

BUILD — Low-cost IC signal generator

60c ■ JAN. 1968

Radio-Electronics

TELEVISION

MASTER
FIFTH ANNUAL COLOR TV ISSUE
~ IP 86-84 --

GERNSBACK PUBLICATION

How to fix intermittent color TV sets
ABC's of color purity
How to kill color ghosts



Getting a hernia and not getting paid for it?

Let Arcolytic® capacitors lift the load off your mind. Or anywhere else it happens to be.

These aluminum electrolytics are built to last: wound with computer-grade 99.99% pure aluminum foil so they'll keep operating in your customers' sets even at continuous temperatures of 85°C.

You'll find they take the worry right out of premature failure, lost customer confidence and costly call-backs.

There's no premium cost, either. Arcolytics are priced along with other home entertainment capacitors.

Ask your Authorized Arco Distributor for Arcolytic electrolytic capacitors in single-section tubular, multiple-section tubular, or twist-mount designs. It may be the best break you get this year.

Arco Electronics

A DIVISION OF LORAL CORPORATION
Community Drive, Great Neck, N. Y. /
Arlington, Texas / Elk Grove Village,
Illinois / Pasadena, Menlo Park,
California. Write for our free catalog.



Circle 7 on reader's service card

COLUMBIA STEREO TAPE CLUB

now offers you

ANY 5 STEREO TAPES FREE

Value up to \$46.75 at regular Club prices

If you begin your membership by purchasing just one tape now, and agree to purchase as few as five additional selections during the coming year, from the more than 300 to be offered



5346. Includes: The Lady Is A Tramp, My Funny Valentine, etc.



5440. "An all-time great screen musical!"—Variety



5236. Selections from Bernstein's most popular albums.



5488. Plus: When It's Over, Lay Some Happiness On Me, etc.

FREE-if you join now



Just drop the end of the tape over this reel, start your recorder, and watch it thread itself! Unique Scotch® process automatically threads up tape of any thickness, releases freely on rewind.



4785. Plus: Mama, What Now My Love; Sunrise, Sunset, etc.



5553. Plus: Maria, Moon River, Yesterday, Dominique, etc.



3782. Musical fantasy for the young at heart



5546. Also: Pride, Wallpaper Roses, Turn To Me, 10 in all



5370. Plus: We Love Us, Reputation, On A Quiet Night, etc.



3728. Also: The Impossible Dream, Give Her Love, etc.



3335. This special Twin-Pack includes two great Ray Conniff albums. Counts as only one selection!



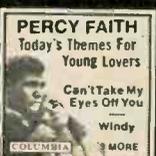
3767-3768. Twin-Pack Counts As Two Selections.



2595. Also: Do You Wanna Dance, Spanish Harlem, etc.



5373. March of the Boys, Wedding March, etc.



5420. Plus: Mary In The Morning, Release Me, etc.



2875. Works by Grieg, Tchaikovsky, Dvorak, Copland, etc.



5430. Plus: Secret Love, The Trouble With Me, Ivy, etc.



5509. Plus: If I Had Wings, Rolling Home, 12 in all



3764-3765. Twin-Pack counts as two selections



3527. A bargain for lovers of light classics! This special Twin-Pack tape counts as only one selection!



5095. Plus: Orange Blossom Special; It Ain't Me, Babe; etc.



5508. Meet Cosby as "Silver Throat" in this fun-filled album



5487. Plus: I Will Wait For You, Lover Man, Groovin', etc.



5485. "... greatest virtuoso orch. of all time."—N. Y. Times



3718. Two favorite Streisand albums on one tape! This special Twin-Pack counts as only one selection!

5233. ANDY WILLIAMS — Born Free, Some-where My Love, etc.

5368. HERB ALPERT & THE TIJUANA BRASS — Sounds Like. 12 songs.

5486. FRANK SINATRA — The World We Knew (Over And Over). 10 in all

THERE MUST BE A REASON WHY the famous Columbia Stereo Tape Club sells more pre-recorded 4-track stereo tapes than any store in the country! It's because so many thousands of tape recorder owners find Club membership the easy and economical way to get all the tapes they want! And to introduce you to the many benefits of membership, you may select any five of the stereo tapes shown here, and we'll send them to you FREE! That's right . . . 5 FREE STEREO TAPES, and all you need do is purchase one tape now at the regular Club price, and agree to purchase as few as five more tapes during the coming year. In short, at the end of a year, you'll have at least eleven brand-new stereo tapes, and you'll have paid for only five!

HOW THE CLUB OPERATES: Each month you'll receive your free copy of the Club's magazine which describes and displays tapes for many different listening interests and from many different manufacturers. You may accept the regular selection for the field of music in which you are primarily interested, or take any of the scores of other tapes offered you, or take no tape at all that month.

TAPES SENT ON CREDIT. Upon enrollment, the Club will open a charge account in your name . . . and that means that you'll pay for the tapes you want only after you've received them and are enjoying them. The tapes you want will be mailed and billed to you at the regular Club price of \$7.95 (occasional Original Cast recordings somewhat higher), plus a small mailing and handling charge.

YOU GET MORE FREE TAPES! Once you've completed your enrollment agreement, you'll get a stereo tape of your choice FREE for every two tapes you purchase!

SEND NO MONEY NOW! Just fill in and mail the coupon today! Your five FREE tapes and your first selection will soon be in your home for you to enjoy for years to come!

Note: All tapes offered by the Club must be played back on 4-track stereo equipment.

APO, FPO addressees: write for special offer

COLUMBIA STEREO TAPE CLUB • Terre Haute, Indiana

SEND NO MONEY—JUST MAIL COUPON

COLUMBIA STEREO TAPE CLUB
Terre Haute, Indiana 47808

I AM BUYING THIS TAPE NOW (fill in number)

Please enroll me as a member of the Club. I've indicated at the right the five tapes I wish to receive FREE. I've also indicated the tape I am buying now as my first selection, for which I am to be billed \$7.95, plus postage and handling. Include the self-threading take-up reel FREE. My main musical interest is (check one):

ALSO SEND THESE 5 TAPES — FREE!

In addition to the first selection I am buying now, I agree to purchase five additional selections during the coming year . . . and I may cancel membership at any time thereafter. If I continue, I am to receive a stereo tape of my choice FREE for every two additional selections I accept.

Name..... (Please Print) First Name Initial Last Name

Address.....

City..... State..... Zip Code.....

418-4/49

1

Success in Electronics Comes as Naturally as

1-2-3

through Education

Grantham School of Electronics 1-68-RE
1505 N. Western Ave., Hollywood, Calif. 90027

Please mail me your free catalog, which explains how Grantham training can prepare me for my FCC License and Associate Degree in electronics. I understand no salesman will call.

Name _____ Age _____
Address _____
City _____ State _____ Zip _____

There they are — three big steps — three deliberate steps which lead directly to success in electronics. Your future is shaped by the moves *you* make — by the steps *you* take. Begin now with Step #1.

STEP #1 is a simple request for full information on the Grantham Associate Degree Program in Electronics. You take this step by filling out and mailing the coupon. We mail our catalog to you; we do not send a salesman.

2

STEP #2 is earning your FCC first class radiotelephone LICENSE and radar endorsement. You complete this step in the first two semesters of the Grantham educational program (by correspondence or in residence). Train with the school which gives associate-degree credits for your license training, offering you the opportunity to advance beyond the FCC license level to a college degree in electronics.

STEP #3 is earning your ASEE DEGREE. This degree is conferred when you have earned credit for all five semesters of the Grantham curriculum.

Semesters 1 and 2, as mentioned above, are offered by correspondence or in residence.

Semester 3 is offered in residence, or students who have extensive *practical* experience in electronics may receive credit for this semester — credit based on that experience.

Semester 4 is offered by correspondence or in residence.

Semester 5 is offered in residence.

Accreditation, and G.I. Bill Approval

Grantham School of Electronics is *accredited* by the Accrediting Commission of the National Home Study Council, and is *approved* for both correspondence and resident training under the G.I. Bill. Just mail the coupon, or write or telephone us for full information without obligation.

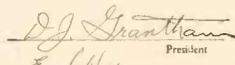
3

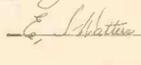
Grantham School of Electronics

has conferred on
John Doe
the degree of
Associate in Science in Electronics Engineering

with all the rights and privileges thereunto appertaining. In witness thereof this diploma duly signed has been issued by the School Administration upon recommendation of the faculty at the School on this

first day of October, 1965.

