Narrow-band Scopes for Color TV
How to Read Capacitor Codes
Crowhurst on Followers

Home Video Recorders:
- Who makes them
- What they cost to buy, to run
- How they work
If you think all replacement tubes are alike, you've got a surprise coming.
ARE YOU NEXT?

HOW MUCH WOULD YOU LOSE IF BURGLARS STRUCK TONIGHT?

TECHNICAL INFORMATION

The RADAR SENTRY ALARM is a complete U.H.F. Doppler Radar System which saturates the entire line of sight area with invisible r.f. microwaves. It provides complete wall to wall—floor to ceiling protection for an area of up to 5,000 square feet. Without human movement in the protected area, the microwave signal remains stable. Any human movement (operation is unaffected by rodents and small animals) in the area causes the doppler signal to change frequency approximately 2 to 4 cps. An ultra-stable low frequency detector senses this small frequency change, amplifies it and triggers the police type siren—which is heard up to a half mile away.

In addition, the RADAR SENTRY ALARM’s protection can be extended to other areas with the use of the following optional accessories:

- remote detectors for extending coverage to over 10,000 sq. ft.
- rate of rise fire detector U.L. approved for 2,500 sq. ft. of coverage each (no limit on the number of remote detectors that can be used)
- hold-up alarm
- central station or hospital call transmitter and receiver (used with a leased telephone line)
- relay unit for activating house lights
- battery operated horn or bell which sounds in the event of: power line failure; equipment malfunction or tampering


Add it up. What’s the total? . . . $1,000.00? . . . $5,000.00? . . . $10,000.00? . . . more?

Can you afford a loss like that?

Can you afford to be out of work for two or three weeks because your test equipment was stolen? Or smashed? Because if a burglar isn’t satisfied with your haul . . . he’ll smash everything in sight.

And don’t count on insurance to cover your losses . . . At best, you’ll get only partial restitution . . . and nothing for all the time you lose.

When will your time come? We hope . . . never.

Install a "RADAR SENTRY ALARM" security system . . . And we know never!

But there’s another reason why you should install "RADAR SENTRY ALARM" in your business. Before you know it you’ll be installing them all over town. Because everyone needs protection. Of the more than 100 million buildings . . . stores, offices, factories, schools, churches and homes . . . only a small percentage are protected by an effective security system.

You can sell them! And you don’t have to be a super salesman either. For hundreds of electronics professionals like yourself are selling them . . . all across the country. All you have to do is demonstrate it. It sells itself. A glance at the technical information shows why. It’s the most unique, effective and advanced security system available.

Here is a list of just some customers who are protected by RADAR SENTRY ALARMS: U.S. Government; U.S. Air Force; Detroit Board of Education; Catholic Diocese of North Carolina and Detroit; Hundreds of Businesses, homes and factories.

You, too, can protect your possessions and property . . . the same way you earn them . . . ELECTRONICALLY . . . with a "RADAR SENTRY ALARM". And at the same time expand your business in a totally new area that yields high profits.

Don’t wait.

Write today for complete details.

RADAR SENTRY ALARMS BY DAY . . . PROFITS BY NIGHT . . . PROTECTION

RADAR SENTRY ALARM

Mail to: RADAR DEVICES MANUFACTURING CORP.
22003 Harper Ave., St. Clair Shores, Michigan 48080

Please tell me how I can protect and expand my business with Radar Sentry Alarm. I understand there is no obligation.

Name ____________________________
Address ____________________________
City ____________________________ State & Code ________________

Circle 8 on reader’s service card
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A CAPTAIN’S CAPTAIN

Remarkable developments in electronics have helped make possible such luxury liners as the S.S. France, of which Joseph Ropars is commandant. Ropars is known as a “captain’s captain,” one of the most popular masters of the French Line’s trans-Atlantic fleet.

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☐ Microwaves ☐ Industrial Electronics
☐ Automation Electronics ☐ Broadcasting
☐ Radar ☐ Electronic Control

☐ I AM INTERESTED IN AUTOMOTIVE AND MAINTENANCE ELECTRICAL. Please supply further information.

NAME: ____________________________
AGE: ____________________________

ADDRESS: __________________________________________
APT. __________________________________________

CITY STATE ZONE

☐ Check here if you are under 16 years of age

2099 Available in Canada

ACCREDITED MEMBER OF NATIONAL HOME STUDY COUNCIL

MAY, 1966

Circle 9 on reader’s service card
GAS LASER WITH HIGHER POWER

The world’s most powerful gas laser can emit 280 watts of coherent light energy continuously at better than 10% efficiency. Its concentrated beam can melt and vaporize even refractory materials used in high-temperature furnaces. Some ruby lasers have attained higher peak power but emit their energy only in pulses. Gas lasers, which generate sustained radiation suitable for telecommunication and other uses, have previously achieved outputs of some 130 watts. Developed by Compagnie Générale d’Electricité, in France, this new laser uses a discharge tube containing carbon dioxide, helium and nitrogen to produce 10.59-micron-wavelength infrared rays.

ELECTRONIC SPACE STUDY

A rocket-propelled 210-lb payload, plunging back into the Earth’s atmosphere at 18,000 mph, used a continuous telemetry channel to help test low-density heat-shield material. The experiment provided essential test data by radio to down-range ships and aircraft.

A delayed telemetry system is used to transmit information about the 1-minute communications blackout that occurs during re-entry.

NASA also launched a series of nine rockets to make meteorological investigations of the upper atmosphere. Grenades (special explosive charges) are ejected and detonated at programmed altitudes between 20 to 60 miles, over widely spaced geographic areas. The position of each grenade at detonation is determined by radio measurements of range, azimuth and elevation. The time of arrival and direction of sound waves caused by the detonations are measured by sensitive microphones on the ground. As a result, wind directions and speeds, atmospheric densities, pressures, and temperatures can be determined.

In other tests, pulsed laser radar will be used for upper-atmosphere investigations under an agreement between the Swedish Space Research Committee (SSRC) and NASA. The principal scientific objective is to determine height, distribution and scattering properties of cosmic dust and aerosol particles during the presence and absence of noctilucent clouds (faintly luminous clouds which can be seen at heights of 75 to 90 kilometers at high latitudes at dusk or sunrise).

A pulsed ruby laser, an extremely high-energy light source concentrated into a narrow spectral line and confined to a very narrow beam, has been selected for this purpose. The laser operates on the same principle as ordinary radar, but uses the laser beam instead of a radio beam. Returns are detected by a photomultiplier receiving unit and fed into a memory unit where they are analyzed automatically. Stored information is displayed either on an oscilloscope and photographed, or punched on tape for further evaluation.

COMPUTERS IN USE ON ALL FRONTS

Computers are finding their way into the news, being used in all sorts of unusual ways.

The USS Enterprise, first nuclear-powered carrier to enter battle, brings into action off Vietnam a new automated combat-direction system which provides Navy commanders with information from the battle zone. Called NTDS (Naval Tactical Data System), the system is described as “an advanced ship-board system for command and control of a tactical situation.”

NTDS provides a ship’s combat-operations team with a comprehensive information picture of ships, aircraft, and submarines–friend and foe–gathered by shipboard radars and other sensors, compiled by computers, and displayed before the eyes of the command team on NTDS consoles. The Enterprise’s system uses a Hughes Aircraft Co. Scanfan radar–computing system—a fixed-array radar and data-processing complex that detects and automatically tracks hundreds of targets simultaneously. It stores and displays information relating to aircraft on a variety of missions.

Back home, a cooperative program in the Minneapolis-St. Paul area, allows eight hospitals to share common computer facilities for improving patient service and hospital administration. The program is the start of a nationwide information network which will connect hospitals to a central computer complex that will provide a range of accounting, administrative, and hospital management services, at a cost substantially less than if each hospital had its own computer.

At a demonstration, the 292-bed Abbott Hospital sent and received accounting information over telephone lines to a pair of Honeywell 200 computers about 4 miles away at the Minnesota Blue Cross Cooperative Data Center. The computers processed some of the data, stored some for future use, and upon request automatically transmitted patient-billing information to Abbott. In less than 90 seconds, complete bills were printed and given to discharged patients.

Inventory control, purchasing of hospital supplies and nonperishable foods, employee payroll and personnel records, property accounting for hospital equipment and facilities, preventive-maintenance scheduling, and general accounting will be added later this year and in 1967. Applications more directly related to patient care will be developed in gradual stages—for example, a dietary-management program based on nutritional and cost

continued on page 6
Plain Talk from Kodak about tape:

**Giving your tape library a longer prime of life**

How long can you keep a recorded tape? As of today, nobody knows for sure. Recording companies have tapes dating back to the late 1940s that are still in fine shape. Actually, the aging problem for tape is somewhat akin to the ones faced by moviemakers. Their problems are tougher, though...movie-makers have to worry about latent chemical reactions, greater mechanical strains, etc. And yet, we can see movies made more than a half century ago if the films have been given proper care and expert duping. Like photographic films, many audio tapes are made on acetate base. Ours is Kodak's famous Durol Base, the stronger, tougher tri-acetate (we also make KODAK Tapes with a tempered polyester base for extra toughness or for long-play applications). Lab tests show that Durol Base holds up as well as photographic film. So...tape wise, there's no reason your great grandchildren won't be able to enjoy your present efforts.

**T.L.C. makes the big difference.** Tender loving care is a must when saving anything worthwhile. The same goes for tapes. One obvious safeguard is to keep tapes away from strong magnetic sources like large electric motors or transformers which could demagnetize a recording. Keep it clean. Tapes hate dirt just as much as regular records do. Thanks to sturdy, one-piece construction, Kodak's new "library décor" box helps keep dirt out...won't fall apart over the years as conventional tape boxes sometimes do. And this new box looks better. Play it clean too, of course. Clean your recorder heads, capstans, rollers and guides regularly with a cotton swab moistened with one of the commercial cleaners sold for that purpose. Use a degausser periodically to remove any magnetization of recording heads.

**Keep it cool.** Tapes should be kept away from extremes of temperature and humidity. High temperatures may affect the plastic support and increase the possibility of print-through...the transfer of magnetic signals from one layer of tape to the next. Keep it "backwards." For truly valuable recordings, a good trick is to keep your tapes in the "tails out" format rather than rewinding them. The uneven winding induced in the tape by fast rewinding can cause physical warping of the tape over a period of time. Here too, you're better off with KODAK Tapes because KODAK 5" and 7" Thread-Easy Reels are of dynamically balanced, one-piece construction. This gives you freedom from wobbles and pulsations on both "record" and "rewind"...keeps the tape under smoother tension...just what the doctor ordered for long tape life. The need for smooth winding can not be overemphasized.

Last but not least, it's a good idea to dupe your really old tape recordings onto fresh KODAK Tape in order to standardize on KODAK Tape quality. That's an interesting subject all by itself, and we'll try to devote a "Plain Talk" to it soon! KODAK Tapes on Durol, and polyester bases are available at electronic, camera and department stores. To get the most out of your tape system, send for free 24-page "Plain Talk" booklet which covers the major aspects of tape performance. Write Department 940, Eastman Kodak Company, Rochester, N. Y. 14650.
In the field of travel, a new system of passenger check-in and load control is now in its sixth month of operation at Pan American in New York. The heart of the system is an IBM 1440 computer. Agents communicate with the computer using a Bunker-Ramo Teletypewriter “interrogator” which combines a small TV screen and a keyboard. When a passenger checks in, the agent punches the flight number and the first two letters of the passenger’s last name. In less than a second the display shows all reservations meeting this description. The agent selects the correct name, and the computer then shows the complete passenger record—name, initials, class of service, destination, number of infants, etc.

The special CRT device used in the system has a display capacity of nine lines, each of 42 characters. Data transmission between interrogators and computer is at the rate of 42,000 characters per second. The display sets connect to two universal control units, which supply delay-line storage and multiplexing. The control units feed into a single interface unit which in turn connects to an IBM 1441 processing unit. Remote positions at ticket counters transmit over Data-phones on a 1200-character-band (150 character-per-second) telephone line. The high-speed memory has 16,000 positions. An additional 2 million characters can be stored on discs—sufficient for all programs, active flights, permanent aircraft and flight files, and training data.

Cornell University will soon be able to allow some of its scholars, administrators, and students to ask questions of a fact-stuffed, lightning-fast, $3 million central computer and receive immediate answers. This facility is a time-sharing multiprogramming computer that can be used simultaneously...
WELCOME ABOARD!

International's "FLYING SHOWROOM 66" will visit your area soon. Welcome aboard this fabulous electronic flying display.

During 1966, International's Martin 202 Flying Showroom will tour cities throughout the United States, bringing with it displays of International electronic equipment and products, plus a technical staff available for consultation. ■ A space age electronic show for Citizens Radio dealers and users, Amateur Radio operators, users of commercial 2-way radio, manufacturers requiring special electronic products, radio experimenters and hobbyists. ■ If you are a manufacturer, radio equipment dealer, Amateur or Citizens Radio Club, or other interested groups, we will attempt to schedule a specific time and date to visit your area. Watch for announcement or write International Crystal Manufacturing Co., Inc. for details.

Discuss your technical and engineering requirements with International's staff. See how International electronic products can work for you.

INTERNATIONAL CRYSTAL MFG. CO., INC.
18 North Lee
Oklahoma City, Okla. 73102

Circle 12 on reader's service card
Discover the excitement of learning Electronics with training kits NRI sends you

New Achievement Kit Custom Training Kits “Bite Size” Texts

Only NRI offers you this pioneering method of “3-Dimensional” home-study training. It’s the result of more than half a century of simplifying, organizing, dramatizing subject matter. As an ambitious man you can effectively learn the Electronics field of your choice the NRI way. But NRI training is more than kits and texts. It’s personal services, too, which have made NRI a 50-year leader in the home-study field.

YOU GET MORE FOR YOUR MONEY FROM NRI

Everything that you see here is included in just one NRI course. Other courses are equally complete, yet you’ll be surprised at the low cost. Text for text, kit for kit, dollar for dollar—your best home study buy is NRI.
Earn $3 to $5 an hour spare or full time in TV-RADIO SERVICING

Want to earn extra money? Looking for a good paying job? Interested in your own full-time business? Radio-TV Servicing is the branch of Electronics offering all these opportunities. In addition to teaching you the facts, NRI shows you how to earn while you learn.

You can learn quickly how to install, maintain and service tube and transistor home and auto radios, TV sets (including booming Color TV), hi-fi and stereo, public address systems. Like thousands of others, you can be earning $3 to $5 an hour in spare-time starting soon after you enroll.

There's glamor and success awaiting you in BROADCASTING—COMMUNICATIONS

Good paying, fascinating positions await competent Communications Operators and Technicians. Broadcast stations, commercial stations, ships, aircraft, land vehicles all need men who know how to maintain and repair transmitting and receiving equipment. With closed-circuit TV, Facsimile, Microwave, Radar, Telemetry and all the communications needs of the Space Age, you can see how important training in this field has become. NRI training includes preparation for your First Class Radiotelephone FCC License. And you must pass the FCC exam or NRI refunds your tuition in full!

Move ahead in America's fast moving industry as an ELECTRONICS TECHNICIAN

There is a serious shortage of qualified Electronics Technicians. Electronics has found its way into hundreds of areas not even dreamed of ten years ago: offices; manufacturing; medical and dental uses; transportation; space exploration; government and military equipment... there's no end of opportunity for trained men. This course stresses the basic principles around which most Electronic devices are built; prepares you for many current job openings. Prepare now. Learn Automation, computers, data processing, ultrasonics, telemetry. Whatever your interest in Electronics, you'll find an NRI training plan for you. Check the course of most interest to you on the postage-free card and mail it today for your free NRI Catalog. No obligation. No salesman will call.

NATIONAL RADIO INSTITUTE, Washington, D. C. 20016.

More than 50 years of leadership in Electronics Training

MAY, 1966
NEWS BRIEFS continued
by 40 or more individuals, some of
who may be in their own offices a mile
or more away. A Cornell spokesman
noted that "it will permit us to devolv
new applications of electronic compu-
ters and new ideas in teaching and
in data processing for other university
needs."

At the University of California
(San Francisco), a new language called
"Computest" allows man and machine
to communicate with each other. Dr.
John A. Starkweather demonstrated
how a computer gives tests and how it
can participate in an interview. The
IBM 1620 computer, although not yet
programmed to a point that allows its
use with patients, is proving valuable
as a teaching tool for students in the
health sciences. The interviewer and
the machine communicate by a type-
writer attached to the computer, and
programs are written in a "Computest"
vocabulary related to normal speech.

BRITISH TOWN USES COMPUTER
IN BRIDGE DESIGN

A computer is being used to help
design a bridge over the River Aire in
Yorkshire. The bridge, to be construc-
ted by cantilevering from each bank,
with the two sections finally joined by
a pin, is the first of its type to be built
in England. If conventional bridge-de-
sign techniques were used, they would
block the river's small navigable chan-
nel.

A Honeywell 400 computer is
computing the profile of each of the 64
sections of the bridge to correct shrink-
age, stress and creep problems that
could prevent the bridge from meeting
exactly at midpoint over the river.

The county also plans to use the
computer in constructing roads, by
having it provide data on proper road
curvature and camber. The computer
can produce perspective drawings that
permit road and bridge designs to be
viewed from different angles—a tech-
nique used by engineers to correct
misalignments and other design errors.

TAPE RECORDERS FOR
SOLDIERS IN VIETNAM

Too much mud, not enough mon-
ey for equipment, and an urgent need
for tape recorders. These were some of
the problems revealed by Gene
Schram, Jr., executive director for the
USO Pacific Command, in a letter
acknowledging receipt of six tape re-
corders from Craig Panorama, Inc. and
Sayer Brothers, both of Los Angeles.
The tape recorders are being used at
the only four USO centers in operation
in South Vietnam—at Tan Son Nhat,
Qui Non, Nha Trang and Saigon. The
USO director added: "We will always
need tape recorders and radios. Any-
thing you and your friends can do at
home to swell the `kitty' will do more
than words of mine can express."

COLOR TV LEADS
HOME-ENTERTAINMENT GROWTH

Color television leads the latest
upsurge in sales of home-entertain-
ment equipment, just as black-and-white
did a year ago. Improvements in technol-
ogy have also instilled new life in radio
and phonograph markets. New tape
recorders and electronic organs have
opened other fields for expansion.

The US market absorbed 11.6
million television receivers in 1965, ac-
cording to a tabulation, an increase of
more than 50% over the 7.76 million
TV sets produced in 1955. The 1965
total included 1 million imported re-
civers.

The sale of color TV sets last year
practically doubled over 1964 to reach
2.7 million sets.

INERTIAL NAVIGATION
SYSTEM IN JETS

The first commercial inertial navi-
gation system to be used in airline
operations will enable Alitalia's new
DC-8 Super 62 jets to operate without
navigators in any part of the globe, in-
cluding polar regions, without refer-
cence to celestial or ground-based navi-
gational aids.

The Douglas Aircraft Co. has an-
ounced an order for the Sperry SGN-
10 inertial navigation system for instal-
lation in their new DC-8 Super 62 jet-
liners which will be delivered to the
Italian flag carrier in early 1967.

Produced by Sperry Rand's Sperry
Gyroscope Co. Div., the system will
serve not only as the basic navigation
reference but will also be the attitude-
and heading-reference source for the
autopilot and flight instruments.

CALENDAR OF EVENTS

AES (Audio Engineering Society) Thirteenth
Annual Convention, Apr. 25–28; Hollywood
Roosevelt Hotel, Los Angeles, Calif.

1966 INTERMAG (International Conference on
Magnetics), Apr. 20–22; Liederhalle, Stuttgart,
Germany

SWIEEEO (Southwestern IEEE Conf.), Apr.
20–22; Dallas Memorial Auditorium, Dallas,
Texas.

NATESA (National Alliance of TV & Electronic
Service Associations) Spring Conference,
Apr. 23–25; St. Louis, Mo.

International Instruments, Electronics &
Automation Exhibition, May 23–28; Olympia
Hall, London, England

National Electronics Week, May 29–June 5;
Civic Auditorium, San Francisco, Calif.

42nd Annual EIA Convention, June 7–9; Con-
tinental Plaza Hotel, Chicago, Ill.

1966 IEEE Communications Conference, June
15–17; Sheraton Hotel, Philadelphia, Pa.
"Sure, you work hard, but that's not enough...

...you need more education to get ahead in electronics"

No matter how hard you work, you can't really succeed in electronics without advanced, specialized technical knowledge.

Going back to school isn't easy for a man with a full-time job and family obligations. But CREI Home Study Programs make it possible for you to get the additional education you need without attending classes. You study at home, at your own pace, on your own schedule.

CREI Programs cover all important areas of electronics including communications, servomechanisms, even spacecraft tracking and control. You're sure to find a program that fits your career objectives.

