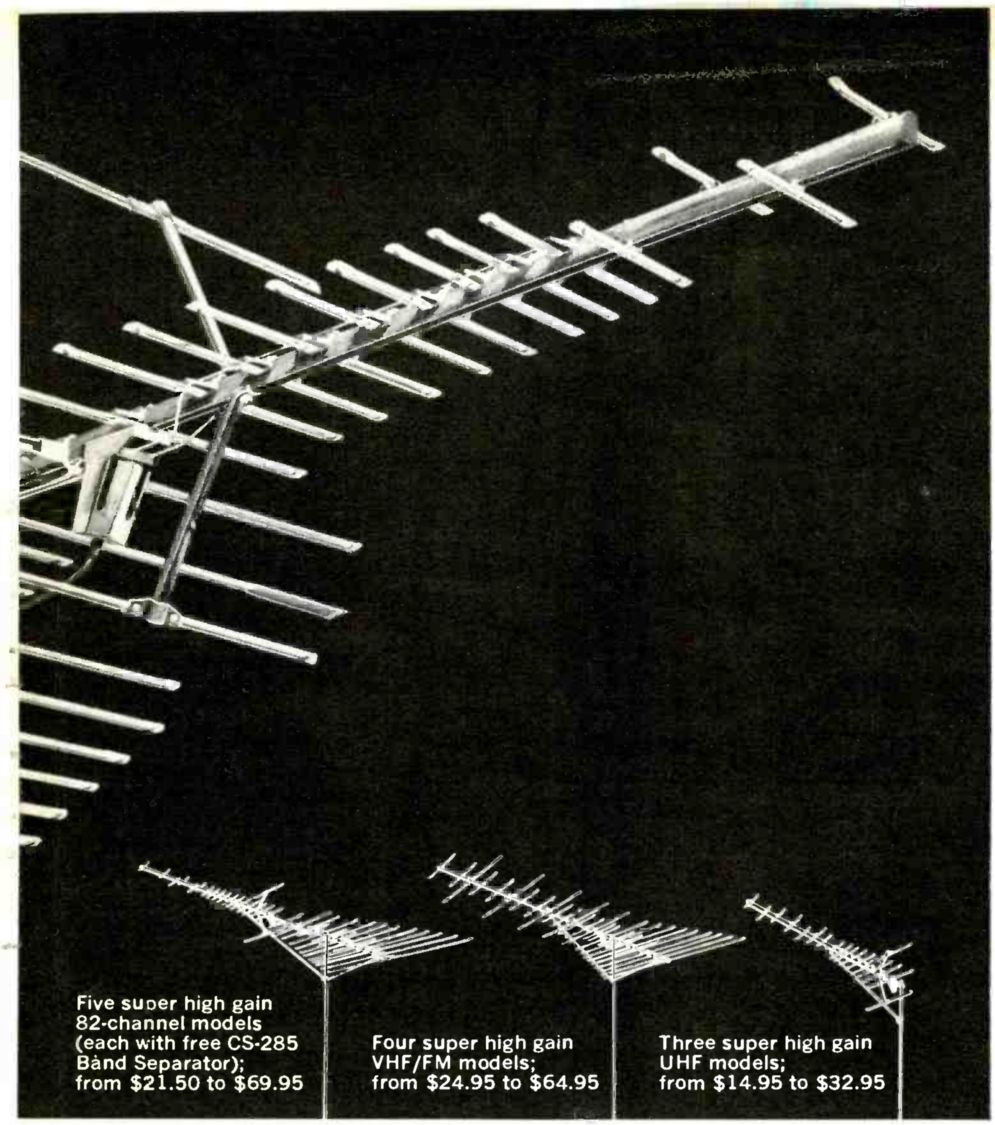
(A) Total Design Cartridge Pre-Amps: Exclusive solid state, instant-loading cartridge pre-amps drop into totally enclosed, weatherproof cartridge housing at point of signal interception. Models for 82-channel (VHF-UHF) antennas, VHF only, UHF only—plus a color spectrum filter. Custom-match the Super Colortron to any reception requirements.

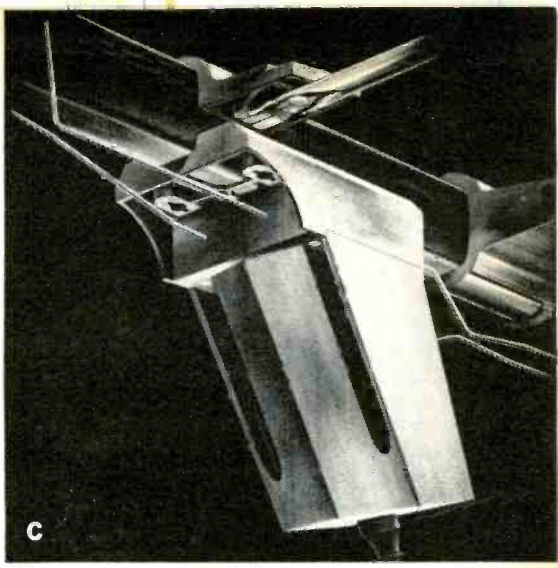
Total Design Impedance Correlators: Exclusive impedance correlators (2 patents pending) automatically increase 75 ohm driven elements to 300 ohms to provide 100% signal transfer from antenna to set. Enables antenna to be 20% more compact!

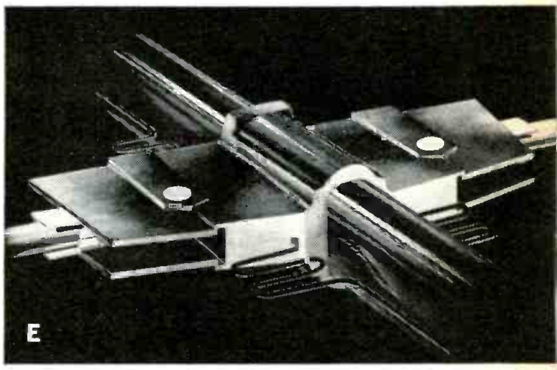
(B) Total Design Vertical Resonant Reflectors: Exclusive UHF vertical resonant reflectors achieve highest realizable gain on channels 14-83 because of exceptionally large vertical capture area. More UHF gain than any other 82-channel antenna design.

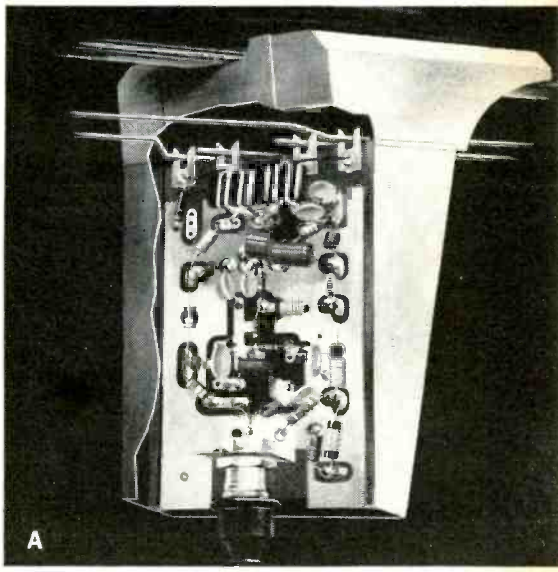
Total Design Electro-Lens Director System: Exclusive patented Electro-Lens system (U.S. Patent 2,700,105; Canada 511,984) absorbs entire signal and focuses it directly onto the driven elements to give Super Colortrons pinpoint directivity.

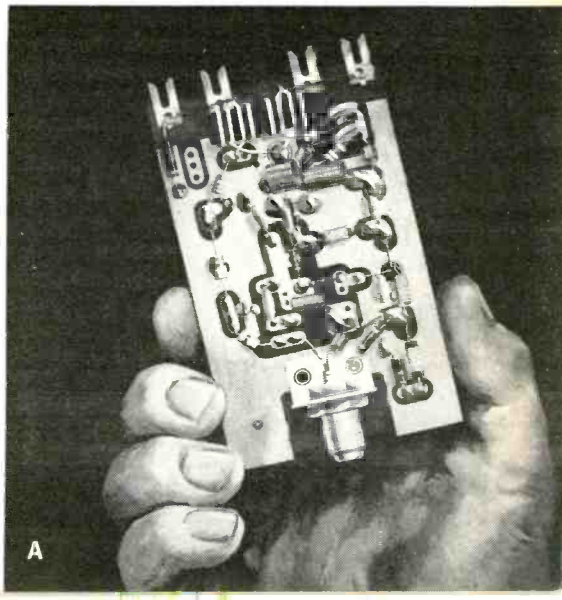
Circle 19 on reader's service card











Total Design FM Control Element: Exclusive FM element provides high gain on FM bands—and enables you to attenuate FM bands in areas where strong FM signals interfere with TV reception.

(C) Total Design Cartridge Housing: Exclusive housing is an integral part of Super Colortron—built-in and permanent. Completely weatherproofed to protect solid state cartridge pre-amps and connections.

(D) Total Design Ellipsoidal Boom: Exclusive boom is the first aluminum tubing shape engineered especially for antenna use. Proved far stronger than any other existing boom design.

(E) Total Design Wrap-Around Insulators: Exclusive low loss dielectric insulators completely encapsulate and weatherproof elements and correlators at point of electrical contact. Hi-impact polystyrene. Provide perfect alignment of elements and eliminate sagging and loosening.

Total Design High Tensile Aluminum Elements: Exclusive aluminum alloy has PSI rating of 38,000 as compared to 27,000 PSI for alloys used in other antennas. More than 49% stronger—and 29% more resistant to bend and wind distortion.

Total Design Wrap-Around Mast Clamp: Exclusive mast clamp has 4 pair of locking jaws (not just 2) to automatically align antenna on mast and for greater strength and durability. Requires only one U bolt.

Total Design Gold Anodizing: Exclusive Gold Anodizing is the only permanent gold finish used on any antenna—the only positive protection against corrosion and fading.

Total Design Assembly: Exclusive construction makes the Super Colortron truly easy-to-install—unfolds in seconds—completely factory pre-assembled.

Winegard
ANTENNA SYSTEMS

WINEGARD COMPANY, 3000 KIRKWOOD STREET, BURLINGTON, IOWA 52601

50 feet of 300-ohm ribbon going straight up.) The other antenna was hooked to a portable, as a "control."

By observation, I've found that when the antenna is pointed away from the highway, putting the road in the insensitive back lobe of the pattern, there is very little if any noise pickup. What ignition noise I do get seems to be getting into the antenna itself, and this is pretty much unavoidable.

This leads me to the conclusion that a good high FTB (front-to-back) ratio is important. Not only does it reduce ignition-noise pickup but it also helps a lot in other troubles. We have a strong channel 5 station to the northwest, practically back to back with channel 6 to the southeast. With an antenna having a low FTB ratio, you get so much channel 5 signal when you're looking at channel 6 that the screen is one solid herringbone! I have had to resort to very sharp-tuning notch-filter traps to get rid of it when the antenna FTB ratio won't reduce it.

Incidentally, with a highly directional antenna, you can also "shoot thunderstorms!" If you see static flashes on the screen, turn the antenna until they're at a maximum, and that's the bearing from you to the storm center. Almost a home weather-radar system!

We get much less ignition noise from cars now than we did a few years ago. This is undoubtedly due to the increasing numbers of cars which have been built with resistive ignition wiring, whether they have car radios or not. The car makers started this about 7 or 8 years ago, I think, and it has been a great help to harrassed TV viewers. Despite very heavy traffic during an evening viewing period, say between 6 and 10 pm (I go to bed early!) I will seldom see more than one or two cars out of a couple hundred make any noise on the screen.

Going back to the problem of antenna height, I'd like to contradict myself partially, and say that in such applications as two-way radio, CB and similar uses. the height rule still works (up to a point). As long as you work line-of-sight, it *is* valid. Raising the base-station antenna will increase the line of-sight area tremendously and give a lot more coverage. Of course, there is a practical limit, due to the inevitable losses in the transmission line. These are fixed, and can be figured out from a table of characteristics.

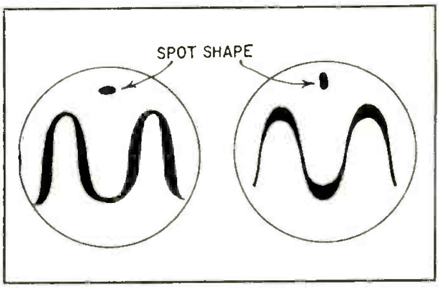
The popular RG-58/U coax. for example. has 5.2 dB loss per 100 ft at 100 MHz, even if it is matched to the transmitter and antenna. One CB enthusiast asked me if he could use a 300-foot tower to get better range. I told him, "Well, if you insist, but by the time you get that 5 watts up that far, I'd say your power output would be about half a watt!"

Line-of-sight is a wonderful thing, though. There's a resort hotel on a 2,500-foot mountaintop not too far from here. I noticed a TV set in the lobby, and the station-break slide came on just as I walked by. To my surprise, there was a nice clean picture, from a station I knew was at least 185 miles away. And, there on top of the set—you guessed it—*rabbit ears!*

Adjusting kit scope

I've just built an EICO 460 kit scope. The spot on the screen isn't round, and when I put a sine wave on the screen, it is flattened. Also, the spot or pattern moves when I change the vertical attenuator switch. What's doing this?—J. L., Cumberland, Md.

Two things: To get a round spot, turn the vertical and horizontal gain controls to zero; then adjust focus, brightness (intensity) and astigmatism controls to get a perfectly round spot. You can do this on a sine-wave or other stationary pattern by noting the thickening of certain parts of the pattern (see diagram). It's easier to do with a stationary spot. Don't leave the spot in one place for too long, on general principles; move it back and forth with the positioning controls.



The spot movement when the attenuator is turned, also the flattening of top or bottom of the sine waves, are probably due to an incorrect adjustment of the dc BALANCE control. Set your vertical attenuator control (the selector switch) at X 1,000, and turn the vertical gain control to minimum (off). Set the trace at exactly center-screen with the VERTICAL POSITIONING control.

Now, adjust the dc BALANCE control until the spot doesn't move at all, vertically, when the vertical gain control is turned from full off to full on. An unbalance here can cause clipping of one side or the other of the 0.4 p-p calibration voltage, which is a pure sine wave. END

In just a few short months the Electro-Voice Model 676 has gained quite a reputation as a problem solver—no matter what the odds. Now the 676 has a teammate. The Model 674 has the same unique backbone that rejects unwanted sound... an exclusive with Continuously Variable-D (CV-D)T.M. microphones from Electro-Voice. And the improvement in performance is dramatic.

Troubled with feedback or interfering noise pickup? Most cardioid microphones cancel best at only one frequency—but CV-D* insures a useful cardioid pattern over the entire response range. And its small size means the pickup is symmetrical on any axis.

Bothered by rumble, reverberation, or loss of presence? A recessed switch lets you attenuate bass (by 5 or 10 db at 100 Hz) to stop problems at their source. And there's no unwanted bass boost when performers work ultra-close. CV-D eliminates this "proximity effect" so common to other cardioids.

Wind and shock noise are almost completely shut out by the CV-D design. Efficient screening protects against damaging dust and magnetic particles, and guards against annoying "pops".

As for overall sound quality, only expensive professional models compare with the 676 and 674. The exclusive Acoustalloy® diaphragm gets the credit. It's indestructible—yet low in mass to give you smooth, peak-free, wide-range response with high output.

The Model 676 slips easily into its 1″ stand clamp for quick, positive mounting. The fine balance and shorter length of the 676, and absence of an on-off switch makes it ideal for hand-held or suspended applications.

The Model 674 offers identical performance but is provided with a standard mounting stud and on-off switch. Either high- or balanced low-impedance output can be selected at the cable of both microphones.

Choose the 676 or 674 in satin chrome or non-reflecting gray finish for just $100.00. Gold finish can be ordered for $10.00 more (list prices less normal trade discounts). There is no better way to stand up to your toughest sound pickup problems. Proof is waiting at your nearby E-V sound specialist's. Or write for free catalog of Electro-Voice microphones today.

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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NOT SATISFIED with your present income? The most practical thing you can do about it is "bone up" on your electronics, pass the FCC exam, and get your Government license.

The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, taxicabs, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and the number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE-trained men who take the exam pass it...on their very first try! That's why we can afford to back our courses with the iron-clad Warranty shown on the facing page: you get your FCC License or your money back.

There's a reason for this remarkable record. From the beginning, CIE has specialized in electronics courses designed for home study. We have developed techniques that make learning at home easy, even if you've had trouble studying before.

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Your CIE instructor gives his undivided personal attention to the lessons and questions you send in. It's like being the only student in his "class." He not only grades your work, he analyzes it. Even your correct answers can reveal misunderstandings he will help you clear up. And he mails back his corrections and comments the same day he receives your assignment, so you can read his notations while everything is still fresh in your mind.

It Really Works

Our files are crammed with success stories of men whose CIE training has gained them their FCC "tickets" and admission to a higher income bracket.

Mark Newland of Santa Maria, Calif., boosted his earnings by $120 a month after getting his FCC License. He says: "Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand."

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Want to know more? The postpaid reply card bound-in here will bring you free copies of our school catalog describing opportunities in electronics, our teaching methods, and our courses, together with our special booklet, "How to Get a Commercial FCC License." If card has been removed, just send your name and address to us.

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Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE

"I give Cleveland Institute credit for my First Class Commercial FCC License. Even though I had only six weeks of high school algebra, CIE's AUTO-PROGRAMMED™ lessons make electronics theory and fundamentals easy. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing. Believe me, CIE lives up to its promises."

Chuck Hawkins, Chief Radio Technician, Division 12, Ohio Dept. of Highways

"My CIE Course enabled me to pass both the 2nd and 1st Class License Exams on my first attempt...I had no prior electronics training either. I'm now in charge of Division Communications. We service 119 mobile units and six base stations. It's an interesting, challenging and rewarding job. And incidentally, I got it through CIE's Job Placement Service."

Glenn Horning, Local Equipment Supervisor, Western Reserve Telephone Company

"There's no doubt about it. I owe my 2nd Class FCC License to Cleveland Institute. Their FCC License Course really teaches you theory and fundamentals and is particularly strong on transistors, mobile radio, troubleshooting and math. Do I use this knowledge? You bet. We're installing more sophisticated electronic gear all the time; what I learned from CIE sure helps."

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of success in obtaining a Government FCC License

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OR upon completion of the Electronic Communications course you will be able to pass the FCC examination for a Second Class Commercial Radio Telephone License;

AND in the event that you are unable to pass the FCC test for the course you select, on the very first try, you will receive a FULL REFUND of all tuition payments.

This warranty is valid for the entire period of the completion time allowed for the course selected.

G. O. Allen

G. O. Allen
President

Record and Play Video Tapes with Your TV Set

Receiver doubles as tape monitor **By G. McGINTY**

HERE'S A WAY TO JOIN IN THE FUN OF MAKING HOME VIDEO recordings with a minimum investment. You can save on the cost of a video monitor by converting your TV set to work as recording and playback monitor. The conversion shown here is for the Sony model CV-2000 or CV-2000D Videocorder.

Almost any black-and-white receiver can be made to work as a video monitor. Best results come from sets with power transformers, since a source of 6.3-volt ac is needed for the auxiliary amplifiers on the adapter board. Transformerless sets must be equipped with line-isolation transformers and a separate filament transformer.

Next, consult the schematic of your set to see where the video feed to the sync separators is taken from. In almost all sets, it's from the plate circuit of the video amplifier. If your set is wired that way, the simple adapter board shown in this article will work fine. If sync is taken from the video detector circuit, a few extra connections will have to be made.

Fig. 1, the schematic, shows how the adapter works. The relay is shown de-energized, as it is when the recorder is not in use and also when off-the-air recordings are to be made. Normally closed contacts of the relay complete the original circuit paths in the receiver. Video from the picture detector feeds through contacts 4 and 5 to the video output stage. Similarly, audio from the sound detector goes through contacts 1 and 2 to the top of the volume control.

Contacts 10 and 11 complete the dc path for the plate circuit of the last i.f. stage. This path is broken during playback and camera recording to prevent TV-station signals from interfering.

Video signals sent to the video output stage are also applied to a two-stage emitter follower, which acts as a high-input-impedance buffer to supply video signals to the recorder for off-the-air recordings.

When the recorder is turned on and put into the PLAY or the CAMERA RECORD mode, the relay in the adapter operates. Now the normal TV audio and video signal paths are broken and the audio and video signals supplied by the Videocorder are substituted.

Amplifiers are placed in the audio and video return lines from the recorder because the signal levels at the output of the recorder are not high enough to drive the audio and video output stages of the receiver directly.

Two semiconductor power supplies are built into the adapter. One supplies power to the adapter's amplifiers. The other provides a negative bias voltage for the video output stage. This bias takes the place of the normal negative dc voltage produced by the video detector. The audio playback amplifier receives its supply voltage from B+ in the TV receiver. A Zener diode in the collector circuit of this amplifier maintains correct collector voltage.

How to build the adapter

Construction is quite simple and parts layout is not critical. I used a perforated foil-clad board. Mount the video amplifiers close to the relay to keep video leads short. Use shielded leads to carry audio signals to and from the adapter board, but do not use shielded leads for the video lines except

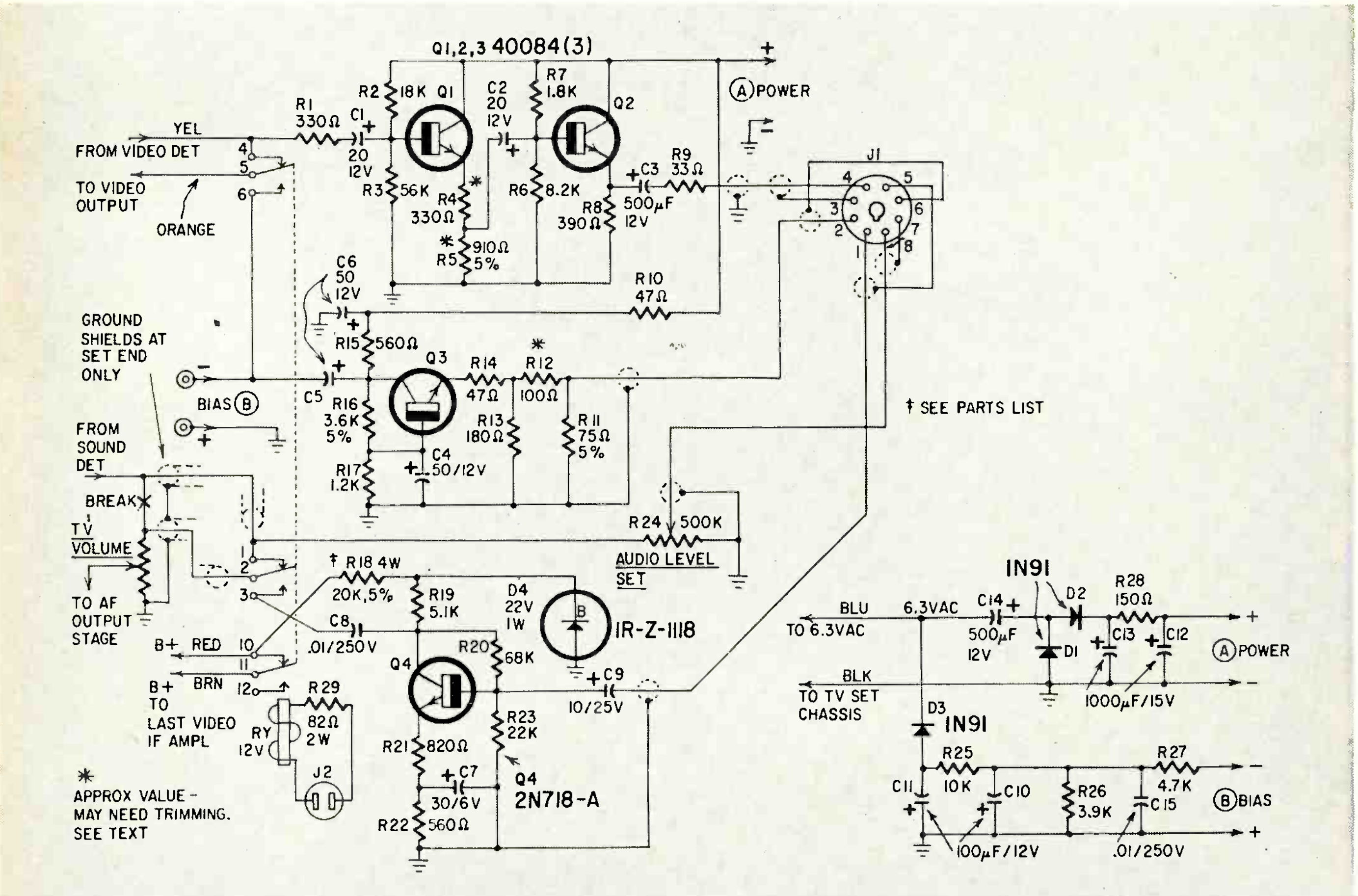


Fig. 1—This adapter couples the recorder to the receiver, changing modes from recording to playback.

where they are indicated on the diagram.

Resistors R4, R5 and R12 are selected to suit the video levels used in your receiver. Resistor R26 may have to be changed to suit bias in your set. You can install the values shown in Fig. 1 to begin with, but make temporary connections so that you can change the resistors easily later.

Do not wire the octal and two-prong jacks until the adapter board is installed. Put extra-long cables at the points that connect to these jacks; you can cut them later to the lengths required by the installation.

Mount the adapter board on the chassis as close as possible to the video amplifier. Keep video leads short, especially from the detector to the adapter board, to minimize extra capacitance and stray pickup. In addition, i.f. harmonics radiated from the video lead may be picked up in the antenna system and show up as interference on channel 6 or 8, so keep video leads away from tuner or antenna leads.

Do not mount the board above or near tubes that radiate heat. If possible, avoid putting the board too close to unshielded i.f. transformers. A photo shows how I mounted the board in a Zenith portable. The mount is close to an exposed i.f. transformer, so I checked alignment before and after installation to make sure the i.f.'s were not detuned.

Connect the video leads of the adapter board to the TV chassis as shown in Figs. 2, 3, 4 and 5. The yellow lead connects to the output of the video detector. A test point is provided in many sets at this point; use it as a tie lug for the yellow lead. The orange lead connects to the grid of the video output stage. Use the grid lug of the tube socket as a tie point. Next, the normal coupling between the video detector and the video output stage must be broken (Fig. 2-a). If the set uses a printed circuit, you can sever the conductor by cutting out a bit of foil with a razor blade.

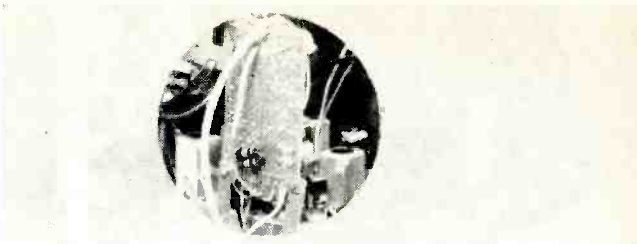
If your set employs capacitance coupling between the video detector and the video amplifier, make connections as shown in Fig. 2-b. In addition, increase the size of the coupling capacitor by bridging the original capacitor with an additional 0.5-μF unit. Use a 50- or 75-volt type.

Connect the audio circuits as shown in Fig. 3. All connections can be made at the volume control.

Make connections to the plate circuit of the last i.f. stage as shown in Fig. 4. Note that the plate and screen voltage for the last i.f. stage now passes through the normally closed contacts of the relay. Make sure only the last i.f. stage is supplied from the point at which you break the circuit. Also, make sure the screen voltage as well as the plate voltage will be interrupted by the relay.

Power connections are made as shown in Fig. 5. Wire the blue lead to any convenient source of 6.3-volt heater power. Connect the black lead to the chassis.

The octal and two-prong jacks can be mounted on the



Adapter board is best installed on the receiver chassis.

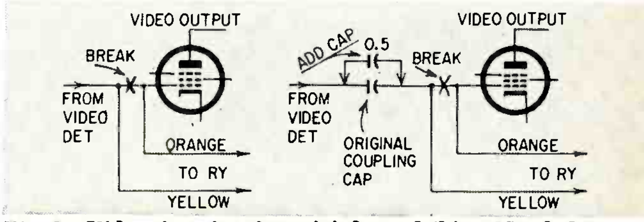


Fig. 2—Video tie points from (a) dc- and (b) ac-coupled stages.

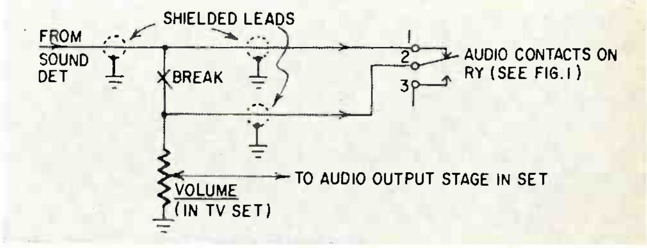


Fig. 3—Make audio connections at receiver volume control.

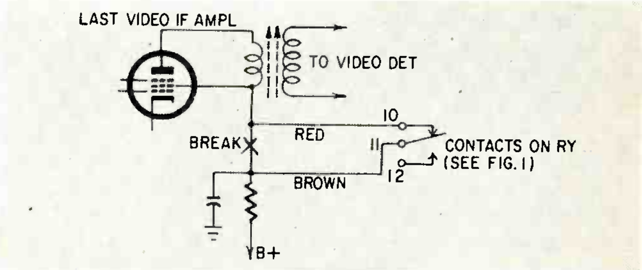


Fig. 4—Break last video i.f. plate circuit to connect adapter.

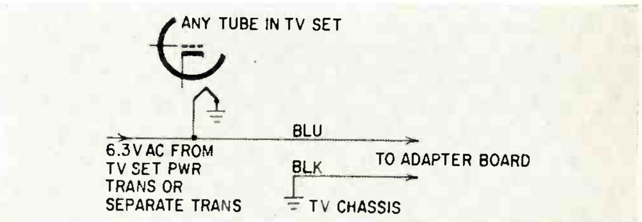


Fig. 5—Power supply and ground connections from receiver.

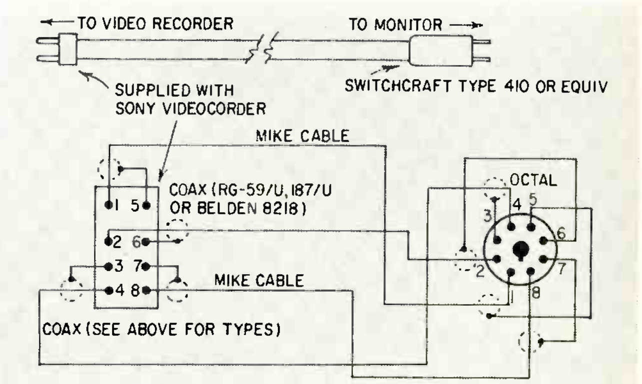


Fig. 6—Make this cable to connect recorder to TV receiver.

C1, C2—20 μF, 12 volts
C3, C14—500 μF, 12 volts
C4, C5, C6—50 μF, 12 volts
C7—30 μF, 6 volts
C8, C15—.01 μF, 250 volts ceramic
C9—10 μF, 25 volts
C10, C11—100 μF, 12 volts
C12, C13—1,000 μF, 15 volts
All capacitors except C8 and C15 are electrolytics
D1, D2, D3—100 piv, 500 mA, germanium or silicon rectifiers (1N91, 1N1692, 1N-537, etc.)
D4—Zener diode, 22 volts, 1 watt (International Rectifier experimenter series No. Z-1118, or type 1ZF22T10)
J1—Octal socket with shell for cable use
J2—two-prong socket (Switchcraft 810 or equivalent)
Q1, Q2, Q3—40084 (RCA)
Q4—2N718A (RCA, TI, Motorola, Raytheon)
R1, R4—330 ohms
R2—18,000 ohms
R3—56,000 ohms
R5—910 ohms, 5%
R6—8,200 ohms
R7—1,800 ohms
R8—390 ohms
R9—33 ohms
R10, R14—47 ohms
R11—75 ohms, 5%
R12—100 ohms
R13—180 ohms
R15, R22—560 ohms
R16—3,600 ohms, 5%
R17—1,200 ohms
R18—20,000 ohms, 4 watts (two 10,000-ohm 2-watt in series)
R19—5,100 ohms, 5%
R20—68,000 ohms
R21—820 ohms
R23—22,000 ohms
R24—subminiature pot, 500,000 ohms
R25—10,000 ohms
R26—3,900 ohms
R27—4,700 ohms
R28—150 ohms
R29—82 ohms, 2 watts
All resistors, unless otherwise indicated, are ½-watt, 10%
RY—4pdt relay, 12-volt coil (Potter & Brumfield MG-17D or equivalent)
Foil-clad perforated board
Cables as described in text
Hardware

rear of the cabinet or on a suitable bracket on the chassis apron. It is easier, however, to bring the cables for these jacks out through holes or ventilating slots on the rear cover. Install the jacks, with protective shells, directly on the cables and let the cables hang loose.

Wire the jacks as shown in Fig. 1. Dress the leads away from the deflection yoke and the high-voltage cage to minimize pickup of flyback pulses.

Make up a set of connection cables as shown in Fig. 6. Length is not critical, and the 2-prong plug need not be polarized. For safety, don't use an ac line plug and socket. The recorder end of the cable connects to the special 8-pin plug and 2-prong plug that connect to the jack panel on the rear of the Videocorder. These plugs are supplied with Sony CV-2000 and 2000D decks.

Adjustments to the adapter

Make initial adjustments with all cable connections set up between the recorder and your monitor. Leave the recorder turned off for the moment (turn the Sony Videocorder off at the POWER switch). Turn on the monitor and adjust its controls for normal picture and sound. The set should work as a normal TV set. If picture or sound are absent, check the connections between the audio or video circuits and the relay.

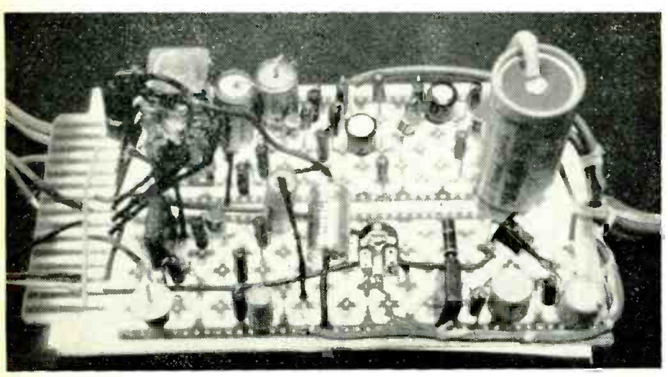
Circuit adjustments are best made with a calibrated scope, but you can manage without one. Make all adjustments with the TV chassis out of the cabinet.