 
President


Acting Dean

Grantham School of Electronics

1505 N. Western Ave.
Hollywood, Calif. 90027

or 818 18th Street, N.W.
Washington, D.C. 20006

Telephone:
(213) 469-7878

Telephone:
(202) 298-7460

Radio-Electronics

January 1968 VOL. XXXIX No. 1
Over 55 Years of Electronics Publishing

COLOR TELEVISION

- 32 How To Kill Color Ghosts**Lon Cantor
One way to get rid of green giants and purple people
- 34 ABC's of Color Purity**Wayne Lemons
In the beginning . . . you need a pure screen
- 36 High Voltage Shunt Regulators For Modern Color-TV Sets**Bob Barkley
Pumping and blooming rasters can be put to rest
- 38 How to Fix Intermittent Color-TV Sets**Matthew Mandl
Handle come and go troubles like a pro
- 42 New Color-TV Tuning Indicator**
When 2 vertical bars on the screen coincide tuning is correct

CONSTRUCTION PROJECTS

- 50 30 Basic IC Projects**R. M. Marston
Useful applications for an 80-cent integrated circuit — Part 2 of 2 parts
- 54 Build Low-Cost IC Signal Generator**Jack Althouse
Square waves at low cost for audio circuits
- 73 Build Quickie Spectrum Sweeper**Fred W. Rodey
Salvaged phono motor becomes saturable core tuner

SERVICING

- 16 In the Shop . . . With Jack**Jack Darr
Service Clinic
- 40 Your Scope: A Guided Tour**Robert G. Middleton
It's not a travelogue, but it is well illustrated
- 44 How to Service and Adjust Relays**Leo Sands
Telephone relays can trip you up
- 68 CB Troubleshooter's Casebook**Andrew J. Mueller

GENERAL ELECTRONICS

- 56 Keeping In Touch Underground**Peter E. Sutheim
Two-way radio in an underground railroad
- 59 Imaginary Numbers Are a Cinch**Norman H. Crowhurst
Plus j times plus j equals?
- 69 Equipment Report: Triplett 600 TVO**
- 70 Equipment Report: Heathkit AR-15**
AM-FM-Stereo Receiver
- 71 Equipment Report: Knight-Kit KG-663**
Regulated DC Power Supply

THE DEPARTMENTS

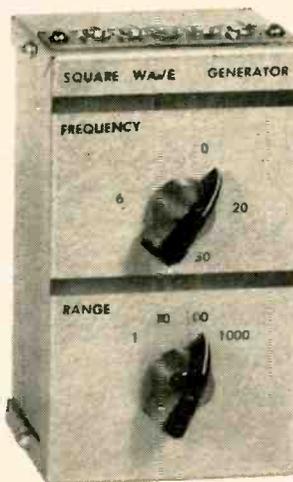
- | | |
|---------------------------------------|--|
| 6 Correspondence | 92 New Semiconductors and Microcircuits |
| 95 New Books | 84 New Test Equipment |
| 77 New Communications Products | 4 News Briefs |
| 82 New Component Products | 96 Noteworthy Circuits |
| 86 New Literature | 88 Technotes |
| 80 New Products | 97 Try This One |
| | 74 Reader's Service Page |



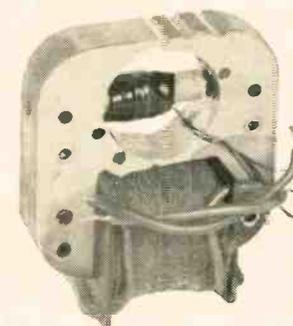
p 38—COLOR TROUBLES



p 42—TUNING BAR



p 54—AUDIO GEN



p 73—RF SWEEPER

p 56—UNDERGROUND RADIO



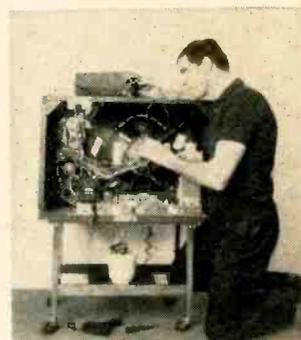
RADIO - ELECTRONICS, JANUARY 1968, Volume XXXIX, No. 1, Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302

Editorial, Advertising, and Executive offices: 154 West 14th Street, New York, N. Y. 10011. Circulation Office, Boulder, Colo. 80302.

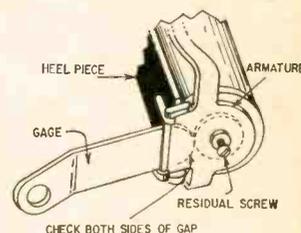
Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, \$5. Pan-American countries, \$6. Other countries, \$6.50. Single copies: 60c. © 1967, by Gernsback Publications, Inc. All rights reserved.

POSTMASTERS: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.

COVER FEATURE



Today's color-TV set is better than ever but requires specific skills to keep in tip-top shape. Starting on page 34 you can read about the foundation for color setup—purity adjustments. Then, on page 36, learn about the critical high-voltage regulator circuit.



p 44—FIX RELAYS



Member,
Institute of High Fidelity.
Radio-Electronics is indexed in
Applied Science & Technology Index (formerly Industrial Arts Index)

NEWS BRIEFS

ATTACHE CASE TELEPHONE



Perhaps the first fully portable radiotelephone fits inside an ordinary attaché case, yet enables the user to place a phone call from many locations where a land line isn't available.

Made by Carry Phone Corp., the new transceiver uses duplex operation, has 25 watts of output power and a receiver sensitivity of $0.3 \mu\text{V}$, operating in the 147-174-MHz band. Normally the transceiver is in the "receive" mode, and an incoming call triggers both visual and aural alarms.

The unit can be used anywhere within range of a mobile telephone station.

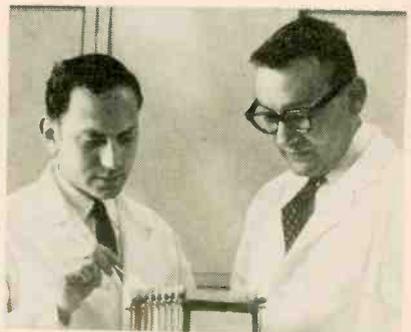
TECHNICIAN DEVELOPMENT PROGRAM

One solution to the current widespread shortage of electronics technicians is to encourage new people to enter the field. Now under way is a program to channel youngsters' interests into the electronics industry.

Initiated last fall by the Consumer Products Division of the EIA, the program has been allocated \$100,000 for fiscal 1967-68. Among the tactics used are color films, brochures and seminars at high schools and vocational institutions. Members of the program meet with guidance counselors and vocational officials at educational institutions. Efforts are also being made—via radio and TV announcements—to enhance the public image of consumer electronic technicians.

AIR-BREATHING BATTERY

The search goes on for a more efficient chemical battery to eventually power automobiles. Most rechargeable batteries today are lead-acid cells, a type which has nearly replaced the original iron-electrode



Edison cell of the early 1900's. But two researchers at General Telephone & Electronics Labs have gone back to the iron electrode to devise a battery that promises greater efficiency per pound than conventional cells.

The battery (see photo) uses a porous iron anode together with state-of-the-art air depolarized cathodes which "breathe" atmospheric air somewhat like fuel cells. An alkaline electrolyte is used between anode and cathodes. The battery promises to remove the weight handicap which has limited battery-powered electric vehicles until now. It also would have extensive application in portable TV and radio receivers and space equipment.

R-E

3-Way Combination FREE SPACE STANDING WAVE MAGNETIC ANTENNA

ZEROS IN
YOUR SIGNAL—

Discriminates Between Desired Signal and Unwanted Noise!

Here is an antenna with the unique ability to discriminate between the desired signal and unwanted noise! A complete absence of minor lobes and an extremely high front to back ratio are characteristics of these antennas. This is made possible by the development of the Free Space Standing Wave Magnetic Drive Antenna system (F.S.M.). The outstanding electrical qualities, combined with the simplified mechanical construction of this system yields a total performance package unparalleled in today's market. 4 models, 60-inch to 180-inch boom, all modestly priced.

UNEXCELLED!

UHF — VHF — FM — COLOR

INVESTIGATE NOW!

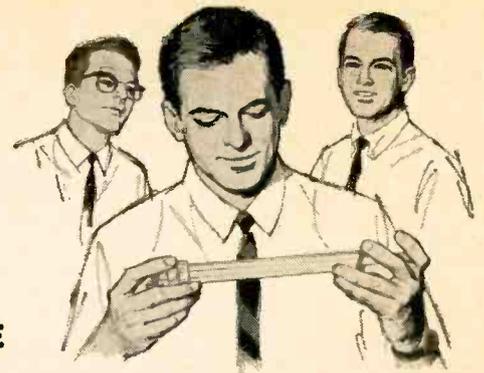
S&A Electronics Inc.