You're eligible for a CREI Program if you have a high school education and work in electronics. Our FREE book gives all the facts. Mail coupon or write: CREI, Dept. 1405-D, 3224 Sixteenth Street, N.W., Washington, D.C. 20010

SEND FOR FREE BOOK
What does **JFD** have that other TV antenna manufacturers wish they had?

![Image of JFD antenna models](http://www.americanradiohistory.com)
Mr. Dealer:

Don’t let other antenna makers “snow” you with claims of how their antenna “break-throughs” work so sensational you hardly need a TV set to get a picture. They’ve got little choice.

Ever since the LPV Color Log Periodic was introduced by JFD back in '62, our competitors’ engineers have been going around in circles. They’ve copied it down to the rivets. They’ve camouflaged their use of the log periodic principle with terms such as “energy distribution.”

They’ve imitated its name by calling theirs “V-log,” “Super-log” and .......................................................... -log. (fill-in-yourself)

They’ve tried to equal its performance with “half-size” compacts—but you can’t send a midget to do a man’s job—this just doesn’t work.

They still don’t know whether to knock it...fight it...join it...or how to live with it.

We say the proof of it all is the picture your antenna delivers to your customer’s set. That is where the JFD LPV Color Log Periodic conclusively demonstrates its basic performance superiority.

If you’re looking to give your customers the finest and truest color...crispest black & white...more VHF and UHF channels...even better FM stereo—don’t compromise your professional reputation with “antenna-compromises.” Rely on the patented JFD LPV Color Log Periodic as do so many tens of thousands of knowledgeable service-dealers.

We don’t expect you to take our word for it either. Let the picture (and your profits) be the proof.

Exactly WHAT the JFD LPV Color Log Periodic has that other so-called antenna “break-throughs” would like to have!

- ONLY the JFD LPV delivers genuine frequency-independent performance. The entire antenna (not part of the antenna as in other ordinary antennas) responds to every channel.

- ONLY the JFD LPV follows the patented log periodic design of the University of Illinois Antenna Research Laboratories.

- Only the JFD LPV uses Cap-Electronic (capacitor-coupled) elements. This permits (1) precise and independent tuning for optimum performance in both fundamental and harmonic modes—plus (2) increased capture area—plus (3) directors tuned to perform on all bands, not just one. The result is higher gain, narrower directivity, higher front-to-back ratios for brilliant color, better-than-ever black & white—on channels 2 to 83.

NATIONALLY ADVERTISED IN LIFE. Month after month, 32 million readers of LIFE are being exposed to the reasons why the JFD LPV works best.

COLORFULLY ADVERTISED OVER TELEVISION. Spectacular motion-picture commercials in full-color are pre-selling millions of present and prospective color TV owners.

DIFFERENT LPV LOG PERIODICS TO CHOOSE FROM.

Interested in VHF?...UHF?...VHF/UHF/FM? Whether it’s just one band or all, town or country, you get the precise antenna-answer when you make it an LPV Color Log Periodic. Interested in more facts? Just write us.

MERCHANDISED IN DEPTH. Banners, direct mail, newspaper mats, radio/TV commercials...you name it JFD’s got it to help you sell your way to top antenna profits.

A WORD ABOUT OUR PATENTS...

Eleven different U.S. patents and patents pending embrace the scientific advances of the JFD LPV—more than any other outdoor TV antenna. Our competitors’ attorneys are burning the midnight oil trying to find loopholes and ways to circumvent this patent protection which assures you of getting the only genuine antenna designed according to the original patented log periodic design of the famous University of Illinois Antenna Research Laboratories.

AT THE MOMENT OF TRUTH THE PICTURE IS THE PROOF WHY JFD LPV COLOR LOG PERIODICS WORK BEST!

JFD ELECTRONICS CORPORATION

15th Avenue at 62nd Street, Brooklyn, N.Y. 11219
JFD International, 64-14 Woodside Ave., Woodside, N.Y. 11377
JFD Canada, Ltd., Canada

See what’s NEW from JFD at BOOTH #2101 in San Francisco Parts Show June 3, 4, 5

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ATTENTION! CB OPERATORS

save on citizens radio equipment

Discontinued Models From International Radio Exchange

Select that extra transceiver for mobile or base installation, or equip a new station. Our stock includes International types as well as other makes.

Write Today for A Complete List of Equipment in Stock

The story of your career in electronics surely hasn't been written yet.

But you may find the preface to it on page 31

WELL, IT'S ALMOST PERFECT

Dear Editor:

The "Component Curve Tracer" in the November 1965 issue is a very useful piece of test gear. But there is another component you can't check with it. [The article mentioned that frequency crystals and batteries couldn't be checked with the Curve Tracer.—Editor] If you test a small, low-power SCR you'd expect to get a diode curve on the scope. However, due to the small capacitance of a low-power SCR, the display indicates a dead short. An SCR that checks as shorted on the Component Curve Tracer comes up as good on a Tektronix curve tracer.

TAD E. COWELL

Seattle, Wash.

[Author Fred Blechman comments: "The low voltage in the Component Curve Tracer makes it difficult to test every type of component. The operator should try a known-good component to be familiar with its characteristic trace; from then on, abnormalities in other parts of the same type will be readily apparent. The Component Curve Tracer is still a simple and almost universal quick-check."]

OUR CHANGE HERTZ SOME READERS

Dear Editor:

You have taken a perfectly good term—cycles—that has a valid intrinsic meaning, and which has been used for ages in applications relating to that meaning, and substituted for it the word "Hertz," which has no meaning at all. If this stands, and the trend continues, engineering education of the future will become as idiotic and inefficient as the medical field now is. (I am now a physician, having entered medicine after 20 years in engineering.)

Can you actually give a good reason for this word change?

ROBERT C. BEARD

Indianapolis, Ind.

[We have received many letters asking us why we changed. One reason is that the new term follows the practice adopted by the National Bureau of Physics.]
successful service shop beats rising costs with B&K television analyst

"As every serviceman knows, major TV repairs represent an increasingly large part of the service business and the average time per repair has increased"...


After more than 25 successful years in the service business, twenty of them in the same location, Mr. Horne can be considered an authority on how to keep a business profitable. Mr. Horne says, "In order to be successful, our 3-man shop has to be competitive on the large jobs as well as the small ones. With the increase in bench time that we were experiencing and the limitations on what we could charge, there was a reduction of profit that had to be stopped. Then we bought a B&K Model 1076 Television Analyst."

"Now our customers get the same extra-value service on the big repairs and the small ones," said Mr. Horne. "We use the Television Analyst for troubleshooting a wide variety of complaints, particularly for those that require touch-up alignment, location of IF overloads and color convergence. We are more competitive now that we use the B&K Television Analyst because we spend far less time on the jobs that used to be dogs, with benefits both to the shop and our customers."

*B&K Model 1076 Television Analyst checks every stage in a black and white or color TV receiver. Nine VHF RF channels, 20 to 45 MC IF, audio, video, sync, bias voltage and AGC keying pulse are available. The model 1076 provides its own standard test pattern, white dot, white line crosshatch, and color bar pattern slide transparencies. It includes a blank slide which can be used for closed-circuit TV display floor promotion. Its net price is $329.85.

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Circle 16 on reader's service card
Why Fred got a better job...

I laughed when Fred Williams, my old high school buddy and fellow worker, told me he was taking a Cleveland Institute Home Study course in electronics. But when our boss made him Senior Electronic Technician, it made me stop and think. Sure I’m glad Fred got the break... but why him... and not me? What’s he got that I don’t. There was only one answer... his Cleveland Institute Diploma and his First Class FCC License!

After congratulating Fred on his promotion, I asked him what gives. “I’m going to turn $15 into $15,000,” he said. “My tuition at Cleveland Institute was only $15 a month. But, my new job pays me $15 a week more... that’s $780 more a year! In twenty years... even if I don’t get another penny increase... I will have earned $15,600 more! It’s that simple. I have a plan... and it works!”

What a return on his investment! Fred should have been elected most likely to succeed... he’s on the right track. So am I now. I sent for my three free books a couple of months ago, and I’m well on my way to Fred’s level. How about you? Will you be ready like Fred was when opportunity knocks? Take my advice and carefully read the important information on the opposite page. Then check your area of most interest on the postage-free reply card and drop it in the mail today. Find out how you can move up in electronics too.
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MAY, 1966
CORRESPONDENCE continued

Standards and numerous respected manufacturing corporations and scientific journals. As to why NBS adopted it, we won't speak for them, but it does bring American terminology into line with continental European practice, which has used the Hertz for many, many years.

[That's mere conformity, true. A more logical reason is that "cycles" alone is not really accurate. The correct unit is "cycles per second," which leads to somewhat unwieldy abbreviations like "cps" or "c/s." Since "Hz" is defined as cycles per second, "60 Hz" is really more accurate than the common "60 cycles."]

The physical sciences have set a long and honorable precedent for naming units after researchers associated with them: volt, amperes, ohm, farad, gauss, newton, joule, and many others. That practice is no more or less silly than making Columbus Day a bank holiday or minting a Kennedy half dollar. Nonsentential people may bristle at the thought; but the fact remains that it is much easier to talk of a newton of force than of a kilogram-meter-per-second-per-second.—Editor]

Let these experts answer your questions on COLOR TV servicing

![Color TV Repair](image1)

10 servicing experts who write for Radio-Electronics magazine reveal tested techniques, practical ideas, tricks-of-the-trade. Shows how to pinpoint defective color section fast, describes trouble-shooting with a color bar generator, outlines causes of TV failure. Includes servicing of chroma circuits, etc. 160 pages, paperback.

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![Servicing Color TV](image2)

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by Jack Darr. Gives you fast, simple methods of locating and repairing troubles in the sweep system. Practical shortcut, developed on the bench for rapid isolation of trouble. Includes horizontal oscillator, multivibrator, output stage, etc. 224 pages, paperback.

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Heath Company, Dept. 20-5
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Circle 18 on reader's service card

MAY, 1966

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SERVICE CLINIC

By JACK DARR  Service Editor

Finding Coax Cable Breaks

A little applied ingenuity will often save you a lot of time. You can use conventional test instruments in unusual ways to do jobs that could stymie a lesser man!

In audio work, for instance, you find a lot of shielded cables. Suppose you have a shielded, jacketed cable, and it's open. Where's the break? Same problem applies to coax cable.

You can use the old method of cutting off 6 inches from each end and replacing both plugs. This will fix most opens, for the ends of a cable get the hardest wear, from bending and flexing. However, you've whacked off a foot, and maybe it's going to be too short now, huh? Let's pin-point the break a little more exactly.

An ohmmeter can't tell you, of course, but your capacitance tester will! An open cable like this is just a "long

... one of the finest stereo FM tuners we have tested and...easily the best kit-built tuner we have checked."

Hi Fi/Stereo Review April 1966

"The Scott LT-112 met or exceeded all its specifications that we were able to check. Its sensitivity was 2.1 microvolts (rated 2.2). Harmonic distortion at 100 per-cent modulation was about 0.5 percent (rated 0.8 per-cent). Capture ratio was 2.4 db (rated 4 db). Hum was -66 db, which is the lowest we have ever measured on a tuner...it is a logical choice for anyone who wants the finest in FM reception at a most reasonable price."

Build the stereo tuner that has won rave reviews from audio experts...the Scott LT-112. Here are the same features, performance, quality, and reliability you'd expect from Scott's finest factory-wired solid-state tuners...the only difference is, you build it. LT-112 price, $179.95.


Circle 19 on reader's service card

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.
All-Band UHF-VHF-FM Antenna

The one antenna that does the work of 3! Gives startlingly clear black and white pictures and beautiful color on both UHF and VHF television channels — plus the finest in stereophonic and monophonic sound reproduction.

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Write for beautiful color brochures Number 20-322, and 20-307, Dept. RE

MAY, 1966

Circle 20 on reader's service card
WHY bother with makeshift twist-prong capacitor replacements?

When you substitute capacitor sizes and ratings, you leave yourself wide open for criticism of your work . . . you risk your reputation . . . you stand to lose customers. It just doesn't pay to use makeshifts when it's so easy to get the exact replacement from your Sprague distributor!

Get the right SIZE, right RATING every time with improved SPRAGUE TWIST-LOK® CAPACITORS!

1,863 different capacitors to choose from!
The industry's most complete selection of twist-prong capacitors, bar none. Greater reliability, too. Exclusive Sprague cover design provides a leak-proof seal which permits capacitors to withstand higher ripple currents.

Restoring old Patterson radio

I've just picked up an old "Patterson" 86AW four-band table radio, in pretty good shape, but it looks as if there have been a few "unauthorized modifications." Among other things, one socket is stamped "59," and there's a 59 in the socket, but that is a 2.5-volt tube, and the set has a 6-volt heater line. I'd like to get this thing back in shape. Where can I find a schematic and service data on it?—P. M., Hollywood, Calif.

You'll find the service data for this set on page "Patterson 6-3" in John F. Rider's "Perpetual Radio Troubleshooter's Manual," Vol. 6. It will be listed in the index as a model 186AW, but it's the same set.

You mentioned a mismarked socket. This comes from a revolting habit manufacturers had in those days of using up leftover sockets from previous runs! The socket marked "59" must be for the 6A6 driver tube. Feeds the two 42's in the output stage. Look for the .02-µF coupling capacitors connected between the plates (pins 2 and 6) of the 6A6 socket, to the grids (pins 4) of the 42 sockets; these, of course, can be identified by the output transformer connections to their plates, on pins 2.

Intermittent raster, CTC9A

I found an RCA CTC9A color set with an intermittent that's buggering me. The raster disappears after about 20 minutes. High voltage OK. It'll stay off for 3-4 minutes, then pop! there it is continued on page 28
BREAKTHROUGH...

TALK RIGHT THROUGH SKIP AND NOISE INTERFERENCE WITH THE NEW JOHNSON MESSENGER “350” SINGLE SIDEBAND CB TRANSCEIVER.

The Strategic Air Command, U.S. Signal Corps and overseas telephone companies pioneered single sideband because they required dependable, long range communications, particularly when operating conditions were at their worst. They proved that single sideband penetrated jumbled skip signals, atmospheric noise and other interference with clean, sharp clarity.

Now this “talk power” is yours for CB communication with the new Johnson Messenger “350” single sideband transceiver. The Messenger “350” will give you up to 30% more range than ordinary CB communication. Under severe skip and noise conditions, the “350” can deliver up to 3 times the range previously possible.

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MAY, 1966

Please send me my FREE booklet—Why Single Sideband?

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Circle 22 on reader's service card

27
You've found it. While it would be a good idea to check the high voltage very carefully to be sure that it is OK with the raster off, this video amplifier trouble looks like the real villain.

You've found it. While it would be a good idea to check the high voltage very carefully to be sure that it is OK with the raster off, this video amplifier trouble looks like the real villain.

Since all color sets use "pure" dc coupling back at least as far as the video output, anything that affects the voltage on the video amplifier plate will also affect the CRT cathode voltage! The schematic shows how they're hooked up.

In the ordinary CRT, what happens when you increase the cathode voltage by 100 volts? You cut the beam off completely and the raster goes out! This is what's happening here. Quite a few resistors could be causing it, or it could be due to a bad tube, or even to a loose or dirty connection on the video amplifier tube socket. (Open the plate circuit and what happens? The voltage goes up.)

So, you'll just have to take the schematic and trace that plate circuit back to the voltage source. If you do, you'll find out where the voltage is going wrong. Since you're getting a "rise" that is much more than the normal no-load voltage, it might pay to look for an "oddball" trouble, like a leakage or accidental wiring short between the 385 volt line and the boost, etc. That 100 volt jump is too much for something like an open plate on the 12BY7; that tube doesn't pull that much current. Be sure that all your cathode connections on the CRT are tight, and check the contrast control for an intermittent connection.

Bigger resistors?

I've had several cases lately where resistors burned out. They looked awfully little to me. Would it be better to replace them with heavier ones, say 1-watt size instead of ½-watt?—C. W., Oakland, Calif.

Yes and no. A resistor burns out because too much current flows through it. This is caused by a short or leakage somewhere else! So, a burned resistor is a sign of trouble. In many cases, the designer deliberately uses ½-watt resistors so they will blow as soon as there is a short in the circuit. For example: the little surge resistors used in ac-dc tube radios, the 1KΩ resistors used as filters in TV plate and screen circuits, especially in video i.f.'s, and so on.

Best way to make sure about resistor ratings is to check the current through the resistor, or measure the drop across it, and figure the power being dissipated.

---

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Circle 23 on reader's service card

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The Most Trusted Name in Electronics

MAY, 1966
Using Dual Trigger Diodes in SCR Control Circuits

The new Mallory dual trigger diode has many interesting applications in control circuits, as a means of supplying adjustable voltage peaks to the gate of an SCR or a bi-switch.

First, let's look at this device. It’s somewhat like two zener diodes connected back to back. If you apply AC to it, the trigger will only allow current to pass during that part of each half cycle when applied voltage exceeds its rated firing voltage. So it’s sort of a clipper. And as such it’s an ideal way to feed pulses to switch on an SCR.

The light dimmer circuit diagrammed here is an example of how the dual trigger can be used. You might want to try this out. It’s easily assembled in compact space to fit into a standard wall switch receptacle. Dress it up with a decorator-styled knob and panel, and you’ve got a high-fashion lighting system handling up to 750 watts. For details, write to Mallory or circle Reader Service number.

In this circuit, the dual trigger feeds the gate of a bi-switch (or dual SCR). The resistor-capacitor combination in series acts as a voltage divider. At the zero resistance end of the control, zero voltage is applied to the SCR gate through the trigger diode, and there’s no load current. As you turn up the control, you apply more voltage to the trigger until you exceed its firing point; then you begin to allow current through the lamp load. The higher you turn up the control, the more voltage pulse goes to the SCR gate, and conduction through the SCR takes place during a greater portion of each half cycle ... since the trigger fires in both directions. Net result: continuous control of lighting current without the heat dissipation of a power rheostat.

The Mallory STD dual trigger diode has several qualities which make it especially useful for this kind of control. Its breakover characteristic is symmetrical in both directions within 5%. And it has a “snap back” action, shown by the reverse traces at each end of the trigger characteristic curve; that is, past the breakover point, resistance suddenly decreases and current increases. This is the correct control characteristic for working with the SCR. The STD dual trigger, by the way, is only 3/8” long and 3/16” in diameter, so it fits practically anywhere, and has an insulated case.

See your Mallory Distributor for complete data and for STD dual triggers for your own experimentation. Breakdown voltage ratings go from 24 to 120 volts. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.
Color TV Has a Problem

Color TV has invaded nearly 5 million American homes, a little less than 10% of all that have television. Why don't the other 90% have color?

One factor is no doubt cost. But, color receivers are available now priced lower than many monochrome models—often less than small-screen monochrome sets were priced only a few years ago. If you question those who can afford color, yet don't have it, a common answer goes: "I don't like the pictures. The colors aren't true."

Their complaint is well founded. Today's most annoying color-TV problem is caused by slight chroma-phase differences among the three networks, among stations, from film chain to film chain—even from camera to camera in the same studio. No matter how carefully chroma phase is adjusted in each, these few degrees of difference create annoying hue changes for viewers.

No sooner does a color-TV viewer get the hue of tint control set for a good flesh tone than the scene changes to another camera and some actor's face turns sickly green; another camera change is just as likely to make a fair-skinned starlet look purplish.

And the flesh tone itself poses a slight difficulty. What if the actor has a deep tan? Or, suppose a dancer is momentarily flushed with excitement or from exertion in the preceding scene. Under either circumstance, adjusting hue—even in a closeup—is anything but precise. Then, before the viewer can hardly move the knob, the scene may become a fast-action sequence and further adjustment is impossible.

There's been a tendency to pretend, at least publicly, that the problem doesn't really exist. But it does nevertheless, and mass magazines and newspapers have been needling the industry because of it. We may as well face this inherent problem and set about solving it.

What color television needs now is some way to assure precise phase agreement among the 3.579545-MHz bursts at all cameras, film chains, stations, networks, and color sets. At least three approaches come to mind, and there must be many more.

One possibility would involve a Standard Hue Card and a resulting Standard Hue Signal. The card might contain seven bars: black, yellow, black, flesh, black, white, and black. Every studio camera and film chain would be set up initially to reproduce this Standard Card faithfully, and then would be fed the Standard Hue Signal automatically between "takes" so the operator could match the card at all times, thus maintaining a standard, precise phase alignment. The Standard Hue Card could be flashed for a few seconds at the start of each show, before or after each commercial, and with each station-ident card, for viewers to use and for checking retransmission. All local stations and network relay points would make sure they were duplicating the Standard Hue Signal exactly each time it was transmitted. Such a system would be complex, but might be workable with proper cooperation and coordination.

A second possibility is a 3.579545-MHz standard signal, critically phase-controlled throughout the US by some primary source such as WWV. If chroma from all color-TV stations were phase-locked to this single primary source, one setting of the hue of tint control at any color receiver should hold the colors true for all programs.