Step 1. Measure the dc voltage at the control grid of the video output stage and record the reading.

Step 2. Measure the dc voltage at contact 6 of the relay or at the negative side of C5 (Fig. 1). This reading should be approximately equal to that found in step 1. If the reading is too high, decrease the value of R26 until you get the voltage found in step 1. If too low, increase R26. The voltage readings in steps 1 and 2 should be within 0.3 volt of each other.

Step 3. This step adjusts the video amplifier to produce the necessary video level at the input to the recorder. If you have a calibrated scope, measure the video amplitude at J1 pin 4. If this voltage is between 1 and 3 volts peak to peak, okay. If it is below 1 volt p-p, decrease R4 and increase R5. Keep total resistance (R4 + R5) the same. If the video level is higher than 3 volts p-p, increase R4 and decrease R5.

If you do not have a scope, do step 3 as follows: Turn on the Videocorder by depressing the POWER switch. Set the TV-CAMERA switch to TV. Press the red RECORD button until it clicks into position. Set the METER SELECT switch to VIDEO. Adjust the VIDEO LEVEL control for a reading in the blue zone of the meter on the Videocorder. If you can get this reading with the VIDEO LEVEL control set near midrange, the values of R4 and R5 are okay. If the control must be turned too far clockwise to get a blue-zone reading, reduce R4 and increase R5, keeping the total resistance about the same. If the control must be set near maximum counterclockwise to obtain the blue-zone reading, increase R4 and reduce R5.



Perforated board is handy for mounting adapter components.

Step 4. Set the METER SELECT switch to AUDIO. Set the AUDIO LEVEL control to mid-position. Adjust R24 until sound peaks produce meter readings that extend just into the red zone on the meter scale.

You are now ready to make video recordings. The remaining receiver adjustments correct playback conditions.

Make a recording

Follow this procedure to make a trial recording.

Step 1. Turn on your TV monitor and recorder.

Step 2. Depress the RECORD button. (With the Videocorder on and the RECORD button in the OFF position, the Videocorder is in playback mode and the monitor will display the signals supplied by it. As there is no tape moving past the heads, the screen will remain blank.)

Step 3. Set the controls on the TV monitor to produce a normal picture. Pick a channel that gives good reception and obtain a picture with a good range of whites, grays and blacks. It is important to have a good picture at this point.

Step 4. Set the METER SELECT switch to VIDEO. Adjust the VIDEO LEVEL control for a reading in the blue zone.

Step 5. Set the METER SELECT switch to AUDIO. Adjust the AUDIO LEVEL control so that sound peaks produce readings that do not reach beyond the right edge of the blue zone.

Step 6. Thread a tape according to the manufacturer's instructions. Set the tape counter to 000.

Step 7. Start the motor in the recorder.

Step 8. Hold the RECORD button down and move the FUNCTION SELECT lever to the PLAY position. As the tape begins to move, your recording will begin.

Step 9. Record for about 5 minutes. Then move the FUNCTION SELECT lever to STOP. Set the lever to REWIND, and then to STOP when the tape counter again shows 000.

Step 10. Move the FUNCTION SELECT lever to PLAY (do not depress the RECORD button).

Step 11. Your TV monitor should now display the recording you have made. If the screen remains blank, trace the signal through Q3 and the relay to the video output stage.

Step 12. Observe picture contrast, but ignore for the moment any horizontal jitter or pulling at the top of the picture. If contrast is greater than when the recording was in progress, increase the value of R12. If contrast is weak, reduce R12. You might have to repeat this step a few times to achieve proper playback contrast level. Make sure that you turn off the motor in the Videocorder when you make adjustments.

Step 13. Repeat step 10 and check the audio volume level during playback. Usually any difference in level can be adjusted by resetting the volume control in the monitor. In most cases, sound is normal and no circuit changes will be needed. However, if playback sound is too loud, you can try adding a resistor in series with C8.

Horizontal afc modification

Now to tackle that horizontal instability you may have noticed during playback. If the afc in the set does not recover fast enough, the picture shows some tearing or pulling, especially at the top. To cure this the time constant of the error-voltage filter in the horizontal afc system must be modified. The collection of circuits on page 35 show typical horizontal afc filters. Most consist of two RC networks in the feed path between the sync discriminator and the horizontal oscillator. This same network may be drawn several ways, so check your circuit carefully. R1 and C1 form a short-time-constant filter and control the high-frequency rolloff point of the network. The time constant of this network has to be shortened to make the horizontal afc system respond quickly to changes in error voltage.

R2 and C2 affect the low-frequency rolloff point. The

Horizontal afc hunting, caused by afc filter overcorrection.

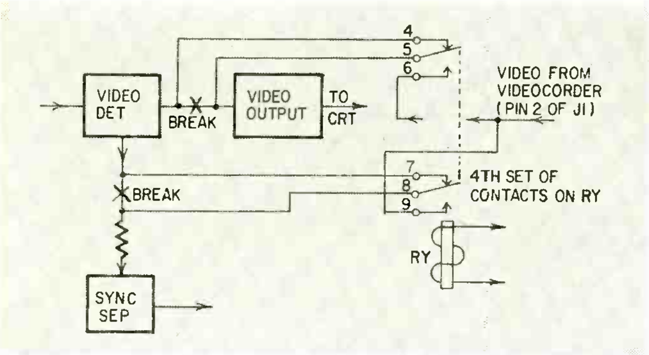


Fig. 7—In some sets, sync must be routed through the relay.

resistor of this network is increased to increase the gain of the system at lower frequencies. The capacitor also may be reduced in value to speed up afc action. Not all circuits have these resistances as four discrete parts. Sometimes circuit impedances are used as part of the network. Don't look for exactly the same parts in every circuit in this collection.

The first job in making the circuit changes is to locate the filter network. In sets that use double-diode sync discriminators (phase detectors) the network is between the diode discriminator and the horizontal oscillator. In pulse-width (Synchroguide) afc systems, the network is in the cathode circuit of the horizontal control tube.

When you have located the filter network, compare it with the typical examples shown here. If the network in the receiver is similar in form and has the same or nearly the same values, make the circuit changes indicated.

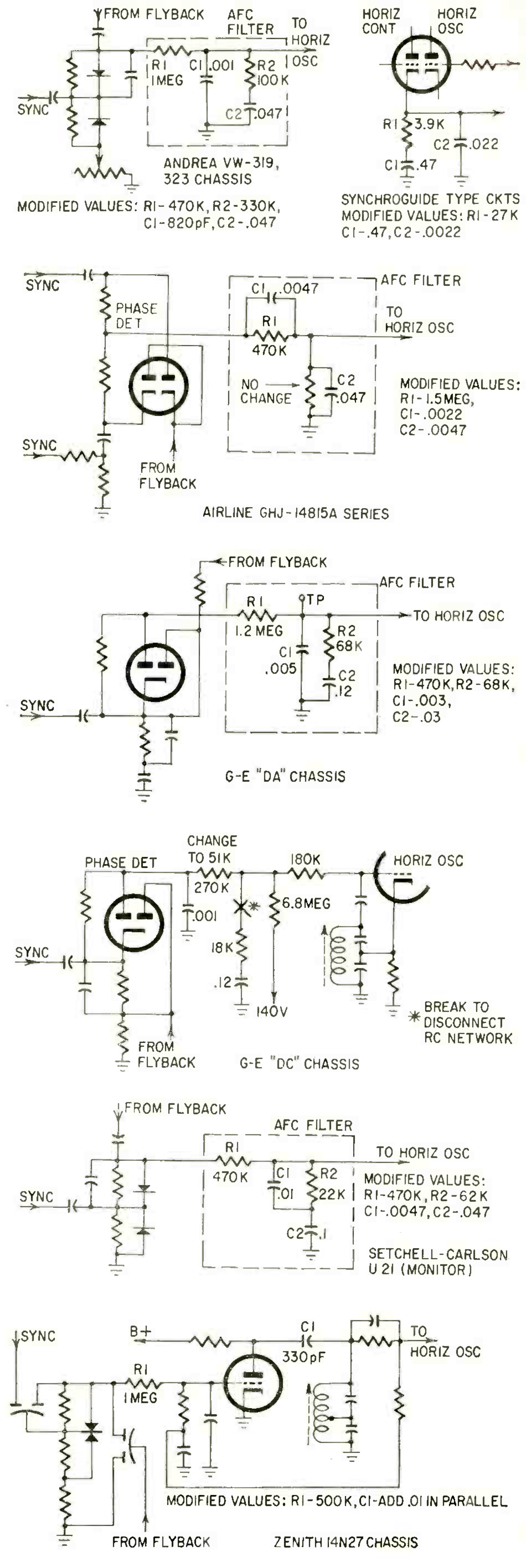
If the set you are working on doesn't match any of the examples, follow this general procedure, checking the results of each change by playing back a recorded tape. Reduce the value of C1 by a factor of 2 or 3. If that's not enough, decrease the value of R1 by a factor of 2 or 3. You are trying to eliminate horizontal jitter and pulling or tearing at the top of the picture. Next increase R2 by a factor of 2 to 4. Try a few values. Try reducing C2 by a factor of 2 to 3.

Continue to alter C1, R1, R2 and C2 by trial and error until you get good results. If you change values too far, afc hunting will appear in the picture. This looks like a ripply weave in the picture, most noticeable on vertical lines near the top of the picture (see photo above).

Sets with low-level sync feeds

In sets in which the feed to the sync separators is taken from the video detector, the circuit of Fig. 1 would result in no sync during playback. To run video into the sync separator during playback, wire the unused set of relay contacts as shown in Fig. 7. [*A video recorder should not be used to record copyrighted material without permission.—Editor*] END

Horizontal afc modification of receivers



THE MAST-MOUNTED PREAMP

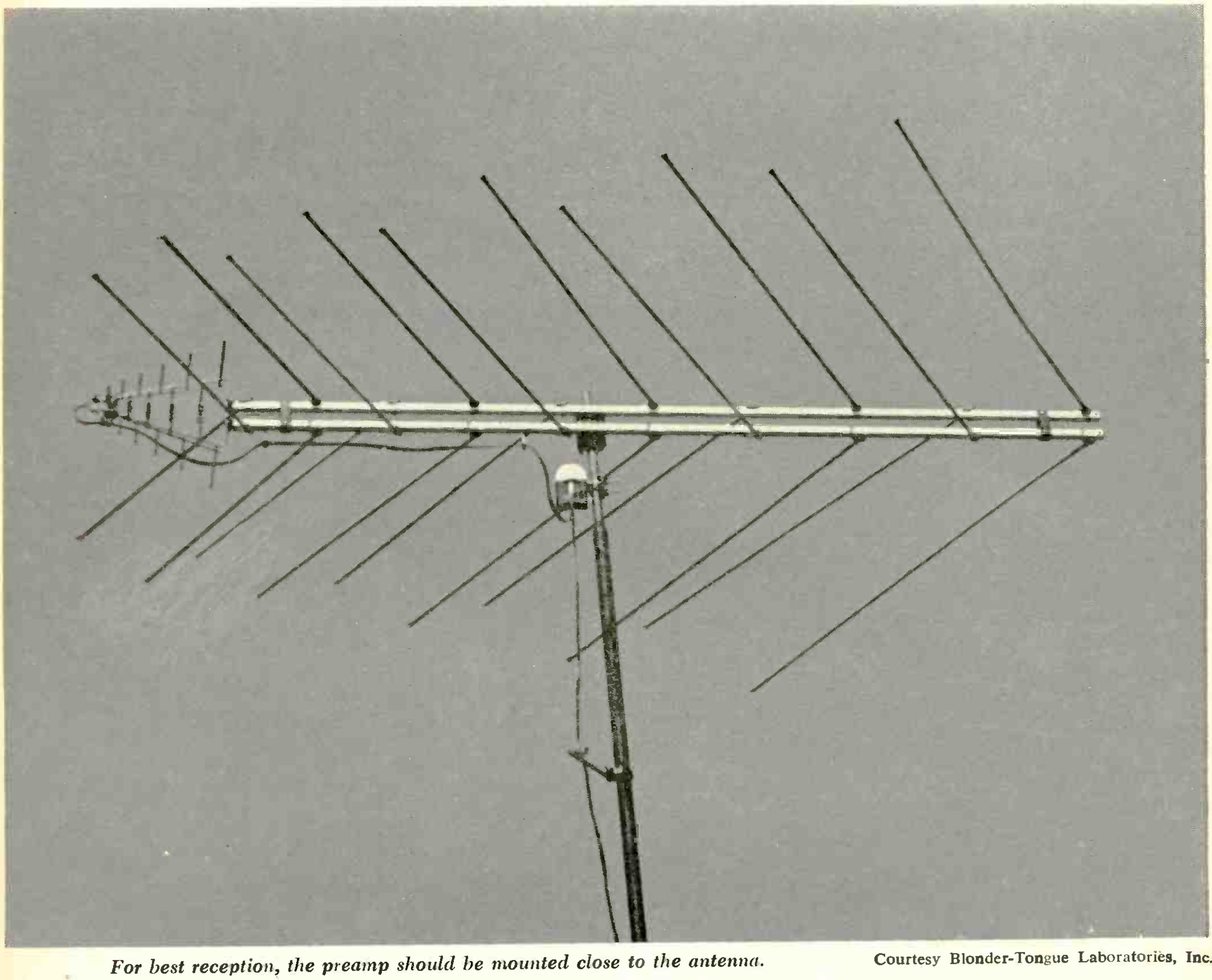
How to select the one that will produce the best TV picture for you

By ABRAHAM E. SCHENFELD

WHEN PEOPLE MOVE FROM THE CITY to the suburbs, one of the first things they notice is the TV picture. It's weaker, perhaps even snowy. Rabbit-ear antennas, which work fine in the city, give way to relatively simple outdoor antennas. Farther out, conicals and log periodics must be used, sometimes stacked. However, a point is reached where a larger antenna just isn't the answer. The next logical step is the mast-mounted preamplifier. This unit provides a simple and economical method for improving reception in fringe areas. It can also provide enough signal to feed more than one TV set.

Advantages

Since the signal captured by a TV antenna must travel through the down-lead without amplification, a loss is introduced. If you have a weak signal to begin with, it's not hard to end up with snow on the picture tube. But if the rf is amplified *at the antenna*, lead-in loss becomes relatively unimportant. The mast-mounted preamp, then, provides a safety margin which can often mean the difference between snow and a picture.



For best reception, the preamp should be mounted close to the antenna.

Courtesy Blonder-Tongue Laboratories, Inc.

Fig. 1 shows the usual arrangement. The amplifier section (a) is mounted on the antenna mast. The power supply can be any convenient place indoors, usually near the TV receiver. Why isn't the power supply up on the mast? If it were, 117 volts ac would have to be fed to it. For safety—and to comply with the law—rather expensive outdoor 117-volt wiring would have to be used.

The power supply, in a typical preamp, converts 117 volts ac to some low voltage (generally 12–30 volts ac) which is then fed *up* the downlead (see Fig. 2). Chokes and blocking capacitors are used, to separate rf and ac. Thus no separate wiring is needed. and installation is simple. Some preamps, by the way, send dc up the lead-in.

Fig. 3 is the schematic of the preamp shown in Fig. 2. Rf from the antenna is fed through a balun (to match antenna impedance to the circuit) and then to a band-splitting circuit. Q1 amplifies low-band signals. while Q2 handles the high band. Outputs of these two stages are then combined and fed to an output balun.

Preamplifier specifications

Before you can choose the proper preamp for a particular application, you must know how to interpret preamp specifications.

Bandwidth: The frequency range the unit will amplify. The television band includes:

Vhf low band. 54–88 MHz (or 54–108 MHz including FM)
Vhf high band. 174–216 MHz
Uhf, 470–890 MHz

Frequency response: Specifies gain variations within the bandwidth. A well-designed amplifier will have small gain variations. This is a very important feature for color television. Variations are given in dB (decibels).

Gain: The ratio of output power to input power. If input and output impedances of the preamplifier are the same, gain is given in dB.

Noise figure: The factor that tells us how "noisy" the preamplifier is. Every amplifier generates noise: the less noise, the lower the noise figure. This figure is defined as the signal-to-noise ratio at the input, over the signal-to-noise ratio at the output, and is given in dB. For a snow-free picture, the TV signal must be much stronger in amplitude than the noise level generated by the preamp. The lower the noise figure, the better the preamplifier.

A preamplifier will be driven into overload when strong enough signals are fed into it. Several forms of overload conditions will cause interference.

Crossmodulation: A form of overload where the modulation information of one channel is visible on another channel. This type of overload occurs when the preamp tube or transistor is driven into third-order distortion by a very strong channel. Crossmodulation appears as "windshield wiper" effect on the TV screen. (In severe cases, the picture from one channel is superimposed on that from another.)

Harmonic generation and beats: An overload condition where transistor (or tube) nonlinearity generates harmonics which produce beat interference—the familiar herringbone pattern on the screen. This is a common problem of one-transistor (or tube) amplifiers that cover the entire band. Second-harmonic interference is often caused by the second harmonic of an FM station beating with a high-band TV signal. For example, the second harmonic of a 100-MHz FM station is 200 MHz, which will interfere with channel 11 (198–204 MHz). The same thing can occur with the third harmonic of a low-band channel beating with a high-band channel. For example: channel 3 (61.25 MHz) × 3 = 183.75 MHz, which will interfere with channel 8 (180–186 MHz).

Intermodulation: Interference produced by signals of two frequencies, and

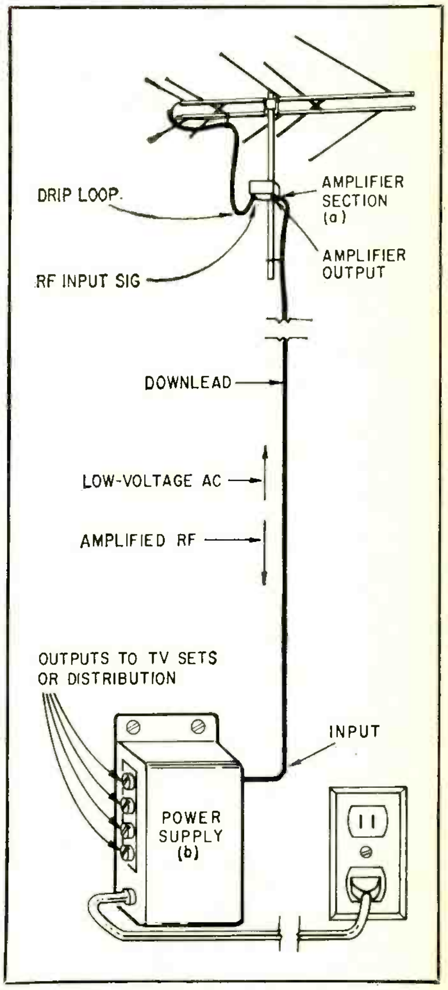


Fig. 1—Head end or amplifier section is mounted on mast near antenna. Power-supply unit is usually near TV receiver.

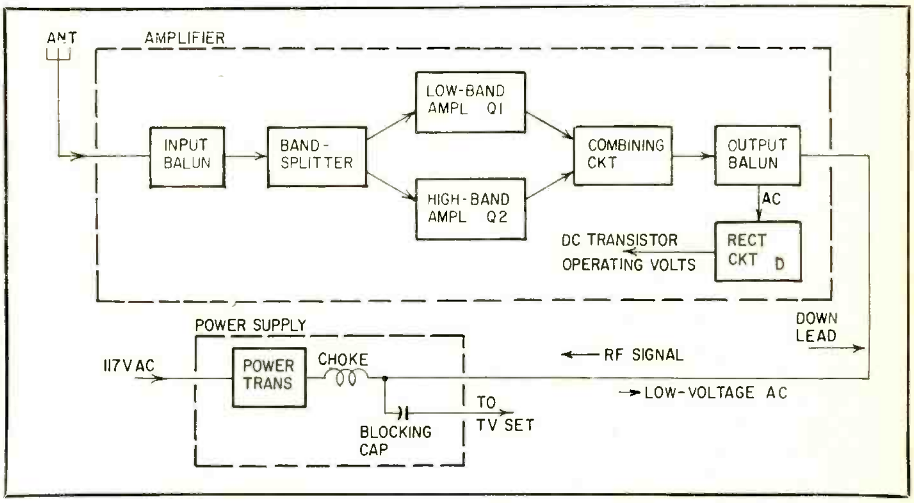


Fig. 2—Block diagram of a typical preamp for FM and vhf TV use on an antenna mast.

THE MAST-MOUNTED PREAMP

causing beats that interfere with another channel.

Because of overload, an amplifier is specified by its input or output capability. The maximum input or output level for a certain amount of distortion is usually specified.

Available preamplifier types

One transistor (or tube), vhf, 300 ohms input and output

One transistor handles both TV bands (low and high). Some amplifiers of this type trap out the FM to prevent overload by strong local stations. Since one transistor amplifies both bands, this preamplifier should be used only in weak-signal areas where no strong local stations exist that can cause overload. This type of amplifier feeding a signal splitter can be used to drive several receivers.

Two transistors, vhf, 300 ohms input and output

One transistor handles the low-band channels and the FM band; the other handles the high-band channels. Again, some versions trap out FM. Since it is less prone to overload, the FM-trap type is recommended in fringe areas where strong local stations exist. Second- and third-order distortions are minimized in this type.

Two transistors, vhf, 75 ohms

Same as the above, but having a coaxial cable downlead.

Two transistors, uhf only, 75 or 300 ohms

This type is relatively new and used primarily in areas where only uhf channels have to be amplified. If vhf signals are available, they can be separately amplified or directly mixed with the uhf signals.

Two transistors, vhf/uhf, 300 ohms

A broadband amplifier for the vhf low band (54–88 MHz), vhf high band (174–216 MHz) and the entire uhf band (470–890 MHz). Two types are available. One has a single vhf/uhf input; the other has two inputs, one for vhf and another for uhf.

The model with the single vhf/uhf input is used with a single antenna covering the vhf–uhf bands, as shown in the photo. The other model is used when separate vhf and uhf antennas are employed.

In a vhf-only installation, either a one- or two-transistor unit can be used. Both a 300-ohm ribbon model and a 75-ohm, coaxial-cable model are available. In a fringe area where no strong local stations exist, the one-transistor model will be adequate. In other areas, where some stations are fringe and some local, the two-transistor model is preferred because of its good signal-handling capability. For a vhf/uhf installation, the two-transistor model should be used.

In areas where severe ignition noise exists, use 75-ohm coaxial cable or shielded twin line. Encapsulated 300-ohm twin line is recommended, rather than the conventional flat type, in most applications—especially in uhf installations. The encapsulated twin line has less loss than most coaxial cables. It also has more stable characteristics and is not affected by moisture, as flat twin line is.

For the best signal-to-noise ratio, always mount the preamp as close to the antenna as possible.

Extreme hot or cold temperatures degrade preamplifier performance and can cause transistor failure. Reliable manufacturers compensate for this and thereby provide that extra margin for year-round performance.

Avoid placing an amplifier where it's exposed to hot smoke and gases from a chimney.

Always provide a drain (or drip) loop in cables connected to the preamp (see Fig. 1). A drain loop prevents moisture from entering the amplifier housing and causing damage.

Although some preamps provide outputs to two receivers, additional sets can usually be fed by using splitters.

Coaxial-cable installations require baluns (transformers) to match the 75-ohm downlead to the 300-ohm receiver antenna input.

Frequency splitters can be used to split a common signal (vhf, uhf and FM) into separate frequency bands. TV receivers can then be fed only TV, and FM receivers only FM. This practice minimizes crossmodulation.

Wherever TV signals are weak—especially if antenna-mounting space is limited—a mast-mounted preamp can produce a noticeable improvement in picture quality. It gets the signal *above* the noise before going down the lead-in. A good preamp often means a viewable picture where none was obtainable before. END

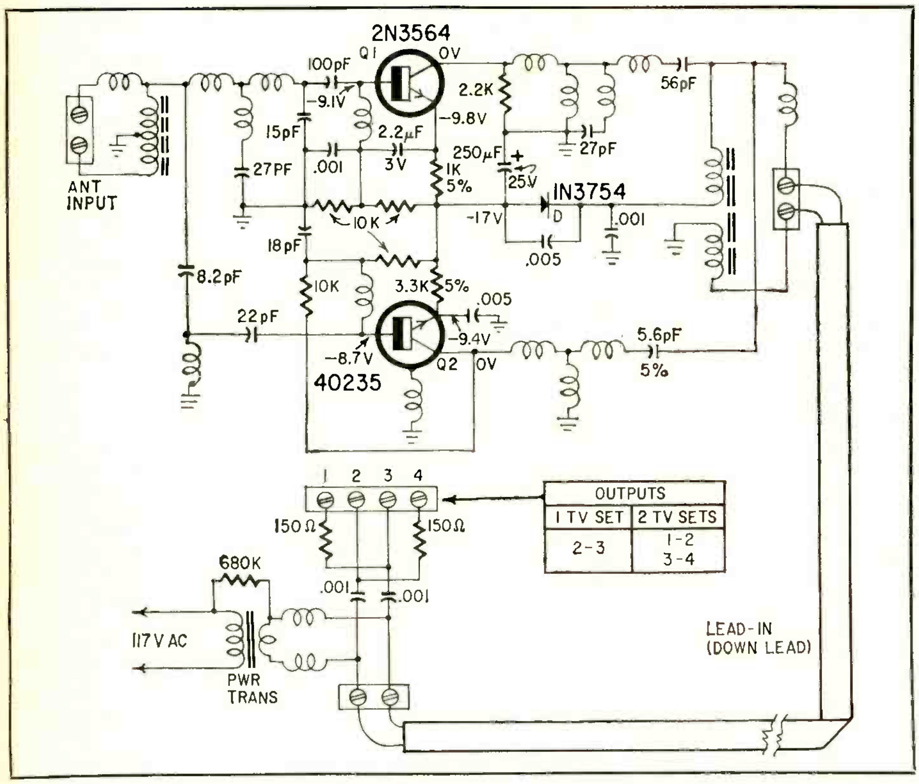


Fig. 3—Schematic of the Fig. 2 preamp shows separate stages for high and low bands.

SERVICING WITH D·U·D

A computerized troubleshooting system called Digital Unit Diagnosis

by ROBERT L. GOODMAN

PUSHBUTTON SERVICING OF TV AND electronic systems has come of age. The service technician and shop owner, not to mention the set owner, have long awaited this event.

Digital Unit Diagnosis (DUD) is the latest innovation to increase the efficiency of service technicians. At present, five prototype systems are in operation in various sections of the country for evaluation and debugging test runs.

Many years and manhours of R & D have gone into perfecting the DUD system and into programing the memory tapes for all brands, models and chassis numbers of TV sets. Every type of malfunction that may occur in any chassis is programed into this tape memory and computer readout system. At this point, DUD is ready to go.

The following is a brief rundown of DUD operation. The color or black-and-white TV set to be checked is set up and put into operation. The set is cleared of any direct short circuits in its primary power supply, and all tubes are checked. The set is then connected into the automated testing system. The DUD unit feeds a complete b-w or color video signal and sound to the antenna terminals of the set under test. The other connections are made through agc, sync, video, B+ and audio leads. An ac outlet is provided so that input current and voltage can be monitored. The entire system is then fired up and DUD is ready for a look-see.

The heart of the computer system is the memory-tape bank and the tricolor camera pickup head. The camera head is focused on the screen of the TV receiver. You then select a prepunched card for the model and chassis number.

The card is fed into the computer and the TEST START button is pushed and you await DUD readout on the monitor. This is a digital-type computer, but with direct CRT readout. The system will display the defective part by symbol number as given on manufacturers' schematics. (An accessory is available that converts this information to Sams-schematic symbol numbers.) The CRT display also describes any adjustments that are to be made.

If there is more than one defect in the set, you repair the fault displayed and then push the TEST START button again, which will recycle the system for the next trouble. This can be repeated until all circuits are okay.

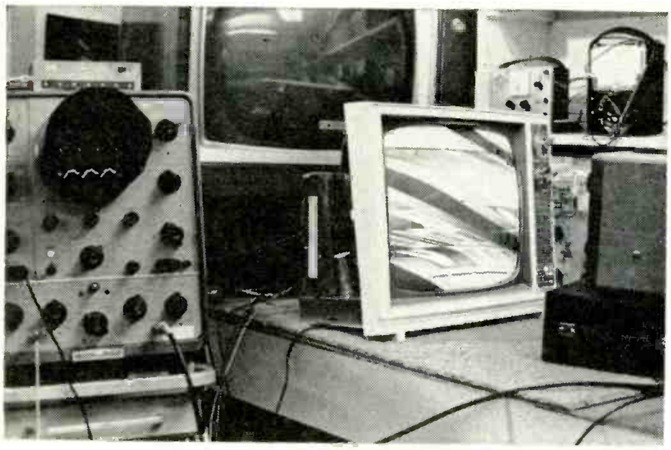
When the picture or sound circuits do not contain enough information for accurate analysis, the readout monitor will ask for more information. This could be voltage or resistance measurements on a certain tube or transistor socket or section. In some cases, a waveshape analysis may be called for. For that, the DUD camera head is focused on the test scope and the waveform being sampled is analyzed by the computer in this manner. After the supplementary readings are obtained and fed into the computer, the system is recycled.

The DUD system works equally well for tube or transistor TV and also for audio-amplifiers or radio testing. One beauty of this system is that it is like having a TV technician on duty for you 24 hours a day. When those tough-dog intermittent sets come into your shop—the ones that act up only every hour or two—this system is a natural. The set and the DUD system can be kept on all night, with the operating switch set at STORE. The next day the memory tape is reviewed for the previous 24 hours. Any malfunction is again read out directly on the monitor screen.

On a monthly basis, the testing system is updated by punch-card information fed into the system, and twice a year new memory tapes are added for all new chassis and production changes. Now that DUD has eliminated the tedious brain-racking usually associated with electronics troubleshooting diagnosis, the service technician can at long last run enough sets through his shop to make a reasonable profit, if he doesn't lower his prices too far. The time and energy he saves can be spent paying more attention to the business side of his service operation.

When full production begins, DUD systems will be available on a lease basis for about $200 a month. The system does not include the lab-type test scope.

The worst problem the developers have run into to date is finding someone to repair the DUD system. Once this problem is licked, they hope to have enough of these computer systems available for most large TV service shops across the country by April 1. END



Camera head at right views screen symptom of faulty TV set. Waveshape across bad component is shown on scope.

DUD monitor (left) displays repair instructions. Computer programer is in foreground, tape memory and tech files behind.

Lightning, Plasma and Balls of Fire

A review of natural electrical discharges in the skies **By ALLEN B. SMITH**

TO MOST OF US, LIGHTNING IS SOMEthing that comes naturally with summer thunderstorms, and we usually don't worry about it. It's only when this powerful atmospheric electricity oversteps the bounds of good manners that it becomes a matter for attention. It's difficult to overlook the explosive shattering of a large tree near your house, or a lightning-caused forest fire which ravages thousands of acres of valuable timber. Worst of all is the stroke that snuffs out the lives of a family huddled away from a driving rainstorm under the branches of an old oak.

Electronics technicians—like many other people—have long been aware of the lethal power of lightning. We know that human carelessness leads to serious injury and property damage caused by lightning. In the normal course of our work, we've established safety procedures: Ground that antenna mast; use a lightning arrester on that lead-in. We have developed a healthy respect for the power contained in a storm cloud—and with good reason.

A typical discharge of lightning releases nearly *100 million volts* along its path—through which as much as *250,000 amps* of current flows. Temperatures reach 30,000°C, roughly five times the surface temperature of the sun. The stroke lasts only a few milliseconds, so the average power is low—typically from 10 to 100 watts. But its energy, as we all know, has astonishing effects. We also know that this form of electricity is the least predictable. About all we can do is wait for it to strike.

Early discoveries

The apparently random and capricious behavior of lightning accounts in part for the belief in fire gods and other mystical beings among men of earlier civilization. Not surprisingly, some primitive cultures were strongly centered around the power of lightning, usually in the keeping of their strongest god. Even the Greeks and Romans had rather special views about atmospheric electricity.

In Rome, for example, there was a body of especially learned men known as the *College of Augurs* whose sole purpose was to predict the will of the gods. To obtain this extremely important information, the augurs observed the random action of birds, meteorites and comets, and lightning. Lightning, it was believed, was controlled by Jupiter, the most powerful of Roman deities. The direction from which lightning struck, the quarter of the sky in which it was seen, its intensity and physical character—all these had significance in determining the will of Jupiter.

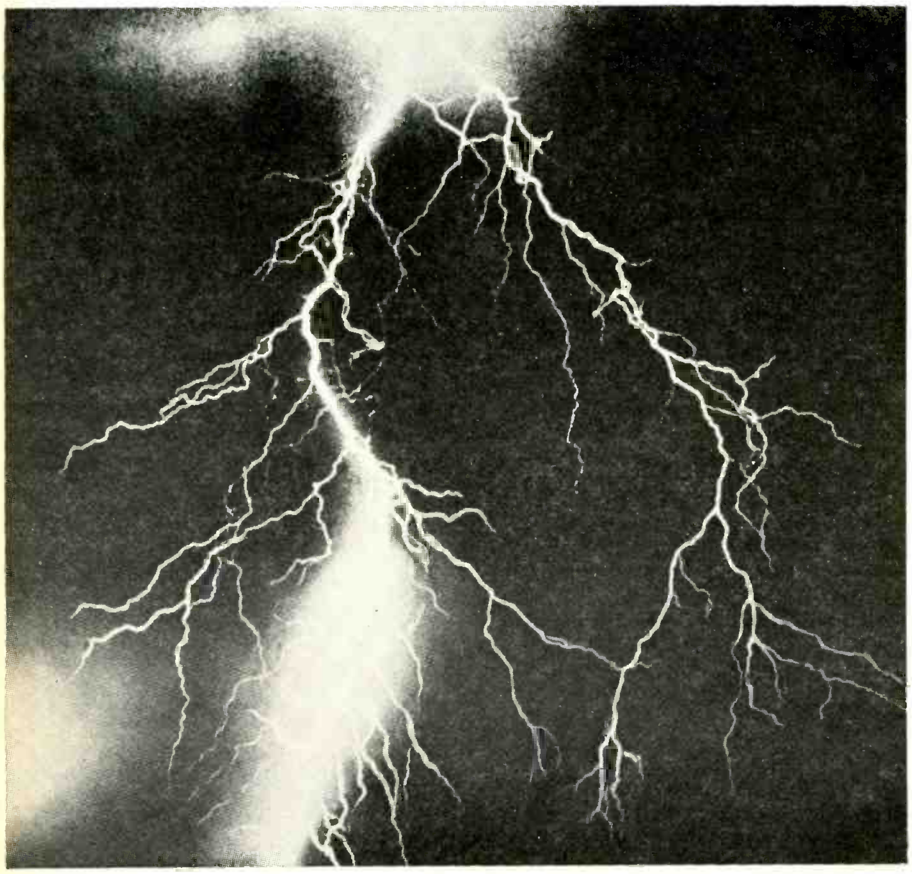
Today, we have a far more scientific understanding of the causes and effects of lightning, but the new confidence with which we regard it is only as old as the experiments and observations of Benjamin Franklin. As one of a small number of educated men using the scientific method in studying natural phenomena, Franklin described, in 1750, an apparatus to determine whether the electrical charge held within a cloud could be tapped off and carried harmlessly to the ground. The device was constructed first in France, but Franklin proved to his own satisfaction—during the famous kite experiment—that the charge could, indeed, be grounded. He later described the construction and installation of lightning rods and grounding systems based on these observations.