Manufacturers of the TARGET ANTENNA

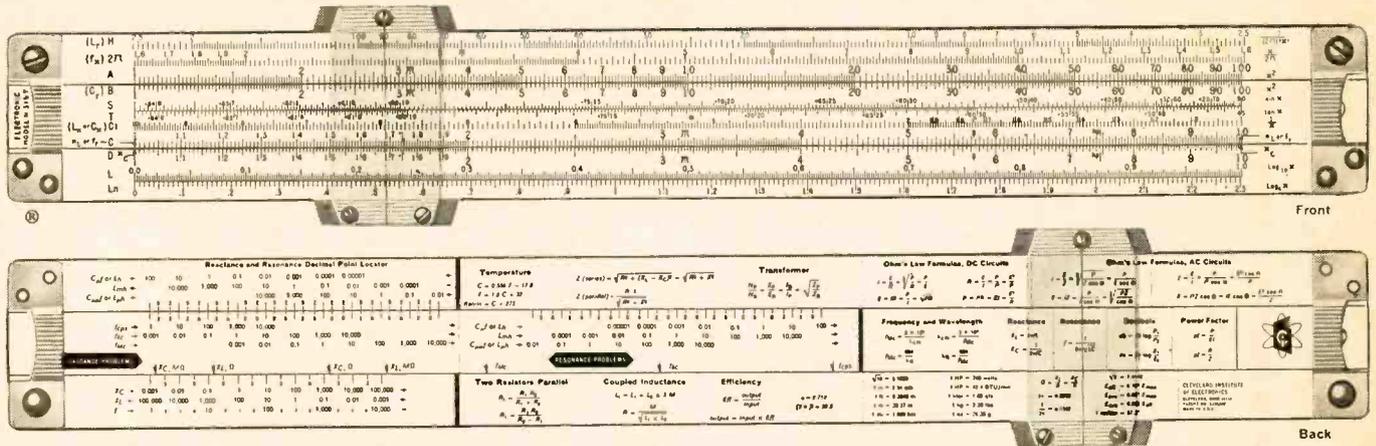
210 West Florence Street
Toledo, Ohio 43605

Circle 8 on reader's service card

Be the man who's always
first to say: "I've got
the answer right here!"



START USING THIS REMARKABLE
ELECTRONICS SLIDE RULE



SOME DAY EVERYONE in electronics may have a slide rule like this. Till then, the man who uses one will seem like a wizard as he solves reactance and resonance problems in 12 to 20 seconds—without pencil and paper.

This is a professional slide rule in every detail, a full 10" long, made exclusively for Cleveland Institute of Electronics, to our rigid specifications, by Pickett, Inc. It can be used for conventional computation as well as special electronics calculations. All-metal construction assures smooth operation regardless of climate.

Handsome top-grain leather carrying case has heavy-duty plastic liner to protect slide rule; removable belt loop for convenient carrying. "Quick-flip" cover makes it easy to get rule in and out of case.

You also get four full-length AUTO-PROGRAMMED™ Lessons, which teach you how to use the special electronics scales on the slide rule. These lessons have been carefully designed to meet the same high educational standards as the electronics career courses for which our school is famous. Even if you've never used a slide rule before, you'll soon whiz through the toughest problems with this CIE rule.

Deliberately underpriced. Many men in electronics have told us that this unique slide rule, leather case, and 4-lesson course easily add up to a \$50 value. But we have deliberately underpriced it at less than \$25. Why? Our reason is simple: we are looking for men in electronics who are ambitious to improve their skills...who know that this will require more training. If we can attract you with the low price of our slide rule and course—and impress you with its quality—you are more

likely to consider CIE when you decide you could use more electronics training.

Send for free booklet. See for yourself why this amazing slide rule and course have made such a big hit with busy electronics men everywhere. No obligation, of course—just an opportunity to get in on the best offer ever made to people in electronics. Just mail coupon, or write Cleveland Institute of Electronics, Dept. RE-148, 1776 East 17th St., Cleveland, Ohio 44114.

CIE Cleveland Institute of Electronics
1776 East 17th Street, Cleveland, Ohio 44114

MAIL THIS COUPON FOR **FREE BOOKLET**

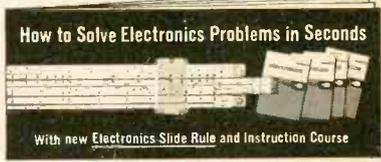
Cleveland Institute of Electronics
1776 East 17th Street Cleveland, Ohio 44114

Please send me without charge or obligation your booklet describing CIE Electronics Slide Rule and Instruction Course. **ALSO FREE** if I act at once: a handy pocket-size Electronics Data Guide.

Name _____ (please print)
Address _____
City _____ State _____ Zip _____

Accredited Member National Home Study Council
A Leader in Electronics Training... Since 1934

RE-148

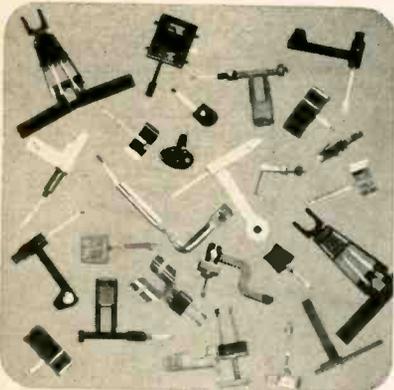


Circle 9 on reader's service card

349 PHONO CARTRIDGES!



459 PHONO NEEDLES!



NEW! PHONO AND TAPE RECORDER WHEELS, DRIVES, BELTS!

(E.V.) That's how many models are listed in the current Electro-Voice phono needle and cartridge catalogs. With more being added as you need them.

No other single source offers such variety—all built to the highest industry standards. All are exact replacements that install quickly, to give your customers "like new" performance—or better!

Electro-Voice models are listed in your Photofact files, or ask your E-V distributor for free copies of the E-V catalogs. It's your guarantee of complete customer satisfaction!

ELECTRO-VOICE, INC., Dept. 187E;
613 Cecil Street, Buchanan, Michigan 49107

Electro-Voice®
SETTING NEW STANDARDS IN SOUND

Circle 10 on reader's service card

C Correspondence

TRANSISTOR PLOTTER ✓ P 44

I have just finished reading the article by Mr. John Fasal about the construction of the Transistor Characteristic Plotter (September, 1967). He has devised a very novel method of displaying a complete family of curves, but the circuit needs some modification before it will present an undistorted plot. The scope hook-up that Mr. Fasal advocates does not give collector to emitter voltage (V_{CE}) on the horizontal input. It gives V_{CE} plus the voltage drop across the emitter resistor. This gives a rather bad distortion to the plot and will make a high quality transistor appear to be quite poor. Every point on the family of curves will be shifted to the right by the product of I_C and R_E . For example, the average curves for a Motorola 2N2957 shows that when $I_C = 50$ mA and $I_B = 400$ μ A, V_{CE} will be 0.8 volts. Mr. Fasal's circuit would indicate that $V_{CE} = 0.8 + 200 \times .05$ or 10.8 volts for the same values of I_C and I_B . This is due to the 200-ohm emitter resistor. This fault in the circuit can be overcome simply by reversing the scope's common and vertical connections across the emitter resistor. Now the data on the scope is correctly presented, but it is inverted about the horizontal axis and is upside down. The vertical polarity switch on the scope can be switched to put the trace on its most common position, or with a little re-orientation the graph can be read in its inverted position.

JOHN BRUCKER

Sr. Equip. Engr.

Motorola Semiconductor

Phoenix, Ariz.

ARTICLES FOR R-E

I am interested in submitting a number of articles for publication. I would appreciate full information on the required format and types of articles you are looking for.

ODO HERGENHAN

Address?

We have an author's guide to send you, Odo, but you failed to show your address in your letter. Won't you please (continued on page 12)

6

Radio-Electronics

154 WEST 14TH STREET
NEW YORK, N. Y. 10011

HUGO GERNSBACK (1884-1967)

editor-in-chief and founder

M. HARVEY GERNSBACK, publisher

ROBERT CORNELL, editor

Robert F. Scott, W2PWC, senior editor

Thomas R. Haskett, managing editor

Jack Darr, service editor

Peter E. Sutheim, audio editor

I. Queen, editorial associate

Matthew Mandl, contributing editor

Linda Albers, assistant to editor

Wm. Lyon McLaughlin,

technical illustration director

Bruce Ward, production manager

Adelaide Cassidy, production assistant

G. Aliquo, circulation manager

Cover by Harry Schlack

RADIO-ELECTRONICS is published by
Gernsback Publications, Inc.