A third idea could be used with either of the other two approaches or (perhaps better) could be developed to function independently. This would be a circuit or device that automatically compensates for any color-phase variation—right in the color receiver! This approach would eliminate some of the worry about phase differences at points of program origin. Solving the phase-difference problem at the receiving end would be the most satisfactory way from many points of view, although it is merely "wiring around the trouble" rather than curing the trouble itself.

There are undoubtedly other approaches. The important thing is not really how it's done. What is important is the challenge this color-phase problem lays before the designers of tomorrow's color-TV receivers. Whoever devises a workable solution will eliminate one of the last reasons the public has found for not making color-TV ownership unanimous.

—Forest H. Belt
HOME VIDEO TAPE RECORDERS: THEY’RE COMING IN THE WINDOWS!

Two basic methods are in use: helical recording and linear recording. Read how they work, see their advantages and disadvantages

By FRED SHUNAMAN

By Fred Shunaman

NOT MANY PEOPLE REALIZE IT, BUT TELEVISION RECORDING came in almost as soon as television. At first, TV programs were recorded simply by photographing TV pictures on ordinary motion-picture film. Speed compatibility was a problem — 30 frames per second in TV, versus 24 in motion pictures — but it was soon overcome, and much TV was recorded for rebroadcast. The process was slow: the film had to be developed before it could be used, and it was expensive — much film had to be thrown away after being used once. Engineers wondered: Why not use magnetic tape recording? Playback could be instantaneous, and the tape could be erased and reused indefinitely.

But tape recordings, at least at that time, had a high-frequency limit of about 15 kHz, and at least 2.5 MHz would be needed for TV recording.

Engineers here and in Britain tried different approaches. The British divided the frequency band into several segments and then recorded them on tape as separate tracks, at tremendous tape speed. Bing Crosby Enterprises, in the United States in 1954, used a 12-track tape with an electronic switch to record a little bit of the signal on each track, then start back on the first track about the time it had moved out from the gap in the recording head. The television signal was divided among the tracks in time instead of in frequency.

At about the same time, RCA’s Harry Olson demonstrated a system that recorded linearly — like an ordinary tape recorder. He used five tracks for color TV. Three were used for the three colors, one for sync, and one for audio. The secret of Olson’s method was tape speed. The tape passed the head at 30 feet per second. It was hoped that with improve-

Spinning-head assembly on Sony TCV-2010.

34 R A D I O - E L E C T R O N I C S
ments in tape it might be possible to lower the speed.
But before that development was complete, something else entered the picture.

The transverse recorder

Ampex announced a new method of recording in 1956. Instead of running the tape at high speed, the head as well as the tape was moved. A drum that carried four small heads, only one of which was in contact with the tape at any time, spun at more than 14,000 revolutions a minute, while the tape moved forward at moderate speed. Even with this arrangement, it seemed impossible to record the whole band, from at least as low as 30 Hz to 4.5 MHz. Therefore, the video signal was frequency-modulated onto a carrier from 1 to 7 MHz wide, reducing the frequency range from 150,000 to 1 to a mere 7-to-1.

This transverse scan system solved most of the problems of television recording, at least for large broadcast stations that could afford to pay nearly $50,000 for each machine. RCA soon brought out a closely similar television recorder and most large TV stations did install one or the other. But there was still a need for tape recording in educational institutions, for example, where the usefulness of ordinary closed-circuit television could be extended tremendously with the help of recording. But the cost kept all but the largest institutions from considering it seriously.

Helical recording

Then, late in 1959, the Japanese firms Toshiba and Sony announced, almost simultaneously, another type of moving-head video tape recorder. The tape was wrapped diagonally around a cylinder inside of which the moving head (or heads) spun (Fig. 1). Instead of short tracks almost directly across

The tape, the new helical scanning method made longer diagonal ones. The plethora of equipment needed on the multi-head transverse scanners (to synchronize the various tracks, to keep the heads at exact speed, etc.) immediately became unnecessary, and the price—a much reduced $12,000—reflected that. The quality, however, was not always quite what was needed for broadcasting.

Then, on June 8, 1965, after rumors and announcements over nearly 2 years, Sony demonstrated a practical video tape recorder, the TCV-2010, intended for home use. The price quoted was $995. Shortly afterward, other manufacturers

<table>
<thead>
<tr>
<th>Maker</th>
<th>Model</th>
<th>Weight (lb)</th>
<th>Recording method</th>
<th>Tape speed (ips)</th>
<th>Tape width (in.)</th>
<th>Video bandwidth (MHz)</th>
<th>Horiz. resol. (lines)</th>
<th>Price</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>AMPLEX</td>
<td>VR-6000</td>
<td>98</td>
<td>1 head helical</td>
<td>9.6</td>
<td>1</td>
<td>20 Hz-2.5 MHz</td>
<td>250</td>
<td>$1,095</td>
<td>2 models—one with video control center</td>
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<td>80</td>
<td>1 head helical</td>
<td>9.6</td>
<td>1</td>
<td>30 Hz-3.5 MHz ±3 dB</td>
<td>310</td>
<td>$3,150</td>
<td>For educational-commercial-industrial use. Avail. as recorder only or complete CCTV system</td>
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<td>FAIRCCHILD</td>
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<td>65</td>
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<td>200 Hz-2 MHz</td>
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<td>2 heads helical</td>
<td>12</td>
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<td>2 MHz+</td>
<td>200+</td>
<td>$1,500</td>
<td>Price includes recorder, camera, monitor and all accessories</td>
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<td>3 MHz</td>
<td>300</td>
<td>approx. $1,000</td>
<td></td>
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<tr>
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<td>TCV-2010</td>
<td>66</td>
<td>2 heads helical</td>
<td>7.5</td>
<td>1/2</td>
<td>NA</td>
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<td>11.8</td>
<td>1/2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>($556)</td>
<td>Japanese price</td>
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<td>WESGROVE</td>
<td>VKR-500</td>
<td>NA</td>
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<td>90, 120, 144</td>
<td>1/4</td>
<td>NA</td>
<td>NA</td>
<td>$650</td>
<td></td>
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</tbody>
</table>

NA — Not announced

MAY, 1966

Ampex VR-6000, a helical-scan recorder.
demonstrated machines that they stated would be sold at prices slightly higher than Sony's. The prices, however, turned out to be rather more than just slightly higher, and at this writing, no comparably priced helical-scan recorder has reached the market. (Concord, Roberts and 3M are rumored to be readying machines in the $1,000 range.)

The Sony recorder uses helical scan, with two rotating video heads and a stationary audio/control head. The tape is ¼ inch wide, with the audio/control track along one edge and the video recorded in the long slanting tracks typical of the helical recorder (Fig. 2). Tape speed is 7½ ips. It runs 1 hour on a 7-inch (2,370-ft) reel of tape; rewind time is 6 minutes.

A special feature of the Sony is that it has its own TV set, which monitors the recording and shows the playback. The recorder can be connected to a standard TV receiver by a technician, and Sony demonstrated such a combination recently. The monitor can also be used as a conventional television receiver, and is of course used to record TV programs off the air. It has its own telescoping antenna, good for strong-signal areas.

The electronics of the TCV-2010 includes some 76 transistors, 38 diodes, 4 thermistors and a single semiconductor rectifier in the power supply.

The head speed is comparatively slow—30 revolutions per second—or a tape-to-head speed of approximately 300 inches per second. Adjustments are simple and operation easy. Set up in RADIO-ELECTRONICS' editorial office, the camera was operated by inexperienced personnel, who were able to record and play back good pictures of scenes on the street below, as well as office scenes.

Shortly after the Sony first appeared, both Philips (Norelco) and Ampex announced and demonstrated low-cost video recorders. Pictures were excellent. The prices, however, remained at a level between the expected price for a home-type instrument ($1,000) and the industrial-type recorders in the $10,000-and-up class. Both these recorders are intended to work with an ordinary television set of any size. The Norelco has a particularly ingenious method of coupling to the TV set for off-the-air recording. A shield is slipped over the last i.f. tube in the set and the signal picked up by capacitive coupling.

A color recorder

Not content with a black-and-white-only recorder, Sony continued research and, late last winter, unveiled a color TV recorder, which will also record and play back in black-and-white. It can be used with any standard color TV receiver (an adapter is needed). Present users of the black-and-white Sony recorder will be able to purchase equipment to modify their machines for color.

The color recorder is housed in the same case as the earlier recorder and the weight is the same. Tape speed is higher—12 inches per second. Other specifications are roughly the same as for the TCV-2010. The played-back color picture—as seen at a demonstration—would have been accepted by the ordinary viewer as a program straight off the air.

Two other monochrome recorders—Panasonic and Sharp—were announced very recently, but at the time of writing had not yet reached the American market, and detailed information on them was not available. They are expected to sell for near $1,000. Another company, Vitor of Japan, which supplies Delmonico, is considering exporting its VTR to the USA. Its price in Japan is about $560.

Linear recorders

Meanwhile, proponents of the so-called linear (longitudinal) type of recording continued their work. Fairchild's Winston Research Corp. demonstrated a recorder that uses ¼-inch, high-quality tape at a speed of 60 or 120 inches per second. The recording time with 8-track tape on an 11½-inch reel is 2 hours (15 minutes a pass) and rewind time is about 5 minutes.

Another concern, Wesgrove, has actually built and sold recorders in limited quantities, and had recorders on the market before the home-style Sony. The Wesgrove is a direct descendant of the Telcan unit, first mentioned in RADIO-ELECTRONICS in October, 1963. It uses ¼-inch audio tape at a speed of 90, 120 or 144 inches per second, and records up to 1 hour on a 11½-inch reel, double track. Quality is lower than that of the single-track Fairchild industrial machine, but so is the price: $650 ($450 in kit form). How one of these recorders worked when constructed from a kit was described in our June, 1965 issue.

Still another contender, Par Ltd., has been engaged in developing a linear-type recorder for some years. Pictures of gradually improving quality have been demonstrated at regular intervals, and the system continues to show promise. Par puts four tracks on the tape, with audio on one and video on another, thus recording for 1 hour in two passes on an 11½-inch reel. Incidentally, one of the byproducts of the development has been a new tape transport system (RADIO-ELECTRONICS, Jan. 1966, page 4) which may find application not only on other television recorders but also in audio. So (unless some of the companies not yet on the market change their positions before this is printed) Sony appears to be the only tape recorder with a commercial-grade television picture that sells for less than $1,000.

What can you do with it?

While many home viewers will want to use a video tape recorder for strictly amateur purposes, the Sony recorder is

---

Fig. 1—How slanting tracks are recorded on tape with heads spinning in horizontal plane. Tape leaves head assembly about its own width lower than it enters. It is kept firmly against spinning heads by controlled tension.

Fig. 2—Slanting video tracks on one kind of helically scanned tape. Video is erased all at once by normal type of ac erase head that spans full width of video area. New signal is recorded by spinning heads on slanting tape, as in Fig. 1. Audio and control tracks are recorded with conventional fixed heads.
especially adapted to small institutions or individuals who have special reasons for using such an instrument. There are many strictly domestic uses for the recorder. Most important is probably recording programs when you can’t get to the set. If you’re out for an evening, the recorder can be set up with a timer clock to turn it on at the right moment and let it run for a preset time. And if there are two simultaneous programs you want to see, you can watch one and record the other.

A living “sound and vision” record of growing children is many times more effective than a purely photographic record (or the sound tape records that some parents are now making).

The amateur sportsman may find such a recorder useful. (Akio Morita, chairman of American Sony, told how he used his video recorder to improve his golf form.) But the professional finds it necessary. Football games have been filmed and the films studied by the coaches or shown to the teams for instruction and exhortation. Teams have already started using VTR’s for that purpose. Playback is immediate, there are no processing costs, and the tape can be erased and reused as often as required.

Actors, educators and even politicians can use the recorder to see themselves as others see them. A comedy routine can be polished without aid from a consultant, and a speaker or teacher can improve his strong points and correct unfortunate mannerisms. (More than one political candidate in the recent past has listed poor appearance as one of the factors that contributed to his defeat.)

And educational institutions, which have already made a start with the intermediate industrial type recorders, will find

recorders at one-tenth the former price much more attractive. Special lectures and demonstrations can be shipped the same way film is now, but sooner after the event. With modifications, VTR’s can be hooked into a school’s closed-circuit TV system.

What will it cost?

The initial cost—for any tape recorder likely to be on the market in the near future—will hardly be less than about $1,000. The other main cost is tape. A 30-minute reel costs $29.95—a 1-hour reel $39.95 (these figures are for the Sony recorder). This sounds high until you remember that—unlike home movie film—magnetic tape can be erased and used over and over again. Thus much editing waste and the cost of film that didn’t turn out so well is eliminated. The head assembly, which will run for some 1,000 hours of recording or playback, can be replaced for under $100.

An innovation like low-cost television tape recording requires two main ingredients: a need, and a technology sufficiently developed to meet that need. The need is here; thousands of educators, entertainers, athletic directors and ordinary individuals will attest to that. The technology is coming so fast that many people already consider it “here.” The video quality of the better “low-priced” machines is at least as good as what we’re accustomed to seeing on home TV. Even the least expensive recorders produce a picture good enough for many applications where fine detail isn’t necessary. Color recording is around the corner—Sony hopes to have its new machine out late in 1967.

So it looks as though low-cost video tape recording may be about to become just as economical, just as reliable, and just as firmly implanted as home movies became some 20 years ago.

end
For C2 to eliminator, J1, D5, D1, D2, D3, diodes, marily 50 Zener diodes, the is ALMOST Simple, low current drain Supply being used -J5- 250 -250 some multiple of or power D6-6- 50 10, dio Shack equivalent) 9 12 -volt it Binding piv. for volts at F, 500 ma 117 27B1133 or transistor radios, as silicon rectifiers the battery voltage which is good regulation and very low ripple are its characteristics. You can build the supply for about $10 by shopping carefully for the components listed. Of course, electrical equivalents can be used, but they may cost more. The Zener-regulated supply, (Fig. 1) is a shunt-regulated voltage source. The 24 volts from T is rectified by a bridge, D1 through D4, and filtered by a two-section R-C filter. The two Zener diodes are in series so that 6 volts is available across either one or 12 across both. For the 3- and 9-volt supply points, it was necessary to use low-resistance dividers across each Zener diode.

The Zener diodes have approximately 80 mA flowing through them and 6 volts drop across each. When an external load is connected across the di-

**Zener Power Supply For Transistor Radios**

Simple, low-cost supply has four voltage taps, no controls, low ripple

MARVIN J. MOSS and ROBERT E. BEVILLE

Almost all transistor radios today are powered by a battery voltage which is some multiple of 3. Most common is the 9-volt battery. This supply, using Zener diodes, will deliver regulated 3, 6, 9, or 12 volts at a current drain of up to 50 mA to an external load. Designed primarily for servicing small transistor radios, it can also be used as a battery eliminator, life extender, or charger, or to power small experimental circuits.

Good regulation and very low ripple are evident. You can build the supply for about $10 by shopping carefully for the components listed. Of course, electrical equivalents can be used, but they may cost more. The Zener-regulated supply, (Fig. 1) is a shunt-regulated voltage source. The 24 volts from T is rectified by a bridge, D1 through D4, and filtered by a two-section R-C filter. The two Zener diodes are in series so that 6 volts is available across either one or 12 across both. For the 3- and 9-volt supply points, it was necessary to use low-resistance dividers across each Zener diode.

The Zener diodes have approximately 80 mA flowing through them and 6 volts drop across each. When an external load is connected across the di-

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**Fig. 1—Circuit of the Zener-regulated supply.**

C1—250 μF, 50 volts, electrolytic C2—250 μF, 25 volts, electrolytic D1, D2, D3, D4—silicon rectifiers (top-hat style), 50 psv, 500 ma (Radio Shack 2781099, or equivalent) D5, D6—6- or 6.3-volt Zener diodes, 1 watt (Radio Shack 2781133 or equivalent) J1-J5—Binding posts (Lafayette 99RE233 kit of 10, or equivalent)

R1, R2—47 ohms, 2 watts R3, R5—33 ohms, 1 watt R4, R6—39 ohms, 1 watt S—spst slide switch T—filament transformer, 24 volts, 0.3 amp (Burr-stein-Applebee 188506 or equivalent) Aluminum case, 5 x 4 x 3 in. (Bud Minibox CU-2105A or equivalent) Terminals, miscellaneous hardware

**Fig. 2—Regulation at each output up to 50 mA.**
TABLE 1—MAXIMUM RIPPLE

<table>
<thead>
<tr>
<th>Supply volts</th>
<th>Ripple (volts rms)</th>
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</thead>
<tbody>
<tr>
<td>-3</td>
<td>.001</td>
</tr>
<tr>
<td>-6</td>
<td>.001</td>
</tr>
<tr>
<td>-9</td>
<td>.003</td>
</tr>
<tr>
<td>-12</td>
<td>.006</td>
</tr>
</tbody>
</table>

This power supply will dissipate approximately 6 watts when turned on, so the case will get slightly warm during normal use.

No wiring precautions are necessary in constructing this supply, except for observing electrolytic capacitor polarity.

Zener-diode breakdown voltages vary, in general, by several percent. After the circuit is wired and checked, use the diode whose voltage is nearest 6 as D5. This makes the output voltages at the intermediate points closer to 3 and 6 volts, percent-wise.

Get a used 9-volt battery and carefully remove the top with the two connectors. Wire this with flexible leads to the power supply, and you can eliminate clip leads to the battery plug in the radio. Clip leads are necessary with other types of radios. Be especially polarity-conscious at all times with transistor radios!!

Because the power supply has a floating ground, either polarity is available. And, by using the center (-6) binding post as a ground reference, both +6 and -6 volts can be used simultaneously.

A voltmeter is necessary with this power supply, but its versatility can be extended by adding a 50-mA meter in series with the lead to the positive terminal (Fig. 3). This enables you to monitor continuously the current to the radio under test to determine whether it is within the specified limits. Currents appreciably higher shorten battery life and may indicate open or off-value resistors in the bias networks or possibly a shorted transistor. Low readings suggest open bias resistors, transformer windings or transistors.

The higher output impedances of the 3- and 9-volt points can be substantially reduced by inserting a transistor as shown in Fig. 4 in each of the two outputs. Any inexpensive power transistor will work fine here—for example, the 2N554. This will add another $2 to the cost, since heat-sink mounting kits must be purchased for each transistor also.

This Zener-regulated power supply will pay for itself in a very short time around the service shop. Because there is no need to set a control to a particular voltage, servicing transistor radios can be more efficient and profitable.

Despite small case size, parts are not particularly crowded.

**TUNED BYPASS CAPACITORS**

In vhf transmitters and receivers it is often desirable to have certain elements of a tube or transistor at rf ground. Disc ceramic bypass capacitors are commonly used. By carefully trimming the leads of these capacitors we can make them series-resonant. This will make the impedance even lower than with the bypass alone. One home-brew 50-MHz transistor was completely cured of spurious signals and parasitic oscillations by properly resonating its bypass capacitors at the operating frequency.

This method does not absolutely guarantee to solve all spurious signal problems, but it is certainly simple enough to apply and will almost certainly reduce some faults. Either the chart shown or a grid-dip meter can be used to determine the resonant frequency of the capacitor.

In the chart, lead length is given for some of the vhf bands with typical disc ceramics with No. 20 tinned leads. All values were obtained with a B & W grid-dip meter. They will probably be different for other types of capacitors.—Irwin Math, WA2NDM

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**BEND**

A RADIO-ELECTRONICS editor who used the supply for several home workshop jobs reported that the unit measured up to (or even exceeded) the authors' specifications in every respect. He found it easy to use. The multiple outputs were especially useful for one experimental circuit that required a "tapped" battery—1½ volts on one side, 3 on the other. Dividers can be used to get fractional voltages, just as was done to get 3 volts from 6, and 9 from 12.) Ripple was completely inaudible.

---

**LEAD LENGTH FOR RESONANCE**

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<tr>
<th>FREQUENCY</th>
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</tr>
<tr>
<td>50 MHz (6 m)</td>
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<tr>
<td>144 MHz (2 m)</td>
<td>0.9&quot;</td>
</tr>
<tr>
<td>220 MHz (¼ m)</td>
<td>0.4&quot;</td>
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</tbody>
</table>

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**MAY, 1966**
YOUR FUTURE IN MICROWAVE

Giant microwave radar antenna is part of Air Force AN/FPS-17 installation at Laredo, Tex. It watches missiles launched at White Sands and other places. General Electric developed the 15-story-high, 100-foot-wide structure.

CAREER OPPORTUNITIES—Fifth of a series

Read about a field begging for qualified technicians and engineers ... learn how you can break into it

By RAY D. THROWER

THE POPULATION EXPLOSION IS CREATING A JOB FOR YOU!

Increased demands for goods and services has created a need for more and more private communication systems for video, data and voice.