Scientific studies of lightning in its various forms have been pursued by a surprisingly large body of scientists. In all parts of the world, visual, photographic and physical observations have resulted in a massive written record. Practically every aspect of the phenomenon is quite neatly cataloged.

Fire balls

There is one significant exception, however. Like a thin wisp of smoke in a clear sky, descriptions of a maverick variation generally called "ball lightning" are found throughout the entire recorded history of lightning sightings. Refusing to follow the well-known behavior patterns of its common relative, ball lightning may roll along the ground, pop through an open window or down a chimney, ricochet off the walls of a house, sit on a fence, hum, buzz, hover, fade away or explode. Somehow, the first impression one gets in reading about the stuff is that everyone who claims to have seen it has a different story to tell.

Following an extensive study of ball-lightning observations, scientist Donald J. Ritchie concludes that there



The common form of lightning is now believed to energize the type of "ball lightning" that may explain reports of several kinds of visual phenomena, including many UFO's.

probably are two basic types. The first is a diffuse red ball which fades slowly without doing any apparent damage. The second is bright, bluish-white and decays rapidly with a loud explosion, charring and blasting nearby objects. The balls apparently range in size from an inch or so to as much as 30 or 40 feet in diameter; the average seems to be about 1 foot. Their lifespan is anywhere from a few seconds to 3 minutes on the average, yet Ritchie notes that one very large ball was seen hanging below the base of a storm cloud for 15 minutes.

Probably the most unusual aspect of these electrical enigmas is that they move as if they had no appreciable weight, sometimes very quickly, sometimes just barely creeping along, changing direction rapidly and at random. In one incident, reported by eyewitness J. Durward (a one-time director of the British Meteorological Service), a ball of fire entered the cockpit of an airliner flying through a heavy thunderstorm. It passed in through an open window vent, singed the eyebrows of the captain, burned holes in his safety harness and flight case, bounced through the passenger cabin into the rear of the craft, where it burst in a loud explosion.

In spite of literally hundreds of reported sightings in recent years, photographs of ball lightning are extremely rare. Those which do exist have been judged by some investigators as frauds and by a few as due to other natural phenomena. Others, of course, believe that the pictures represent actual images of ball lightning.

UFO's and lightning

At this point you already may have formed the idea that many of the characteristics of so-called ball lightning also may be ascribed to at least one kind of UFO's (unidentified flying objects). In one famous case, investigated by John Fuller and reported in his book *Incident at Exeter*, 60 people observed some kind of bright and highly mobile object. It darted through the skies of Exeter, N. H., before disappearing. There seems to be no doubt that observers actually saw something strange and captivating that night in September 1965. Fuller's conclusion was that the shimmering glow which visited Exeter was a spaceship from a planet in another solar system. Even though such a visit is possible, Fuller's explanation doesn't seem too convincing. Exeter's spaceship sounds like many descriptions of ball lightning.

Noted astronomer Harlow Shapley (fifth director of the Harvard Observatory) believes that perhaps as many as 100,000 planets capable of supporting some form of intelligent life may exist within our own galaxy, the Milky Way. Harrison Brown of Cal Tech says a thousand or so. If either is correct, then at least one of these higher forms of life may wish to visit what must seem to them to be our remote and insignificant solar system. But, all "evidence" of such visits seems poorly observed, badly reported and devoid of *scientific basis* or credibility. Visual evidence, as we all know, can be extremely misleading.

Until recently the subject of ball lightning was a muddled morass of unsupported observation. Like reports of flying saucers and other UFO's, it was regarded by most of the scientific community as part of an interesting folklore, good for spirited conjecture and little else. In May 1966, however, two scientists at the Westinghouse Research Labs published a report that has added strong evidence that ball lightning actually does exist. Its physical and electrical characteristics are described in careful detail.

Drs. M. A. Uman and C. W. Helstrom, with the assistance of a high-speed computer, have constructed a mathematical model that predicts the properties of ball lightning in terms of known physical forces. The Uman-Helstrom model describes the ball in terms of current density, temperature and diameter. The descriptions agree in surprising detail with recorded observations of ball lightning.

As Fig. 1 shows, central temperatures in a lightning ball may range from 3,500°C to 6,000°C, 58% to 100% of those found at the sun's surface. Current flowing within the ball itself varies from a few tenths to several hundreds of amps. The ball size is predicted as a function of temperature and of the current density that exists in the air between the storm cloud and the ground.

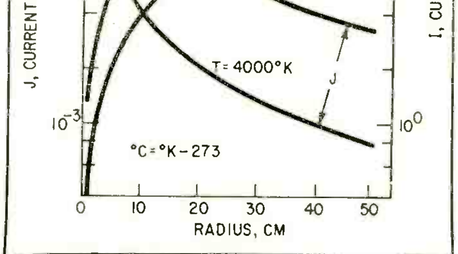


Fig. 1—Graphical representation of the Uman/Helstrom theory of ball lightning shows the limits of current density and current for balls of varying diameters.

The theory also predicts that a ball having an 8-inch diameter and a 5,000°C central temperature would be as bright as a 1,000-watt light bulb.

Electric gas

Uman and Helstrom based their work on a phenomenon that's been known only a short time to physicists—the effect known as *plasma*. (Not to be confused with *plasma*—the fluid part of blood.) When a gas becomes ionized to the point that it contains a nearly equal quantity of electrons and positive ions, it's called plasma. How does it differ from ordinary gas? For one thing, it's a good conductor of electricity. Also, it's affected by magnetic fields.

We know that gas in its normal state is an electric insulator, and that application of intense electrostatic or electromagnetic fields will release free electrons and ions. Under these conditions, the gas becomes conductive and remains so as long as the gas-discharge conditions are met. The ionized gas consists of electrons, positive ions, and neutral molecules. The electrons and ions in a given volume of ionized gas tend to balance in number, because any excess, either of ions or electrons, creates an intense electrostatic field that tends immediately to restore the condition of particle balance.

Complete equilibrium for the ionized gas depends additionally on the molecular density of the gas, its temperature and the degree of ionization. This total equilibrium normally exists for all degrees of ionization. In weakly ionized gases, the ratio of positive ions and free electrons to neutral molecules is very low. In strongly ionized gases, however, the ratio is high. And, in a completely ionized gas of specific volume, the density of neutral molecules is zero. The resulting incandescent gas cloud is called a plasma.

To put it another way: The ionized gas which generates the light in a fluorescent tube is weakly ionized; the controlled-fusion reaction of the sun with its extraordinarily powerful magnetic field is a hydrogen plasma.

Because large regions of the universe and many specific stellar and nebular bodies now are assumed to be plasmas, the study of their characteristics is of basic interest to astrophysicists and cosmologists. Nuclear explosions produce matter that is almost completely ionized, as do the superconducting magnets used by physicists working to control the fusion reaction of heavy hydrogen. The entire concept of radio astronomy is based on the intense electromagnetic radiation of stellar bodies, particularly the class of radio stars known as quasars—another form of galactic plasma.

Physicists often remark that plasmas constitute the fourth state of matter, being neither liquid, gas nor solid. No matter how one views them, certainly their importance in achieving a better understanding of basic physical forces is hard to exaggerate. Plasma research undoubtedly will lead to controlled-fusion power, to pulsed-plasma engines of low thrust and extremely high (near the speed of light) velocities for interplanetary and interstellar spacecraft, and to a more complete understanding of how the entire universe was formed and developed.

Lightning and plasma

How does the Uman-Helstrom theory of ball lightning relate to the conditions of plasma generation? The electrostatic charge necessary for ionizing a small volume of air lies between a highly charged cloud and the ground. The heating requirement is met by a lightning stroke—usually far in excess of the temperature needed to ionize the air completely. Still, there must be a missing ingredient. Otherwise, every lightning stroke would create a plasma, and ball lightning would be bouncing from wall to wall during every thunderstorm.

According to research conducted at the Illinois Institute of Technology in which ball lightning was artificially generated, the volume of air from which the plasma is formed must differ in some way from the air that surrounds it. This difference may result from just the right distribution of dust particles, from random concentrations of foreign gases (hydrogen sulfide, methane, ammonia, etc.) or from almost any form of contamination that happens to be directly in the path of a lightning stroke and in the presence of a strong magnetic field. The relative rarity of ball lightning attests to the odds against all of these circumstances occurring simultaneously and within the limits shown in the graph. But when they do occur—FIREWORKS!

Once the plasma has been formed, the fireball is free to move in response to the constantly changing magnetic field surrounding it. When the cloud-to-ground currents are symmetrical around the ball and flow symmetrically through it, the net force is zero, and the ball hangs stationary in space. It has, after all, the same weight as the surrounding air. Any change in the distribution of the magnetic field will cause the ball to move. Further, any change in the symmetrical shape of the ball also will impart motion, due to a resulting distortion of the field. In particular, *an elongated or cigar-shaped ball is very unstable and moves at high speeds.*

When the magnetic field supporting the plasma collapses slowly, the degree of ionization is reduced and the ball, like an old soldier, just fades away. If the magnetic field collapses abruptly, or if the ball moves into an area shielded from the field, all the latent energy held in the ball is released at once. The result is an explosion, the severity of which depends on the size of the ball, the temperature inside it, the molecular current density and the strength of the field at the time of collapse.

Well-documented accounts of this phenomenon have described massive damage to buildings, multiple deaths from blast and burns, and other examples of high-energy release. One of the most serious of these occurred during a tornado that struck a small village in Dartmoor, England, on a Sunday in October 1638. After being assaulted by high winds and lightning, a church (in which services had just begun) was bombarded by a fireball which moved through the main hall, severely burned several parishioners, then exploded. More than 60 persons were killed in the resulting blast and collapse of the damaged building.

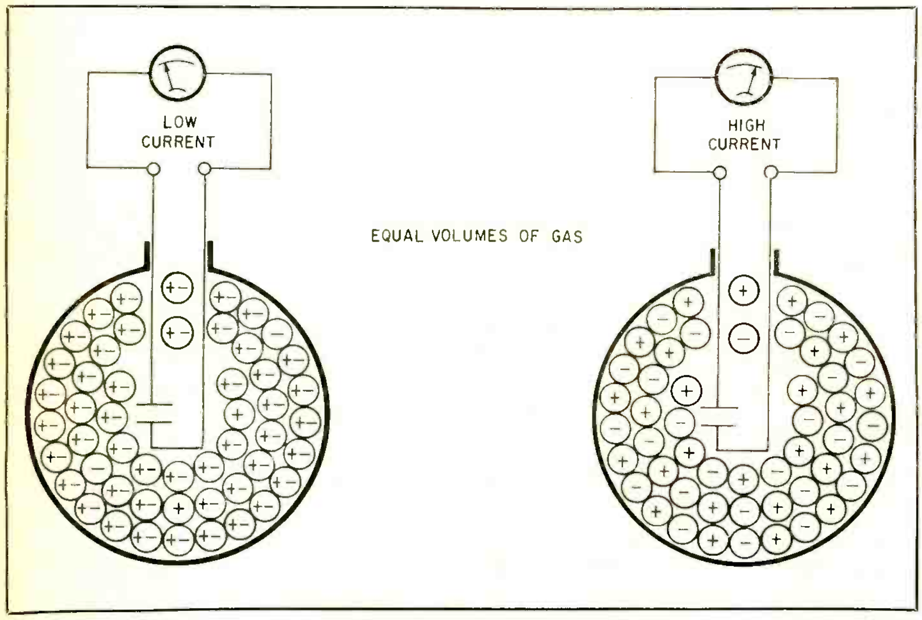


Fig. 2—Weakly ionized gas has a high density of neutral molecules. Increasing ionization decreases number of neutral molecules. Completely ionized gas has no neutral molecules.

It's apparent that ball lightning, especially now that its formation and existence have been verified by mathematical computation and by the IIT experiments, may hold the answer to a variety of previously unexplained occurrences. Foremost among these, of course, are the reports of UFO's that glow in night skies, move erratically at high speed with a buzzing sound, then disappear—either silently or with a loud report.

This possible explanation for several types of UFO's is strengthened when we learn that a plasma may be formed in the vicinity of high-voltage power lines, even in particularly dry weather. What's more, operators of NASA's rocket-tracking radars, who follow the paths of satellite-launch vehicles, know that the plasma trail formed by a massive rocket is easier to obtain an echo from than the craft itself.

Since the Air Force now has authorized a serious study of UFO's—interestingly enough, under the direction of the research and development branch rather than the intelligence agency as before—this new interest in plasmas and ball lightning surely will not go unnoticed. At this time, of course, we have no way of knowing whether further investigation will show that ball lightning and other plasmas account for most UFO reports.

If it does—and this seems likely—I'll be among those who will feel a little let down. I've been interested in some of the serious efforts in books and magazine articles that attempt to show that earth has been visited by visitors from outer space. Theories have been proposed describing members of some higher life form, whose home probably lies far beyond the comfortable confines of our own solar system. Frankly, I like the idea that the extraordinary interstellar and intergalactic distances can somehow be spanned despite the contradictions of our brief lifespans and the apparent limitation of the speed of light (186,000 miles per second) as our greatest attainable spaceship velocity.

I'd like to believe the theories. But the evidence—*scientific* evidence—so far isn't convincing. Right now, I'll place my bets on the balls of fire. END

Convergence Without A Color Generator

Imagine getting this timesaving letter in YOUR mailbag **By ALAN JAMES**

Forest H. Belt, Editor
Radio-Electronics
154 West 14 Street
New York, N.Y. 10011

Dear Mr. Belt:

About a month before Christmas, at one of the shops where I sometimes help out, the boss got in a supply of color sets for the pre-Christmas selling season. There were several dozen of them.

He has this thing about making sure all new sets are checked out before they're even stored away, not to mention when they're out on the showroom floor (there, they have to be A-1 perfect). So he called me in to work with his two technicians setting them all up. He had a big promotion going out for his first heavy sale the next weekend, so there couldn't be any waiting around to get the sets ready. He wanted them all done, and in short order.

We ran into a problem, though. He has only one color generator. Mine was on the blink, so we couldn't use it until I could find time to fix it. However, I did have an old video-dot-bar generator—one of the kind we used to check linearity in the days before color. It doesn't put out color bars, but it has a nice cross-hatch and can be used for gray-scale and convergence adjustments. We didn't really need color bars anyway, because we could check out color operation on stations. Seems there's almost always something on in color nowadays.

But that still left us with only two generators to do the important part: convergence. We thought about it awhile and then I happened to remember that a long time ago my video-bar generator had gone bad and I had used an audio generator for linearity adjustments. You know, you just clip it in right after the video detector and it makes horizontal bars on the CRT screen. So, I thought, why not use it for convergence?

Sure enough, the boss had an audio generator (who hasn't?). It was only a sine-wave type, and it took some experimenting to figure how to get the sharp bars you need for convergence. As you know, if you ever used an audio generator for video or linearity tests, the smooth rounded rise and fall of a sine wave will cause a slow change on the CRT from white through gray to black. The bars aren't clearly defined, as you can see from my first photo (A), taken with the generator at 400 Hz.

Overcoming that problem was less trouble than finding the right frequencies. That, too, took a little fiddling around, but in a short while I had it all worked out. Worked pretty good, too.

In fact, it worked so well that I decided I should pass the whole idea along to you for your readers. I made up my mind to get a couple of older sets at my place later and take pictures and make careful notes. That way I could tell and show you exactly how this setup works. I took only black-and-white (I wonder if I should say monochrome?) photos, but I took the important ones up close and I hope you can make out from them what's going on.

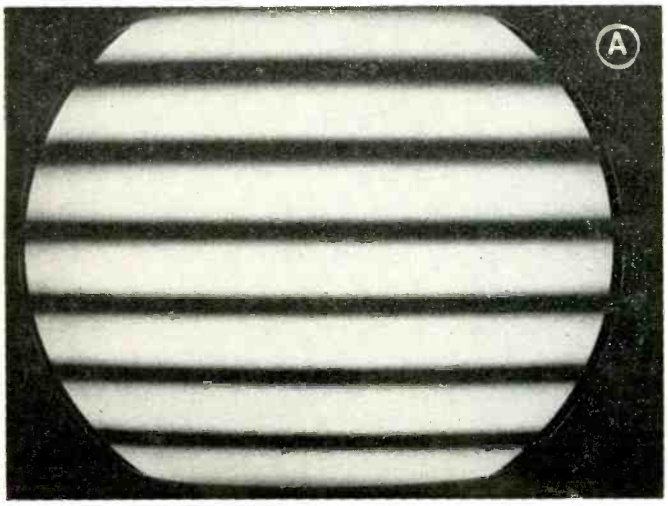
First of all, turn the set to some unused channel and connect the generator directly to the input of the video stage. That's usually accessible as a test point following the video detector. On some sets, I found it more expedient (easier to reach without pulling the chassis) to clip in *before* the video detector diode. No real difference in operation.

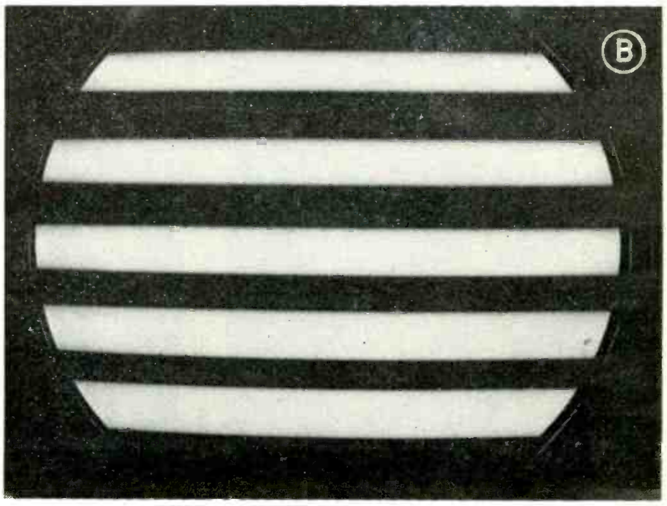
One thing you have to keep in mind is the problem of sync. If the sync take-off point doesn't *follow* the point where you hook in the audio generator, you'll have a terribly unstable pattern, especially on vertical bars. In one Zenith I used, for example, the sync has its own detector diode separate from the video detector.

In every case of separate sync, the solution was the same: Clip a 15K resistor from whatever feed-in point you're using (for video) directly to a sync point just following sync takeoff. This locks the bars in solid every time.

The secret of using sine waves for convergence is to drive the video stage in the receiver real hard. In fact, you overdrive it. If you do, you'll get sharper edges to the bars, and it's those edges that mean the most to you in convergence. The effect is slightly better when you feed in the audio signal *before* the video detector, as the diode has some tendency to clip a strong sine wave.

To see what I mean about sharp edges, compare my photo B with photo A. Photo A was taken with the generator turned up just enough for good contrast —a little over a volt, usually. See how the blacks and whites fade gradually into one another? Photo B is with the output of the generator turned up to 5 volts; the edges are much better defined. The reason is that, when the video stage is overdriven, it tends to flatten (clip) the





Convergence Without A Color Generator

tops of the sine waves. Sharper fronts and backs result.

(I tried this system of convergence with a square-wave generator, too. With it, there is no need to overdrive, because the fronts and backs are already sharp. Photo C depicts how a square wave shows up on a color CRT. But, not everyone has a square-wave generator, so I'll stick to explaining the sine-wave method.)

I'll tell you next how to select frequency. For horizontal lines, you can use any of several frequencies. It depends on how thin you want the lines to be. Start by swinging the generator dial until you get a few bars on the screen. A good place to begin is near 400 Hz, which produces about six black bars with alternate white ones. Why six? Because 420 Hz is seven times the TV field rate (60 fields per second), so the generator signal goes through about seven complete cycles during each field. One bar usually gets lost in blanking, so you only see six of the full excursions. At 600 Hz, you'll see nine bars; again one is hidden in the blanking.

If you have had to use the 15K sync jumper, the raster may appear to have shrunk, and you'll see fewer than six bars. The cause of this is the vertical integrator, which picks up the first couple of cycles and integrates them into a wide blanking bar. At higher-frequency settings of the audio generator, the integrator soaks up more of the cycles, because the cycles are of shorter duration. This shorter cycle also makes the lines thinner. Therefore the blanked portion of the screen is also thinner, and the raster doesn't seem quite so shrunken. You can clear it up some by readjusting the receiver's vertical hold control.

I found that running the generator frequency up to 1,200 Hz provides thin bars and allows the extra blanking to remain near the top of the screen. Thus you can see the results of horizontal convergence at the top of the screen. At 1,200 Hz, the pattern will look something like photo D. You can see the lines clearly for convergence. Also notice the slightly shrunken appearance of the raster.

For vertical convergence lines, your audio generator must go well above audio frequencies. For every vertical line or bar, the generator has to mark once in each horizontal raster line. For 10 vertical bars, then, the generator would have to be set at 10 times the horizontal sweep frequency of the receiver—at 157,500 Hz (157.5 kHz). Because a little is lost in blanking, and to get thinner lines, I ended up using 252 kHz. If your generator doesn't go that high, you can use the low end of an rf generator.

If you find the vertical lines critical to adjust, it is probably because you haven't made the proper sync connection. Without it, the vertical bars will wiggle and jiggle so much you can't use them. Photo E shows the kind of trouble I had without the sync jumper.

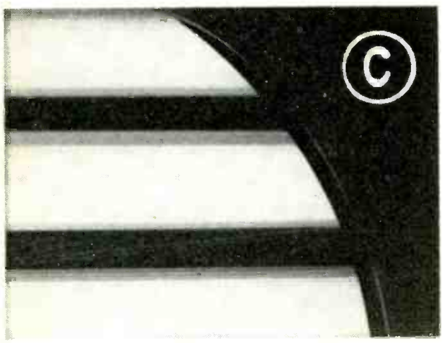
With sync connection properly made, the pattern looks like photo F when you get the generator near the correct frequency. When you're just a hair off frequency, it looks like photo G; and like photo H when you're right on the money. Lower frequencies will be a little easier to tune, but the bars will be thicker and not so well defined.

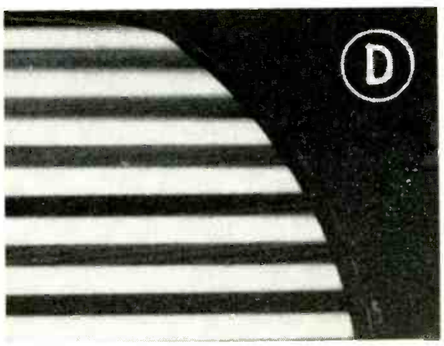
Dynamic convergence by this method is as easy as with a color generator. After you have checked purity and have set the static-convergence magnets, you can do the rest with the audio generator.

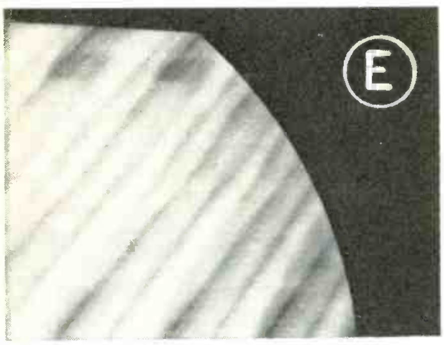
What you want to watch are the sharp edges of each bar. You'll be able to see misconvergence best in the whites, of course. Start with vertical bars (252 kHz), as most set makers recommend. Kill the blue gun (the 100K resistor from CRT grid to ground is still a good way) and check red-and-green vertical convergence. Photo I shows the blue gun cut off, with red and green not quite converged. Photo J was taken after I converged red and green with the convergence-board controls to get yellow solid. Turn the blue gun back on (photo K shows blue slightly misconverged). Photo L shows the blue vertical neatly tucked away behind the yellow, where it belongs to make white.

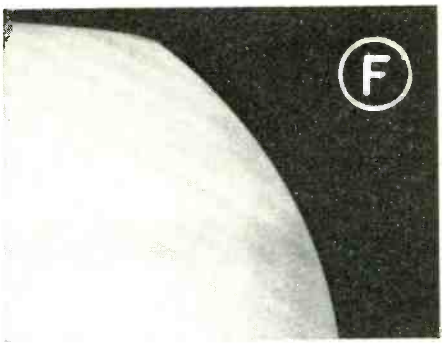
Go through the same procedure with horizontal bars (1,200 Hz). The photo sequence comprising M, N, O and P shows how the pattern looks at various stages: blue gun off, with red and green misconverged; red and green converged; blue gun back on, but not yet converged; and, finally, all converged.

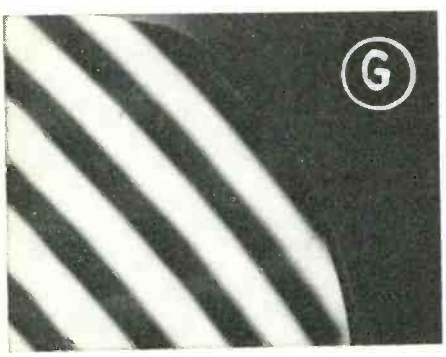
The last step is to check gray-scale tracking, and the sine-wave generator is great for that. Turn the output level of the generator down to the gradual shad-

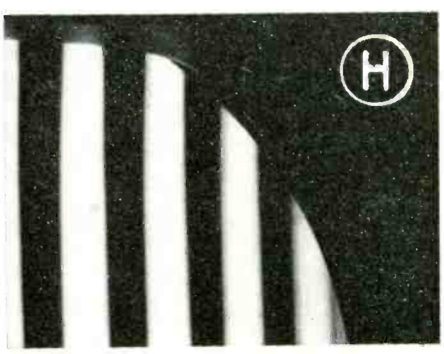


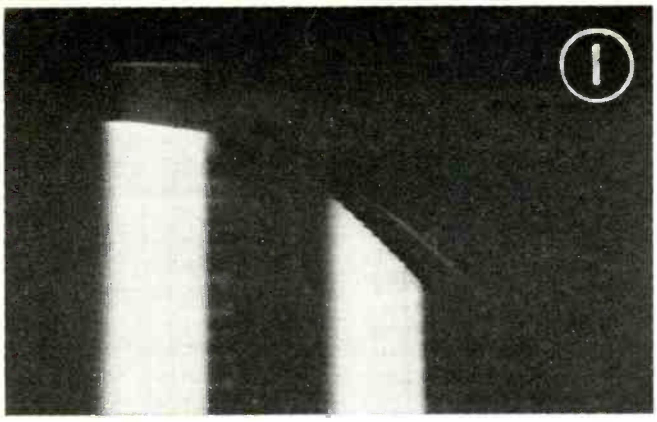


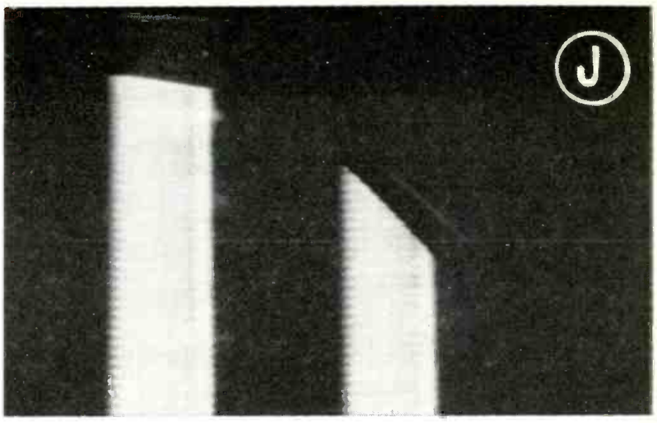


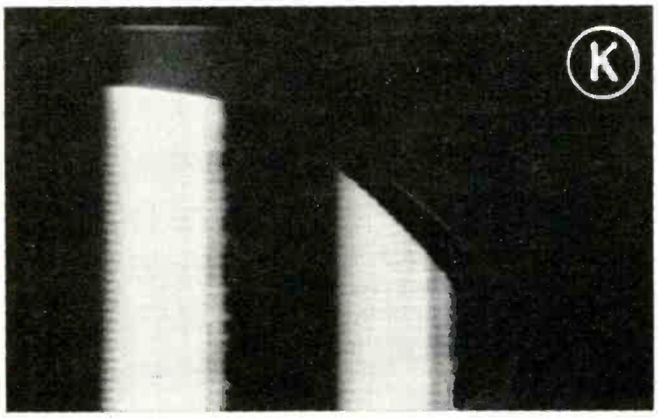


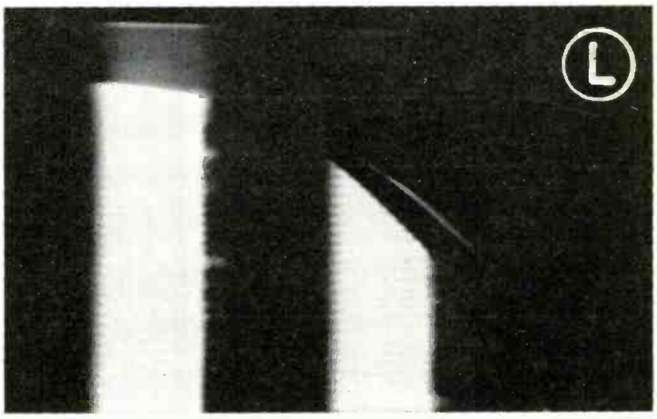












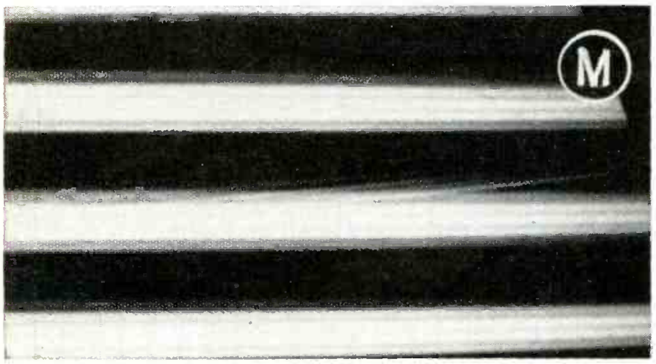
ings you saw back in photo A. If the gray tones don't track—that is, if they don't go from white to black without a trace of color shading—go through the gray-scale adjustment procedure recommended for the receiver.

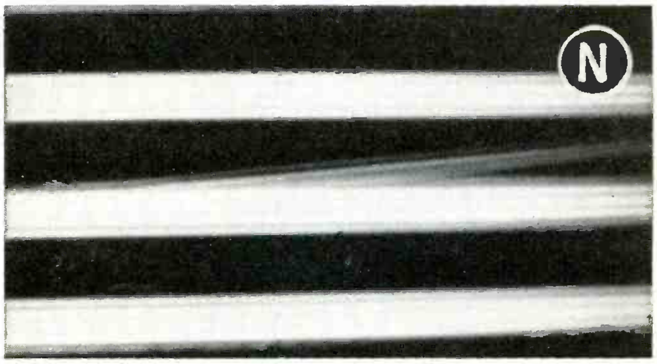
I hope your R-E readers can get some use out of this idea. It pulled us out of the bind we were in trying to get all those sets ready for Christmas. (One of the bench technicians liked the system so well that he built a small battery-operated transistor unit to carry along on outside calls. He made it with only two fixed frequencies, crystal-controlled at 189 kHz and phase-shift-tuned at 1,200 Hz. With one stage of amplification after the oscillator, it works great, according to him.)

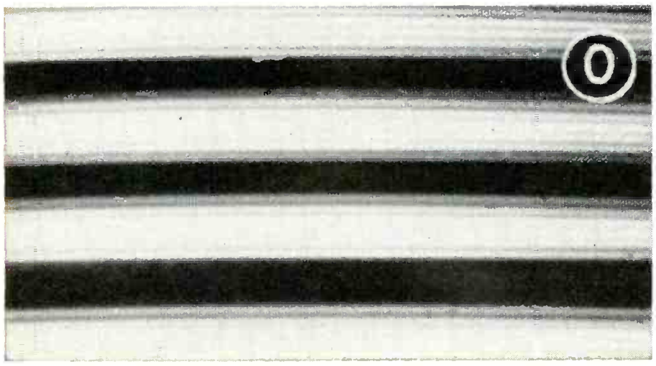
Regards.

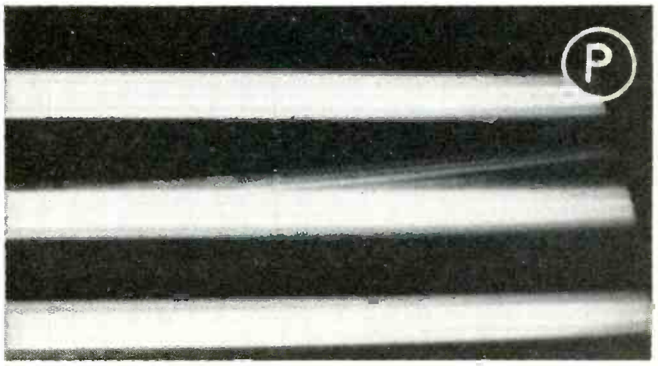
Alan James

END









A CB LIGHTNING ARRESTER

Protect your valuable equipment—and yourself—with this simple device

I STOOD AT THE WINDOW OF MY DEN, golf bag in hand, watching the rain scouring the sidewalk. The sudden shower was washing out my weekly game with Bob, a friend of mine who operates a CB repair shop. As thunder rumbled in the distance, I became aware of a crackling sound coming from my CB rig on the desk behind me.