President: M. Harvey Gernsback

Vice President-Secretary: G. Aliquo

ADVERTISING REPRESENTATIVES

EAST

John J. Lamson,

RADIO-ELECTRONICS, 154 West 14th Street,
New York, N. Y. 10011, 212-255-7755

MIDWEST/N.&S. Car., Ga., Tenn.

Robert Pattis, the Bill Pattis Co., 4761 West
Touhy Ave., Lincolnwood, Ill. 60646,
312-679-1100

W. COAST/Texas/Arkansas/Oklahoma

J. E. Publishers Representative Co., 8380
Melrose Ave., Los Angeles, Calif. 90069,
213-653-5841; 420 Market St., San Francisco,
Calif. 94111, 415-981-4527

UNITED KINGDOM

Publishing & Distributing Co., Ltd., Mitre
House, 177 Regent St., London W.1, England

SUBSCRIPTION SERVICE: Send all subscription correspondence and orders to RADIO-ELECTRONICS, Subscription Department, Boulder, Colo. 80302. For change of address, allow six weeks, furnishing both the old and new addresses and if possible enclosing label from a recent issue.

MOVING? Or writing about subscription? Be sure to fill out form below.

For FASTEST service on address change, missing copies, etc., attach old mailing label in first space below. Otherwise please print clearly your address as we now have it.

OLD ADDRESS (Attach old label if available)

Name

Address

City State

Zip Code

NEW ADDRESS

Name

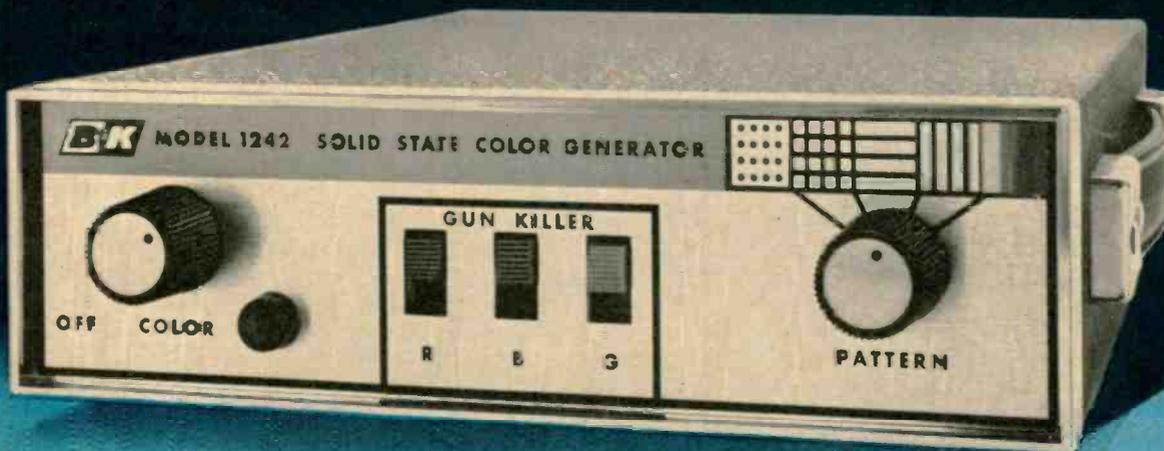
Address

City State

Zip Code

Mail to: RADIO-ELECTRONICS
Subscription Dept. Boulder, Colo. 80302

**New low cost.
 New ease of operation.
 No waiting. No warm-up.
 No adjustments.
 Brightest patterns in the industry.**



The **B&K** 1242 Color Generator is all bu\$ine\$\$!

There's nothing else like it. The all-new B&K 1242 represents the highest state of the art today. Go ahead and compare it; it's unique.

Ultrastable solid-state circuits make antiquated heating elements unnecessary. The 1242 works instantly in all service

environments — no waiting, no warm-up, no adjustments. Other units have up to 3 times as many front panel controls. For ease of operation, the 1242 has just two: color level and selector switch. It provides dots, crosshatch, horizontal or vertical lines, and color bars. And these are the sharpest, brightest patterns in the industry.

The 1242 handles easily, too. It's the smallest, lightest-weight color generator! Rugged, too; it's all steel, with storage

space for leads. It's transformer-powered and complete with leads. Calls take less time and you make more money, because you can go from a cold or hot truck into a home and get right to work.

On every count, the new B&K 1242 is amazing. In time saved, it will pay for itself in just a few weeks — especially at this low price: \$99.95

B&K Division of Dynascan Corporation
 1801 W. Belle Plaine • Chicago, Illinois 60613



Where Electronic Innovation Is A Way Of Life

Circle 11 on reader's service card

You get more for your money from NRI-

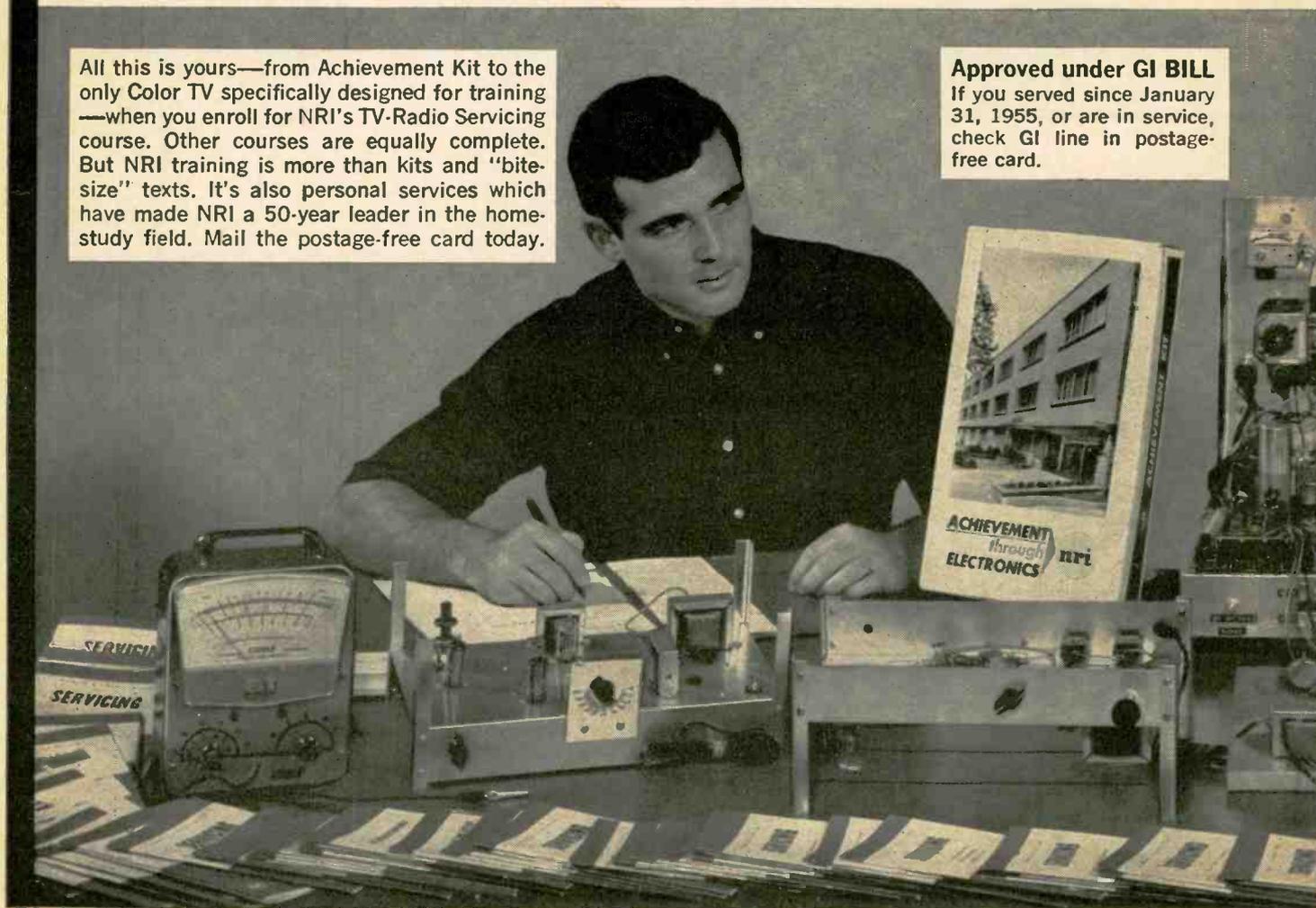
America's oldest and largest Electronic, Radio-TV home-study school

Compare if you like. You'll find—as have so many thousands of others—that NRI training can't be beat. From the delivery of your first lessons in the remarkable, new Achievement Kit we send you, to "bite size," easily-read texts and carefully designed training equipment . . . NRI gives you more value.