Just how does this mean a job for you? In the 17 years or so since the first commercial microwave systems began operation, the demand for more systems has resulted in more openings for skilled technicians and engineers than there are men to fill them.

The Federal Communication Commission's latest annual report shows slightly more than 60,000 Second Class Radio Telephone licenses issued. Of this class license (needed for working on "on the air" transmitters), estimates indicate that approximately one-fifth, or 12,000, are "non-practicing" in communications. Of the remaining 48,000, it is estimated that roughly 25% are non-practicing because they are in supervisory positions. This still leaves a pool of about 36,000 practicing licensed technicians to service all categories of transmitting and receiving equipment (excluding broadcast radio and TV, for which a First-Class license is required). Current estimates show that microwave alone needs 24,000 technicians!

Why is microwave becoming so popular? With it, companies can do away with open-wire and aerial cable facilities exposed to storm and ice breakage. They can forget about buried cable systems that are frequently cut by construction crews and farmers' plows. Relatively inexpensive mountain-top repeater sites and small plots of land in more expensive areas are very appealing to businesses when compared to the costs for hundreds of miles of open wire and buried-cable right-of-way. Just think of all those property owners that have to be dealt with for cable and wire systems!

One of the more important technical reasons for using microwave is that it can carry a larger number of voice channels, wideband video or high-speed data circuits with less distortion and fewer repeater stations than its cable-carrier counterparts. The FCC has aided the development and use of microwave and has made special provisions for tying in with educational TV systems.

A private microwave system can provide up to 960 simultaneous voice circuits on one transmitter and receiver, without interference. Developments promise thousands of circuits on one transmitter/receiver. Fig. 1 shows how 600 circuits can be stacked.

Frequencies above the usual 30 GHz are not far off, either. A recent issue of Microwaves reported successful propagation studies of equipment operating at 90,500 MHz.

Some systems are small and relatively inexpensive ($40,000 or so), while others are large and complex and may run $5,000,000 to $20,000,000 or more. In the last year and a half, Western Union began service between New York and the West Coast on its new $80,000,000 transcontinental microwave system. Links to other eastern cities are being built.

With new systems being added daily, communication companies are pressed to find qualified technicians. As the need for technicians and engineers grows, so grows the need for able supervisors. So, the chance for advancement in an advancing field is limited only by your ability.

If you have little electronics background, some companies will hire you as a trainee, giving you on-the-job training and sending you to company-sponsored schools. The pay may be low at first, but the training you'll get will pay off in later years. And, while you're working, don't pass up the chance to take some night-school courses. More and more employers
are giving first consideration to the guy who has shown his spirit by trying to learn just a little more. Of course, if you’re a real glutton for self-punishment, you can get a full-time job on a night maintenance shift and go to school full time during the day. And don’t forget correspondence courses.

“Well,” you might ask, “exactly what kind of job is there for me in microwave? This must take years of experience and education.” Let’s meet a few people who have worked with it.

Jim Reeve is 26, has been with Lenkurt Electric Co., Inc. for over 4 years since he got out of the Air Force and has been in electronics generally since 1957. Jim is a Senior Technician in Lenkurt’s System Test Microwave Group. After the microwave equipment has been built on the production line, Jim and his associates completely align the systems before they are shipped out for installation. This involves actually operating the equipment as it will operate in the system when it is installed. The only difference is that instead of using antennas to radiate the signal and having some 30 miles between transmitter and receiver, Jim has to work on the equipment “back-to-back”, that is, with transmitter and receiver a few feet apart. To weaken the signal in that close-by setup, Jim uses special microwave attenuators to simulate the “path loss” the system is designed for.

In his 4 years with Lenkurt, the leading supplier of microwave and carrier system equipment to the US independent telephone industry, Jim has worked on a lot of equipment for telephone, oil and utility companies, railroads and others.

I asked Jim what had been the most interesting microwave project he had worked on.

“Oh, that’s easy! It was the educational TV system equipment Lenkurt built for Nebraska’s educational system” (Fig. 2).

“Why was this one more interesting than the others?”

“Well, I graduated from Omaha Tech High School and Nebraska is my home country.” He smiled nostalgically. “And with all the familiar names tagged on the equipment scheduled for each repeater site, I felt right at home with that gear. I could just see that old microwave beam going right across the country around the North Platte River.”

I asked if he had taken any science courses in high school that helped him get into electronics.

“Sure did! I had three years of high school electronics at Omaha Tech. It’s a great school,” Jim said enthusiastically. “Actually, we didn’t realize how lucky we were there. I always thought every school system had a technical program. I found out how wrong I was when I got to tech school in the Air Force. Most of the guys had never heard of Ohm’s law!”

“What schools did you go to in the service, Jim?” I asked.

He laughed. “A lot of them.” With a grin, he added. “And sometimes we thought they would never end, the way the instructors pounded information into our heads. One thing about it, though. Those service schools will teach it to you. Any guy that really wants a technical education should see what kind of programs are available through military service schools.

“The one I learned the most about microwave was at Radar Tech School at Keesler Air Force Base, Mississippi. I was down there for about a year and then they sent me to Scott AFB, Illinois, for 6 months to Communications School. I learned a lot about radio there.”

All together, Jim says he spent over 2 years of his 4-year hitch going to school. Did his military training have anything to do with his getting on with Lenkurt Electric?

“You bet your boots it did! I probably wouldn’t have been able to get on if I hadn’t had my training in the service. I figure I got a pretty expensive education that I never could have afforded on my own.”

Jim, his wife Diana and their new daughter Lynda enjoy living on the San Francisco peninsula, where Jim’s company is located. They appreciate the ease of living in California, the facilities available for entertainment and education in and around the peninsula. And Jim thinks working for Lenkurt, a prestige company in communications, is a wonderful opportunity for him professionally.

When overtime schedules permit, Jim attends Foothill College in Los Altos, Calif. He has completed about 2 years of full college work by going to night school for 3½ years. He hopes to get his degree in a few more years, majoring either in electrical engineering or physics, so he can get into some of the more complex work with microwave and communication.

“Breadboarding and testing are interesting”, acknowledges Jim, who builds much of his own hi-fi equipment, “but I like microwave work the best. We’ve always been razzed in here about when we’re going to get our plumber’s card, working on the waveguides and all. It’s called ‘plumbing’ in the electronics trade, and I guess anybody that works with it gets ribbed.”

His advice to anyone thinking of entering microwaves or electronics generally is to get plenty of science and math background in high school if there is no electronics vocational program in your school.

Jim Reeve is an example of the thousands of technicians that will be needed in the next few years. People like Jim will be moving up in a few years to engineering and administrative positions, which means even more technicians will be needed.

In addition to the technicians, thousands of engineers are going to be needed. According to a report prepared by the Bureau of Labor Statistics for the National Science Foundation, demands for new engineering personnel will exceed 700,000 by 1970. With only about 450,000 to be available, there will be a deficit of more than 250,000. Of these, about 10,000 will be needed to fill engineering gaps, principally in the telecommunications field associated with microwave. What will these engineers do? Let’s choose an example, and get an idea of what it takes to be “an engineer”.

Don Shaffer is a displaced Missourian who came to Lenkurt Electric Co., Inc., by way of Arizona, where he worked as an engineer for a power company.

Satellite communication systems will provide worldwide phone, video and data channels. Orbiting relays will be serviced by satellite “shuttle bus” with crews on several-month tours of duty.
At Lenkurt, Don is a transmission engineer. The title belies what Don and his fellow transmission engineers do. They do the microwave path surveys for the microwave systems that Lenkurt engineers. Whenever a customer comes to Lenkurt for a microwave system, Don or one of the other transmission engineers goes to the customer's area, locates suitable sites for microwave repeaters, determines the path loss, the size and type of antennas required, tower heights to get away from things such as Fresnel-zone interference, and designs the system path.

Once Don has gathered his background data and photographs (the camera seems to be the engineer's best friend on field surveys), he returns to Lenkurt's offices in San Carlos, California, where he formalizes his report, prepares graphs and charts from the field data, and selects the best photographs for publication. Then, the entire report is sent to Lenkurt's printing plant where it is reproduced and bound in book form, and copies sent to the customer. Don says this is a rewarding type of engineering in that he sees his end product all neatly prepared in book form.

Don, who is a registered professional engineer, says, "We sure have to be accurate. A difference of just a few feet can make the difference between a microwave path working or not working. And if it doesn't work, our figures are right there in black and white, and it doesn't take long to figure out who goofed where. But with all the computer help we have now, errors just hardly exist any more."

Don enjoys his work, even though it takes him away from home frequently, and that is the only bad feature about it.

"It's a great chance to see a lot of country and travel", he says, "and it's almost a vacation every time we go out. This way, I get to scan a lot of country and pick the places where I want to take my vacation."

"Our favorite time is the fall of the year", he laughed when being interviewed. "That's when each of the hunters in our crowd hopes to be the one selected to do the path study that inevitably comes from the hunting country. It's all business during the week, but when the weekend comes, we all want a try for some of that venison!"

Don, a licensed ham operator (W6BLO), likes to work 80-meter CW. He enjoys building his equipment, but says, "If I did any building now, with all my traveling, I'd never get to do any operating." So, he contents himself with commercial equipment and tinkering on small projects.

Don's background includes graduation from the University of Missouri with a bachelor of science in electrical engineering in 1959. He was graduated from Memphis High School in Memphis, Mo. in 1949 and has been interested in radio since he was 16 in 1947. He was originally licensed as a ham in Missouri with the call WOYYE. Besides his ham ticket, Don's licenses include an FCC First Class Radiotelephone license. "I guess the first-class license is about one of the hardest to get", he admits. "It took only one try for my second-class ticket, but I had to go back for two additional tries before I got the first." He looked with pride at the blue license hanging on his wall. "It was worth it, though."

"The most difficult thing about microwave", according to Don, "is keeping up with advances in the state of the art. New
developments in equipment and new discoveries in theory and application of old knowledge to new areas make it pretty difficult to keep ahead—or even keep up with what's going on."

Advice to newcomers in the field? Don says, "Learn your basics very well, because even the most complicated electronic circuits are derived from a few basic principles."

With three years in microwave work behind him, Don's only comment about the future of microwave is "Unlimited!"

Now you'll ask, "How and where can I get into microwave work?" Finding the right job, of course, is a personal venture and requires a lot of leg-work. One of the best helps when looking for a job is to have a short résumé of your background. Make several copies (but not carbons), and be prepared to hand or send one to every man who interviews you.

The places to look are unlimited. Practically every community of any size now has at least one microwave facility. There are some in some pretty remote areas as well. If the station in your area is an attended one, chances are there will be a small sign on the building or fence that will tell you who it belongs to. One thing about job hunting of any kind: don't be hasty. If there is no way of finding out who operates a particular microwave station, try tapping a note with your name, address and intention, to the door of the station.

A good percentage of state and county governments are now using or planning microwave systems for administration and enforcement. For instance, Nevada is planning a microwave system (Fig. 3) to run from Reno in the north to Las Vegas in the south and from Reno east to Elko and from Elko south to around Las Vegas where it will tie in with the Reno-Las Vegas leg of the system. When completed, the system will handle two ETV circuits for the University of Nevada as well as approximately 120 voice communication channels.

Nevada is only one of many state governments supplementing their commercial telephone circuits with their own microwave systems. To find if your state has or plans similar programs, contact your state director of communications or state civil service commission. Usually, these jobs have no training programs. They normally require experienced people with at least a second-class license. Some states have on-the-job training programs in many vocational areas. These programs are open to high school students part-time during school and full-time during the summer. These part-time ventures often work into full-time jobs with excellent futures for the high school graduate. Again, check with your state civil service commission, state director of communications or high-school vocational training directors to find out who is putting in microwave systems by subscribing to trade journals. These magazines usually tell of the issuance of FCC construction permits ("CP's") as well as other pertinent information in the communication industry. Two side advantages to subscribing to the trade journals: you can pick up a lot of technical education just by reading the ads, and you might even find that job waiting for you in the classified "help wanted" section of the magazines. One good source for the independent telephone industry is Telephony, published weekly at 608 Dearborn St., Chicago, III. Subscription rate is $4.50 per year. Another trade magazine is the Microwave Journal, published at 6:0 Washburn St., Dedham Plaza, Dedham, Mass. Subscription rate is $1 per year. Microwave Journal deals mostly with industrial and military application of microwave. Between the two, you should be able to get a pretty good cross-section of the industry. You can subscribe to only one if you already know the area you wish to explore.

Time was, in the communication industry, when there was little turnover; few jobs were available to the newcomer. The expansion of microwave communications has made many jobs available. There is still stability, but it is no longer static stability. After a few years in one place, if you feel you have progressed as far as you can, professionally, you can find more rewarding work elsewhere. In fact, many technicians and engineers recommend two or three changes during the first 10 years to get a broad knowledge of the communication industry. A broad background will be profitable for yourself and your ultimate employer. Remember, the requirements for getting into microwave vary all the way from a high-school education to an advanced college degree with 15 or 20 years experience. But, there are engineers without degrees as well as maintenance men with master's degrees in engineering. It all depends on what you want and how much effort you are willing to put forth. Formal education, though important, is not the main consideration to every microwave employer. You will always be more valuable, though, with as much training and experience as you can get, so don't turn down any opportunities. Get that second-class radio license, if possible. It can open many doors and pave the way for professional advancement.

We've talked a bit about the past and some of the present of microwave. What's in store for the future? Communication experts see the day not too far distant when a series of stationary satellites above the earth will beam thousands of messages and supply dozens of video and data circuits to all points on the globe. Special remote pickups will be available on a moment's notice via satellite microwave. Already, scheduled satellite communication is a reality across continents. And one day, say the experts, it will be cheaper and a lot less trouble to have maintenance personnel stationed for 3-, 6- or 12-month tours of duty on a centrally located satellite. If a malfunction occurs on one of the relay satellites, special bypass circuits will be put into operation while a maintenance man hops into a special shuttle craft, punches the button for the preprogrammed coordinates of the station in trouble and gets there in a matter of minutes, across thousands of miles. After maintenance, he shoots back to the mother satellite.

Who will he be? Maybe you? END

MAY, 1966

Fig. 2—Nebraska educational TV system is scheduled for completion in 1967. It will include 20 microwave relay stations and six ETV transmitters. System will supplement normal school programs, and continue them during severe winter weather when schools can't open. Mead-to-Atlanta link, about 200 miles, has been completed at this writing.

Fig. 3.—Nevada microwave ETV links will tie University of Nevada Reno and Las Vegas campuses. Old Winnemucca Air Force radar site is expected to be used for training university personnel in ETV operation. Nevada Highway Patrol will have vhf repeaters on mountain-tops to receive signals from patrol cars. Signals will feed microwave systems and be relayed to distant mountain installations, then be restored to vhf band. Thus any patrol car in the state can reach centrally located base station.
With parts in most experimenters' junk-boxes, the Multi-Alarm can be built for less than $15.

**Circuits**

For the distinctive "siren" signal, a very simple relaxation oscillator is used. The sound generated by the little unit begins at around 15 Hz and rises to around 500 Hz. When the highest frequency is reached, the sound pulsates between about 450 and 500 Hz. Fig. 1 shows the simple circuit.

A minimum of 300 volts dc is needed to operate the oscillator. This can come from an existing power supply in a radio receiver, public-address amplifier or other equipment. A 300-volt battery can also be used, but its cost (around $8) is higher than the cost of the high-voltage supply shown in Fig. 2.

The supply shown in Fig. 2 is a modified Hartley oscillator. It provides (after quadrupling) a dc voltage between 300 and 500. Any good high-gain transistor may be used. Powered by a 9-volt battery, the supply is instant-starting and very reliable.

Although International Rectifier Corp. type U100P selenium rectifiers were used, other high-voltage units may be used as long as the pem (peak inverse voltage) rating is around 400 to 500.

Any amplifier may be fed with the "siren" oscillator. With an amplifier that has a high-impedance input (such as a microphone input), connect diately from the 470,000 ohm output resistor and ground. An input transformer (Lafayette 99 R 6034) is used to feed the Lafayette PK-544 transistor amplifier (now stock No. 99 R 9037) used in the Multi-Alarm.

The Lafayette amplifier is a complete unit and can't be built from scratch for that price ($6.95), unless you are fortunate enough to have an unusual collection of miniature parts. It and the transformer can be ordered from Lafayette Radio Corp., 111 Jericho Tpke., Syosset, N.Y. 11791.

With 350 mW output into a 3-inch speaker, the amplifier can be heard throughout an eight-room house above the usual household noises.

To warn of ac power-line failure due to any reason (including electrical fires), the circuit shown in Fig. 3 was incorporated in the Multi-Alarm.

Although a 117-volt ac relay may eliminate the transformer and some other components, heat and eventual chattering may become a problem. I decided to use an inexpensive low-current relay.

A 6-volt transformer (Knight 61 U 416 or equivalent), two diodes and two capacitors supply doubled voltage (at low current) for the relay; a Lafayette 99 R 6091. The diodes used are IN645 surplus units. Other inexpensive diodes such as the 1N38 may be used as well.

When the control unit is on line, the relay contacts are open. Any interruption of line voltage will allow the contacts to close, turning on the amplifier and oscillator.

**Interconnection and construction**

Fig. 4 shows how the unit is interconnected.

The entire unit was constructed in a Minibox 7 x 5 x 3 inches. Parts layout is not critical. The amplifier and oscillator chassis (on which the input transformer is mounted) should be oriented for minimum hum pickup from the relay transformer.

Although two 9-volt (or two 8.2-volt mercury) batteries are used, one is sufficient. If the device is used often, battery life is longer with two batteries—one for the amplifier and one for the siren high-voltage supply.

To hold the batteries in position, I made two clips from cable clips; these I bolted to the chassis.

The speaker was fastened to the

---

**BUILD THE MULTI-ALARM**

**CHARLES J. SCHAUERS**

All-electronic alarm stands guard over your home, warns of fire, power failure, forced entry and dozens of other potential catastrophes.

**THE MULTI-ALARM IS AN ELECTRONIC warning device that emits a loud, piercing sirenlike sound that can be heard clearly above household sounds (including a blaring TV). Coupled to a 4- or 5-watt amplifier connected to a 6- or 8-inch speaker, it can be heard more than five blocks away.**

Used with inexpensive outboard devices, it can warn of fire, overheated electrical equipment, a malfunctioning air-conditioning system, the beginning of rain, a child falling into an unattended swimming pool, attempted entry into a home or garage, power failure due to a blown fuse or shorted wiring. Other uses are limited only by your imagination.
Minibox with small clips. I cut holes for the speaker with a 1½-inch chassis punch and covered them with metal screen. The hole in the chassis back, directly opposite the speaker, permits a louder output.

**How it operates**

With a switching (sensing) device connected to the Multi-Alarm switching terminals (two binding posts on the top left of the unit), the device will go on when the external circuit is closed—whether the unit is off or on line. The battery circuits for the amplifier and the high-voltage power supply are activated.

The **Power Adjust** pot in the base of the transistor in the high-voltage power supply (Fig. 2) is adjusted for quick starting. Adjust the pot so that the four neon lamps fire. As they do, the tone of the oscillator will descend and then rise until capacitor C again charges to the firing voltage of the neon bulbs. (Incidentally, to mount the neon bulbs rigidly in the holes cut for them, use high-voltage corona cement.)

The volume of the amplifier may be adjusted with the pot on the front panel. If you need only visual indication from the unit, the amplifier can be turned off separately.

A test push switch on the upper right of the front panel may be used to check the unit off or on line.

With the Multi-Alarm’s 117-volt ac cord plugged in and the small toggle switch on the upper left panel front placed in the **Line** position, any power failure will activate the unit. Off-line, the switch is turned off. This makes the unit available for portable use—in a car, for example.

**Booster amplifier**

Fig. 5 is the diagram of an amplifier using one power transistor. It can be added to the Multi-Alarm along with a 6- or 8-inch speaker to provide enough sound for nearly any warning application. A small relay capable of handling at least 2 amps must be used to turn the amplifier off and on with the Multi-Alarm. (Input and output transformers are Lafayette AR-172 and 33 R 7501, respectively.)

**Uses for the Multi-Alarm**

**Fire alarm.** The Multi-Alarm was constructed originally for fire warning. However, it can be used very effectively in other warning applications. To detect fire, temperature-sensitive button switches were used. These came from Lafayette Radio Corp. For 135°F or 200°F operation; they cost only $1.95 each plus postage for 3 oz. The 135°

Should you take an extended vacation, take the Multi-Alarm to a neighbor and connect it with your “fire line.” Should a fire start while you are gone, the neighbor can call the fire department in time.

**On the car.** In addition to using the Multi-Alarm for theft protection, it can be wired to the backup light or turn signals to warn pedestrians (especially children). It can also be connected to the doorbell switch to operate if a door is opened (or partially open). This will also serve as car protection when you are on camping or hunting trips, and must park your car some distance away.