Though I quickly turned off the set, I could still hear sparks inside. I jerked the electric cord out of the wall socket and then gingerly disconnected the coax from the still crackling set. It was then I noticed tiny sparks jumping from the center of the coax connector to the shield. I instantly dropped the connector and it fell against a radiator pipe. The fireworks subsided.

After a while, the storm subsided also, and I decided to keep my golf date. Maybe Bob could explain what had happened. After all, I thought, I bought the rig from him and didn't he guarantee it?

Besides showing me a few things about golfing that afternoon, Bob also told me some facts about antennas and static electric charges.

"Your antenna wasn't hit by lightning," he began. "But it doesn't take a direct hit to cause trouble. You had a case of *precipitation static*, which does not even require lightning. It can happen in rain, sleet, snow or even in a high wind. What happened to your system could happen to any ungrounded antenna. I repair a lot of rigs with burned-out antenna coils and arced-over loading capacitors. Sometimes I even have to replace coax transmission line because it has shorted."

"Come on . . . what are you building up to? My mast is grounded," I said, just to keep him on the right track.

"Doesn't matter, when the antenna itself is not grounded. I tried to tell you that when you put up that quarter-wave ground plane last fall."

"You told me to ground the antenna lead-in whenever the rig was not in use. But who's going to remember that every time?"

Bob took a pencil from his pocket

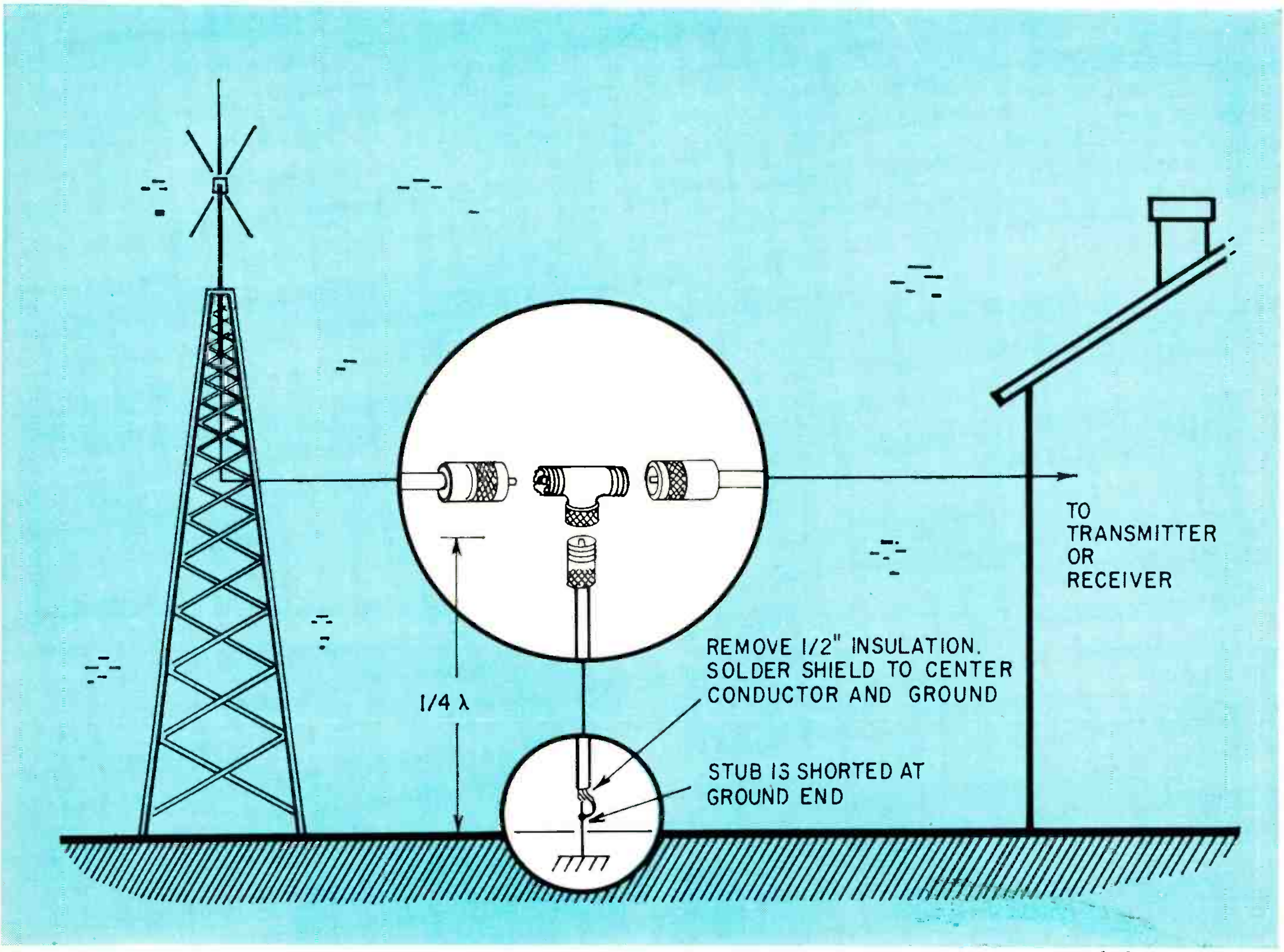
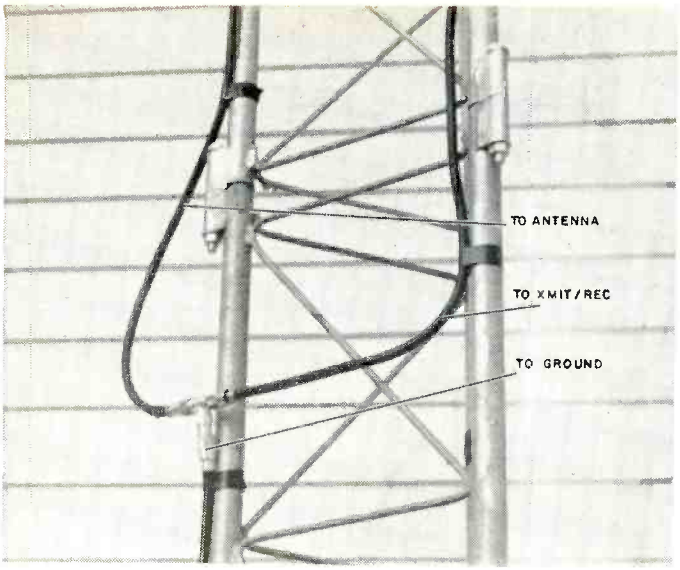


Fig. 1—Install grounding stub anywhere between tower (or mast) and building. Run single wire from stub bottom to earth.



Stub has a tee connector at one end, a short at the other.

If the tower is near the house, it's convenient to install the stub and tee connector on a leg. Tape the cable securely.

and began to sketch on the back of the bill the waitress had left on our table.

"No," he said, "what I told you was that you could leave the antenna permanently grounded, even while you're on the air, if you do it right."

He handed me the sketch (and the lunch tab!). He had drawn the diagram you see in Fig. 1.

"Oh, come on, Bob. You mean all I have to do is cut the coax transmission line anyplace, attach some fittings, and run another piece of coax to ground?"

"Yep! That's about it. But there's one catch. The coax you add must be *exactly* one quarter-wavelength long."

I handed the lunch bill back to him and asked how to figure the length of a quarter-wave.

"Simple." He grinned: "Just divide 246 by the frequency in megahertz, and multiply by the velocity factor of the coax line. This gives you the length of a quarter-wave, in feet."

"Oh, is that so?" I said, trying for my most intelligent voice.

"Well, if you use polyethylene coax, which is the most popular kind, it has a velocity factor of 0.66. You just divide 246 by 27.085, which is the middle of the CB band, and then . . ." He paused a few minutes while he scratched away with his pencil.

"It comes out to 5 feet 11¾ inches. If you want to use polyfoam coax, the velocity factor is 0.8. Length then is . . . 7 feet 3¼ inches."

He slid the bill back to me.

"That's nice," I told him. "But what do I do if a quarter-wave isn't long enough to reach the ground?"

"You can add an extra piece of ground wire to the end if you need it. The only critical part is to be sure the shorted point of the coax stub is exactly one quarter-wave from the point where it leaves the lead-in. Solder the shield to the center conductor and from there on use any kind of good conductive wire to reach the ground. Use a ground clamp and hook to a water pipe if you can, or else pound a stake into the ground."

I still couldn't see how I could get any signal on the air with a grounded transmission line. There was still a little space left on the back of the bill, so I slipped it back to him and asked for a *simple* explanation.

Bob drew the sketch of Fig. 2 and explained, "Here's a graph of how voltage and current would distribute themselves on a pair of wires cut to one full wavelength at the applied frequency, if the two wires were shorted at one end. The solid line is the voltage alternation, and the dotted line is the current.

"Here at the shorted end, the voltage between the wires is nearly zero and current through the shorting bar is maximum. Current and voltage along the line are 90° out of phase.

"Now, you can see that in any quarter-wave section of the line the voltage is maximum, and current is minimum at one end of the section while conditions are just the opposite at the other end of that section.

"Electrical impedance is to rf energy what resistance is to dc. Impedance is maximum where voltage is maximum and current is minimum. This point is one quarter-wave from the shorted end, at the point where the stub connects to the lead-in.

"If you use only this last quarter-wavelength for your ground stub, then the end connected to the antenna lead-in will have very high impedance to radio signals. Static voltage from the atmosphere, however, develops as dc, and there is no impedance (resistance) for that. In fact, the antenna and lead-in will be grounded directly, preventing any static buildup."

"It sure will . . . I think," said I. "How about making up one of those quarter-wave grounding stubs for me, ol' buddy?"

We left (guess who paid the lunch bill), and the next week he fixed one up for me. Here's a picture of the stub, and another of the finished installation.

My rig works fine again (after Bob replaced the loading capacitor and antenna coil). He assures me I'll never have any more trouble with static charges.

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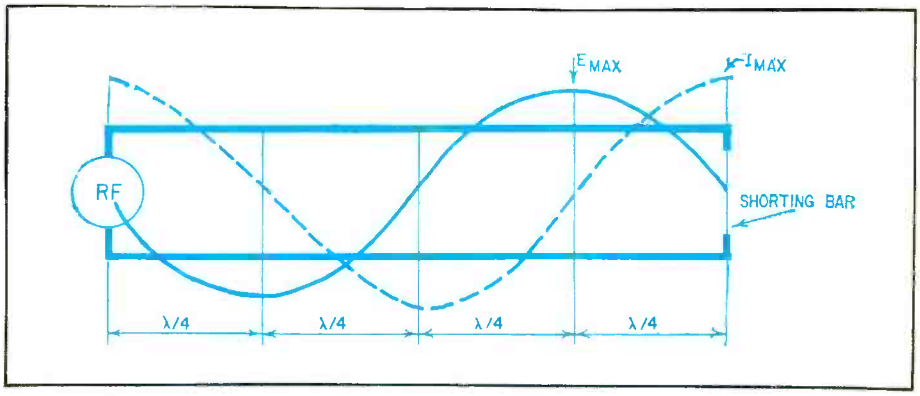

Fig. 2—The voltage is always minimum at one end of a quarter-wave section of line.

The Nomorule in Electronic Calculations

Part 2—More uses for last month's Nomorule: How to multiply and divide by using logarithms; trig functions and some practical examples

By JOHN H. FASAL*

THE BASIC NOMORULE DESCRIBED IN PART 1 is repeated here as Fig. 1. We showed that you can multiply two numbers by aligning a straightedge across one on scale A and the other on scale C, and reading off the product on scale B. If you have more than two factors, you must transfer the first product back to either scale A or scale C, to use it as a

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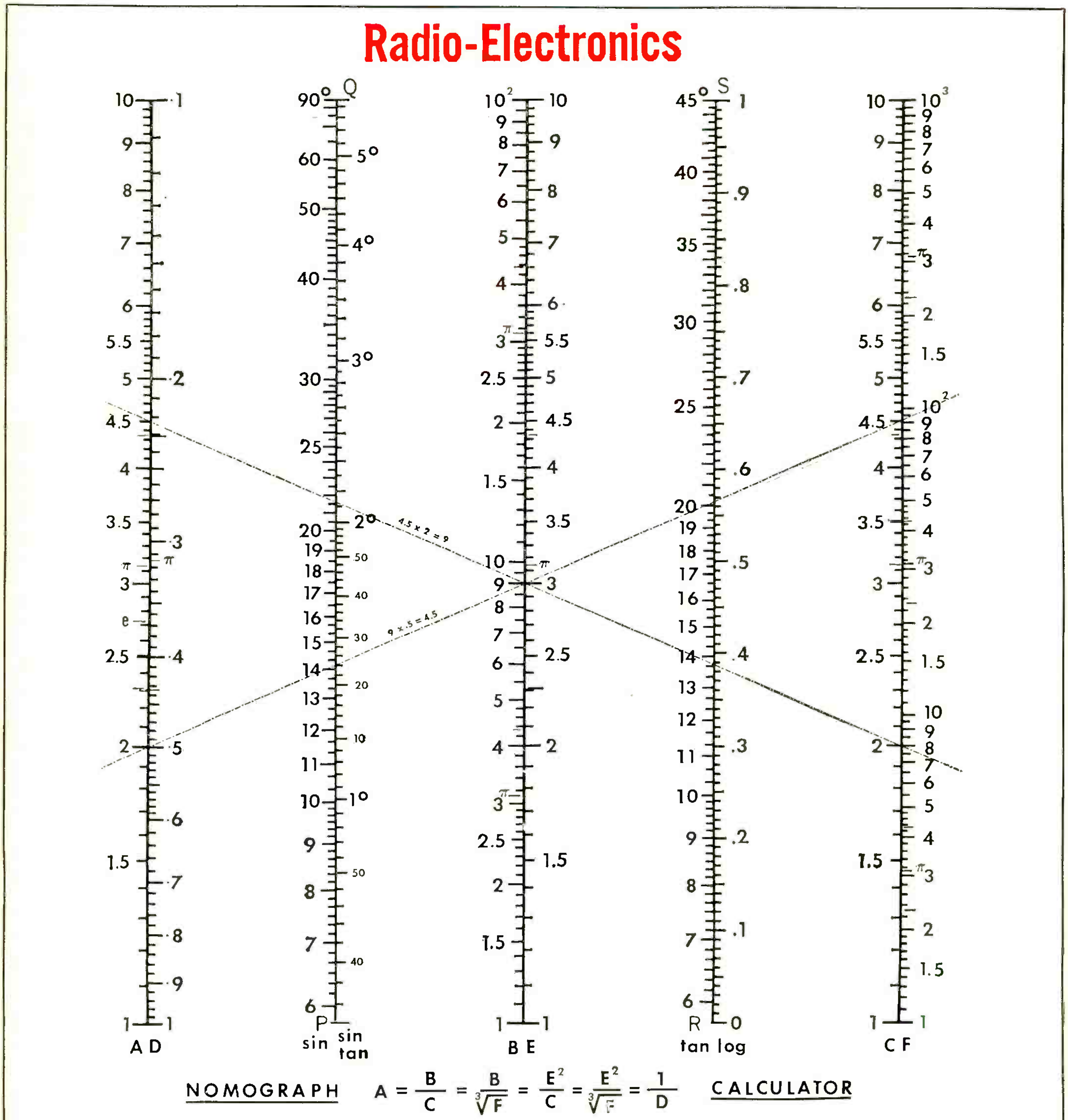


Fig. 1—Here is the Nomorule again, repeated from last month. Cut out and mount it on cardboard.

factor in the next product.

If any number at B is aligned with 1 on scale C, the line will intersect the same number at A. This is true because B = AC, and in this case C = 1, so B = A. Thus we can transfer the number from B to A without changing it.

We can also transfer a number from B to C. Let a line intersect the number at B with the top index (0.1) at D. At C we will find 0.1 B. The equation used is C = B/A = BD, and D = 0.1 in this case. We must remember to multiply the transferred number (A) by 10 to make it equal the original number at B.

Another transfer is possible using 10 on scale C as pole (or pivot point). Align it with the number at B, and find the answer at A. We are using the equation A = B/C with C = 10. Therefore A will be 0.1 B and it must be multiplied by 10 to equal B.

The Nomorule is ideally suited for calculations with trigonometric functions. To find the sine of an angle (such as 30°) look for the angle on the "sin" scale and align it with either point R or point S on the fourth scale (Fig. 2). The answer is found on B, the center scale. Values of sine for angles between 6° and 90° lie between 0.1 and 1. For better accuracy, align with point R if the angle is smaller than 18° (midway up the "sin" scale). Use S for angles larger than 18°.

Sine or tangent values for smaller angles, between 36′ and 6°, are based on the "sin-tan" scale and are calculated in the same way. All readings found on the B scale, lie between .01 and 0.1.

To find the tangent of an angle larger than 6° use the "tan" scale. Align the given angle (for example, 20° as shown) with either point P or point Q of the second scale. The answer is tan 20° = 0.364, as shown in Fig. 3. An angle smaller than 45° has a tangent smaller than 1.

When the angle is greater than 45°, use the equation tan B = cot (90 − B) = 1/tan (90 − B). For example, tan 70° = cot 20° = 1/tan 20°. To find tan 70°, determine tan 20°. Transfer the reading from B to the inverse scale D as shown by the phantom lines of Fig. 3. In other words, we have transferred tan 20° to scale A, then found its reciprocal at D. This indicates 1/tan 20° or tan 70°, which is 2.74.

For cotangents of angles smaller than 45°, use the formula cot B = 1/tan B. Determine tan B on scale B, then transfer reading to inverse scale D. For angles larger than 45°, use cot B = tan (90 − B). The reading appears on scale B directly.

You can find common logarithms by using the "log" scale with point P or point Q on the second scale, and the B scale. Align the number (for example, 6) at scale B with P or Q and read off the logarithm on the "log" scale, as 0.78. To find log 6,000, write it as 6 × 10^3, and *add* the corresponding logs. The answer is 3.78. Log 2 is also shown in Fig. 4: 0.301.

Now how about a couple of practical electronic examples worked out on the Nomorule? Let's say we want to find the resonant frequency of a circuit having L = 2.5 × 10^{-1} henries and C = 1.6 × 10^{-9} farads. The frequency is

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{10^5}{2\pi\sqrt{2.5 \times 1.6}}$$

Align 2.5 on scale A with 1.6 on scale C, as in Fig. 5, and find the product 4 on scale B. The square root is read off directly as 2 on scale E. A point on scale B may be transferred to either scale A or C, as we've said before. But you can't do it that way from E. Instead, use a "cross alignment" onto scale C, like this: Connect 2 on scale E with (1) on scale C, intersecting the "tan" scale. Through this intersection draw a line through 1 on scale E, giving a point on C which is identical to the original point on E.

The next step is to multiply by 2π on A. This gives us 12.56 (scale B). Transfer this value to A, using 10 (scale C) as pole. We are using the relation A = B/C where C is 10. Therefore, the value at A has been reduced by a factor of 10. It is restored to its correct value by multiplying by 10. Instead of 1.256 (scale A) we actually have 12.56. The last step is to find the reciprocal of 12.56, which is .0795 (scale D). Multiplying by 10^5 (see formula above), we get the frequency: 7.95 kHz.

Several problems are worked out in Fig. 6. The inductive reactance of a coil (X_L) is given by ωL where ω is $2\pi f$. Let f = 6 × 10, and L = 5.6 × 10^{-1}.

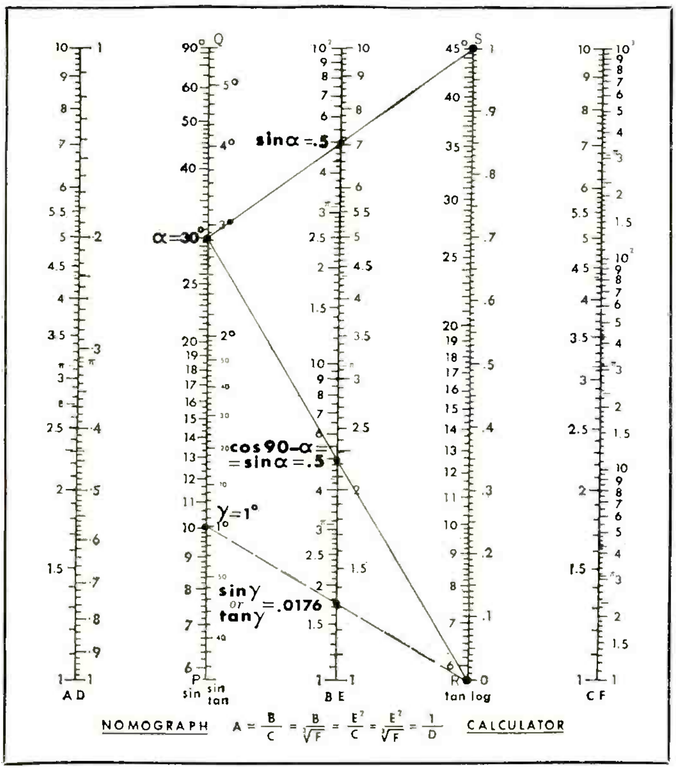


Fig. 2—Finding sine of any angle, or tangent of a small angle.

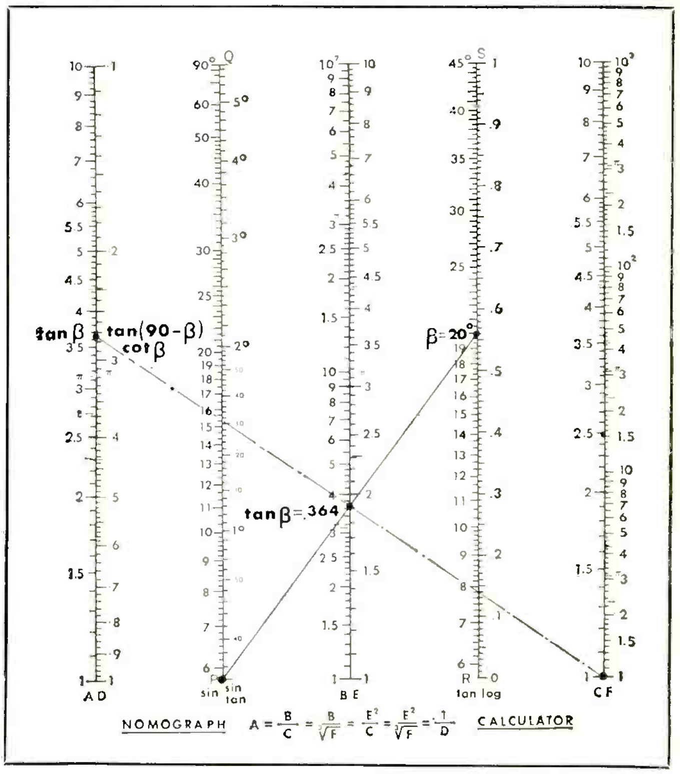
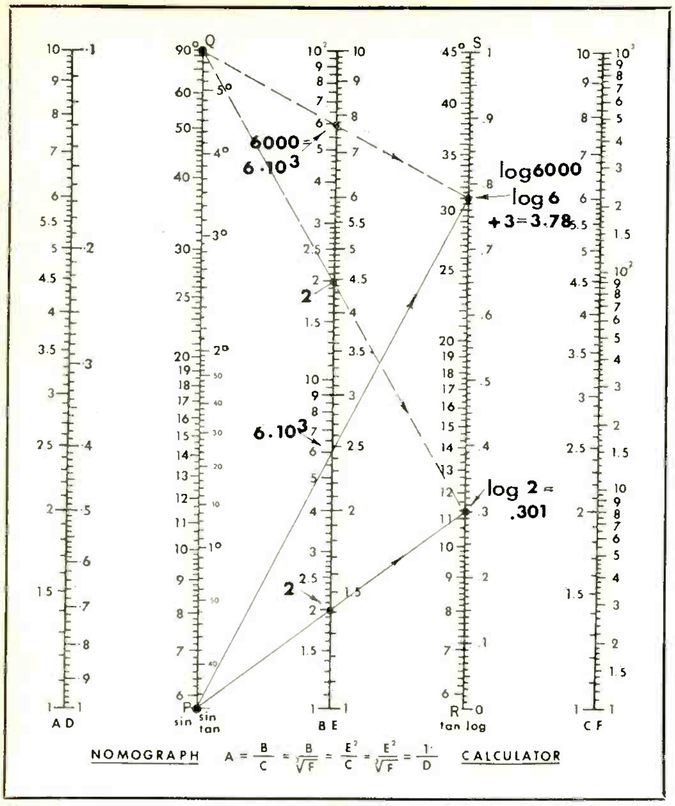


Fig. 3—Tangents and cotangents are determined like this.



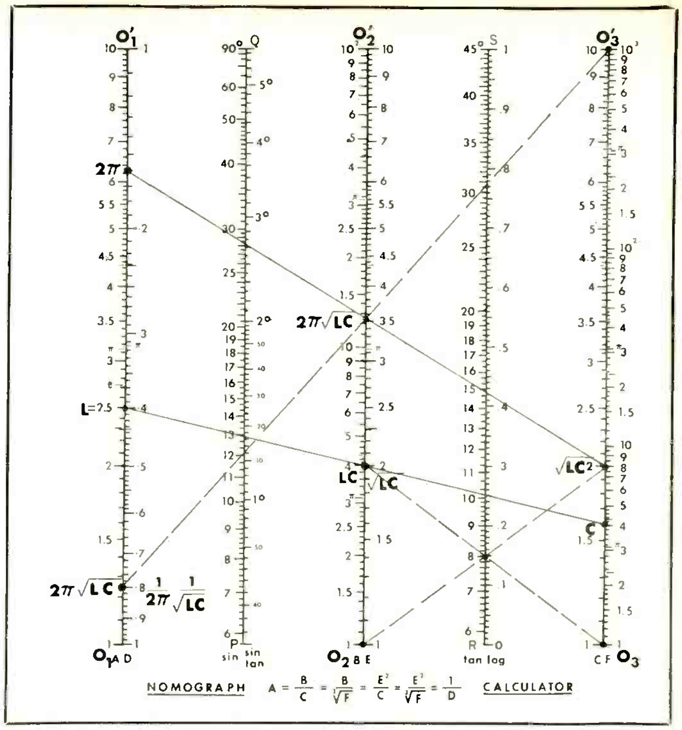


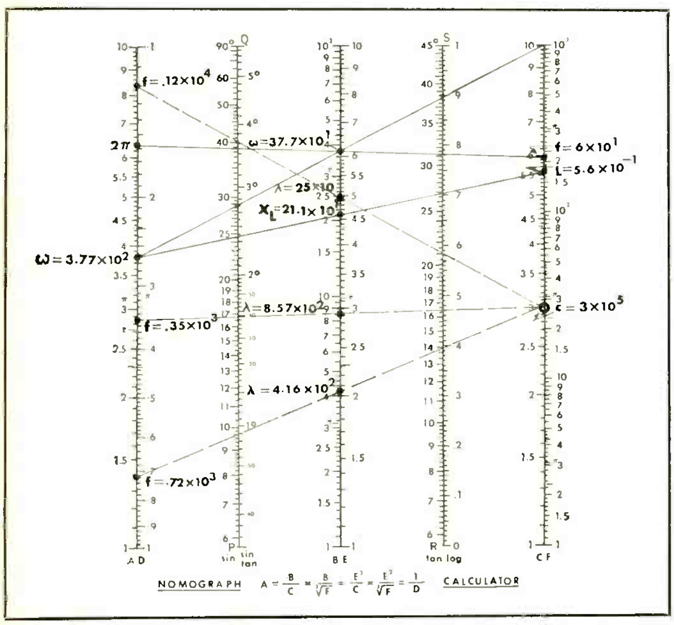
Fig. 5—Working the resonance formula with the Nomorule.
Fig. 4—How to read the logarithm of a number (at the left).

The Nomorule in Electronic Calculations

First find $2\pi f = 37.7 \times 10$ as shown. Now transfer this result from B to A, using 10 on C as pole. We know that this transfer divides the number by 10, so we must multiply by 10 to compensate. We have, therefore, 3.77×10^2 at A. Now multiply this by the value of L (at C) and obtain the reactance as 21.1×10 at scale B.

Other examples in Fig. 6 show how to convert frequency to wavelength. The formula is $f = \frac{300,000}{\lambda}$, where f is in kHz, λ in meters, and 300,000 is the velocity of light in km/sec. The Nomorule shows that 416 meters corresponds to 720 kHz; 857 meters corresponds to 350 kHz and 250 meters to 1.2 MHz.

As a last example, let us calculate the Q at 5 kHz of a coil with 0.4 henry inductance and 628 ohms resistance, in accordance with the formula $Q = \frac{2\pi fL}{R} = \frac{2\pi(5 \times 10^3)\,(4 \times 10^{-1})}{628}$. Fig. 7 shows how. The first product is read off as 31.4×10^3 on B. Transfer this result to C by using the top index (0.1) on D as pole. Line TR shows this. Align this result with 4×10^{-1} at A, and we find 12.56×10^3 at B. Transfer this to C (line TR′), then divide by 0.628×10^3 at D. The result is 2×10. END



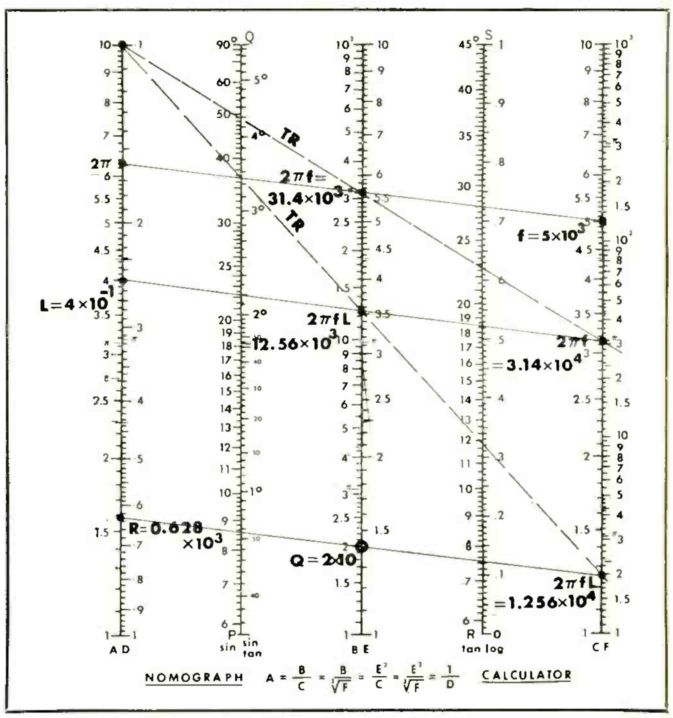


Fig. 6—Inductive-reactance, frequency/wavelength problems.

Fig. 7—Rapid method of calculating the Q factor of a coil.

Efficiency-Testing Air-War Tactics

Electronics plays a major role in a new Air Force program which makes extensive use of telemetry equipment. Flight information is transmitted to ground stations continuously **By JACK DARR**

SUNLIGHT GLINTS FROM THE WING OF an Air Force F-105 as it appears over the Ouachita Mountains in Arkansas. Seconds later, the low-flying jet flashes over a meadow filled with strange objects and disappears rapidly behind a steep ridge. A young man, standing by a barbed-wire fence, clipboard in hand, watches closely as the fighter swooshes overhead. He marks a notation on a sheet of paper, then sits down again. Several cows in the next field go on grazing. A peaceful scene.

Apparently, nothing much has happened—or has it? Yes, indeed it has! During the few seconds the young technician watched the jet, a network of electronic sensors recorded every detail of the low-level pass and transmitted the data to three C-130 transport airplanes, circling on station several miles away. The telemetric data was stored on tape by a crew in each C-130 for later evaluation.

This was one "event" in a test being conducted by Joint Task Force Two of the Department of Defense (DoD). The primary purpose of the high-speed, low-level pass was to collect information that might improve a jet pilot's technique in locating and destroying ground targets during low-altitude attack. In 1964, the Pentagon decided there were not enough data on strategic pilot/aircraft operations at low altitudes. The DoD's Weapons Systems Evaluation Group proposed a series of tests that would collect new information on combat air strikes at low altitude.

Joint Task Force Two (JTF-2) was organized to run the project and placed under the command of Air Force Maj. Gen. Winton R. Close. The first test series was run in the Nevada desert area north of Las Vegas in 1965; the second during 1966 in the Ouachita Mountains area of Arkansas.

The test area for the second series extends from slightly north of Alexandria, La., to just south of Fort Smith, Ark. Flying from England AFB in Louisiana, each "attacking" aircraft follows one of two navigation corridors until it reaches the simulated target area. The target site also provides two options, and typical "targets" are set up at several points along each path—fuel dumps, radar and missile sites, etc. Before takeoff, the pilots get an intensive combat-style briefing for each mission, with aerial reconnaissance photos and all other data that would be provided for a "live" combat mission.

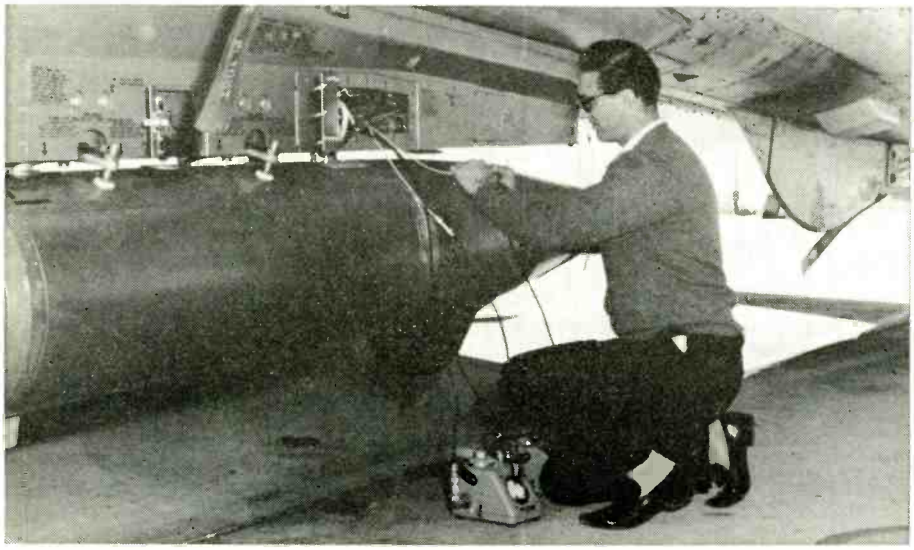
Combat aircraft from all armed services are used, ranging from the giant B-52 Stratofortress to the F-105 Thunderchief of the Air Force and the Navy's A-4 Skyhawk. They fly in three "altitude bands" to determine which approach gives the most consistent success. Approach altitudes range from near ground level to a maximum of 900 feet.