Shown below is a dramatic, pictorial example of all of the training materials included in just one NRI Course. *Everything* you see pictured below is included in low-cost NRI training. Other major NRI courses are equally complete. Text for text, kit for kit, dollar for dollar—your best home-study buy is NRI.

All this is yours—from Achievement Kit to the only Color TV specifically designed for training—when you enroll for NRI's TV-Radio Servicing course. Other courses are equally complete. But NRI training is more than kits and "bite-size" texts. It's also personal services which have made NRI a 50-year leader in the home-study field. Mail the postage-free card today.

Approved under GI BILL
If you served since January 31, 1955, or are in service, check GI line in postage-free card.



GET A FASTER START WITH NRI'S NEW EXCLUSIVE ACHIEVEMENT KIT

LEARNING BECOMES AN ABSORBING ADVENTURE WITH NRI TRAINING KITS

The day we receive your enrollment application we mail out your Achievement Kit. It contains everything you need to make an easy, fast start in the Electronics training of your choice. This attractive, new starter kit is an outstanding, logical way to introduce you to home-study as NRI teaches it . . . an unparalleled example of the value of NRI training . . . training that is backed up by a dedicated staff and the personal attention you should expect of a home-study school. It is your first of a number of special training aids carefully developed by the NRI laboratories to make your adventure into Electronics absorbing, meaningful. What's in the Achievement Kit? Your first group of lesson texts; a rich vinyl desk folder to hold your study material; the industry's most complete Radio-TV Electronics Dictionary; valuable reference texts; lesson answer sheets; pre-addressed envelopes; pencils; pen; engineer's ruler—even postage. No other school has anything like the NRI Achievement Kit.

Electronics comes alive with NRI training kits. What better way to learn than by doing it? That's why NRI pioneered and perfected the "home lab" technique of learning at home in your spare time. You get your hands on actual parts and use them to build, experiment, explore, discover. NRI invites comparison with training equipment offered by any other school. Begin NOW this exciting program of practical learning. It's the best way to understand the skills of the finest technicians—and make their techniques your own. Whatever your reason for wanting to increase your knowledge of Electronics . . . whatever your field of interest . . . whatever your education . . . there's an NRI instruction plan to fit your needs, at low tuition rates to fit your budget. Get all the facts about NRI training plans, NRI training equipment. Fill in and mail the attached postage-free card today. No salesman will call. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

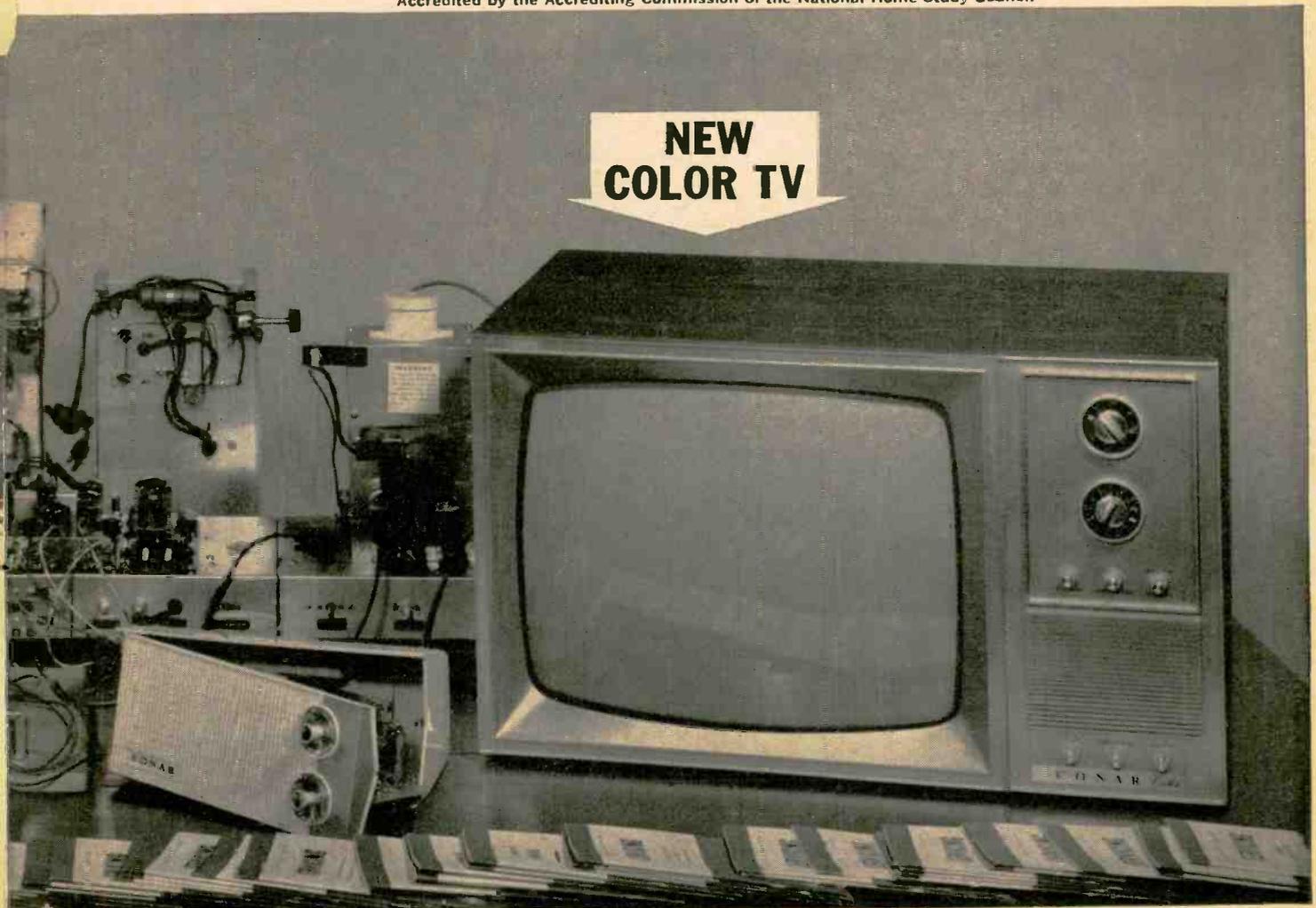
OVER 50 YEARS OF LEADERSHIP



IN ELECTRONICS TRAINING

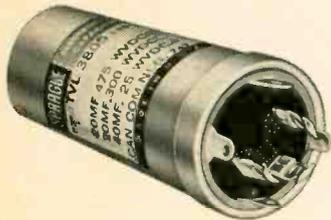
Accredited by the Accrediting Commission of the National Home Study Council

NEW
COLOR TV





LET'S FACE IT . . . TWIST-PRONG CAPACITORS JUST DON'T HAVE THE "FITS-ALL" ABILITY OF STRETCH SOCKS



. . . THERE'S NO NEED TO STRETCH ANYTHING WITH A SPRAGUE TWIST-LOK®

they come in 2,365 ratings and sizes so you can make EXACT replacements

Some people claim that you can use multi-rating twist-prong capacitors to make replacements "as exact as they need be." Putting it another way, some other people say that you can take "a certain amount of leeway in the matching of ratings and sizes."

BUT—there is nothing exactly like an exact replacement, particularly when working with the exacting requirements of Color TV circuitry.

Yes, you can replace one twist-prong capacitor with another that has a higher voltage rating and everything's OK. That is, everything except the cost. You have to pay for the extra voltage.

True, too: Circuit tolerances may allow you to make successful replacements without matching original

You can get a copy of Sprague's comprehensive Electrolytic Capacitor Replacement Manual K-109 from your Sprague Distributor or by writing to Sprague Products Company, 81 Marshall Street, North Adams, Massachusetts 01247.

DON'T FORGET TO ASK YOUR CUSTOMERS "WHAT ELSE NEEDS FIXING?"

capacitance values exactly. However, if you pick a replacement that's at the high end of the circuit's tolerance, its own manufacturing tolerance may throw it out of the ball park. For example, you pull out a 100 μF @ 350 V unit and figure that the 150 μF capacitor on your shelf is a close enough replacement. But the standard industry tolerance on this part is +50%, -10%. Therefore, it may actually have a capacitance of 225 μF —more than double the value your circuit calls for. And probably will get you called back.

We repeat: There is nothing exactly like an exact replacement.