If the unit is to be operated exclusively in the car, the car (12-volt) battery can be used instead of the 9-volt units. Three volts more will not damage either the high-voltage power supply or the amplifier.

The button switches are mounted in each room as high as possible and connected in parallel. The “fire line” is then connected to the Multi-Alarm switch terminals. The Multi-Alarm is plugged into the house power system and the control switch placed on line.

Do not install the temperature-sensing buttons close to radiators, hot-air registers or any other heat-producing devices.

Incidentally, with the Multi-Alarm mounted in the engine compartment of a car, a 200°F sensing button may be placed near the manifold. Should some auto thief make off with the car, the heat from the manifold will cause the button switch to close and turn on the Multi-Alarm. No thief will drive far with a siren screaming!
Rain alarm. Fig. 6 shows a rain-alarm circuit. The relay contacts of the rain sensor are connected to the Multi-Alarm switch terminals. When the sensor recognizes rain, the relay is closed, actuating the Multi-Alarm.

The sensing element is made from two 4-inch square pieces of copper screen insulated (at the corners) from each other. When a drop or two of rain "shorts" the two pieces of screen, the transistor is biased on and closes the relay.

This device can be connected into the motor control circuit of a convertible auto-top system to close the top when it rains. The sensor device can be modified to rectangular shape and mounted just below the top of the windshield.

Swimming-pool warning. Kids will do the unexpected when no one is around; this includes falling into an unattended swimming pool. If a water-wave-operated switch is used with the Multi-Alarm (and perhaps the 4-watt amplifier), everyone in the neighborhood will be warned when a child falls into an unattended pool. A light-weight float can be fastened to a Microswitch, or you can try a pendulum that closes a set of contacts when the disturbance makes it swing.

Over-temperature warning. To warn that electronic equipment temperatures are at a dangerous level, or that an air-conditioning system is not operating properly, the device shown in Fig. 7 can be used with the Multi-Alarm.

The sensing element in this case is a thermistor in a bridge circuit. The sensor may be placed at any remote location, and the unit adjusted, with the 3,000Ω pot, to operate when a certain temperature level has been exceeded. A high-scale (up to 250°F) thermometer can be used to set the instrument.

Light-out warning. The simple device shown in Fig. 8 is used with the Multi-Alarm to let you know that an important light (such as an obstacle light) is out. As long as light falls on the photocell (daylight or electric light), the relay contacts are open. Should night come and the electric light fail to function, the alarm will sound.

Intrusion warning. Pressure or other switches may be installed on doors or windows of a building and connected to the Multi-Alarm as a warning of intruders. A separate switch to disconnect the unit at each door or window should be installed so that the door or window can be opened normally without releasing the alarm. Perhaps one master switch can be placed at or near the unit to handle all entrances and exits.

So, you see, the Multi-Alarm can be used in many important ways, and it's fun to play with, too. No doubt you can think of other uses for this versatile warning device. The sensitive relays in Figs. 6, 7 and 8 may be GB5D's, Potter and Brumfield GB5D's or Lafayette No. 99 R 6091's.

CEILING HAS EARS

A conference room that can "communicate" with its occupants is nearing completion at the Federal Aviation Agency (FAA) Aeronautical Center in Oklahoma City. It's a room in which the ceilings have ears and the walls have voices.

A flick of a switch can cause the room to dim its lights, create pictures on its walls, draw back curtains to reveal magnetic chalkboards, and talk via audio tapes. The room can repeat conversations that took place within its walls only seconds before.

The room contains an AM-FM-multiplex tuner, tape recorder, phono turntable, projection TV tuner, 16-mm projector, and stereophonic speaker system.

The second—and more complicated—sound system is designed to pick up and amplify voices within the room and to tape-record conversations at the conference table. Overhead microphones feed words spoken at the table into amplifiers and back into dual-cone speakers in the ceiling. These microphones and speakers are engineered by LTV-University so that words picked up by mikes in the front of the room are amplified more in the speakers at the back of the room, and vice versa. Feedback from speakers to microphones is practically nonexistent at ordinary loudness levels.
Cheap-to-build rf power meter does away with expensive meter movements by brightness-comparison trick

THE DETROIT DUMMY

By BASIL BARBEE

LIKE A DETROIT "IDIOT LIGHT," THIS handy little rf power meter uses panel lamps instead of an expensive meter movement. But most unlike the idiot light, it makes fairly accurate measurements.

Many CB operators use four No. 47 bulbs in series-parallel as a dummy antenna. Although the resistance of the dummy varies with the rf power, this scheme works very well. Even the actual power output can be estimated by an experienced eye, although the accuracy of the estimate depends a lot on the room brightness.

The Detroit Dummy is a refinement of the popular four-47 dummy. Since the eye can compare the brightness of two or more adjacent bulbs accurately, not even a photocell is necessary.

The four 47's of the conventional dummy are mounted in 3/8-inch holes near the corners of a 1 1/2-inch-square piece of 3/4-inch thick Bakelite at the end of the case next to the SO-239 coax connector. In the center of the Bakelite subpanel is a fifth 47, which is powered by either dc or ac taken from the car battery or other convenient source. Its brightness is controlled by the 40-ohm potentiometer. R2 drops the usual 12.6-volt source down to 6.3 volts. (For a 6-volt battery or 6.3-volt transformer, omit R2.) The .0047-µF capacitor bypasses the battery to ground to prevent radiation.

A 1/8-inch round hole in the front of the case lets you look at the lights. This hole is covered with aluminum screen to protect the bulbs and complete the rf shielding.

How to use it

The instrument's coax receptacle is connected to the transmitter output by a short piece of coax cable. Power plug P is inserted into the car's cigarette-lighter socket, or, for bench operation, connected to a 12-volt ac source.

When you key the transmitter, the four bulbs of the dummy antenna light. Rotate the potentiometer knob until the brightness of the center bulb matches that of the other four. The power in watts being dissipated by the dummy load can be read from the potentiometer dial after you've calibrated it.

Calibrating the potentiometer dial is the hardest part, and we've done that for you in the table. You can use the table as-is with pretty fair accuracy, but we'll tell you how it was compiled in case you want to calibrate your unit individually.

The table was made by measuring the voltage and current at several points along the rotation of the potentiometer, multiplying them to get the power, and multiplying that by 4, since there are 4 times as many bulbs in the dummy as in the comparator circuit.

Wiring is simplicity itself. Bulbs will last for years of intermittent use, so are soldered in directly, without sockets.

C—.0047-µF disc-ceramic capacitor
J—SO-239 coaxial receptacle
P—cigarette-lighter plug
R1—pot. 40 ohms, linear taper
R2—20 ohms, 5 watts (omit for use with 6-volt supply)
PL1—PL8—No. 47 pilot lamps, all from same carton
Aluminium box, 4 x 2 1/8 x 1 7/8 in. (Bud CU-3002A or equivalent)
1 1/8-inch-square piece Bakelite
2-inch square piece aluminium window screen
Any length zip-cord, ribbon lead, etc. for connection to P
Miscellaneous hardware

Circuit of the Detroit Dummy.


**Potentiometer Calibration**

<table>
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<th>Per cent of rotation</th>
<th>Rf watts</th>
<th>12.6 v</th>
<th>6.3 v*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.1</td>
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</tr>
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<td>30</td>
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</tr>
<tr>
<td>0.75</td>
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<td>49</td>
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</tr>
<tr>
<td>1</td>
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</tr>
<tr>
<td>1.5</td>
<td>58</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>79</td>
<td>79</td>
</tr>
<tr>
<td>2.5</td>
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<td>85</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>88</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>3.5</td>
<td>96</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>3.75</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>* R2 shorted out.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Separate columns of percentage rotation are given for 12.6- and 6.3-volt calibrations. The difference arises from the better voltage regulation with R2 shorted out, and from the variation of the bulb’s resistance with temperature.

Since the resistance of a four-watt dummy dissipating 3.75 watts is only 42 ohms while the usual RG-58/U coax cable is rated at around 53 ohms, and since the resistance of incandescent bulbs varies with power, the coax cable connecting the Detroit Dummy to the transmitter should be as short as possible to prevent standing waves. In any event it should be very short compared to a quarter-wavelength (that is, not more than a foot or so at CB frequencies). The length of the dc (or ac) cable is unimportant as long as it does not cause excessive voltage drop. Even 25 feet wouldn’t hurt.

Accuracy of the Detroit Dummy is unaffected by ambient light, since we’re matching the illumination of one bulb to that of other identical bulbs. Of course bright sunlight will make it impossible to judge the brightness of the bulbs at low powers, but indoors even 0.1 watt can be read if the room is not too brightly illuminated.

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**WHAT’S YOUR EQ?**

Conducted by E. D. CLARK

**Black-Box Equivalent**

Can you develop an equivalent circuit for the contents of the box in the diagram? The procedure is to connect a variable voltage source across the input terminals and note the resultant current readings in the reference direction shown. The following results were obtained: When $E = 12V$, $I = 2A$; $E = 6V$, $I = 0$; $E = 0V$, $I = 2A$.

What’s the equivalent circuit of the black box?—Phillip Cutler

**Capacitor Puzzler**

In the diagram, $C1$ (1 $\mu F$) is initially charged to 2 volts with the polarity shown. The switch is now closed at $t = 0$. Can you determine the final voltages across the two capacitors and their polarities?—S. G. Joshi

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**3-Way Switching?**

The No. 222 (2.5-volt) flashlight bulb mounted on this black box may be switched on or off by either spst switch (usually three wires and three-way spdt switches would be used). There is a battery in the box. What else? No tubes, relays or semiconductors are involved.—Albert S. Lombard

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**50 Years Ago**

In Gernsback Publications
In May, 1916
Electrical Experimenter
Locating Vessels at Sea by Radio and Sound Waves
Washington’s Birthday Amateur Radio Relay
Designing a Spiral Antenna
A Balanced Detector
Construction of a Wireless Telephone Set

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**TESTING TRANSISTORS WITH AN OSCILLOSCOPE**

is the best way to get to know them. (Ohmmeter tests don’t tell all.) Learn how to interpret the traces on the screen, how to match transistors, how to pick the best one for a particular job.

Coming in June

**RADIO-ELECTRONICS**

Microelectronics and Solid State Special Issue

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END
The TV Silencer is a wireless speaker “killer” which uses an ordinary flashlight as a “gun.” By shooting at either of two photoelectric eyes, you can kill the speaker or bring it back to life!

The TV Silencer costs about $11 to build from all new parts, and installation requires only a very minor change to your speaker circuitry. It operates from the power line—no batteries are required. A unique latching circuit requires only a momentary “shot”—you do not have to hold the flashlight on target during the entire commercial. The “killing” is almost instantaneous.

**Circuit description**

The circuit of the TV Silencer is shown in Fig. 1. The filament transformer, chosen because it is small and inexpensive, does not supply enough voltage with a conventional half-wave rectifier to operate the circuit. Therefore, two inexpensive diodes, D1 and D2, and two low-voltage electrolytic capacitors, C1 and C2, are wired as a full-wave voltage doubler, boosting the output to 20 volts. Two transistors, Q1 and Q2, are wired in the common-emitter configuration, with sensitive plate relays RY1 and RY2 as collector loads. Photocells PC1 and PC2, which have a very high resistance in the dark, keep the transistors almost cut off, so both relays are de-energized. The TV speaker is connected through contacts A–B of RY1.

Now let’s assume the flashlight beam strikes PC1. The resistance drops down to only a few thousand ohms, and Q1 is thrown into conduction. The emitter-collector current energizes RY1, and speaker contacts A–B open, disabling the TV speaker. Notice that now-closed contacts B–C of RY1 connect the full supply voltage (through contacts A–B of de-energized relay RY2) to the coil of RY1, latching RY1 closed.

To return the speaker to operation, the flashlight is aimed at PC2, which throws Q2 into conduction. This closes relay RY2, opening the latching circuit to RY1. Therefore, RY1 drops out, and the speaker is connected again through contacts A–B and the set’s sound is restored.

All this may sound complex, but it works very smoothly and positively, with no annoying time lags. A regular two-cell flashlight will operate the Silencer from about 20 feet away; a three-cell flashlight will work up to a mile.

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**Build a Flashlight Operated TV Silencer**

By Fred Blechman

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**Fig. 1—Circuit of the Silencer**

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**Fig. 2**
cell flashlight is usable to about 40 feet. However, don't expect to use the Silencer in brightly lit rooms, or during the daytime; it will lock-in on the high ambient light level. The TV Silencer is designed to operate in the normal televiewing situation—nighttime, with some room lighting. To make it meet other requirements would greatly complicate the circuitry and increase the expense.

must be placed far enough apart so that the flashlight beam doesn't cover both simultaneously. I put PC1 in a Minibox, with all the circuitry, and mounted it on the lower side of my TV. This is near the speaker and fairly well out of sight, yet an easy target for the flashlight. PC2 was placed all by itself in a separate small plastic box attached farther up the side of the TV.

Switch S, photocell PC1 and the pi-
sistor and operating directly from the power line, is unsafe, so don't try it!

The photoconductors are most easily mounted by cementing them behind a rectangular cutout. In the plastic box used to house PC2, a two-terminal strip provides tie points for the photoconduc-
tor leads. Small speaker or earphone wire connects PC2 through an insulated connector at the Minibox. If you use a single-hole mounting RCA type phono jack for the connector, mount it in a rubber grommet for quick and easy in-
sulation.

Bench checkout is simple, but must be carried out in subdued light. Use a flashlight battery and bulb in series as a substitute for the speaker. With PC2 connected, but separated a few feet from the main unit, plug in the Silencer power cord and turn on the switch. The pilot light should go on instantly, and the "speaker" (bulb) should stay on. Now back away 10 feet or so and trigger PC1 with a flashlight. The "speaker" bulb should go out instantly, and should stay out when the flashlight beam is removed. Wait about 30 seconds to make sure everything is stable, and then trigger PC2 with the flashlight; the bulb should come on instantly. Operate the unit several times to ensure proper action. Difficulties can be traced to inverted diode or capacitor polarities, improper transistor hookup or incorrect wiring.

The simple modification to your TV speaker wiring, as shown in Fig. 2, involves adding a closed-circuit jack. Sim-
ply remove the wire at one speaker term-
inal and reroute it to terminal 1 of the
added jack J2, which may be located at
any convenient spot. Add a wire be-
tween terminals 2 and 3 of J2 and run a
new wire from J2, terminal 2, to the
speaker lug just vacated. Now, with the
mating plug from the TV Silencer in-
stalled, the speaker circuit is controlled
by relay RY1. When the plug is re-
moved, J2 closes the circuit so that it
works just as it did before.

You'll really appreciate the golden silence available at the flick of your wrist when you put the TV Silencer on your set. Give it a try. You'll wonder how you didn't go batty without one!
Followers: Cathode, Plate and Others

By NORMAN H. CROWHURST

The Cathode Follower is an Old Favorite and we occasionally hear about plate followers and transistorized equivalents of these circuits. The word “follower” originated to explain the action, but sometimes its implication gets taken too far. So let’s look at the whole group.

In the cathode follower, cathode voltage is supposed to follow grid voltage. Where the source of grid voltage applied may have a high impedance, the duplicate produced at the cathode provides an abundant supply of current, at low impedance (Fig. 1). That’s the notion. Another description of the cathode follower says it has 100% voltage feedback. And because it has 100% feedback, it is assumed that the waveform must be perfect.

Fig. 1—Basic cathode-follower idea. As grid is driven negative, current through tube decreases, as does current through cathode resistor. That means less voltage drop across the resistor—so its top end gets closer to ground potential; more negative, like the grid.

Readers of Radio-Electronics know, from previous discussions on this subject, that “isn’t necessarily so.” That 100% feedback statement means that the feedback fraction, beta (β), is unity, or 100%. The erroneous notion follows from confusing that beta with the feedback factor (1 + Aβ). If the latter were infinite, gain would be zero dB, and the voltage-gain-with-feedback expression,

\[ \frac{A}{1 + A\beta} \]

would have to equal 1.

Making this substitution and doing a little algebra, to solve for beta, we find the feedback fraction has to be

\[ \beta = 1 - \frac{1}{A} \]

which is quite realizable in theory. To achieve it in practice, if the gain of a tube, with a particular plate load and operating point, is 50 (ratio, not dB), beta needs to be 49/50, or 0.98. Put 0.98 of the load in the cathode and the other 0.02 of it in the plate, and take the output from plate to cathode (Fig. 2), and you have no gain (unity gain, that is).

In practical use, the cathode follower’s output is always taken from cathode to ground, which upset the gain calculation of the last paragraph. Actually, gain of a cathode follower is always a fractional ratio, nearly 1, or slightly negative in dB. In the example just read, the gain proves to be 50/51, approximately 0.98 (as a ratio) or −0.2 dB.

This can be applied to a practical circuit as shown in Fig. 3. A bias resistor of 1,000 ohms sets the correct operating point for the 12AX7 with a 75,000-ohm plate load. This load is connected from the lower end of the bias resistor to ground. The circuit will have a gain of 50/51 (−0.2 dB) and will reduce distortion by the feedback factor of 1 + 50 = 51. The source impedance presented at the output is the reciprocal of the tube’s transconductance. The grid-return resistor, shown as 1 megohm, is effective-ly multiplied by the same factor of 51, in determining the circuit’s effective input impedance (loading), and its grid-to-cathode capacitance is divided by 51.

If the tube’s distortion at full swing, with the plate load used, is 5%, working as a follower will reduce distortion to about 0.1%. Assuming the transconductance is 1,250 µmhos, the source resistance at the output is about 800 ohms.

Couple an 800-ohm load to a tube with a transconductance of 1,250 µmhos, and working gain drops from 50 to precisely 1. Not only that, but the distortion without feedback at full swing jumps from 5% to about 30% as a result of loading. Acceptable input swing is also cut drastically. The feedback factor is now 2 instead of 51, so follower gain drops from 0.98 to 0.5 (or from −0.2 to −3 dB), distortion jumps from 0.1% to 15%, and the available output voltage drops by about 50:1, because the tube only delivers about the same current swing. If the unloaded cathode follower delivered 50 volts rms at 0.1% distortion, the “matched” follower will deliver only 1 volt at 15% distortion!

Apart from the fact that loading destroys the advantage of a cathode follower, the normal limit to its working range is sometimes overlooked. One would think that obvious that, with a 250-volt plate supply, a cathode follower could not handle a 300-volt signal, but the limits do get forgotten. Cathode volt-

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age must always be a little positive of
grid voltage, by the same amount the
grid is momentarily negative from cath-
ode (measuring the same voltage the
opposite way).

The more positive the grid goes, the
higher the tube current and the less the
momentary cathode-to-grid voltage must
be. When this difference reaches zero,
the grid starts to conduct, as in any
other tube circuit, abruptly clipping the
waveform. At the other end, the grid can
go negative of ground only by a voltage
equal to grid cutoff for the operating load
line chosen. Fig. 4 shows relative volt-
ages at these instants.

From the fact that loading destroys
the low-distortion advantage of a cathode
follower, we can see just where the fol-
lower is and isn’t practical. It is not, as
has sometimes been claimed, an
improved substitute for a line-matching
output transformer—the line trans-
former does a better job, where matching
is required. But for providing a low-im-
pedance source to an output line, for
example from an FM tuner, preamplifier
or control center, either in a home high-
fidelity or professional system, a cathode
follower does serve better than a line
transformer, provided it connects only to
a high-impedance input.

[With certain transistor emitter
follower circuits, it is possible to pro-
duce source impedances so low that
they will work effectively into load im-
pedances of 600 ohms or less (see the
“Transistor Line Transformer”, April
Radio-Electronics). But this is still not
matching, and the material in the
preceding paragraph still holds. The
load should not be less than 100 times
the effective source resistance if the
properties of the cathode or emitter
follower are to be kept.—Editor]

Plate follower

Here plate current is supposed to
follow cathode current, input being ap-
plied to the cathode, with the grid
grounded. A larger voltage is available
at the plate than is presented to the
cathode (Fig. 5). This circuit is a little
more difficult to visualize, because in
practice we have to provide somewhere
for the cathode current to “go”. But
first let’s treat it as an “ideal” follower.

Without any other connection to the
cathode, plate current must equal cat-
ode current, unless the grid is more posi-
tive than the cathode (cathode negative
of grid, or ground). So, if a certain in-
put current is fixed, plate voltage will be
fixed by the drop in the plate resistor
(Fig. 6). Cathode voltage is fixed as the
equal and opposite of the grid voltage
that would be required for this plate
voltage and current combination. If cat-

Fig. 6—Plate-follower relationships shown
on load line.

ode current is changed, the change in
cathode voltage must be equal to the
change in plate voltage, divided by the
working voltage gain of the tube. This
means the effective resistance in the cat-
ode circuit, presented as a load imped-
ance to the input source current, is the
plate resistor divided by the working
voltage gain of the tube.