The operation is designed to get as much data as possible about *everything* that happens during a low-level mission. This is where electronics equipment plays a large part. Without complex instrumentation, data transmission, and data recording and evaluation techniques, the tests would not be possible. Each split second during every low-level simulated attack, the speed, altitude, position and flight attitude of the aircraft are sensed and transmitted by telemetry to the data recorders in the C-130's.

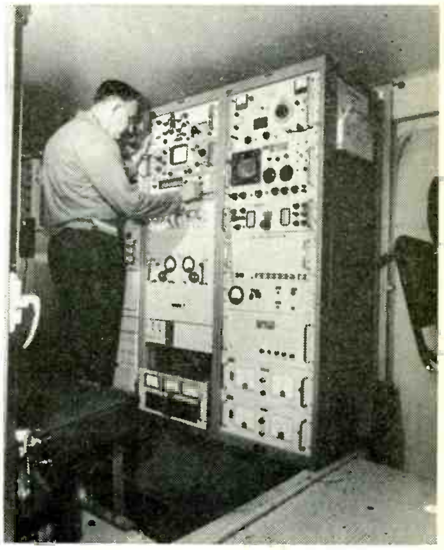
When the pilot reaches a target area, the precise split second at which the aircraft radar "sees" the target is detected and recorded. A similar response is obtained from a radar device which is part of the "target."

Although each test normally uses only one aircraft, the instrumentation system has a capability that would permit storage of data from as many as 12 planes flying missions simultaneously. At the end of each day's testing, the data tapes are flown to JTF-2 headquarters at Albuquerque, N. M., where they are processed through computers.

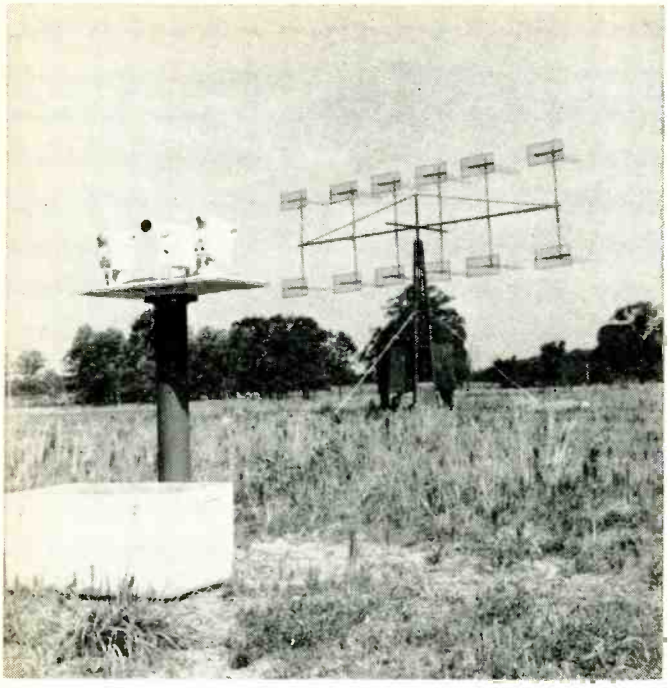
The instrumented navigation and target range over which the tests are conducted is operated by the Sandia Corp., prime contractor for JTF-2, with assistance from the engineering firm of



Technician performs final checkout of equipment pod slung beneath fuselage of Air Force F-105 jet fighter prior to low-level simulated mission. Pod contains telemetry gear.



Calibration and service instruments are used to check out telemetry devices.



Part of the GSIP instrument package. The three optical devices on the platform record light levels of sky and target.

Antennas and equipment cases contain radar-range transponder, central timing recorder and aircraft tracking units.

Efficiency-Testing Air-War Tactics

EG&G. A technical staff of 30 engineers, site observers and technicians takes care of the electronic equipment. Flight control is handled by military personnel from all armed services.

How it's done

Each test aircraft carries a streamlined "pod" that holds several instruments. A radar altimeter gives the exact altitude. Three accelerometers read acceleration (any outside force change) in all directions. Two gyros read pitch and roll, and provide a heading reference. An L-band (1,450-MHz) radar transmitter is used in conjunction with a receiver at the ground site. A C-band (4,375-MHz) radar transmitter also is located in the equipment pod. Other transmitters are used with the distance measuring equipment (DME) so the exact geographical position of the plane can be determined at any time.

A telemetry encoder/transmitter records and send out data continuously during each flight. Inside the aircraft cockpit, the pilot has a control referred to as a "pickle" button. When he first sees the target, he presses the button and the exact acquisition time is recorded. When directly over or beside the target, he "pickles" again; this, too, is recorded. In the nose of the pod, a 16-mm motion-picture camera makes a continuous film record of the terrain, light conditions, visibility of the target, and provides a permanent record of what the pilot sees as he approaches the target.

At each target site, tucked in among the dummy radars and other staged targets, a ground-site instrumentation package (GSIP) works with the in-flight transmitters and transponders. An L-band receiver picks up the signal from the transponder in each GSIP at the exact moment the aircraft comes into view over the horizon or "unmasks," and records also the instant that the plane is "remasked" (disappears from sight).

Four photometers in the pod give readings of the light conditions, sky conditions, light reflected from foliage around the target areas, and so on. A long-range "telephotometer" reads the light in a direction parallel to the line of flight.

All input data are encoded in pulse-code-modulated (PCM) form for telemetric transmission. It can be recorded at the GSIP site, transmitted to the C-130's for recording, or both.

The heart of the system is the airborne recording center. Three such centers make up the data-recording system, one installed in each of the C-130 transports. Multiple-channel tape recorders can receive as many as 56 channels of PCM data simultaneously. One aircraft is stationed on each side of the test area during each flight event. To provide a true-distance reference, they determine their own exact position by means of simultaneous "slant-range" measurements to DME stations set up around the area. The position of each C-130 is determined continuously within *±10 feet* at all times! That's accuracy.

All measurements and tests would have little meaning without some method for exact timing. To establish an accurate time reference, a centrally located 10-kW timing transmitter sends out IRIG-B (*I*nter-*R*ange *I*nstrumentation *G*roup) time signals. The timing signal is checked continuously against WWV and employs a coded form for time-signal transmission. The main frequency is 1 kHz, and coded "bursts" at greater amplitude provide day, hour, minute and second information that is recorded along with all other data for later evaluation. The IRIG-B generator is energized and calibrated at the beginning of each test. By checking against the time reference, the exact time of any event can be determined to within ±1 msec, even closer if necessary.

In addition to the many TM data channels, a complex radio-communication network allows complete control of the entire operation from the central site at Mena, Ark. Two vhf channels, three uhf channels (air-to-ground and air-to-air between the C-130's, the ground stations and the test aircraft) and three high-frequency channels are used, plus telephone, teletype (TWX) and the military "hot line."

The success of the entire program can be judged from the fact that more than 4,000 miles of tape have been processed. More than 20 billion separate bits of information have been collected. Just another example of the tremendous capability of telemetry, this program has done much to advance the progress of aeronautical science. END

Erecting Towers on Bonded Roofs

Beams and towers can be put on roofs covered by insurance—if you know how. Protect yourself, the customer, and the insuring firm, and you'll get the job

By JAMES A. GUPTON, JR.

TECHNICIANS WITH EXTENSIVE EXPERIence in erecting antennas on houses, apartments and small commercial buildings often avoid jobs involving a "bonded" roof. There is no reason, however, why a good antenna installer can't do a perfectly good job on any roof—bonded or not. The only difference in the two kinds of jobs is that the bonded roof is guaranteed by a bonding company not to leak. All you must do is to be sure that you don't void that guarantee. The whole idea is to provide the building owner with protection against damage to his merchandise and the interior of the building. It's a kind of insurance policy.

The roofing contractor builds the roof to certain minimum standards, usually those set by the bonding company itself. The bonding company then inspects the finished job and certifies that it was completed according to specifications. It then guarantees the building owner the roof is sound and backs up the guarantee with a promise to pay damages if it fails. When installing an antenna on a bonded roof, therefore, all you have to do is conform to the specifications set by the bonding company and have the finished job inspected and accepted by the company's inspector. He will certify that the roof has in no way been weakened or damaged by your installation.

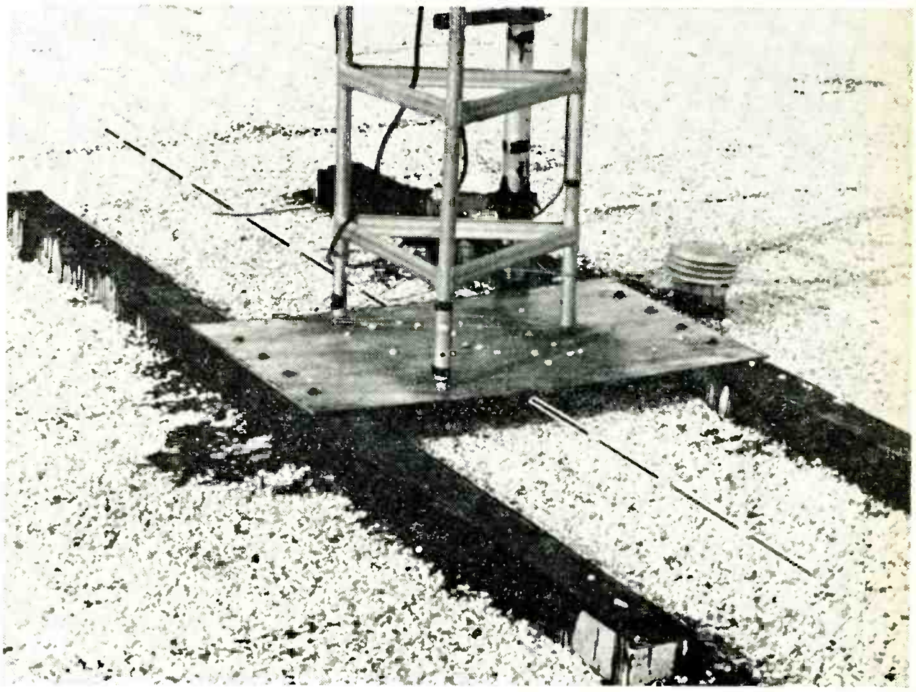
An important thing to remember is that if you have a written statement of acceptance from the bonding company inspector and have followed his specifications and recommendations, and can prove it, you will not be held liable. That liability is the responsibility of the bonding company. As in so many commercial agreements, cooperation is the answer to satisfied customers; that, and doing a first-rate job.

The Florence-Darlington Technical Education Center in Florence, S. C., is a good case for illustration. The problem was to install a 200-lb antenna tower on a flat roof. Guy-wire pull added more download, and the mast was climbable, so additional weight of workers on the tower also had to be considered. The installation then had to be formally approved by the bonding company.

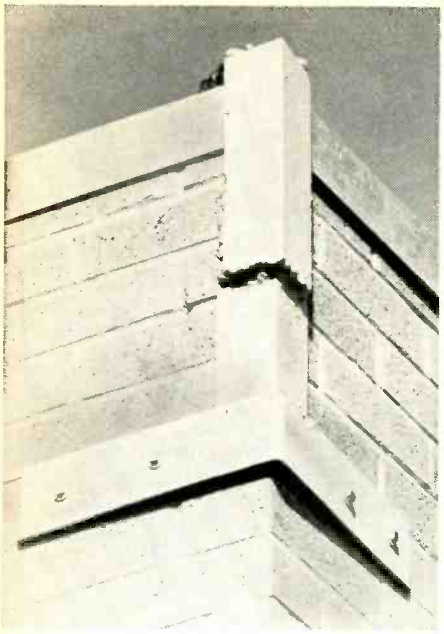
The first step was to determine the correct tower position. The bonding company required the tower to be placed on or astride a "load-bearing wall." This is a structural wall used to support roof members. There were several load-bearing walls at the TEC, and it was possible to find one at the center of the building. Having located the tower position, a suitable tower base was designed to assure a safe load distribution across the actual roof-contact area. The base consisted of two oak timbers joined by a steel cross plate on which the tower itself was mounted. The timbers were laid flat on the roof and distributed the weight evenly.

The two 4 x 4-inch oak timbers, 10 ft long, were chemically treated for protection from rot and insects. Half-inch lag screws were used to attach the 20 x 40 x ¼-inch plate to the timbers. Three 1-inch-diameter steel posts were welded to the plate to locate and anchor the tower legs. A ⅜-inch bolt was then passed through each tower leg and each base post.

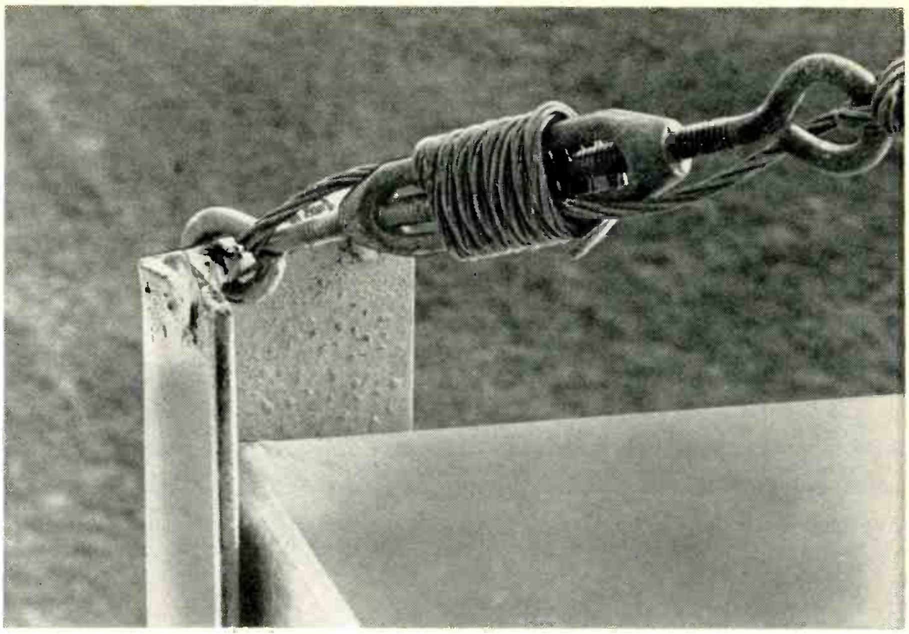
Two troughs were constructed of galvanized steel sheet to hold the timbers and provide a 1-inch clearance around the timbers. These "tar sinks" were then filled with tar which was allowed to overflow onto the roof itself, providing a tight bond. The weight of the tower and its antennas and its guy pull totaled 227 lb, and the base with



The tower base lies astride a load-bearing wall (indicated by the broken, dashed line) to distribute the tower weight evenly over a major structural member of the roof itself.



Mounted on the four corners of the building, the posts anchor guys firmly.



Detail of the turnbuckle mounting shows anchor bar passing through eye, welded to open end of the angle iron. Wrapping the buckle tightly keeps it from twisting loose.

Erecting Towers on Bonded Roofs

tar sinks totaled 100 lb. The total weight of 327 lb, when distributed over the roof-contact area of the base resulted in a contact load of 0.340 lb/sq in. However, this load is distributed over 4,800 sq in. of roof area, giving an overall roof stress of only .069 lb/sq in.

To mount the base on the roof, all stone was removed from the mounting area. The tar sinks were set directly on tar roof base. The "H" base was then placed in the sinks, and the hot tar was poured in. Replacing the stone completed the tower-base installation.

Before erecting the tower, four guy posts were constructed from 4-inch angle iron and 4-inch strap. A section of the angle iron 18 inches long was welded, as shown in the photo, to an L-shaped steel strap. The strap formed a base and was 24 inches along each leg. One assembly was bolted to each of the four corners of the building. A second 1-foot section of 4-inch angle was welded vertically to the first to provide clearance for the aluminum wall cap. A ½-inch steel bar was welded across the angle to hold each guy turnbuckle.

There are two acceptable methods of guying towers: where space permits, three wires spaced at 120°; for limited space, four wires spaced 90°. It's desirable, for single or midguys, to have 3 feet of base-to-guy-post distance for every 2 feet of tower height. On small buildings where the 3-to-2 ratio cannot be used, four-wire guying, with a smaller ratio, will provide sufficient support.

The four guy posts used at the TEC were bolted to the building walls with ½-inch lag screws driven into lead anchors inserted into the walls. The guy-wire turnbuckles were attached to each guy post by slipping the ½-inch steel bar through one turnbuckle eye before welding the bar to the guy post. After erecting the tower, the guy wires were tensioned, and regular guy-wire clamps were applied to secure them. Excess wire was then wrapped neatly around the turnbuckles and tied to prevent wind vibration from loosening them.

When the installation was completed, the bonding company arranged for inspection and accepted the job without question. Another satisfied customer and a still-safe bonded roof. END

WHAT'S YOUR EQ?

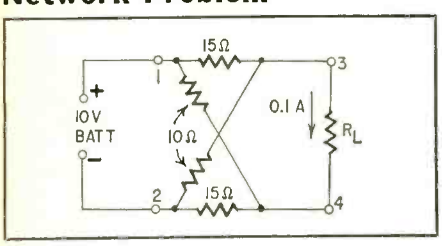
Conducted by E. D. CLARK

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 87.

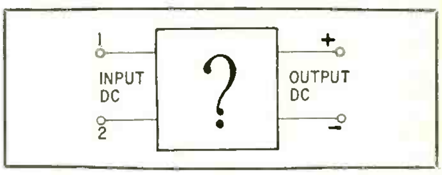
Network Problem



Given the above values, what's the value of R_L?—*Joseph P. Hallisey*

Polarity Straightener

Within a certain voltage range, output volts equals input volts in the above



box. No matter which way the input is polarized, however, output remains polarized as shown. Do you know what's in the box?—*David A. Hinton*

TELEVISION'S 40th BIRTHDAY

An account of what was probably the world's first demonstration of live TV by both wire and wireless

By RONALD L. IVES

FORTY YEARS AGO THIS MONTH—ON April 7, 1927, a select group of scientists, engineers and press representatives assembled in the Bell Telephone Labs auditorium on West Street in New York. They were there to witness a public demonstration of wire television from Washington. D.C., and of radio television from Whippany, N.J.

It's hard for us now, in this time of television in almost every home, bar and hospital, to imagine the excitement in the auditorium that evening. Remember that though all the people present there had seen motion pictures, none had ever seen a moving image that was not stored. This one was being created live at virtually the same instant it was being seen—and being transmitted (in one half of the demonstration at least) without wires!

Let's watch what happened. As the guests drifted in, before the demonstration itself, they heard Johann Strauss' "Tales from the Vienna Woods," played on what was then the world's finest high-fidelity system. When everyone had assembled, there were short welcoming speeches by AT&T president Gifford and by Frank Jewett, president of Bell Telephone Laboratories. Then Dr. Herbert E. Ives, director of electro-optical research at the Labs, explained how the equipment worked.

As soon as he finished, he gave a signal and the Washington operator, Miss Edna May Horner, appeared on the screen and said Mr. Hoover was on the line in Washington and wanted to speak to Gifford. Miss Horner moved aside, and the Hon. Herbert Clark Hoover, then Secretary of Commerce, appeared on the screen. He spoke briefly, beginning with the words, "It is a matter of just pride to have a part in this historic occasion . . ." Perhaps the occasion turned out more historic than Mr. Hoover knew. He was elected President the next year. and so became the first President of the US to have appeared on television!

Later, via a small screen, guests in New York City saw friends in the Washington station (a converted funeral parlor) and talked to them.

All this was over wire lines. Then the equipment was switched to rf-carrier transmission, and the party was treated to a variety show put on by the Whippany radio research station staff.

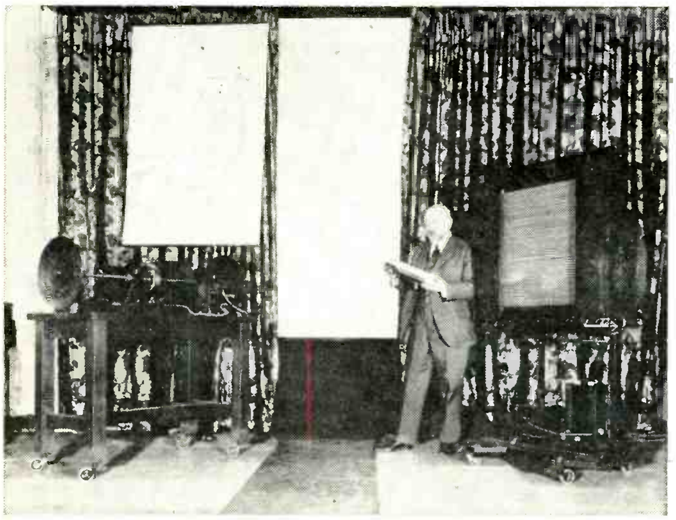
A yard-square neon lamp

What kind of equipment transmitted these first television images? This was before the cathode-ray tube, and before the TV camera tube was a commercial reality. Let's peer back for a moment to get a view with some historical perspective.

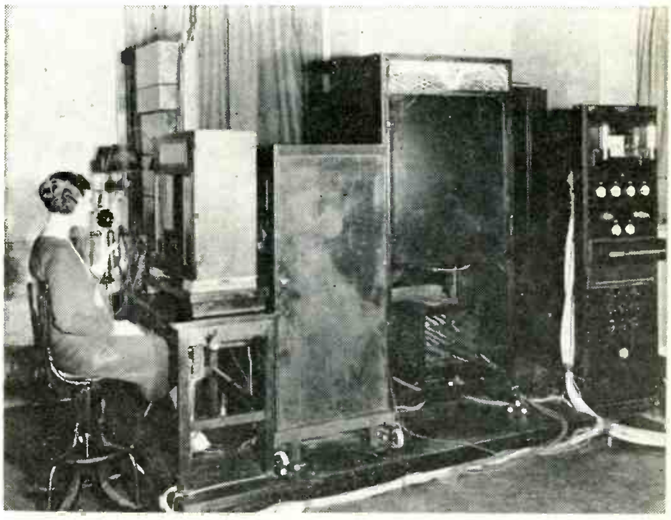
Television of 1927 was the embodiment of some ideas that were centuries old, and of some very practical discoveries at least a few decades old. That most amazing of Rennaissance scholars, Roger Bacon, who lived during the 13th century, mentioned "seeing from a distance" as a philosophical notion. A German named Athanasius Kircher (1601–80) discussed it in more practical terms and also considered long-distance sound communication. The photoresistive effect, essential in modern television cameras, was discovered by Willoughby Smith in 1873. The principle of scanning, by which an image is broken up into discrete bits, was worked out by Peter Nipkow in 1884.

The picture transmitter for the 1927 demonstration consisted of an intense light source scanned across the subject by a Nipkow disc. Light reflected from the subject was picked up by cesium photoelectric cells developed especially for the project. About the size of a loaf of bread, they were the largest cells in world. The output from the cells was amplified and transmitted by wire or used to modulate a carrier wave. The positioning of the light source and photocells was worked out by Dr. Frank Gray to look like general illumination without "cooking" the subject.

Several receivers were used. The small images were produced by a modulated light behind a scanning disc. The

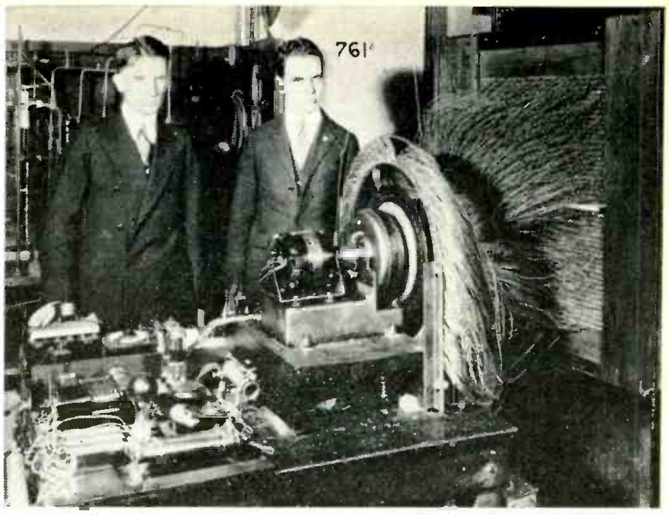


The late Dr. Herbert E. Ives of Bell Telephone Laboratories beside television receiving screen used in the 1927 broadcast.



Model sits in front of "camera" to left of the transmitting apparatus employed to convey the pioneer television picture.

Herbert Hoover, in Washington D. C., took part in 1927 telecast. His image was seen on television screen in New York.



No CRT was used in this 1927 Bell Labs TV receiver. Neon lamps were connected through many wires to sync wheel.

TELEVISION'S 40th BIRTHDAY

disc was synchronized with the disc of the transmitter. The large image, visible to a whole auditorium full of people, was produced by a 2,500-element neon lamp, a yard square. Its elements were fired individually in turn by a commutator synchronized with the transmitter scanning disc. The commutator, motor and sync circuits cost considerably more, and were quite a bit bigger, than a modern TV receiver. The "big grid," as the monster lamp was called, was a glassblower's nightmare.

Transmitting the picture signal, with its comparatively wide bandwidth (though still much smaller than the 4-MHz picture bandwidth of today's TV), was a serious difficulty. Three engineers (one of them was H. Nyquist, well known today for his feedback and stability equations for amplifiers) worked out a way of loading and equalizing a line to keep it phase-linear over the necessary frequency range. Additional wideband lines were used for the sound and the sync signals. All this was before coaxial cables.

Picture signals by radio from Whippany were transmitted on a wavelength of 191 meters (1,570 kHz), and the speech signals on 207 meters (1,450 kHz). Only 9 days after this demonstration. it was found possible to transmit picture and sound on a single wavelength with a single transmitter, without distortion or cross-modulation.

Technical staff responsible for the demonstrated television developments included Herbert E. Ives, Frank Gray, E. F. Kingsbury, A. W. Horton, C. R. Keith, Pierre Mertz, F. W. Reynolds, J. R. Hefele, S. D. Morrison, J. G. Knapp, G. R. Stilwell, P. B. Findley, M. W. Baldwin, Jr., A. C. Norwine, Al Johnsrud, E. Peterson, H. A. Etheridge, Ray Rulison, and Miss P. I. Papace.

These same people had developed a wirephoto system in 1924, and later a system for color television (1929), two-way television (1930) and television via coaxial cable (1938). During World War II, most of these television pioneers were busy with military research, and from their efforts came many devices, of which the snooperscope (an infrared telescope to permit observation without light) and sniperscope (a snooperscope mounted on a rifle) are probably the best known.

But these weren't the only men working on the problem of "seeing at a distance." Also busy, using the same fundamental ideas and equipment, were C. Francis Jenkins (Washington, D. C.), John Logie Baird (England) and Ernest Alexanderson (Schenectady, N. Y.)

The principal components of modern television were already being developed. Vladimir Zworykin of RCA had already patented the *iconoscope* and Philo T. Farnsworth the *image dissector*, ancestors of our modern camera tubes. Allen B. DuMont in Montclair, N. J., and Manfred von Ardenne in Germany were experimenting with cathode-ray tubes.

Besides publishing annuals about TV, Radio-Electronics' founder and editor-in-chief Hugo Gernsback was doing practical work in TV. After some experimental work with equipment designed and built by Pilot Radio Corp.'s chief engineer John Geloso, Mr. Gernsback's New York radio station WRNY began a regular schedule of TV programs in August 1928. There were about a dozen broadcasts per day. Three broadcasts each week lasted 20 minutes apiece; the others were 5-minute transmissions. The WRNY broadcasts were on 326 meters (920 kHz) and were accompanied by short-wave transmissions from W2XAL on 30.9 meters (9.72 MHz). Transmissions continued for several months.

(Geloso, incidentally, reversed the poor-immigrant-boy story by returning to the land of his ancestors. where he is now Italy's largest manufacturer of high-quality radio, audio and TV equipment.)

All-electronic television, using the iconoscope at the camera and the cathode-ray tube at the receiver, began in the middle 1930's. In 1936, the British Broadcasting Corporation established regularly scheduled television programing which has continued to this day. Experimental stations sprang up all across the US in the late 30's. Then, on July 1, 1941, the FCC adopted our present 525-line standards and authorized the first commercial TV service.

Growing forward

In 40 years, television has come from a laboratory curiosity to a household device used every day by small children. Its transmission range has grown from 250 miles by wire (Washington to New York) to nearly halfway around the earth, by radio and satellite. The 50-line resolution of 1927 has become 525 lines on commercial TV (in the US) and much greater in specialized industrial and scientific work. We can see television in full color many hours a week in most parts of this country.

Coming soon perhaps (and already being worked on) are even higher-resolution pictures, stereoscopic television by direct methods, by parallax panoramagrams and by holographic techniques. (See "Direct-View 3-D Images!" Radio-Electronics, January 1967.)

Yet still all television uses the fundamental scanning idea stated by Nipkow in 1884. END

An Engineer Talks About Transistors in Audio

Part 1—What is transistor sound? Are tubes really done for? Are transistor hi-fi components better now?

By PETER E. SUTHEIM

THE SUPERFICIAL ADVANTAGES OF transistors are obvious. They're more efficient, for one thing, because they don't have heaters. A typical amp/preamp combination needs between 30 and 40 watts just to keep the heaters heated—about one-third of the total power it consumes. This heater power is a total waste as far as useful output is concerned.

Because heaters can be eliminated, the total heat output of an amplifier is much smaller. Temperatures are lower, parts can be spaced more closely, reliability is increased. And transistors are small to begin with. They last longer than tubes, too—some last so long that no definite figure for life expectancy has been computed.

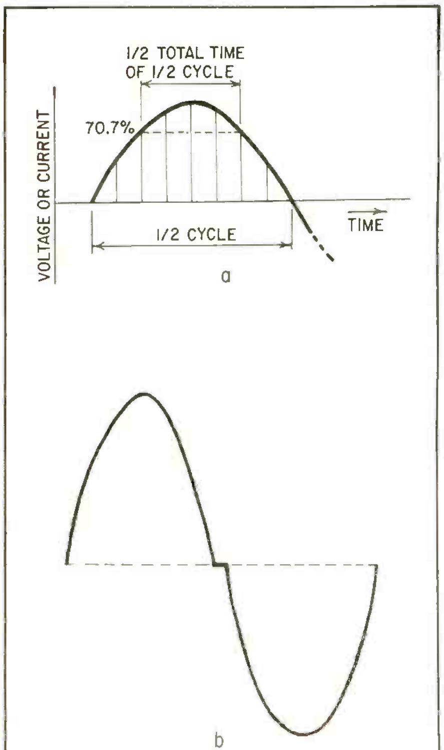


Fig. 1-a—A sine wave spends a good bit of time around its peak amplitude and passes rather quickly through zero. Music waveforms have narrower (briefer) peaks, in general, and spend more time around zero axis. b—How fairly severe crossover distortion looks on a scope. Mild crossover distortion, difficult to detect on a scope, is plainly audible. But crossover distortion occurs if transistors in push-pull class B aren't biased to transfer each complete half-cycle.

But all this is usually secondary to the audiophile. While he might be willing to accept transistor equipment for these advantages as long as it is *as good as* tube equipment, he doesn't usually want to sacrifice audio quality to get them. (We'll pass by the man who buys a transistor amplifier just so he can tell all his friends he has one.) Especially if the transistor amplifier is considerably more expensive than the tube job.

The real question in a prospective amplifier buyer's mind seems to be: Does a transistor amplifier really *sound better* than a tube amplifier?

Most people who had the opportunity a few years ago to compare the two agreed that there was a *difference*. Soon, though, some unfriendly explanations of "transistor sound" found their way into print. Most of them centered around the assertion that transistor amplifiers produced a sneaky aberration called "crossover distortion."

But recently a man in the industry made a pretty high-powered remark. He said that it is now possible to build transistor audio equipment that is better than the best tube equipment. I asked him if he'd be willing to back that up with evidence, and supplement it with an explanation. The man is Daniel R. von Recklinghausen, chief research engineer of H. H. Scott, Inc. He was more than willing, so I went up to Maynard, Mass., with a portable tape recorder to hear his story.

We had some lunch, a tour through the Scott plant, and then we settled down in his office/lab to talk. The first thing I asked about was transistor sound.

"What transistor sound really turned out to be," he explained, with a few percent of soft Munich German modulating his English, "was not something *better*, but merely an *unfamiliar* sound, caused by a number of faults—all of them due to the designers' unfamiliarity with transistors. The most important was probably crossover distortion."

"But couldn't they measure that, or see it on a scope?"

"Well, it might have been visible on a scope, but it's not easy to see a few percent of crossover distortion. And it doesn't measure too bad, because it occurs in the middle of a sine wave [see Fig. 1], so it's a small percentage of the total amplitude and of the total time of a cycle. A sine wave spends most of its time at the extreme peaks. But music waveforms lie mostly around the zero axis—which is where the distortion is occurring. And you can hear it, even though the results of your measurements might be very good."

Dan also pointed out that many engineers weren't expecting this kind of distortion, so they didn't go out of their way to measure it.

"Another thing early designers did was measure distortion primarily at full power—an old tube habit."

"Ah—and crossover distortion shows up most at low power."

"Right. This is one of the reasons why the new IHF standard on amplifiers specifies the need for distortion measurements at low levels, 'way down into the mud." [See "What's in the New IHF Amplifier Standard?" in the March 1966 issue.]

"So this transistor sound, then, was almost entirely something bad? It wasn't really cleaner or sharper?"

"Yes. It was *different*."

"And people may have had the illusion that it was better because of all the hoo-hah about transistors being a Good Thing."

"Right. Could be."

"Aha! That's what I suspected!" I recalled that crossover distortion tends to generate high-order odd harmonics, which are much more audible than common second- or third-harmonic distor-

". . . transistor sound turned out to be . . . not better, but merely unfamiliar . . ."

An Engineer Talks About Transistors in Audio

tion. They give sound a wiry edge that's often attractive on first hearing, but leads to irritation and fatigue after a while.

"To avoid crossover distortion, you have to adjust the bias on the output stage so that each transistor operates with optimum bias. And the way you pick the bias is for minimum distortion, at low levels and at high levels. Now to do that, you have to recognize a few things. First, every transistor is a little different from every other. This means you have to have some sort of bias adjustment to compensate for individual variations."