And . . . we make Twist-Lok Capacitors in 2,365 ratings and sizes so you can make exact replacements.



CORRESPONDENCE
(continued from page 6)

write again? We welcome construction and service articles as well as state-of-the-art reports. Don't worry about format . . . if you will double-space your copy our editors will do the rest.

IMAGINARY NUMBERS CONTINUED

"Imaginary Numbers Are a Cinch," by Norman H. Crowhurst, was really a cinch as far as it went, but where is the rest of the article? When is the rest of it to be printed, anyway? Please don't forget or abandon it. It sure was an easy way to understand that "-1" math.

M. E. OVERSTREET
Oklahoma City, Okla.

59

See page 57 for Part II. Part III is scheduled for the February issue. Normally, a 2 or 3 part article will be published in consecutive issues. However, for the sake of timeliness, as well as for providing a balanced assortment of articles of interest to most, certain articles are given precedence even if it breaks into a serial type presentation.

MIXER-AMPLIFIER PROJECT ✓ p54

The "Build An All-Transistor Mixer-Amplifier" by Harvey Inman (August, 1967) seems to be a perfect answer for mixing signals for home movie dubbing. What is the input impedance? Can microphones with 150-ohm or 100,000-ohm impedance be used? Can I feed a record player into this unit? I enjoy your magazine very much. You always seem to come up with new ideas which are not only instructive but usually highly practical.

DR. PIERRE GRAVEL
Montreal, Canada

The input impedance to the mixer-amplifier is designed with low impedance microphones in mind in the range between 150 and 50 ohms, as are usually used in broadcast work. Exact input impedance will vary a little with the gain of the transistor used in the input stage, but it would probably be between 2000 and 3000 ohms. You can go up to a source impedance of 600 ohms. You should use a matching transformer to go higher. You can feed a phono output into the mixer-amplifier. If the cartridge puts out a voltage on the order of 1 volt or more, you can first put a 1000-ohm resistor across the input, then put 1-megohm resistor in series with the ungrounded lead from the cartridge, forming a voltage divider. This will give you a fair load for a crystal type phono cartridge and at the same time supply

NEW

FINCO®

COLOR SPECTRUM™ ANTENNAS

*are "signal customized"
for better color reception...*



0007
1467
P.M.M.
57

"the ANTENNA that captures the RAINBOW"

FINCO has developed the Color Spectrum Series of antennas — "Signal Customized" — to exactly fit the requirements of any given area.

There is a model scientifically designed and engineered for your area.

Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION	Strength of VHF Signal at Receiving Antenna Location				
	NO VHF	VHF SIGNAL STRONG	VHF SIGNAL MODERATE	VHF SIGNAL WEAK	VHF SIGNAL VERY WEAK
NO UHF →		 CS-V3 \$10.95	 CS-V5 \$17.50 CS-V7 \$24.95	 CS-V10 \$35.95	 CS-V15 \$48.50 CS-V18 \$56.50
UHF SIGNAL STRONG →	 CS-U1 \$9.95	 CS-A1 \$18.95	 CS-B1 \$29.95	 CS-C1 \$43.95	 CS-C1 \$43.95
UHF SIGNAL WEAK →	 CS-U2 \$14.95	 CS-A2 \$22.95	 CS-B3 \$49.95	 CS-C3 \$59.95	 CS-D3 \$69.95
UHF SIGNAL VERY WEAK →	 CS-U3 \$21.95	 CS-A3 \$30.95	 CS-B3 \$49.95	 CS-C3 \$59.95	 CS-D3 \$69.95

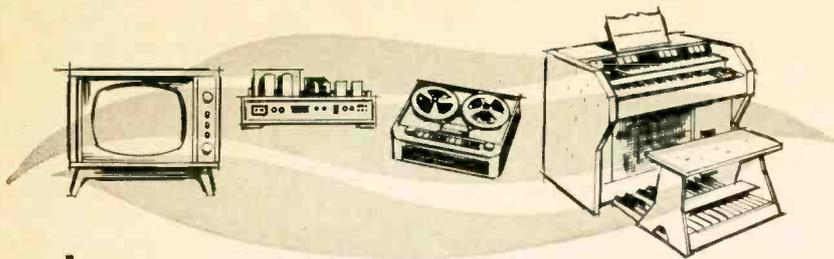


NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable download where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

THE FINNEY COMPANY

34 West Interstate Street • Dept. RE • Bedford, Ohio 44146

Circle 13 on reader's service card



give your
**COLOR-TV &
 HI-FI STEREO**

heat problems
 the **AIR**



only
\$14.85
 complete

install a DELWYN

Whisper Fan[®]

Everyday, everywhere, fans are at work cooling billions of dollars worth of electronic equipment in computers, missile and airborne electronics. Now, you can have this same kind of proven protection in your home electronic equipment. You need never miss your favorite TV program or the music you want because of heat-caused part failures.

Quickly and easily installed, no extra hardware needed, the Delwyn Whisper Fan keeps a steady stream of fresh cool air circulating over all heat generating components.

Use a Delwyn Whisper Fan in your Color-TV, Hi-Fi Stereo, electronic organ, tape recorder and other home electronic equipment. Guard against costly repair bills — add years of service-free life to your home entertainment equipment.

See your local dealer for a convincing demonstration. The Delwyn Whisper Fan is aerodynamically designed by Rotron, the world's leading supplier of cooling devices for electronic equipment.



DELWYNTM Box 195 B, Route 28
 Kingston, New York 12401

Circle 14 on reader's service card

CORRESPONDENCE *continued*

about the correct input signal level to the amplifier. If you use a magnetic type cartridge, you need an equalized pre-amplifier. The preamp puts out about as much signal as a crystal cartridge and it should work into the same voltage divider.

EICO CONSTRUCTION MANUAL

Would you please inform me where I could obtain the construction manual for the Eico 324 Rf Signal Generator. I wrote to the manufacturer and I didn't get an answer.

DENNETT AYLING
 Merrickville, Ont. Canada

Eico has just moved to new and more modern quarters. Their new address is 283 Malta Street, Brooklyn, N. Y. 11207

**AMATEUR ELECTRONICS CLUB
 (NOT NECESSARILY HAMS)**

I am enclosing herewith a copy of our sixth newsletter which has been completely redesigned, and I hope that you will find it of interest. As we have members in the USA who joined us because of the letter you published from me (January, 1967) it is apparent that the aims of the British Amateur Electronics Club (B.A.E.C.) are of interest to all those interested in electronics as a hobby wherever they may live. I am looking forward to hearing from you in due course, and would like to thank you for the interest shown in the B.A.E.C. by publishing my letter earlier this year.

CYRIL BOGOD
 Great Britain

C.B., your newsletter looks good, is very interesting and is recommended reading. Do you wish to send your newsletter to interested persons in other parts of the world? If so, what does one have to do to get on your mailing list?

SQUARE POWER . . . WITH JACK ✓

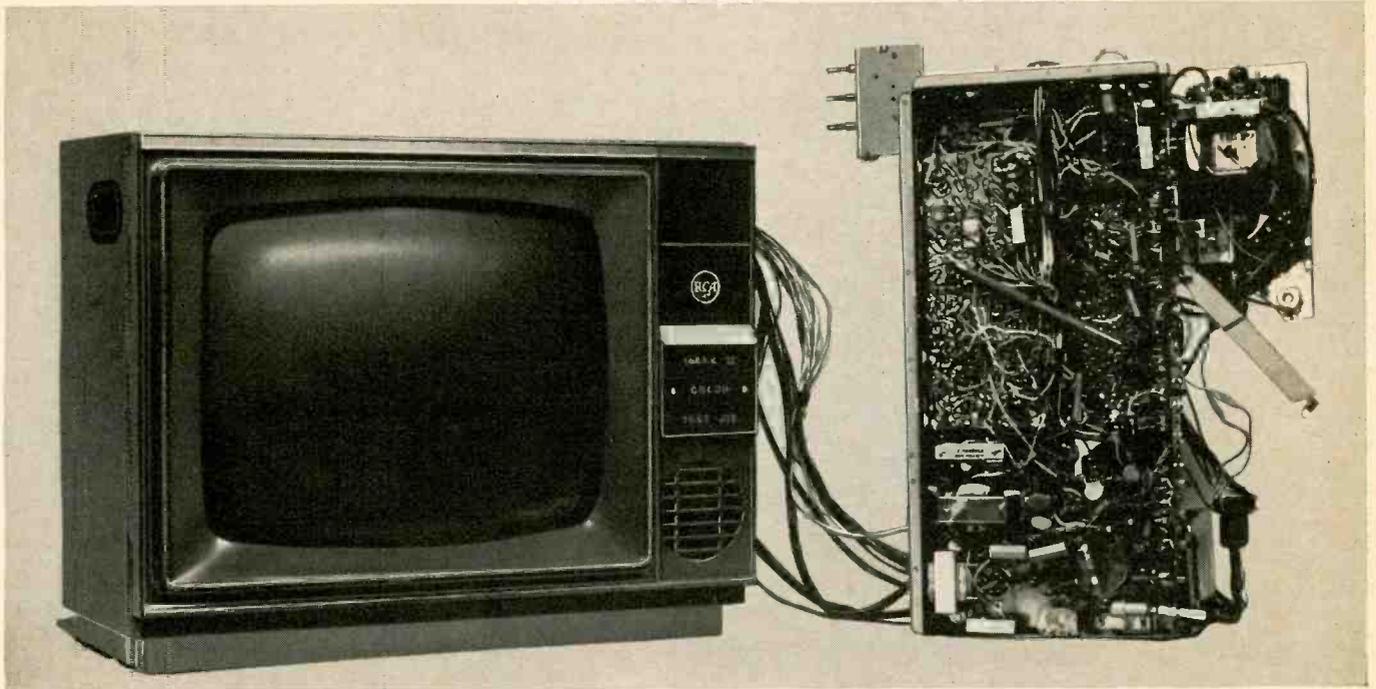
In your solution to the problem described "In the Shop . . . With Jack", (October, 1967), I think you erred. If you step up the audio voltage to 100.5 as described, the current would be reduced to a smaller value than 0.54 amp; it would be reduced to about 0.29 amp. You used a formula $P = I^2E$. This can't be right.