This circuit is subject to the same
limitations as the cathode-follower cir-
cuit at cutoff and at zero grid voltage. It
has no negative feedback, so the voltage
and resistance transfer ratio is far non-
linear as the tube’s characteristics from
the operating point chosen.

When one tries to provide a con-
stant-current input circuit to the cathode,
while also achieving correct bias, a diffi-
culty appears: the first requires a high
input resistance and the second a much
lower value of resistance between cath-
ode and ground. The circuit can be used
in its true form only in conjunction with
a transformer, either tuned to a specific
frequency or a wide-band audio type
(Fig. 7). The impedance presented by
the transformer to the cathode must be
high enough to achieve essentially con-
stant-current input, while the winding
resistance (padded, if necessary), be-
tween cathode and ground, sets up cor-
cert bias.

For this reason, the plate follower

has found little use in audio circuits. It
has proved useful in higher-frequency
radio circuits (usually under the name
“grounded grid”), where it helps keep
unwanted circuit interaction at a min-
umum, by using lower working imped-
ances throughout than do other tube cir-
cuits. The cathode follower provides a
low output source impedance, but a very
high input loading impedance. The plate
follower loads down its input source and
the output impedance is no higher than
conventional plate circuits. Thus it serves
in the nature of an impedance stepup, at
constant current, so voltage gain is the
same as impedance stepup effect.

Transistor versions

The transistor version of the cath-
ode follower is an emitter follower (Fig.
8). Bias is simpler for an emitter fol-
lower than for a cathode follower. But
the result has certain differences. In the
cathode follower, the source resistance
is governed by the tube’s transconduct-
ance. In the emitter follower, the rele-
vant parameters are working-current
gain ratio and the source resistance pre-

Fig. 8—Basic emitter follower for n-p-n
transistor. Looks and works much like
cathode follower.

sented to the transistor. With the tube,
the source resistance the grid sees is
almost completely irrelevant. With the
transistor, base source resistance controls
the reflected source resistance almost en-
tirely.

Transistor gain varies along its
characteristic, so the reflected source
and load resistances (it works both ways

Fig. 9—Impedance reflection in emitter fol-
lower.

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—Fig. 9) will change at different points on the waveform, to some extent. However, the emitter follower is essentially the cathode follower in being a voltage-follower device: the emitter voltage closely follows the base input voltage.

But in this respect its action is subject to limitations like its tube counterpart. Fig. 10 shows the circuit with which the accompanying photographs of scope traces were taken. With the output open-circuited, input and output voltages, using a 12-volt supply, measured 3 volts rms (both almost identical, as shown by the straight-line trace 1). Connecting the matching load (calculated at 15 ohms, here) limits the output, causing the transistor to be cut off most of the way, with only a little kink at the left end, where it still transmits signal (trace 2). Cutting down the input to where cutoff no longer occurs (trace 3), the input measures 0.3 and the output 0.15 volt. Note the curvature, which indicates substantial distortion.

**Fig. 10—Circuit used in making scope traces shown in photographs.**

The transistor version reflects impedances both ways, which the tube version does not. The input impedance presented by an emitter follower is its load impedance (including reactance, if any) multiplied by the current gain ratio (h_v) plus the base-to-emitter ac resistance of the transistor (measured at constant collector voltage), which is usually relatively small. The output source impedance is the source impedance presented to the base divided by the current gain ratio, plus base-to-emitter resistance (measured with collector open), which gain is relatively small.

**Fig. 11—Transistor equivalent of plate follower is common-base stage.**

The transistor equivalent of the plate follower is more basic to the transistor—it is the grounded-base configuration (Fig. 11). The difficulty of separating bias and input source impedance functions is not encountered, so the current-follower action can easily be realized.

Just as in the tube version, there is no inherent feedback, except for a small amount included in the transistor's internal parameters. Any nonlinearity of the transistor working in this mode is not reduced in any way by the so-called follower action. However, most recent transistor types have quite good linearity—better than tubes. The main difficulty with this configuration is that it requires supplies of opposite polarity for the emitter and collector circuits.

### Global Navigation Communications Is Subject of Much Attention

Pan American Airlines recently completed tests of an inertial navigation system that can be used on airliners. With inertial guidance, used till now only for navigating space vehicles, flights can hold courses within less than 10 miles—important for forthcoming supersonic flights and in today's crowded skies.

At almost the same time, Communications Satellite Corp. (Comsat) proposed a satellite system that will provide worldwide vhf communications for all global flights. The first satellite would be sent into synchronous orbit over the North Atlantic, where present hf communications are often blocked by weather.

The National Aeronautics and Space Administration (NASA) has gone a step further and suggests a global satellite system that will provide both navigation and communications facilities, simultaneously. The proposed principle of the "NavSat" system is reminiscent of that used presently in ground-based VORTAC (vhf omnirange and tacan) facilities for aircraft navigation over the U.S.

One antenna on the spinning satellite would generate a pulsed reference signal, while other antennas would transmit a directional continuous beam. The result: a plane or ship could take a position fix at almost any instant that would be accurate within a mile. A computer with suitable readout, could show continuous position readings to the pilot or navigator.

Combining the automatic navigation information with voice facilities would offer worldwide traffic control even at supersonic speeds.

### Radio-Electronics Adopts Hertz

**Radio-Electronics** is now using the term hertz—recently adopted officially in the United States—in place of cycles in all references to frequency. This term has been used for many years in other countries. Hz, kHz and MHz, abbreviations for hertz, kilohertz and megahertz, are replacing cycles, kc and me in all recently edited materials. You may run across the older abbreviations in copy set in type before the change.
Using a Narrow-Band Scope for Color TV

You think it's impossible? Read how to get revealing information from even 200-kHz scopes

By ROBERT G. MIDDLETON

IS THE TITLE ABOVE A MISTAKE? NOT at all. You can use a narrow-band scope in color TV servicing, but you have to know how. Your narrow-band scope has extremely wide-band response (out to about 50 MHz) when you feed signals directly to the CRT deflecting plates. Let us see how easily we can check chroma-demodulator operation with such a scope. There are several ways; let's assume first that you are going to use a color generator which supplies R-Y and B-Y signals.

Connections

The output from the color generator is fed to the input terminals of the color TV receiver. How shall we connect the narrow-band scope? Fig. 1 shows a typical terminal board on the rear of the scope, and the connections to the CRT. Note that if you disconnect the jumpers between 1 and 6 and between 2 and 7, the vertical deflecting plates are open-circuited. Similarly, if you disconnect the jumpers between 4 and 9 and between 5 and 10, the horizontal deflecting plates are open-circuited. Thus we can connect leads to 1 and 2 and drive the vertical plates, disregarding the vertical amplifier. Likewise, we can connect leads to 4 and 5, and drive the horizontal plates.

The frequency response is enormous, although a fairly high signal voltage must be applied for full-screen deflection. In some cases, ample signal voltage is available direct from the color receiver. But before we get down to actual patterns, note that merely disconnecting the jumpers in Fig. 1 disables not only the vertical and horizontal amplifiers, but also the centering controls, so you can't use them to position the spot on the screen. This is not so desirable in practical work, so we connect 3-megohm resistors between terminals (Fig. 2). (A few scopes already have such resistors on the back of the terminal board, but many do not.)

Now the centering controls operate normally. The 3-meg resistors provide almost complete isolation from the vertical and horizontal amplifiers. How about the grid terminals? Forget them—we are not concerned with intensity modulation of the pattern. Note that, although we have two connections to the vertical plates (terminals 1 and 2), we seldom have a push-pull signal from a color receiver to drive both terminals. Therefore, we ground terminal 2 for ac (Fig. 3). We also ground terminal 4 (horizontal) for ac, for the same reason.

You may ask, "Since terminals 2 and 4 are grounded for ac, why not merely leave the jumpers between 2 and 7, and 4 and 9?" The reason is simply that jumpers will not provide a good ac ground. The internal circuitry of the scope is resistive and capacitive, and sometimes inductive also. Hence, we isolate the internal circuitry with 3-meg

Fig. 1 (left, above)—Many scopes have jumper wires or links for direct access to deflection plates. Substituting resistors (Fig. 2, right) allows use of scope's centering controls while isolating plates from amplifiers. Fig. 3 (left, below)—Ac-grounding one of each pair of plates with capacitors. Fig. 4 (right)—Clip-leads with 0.1-µF capacitors connect ungrounded plates to color circuits.

Fig. 2—Actual R-Y vs B-Y vector plot on scope screen; b—Ideal relationship.

Fig. 3—3.58-MHz quadrature phase-shift network sometimes needs slight alterations.

RADIO-ELECTRONICS
Fig. 7—Circled resistors can cause phase errors if their values drift off.

resistors, and get a good ac ground with 0.1-μF capacitors.

Connecting the color-TV chassis

Now, terminals 1 and 5 are the active terminals of the CRT, which we will drive from the color receiver. This is done as in Fig. 4. The series blocking capacitors prevent dc from the receiver circuits from displacing the pattern on the CRT screen. Note what we are doing in Fig. 4. We are applying the R − Y signal to the CRT vertical plate, and the B − Y signal to the CRT horizontal plate. Switch the color generator to R − Y and B − Y output, and you will see on the scope screen the pattern illustrated in Fig. 5.

This is an undistorted pattern which shows whether the chroma demodulators have a phase error or not. You could not get this pattern by feeding the signals through the scope amplifiers. Hardly any service scopes have enough horizontal-amplifier bandwidth to display the B − Y signal without severe distortion. Only wide-band service scopes have sufficient vertical-amplifier bandwidth to display the R − Y signal without distortion. However, you can believe what you see when you use the Fig. 4 test method.

Pattern analysis

Ideal and actual pattern displays are shown in Fig. 5. Obviously the receiver response shown in the photo is less than ideal. This means that reproduced colors will be a bit off hue. What do we do about it? We must trim up the phase-shift network in the 3.58-MHz feed lines to the chroma demodulators. Older color receivers had quadrature transformers with adjustable slugs; this made it easy to adjust phase. Recent receivers generally have simplified circuitry with fixed components (Fig. 6). Hence, a phase correction can be made only by adjusting the values of the resistor or capacitor in Fig. 6.

You will sometimes find instructions for small changes of R or C values in supplementary service data. In any case, the procedure is to determine the values that give a quadrature (90°) output in the Fig. 5 pattern. It is assumed, of course, that tubes have been tested. A weak or otherwise defective chroma demodulator or amplifier tube can simulate a phase error. It should not be necessary to change the R or C value in Fig. 6 very much to reach quadrature. If a large change is required, the trouble is actually elsewhere. Check the plate-load resistors and the common-cathode resistors noted in Fig. 7. An off-value resistor can cause an apparent phase error, which would be falsely attributed to the Fig. 6 network.

Display of I and Q phases

Most color generators provide an I and Q output, in addition to R − Y and B − Y. Using the test connections of Fig. 4, switch the generator to I and Q output. A typical scope pattern is shown in Fig. 8-a. Comparison with the ideal relations (Fig. 8-b) reveals that there is a demodulator phasing error, as before, although it is not alarmingly large. When the circuit components such as those in Fig. 7 all have correct values, patterns in Figs. 5 and 8 will both be very close to ideal.

Note that distortion can be caused by overload. In other words, if you advance the color-intensity control on the receiver too far, you can make the scope pattern occupy the entire screen area—but it is also likely that the traces will bend and become displaced. So it is good practice to work with a pattern about two-thirds of screen size. In any case, try turning the color-intensity control up and down a bit, to see if the scope pattern changes in shape. Keep below the point of chroma overloading. The slight looping of the traces in Figs. 5 and 8 is normal, and is caused by less than perfect transient response in the chroma circuitry and color generator. The patterns have three key points, seen as white dots. These are the zero-volt or origin, and the terminations of the two vectors.

Simultaneous color bar phases

Using the same test setup, switch the color generator next to its six-bar simultaneous position. You will see a scope pattern like Fig. 9. Again, if you compare the photo with the ideal phase diagram, it is evident that there are phase errors. This situation corresponds to noticeable errors in hue on the picture-tube screen (Fig. 10). The remedy, of course, is again to check out the components that affect phase, or apparent phase.

It is now obvious why we started the tests with R − Y and B − Y signals. If you observe the pattern of Fig. 9 at the outset, there are six phases to evaluate instead of two. This can make preliminary analysis confusing. How-

Fig. 8—I and Q representation: a—actual; b—ideal.
even, one of the bars in a bar display is white. While the white bar is being scanned, there is no chroma output. Hence, the scope beam rests at the origin in Fig. 9-a while the white bar is traversed—there is no beam displacement away from the zero-reference point. Therefore, we see six key points in the vector pattern, plus the origin.

**Keyed-rainbow signal pattern**

Suppose you are using a keyed-rainbow generator instead of an NTSC generator. You'll find a complete discussion of these two types of generator, and the unkeyed-rainbow type as well, on page 59 of Jan. issue—Editor] Scope connections remain the same as in Fig. 4. But applying a keyed-rainbow signal to the receiver results in a scope display like Fig. 10. This photo indicates a chroma phasing error. Observe how the ellipse "leans" to the left. In other words, the major axis of the elliptical outline is not straight up and down on the scope screen. We expect to see an elliptical outline formed by the tips of the vectors, but this ellipse should appear with its axis vertical and horizontal on the scope screen. The remedies for chroma phasing errors have already been mentioned.

A chroma phasing error corresponds to incorrect hues and brightnesses of the keyed-rainbow pattern on the screen of the color picture tube. When the chroma circuitry has the correct values for its phase-determining components, the chroma-bar hues and relative brightnesses will be correct, and you will get an upright ellipse on your scope. You can even use an unkeyed-rainbow pattern. On the color picture tube it looks like a continuous "shading" of hues, without distinct bars. The scope pattern is a continuous ellipse, without the "spokes" of Fig. 10. Pattern evaluation is the same as for a keyed-rainbow signal.

**Single-bar chroma signals**

Some color signal generators provide only one bar at a time, as shown in Fig. 11. Individual signals are equally suitable for demodulator phase checks using the test setup of Fig. 4. It is necessary, however, to observe one vector first, and then to switch the generator and observe the other vector. The basis of the test is that the R - Y channel normally has no output when a B - Y signal is applied, and that the B - Y channel normally has no output when an R - Y signal is applied. You must not touch the receiver's hue control when you switch from R - Y to B - Y signal inputs.

Turning the receiver's hue control rotates the pattern on the scope screen. At the outset, you may adjust the hue control. For example, apply an R - Y signal, and turn the hue control to make the vector appear straight up and down on the scope screen. This is an arbitrary and convenient reference position. Then, without touching the hue control, switch the generator to B - Y output. The vector should then be displayed horizontally on the scope screen. Otherwise, there is a phase error in the chroma circuits. Note, too, that when you use single-bar signals, the origin will shift when you switch the generator. This is normal. The scope input is an ac waveform, and its average value will fall at the same point—this point is different for the R - Y and B - Y vector displays.

Space limitations prevent further discussion of how to use narrow-band scopes in color TV service. However,
between them, or both, to indicate the direction in which to read the dots. Note that the coding does not include the dc working voltage. The voltage rating may vary from 100 to 1,000 volts dc. Manufacturers may give case sizes to supply information about the working voltage.

The first dot in the upper row indicates a mica capacitor. This is followed by the first two significant figures. The color dot at the lower right is the multiplier. The dot preceding this is the tolerance while the lower left-hand dot is the characteristic. The color for the characteristic will be brown, red, orange, yellow or green.

Example: What can we learn about a capacitor that has white, green and brown dots across the top, and brown, red and brown across the bottom?

The white first dot indicates that we have a mica capacitor. The next two colors are the first two significant figures of capacitance, 5 and 1. We read this as 51. Our multiplier, brown, at the lower right, is 10. Multiplying this by 51 (51 × 10) gives us 510 pF or 510 µF, the nominal value of capacitance. The characteristic (lower left dot) is brown. Fig. 2 shows that this corresponds to the letter B, and Fig. 3 indicates that this characteristic is not given. The lower center dot is red. Fig. 2 shows that the tolerance is ±2%.

Manufacturers' codes

The codes given in Figs. 1, 2 and 3 are EIA codes. Capacitors may also be stamped with the values (in figures) of capacitance and tolerance, or with nothing more than a manufacturer's code number. A manufacturer's code might be a number such as D15. His catalog would show the full number as D155E301JN3. The number immediately following the letter E (which indicates the characteristic) reveals the capacitance. The first two digits are the first and second significant figures of capacitance. The last digit is the multiplier. In Fig. 5 the capacitance is shown as 301. The last digit is the multiplier and represents the number of zeros to follow the first two numbers. Thus, we have 30 followed by 0, or 300 pF. If the last number had been 2 instead of 1, the capacitance would have been 3,000 pF.

Mica cap—the nine-dot code

The nine-dot code is similar to the six-dot code except that both sides of the capacitor carry information. One side, with six dots, is identical to the usual six-dot code. The three dots on the other side, as shown in Fig. 6, indicate the dc working voltage and the operating temperature range. The final dot is an identifier and repeats the identifier information on the front of the capacitor.

![Fig. 6—Standard EIA nine-dot mica code.](image)

Fig. 6—Standard EIA nine-dot mica code.

Mica cap—three to six dots

A variety of codings, ranging from three to six dots, have been used for mica capacitors, as shown in Fig. 7. While this coding is obsolete, tremendous quantities were manufactured and you will inevitably meet capacitors with such coding in your work.

![Fig. 7—Three-, five- and six-dot codes that have been used for mica capacitors.](image)

Fig. 7—Three-, five- and six-dot codes that have been used for mica capacitors.
Paper capacitors—tubular, oil-filled

Known as tubulars because of their cylindrical shape, these units may come encased in paper or plastic, and will have an EIA color code consisting of five or six bands. Oil-filled capacitors, used in high-voltage power supplies and transmitters, are grouped with the tubulars since their dielectric is also paper. Since they are fairly large, their capacitance and working voltage are often stamped directly on the case.

To read the value of a paper tubular, hold the capacitor so the color bands are toward the left. Fig. 8 supplies the code for molded paper tubulars.

The difference between a five-color and a six-color band is in the voltage rating. A capacitor with five colors follows the voltage rating given in Fig. 8. If the capacitor has six colors, the last two (at the right when you hold the capacitor with the maximum number of bands at the left) are both used for the voltage rating. Multiply the value represented by these two colors by 100, or move the decimal point two places to the right.

Example: What is the nominal capacitance, tolerance and dc working voltage of a molded paper tubular whose color coding is brown, black, yellow, orange, brown, red?

Taken together, the first two colors represent 10. The multiplier, yellow, adds four zeros, making the nominal capacitance 100,000 pF or 0.1 μF. The fourth color, orange, indicates a tolerance of ±30%. The last two colors, brown and red, show that the voltage rating is 12 × 100, or 1,200 volts.

If a molded paper tubular has a rating of 1,000 volts or less, only five colors are used, the end color representing the voltage indicated in Fig. 8.

Flat molded paper and film capacitors

The dielectric is the same as that of the tubular units, hence the coding follows that given in Fig. 8. The coding is

![Image of color bands](https://example.com/image1)

Fig. 9—Types of color coding used for molded-paper flat capacitors.

in the form of dots, not bands, and may follow either of the systems shown in Fig. 9. Unlike paper tubulars, though, flat rectangular paper units may or may not carry a color coding to indicate the working voltage. When the voltage rating is not part of the code, it is usually given by the capacitor's dimensions.

Some color-coded capacitors, about the size and shape of a cough drop or piece of Chiclets gum, have a Mylar or similar polyester film dielectric. The top band is the first digit, and the band below is the second. The band closest to the leads is the decimal multiplier. A drawing of a representative capacitor is shown in Fig. 10 along with its color coding chart.

Ceramic capacitors

Available in a variety of styles, this type may be either

![Image of ceramic capacitors](https://example.com/image2)

Fig. 11—Miscellaneous types of ceramic capacitors: A—temperature coefficient; B—first significant figure; C—second significant figure; D—decimal multiplier; E—tolerance.

fixed or variable and coded by dots or bands. Disc types may be color-coded or may have the capacitance value and other data printed on the unit. The coding may be three, five or six dots or bands. Fig. 11 shows miscellaneous types of ceramic capacitors while Fig. 12 illustrates the coding of tubular types. A summation of the EIA coding for five- and six-color systems is given in Figs. 13 and 14.

Miniature molded ceramics

When these units use four colors in their code, the first two colors are the first and second significant figures of capacitance. The third color is the multiplier and the last color is the tolerance. The colors are numbered according to the
EIA code given in Fig. 1. In some cases, though, manufacturers use a coding system of their own.

Military coding

Capacitors manufactured for the military may find their way into surplus. A representative marking consists of a nine-letter code—actually, a combination of numbers and letters, such as CY30C36J2. Fig. 15 gives the description of the capacitor type, the corresponding military style designation and the applicable MIL specification.