"Which are much wider than with tubes?"

"Right. Second, transistors change their characteristics with temperature. So you have to compensate for that—maybe as low as 50°F at night in a cold bedroom, up to 120° or 130° on a hot summer day with the sun shining on a completely enclosed equipment cabinet.

"Third, the power company supplies nominally 117 volts—plus or minus. Minus when somebody plugs in a toaster or some such thing, plus . . ."

". . . when everybody doesn't."

"Yes, and when the generating station fails to crank down its output accordingly.

"Now we've been talking only about static circuit conditions. Let's look at another thing that's very important in maintaining bias points. The circuit mustn't be designed so that when it gets a big slug of music. coupling capacitors charge up and filter capacitors discharge. and you lose your bias. The music sounds pretty bad . . ."

". . . until the bias currents settle down again, which could be several seconds."

"Yes. This problem of transient overload—we call it 'gulp distortion'—was a failing of some transistor amplifiers on the market—even some with very fine names."

"But certainly nobody would mistake that kind of distortion for a desirable quality."

"It's not a good quality, but it is *different.*"

"And again," I proposed, "people were conditioned to think favorably of transistor stuff, so they lumped that in with the idea of transistor sound."

"Right. Now another thing is that transistors have a definite bandwith. This means that your feedback loop has to be proportioned so the circuit stays stable and doesn't oscillate. even only during parts of a cycle, with reactive loads on the output. If it does oscillate, the oscillation steals power from the useful output, puts kinks in the signal waveform—which is distortion.

"Now these same things occur in tube amplifiers—partly because of the output transformer, but also because a tube amplifier is a very high-impedance device. So, coupling capacitors, tube input capacitances and so on all make problems for the designer. A tube grid can also rectify positive signal peaks and charge up coupling capacitors. That can cause the same kind of bias-shift distortion I was talking about."

I tried to steer the conversation back toward the advantages of using transistors. Dan proceeded talking.

"The first and most important fact is that you can actually get more power out of a transistor amplifier into a reactive load, such as a speaker, than you would expect from just measuring with a pure resistance load. A transistor delivers more power into a reactive mismatch than a tube can.

"A tube has an inherent limitation: its zero-bias point. On the whole, it isn't too practical to push a tube grid more positive than zero bias because then it starts drawing current and rectifying the signal, loading down the driving stage, and so on. But a transistor doesn't have that limitation. It's a current amplifier. The harder you drive it, the more you get out, if your load impedance is low enough."

"Which explains why you can destroy a transistor by driving it into a short circuit?"

"Yes. Transistors are usually operated near the maximum-output-voltage condition, so the output voltage a transistor can give is determined strictly by the supply voltage and the total resistance in the circuit—in this case the load resistance in series with whatever emitter stabilizing resistors are used [Fig. 2], and of course the resistance of the transistor. Typical values might be a total circuit resistance of 8 or 9 ohms—say 9 ohms—and a supply of 45 volts. So the peak-to-peak current you can get out of the circuit is 45 divided by 9, or 5 amps.

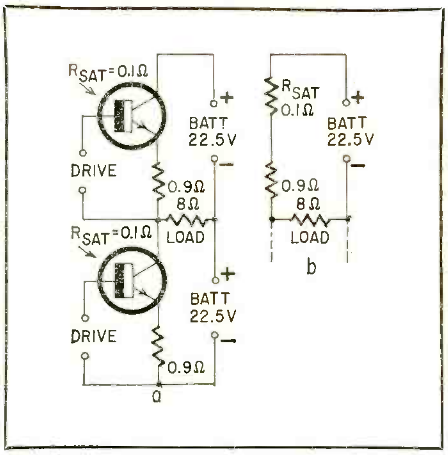


Fig. 2-a—Simplified "single-ended push-pull" circuit for calculating peak power into load. b—Equivalent circuit for half of the schematic at (a). This one functions during one half-cycle; the lower half of the circuit functions during the other half.

"Now if you substitute a 4-ohm load, your total circuit resistance is only 5 ohms, and you get 9 amps.

"In the first case. the voltage across the load would be 8/9 of the supply voltage, or 40 volts. In the second case it's going to be 4/5, which is 36 volts. So you get more power output—50 watts peak in the first case. but 81 in the second, with a 4-ohm load. These figures amount to 25 watts and 40.5 watts music power, respectively.

"Now let's take the case of a reactive load. There you always get *full voltage* across the load. Let's imagine 8 ohms purely reactive—no resistance—as the load. Well, now you're getting 45 volts peak to peak, not 40. In the second case, if we used 4 ohms purely reactive. we'd get 45 also, instead of only 36, because a pure reactance does not take any power.

"Well, what is a loudspeaker? It's a complex impedance, only rarely purely resistive. It can look more like an inductance or more like a capacitance, depending on the frequency and the design of the speaker. Where speaker impedance dips (sometimes down to a quarter of its rated figure) the effective peak output of a transistor amplifier is higher. if you can drive it harder. So you can get more audible power into an 8-ohm partly reactive load from a transistor amplifier than you can get from a tube amplifier—even though the two amplifiers may measure exactly the same with a purely resistive load. It actually *sounds* louder. After all, you have . . . let's see . . . 63.3 and 126.5 peak volt-amperes respectively, compared to 50 and 81 peak *watts.*"

"So this might be another reason for the alleged superiority of transistors over tubes?"

"Yes. But it's also one of the factors that helps you in designing good transistor amplifiers."

Things you can't do with tubes

"Another thing that helps you is having transistors of both sexes—npn and pnp." Dan looked a tiny bit impish behind his serious face. "Technicians around here determine the sex of a transistor by the direction of the arrow. Anyway, that permits a designer to eliminate one of the banes of his existence: the phase inverter. It's hard to make a phase inverter really symmetrical in both phase *and* amplitude at all audio frequencies. You also want the same internal impedance at both sides. The common split-load inverter has a higher impedance at the plate side than at the cathode.

"By having transistors of both sexes, you can design direct-coupled amplifiers without phase inverters—complementary transistors do the inverting for you. Plain direct-coupled circuits are more convenient, too, with complementary transistors. You just haven't got that in tubes.

"Eliminating the phase inverter and direct-coupling everything lets you design a power amplifier like an operational amplifier—with a gain defined only by the ratio of two resistors. Direct coupling helps you in another way, too: Omitting coupling capacitors means fewer phase shifts and fewer charging–discharging networks with long time constants. The low impedances of transistors make stray capacitance less of a problem, so you don't get so much phase shift at high frequencies. All this means you can apply more feedback around the amplifier before stability becomes a problem. You do have to make sure, though, that nothing is happening up there at a couple of hundred megahertz—no oscillation, not even during part of a cycle. That's the price you pay for being able to use nice, low-impedance devices with cutoffs around 250 MHz."

"What about preamplifiers?" I asked. "Do transistors really bring any improvement there, except for things like size and power consumption?"

"Yes, they do. The advantage appears when you look at the optimum source resistance from the point of view of getting minimum noise. A tube is a high-impedance device, and gives you the best noise figure when operated from a source impedance, at low audio frequencies, of 100,000 ohms, a megohm, or thereabouts. That's beautiful for ceramic pickups. But for magnetics—what's their impedance?"

"Couple of hundred ohms, say."

"Well, yes—let's say from 100 ohms up to about 5,000 ohms, depending on the model. Now what does a transistor like for optimum noise figure? Just about a thousand ohms. Perfect for magnetic pickups.

"Another thing: Around here, an equivalent noise input voltage for a preamplifier transistor is typically 0.25 microvolt. Even in our least expensive unit, equivalent noise input voltage in excess of 1 microvolt is cause for rejection."

"And figures like that just weren't possible with tubes?"

"With tubes it was very difficult. With tubes you run into low-frequency flicker noise. What is the typical hi-fi preamp tube?"

"12AX7."

"Right. I don't know if you know it, but the 12AX7 has been manufactured since around World War II. Up until the time they gave up designing new versions of it, there was only one manufacturer in this whole, wide world that could make quiet 12AX7's, with low flicker noise. That was Telefunken. There were at least a dozen other makers, but they just couldn't do it."

"What about those other attempts like the 12AY7 . . . ?"

". . . and the 12AD7, 12AX7-A, 7025? They were no better. Now there's another thing, too. Preamps have to contain resistors. The higher the values of the resistors, the more noise power they generate. It was quite a battle to get quiet resistors. With the low resistances of transistor circuits, we have less of a problem.

"Also, because of the wide gain variations of transistors, we design with a lot of excess gain, and so we can apply more feedback than before. Again, we get quieter preamps."

". . . early designers meausred distortion primarily at full power—a tube habit."

"Another thing that helps . . . is having transistors of both sexes—npn and pnp."

"In a 12AX7 tube preamp I guess there's virtually no feedback at all at the lowest frequencies, because it's all been rolled off to give RIAA bass boost."

"True. Now you can get some extremely low-noise silicon transistors."

"Like which?"

"Well, the G-E 2N3391-A is a pretty low-noise one, or Fairchild's SE4010. Quite decent, at the right current. Better get a batch and select the best, though.

"This noise problem is especially bad with 8-track tape. You get maybe 500 to 800 microvolts on loud passages. So if you want your noise down 40 dB at 1,000 Hz, that means no more than 5 to 8 microvolts of noise. At low frequencies, where you need 20 dB more gain, you have to be well under a microvolt."

A long and happy life

I wanted to get some idea from Dan of transistor reliability and life. He pointed out that really meaningful figures were hard to come by because there just wasn't that much experience yet: transistors haven't been here that long, especially not the newer, most reliable types.

"But something that really helps reliability," he explained, "is the lower operating temperatures you get with transistors. On the transistors alone, you usually figure an increase of 2 to 1 in life for every 10°C drop in temperature—that's up near the top temperatures. Now imagine all the other things that are running cooler than they could with tubes—like insulation, and especially electrolytic capacitors."

Dan showed me a more subtle kind of life increase in transistors: noise. Tubes get noisy near end of life, which may be more significant than the loss of gain that's better known.

"Some of the cathode material evaporates and eventually settles on the grid," he said. "What you get is a slightly photoemissive grid. If the tube is exposed to, say, a fluorescent light, which is a nice pulsed light source, you can get extra electrons in the stream at a 120-cycle rate. Hum. And, sure, you can put a shield around the tube, but there's one light source in there, right in the tube, you can't turn off: the heater. And, just as in a phototube, you get hiss, from that, as well as the usual hum modulation.

"With transistors, no heater, no light, no grid, no evaporation . . ."

By this time I was really beginning to appreciate transistors. But then we went on to talk about semiconductors in rf applications, like FM tuners. Now *there's* a story—especially concerning integrated circuits—but we'll have to leave that for another article.

TO BE CONTINUED

TWO USEFUL PITCHED-ROOF

A pair of problem-solving mast bases for those nonflat housetops

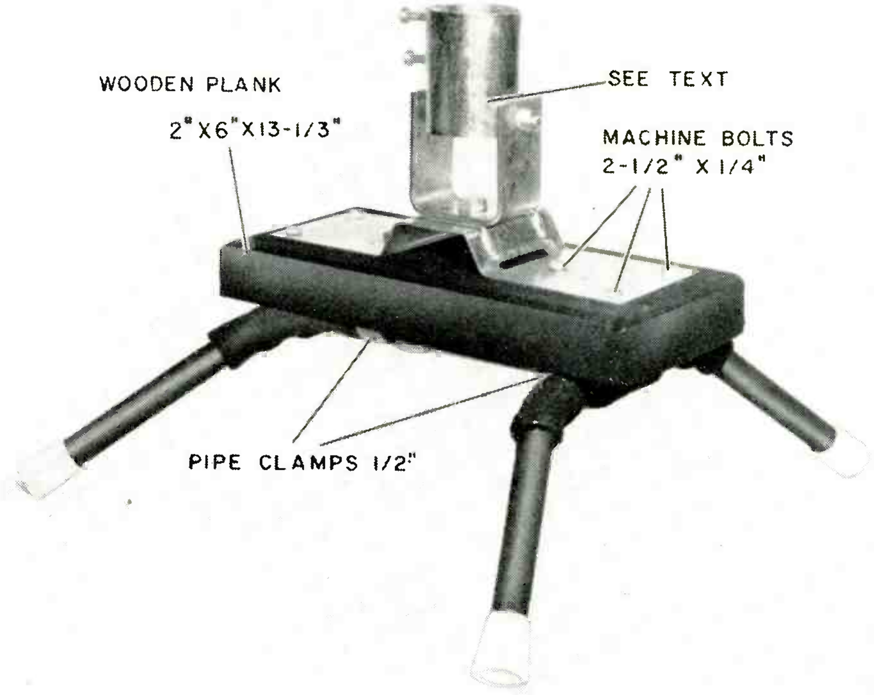
By HOWARD S. PYLE and HAROLD P. STRAND

PUTTING AN ANTENNA ON A FLAT ROOF is relatively simple—you bolt a flat base to the flat roof. But what do you do on a pitched roof? The chimney mount isn't always satisfactory for tall masts, for they are sometimes difficult to guy properly. And suppose the installation must be made without screws, nails or bolts piercing the roof?

Saddle base

The first photo shows a saddle-mount base for an antenna mast which requires no holes in the roof. It can be used, of course, *only* with a guyed mast—because the guys provide the download that keeps the saddle in place atop the roof.

The mount is made of standard ½-inch galvanized pipe fittings. Piece sizes are shown in Fig. 1. To provide



Add swivel base, wooden plank, pipe clamps, machine bolts and the mount is complete.

The assembled pipe sections form the saddle mount. Note white rubber feet.

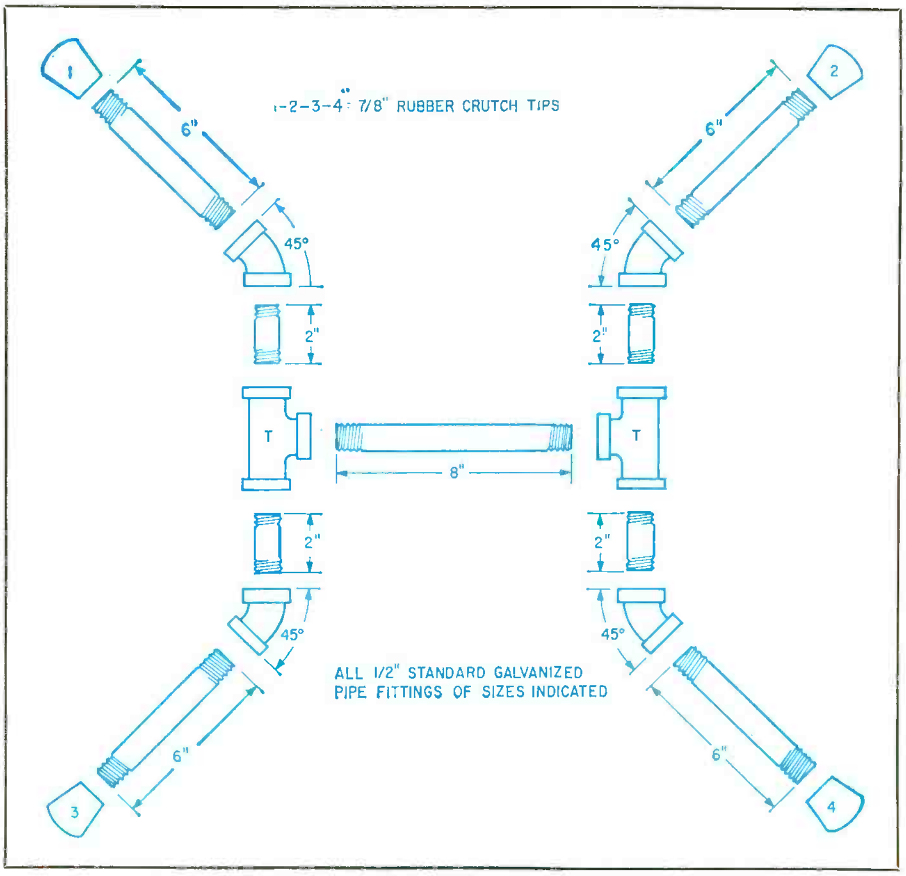


Fig. 1—Construct the saddle mounting assembly with these pieces of half-inch galvanized pipe. Then add coat of paint.

ANTENNA MOUNTS

firm footing and protect roof shingles from the metal pipe ends, ⅞-inch rubber crutch tips (available at hospital-supply stores) are used as "feet."

Once you've assembled the saddle, it's a good idea to cover it with a couple of coats of oil-base paint, to retard corrosion.

The next photo shows the swivel mount in place. This assembly consists of a base plate, swivel and mast collar, and is available as part No. 11 A 2536 from Allied Radio, 100 N. Western Ave., Chicago, Ill. 60680. Bolt the swivel mount to the wooden plank. Then attach the plank to the pipe saddle with pipe clamps underneath. That finishes assembly of the unit.

Because the mast collar pivots, it's easy to erect the antenna mast. One man holds the base while the other raises the mast. Then the second man guys the mast in place. It's equally simple to take the mast down for antenna repair.

Side mount

This second antenna mount can be used where you can make holes in the building. However, you still don't have to pierce the roof, for it's a side mount. There's an additional feature—it allows antenna rotation by hand from an attic or upper-story window. Like the first mount, this one's made simply from pipe fittings.

The bracket (see Fig. 2) consists of a short piece of 1¼-inch galvanized pipe, length determined by the roof overhang. A floor flange is used at one end for securing it to the house siding, and a tee fitting is securely attached to the other end. Two short pieces of pipe are used in the tee, as shown. The mast is a piece of 1-inch electrician's aluminum conduit, which has a thicker wall and is therefore stronger than the usual mast tubing. It will pass nicely through the 1¼-inch pipe. A collar fixed to the mast rests on the top end of the pipe as a stop. A setscrew in a drilled and tapped hole in the tee serves to lock the mast in position after adjustments have been made. The front end of the horizontal pipe is supported from the roof overhang by aluminum straps.

Screw the pipe sections tightly together, using a pipe wrench and a vise. If there is a short roof overhang, a shorter pipe will be used than the one shown here. In some cases, a close or a 2-inch nipple will come out about right. Take measurements first so that the tee will

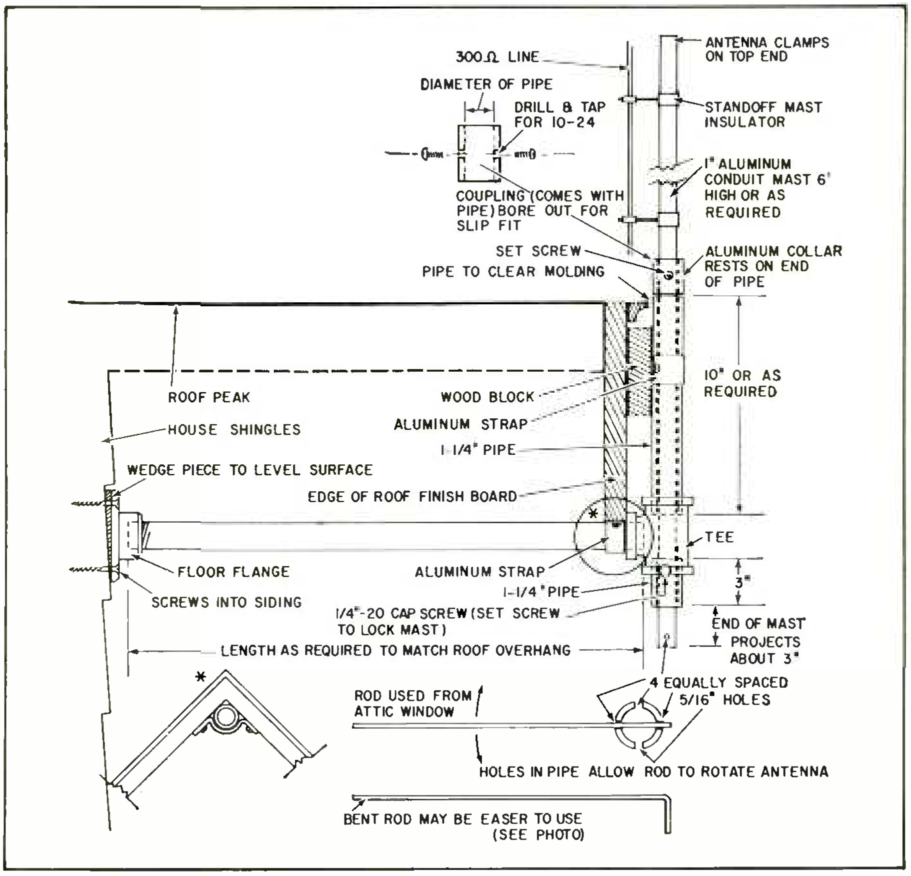
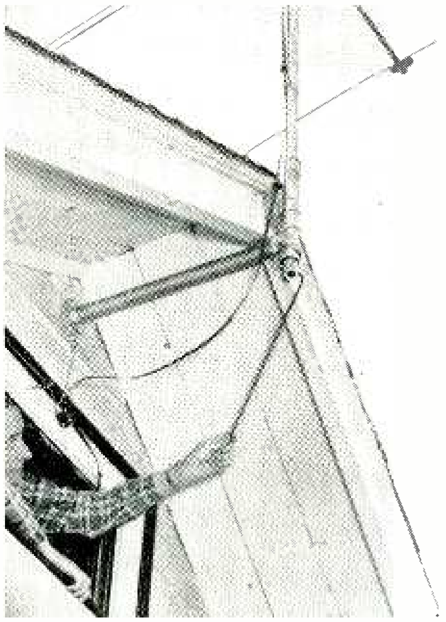
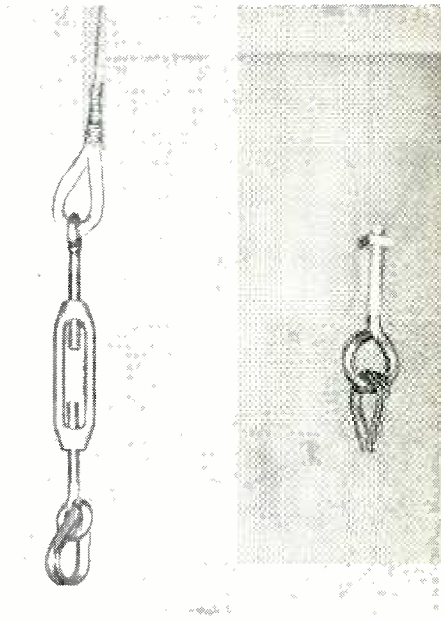


Fig. 2—Side mount assembly is formed with 1¼-inch pipe and 1-inch aluminum electrical conduit, plus straps, a tee connector and a flange. Pipe length depends on eave size.



The side mount fits beside eave with brace below. L-shaped tool permits turning the antenna from inside the house.



Guy wires should be securely attached to a mast. Use wire thimbles and turnbuckles for a safe and professional job.

TWO USEFUL PITCHED-ROOF ANTENNA MOUNTS

come out far enough so the upper pipe just clears the roof edge.

The mast collar is a bored-out 1-inch aluminum pipe coupling with small Allen-head setscrews. The setscrew in the tee is a ¼-20 cap screw.

Guy wires

Without proper guying, neither of these mounts will be safe. Avoid using single-strand fence wire and don't just twist wire into a screw eye at anchor points. Galvanized wire will rust in a short time; it's better to use aluminum clothesline wire. One type is available in 100-foot rolls at building-supply stores, and consists of 7 twisted strands of No. 16 wire. It's strong and won't rust. While it does corrode after some time, this action doesn't affect the wire strength.

How guy wires are attached is what makes the difference between a good job and a bad. The best way (see photo) is to use rope thimbles and turnbuckles, so you can adjust for slack. Fig. 3 shows how to rattail splice the wire end around the thimble. While this method produces a fairly strong termination, the Kearney clip, shown in Fig. 4, will hold the guy end quite securely.

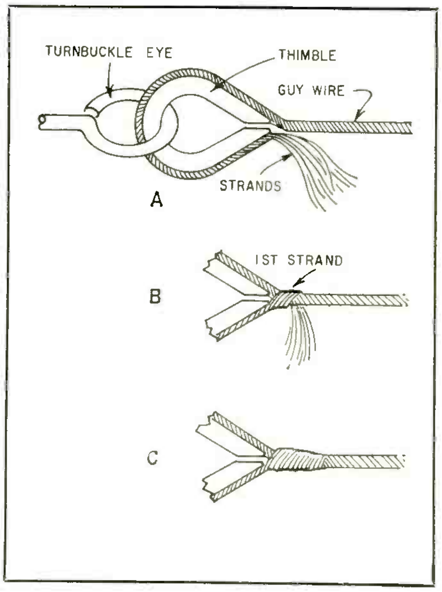


Fig. 3—How to rattail splice the end of a guy wire. (a) Wrap wire around the thimble; (b) wrap first strand completely around guy body; (c) tightly wrap remaining strands further up the body of the guy.

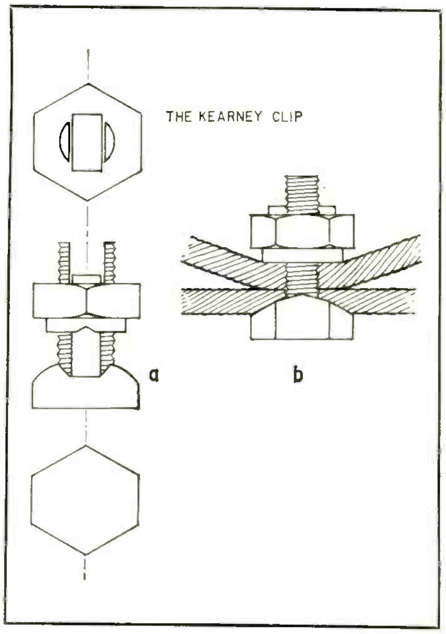


Fig. 4—The Kearney clip (a) is merely a slotted bolt. It clamps end of guy wire (b) back on itself and holds cable securely.

Be sure you locate solid house studs for placing screw eyes. After screwing them into the wood, daub the hole with paint to keep moisture from rotting the wood.

With either of these mounts, you should be able to handle any residential antenna installation with little difficulty.

END

EQUIPMENT REPORT

Electro Products Laboratories TI-100A Transistorized Inverter

Circle 27 on reader's service card

Ever wish for an ac outlet in your car? This inverter is just that—an ac outlet that will power any 60-Hz ac device rated at 125 watts or less. That means you can plug in a small-screen TV, an electric shaver, heating pad, soldering iron, phonograph, lights or even a fan.

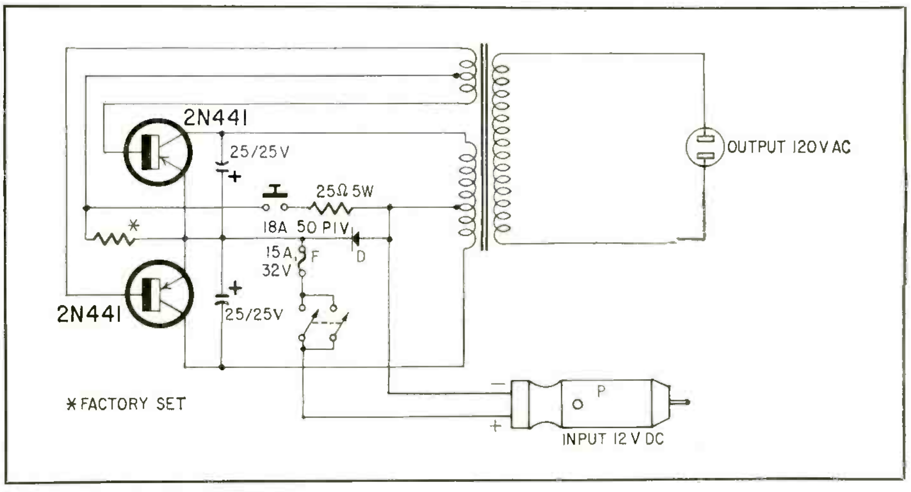
A conventional saturable-core multivibrator using a pair of 2N441 transistors converts the 12 volts dc from the car battery to 117 volts ac. A unique arrangement of the input connector that plugs into the car's cigarette lighter permits a simple polarity change so the inverter can be used in a car that has a positive ground.

I ran two series of tests on this unit. The first group, at the bench, was set up so a regulated dc supply fed input power to the inverter. At the inverter's output I hooked up a line voltage monitor to meter the voltage output. The monitor remained connected in parallel with every load used during the test.

I started off with a 60-watt bulb. To power it the inverter drew 8 amps from the 12-volt supply. Next came a 75-watt bulb. It required 9 amps. Last was a 100-watt bulb which drew 11.5 amps. One important point: Output voltage in each test varied from a high of about 138 volts (for the 60-watt bulb) to a low of 131 for the 100-watt bulb. This slight overvoltage was to cause some minor difficulty in the dynamic tests to follow.

From the bench I went to my car and plugged the inverter into the cigarette lighter. The line-voltage monitor remained connected across the inverter output. As a first test I plugged in a tape recorder rated at 65 watts. Output voltage with the recorder running read 130, and I was able to make good recordings and play them back. However, because of the higher-than-normal voltage, I could not play back any prerecorded material. The recorder was running a bit fast and a high-frequency scramble was the result. This also meant that recorded material, made with the inverter as the power supply, could not be played back when the recorder was powered by a normal home ac outlet. Here it would be running slower than the recording speed and a low-frequency mumble would result. [*Realizing this disadvantage, Electro Products has another inverter—the TI-100TR—specifically designed for tape recorders. The TI-100-TR does not have the disadvantage mentioned here.—Editor*]

As a final test I unplugged the recorder and hooked up an 11-inch TV rated at 110 watts. With the engine running, inverter output read 130 volts and the set performed normally. (Naturally, I needed an antenna located outside the car.) Then I let the engine idle. Inverter output dropped to 122 volts and the set continued to run normally. Finally, I turned off the ignition. Now the voltage



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output dropped to 109 and the TV raster shrank about ½ inch all the way around the screen.

Since the picture remained stable at all three voltage levels, frequency output of the inverter can be assumed to be a reasonably stable 60 Hz.

Conclusions: The TI-100A inverter is a great way to put a 125-watt 60-Hz ac outlet in your car. However, the 10% higher-than-normal voltage might shorten the life of some delicate equipment. With this limitation in mind, the inverter can still be quite useful.—*Warren Roy*

MANUFACTURER'S SPECIFICATIONS:

Input voltage: 12 volts dc
Output voltage: Nominal 117 volts rms, nominal 60 Hz
Power output: 125 watts
Voltage regulation: Approx. 20 volts, nominal load to full load
Frequency regulation: Approx. 5 Hz, nominal load to full load
Size: 3½ x 6¼ x 6¼ inches
Weight: 6¾ lb
Price: $46.50 (suggested list)

Motorola FM106M AM-FM Solid-State Auto Radio

Circle 30 on reader's service card

THIS RECEIVER IS DESIGNED FOR INSTALlation in cars having a 12-volt negative-ground system. The radio comes with an external 8-ohm speaker and is intended for either under-dash or in-dash installation.

The knob positions, width and height of the Motorola unit are identical with at least one other car radio: the transistorized AM radio (model 1225) manufactured by Bendix for installation in Volvos. Although the depth of the Bendix unit is several inches less than the Motorola, sufficient clearance exists behind the dashboard of a Volvo to permit in-dash installation of the Motorola unit in the same instrument-panel cutout.

I installed the FM106M in a Volvo which had been previously equipped with a Bendix receiver. The job was therefore very simple. The existing antenna proved adequate for the Motorola.

Anyone planning to install the FM106M in his car should consider replacing the speaker that comes with the radio. I'd recommend either the Olson S-732 speaker at $7.98; the Realistic

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model FE103, available at Radio Shack for $7.95; or possibly the Lafayette model 99C 0144, at $4.95. All these are long-throw 4-inch speakers with better bass response than the 5 x 7-inch speaker supplied.

The FM106M is equipped with the following controls:

- Combined on–off switch and volume control
- Continuous tone control
- AM–FM selector
- Tuning control
- Acoustinator sensitivity (an rf local/distance control)

The controls are positioned functionally and are easy to operate. The continuous tone control is superior to a three-position control allowing only a fixed amount of bass or treble boost. In my Volvo installation the sound tended toward the boomy side. The continuous tone control made it possible to eliminate the boomy quality without sacrificing the entire lower segment of frequency response.

This receiver is equipped with undefeatable afc, which may be regarded by some as a disadvantage. I found it quite easy to tune in FM stations; a previously tested FM radio with at least as good sensitivity but no afc was considerably more of a chore to tune. In signal areas where two weak stations are competing for the same frequency, the afc occasionally captures first one station, then the other, generating considerable noise during the alternation. Under such circumstances an afc override would be of benefit, but the situation arises infrequently.

The Acoustinator sensitivity control is a two-position switch which affects FM reception only. In strong-signal areas where several FM transmitters are close together, the station signals tend to interfere with each other. The Acoustinator control, when in *local* position, reduces the FM sensitivity of the receiver (by inserting a resistor in the antenna line) and thereby reduces the interference. In weak-signal areas the control should be in *fringe* position; this provides maximum FM sensitivity.