W. McDONALD
 Redwood City, Calif.

You are correct, W.M., but don't blame Jack. One of the editors is eating square "PIE."

R-E

RCA announces 2 new color-TV test jigs



New RCA MARK II

■ **IDEAL** for servicing all the RCA 90° rectangular receiver chassis (18" diagonal and larger) and RCA 70° round (21") receiver chassis made within last 10 years.

■ **COMPACT** in size, weight and price. 30% smaller and less than half the weight of former models.

■ PACKED WITH NEW FEATURES.

- ... Automatic degaussing assembly.
- ... Large padded hand holds double as side entry paths for servicing cables.
- ... Preassembled Kine neck components are ready to slip on and clamp in place.
- ... Rugged welded-steel cabinet, in rich hammered cobalt grey to match test equipment. Picture tube not included.

New RCA MARK III



■ **PORTABLE**, for in-the-home chassis check, without removing chassis from cabinet.

■ **A SALES TOOL.** Lets you compare customer's picture tube with test jig picture tube performance.

■ **VERSATILE.** Use the Mark III with all RCA 90° rectangular receiver chassis (18" diagonal and larger), and all RCA 70° round receiver chassis (21") made within last 10 years.

■ **INCLUDES** all Kine neck components—preassembled. Ready to slip on and clamp in place. Durable polyethylene cabinet. Picture tube not included.

Put an RCA Mark II in your shop and an RCA Mark III in your truck. The combination will help you speed up job completions . . . and sales. See both of these outstanding color-TV test jigs at your RCA Distributor today.

RCA PARTS AND ACCESSORIES, Deptford, N.J.



The Most Trusted Name in Electronics

ALL NEW!

NRI learn-by-doing training in

ADVANCED COLOR TV



- Build your own custom color set in 5 training stages
- 50 designed-for-learning color circuit experiments
- Programmed with 18 "bite-size" lesson texts

A comprehensive training plan for the man who already has a knowledge of monochrome circuits and wants to quickly add Color TV servicing to his skills. DEFINITELY NOT FOR BEGINNERS. It picks up where most other courses leave off—giving you "hands on" experience as you build the only custom Color TV set engineered for training. You gain a professional understanding of all color circuits through logical demonstrations never before presented. The end product is your own quality receiver.

TRAIN WITH THE LEADER

This NRI course—like all NRI training—is an outgrowth of more than 50 years experience training men for Electronics. NRI has simplified, organized and dramatized home-study training to make it easy, practical, entertaining. You train with your hands as well as your head, acquiring the equivalent of months of on-the-job experience. Demand for Color TV Service Technicians is great and growing. Cash in on the color boom. Train with NRI—oldest and largest school of its kind. Mail coupon. No obligation. No salesman will call. NATIONAL RADIO INSTITUTE, Color Div., Wash., D.C. 20016.

MAIL FOR FREE CATALOG



NATIONAL RADIO INSTITUTE
Color TV Division
Washington, D.C. 20016 30-018

Send me complete information on NRI new Advanced Color TV Training. (No salesman will call)

Name _____ Age _____

Address _____

City _____ State _____ Zip _____

ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL



In the Shop . . . With Jack

By JACK DARR

"HIGH-VOLTAGE TROUBLE" OR VIDEO AMPLIFIERS

RASTER BLOOMING? POOR FOCUS? NO raster at all? These symptoms can be caused by troubles in the high-voltage supply, focus rectifier, color demodulators or boosted-boost. Also, they can all have a common cause—the video amplifiers.

In the standard color TV video circuit, the video (or Y) amplifiers are direct-coupled to the picture-tube cathodes (Fig. 1). Therefore, video amplifier plate voltage is the CRT cathode bias voltage. So, the amplifier plate-current drain determines the voltage drop across the load resistor (5600 ohms) in Fig. 1. This sets the CRT cathode voltage.

Voltages shown are from a schematic; in actual sets, you'll find variations, depending on control settings. Still, it takes about a 120-volt difference, measured between the CRT cathode and grid, to cut the picture tube off.

Let's check out a typical case. An RCA CTC16XL came in with the complaint, "The brightness and contrast controls won't work. The raster won't go out." The picture tube was checked for heater-cathode shorts, and found okay. The screen controls and CRT bias were turned full on. Resetting these, with the SERVICE switch thrown to SERVICE, gave a normal action. When the switch was flipped back to NORMAL, no raster. Neither brightness nor contrast control would make the screen light up. High voltage was normal, and the high-voltage regulator action okay.

The video amplifier plate read almost 400 volts instead of the 260 shown on the schematic (Fig. 1, yet). Screen grid voltage was 250; normal,

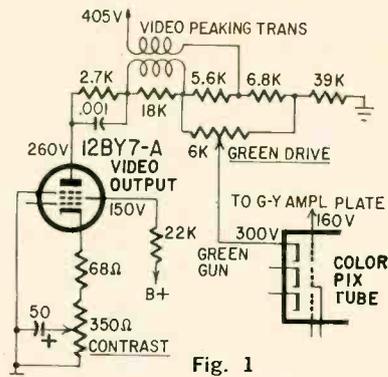


Fig. 1

150. Tube good, control grid about +5 volts. Brightness and contrast controls had no effect on any of these voltages.

From the voltage drops, or the lack of them, the tube was obviously drawing no current at all. The cathode circuit was checked, and found completely open. The contrast control was open near the ground end.

In this and many others like it, the cathode circuit goes "straight through"; there is no resistance variation. Control of contrast is done by varying the amount of degeneration in the circuit, by moving the 50-µF electrolytic from the top to the bottom of the 350-ohm resistor. We could bring the picture back, by grounding the slider of the control with a clip jumper.

With the cathode open, the 12BY7 drew no current at all and its plate voltage jumped to the supply value. This in turn put a high positive voltage on the CRT cathodes. This is the same as putting a high negative voltage on the grids, and the picture tube simply cut off.

The raster was visible when the set first came in simply because someone had turned the screen and bias controls up far enough to override the normal bias. There was no "picture" information on the screen, of course, because the video output stage was blocked—dead, as far as any signal-amplification was concerned.

For a case with an opposite reaction, take the old CTC7AA RCA chassis. This uses the same basic circuit, but without the SERVICE switch, CRT bias control, and so on. This one suddenly

(continued on page 22)

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.