![fig.12](image)

**Fig. 12—Coding for tubular ceramics.**

First color = Temperature coefficient of capacitance  
Second color = First significant figure of capacitance  
Third color = Second significant figure of capacitance  
Fourth color = Decimal multiplier of capacitance  
Fifth color = Tolerance of capacitance  
First sig. fig. of temp coeff. = Sig fig of temp coefficient of capacitance  
Second sig. fig. of temp coeff. = Mult to apply sig fig of temp coeff  
Third color = First sig fig of capacitance  
Fourth color = Second sig fig of capacitance  
Fifth color = Decimal mult of capacitance  
Sixth color = Tol of capacitance

![fig.13](image)

**Fig. 13—Tubular ceramic capacitor EIA five-color system (top); six-color system (bottom).**

<table>
<thead>
<tr>
<th>Color</th>
<th>1st sig fig of capacitance</th>
<th>2nd sig fig of capacitance</th>
<th>Mult to apply to sig fig of capacitance (6-dot system)</th>
<th>Temperature coefficient of capacitance (5-dot System)</th>
<th>Temperature coefficient of capacitance (6-dot system)</th>
<th>Tolerance (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
<td>1</td>
<td>-1</td>
<td>0 pF/C</td>
<td>-0.1 pF/C</td>
<td>±2.0 ±20%</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>10</td>
<td>-1</td>
<td>150 ±33 pF/M°C</td>
<td>10000 ±0.5 pF/M°C</td>
<td>±0.1 ±1%</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>100</td>
<td>-1</td>
<td>0 ±75 pF/M°C</td>
<td>0 ±75 pF/M°C</td>
<td>±0.5 ±5%</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>1000</td>
<td>-1</td>
<td>-150 ±30 pF/M°C</td>
<td>10000 ±1 pF/M°C</td>
<td>±0.05 ±10%</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>10000</td>
<td>-1</td>
<td>-220 ±20 pF/M°C</td>
<td>100000 ±2.2 pF/M°C</td>
<td>±0.01 ±10%</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>0</td>
<td>-1</td>
<td>-330 ±30 pF/M°C</td>
<td>0 ±1 pF/M°C</td>
<td>±0.25 ±10%</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>0</td>
<td>-1</td>
<td>-470 ±30 pF/M°C</td>
<td>0 ±0.01 pF/M°C</td>
<td>±1.0 ±10%</td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>0</td>
<td>-1</td>
<td>-750 ±30 pF/M°C</td>
<td>0 ±0.1 pF/M°C</td>
<td>±1.0 ±10%</td>
</tr>
<tr>
<td>Gray</td>
<td>8</td>
<td>0.01</td>
<td>-1</td>
<td>General purpose</td>
<td>General purpose</td>
<td>±1000</td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td>0.1</td>
<td>-1</td>
<td>General purpose</td>
<td>General purpose</td>
<td>±10000</td>
</tr>
</tbody>
</table>

ppM = parts per million (per degree Centigrade)

**Fig. 14—EIA color code for ceramic capacitors.**

![fig.15](image)

**Fig. 15—Military designations and corresponding spec numbers for capacitors.**

The number 30 following the letters CY refers to the case size. The letter C following the number 30 refers to the characteristic. You can obtain this information by consulting Fig. 3, given earlier. The number 362 gives us the nominal value of capacitance. The first two figures, 36, are the first two digits of capacitance. The number 2 represents the multiplier, and indicates the number of zeros to follow. In this example, the capacitance is 3,600 pF. If the multiplier had been the number 1, the capacitance would have been 360 pF. If it had been a zero, the capacitance would have been 36 pF.

The last letter of the part number marked on the capacitor is the tolerance and is given in Fig. 16.

Capacitors made to military specifications may be coded with a combination of numbers and letters, but may also use the EIA code with some small modifications. Thus, molded micas will conform to MIL-C-5A military specs and EIA specification RS-153. In the six-dot code the dielectric identification (first dot to the left, upper row) is white for EIA and black as the MIL-C-5A color.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Voltage</th>
<th>Capacitance</th>
<th>Capacitance tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap, paper—notmetal case</td>
<td>F = 1%</td>
<td>G = 2%</td>
<td>H = 3%</td>
</tr>
<tr>
<td>Shape &amp; dimensions</td>
<td>J = 5%</td>
<td>K = 10%</td>
<td>M = 20%</td>
</tr>
<tr>
<td>Characteristic</td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>202</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 16—Tolerance values of capacitors coded to military specifications. Figures are plus/minus percentages of nominal capacitance.**

The military designation for plastic molded tubulars is CN22AE202N. The characteristics corresponding to this number are given in Fig. 17. However, the capacitor color coding follows the EIA system given in Fig. 8.
The problem of maximum power.

Careful laboratory studies, we have applied up to 100 watts of musical program material to E-V high fidelity speakers with no apparent distortion and no signs of immediate failure due to heat or fatigue. One fact became quickly evident. The absolute loudness limit for most high fidelity systems lies not with the speaker, but rather with the amplifier.

Careful oscilloscope analysis revealed that waveform distortion appeared first at the amplifier output, usually in the form of clipping. The loudspeaker faithfully reproduced this distorted waveform, giving rise to the subjective analysis that the speaker was being "overdriven." Substitution of a more powerful amplifier with greater reserve power at the same acoustic output, eliminated the "speaker distortion" completely!

The problem of maximum loudness in any system is further complicated by the almost universal trend toward speaker systems of medium and low efficiency. If a speaker system, by design, trades six or eight db of efficiency for other benefits (wider range or smoother response), it necessarily places a heavier burden on the amplifier to provide a clean signal at high levels.

The absolute limitations of any speaker system based on peak performance requirements are very difficult to objectively state. Listening tests have proved to have the greatest validity to date, yet results vary from listener to listener, and with the frequency and duration of the peaks. A realistic rating for most small speaker systems would be in the order of eighty to one hundred watts peak handling power. To realize this potential requires an amplifier of forty to fifty watts rating (based on peak performance twice that of the steady-state rating).

For technical data on any E-V product, write:

ELECTRO-VOICE, INC., Dept. 563E
613 Cecil St., Buchanan, Michigan 49107

EQUIPMENT REPORT

The Editall KP-2 Tape-Splicing Block

Circle 26 on reader's service card

THE EDITALL SPlicing BLOCK has long been a standard among professionals, though it seems to appeal to a smaller proportion of amateurs. Perhaps the amateurs are misled by its simplicity: it's just a solid block with a shallow, curved trough running along it, and two narrow slots perpendicular to the surface on which the block is resting.

The tape to be edited is laid along the curved trough, which is undercut slightly to lock the tape in place. Running a single-edge razor blade through one of the narrow slots cuts the tape cleanly in one stroke. One of the slots is at the standard 45° angle to the length of the tape, while the other is at right angles to it. The 45° slot is the more commonly used, since it makes a smoother, less abrupt transition between the two tape sections being spliced. The 90° slot can be used for splicing leader in, but more commonly it is used as a marker. The spacing between the two slots is exactly the same as that between the playback head gap and the right-hand edge of the head cover of Ampex professional, Premier Tapesonic, and perhaps some other machines as well. Most pros mark their tapes where they exit from the head cover, put this mark opposite the 90° slot on the Editall block and cut at the 45° slot.

By marking the tape while it's still on the playback head, you run the risk of dirtying the head with your crayon and altering the head alignment by your pressure on it. On recorders whose head-to-cover-edge distance is not the same as on Ampexes, a mark can be painted at a distance from the playback head gap that corresponds to the spacing between the Editall's slots, and the tape marked at this point for cutting.

The new Editall KP-2 block differs from earlier models in that it is made of plastic, rather than aluminum, and has both an adhesive strip and screw holes, giving a choice of mounting methods. The plastic version may or may not wear as well as the metal (which lasts practically forever, subject only to a very slight widening of the cutting slots after many thousands of splices), but no wear was evident after 50 splices had been made on it.

The KP-2 comes in a kit containing an instruction book, a marking crayon, a cutting blade and 30 "Editabs." The very thorough instruction booklet explains how to use the Editall system and gives the basics of tape editing practice clearly and concisely. The black marking crayon provided adheres well to the tape backing, but is invisible on black-oxide tapes, such as the new 3M Scotch 201, 202, 203 and 290, for which a yellow crayon would be best. The blade, an ordinary single-edge razor blade, should be replaced whenever it begins to tear or stretch rather than slide the tape (which happens frequently with polyester tapes), but blades are available at all drugstores and can be bought very cheaply in boxes of 100 or more at art-supply stores.

The biggest nuisance of tape splicing—no matter what splicer is used—is usually the application of the splicing tape. The Editall system uses 7/8-inch tape that is laid lengthwise along the tape and requires no edge trimming (if you're careful). The new Editabs, 30 of which are included with the KP-2 kit, make splicing even easier. They consist of a precut length of 7/8-inch splicing tape, mounted on a slightly less adhesive, clear plastic strip a full 1/4 inch wide. To splice, merely place the Editab over the splicing point, press down until the splicing tape adheres, then pull off and discard the clear backing. The Editabs make proper alignment of the splicing tape a bit simpler, and eliminate the problem of dirtying the adhesive surface of the splicing tape with your fingers.

The Editall system is about the most precise editing tool readily available. No other splicer or system that I have tried is as simple and none lends itself so readily to adding and subtracting those tiny bits of tape that may rep
New Professional DC 'Scope
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Eleven Years Ago Heath Broke The Price Barrier On Oscilloscopes With A Low-Cost Scope For Hams, Hobbyists, And Service Technicians. Now Heath Breaks The Price Barrier Again! . . . With A Precision, Fast-Response, Triggered Sweep, Delay Line Oscilloscope For The Serious Experimenter, Industrial Or Academic Laboratory, And Medical Or Physiology Research Laboratory.

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MAY, 1966

TE-142

www.americanradiohistory.com
Knight KG-635 DC-Wide-band Oscilloscope

I had been shopping around for an oscilloscope for some time when Allied Radio's Knight-Kit division announced the KG-635, dc-to-5.2-MHz (megacycle) scope with a number of attractive features. A study of the schematic convinced me, not only that all the scopes in its price range this seemed to be the best buy, but also that this new model appeared to be worth telling about in Radio Electronics.

So I ordered the kit and started building. Things like this are always spare-time ventures, so I won't alarm anyone by mentioning the actual time that elapsed between getting the kit and finishing the scope. But as good a tally as it was possible to keep, with all sorts of irregular interruptions, indicates that it took only about 23 hours to build the scope—not bad considering that there are no printed or etched circuits of any kind, no wiring harnesses, no preassembled sections. This is a real-solid, honest-to-gosh kit!

The instructions are superb. The few minor errors in the book had already been noted on a mimeo insert; a few more minor typos turned up, but otherwise the assembly manual is a magnificent piece of work.

The scope is about as close as you can get to a "professional" or "lab" scope without actually getting one of those. Vertical response is flat (within 3 dB) from dc to 5.2 MHz; sensitivity is 17 millivolts rms per inch. The sweep circuit is a sophisticated one with amplified, polarity-switchable sync (internal, external or line), and appears to be linear even out to the limits of the horizontal amplifier's frequency range (down about 2 dB at 400 kHz). Sweep synchronization is effective at very small display amplitudes, even at 3 or 4 MHz.

The trace is bright enough for most shop applications, though a hood over the bezel is helpful with certain kinds of room lighting. It is not as sharp as on a couple of 3-inch scopes I have known and loved. No amount of juggling of the intensity, focus and astigmatism adjustments would crisp it to quite that point, but this is quite normal with the larger trace size from the 5-inch CRT, which largely compensates for the reduced sharpness.

The vertical amplifier attenuator is a switch with four positions: .05, .5, 5 and 50 volts peak to peak per inch. It is frequency-compensated in the usual way with adjustable trimmer capacitors. Some day, as one of a number of "personalizations", I would like to install an attenuator with finer steps—such as .05, .015, .05, 1.5, 5, 15, and 50 volts.
Although there is a vernier vertical gain control, it is normally left wide open, at the CAL position, so that the scope, once calibrated, can be used to measure peak-to-peak voltages at a glance. As a result, a waveform slightly too small to observe in normal range (the -10 dB/decade) disappears off the top and bottom of the screen on the next more sensitive range (0.5 volt in this case). And turning the continuously variable vertical gain control disrupts the calibration. This is not a serious problem unless you frequently measure with the scope. I use it mainly to examine waveforms, and for that the present arrangement is fine.

The scope’s circuitry is not vastly different from that of other modern instruments of its class. It does use some very modern tubes (all RCA’s and Mullard’s, by the way) in the vertical amplifier—real high-transconductance jobs like a pair of 6L8 triodes-pentodes and a pair 6L6G6C, and Shunt and series peaking hold the response up into the 5-MHz region, after which the gain drops off rapidly. The vertical amplifier is of course direct-coupled throughout.

Drift is held down by a combination of voltage regulation (a 0A2 and a NE-2 in the power supply), heavy degeneration in each stage and, at the beginning, by a 15- to 25-hour aging period that is recommended before any adjustments are attempted.

If dc amplification isn’t wanted, a slide switch throws a 0.1-pF, 600-volt capacitor in just before the input attenuator, preventing dc voltages at the input terminals from deflecting the spot.

**MANUFACTURER’S SPECIFICATIONS**

**VERTICAL**
- Sensitivity: 17 mV rms/inch. Calibrated at .05V p-p/inch
- Response: ±1.5 dB dc to 5 MHz; color band-pass ±0.5 dB
- Overshoot: less than 6%
- Range: 0 to 70 V x 100
- Input impedance: 3 meghoms shunted by 35 pF
- Attenuator: frequency-compensated, calibrated; 0.05, 0.5 and 5 V p-p/inch

**HORIZONTAL**
- Sensitivity: 0.6 V rms/inch
- Response: ±1.5 dB 1 cycle to 400 kHz
- Expansion: 2 times
- Positioning: all parts visible
- Input impedance: 7 meghoms shunted by 25 pF
- Linearity correction ranges: 10-100, 100-1000 Hz, 1 kHz-10 kHz, 10 kHz-90 kHz, 90 kHz-400 kHz

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- Internal, external, 60 cycles, external. Sync limiting for semi-automatic operation with level control. Locks on waveform fundamentals at 5 MHz and on display amplitudes as low as 0.1 inch.
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- Calibration voltage: 60 Hz sine wave, 100 mV peak from panel jack
- Z-axis input: -10 V for beam cutoff; impedance 1 meghom
- Size: 7% x 1 11/16 x 15% inches
- Weight: 25 lb.
- Tubes: 12 including CRT and 2 rectifiers
- Power: 110-110 Vac, 50-60 Hz 112 watts power transformer primary tapped for adjustment to local line voltage
- Price: $99.95 kit, $149.95 wired

**Let’s Look Inside The Dynamic Microphone**

THIS is no ordinary microphone. It’s a University Dynamic. Its manner of working is no less complex than a modern day computer. Its system of elements is a carefully integrated electromechanical network in a critical acoustical area. Without showing it, it’s really quite a bit more than it appears to be—you have to listen to know the results of its performance.

For example—you move toward a flurry of activity on a busy street corner and witness a man-on-the-street interview. To you and the observer the conversation is barely audible above the noise of people and traffic. But to radio listeners the conversation is clear and unaffected by the sounds of the city...They are remote...in the background where they belong. This is the distinct advantage of a microphone with a good directional pick-up pattern.

To demonstrate another case in point—a passing by an unobtrusive observer in a conference room of a large organization. A tape recorder, fed by a single microphone in the center of the conference table, is in use to store all that is said. Many speak at once...some face away from the microphone; it appears that all that is said may never be recorded, but every word is captured on the magnetic tape for later review.

Both are University Dynamic Microphones, but they are different in design, to suit different applications. The first is a highly omnidirectional (cardioid) dynamic microphone, sensitive only to the areas of sound intended for radio transmission or recording, proportionally attenuating sounds emanating from adjacent unwanted areas. The second is a highly omnidirectional dynamic microphone sensitive to sounds in all surrounding areas, specifically designed to pick up all sounds.

University makes only dynamic microphones, and they have the precision and reliability of modern day computers. Look at the inside to confirm this. The bullet shaped dome of the directional cardioid is a precise and significant component of the system. It smooths out the internal mid-range to provide a more dynamic, natural quality of sound. Filters, in a series configuration, often sudden bursts of sound, minimize artifacts and protect the inner components from dust, dirt and the elements. A series of ducts further extends the performance of the microphone’s transducer elements providing gross and fine tuning (similar to the back ducts of a speaker system) to sharpen the directional characteristics and reinforce the bass response.

That and capacitors span the space between two lugs on two terminals strips a couple of the box apart. This kind of parallel, which not only looks nice but makes checking, inspection and—if necessary—troubleshooting easy. Plastic cable ties are used extensively, and one large bundle is laced along a structural member with good old waxed lacings cord (supplied, of course).

Large, accurate drawings, in the book and on large folded sheets, are provided wherever they can be a help.

—Peter E. Suthem

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NEW SEMI-CONDUCTORS AND TUBES

THE RISE OF THE FIELD EFFECT

The electronics industry seems to be getting more and more excited about the versatility of field-effect transistors. In many ways, they seem less critical and touchy about circuit constants than transistors are. They are less temperature-sensitive. And, of course, one of their principal features is their extremely high input impedance, which results from the fact that they normally work with their gate-source junctions (input terminals) reverse-biased. Leakage currents in the sub-nan_ampere range (well under one-billionth of an ampere) are common. Input impedances of 400 meg_ohms are easily achieved. Noise figures are extremely low.

At a recent Texas Instruments seminar, one engineer spoke of a 48-MHz crystal oscillator using a field-effect transistor which maintained its frequency within approximately 150 Hz over a temperature range of 0 to 100°C. No temperature-compensation was used—the circuit was extremely simple, just a basic triode design—and the temperature variation was applied to the transistor only.

Another possible advantage of FETs is that they “look” so much like tubes, as far as circuit design is concerned. Once again it is becoming common to talk of transconductance, to get bias by putting a dropping resistor in the source (cathode) lead, to have input impedances of hundreds of meg_ohms. This can make it easier for many people—those who never quite felt at home with the “strange” characteristics of ordinary transistors—to jump in with both feet and exploit the benefits of solid-state devices.

One precaution was emphasized at the TI seminar. Field-effect transistors can be ruined in the twinkling of an eye by an accumulation of static charges around them. If the static voltage gets high enough, it will puncture the gate-source junction permanently, making the transistor worthless. The simplest solution seems to be to keep a shorting link across the transistor leads until after installation.

Siliconix, Inc. has just introduced a line of n-channel junction field-effect transistors designed primarily for low-power audio work. Input current is very low (I_{in} = 10 pA maximum). Input capacitance is only 3 pF. These units, the 2N4117, -4118 and -4119, should make excellent high-input-impedance audio or dc amplifiers, choppers or electrometer devices. The transistors differ principally in their rated currents: I_{in} maximum of .09, .24 and .6 mA, respectively, for the three types in numerical order. They come in the TO-72 can. Quantity prices are in the $10 range.

LOW-COST VVC DIODES

Have you got around yet to experimenting with voltage-variable capacitance diodes? They are very effective in tuning and modulating devices, varying their junction capacitance more or less linearly with applied reverse-bias voltage. (While every junction diode will do that, the VVC’s are designed to do it—with a predictable change of capacitance for a known change of voltage, and with higher Q than ordinary diodes.)

What brings this subject to mind is the introduction of a new line of voltage-variable capacitance diodes from Somerset Electronics Corp. The SV-1748 and SV-1650 series feature minimum Q of 150 and 200, respectively, at 50 MHz, and guaranteed tuning ratios (1-to-15-volt range) of 2.6 or better.

They can be used for tuning, a-c or modulation up to 1 Gc. Nominal capacitances range from 6 to 56 pF at 4 volts reverse bias. The diodes are priced at $1.50 each in 100-quantity lots from Somerset Electronics Corp., PO Box 115, Manville, N.J. 08835.

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It's easy! Just plug Music Associated's Sub Carrier Detector into multiplex jack of your FM tuner or easily wire into discriminator. Tune through your FM dial and hear programs of continuous commercial-free music you are now missing. The Detector, self-powered and with electronic mute for quieting between selections, permits reception of popular background music programs no longer sent by wire but transmitted as hidden programs on the FM broadcast band from coast to coast. Use with any FM tuner. Size: 5 1/2" x 6". Shipping weight approx. 7 lbs.

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500 to 8,000 Hz is depressed 3-4 dB, while leaving the range from 8,000 to 20,000 Hz relatively unattenuated. 19 x 19 x 9 1/2". -British Industries Corp.

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SOLID-STATE RECEIVER (SIX HUNDRED AND AMPLIFIER (SIXTY)). Both deliver 60 watts output at 4, 8, and 16 ohms. Two sets of speaker terminals individually controllable. RF sensitivity 2 dBm. Response 10-100,000 Hz. Harmonic distortion 0.5%. Stereo separation (at 1 kHz) 65 dB. Magnetic phono, tuner, tape inputs. Power 117 volts 60 Hz. 15 x 3 1/2 x 8 1/2 in., 12 lb. -Audio Dynamics Corp.