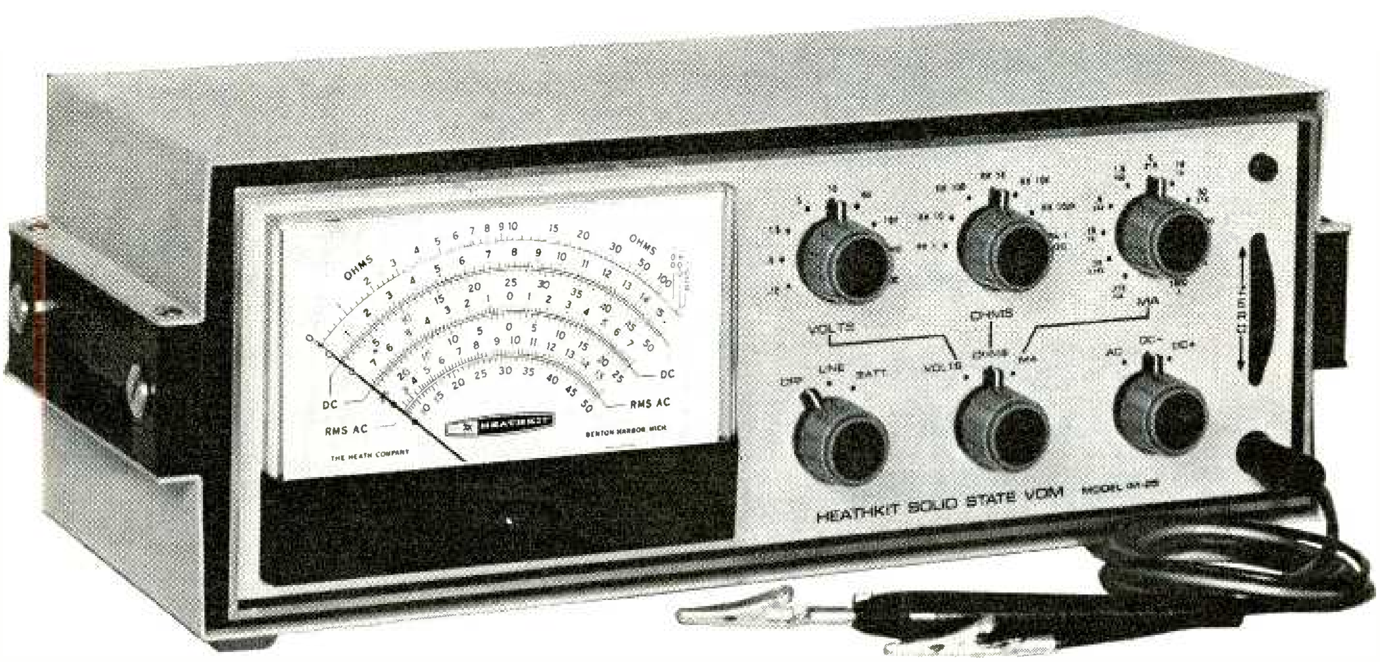
The radio has operated trouble-free nearly a year. Equipped with one of the replacement speakers suggested earlier in this article, the audio quality of the FM106M is excellent. Installation and operation of the compact transistorized unit are very simple. Finally, for those who require stereo wherever they go, a multiplex socket is provided for a stereo adapter.

—*Robert M. Shapiro*

Price: $79.95 (suggested list)

END

New Solid-State High Impedance V-O-M



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IM-25 SPECIFICATIONS — DC SECTION: Voltmeter: Ranges: 0 - 0.15, 0.5, 1.5, 15, 50, 150, 500, 1500 volts full scale. **Input Resistance:** 11 megohms on all ranges. **Accuracy:** ±3% of full scale. **Milliammeter: Ranges:** 0 - .015, .05, 0.15, 0.5, 1.5, 5, 15, 50, 150, 500, 1500 ma full scale. **Input Resistance:** 0.1 ohm (1500 ma) to 10 K ohm (0.015 ma). **Accuracy:** ±4% of full scale. **AC SECTION: Voltmeter: Ranges:** 0 - 0.15, 0.5, 1.5, 15, 50, 150, 500, 1500 volts full scale. **Input Resistance:** 10 megohm shunted by 150 uuf. (Measured at probe tip.) **Accuracy:** ±5% of full scale. **Frequency Response:** ±2 db 10 Hz - 100 kHz. **Milliammeter: Ranges:** 0 - 0.015, 0.05, 0.15, 0.5, 1.5, 5, 15, 50, 150, 500, 1500 ma. full scale. **Input Resistance:** 0.1 ohm (1500 ma) to 10 k ohm (0.015 ma). **Accuracy:** ±5% of full scale. **Ohm Meter: Ranges:** 10 ohm center scale x1, x10, x100, x1k, x10k, x100k, x1 meg. **Probe:** Combined AC - OHMS - DC switching probe, single jack input for Probe and Ground connections, Circuit ground isolated from cabinet. **Dividers:** 1% Precision Type. **Meter:** 6", 200 ua, 100° movement. **Transistors, Diodes:** 2 - 2N4304 FETransistor; 13 - 2N3393 silicon junction transistor; 1 - 9.1 V zener diode; 1-13 V zener diode; 4-1N191 germanium diode; 1 silicon Power Supply diode. **POWER SUPPLIES: Ohms Circuit:** 3 volts, (C - cells). **Ohms Circuit Bias:** 1.35 volt (E1N Mercury Cell). **Amplifier Circuit:** 18 volts. **Battery Operation:** C cells. **Line Operation:** Transformer operated ½ wave circuit, operable on either 120 or 240 V AC 50-60 Hz.

The first of an exciting new line of Heathkit test instruments, the IM-25 Solid-State V-O-M does all the measurement jobs normally required in tube or transistor circuits with the no-loading high impedance of a VTVM, the convenience and versatility of a VOM, and the accuracy and sensitivity of separate lab instruments.

Accuracy of the impressive specifications of the IM-25 are assured by careful attention to design details. For example, the input of the IM-25 "floats," isolating the input circuit from the cabinet. (The cabinet is grounded by a three-wire line cord.) Double Zener-diode regulation minimizes zero shift when changing from line to battery operation. Ohms scale calibration is a set-and-forget adjustment. DC voltage measurements require only a shorted input check of meter zero. Applied voltage during resistance measurements is less than 100 millivolts from a constant-current source to avoid the possibility of erroneous readings or circuitry damage.

Those who choose the kit model IM-25 rather than the factory assembled and tested version will find it far easier to build than any other kit meter we've ever offered. All components mount on just one circuit board . . . even the switches. No more tedious divider circuit wiring. And a special wiring harness is provided.

A die-cast panel bezel ties both front and rear panels together with the circuit board supported between to permit removal of the cabinet shells without impairing operation. Convenient carrying handles are recessed in each of the cabinet shell mounting strips.

Whether you choose the factory assembled model or the kit version, we believe you will find the IM-25 a significant step forward in design and value . . . capable of creditable service in any application.

Kit IM-25, 10 lbs. (Available late April) **$80.00**
Assembled IMW-25, 10 lbs. (Available late May) **$115.00**

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Circle 33 on reader's service card

New Location for WWV

AT 7:00 PM EST ON DEC. 1, 1966, NATIONAL BUREAU OF Standards radio station WWV terminated forever standard time and frequency transmissions from the Greenbelt, Md., site which it had occupied since 1923. At the same instant, the station began transmitting from its new site at Fort Collins, Colo. The central location of Fort Collins provides better signal coverage throughout the US.

There are eight transmitters as in the Greenbelt installation. Each is operated at half its maximum power rating. Three transmitters radiate 10 kW on 5, 10 and 15 MHz. The fourth 10-kW rig is kept on standby, ready to operate on any of these three frequencies. Three 5-kW transmitters radiate 2.5 kW on 2.5, 20 and 25 MHz. The fourth 5-kW unit is on standby, ready for emergency use on these frequencies. The transmitter drivers are bandswitching types built to NBS specifications. The power amplifiers are commercial units.

Six of the antennas are modified sleeve vertical dipoles; each tuned to one of the transmitting frequencies and permanently connected to one of the transmitters. The towers are 200, 100, 50, 33, 25 and 20 feet high. The 200-footer operates on 2.5 MHz, the 100-footer on 5 MHz and so on in inverse order of frequency. The other two antennas, on the standby transmitters, are 88-foot Collins monopoles which can be tuned to any of the WWV frequencies.

The NBS radio stations provide standard radio frequen-

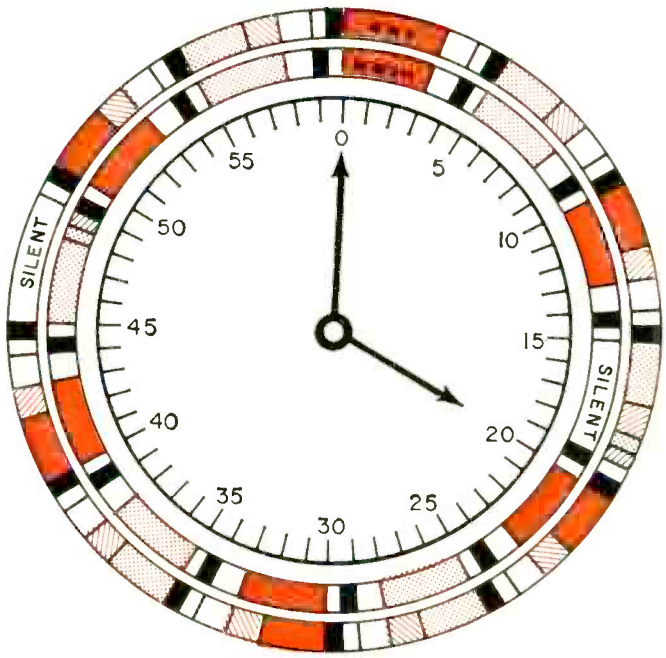
THE HOURLY BROADCAST SCHEDULES OF WWV & WWVH

Seconds pulses (ticks)—continuous except for 59th second of each minute and during silent periods.

Morse code: Call letters, universal time, propagation forecast (WWV only).

Voice: Mountain & Hawaiian Standard Time

Morse code: Frequency offset (on the hour only)



Ticks only

Station announcement

UT-2 time correction

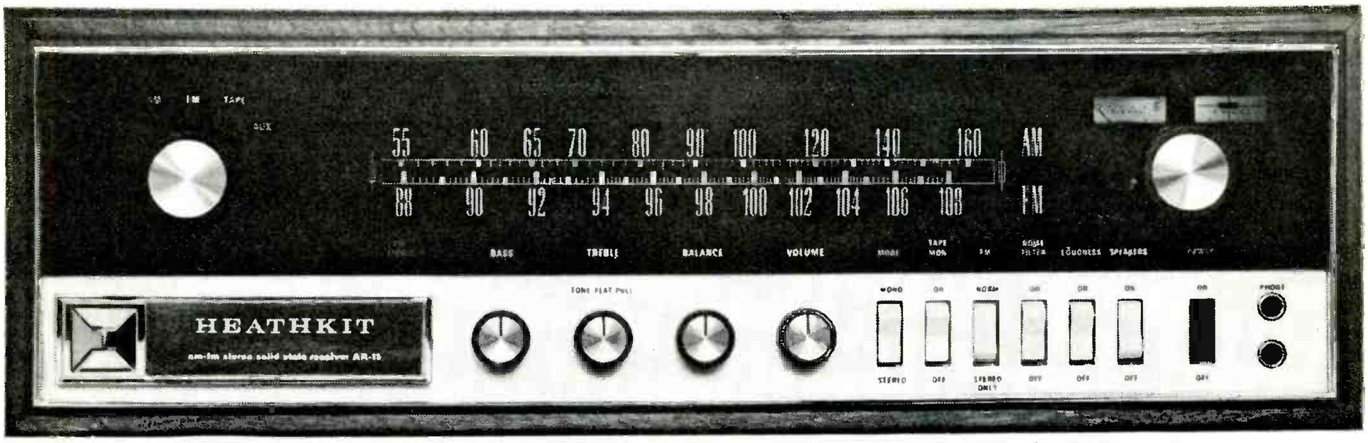
Geoalerts

Tone modulation 600 Hz

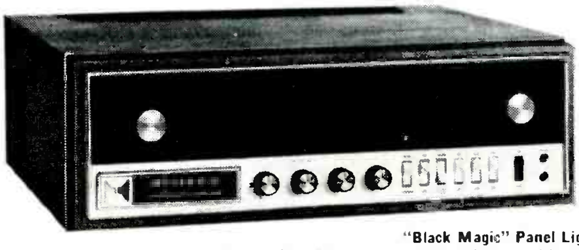
100 pps 1,000 Hz modulation WWV timing code

Tone modulation 440 Hz

World's Most Advanced Stereo Receiver...

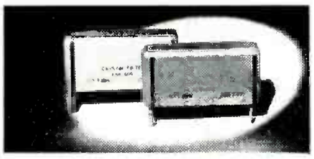


New Heathkit® AR-15...150 Watts...AM/FM/FM...$329.95†



"Black Magic" Panel Lighting
A touch of the power switch and presto! . . . The black magic panel lights up with a slide-rule dial for easy tuning, and instant identification of all controls.

Integrated Circuits . . . two are used in the IF amplifier for hard limiting excellent temperature stability, increased reliability. Capture ratio is 1.8 db. Each IC is the size of a tiny transistor, yet each contains 10 transistors, 7 diodes, and 11 resistors.



Crystal Filters . . . two are used in the IF amplifier to replace the usual transformers . . . Heath hi-fi exclusive. Provide near-perfect bandpass characteristics, (70 db selectivity) yet no adjustment is ever needed!

AR-15 SPECIFICATIONS — AMPLIFIER SECTION: Dynamic Power Output Per Channel (Music Power Rating): 8 ohm load; 75 watts. **Continuous Power Output, Per Channel*:** 8 ohm load; 50 watts. **Power Bandwidth For Constant 0.5% Total Harmonic Distortion*:** 6 Hz to 25 kHz. **Frequency Response (1 watt level):** ±1 db, 6 to 50,000 Hz. ±3 db, 4 to 70,000 Hz. **Harmonic Distortion:** Less than 0.5%, from 20 to 20,000 Hz at 50 watts output. Less than 0.2% at 1,000 Hz with 50 watts output. Less than 0.2% at 1,000 Hz with 1 watt output. **Intermodulation Distortion (60 Hz: 6,000 Hz=4:1)** Less than 0.5% with 50 watts output. Less than 0.2% with 1 watt output. **Damping Factor:** 45. **Input sensitivity:** PHONO; 2.2 millivolts (overload 155 mv). TAPE; 200 millivolts (overload 4.5v). AUX; 200 millivolts (overload 4.5v). **Hum & Noise:** Volume control at minimum position; —80 db. PHONO; (10 millivolt reference); —60 db. TAPE & AUX. (200 millivolt reference); —65 db. **Channel Separation:** PHONO; 45 db. TAPE & AUX.; 55 db. **Output impedance (each channel):** 4, 8 & 16 ohms. **Tape Output Impedance:** 100 ohms. **Input Impedance:** PHONO; 51 K ohm (**RIAA equalized) AUX., TAPE & TAPE MON.; 100 K ohm. **Tape Output:** 0.17 volt. **FM SECTION (Mono): Sensitivity:** 1.8 uv*. **Frequency Response:** ±1 db, 20 to 15,000 Hz. **Volume Sensitivity:** Below measurable level. **Selectivity:** 70 db*. **Image Rejection:** 90 db. **IF Rejection:** 90 db minimum*. **Capture Ratio:** 1.5 db*. **AM Suppression:** 50 db*. **Harmonic Distortion:** 0.5% or less*. **Intermodulation Distortion:** 0.5% or less*. **Hum & Noise:** 65 db*. **Spurious Rejection:** 100 db*. **FM SECTION (Stereophonic): Channel Separation:** 40 db or greater. **Frequency Response:** ±1 db, 20 to 15,000 Hz. **Harmonic Distortion:** Less than 1% at 1,000 Hz with 100% modulation. **19 & 38 kHz Suppression:** 55 db or greater. **SCA Suppression:** 50 db. **AM SECTION: Sensitivity:** 12 microvolts at 1,000 kHz. **Image Rejection:** 60 db at 600 kHz. 40 db at 1400 kHz. **IF Rejection:** 70 db at 1,000 kHz. **Harmonic Distortion:** Less than 1.5% at 400 Hz, 90% modulation. **Hum & Noise:** 45 db. **Power Requirements:** 105-125 or 210-250 volt 50/60 Hz AC. **Dimensions:** Overall, 16⅞" wide x 4¾" high x 14½" deep

*Rated IHF (Institute of High Fidelity) Standards.

The New Heathkit AR-15 . . . Crowning Achievement Of The World's Most Experienced Solid-State Audio Engineers! There's nothing like it anywhere in the transistor stereo market place. Besides the use of space-age integrated circuits and exclusive crystal filters in the IF section, it boasts other "state-of-the-art" features like these:

150 Watts Dynamic Music Power . . . 75 IHF watts or 50 RMS watts per channel . . . the highest power output of any stereo receiver. Delivers the coolest, most natural sound you've ever heard.

All-Silicon Transistor Circuitry . . . a total of 69 transistors, 43 diodes and 2 IC's for maximum reliability & stability.

Positive Circuit Protection . . . four Zener diodes and two thermal circuit breakers protect the driver and output transistors from overloads and short circuits of any duration.

Field Effect Transistor FM Tuner . . . cascode 2-stage FET RF amplifiers and an FET mixer provide high overload capability, excellent cross modulation and image rejection. Sensitivity 1.8 uv. Features a 4-gang variable capacitor and 6 tuned circuits for extreme selectivity under the most adverse conditions. Completely shielded . . . completely assembled for best performance.

Two Calibrated Tuning Meters . . . a signal strength indicator tells you when you receive the strongest signal — doubles as a VOM for check-out *during* or after kit construction. A special "Center-Tune" meter puts you on exact station frequency.

Tone-Flat Switch . . . bypasses tone control circuit for completely flat response.

Automatic FM Squelch . . . noise and AFC operated to hush between-station noise *before* you hear it.

Stereo Only Switch . . . silences all mono when you wish to listen to stereo broadcasts only. An added tuning convenience!

Super SCA Filter . . . removes SCA and noise frequencies above 57 kHz for clean, quiet listening.

Massive Power Supply . . . for low heat and superior regulation — electrostatic and magnetic shielding for lowest hum and noise.

Electronic Filter Circuit . . . provides power supply with exceptionally low ripple and excellent regulation.

Adjustable Phase Compensator for Station Differences . . . so you can be assured of the best stereo.

Wide Range Magnetic Phono Inputs . . . extra overload characteristics (98 db dynamic range). All inputs adjustable from front panel. Plus automatic switching to stereo, transformerless design, filtered outputs and a host of other deluxe features for the discriminating audiophile. An assembled wrap-around walnut cabinet with a vented top is available at $19.95. Liberal credit terms also available.

† **Kit AR-15** (less cabinet), 28 lbs. **$329.95**
AE-16, assembled walnut cabinet, 7 lbs. **$19.95**

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cies, standard audio frequencies, musical pitch, time intervals (1 second, 1 minute, 1 hour, etc), time signals indicating Universal Time, Universal Time corrections (UT2), propagation forecasts and geophysical alerts. The hourly broadcast schedules of WWV and WWVH are shown.

Radio broadcasts from WWV on 2.5, 5, 10, 15, 20 and 25 MHz are continuous night and day except for silent periods of approximately 4 minutes beginning 45 minutes after each hour. Broadcast frequencies are held constant to within 5 parts in 10^{11}. WWVH transmits on the four lower frequencies with 4-minute silent periods beginning 15 minutes after each hour. WWVB and WWVL broadcast continuously on 60 and 20 kHz, respectively, with normal stability of 2 parts in 10^{11}.

Standard audio frequencies of 440 and 600 Hz are broadcast on all WWV and WWVH frequencies. The tones are transmitted alternately in 5-minute intervals beginning with 600 Hz on the hour. The first tone transmission from WWV is 3 minutes long. all others are 2 minutes long. At WWVH, all tone transmissions are of 3-minute duration. WWVB and WWVL do not transmit standard audio tones.

For time signals, the audio frequencies are interrupted precisely 3 minutes before each hour at WWV and 2 minutes before each hour at WWVH. The tones are restored on the hour and at 5-minute intervals throughout the hour.

Universal Time (referenced to the zero meridian at Greenwich, England) is announced in International Morse Code each 5 minutes from WWV and WWVH. At WWV, a voice announcement in Mountain Standard Time is made during the last half of each fifth minute during the hour. At WWVH, a similar voice announcement of Hawaiian Standard Time is made during the *first* half of each fifth minute. WWVB transmits a special time code. WWVL does not transmit time signals.

Corrections to be applied to Universal Time signals are given in International Morse Code during the last half of the 19th minute from WWV and during the last half of the 49th minute from WWVH. The correction symbols consist of UT2 followed by AD (for add) or SU (for subtract) followed by a 3-digit number indicating the correction in milliseconds.

Propagation forecast announcements in Morse Code indicating ionospheric conditions and the quality of radio reception that can be expected within the next 6 hours are made from WWV at 0500, 1200 (1100 in summer), 1700 and 2300 UT. The forecast consists of a letter and a number. The letters N, U and W indicate normal, unsettled and disturbed conditions, respectively. Numbers 1 to 4 (disturbed) indicate useless, very poor, poor and poor-to-fair; 5 (unsettled) is fair; 6 to 9 (normal) indicate fair-to-good, good, very good and excellent, respectively.

A letter symbol indicating the current geophysical alert is broadcast in slow Morse from WWV during the first half of the 19th minute of each hour and from WWVH during the first half of each 49th minute. The geophysical alert identifies days in which outstanding solar or geophysical events are expected or have occurred during the preceding 24-hour period.

The announcement is identified by the letters GEO followed by the letter symbol repeated five times. The letter M means magnetic storm, and N is magnetic quiet. C is cosmic-ray event. E means no geoalert issued. S indicates the presence of solar activity, and Q is solar quiet. W is stratospheric warning.

More complete information on the services of NBS stations WWV, WWVH, WWVB and WWVL will be found in *NBS Standard Frequency and Time Services* (Miscellaneous Publication 236) available from Superintendent of Documents, US Government Printing Office, Washington, D.C. 20402, for 15 cents per copy. END

"I Purchased the Heathkit® GR-295 to Break Into Color, and I Found Your Assembly and Service Manual to be a Complete Color TV Education in Itself"*

*Mr. Philip A. Scandura, Phil's Radio & TV Clinic, Hackensack, N.Y.

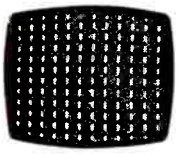
Kit GR-295
$479^95 *
(295 sq. in. viewing area)

Kit GR-180
$379^95 **
(180 sq. in. viewing area)

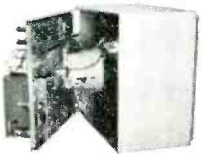
What Better Way To Learn Color TV Than To Build One Yourself! Smart man, Mr. Scandura. He built a beautiful color TV set that's worth $700.00 and got a free education in the process. You can too, with either of these deluxe Heathkit high fidelity color TV's. Kit assembly is easy . . . you just mount the parts, wire the leads and even degauss, converge, and adjust the picture. Takes around 25 hours. UHF and VHF tuners, I.F. assembly and high voltage power supply are preassembled & aligned at the factory.

And each set includes a 178-page instruction manual that's lavishly illustrated with drawings, photographs, schematic diagrams, X-ray views of circuit boards and even 32 pages in full color. Only 59 pages are devoted to the simple step-by-step instructions. The rest is a comprehensive discussion on theory of operation, detailed descriptions of each circuit, trouble-shooting photos & charts, service information, adjustments and operation.

And The Performance? In his letter Mr. Scandura added: "*Your engineers did an outstanding job in designing a set so easy to build, and which produces a picture quality superior to any commercially built set I have seen. What a thrill to find the set operating perfectly the first time I turned it on and adjusted the picture.*" Now compare these other exclusive Heathkit Color TV features!



Exclusive Self-Servicing Aids . . . built into both Heathkit color TV's so you can perform convergence and color purity adjustments anytime. Just flip a switch on the built-in dot generator, and a dot pattern appears on the screen. The manual's simple-to-follow instructions and detailed color photos show you exactly what to look for, what to do and how to do it. Results? Beautifully clean and sharp color pictures day in and day out.



Vertical Swing-Out Chassis. All parts mount on a single one-piece chassis that's hinged to make it more accessible for easier construction, care and installation.

Your Choice Of Installation. Another Heathkit exclusive! Both color TV's are designed for mounting in a wall or your own custom cabinet. Or you can install either set in a choice of factory assembled & finished Heath contemporary walnut or Early American cabinets.

Exclusive Heath Magna-Shield! This unique metal shield surrounds the entire picture tube to help keep out stray external magnetic fields and improve color purity. In addition, *Automatic Degaussing* demagnetizes and "cleans" the picture everytime you turn the set on from a cold start. Also permits you to move the set about freely without any manual degaussing. A mobile degaussing coil is included for initial set-up.

Convergence Control Board! . . . for fast, easy dynamic convergence and gray scale adjustments any time you decide color purity needs it. This board may be mounted up front, so there's *no* awkward reaching around the back of the set, or mirrors to set up.

Plus a Host Of "State-Of-The-Art" Features . . . like the hi-fi rectangular picture tube with "rare earth" phosphors for brighter, livelier colors and sharper definition . . . **Automatic Color Control** and **Gated Automatic Gain Control** to reduce color fading and insure steady, jitter-free pictures at all times . . . deluxe **VHF Turret Tuner** with "memory" fine tuning . . . **2-Speed Transistor UHF Tuner . . . Two Hi-Fi Sound Outputs** for play through your hi-fi system or connection to the special limited-field speaker . . . **Two VHF Antenna Inputs** — 300 ohm balanced and 75 ohm coax . . . **1-Year Warranty** on the picture tube, 90 days on all other parts . . . plus many more deluxe features. For full details, mail coupon for FREE Heathkit catalog.

***Kit GR-295**, everything except cabinet, 131 lbs. **$479.95**

GRA-295-1, walnut cabinet (shown above), 56 lbs. . . 19" D x 31" H x 34½" W **$62.95**
Deluxe contemporary walnut & Early American cabinets also available at $94.50 and $99.95

****Kit GR-180**, everything except cabinet, 102 lbs. **$379.95**

GRA-180-1, walnut cabinet (shown above), 41 lbs. . . 18¼" D x 28¼" W x 29" H **$49.95**
Early American cabinet available at $75.00

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3 Both (I work in electronics, and also consider it a hobby during off hours)

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4 25 years old or under
5 Between 26 and 35, inclusive
6 36 or over

NEW PRODUCTS

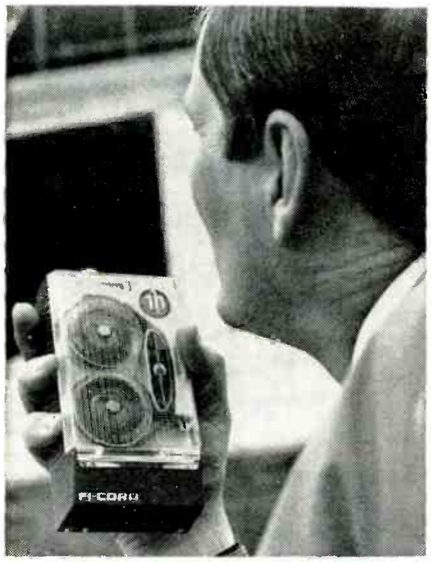
More information on new products is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 74 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

CB TRANSCEIVER KIT, *Safari III.* Solid-state design. All silicon transistors. 12 Vdc. Mounts into separate ac power supply, factory-assembled, to convert into base station. Portable with battery pack. Transmitter section factory-assembled.

Step-by-step instructions. Sensitivity 1.5 μV for 10 dB S/N ratio. I.f. selectivity ±4 kHz at 6 dB down for 10 μV input. Adjacent-channel rejection over 30 dB on 5 tuned circuits. Transmitter power input 5W, output 3W. Output matches 50-ohm antennas. Modulation ±80% minimum. On-off volume control; adjustable squelch; illuminated selector switch; fine-tuning control; transmit indicator light; S-meter. 2⅛ x 6⅞ x 8½ in. $84.50. Power supply and charger, $19.95. Accessory battery pack, $19.95.—**Allied Radio Corp.**

Circle 46 on reader's service card

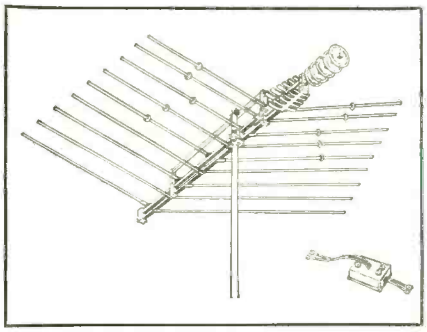
POCKET DICTATING MACHINE, *Fi-Cord 300* and *Fi-Cord 303.* Friction-finish gives nonslip grip. 3 springback pushbuttons. Built-in dynamic micro-



phone–speaker. Playback volume control. 3½-oz amplifier–speaker attachment for higher volume. Insulated snap-in battery tube. Uses standard penlight-size batteries. Instant drop-in loading. ¼-in. self-cleaning tapes record up to 48 min. with audible end-of-tape signal, and motor stops automatically. Electronically governed motor maintains constant speed of 1⅞ ips. 11 transistors, 5 diodes. 3-digit counter, resettable to zero, provides instant indexing. Single input and output socket accepts all accessories. Metal housing. *Fi-Cord 303* is compatible with most single-track units. $209.95.—**Karl Heitz Inc.**

Circle 47 on reader's service card

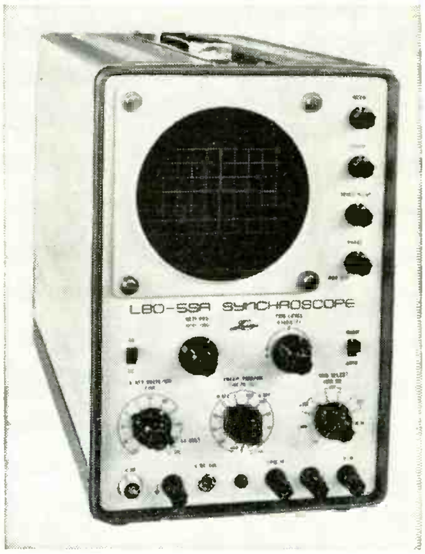
82-CHANNEL TV/FM ANTENNAS, the *LPV Color Laser, model LPV-CL500* illustrated. "Cap-electronic" *Log Periodic-V* for vhf, broadband "zoned" trapezoid driver for uhf and broadband disc-on-rod uhf director system—all integrated into single antenna. Vhf–uhf–FM signal splitter is mounted on back of set. 8 models. Gold anodized. *Model LPV-CL55* has a vhf range up to 30 miles, uhf



and FM up to 20 miles, 9 elements, $17.50. Other models have vhf range from 40–150 miles and from 16–35 elements, $19.95–$69.95.—**JFD Electronics Corp.**

Circle 48 on reader's service card

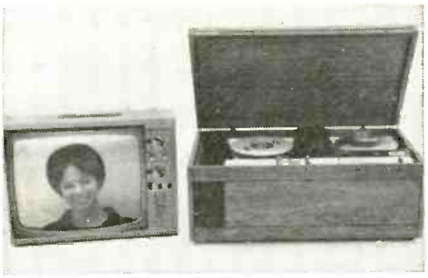
TRIGGERED-SWEEP OSCILLOSCOPE, *model LBO-5SA Synchroscope,* for audio, radio and pulse circuits, waveform observation and voltage measurements. Vertical-channel sensitivity: ac, 10 mV to 20 V p-p/cm; dc, 0.1 V to 20 V p-p/cm. Frequency response: ac–2 Hz to 5 MHz, −3 dB; dc–to 5 MHz, −3 dB.



Input impedance: direct, 1 meg–50 pF; probe, 1 meg–20 pF. Rise time .08 μsec. Horizontal sweep speed is 1 μsec/cm maximum. External sweep, 3 V p-p/cm or better; dc to 300 kHz, −3 dB. 5X sweep magnifier. Power supply 117 V at 60 Hz. Includes 1 probe, 10:1 stepdown, 1 terminal adapter. 12½ x 8½ x 17¾ in., 34 lb. $299.95. —**Fairlane Electronics, Inc.**

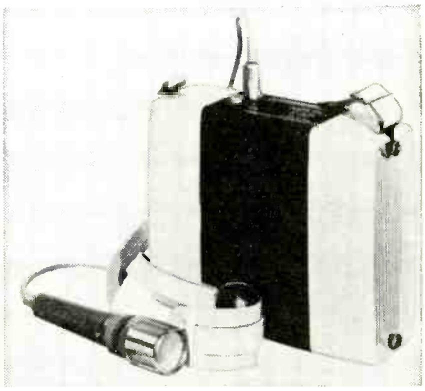
Circle 49 on reader's service card

CLOSED-CIRCUIT VIDEOTAPE RECORDER/TV RECEIVER COMBINATION, the *VR-6175.* Permits recording TV broadcasts for instant replay. 21-in. receiver, *model TR-821* manufactured by Motorola, modified so that no additional equipment or professional installation is required. Companion camera, *model CC-6450,* allows user to make live



recordings. Remote-control operation of recorder from camera. Includes tripod, cable and lens. Recorder/TV combination, $1,695.—Ampex Corp.

Circle 50 on reader's service card



BIDIRECTIONAL PORTABLE PA, the *Amplibox*. Battery-operated, all-transistor. Two built-in speakers. Dynamic, directional cardioid microphone with windscreen. 8 flashlight batteries, 4 W usable power. No warmup time. Remote on–off control, external volume control. 9 x 8 x 3½ in., 4 lb. Shoulder strap and cable.—American Geloso Electronics Inc.