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SINGLE/SIDEBAND TRANSEIVER, model SB-72, 72 modes of operation on 24-channels. USB, LSB, AM. Built-in power supply for 12- and 115-volt operation. 13 tubes, including compactrons and tetrodes. 4 1/2 x 5 1/2 x 7 3/4'. Shipping weight approx. 11 lbs.

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Hz. 7-ft. single-conductor shielded cable with standard phone plug. 45 in. high, $\frac{3}{4}$in. diameter 2$\frac{3}{4}$ oz.—Sonotone Corp.

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TWO NEW SILICON POWER TRANSISTORS, 2N3738 and 2N3739, in—

Hallicrafters' new CB-19 transceiver is about as sleek and trim and compact as an infantry boot.

That's why there's room for the "S" meter, the receiver tuning VFO, the king-size communications speaker and unsurpassed basic performance—for only $149.95
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TUNED ON THE LINE
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That's right! - and that's why
Wizard 300 coupling instantly improves both
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Beat up Ton and a Half
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MINICONIC HANDBOOK, Bulletin 201, 8 pages plus price sheet, gives specs and theory of operation, installation, and designing your own circuit for Miniconic phone cartridges and tone arms.—Euphonics Marketing Circle 81 on reader's service card

REPRINT, "Designing a Ducted-Port Bass-Reflex Enclosure," from Electronics World, Jan. 1966, 5-page article—with illustrations, of course.—Jensen Mfg. Div. Circle 82 on reader's service card

1966 GENERAL CATALOG, describes, in 44 pages, full line of precision components including transformers, capacitors, circuit breakers, controls, flashlights, jacks and plugs, rectifiers, resistors, semiconductors, timers, vibrators.—Mallory Distributors Circle 83 on reader's service card

1966 SPRING CATALOG, no. 663, 108 illustrated pages of CB equipment, auto accessories, musical instruments, hi-fi components, TV sets, etc.—Lafayette Radio Accessories Circle 84 on reader's service card

MIDGET LIGHT CATALOG, 1966, describes Midi-Mates (miniature drivers and encoders), Alpha-Lite (alpha-numerical microminature readout displays), technical data, specs and prices on entire line.—Pilotes Inc. Circle 85 on reader's service card

BROCHURE of specs on Irish 200 Series professional recording tape and 190 Series (semi-professional). Economy Emerald type also described. 6-page foldout.—Morrill National Sales Co.

Circle 86 on reader's service card

"SCOTCH" ELECTRICAL PRODUCTS CATALOG, 8 pages, photos and applications of electrical tapes, connectors, splicing kits, resins, splicing materials, seals, flat cable systems, splice sleeves, mounting plates, cable clips.—Dept. D6-59, 3M Co. Circle 87 on reader's service card

1966 CATALOG. 432 pages of complete product descriptions on more than a million items of electronic, electrical components. Company has 5 warehouses throughout country.—Federated Purchaser, Inc. Circle 88 on reader's service card

ENCAPSULATED-BATTERY BROCHURE, Bulletin VO-113a, 4-page, looseleaf punched, illustrated. Describes VO series of encapsulated alkaline rechargeable batteries.—Gulton Industries Circle 89 on reader's service card

HI-FI/Stereo Component data sheets, on speaker systems, model 16 amplifier, model 18 tuner. Reprints of magazine reports, grouped under title "What Do the Critics Say about KLH?"—KLH Research and Development Corp. Circle 90 on reader's service card

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exactly where do you plan to go in electronics?

PAGE 31 CAN HELP YOU MAP IT OUT.
The Lowdown on Touch Tuning

Lazy-man's automatic tuning systems are popping up even on lightweight portable radios.

By ROBERT F. SCOTT
TECHNICAL EDITOR

Automatic tuning systems, popular features of many prewar radios, are here again! Just touch a button and tune in a station automatically. Let's take a look at four typical circuits and see how they work.

In the early 1950's they were adapted for some auto radios. Now, search or signal-seeking tuning has been added to a number of transistor portables and several hi-fi tuners and receivers. In all cases, the search tuning system is started manually and stopped automatically when the incoming signal is tuned in.

The automatic tuning system used in several imported portables is developed around a clockwork motor and a new 360° tuning capacitor. The capacitor makes it unnecessary to reverse the tuning motor at the end of each 180° sweep of the tuning capacitor. The basic clockwork tuning capacitor is shown in Fig. 1.

The spring motor is wound by turning a winding key alternately clockwise and counterclockwise as you would twist the stem on a watch. The motor is geared to the tuning capacitor and to an impeller. The impeller turns at approximately 10,000 rpm and makes 3,364 revolutions for each revolution of the tuning capacitor. It has four blades that can be latched by the relay armature and two additional blades that control its speed by air resistance.

Pressing the auto-tune button either depresses the relay armature or energizes the relay coil to release the impeller. The motor turns the tuning capacitor until a station is tuned in and a trigger signal releases the relay. The lever drops into the impeller, stopping it instantly. The tuning capacitor stops turning and the tuning cycle is completed. Contacts on the relay mute the receiver and defeat the AFC system during tuning, and set the radio's sensitivity to the desired level.

Radar-Matic tuning

This is Panasonic's name for the signal-seeking system used in their model R-1000 10-transistor AM portable. The Radar-Matic circuit is shown in Fig. 2. The AUTO TUNE switch is an SPDT snap-action type that returns to its

---

Fig. 1 — Clockwork motor saves weight and battery power. Impeller provides speed regulation and instant stopping.

Fig. 2 — Panasonic R-1000's "Radar-Matic" circuit uses system of Fig. 1, plus this circuit.
normal position when the button is released. When the AUTO TUNE button is pressed, the relay coil is momentarily connected directly across the 6-volt battery. The relay pulls in and the lower contacts connect Q8 and Q10’s emitters to the 6-volt line. Q10’s collector current flows through the relay winding so it remains energized after the AUTO TUNE button is released. The relay armature releases the impeller and the tuning capacitor rotates.

The upper set of relay contacts removes the shunt from across R1 and R2 in Q3’s emitter circuit and connects Q4’s collector to the positive 6-volt line. Removing the shunt from across R1–R2 reduces the i.f. gain by the amount determined by the setting of the SENSITIVITY switch. Connecting Q4’s collector to the positive bus cuts off this stage and mutes the audio while the tuning system is seeking a station.

The output of the second i.f. amplifier is tapped off just ahead of the detector, fed through a highly selective crystal filter and then amplified as a very narrow-band signal. This i.f. signal is rectified and amplified as a sharp trigger pulse. When a station is tuned in, the

Fig. 3—Same clockwork tuning motor and impeller are used in Hitachi TH-900, with different circuit idea.
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RADIO-ELECTRONICS

Panasonic R-1000 Radar-Matic. Automatic tuning control is in top right corner.

Hitachi TH-900 Auto-9 has drum dial.
The search tuning circuit in the R209 is shown in Fig. 5. Pressing the POWER TUNE button on the panel or the CHANNEL SELECT button on the remote-control transmitter momentarily applies 24 volts ac to the tuning motor and the coil of relay RY1. The relay closes and locks in the normally closed contact of RY2 and its own “motor hold” contacts. The 3,600-rpm motor drives the tuning capacitor through a speed reducer consisting of a 90:1 gear train and the dial cord. When the tuning capacitor reaches each end of its range, cams on the shaft operate the motor reversing switch. The motor continues to run until a station is tuned in.

With RY1 locked in, its “search energize” contacts apply operating voltage (−16 volts) to the emitters of the p-n-p transistors used as second af amplifiers in the stereo preamp. This voltage reverse-biases the transistors and cuts them off so the audio circuits are muted while the receiver is searching.

The “afc defeat” contacts ground the control line going to the variable-capacitance diode in the FM afc circuit. This insures that the station is tuned to the center of the i.f. passband before the afc is restored. The “radio sensitivity” contacts control the emitter bias of the first i.f. amplifier. When RY1 is closed, the i.f. bias is tapped off the search sensitivity control and is reduced so the amplifier operates at less than maximum gain. This insures that tuning stops only on strong stations.

The search sensitivity control is on the front panel so the owner can adjust the tuning threshold.

The last AM and FM i.f. stages are coupled to the input of the search amplifier through special narrow-band i.f. transformers. When a station is tuned in so the i.f. carrier is exactly in the center of the i.f. passband, a signal is fed to the search amplifier and then rectified by the search detector. The collector current increases, energizing RY2 to break the holding circuit to the motor and RY1.

The AM and FM i.f. transformers feeding the search amplifier are designed for unusually high selectivity at 455 kHz and 10.7 MHz. Their bandwidth is approximately half that of regular i.f. stages. The 3.3-pF capacitor from the collector of the search amplifier to the low side of the FM i.f. transformer provides just enough positive feedback to increase the Q and selectivity of the FM circuit.

Limiting diodes clip the positive and negative peaks of the i.f. signal and provide a constant input to the search amplifier. This insures that the search detector collector current remains constant for all except the weakest signals and interrupts the search cycle at the correct turning point.

---

**How Magnavox does it**

Unlike the other sets just described, the Magnavox R209 is a 21-transistor AM-FM tuner used in some of the manufacturer's top-line consoles. An ultrasonic remote control can be used for automatic station selection on AM, FM or TV, for selecting one of three volume levels, rejecting records or turning off the equipment.

---

![Fig. 5—Magnavox R209 AM-FM tuner, used in top-of-the-line consoles, features this automatic tuning system.](image)

---

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BATTERY HOLDER BECAME BATTERY

An item of industrial electronics I was working on was unstable. After much checking and substitution, I found the trouble in the battery holder, which held a mercury cell that supplied bias for an electrometer tube.

Slight leakage from the cell had found its way between the brass contact and the aluminum bracket of the holder. The resulting battery action produced a potential of about 0.2 volt which varied from day to day, probably depending on the humidity.

Replacing the battery holder corrected the trouble.

—John Terrell

ADMIRAL G13 CONVERGENCE YOKES

You may encounter some early G13 convergence yokes on which the static convergence magnet sticks or becomes intermittent when the thumb wheel is rotated. In such cases the magnet may be stuck to the coil impregnating wax or may be binding against the bronze clip core spring under the magnet wheel.

To correct this condition, loosen the clamp and remove the convergence yoke from the CRT neck. Disassemble the three pole-piece exciters. To remove the cover from the pole-piece exciter, carefully insert a screwdriver or knife blade between the plastic cover and the back near one of the four heat-sealed pins. Pry the two pieces apart gently at each of the four pins and remove the cover by first separating the two pieces at the end opposite the thumb wheel until the iron pole shoes are cleared, then separate the thumb-wheel end and remove cover completely. Take care not to lose the spring washer from the top of the thumb wheel. Remove the thumb wheel assembly which consists of the round magnet, spring washer and plastic thumb wheel.

Examine the round magnet for a copper color on the core-contacting surface. If this color shows on the magnet, then press the bronze clip core spring into the case until it is below the surface of the ferrite core to prevent rubbing. If the core shows excessive wax on the surface where the round magnet fits, remove the excess with a cleaning fluid that will not damage plastic.

Reglue the round magnet to the thumb wheel with a vinyl or epoxy resin cement. Before you apply cement, check that the side of the round magnet which will contact the pole piece has the greatest attraction to it—apply the cement to the WEAK side. Also be sure that the cement doesn’t run down the side or the center hole of the magnet and interfere with the fit of the magnet to the core. Allow to dry.

Assemble the three pole-piece exciters so that the clamp is on the left hand side of the unit with blue up and facing the thumb wheel.—Admiral Service News Letter

MAY, 1966
Clever Kleps 30

Push the plunger. A spring-steel forked tongue spreads out. Like this

Hang it onto a wire or terminal, let go

the plunger, and Kleps 30 holds tight. Bend it, pull it, let

it carry dc, sine waves, pulses to 5,000 volts peak. Not a

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Although accurate, this vtvm has a strong zero drift. The

problem was solved by allowing the tube heaters to remain on

continuously and switching only the B-plus on and off. The

same method can be applied to many other instruments

that drift. —Allan Glaser

END

**CIRCLE 120 ON READER'S SERVICE CARD**
TRY THIS ONE

USE YOUR SCOPES FOR SWEEP-SIGNAL SUBSTITUTION

Your scope will be more useful in bench work if you bring the sawtooth deflection voltage out to the front panel, for use in signal-substitution tests of horizontal and vertical sweep circuits. As shown in Fig. 1, the sawtooth is taken off from the "hot" horizontal deflecting plate of the scope. In push-pull stages, either horizontal plate can be used.

To use the test signal, disconnect the input end of the grid capacitor from the output tube and run a test lead from the scope sawtooth post to the grid capacitor (Fig. 2). If you are testing the horizontal system, operate the scope sweep oscillator at 15,750 Hz, or 60 Hz if you are testing the vertical output system. Adjust the horizontal gain control of the scope for the right drive. If you obtain a raster on the screen of the picture tube, the test signal is OK.

Although it is not always necessary to open the lead to the grid capacitor, this may be found necessary to obtain adequate drive when the receiver drive circuit has relatively low impedance.

With this small modification, a scope becomes a complete horizontal and vertical system analyzer. —Robert G. Middleton

BROOKS

MAY, 1966
PROFESSIONAL PARTS STORAGE

Here’s a convenient, inexpensive way to store a large number of different-valued capacitors or resistors in a relatively small number of plastic parts drawers. A component can be found extremely quickly with this system. One index card is folded as shown and stapled to a flat index card. The two are trimmed to fit the drawer, and a small card at the back is used for labeling parts according to value and voltage or wattage. Tweezers are handy for removal of 1/2-watt resistors. The range of values in each drawer should be labeled on the front of the drawer and the drawers should be arranged in order of increasing resistance or capacitance as should the individual compartments of each drawer. There should be a compartment for each standard value to provide for expansion of your stock, rather than just for the parts you presently own.—Ronald S. Newbower

FREEING STUCK TUNING SLUGS

I unstick tuning slugs with the help of a file tang and my soldering gun. Stick the tang into the slug and apply heat to the file as shown until the slug loosens. Remove the heat but keep twisting the slug back and forth until it cools. Then align the coil with the usual tools, and resheat the slug with wax or a cement that softens with heat.—Peter Legon

CHEATER JUMPER CORD

Wall outlets in homes are often hard to get at. It can be inconvenient to plug in your cheater cord and test equipment on a service call.

A simple way to get around this is to use a jumper cord from the back of the TV (which is already plugged in) to the TV itself. Then an outlet along the jumper cord is a very convenient way to get power to your test equipment.—Stanley E. Bammel

STYROFOAM FOR KIT BUILDERS

A block of styrofoam can come in handy when you’re building a kit. After sorting the small parts, press one lead of each part, in order, into the styrofoam. Now the parts are handy when you need them, won’t roll around the bench top and can be neatly stored in a drawer or on a shelf when it’s time to quit.—Albert Koehler
Black-Box Equivalent

An equivalent circuit can be developed by noting the open-circuit voltage (when \( I = 0 \)) and short-circuit current (when \( E = 0 \)). The open-circuit voltage tells us if there is any voltage source within the box. Since an external 6 volts was required for \( I = 0 \), it follows there must be a 6-volt bucking source inside.

\[
\begin{align*}
\text{The current that flows through a} \\
\text{short circuit across the output terminals (} E = 0 \text{) is determined solely by} \\
\text{the internal voltage and internal impedance.} \\
\end{align*}
\]

The diagram shows the equivalent circuit of the black box.

Capacitor Puzzler

We can replace the charged capacitor \( C_1 \) with its equivalent—a 2-volt source in series with an uncharged 1-\( \mu \)F capacitor. The diagram shows the final-state conditions after the switch is closed.

\[
\begin{align*}
\text{The two voltages add to an effective} \ 4 \text{volts. Since } C_1 = C_2, \text{this voltage} \\
\text{divides equally between the two capacitors. The final voltage across} \ C_2 \text{is} \ 2 \text{volts with upper plate positive.} \\
\text{The final voltage across} \ C_1 \text{is zero (} 2V - 2V = 0V).} \\
\end{align*}
\]

3-Way Switching?

The box contains, in addition to the battery, two 5-ohm resistors or equivalent. I used a 10-ohm wirewound adjustable resistor with the slide in the center connected to battery.

\[
\begin{align*}
\text{If either switch is on when the other} \ \text{is off, the bulb will light. If both} \\
\text{switches are on or both off, the bulb} \\
\text{does not light. This is a variation of} \\
\text{the Wheatstone bridge.} \\
\end{align*}
\]

Lots of Solutions

Several readers have written in about the “Series-Parallel Circuit” puzzler (Feb. '66 issue). In essence, the comments stated that, although the given solution is correct, it is but one of an infinite number of correct solutions.

For total resistance of \( 1,250 \) ohms, \( R_5 \) can vary between \( 272\frac{1}{3} \) ohms and infinity, with an appropriate value between infinity and \( 1,818\frac{1}{3} \) ohms for \( R_4 \).

One reader made a complete analysis of the circuit and produced this formula for \( R_5 \) in respect to \( R_4 \) in kilohms:

\[
R_5 = \frac{0.75R_4 + 3.75}{2.75R_4 - 5}
\]

Although most of the possible values of \( R_4 \) or \( R_5 \) would be fractional, with respect to the other, here are some whole-number values:

\[
\begin{align*}
R_4 \text{ (ohms)} & \quad R_5 \text{ (ohms)} \\
2,000 & \quad 10,500 \\
2,500 & \quad 3,000 \\
10,000 & \quad 500
\end{align*}
\]

Sorry, fellows! Our fault for not inserting restrictions on the problem to yield a unique solution.

END
NOTEWORTHY CIRCUITS

NOVEL FLASHER CIRCUIT

Here is a simple flasher circuit that you'll probably find lots of use for.

The usual transistor light flasher consists of a multivibrator with an incandescent lamp in series with one of the transistors. Battery drain is fairly high because of the current needed to light the lamp to normal brilliance. This type of circuit is often used to warn of road hazards.

The circuit shown here draws much less current. It uses a single transistor and a neon lamp. The neon lamp is not as bright as an incandescent lamp so it cannot be used as a warning device which must be visible from a distance. However, it makes a neat little pilot lamp for transistorized test instruments. Power drain is only 15-20 mA at 1.5 volts so a single penlight cell can be used.

The circuit is a blocking oscillator which develops a high peaked voltage. This voltage is rectified and used to charge capacitor C. When the charge reaches about 70 volts, the NE-2 fires. C discharges to around 60 volts and the lamp goes out. The cycle repeats and the lamp flashes about once every 2 seconds.

The transformer has a 20K primary and 2K center-tapped secondary. (I used an Argonne AR-103 from Lafayette Radio.) Its polarity must be correct for maximum voltage output. Experiment with the values of R1 and R2 for maximum power out with minimum battery drain.—I. Queen

PILOT LAMP DOES DOUBLE DUTY

Here is a circuit in which a single lamp operates both as a pilot and a blown-fuse indicator. When power is applied to the circuit and the fuse is intact the lamp glows. If the fuse blows the lamp flashes. It can be built into any ac operated equipment.

The circuit has two advantages. First, it combines the fuse-indicating and pilot lamp functions into one circuit. Thus, in equipment such as hi-fi amplifiers, where the controls are mounted in plain view, the addition of an unattractive indicating fuse holder is unnecessary. Second, you can build it for as little as 79 cents even if you have to buy all the parts; while the indicating fuse holder, resistor and pilot lamp normally used would cost about $1.58.

The operation of the circuit is simple. With the fuse intact R1 and R2 are in parallel, current flows through R1 and R2, through the diode and charges the capacitor. When the voltage across the capacitor reaches 65 the lamp fires and starts to deionize. The parallel resistance of R1 and R2 is small enough so that the lamp cannot completely deionize before the capacitor voltage has again reached the lamp's firing point. Therefore the lamp stays lit constantly and does not flicker. With the fuse blown R1 and R2 are no longer in parallel and current flows through one and then the other as the line polarity shifts. The increase in resistance in the charging path is great enough to bring the lamp flash rate down to one flash a second.

Construction of the circuit is not critical. The simplest arrangement is to place all the parts except the lamp in the area around the power supply transformer, dressing the lamp leads close to the chassis. If this is not done, circuit location and lead dress could feed a buzz into stages with low signal levels such as rf front ends and low-level audio stages.

Any diode that meets the ratings specified can be used. Any change in the other parts will shift the pulse rate of the lamp and either cause a flicker in the pilot lamp function or the lamp will not light when the fuse blows.

The parts could come from a junk box, but if you have to buy all the parts, use a "Buss" fuse block rather than a panel mounted holder. A diode from a bargain sheet will greatly reduce the overall cost.—D. G. Needle
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Section 4. Black-and-white Setup Adjustments
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Section 6. Color AFPC Field Adjustments
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Section 8. Fuses and Circuit Breakers
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