Circle 51 on reader's service card

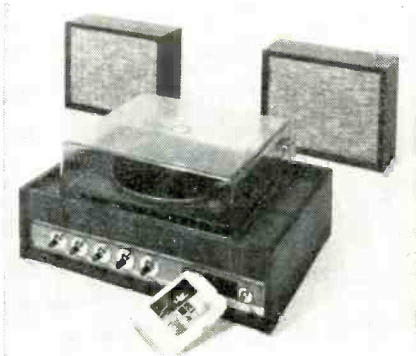
MUTUAL CONDUCTANCE TUBE CHECKER, the *MU140 Continental*. Uses 5-kHz square wave; measures in actual micromhos. Automatic biasing system eliminates one setup control. Measures emission, too. High-sensitivity grid-leakage tests spot as little as 100 megs; tests

NEW PRODUCTS continued

shorts as light as 180K between elements. Space for sockets to accommodate future tubes with different base arrangements. Vinyl-clad steel "attache" case. Up-to-date tube chart. $179.50.—**Sencore, Inc.**

Circle 52 on reader's service card

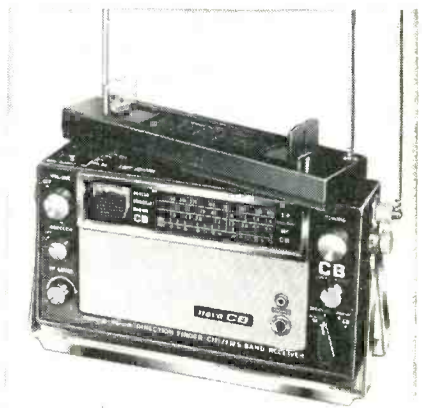
8-TRACK TAPE AND RECORD PLAYER, *model CC-890*. Solid-state, all-transistor. *Garrard 50 MKII* automatic turntable; *Tetrad* cartridge. 14 transistors, 3 diodes. Auxiliary input jack for stereo tuner; stereo earphone, output jack and switch. 4 speakers with crossover network. Frequency response 20–20,000 Hz. 20-W,



cool-chassis amplifier. 6 separate controls. Two 8-in. heavy-magnet woofers and two 3½ in. tweeters. Pushbutton program selector for tape player. Automatic continuous play and repeat. Tape speed 3¾ ips. Wow and flutter less than 0.3% total. Walnut cabinet. $289.95.—**Capitol Records Distributing Co.**

Circle 53 on reader's service card

5-BAND PORTABLE CB RECEIVER AND DIRECTION FINDER, the *Nova CB*. Tunes all 23 CB channels on 2 separate bands. Other tuning ranges: police/marine/shortwave band, 1.5–4.5



MHz; low-frequency beacon/weather band, 200–400 kHz; and standard AM broadcast band. Double conversion with crystal-controlled front end and tunable i.f. strip. Mechanical filter, 4 tuned circuits. Adjustable squelch control. Accurately calibrated rotatable antenna and null metter. 13 transistors. Operates on internal batteries as well as external power (auto or boat batteries; 117 Vac). Leather carrying case, chrome mounting brackets, 3 telescoping whip antennas, headphone jacks, miniature earpiece, pushbutton light, external power cord, and ac adapter. Optional accessories include: rooftop antenna cut to Citizens band, solar cell bank. 2½ lb, 8 x 5 x 2 in. $129.95—**Nova-Tech, Inc.**

Circle 54 on reader's service card

NUVISTOR/ TRANSISTOR TUNER CLEANER, *No. 800 Tun-O-Lube.* Especially developed for nuvistor and all-transistor circuitry. No frequency drift. Safe to use on all plastics. —**Chemtronics, Inc.**

Circle 55 on reader's service card

CB RADIO, *model J-23.* Selectivity: 5 kHz at 6 dB, 20 kHz at 60 dB. Sensitivity: 0.7 mV at 30% mod., 0.3 mV at 100% mod. Adjacent-channel rejection: at least 60 dB. Audio output: 2 watts at 0.3 mV, 100% mod. Audio response: 250–3,500 Hz. Squelch sensitivity: 0.2 mV. PA output: 2.5 watts. Speaker impedance: 3.2 ohms. Transmitter power output: 3.2 watts (nominal) (12.6-Vdc source) for 5-watt input. Temperature range: −20–150°F. Frequency stability: better than .005%. 23 channels, dual conversion, provisions for external speaker and PA. Isolated series noise gate. Heavy-gauge aluminum construction. 2 x 6-in. speaker. $239.95.—**Sonar Radio Corp.** END

Circle 56 on reader's service card

SERVICING COLOR WITH VTVM

It's not impossible, just a technique often overlooked. Use your voltmeter carefully and you'll lick most chroma problems. Learn this useful and valuable troubleshooting method in

May RADIO-ELECTRONICS

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here are free for the asking with a Reader's Service number. Turn to the Reader's Service Card facing page 74 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

PERMEABILITY TUNED OSCILLATOR SPEC SHEET. Oscillator features solid-state design. Temperature-compensated with stability better than 15 Hz drift/degree over temperature range from 0°–140°F. Particularly suited for ham radio.—**TRW Electronic Components Div., Military & Industrial Operation**

Circle 57 on reader's service card

PORTABLE LOUDSPEAKER SYSTEM, *How-to-do-it Instructions* to build the *Super-Cube*, a portable loudspeaker for pocket-sized transistor radios (for under $15). Complete materials list and instruction.—**Jensen Mfg. Div./The Muter Co.**

Circle 58 on reader's service card

SHIELDED CABINET COMPONENTS DATA SHEET, *No. EMC-061.* Contains full specs on *Teckcell* ventilating panels designed to fit standard 19-in. and 24-in. EIA cabinets. Panels feature open or closed mounting holes.—**Technical Wire Products, Inc.**

Circle 59 on reader's service card

SILICON ASSEMBLIES CATALOG, *No. D-66*, 80 pages. looseleaf-punched. Foldout back cover with detailed rectifier circuit diagrams. Circuit values discussed in text. Complete standard line of over 175 pre-engineered rectifier stack assemblies. Includes complete line of molded circuit assemblies; modular line of high-voltage columns. Indexed with numerical cross-reference list and table of contents.—**International Rectifier**

Circle 60 on reader's service card

END

Solution to R-E Puzzler for March 1967

1 potentiometer	13 tetrode
2 resistors	14 insulator
3 winding	15 amplifier
4 dynatron	16 dipole
5 pigtail	17 align
6 decibel	18 discharge
7 condenser	19 kilocycle
8 molybdenum	20 flashover
9 angstrom	21 transistors
10 diheptal	22 linearity
11 ionosphere	23 interference
12 varistor	24 rectifier
25 semiconductor	

Your rating:

60-64 Fair.	76-84 Better.
68-72 Good.	88-96 Even better.

100 Perfect! Give yourself a pat on the back!

By Edmund A. Braun

RCA ANNOUNCES NEW ANTENNA ACCESSORIES ENGINEERED FOR COLOR TV

New catalog tells the full-line story.
Get it from your RCA Distributor.

5

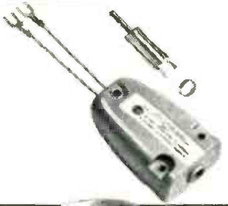
RCA Deluxe Transistorized Antenna Amplifiers . . . a full line of dual purpose units with the most advanced silicon transistors in high-gain, low-noise circuits. They are masterfully designed to bring in the sharpest picture on color or black and white TV. Or they can drive multiple receivers from a single antenna using RCA multi-set couplers as a small distribution system. Five types include: 300 ohm UHF type 10P223; 300 ohm VHF/FM type 10P213; 75 ohm coaxial VHF/UHF type 10P215 and 10P235; and 300 ohm VHF/UHF type 10P233—all with remote, A.C. operated power supplies.

4

RCA Deluxe Multi-Set Couplers
. . . UHF/VHF/FM 300 ohms, couple two or four sets to one antenna or amplifier. Channels 2 to 83, types 10P302 and 10P304. Also VHF/FM 75 ohm coaxial types 10P752 2-set coupler; 10P754 4-set coupler.

3

RCA Deluxe Band Splitters
. . . Separate UHF, VHF and FM signals from a single transmission line or combine separate antennas. 300 ohms. Three types include: 10P311 couples VHF/UHF signals to one line; 10A135 separates UHF and VHF at set; 10P312 separates UHF, VHF and FM.



3

RCA Deluxe Coaxial-to-twin lead Transformers . . . streamlined for fast installation. Coax plugs in using solderless connector. Terminals for twin lead connections. Models: 10P723 and 10P753 for indoor use and 10P375 for outdoor use.

2

RCA Deluxe Lightning Arrestors
. . . Positive contact with all varieties of twin-lead (flat, round, and oval). Eliminate lead stripping, insert line in slot, screw on cap for fast installation. Low insertion loss, does not increase VSWR of a good antenna even at critical UHF frequencies. Screw mount type 10A118; and strap-mount type 10A119.

When you buy antenna accessories bearing the RCA Mark of Quality, you know they're reliable.

RCA PARTS AND ACCESSORIES, DEPTFORD, N.J.

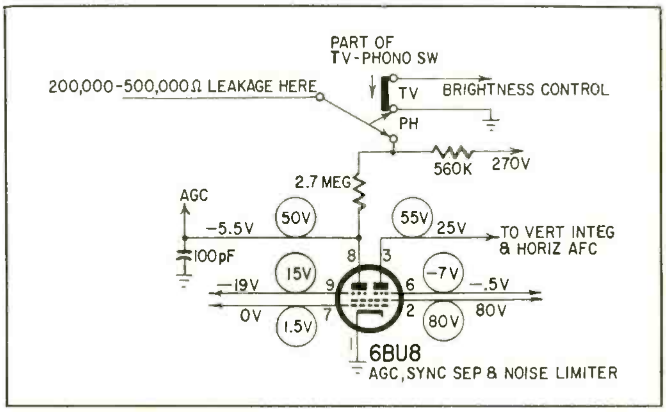
RCA®

The Most Trusted Name in Electronics

TECHNOTES

DU MONT RA-400 AND RA-401—INTERMITTENT SOUND AND PIX

The symptoms indicated agc troubles. The grid of the first video i.f. amplifier, normally −5 volts with no signal input, measured −25. The trouble was traced to an intermittent leakage path of 200,000–500,000 ohms through dust-



laden grease on the TV–phono switch on the rear of the chassis. The circuit shows a section of the switch and how leakage upsets normal voltages on the 6BU8 agc amplifier, sync separator and noise limiter. Normal no-signal voltages are circled; voltages resulting from the trouble are not.

The difficulty was eliminated by cleaning the switch with a combination cleaner and lubricant.—*Ed Dubosky*

WATCH THOSE 6JE6'S

Some premature failures of 6JE6 horizontal output tubes may be caused by incorrect servicing techniques. This tube is extremely sensitive to loss of grid drive. Removing excitation for 10 seconds can ruin the tube. 6JE6's can be damaged simply by pulling the horizontal oscillator tube and replacing it with a cold one while the set is turned on.

To disable the horizontal output circuit during i.f. alignment, either remove the 6JE6 or open the jumper in the cathode circuit. Connect a 2,000-ohm 100-watt resistor from ground to the B+ line (390–405 volts) supplying the 6JE6 screen grid and the damper plate. This resistor simulates the load of the horizontal output circuit.—*RCA Service Bulletin*

PILOT 602MA—CRACKED PC BOARD

To repair the break in the PC board, it was necessary to remove the Danish Torotor 221 tuner. This, in turn, involved unstringing the variable capacitor drum, with the depressing thought of the added labor required for such a small repair. The difficulty was solved by wrapping a piece of twine tightly on the dial cord in the groove on the drum and tying it securely. The same was done on the other pulleys near the drum. Now, the tuning capacitor could be taken out without undue strain on the dial cord.

The repair was then made and the tuning capacitor replaced.

On subsequent jobs of a similar nature, pressure on the dial cord was relieved by first unhooking the tension spring inside the drum and then reconnecting it after the repair.

—*Vergniaud Richard*

REMINGTON CARDVEYOR INTERLOCK

The Remington Rand CardVeyor uses a dual-beam photoelectric switch to safeguard the operator should he place his hand too close to the card trays while they are moving. Breaking either or both beams stops the machine. If the system fails, the CardVeyor cannot be started.

To check, first make sure both exciter lamps are lit. If so, shine two flashlights on the two phototubes at the same time. If the relays click, the trouble is not in the transistor amplifier but is due to a misaligned beam. This is usually caused by sagging filaments in the No. 239 exciter lamps. Changing one or both bulbs will correct it.—*R. C. Roetger*

OLYMPIC CTC17, CTC18

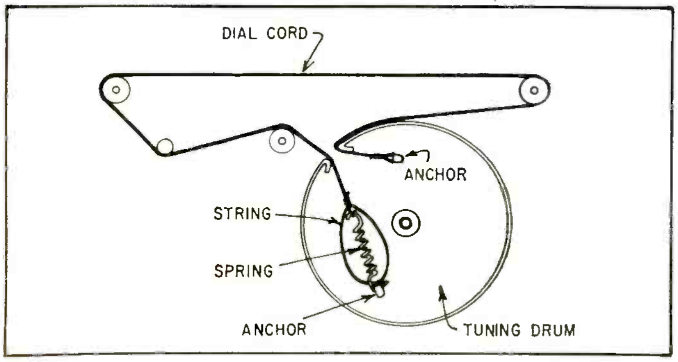
Complaints of insufficient width, ringing bars on left side of raster and excessive blooming can be remedied:

1. Connect a 100-pF 5-kV disc capacitor between pins 2 and 9 of the 6DW4 damper tube. If width increases too much, connect two 130-pF capacitors in series for a total of 65 pF.
2. Replace the 6JE6 and 3A3.
3. Turn brightness to maximum and then reduce to normal viewing level.
4. Adjust high-voltage control for minimum blooming and optimum brightness.
5. Adjust focus control for best focus in center of screen.

—*Olympic Service Bulletin*

LOOP AROUND DIAL-CORD SPRING EVENS CORD TENSION

To prevent backlash in dial-cord tuning mechanisms, tie a bit of dial cord or nylon fishing line around the spring on the tuning drum. Stretch the spring a little more than normal and tie the loop so that the dial cord is taut but the cord loop is just slack.



The loop of cord limits the stretch of the spring to prevent excessive slack in the cord in one direction. This avoids the irritation of always seeing the tuning dial read lower on a particular station when you tune from one direction than when you tune from the other.

Another blessing: If the spring should break or slip off, the loop holds the dial cord in place until the spring can be restored—*Harold D. Mohr*

MONARCH EE-10 LATHE

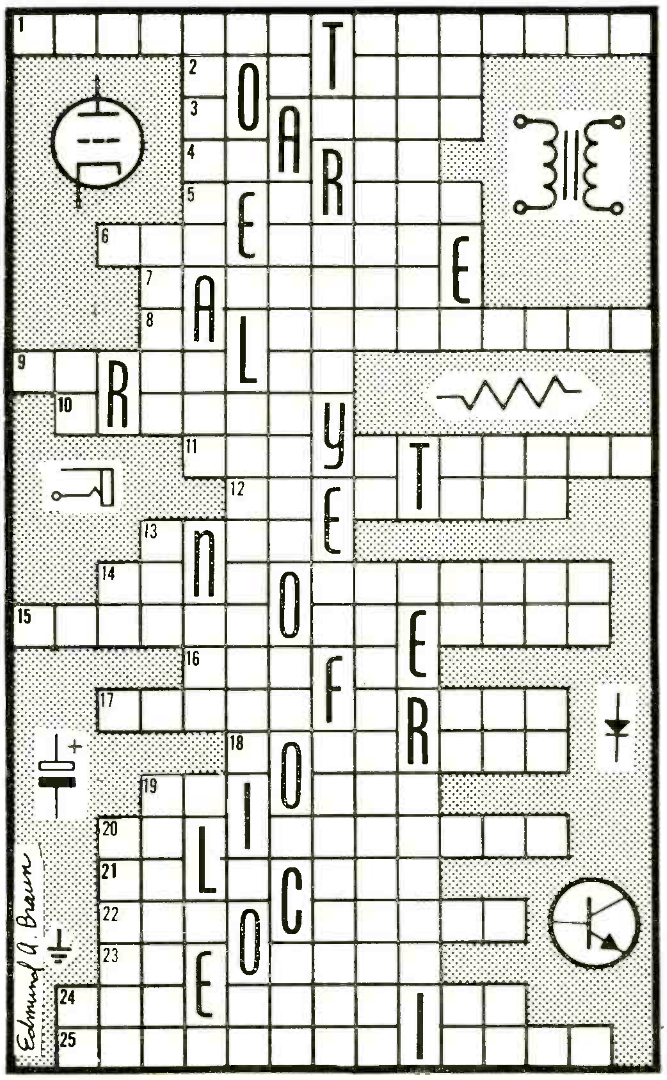
If the complaint is chattering (running roughly), check the compensation. Advance the compensation control beyond its present setting and load the spindle by gripping the chuck with a rag. The lathe should speed up.

Try to set the compensation control so the lathe neither speeds up nor slows down under load. If this can be done, the electronic control circuits are functioning correctly and the trouble is caused by worn brushes, weak brush springs or a rough commutator.—*R. C. Roetger* END

R-E PUZZLER

This only-across-word puzzle is based entirely upon electronic terminology with each word connected to the word above and below by one letter.

1 Reduction of attraction for certain metals.
2 Electromotive force; electrical pressure.
3 Type of transmission line not susceptible to external fields.
4 Mineral often used to control frequency of oscillators.
5 Pertaining to iron.
6 Total opposition a circuit offers to the flow of ac.
7 Phenolic compound having good electrical resistance.
8 Instrument for measuring flow of small electric currents.
9 A shunt connection.
10 Transformer input winding.
11 Clear thermoplastic material having excellent dielectric properties.
12 Range of electromagnetic radiations.
13 Positive electrode; the plate of a vacuum tube.
14 Material through which almost no current flows.
15 Heating aspect of an electric current.
16 An acoustical shield.
17 Changes ac of one voltage to another.
18 Circuit condition that determines current flow.
19 Three-electrode vacuum tubes.
20 Comparison of two instruments to determine accuracy.
21 Device for making connection to a choice of circuits.
22 Pertaining to black-and-white television.
23 A type of variable resistor.
24 Changing direction, as current flow.
25 Ability of color TV system to serve b-w receivers without modification.

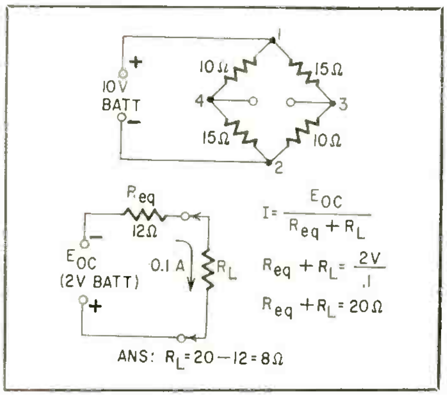


Solution next month

WHAT'S YOUR EQ?

These are the answers.
Puzzles are on page 54.

Network Problem



First, redraw the circuit as a bridge, with R_L temporarily removed. Now determine the Thevenin equivalent circuit.

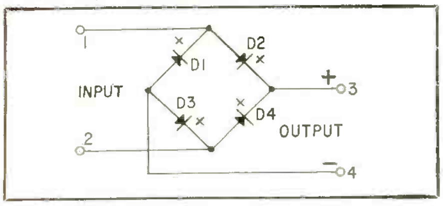
$$I = \frac{E_{oc}}{R_{eq} + R_L}$$

$$R_{eq} + R_L = \frac{2}{0.1}$$

$$R_{eq} + R_L = 20$$

Therefore, $R_L = 20 - 12 = 8$ ohms.

Polarity Straightener



Here's the circuit.

Assume input is: 1−, 2+. D1 and D4 are forward-biased and allow conduction through the load so output is: 3+ and 4−. Reverse the input, so input is 1+ and 2−. Now D2 and D3 are forward-biased and allow conduction through the load for 3+ and 4−. When D1 and D4 are forward-biased, D2 and D3 are reverse-biased and therefore don't conduct. The same is true the other way around. END

50 Years ago

In Gernsback Publications
From April, 1917
Electrical Experimenter

Motorcycle Wireless Telephone Outfit
A Selenium Cell Radiation Ammeter. by Frank Walcutt
A 4,000-Meter Vest-Pocket Radio

UNDERWATER COMMUNICATOR It could be an aid to safety in skindiving. Is it radio—or a radically different system? Whichever it is, it works—and you can build it. See complete details in **May RADIO-ELECTRONICS**

NEW SEMICONDUCTORS, MICROCIRCUITS & TUBES

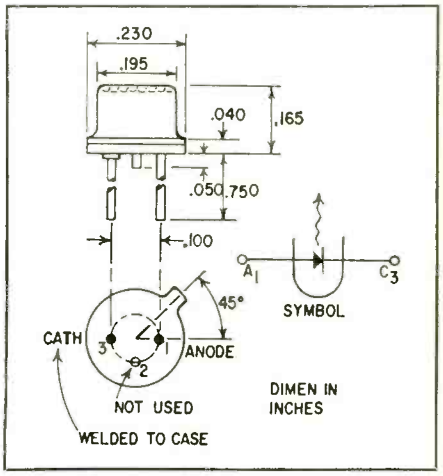
PULSED ROOM-TEMPERATURE LASER

The General Electric H1D1 injection gallium arsenide laser produces infrared light over a temperature range of −196°C to 75°C. It is mounted in a TO-46 header and hermetically sealed in a metal can with a flat glass window in the top. Absolute maximum ratings are:

Breakdown volts (reverse)	1 Vdc
Peak current (I_P)	120 A
Repetition rate	500 Hz
Pulse width	300 nsec
Power dissipation ($T_A = 25°C$) derate 1.5 mW/°C above 25°C	150 mW
Junction temperature	−196°C to 100°C

Typical characteristics:

Peak power output (peak current 100 A, T_C is −196°C	5W
Forward voltage ($I_F = 25$ A)	4 W
Lasing threshold	65 A pk
Power efficiency	0.25%
Power efficiency $T_C = -196°C$	4%
Resistance	0.2 ohm
Wavelength	9,000 Angstroms
Beam divergence	20 x 20 degrees



END

TRY THIS ONE

STOWING ANTENNA MASTS

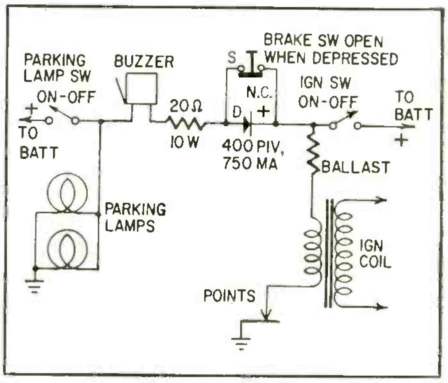
We lacked adequate storeroom floor space for racks to store antenna masts and other long components so we raised the racks to ceiling height and suspended them from the structural-steel roof supports. This takes our most bulky stock off the floor and utilizes previously wasted ceiling space. The masts and other components can be reached from a stepladder. —*Joe Wood*

QUICK COIL FORMS FROM PAPER TAPE

To make emergency or odd-sized coil forms, find something round and smooth to serve as mandrel. Then wet down enough gummed paper packing tape to fit around four times. Wrap the tape tightly and immediately slide it off the mandrel. (If you leave it on the paper will shrink and you'll have to cut it off.) Thorough drying will give you a tube just slightly larger than the mandrel, and rigid enough to wind coils on. —*Tom Jaski* END

NOTEWORTHY CIRCUITS

PARKING LIGHT: BRAKE REMINDER



This circuit can save you time and money if you are inclined to leave parking lights on all day after driving to work on foggy mornings. It can also be used to remind you to release the parking brake before driving. The circuit has been in use on a 1964 Valiant for some months now with no difficulty. Operation of the unit is as follows:

With the lights and ignition off no power is applied and the alarm is silent. When the lights and ignition are on both input terminals of the unit are connected to the positive side of the battery and the buzzer is silent until the ignition is turned off. At this time current flows from ground through the points and coil through D and hence to the positive side of the battery via the light switch. The buzzer sounds. Diode D prevents the buzzer from sounding when the lights are off and the ignition is on.

With the lights off and the parking brake set (S is closed) turning on the ignition lets current flow through the parking lamps, up to the positive supply through S and the ignition switch. The buzzer sounds until the brake is released.

If you want to have the brake set with the motor running, simply turn on the parking lights.

This unit can, of course, be used with either the parking lights or head lights but *not both* unless additional components are used. Operation depends upon the ignition points being closed when the motor is not running, a condition which will usually occur. When it does not, there will be sufficient pulsed operation between ignition turn-off and still motor condition to warn that the lights are on.

The unit is simple and easy to construct; total cost is about three dollars. The buzzer is a Liberty Bell M61 by Miami Carey obtained from Montgomery Ward. Others should work as well. The only care required in construction is to make sure that the case and frame of the buzzer is insulated from automobile ground since it will have battery potential applied to it. Mount the complete unit on a sheet of bakelite or plastic so that no part of the circuit or component mounting screws touch the automobile frame. My unit is mounted on the inside firewall under the dash. Omit the switch if the parking brake alarm is not desired.

Connect a wire from the high side of the buzzer to the positive side of the parking lamp so that 12 volts positive will be supplied to the unit when the parking lamps are on. The buzzer will be returned to ground through the parking lamps when the lights are turned off. Take care not to interfere with the turn signal circuit. Next connect the wire from the diode to the ignition switch side of the ballast resistor, if there is no ballast resistor, make the connection to the ignition switch or positive side of the coil. At this point test the unit by turning on the parking lights, you should hear a loud buzz. (The ignition switch must be turned off for this test.)

The brake portion is completed by mounting the switch on a metal bracket made from scrap metal or from an "L" bracket purchased at the hardware store. This is a very arbitrary mounting and will be different for each make of car. The switch is placed in any position where it will be depressed when the brake is *off*. Otherwise, the unit will buzz any time the ignition is turned on. This completes the installation.—*Jerry W. Hagood*

END

Underwater Communicator

It could be an aid to safety in skindiving. Is it radio—or a radically different system? Whichever it is, it works—and you can build it. See complete details in

May RADIO-ELECTRONICS

NEW BOOKS

FM RADIO STATION OPERATIONS HANDBOOK, edited by Verne M. Ray. *Tab Books, Drawer D, 18 Frederick Rd., Thurmont, Maryland 21788. 5½ x 8½ in., 196 pp. Plastic ring, $9.95*

Taken from articles in past issues of *Broadcast Management/Engineering* magazine. Filled with good information, although its article format means you have to read quite a bit and organize it yourself. Covers wide range of topics relating to FM broadcasting, including dual polarization, automated broadcasting, building a station, SCA, plus troubleshooting information and a couple of articles on the business side of operating an FM station. All well written and nicely edited, but it sure could use an index.

USING YOUR TAPE RECORDER, by Harold D. Weiler. *Allied Radio, 100 N. Western, Chicago, Ill. 60680. 5½ x 8½ in., 96 pp. Paper, $0.50*

Though not very technical, this book covers tape recording comprehensively. Talks about sound, the recorder, microphones, recording and editing techniques, and a chapter on maintenance. Not a dry book, but not easy to read, either. END

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PIV/RMS 400/280 .14 ea.	PIV/RMS 500/350 .19 ea.	PIV/RMS 600/420 .21 ea.	PIV/RMS 700/490 .25 ea.
PIV/RMS 800/560 .30 ea.	PIV/RMS 900/630 .40 ea.	PIV/RMS 1000/700 .50 ea.	PIV/RMS 1100/770 .70 ea.

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3	.08 ea	.12 ea	.16 ea	.22 ea
12	.25	.50	.65	.75
35	.65	.90	1.25	1.40
50	1.00	1.20	1.50	1.75
100	1.60	2.00	2.40	3.00

D.C. AMPS	300 PIV 210 RMS	400 PIV 280 RMS	500 PIV 350 RMS	600 PIV 450 RMS
3	.27 ea	.29 ea	.37 ea	.45 ea
12	.90	1.30	1.40	1.65
35	2.00	2.35	2.60	3.00
50	2.20	3.25	3.50	4.00
100	3.60	4.50	5.25	7.00

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PRV	7 AMP	16 AMP	25 AMP	PRV	7 AMP	16 AMP	25 AMP
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150	.90	1.60	2.00	500	3.20	3.40	3.80
200	1.25	1.80	2.25	600	3.40	4.00	4.50

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Circle 143 on reader's service card

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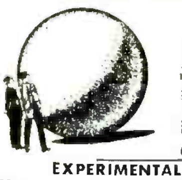

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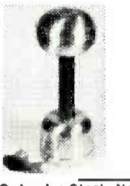

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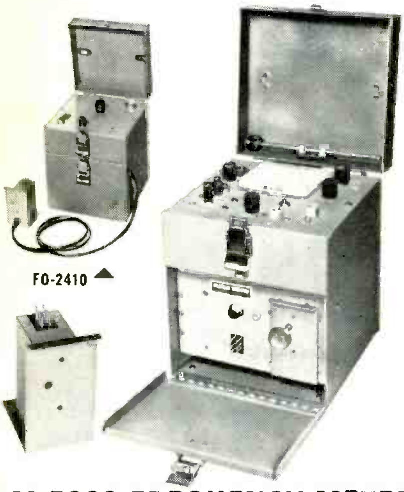

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FM-5000 with batteries, accessories, less oscillators and crystals.
Cat. No. 620-103 .... $375.00

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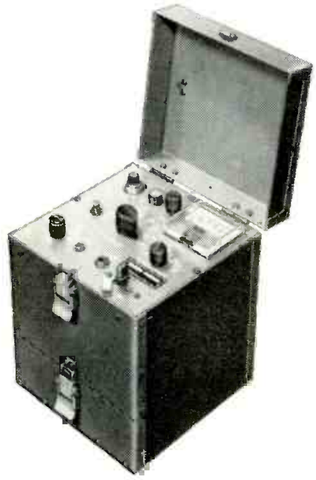

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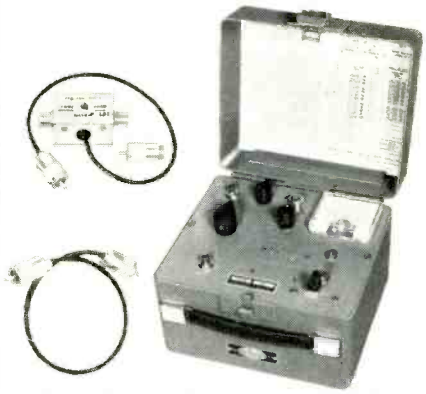

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This extremely portable secondary frequency standard is a self contained unit for servicing radio transmitters and receivers used in the 27 mc Citizens Band. The meter is capable of holding 24 crystals and comes with 23 crystals installed. The 23 crystals cover Channel 1 through 23. The frequency stability of the C-12B is ± .0025% 32° to 125°F, .0015% 50° to 100°F. Other features include a transistorized frequency counter circuit, AM percentage modulation checker and power output meter. Shipping weight: 9 lbs.

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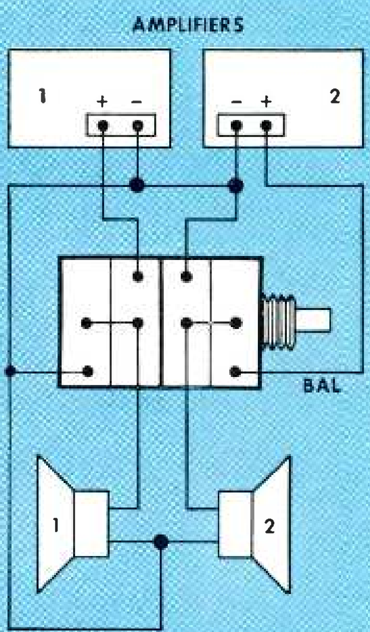
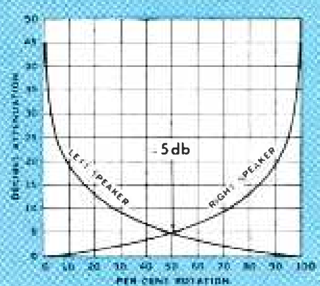
MALLORY Tips for Technicians

New way to balance stereo systems





If your stereo system has the usual independent volume controls for each channel, you've probably gone through all sorts of headaches getting right and left in just the right balance. And just when you've finally brought the whole works into perfect shape, somebody twiddles the knobs. So then you start all over again . . . going back and forth between channels until everything comes out right.

We have a tip that can add an extra touch of convenience to your set up. It's the new Mallory stereo balance control (BAL 8 and BAL 16). It's a pair of L pads on the same shaft, back-to-back . . . or maybe head-to-toe describes it better. As you turn the shaft, one pad *increases* attenuation and the other *decreases*. They're both audio tapers, so that on each side of dead center you get a smooth, gradual change in attenuation with rotation; this makes fine adjustments of balance easier. The center point loss in both channels is only 5 db, which you'll never miss.

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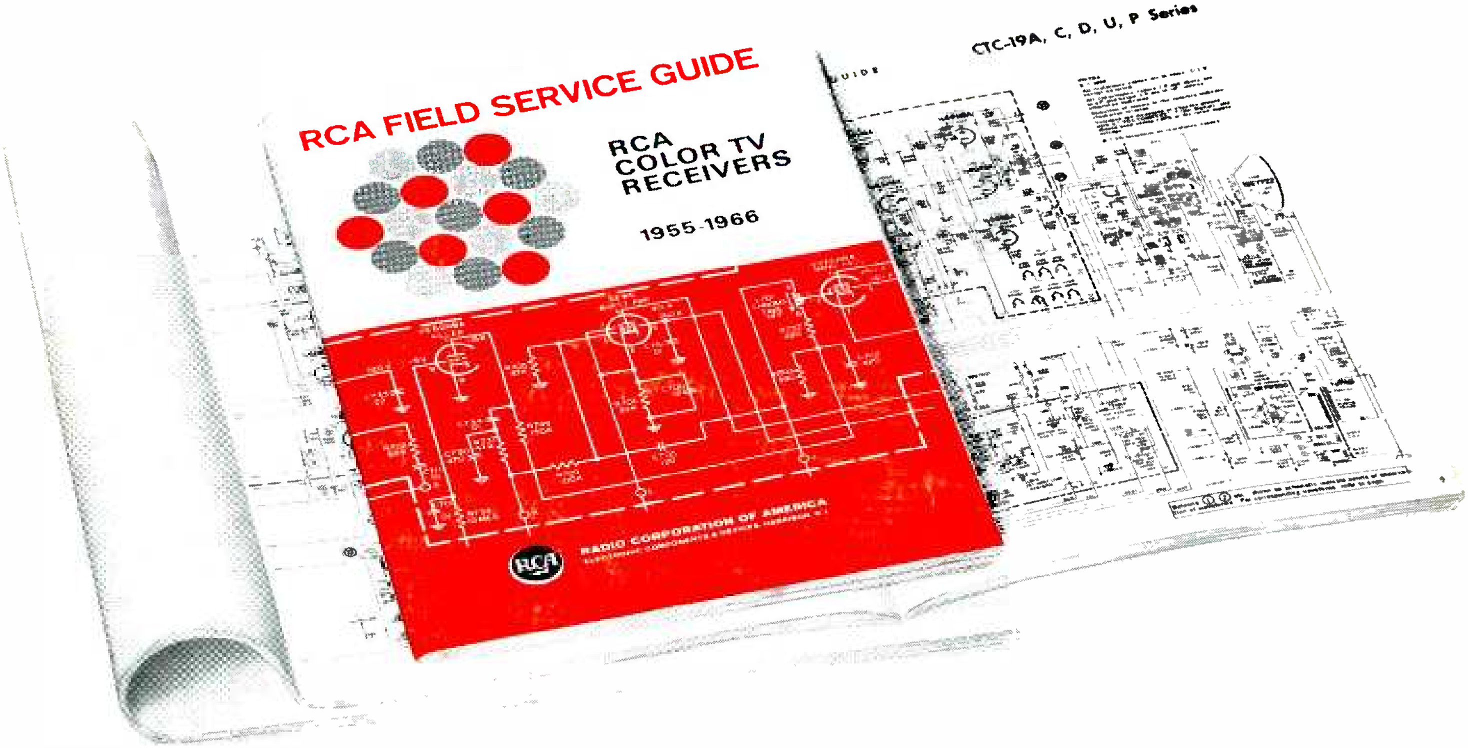

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