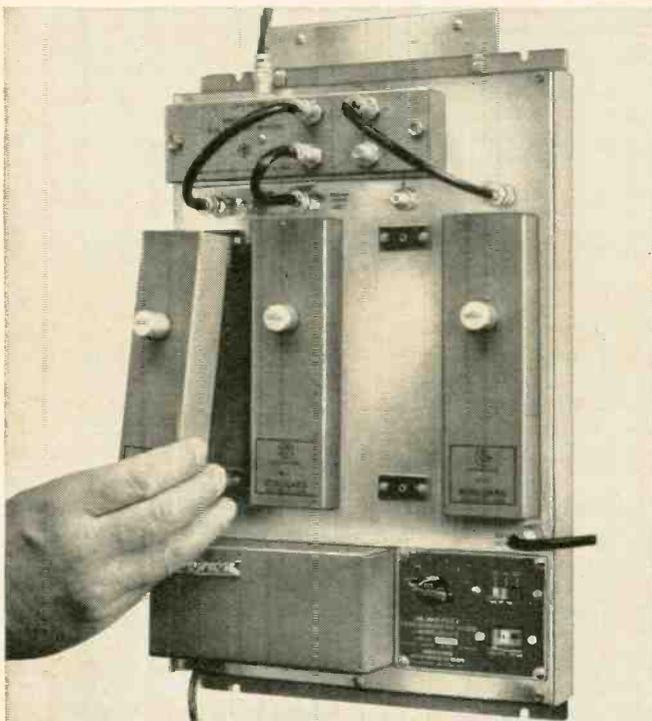
If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

You asked for it, waited for it and now here it is!

WINEGARD

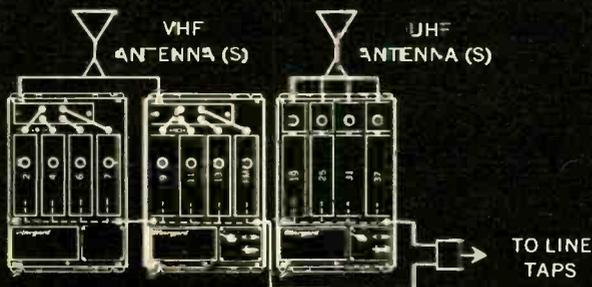
ULTRA-PLEX[®]

The first 82-channel, solid state MATV color distribution system!



82-Channel Ultra-Plex System
using low band plug-in VHF amplifier...
...high band plug-in VHF amplifier...
and broad band UHF amplifier.

82-Channel Ultra-Plex System
using single channel plug-in amplifiers.



Winegard Ultra-Plex is a unique 82-channel, modular plug-in distribution system with all components matched to work together perfectly. The system never becomes obsolete, because you can add new UHF or VHF channels quickly, easily and inexpensively whenever needed.

Now you can have complete signal control of each channel!

- Amplifies! ■ Equalizes!
- and Feeds any number of channels to any number of tv sets —with a minimum of labor and equipment—and at a cost that's actually lower than most "VHF ONLY" systems!

For use in homes, as well as in the largest apartment buildings, hotels & motels, hospitals, etc.

Sensational Winegard Ultra-Plex is the best thing to ever happen to MATV system installers. Because Ultra-Plex gives the installer unprecedented flexibility regardless of system size. Because Ultra-Plex covers the full range of UHF, VHF and FM frequencies.

And because Ultra-Plex is super compact...installs easier than old fashioned equipment...costs less...and operates inexpensively with little or no maintenance.

Plenty of other reasons, too. Ultra-Plex incorporates your choice of either single channel or broad band solid state amplifiers that plug into the modular power panel. Ultra-Plex is totally designed with all the components needed to solve every conceivable distribution system problem. And Ultra-Plex equipment is manufactured to the highest commercial standards of quality—second to none.

If you are now installing MATV systems, you'll want to know more about profitable Winegard Ultra-Plex. Or if you've wanted to get into the booming MATV business, but thought it too complicated, let us show you exactly how easy and profitable it is. Write for Fact Finder #246 today. It gives you all the facts on MATV systems in general, and Ultra-Plex in particular.



WINEGARD COMPANY • 3000 KIRKWOOD STREET
BURLINGTON, IOWA 52601

© Copyright 1967, Winegard Company, Burlington, Iowa

Circle 17 on reader's service card

Hunting for a better job?

**Here's the
license
you need
to go after
the big ones**



A Government FCC License can help you bring home up to \$10,000, \$12,000, and more a year. Read how you can prepare for the license exam at home in your spare time — with a passing grade assured or your money back.

IF YOU'RE OUT TO BAG A BETTER JOB in Electronics, you'd better have a Government FCC License. For you'll need it to track down the choicest, best-paying jobs that this booming field has to offer.

Right now there are 80,000 new openings every year for electronics specialists—jobs paying up to \$5, \$6, even \$7 an hour...\$200, \$225, \$250 a week...\$10,000, \$12,000, and up a year! You don't need a college education to make this kind of money in Electronics. You don't even need a high school diploma.

But you *do* need knowledge, knowledge of electronics fundamentals. And there is only one nationally accepted method of measuring this knowledge...the licensing program of the FCC (Federal Communications Commission).

Why a license is important

An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment—two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and broadcasting, the aerospace program, industrial automation, and many other areas.

So why doesn't everybody who wants a good job in Electronics get an FCC License and start cleaning up?

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

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

CIE courses are so effective that better than 9 out of 10 CIE graduates who take the exam pass it. That's why we can afford to back our courses with this iron-clad Warranty: Upon completing one of our FCC courses, you

must be able to pass the FCC exam and get your license—or you'll get your money back!

They got their licenses and went on to better jobs

The value of CIE training has been demonstrated time and again by the achievements of our thousands of successful students and graduates.

Ed Dulancy, Scottsbluff, Nebraska, for example, passed his 1st Class FCC License exam soon after completing his CIE training...and today is the proud owner of his own mobile radio sales and service business. "Now I manufacture mobile two-way equipment," he writes, "with dealers who operate in seven different states, and have seven full-time employees on my payroll."

Daniel J. Smithwick started his CIE training while in the service, and passed his 2nd Class exam soon after his discharge. Four months later, he reports, "I was promoted to manager of Bell Telephone at La Moure, N. D. This was a very fast promotion and a great deal of the credit goes to CIE."

Eugene Frost, Columbus, Ohio, was stuck in low-paying TV repair work before enrolling with CIE and passing his FCC License. Today, he's an inspector of major electronic systems for North American Aviation.

"I'm working 8 hours a week less than before," says Mr. Frost, "and earning \$228 a month more."

Send for FREE book

If you'd like to succeed like these men, send for our FREE 24-page book "How To Get A Commercial FCC License." It tells you all about the FCC License...requirements for getting one...types of licenses available...how the exams are organized and what kinds of questions are asked...where and when the exams are held, and more.

With it you will also receive a second FREE book, "How To Succeed In Electronics." Together both books without cost or obligation, just mail the attached postpaid card. Or, if the card is missing, send your name and address to CIE at the address below.



ENROLL UNDER NEW G.I. BILL. All CIE courses are available under the new G.I. Bill. If you served on active duty since Jan. 31, 1955, or are in service now, check box on reply card for complete details.

CIE
Cleveland Institute of Electronics
 1776 E. 17th St., Dept. RE-44, Cleveland, Ohio 44114
 Accredited Member National Home Study Council
 A Leader in Electronics Training... Since 1934

Circle 18 on reader's service card

new Sams books

Modern Dictionary of Electronics

NEW EDITION!

by Rudolf F. Graf.



The 3rd Edition of this best-selling book now defines more than 16,500 terms directly associated with electronics. Special Pronunciation Guide includes over 1,100 often-used but frequently mispronounced terms. Also includes terminology often expressed in Greek alphabet symbols, abbreviated expressions for transistor parameters, and the most widely used electronic symbols and abbreviations. Covers many new terms in specialized fields such as micro electronics, space electronics, semiconductors, computers, data processing, etc. This famous work is the most complete and useful electronics dictionary available today. Over 400 illustrations. 608 pages; 6 x 9"; hardbound. \$9.95
Order 20600, only.....

Control Instrument Mechanisms

by John E. Warren. Explains the mechanical and pneumatic principles governing all pneumatic control instrumentation. Thoroughly analyzes all of the basic components used in control instruments, first individually, and then in the groups in which they are commonly used. Case studies of instruments are presented, each explained by a schematic, a block diagram, and a functional word train. This approach enables anyone to analyze and understand similar complex control equipment. Color is used liberally in illustrations to emphasize force arrows, inputs, outputs, and circuit paths. 160 pages; 8 1/2 x 11"; comb-bound. \$8.95
Order 20596, only.....

101 Questions and Answers About CB Radio Operations

by Leo G. Sands. A handy and practical book answering the most frequently asked questions about CB radio. Each of four special sections deals with one generalized area of CB radio operations, including questions and answers about the four classes of CB radio and their permissible uses, licensing and FCC rules, operating procedures, and advice about the selection of CB equipment. Anyone with an interest in CB will find this an easily understandable and invaluable guide. 96 pages, 5 1/2 x 8 1/2". \$2.50
Order 20604, only.....

Experimental Earth Sciences

by Morris Goran. This fascinating book enables you to learn about the earth and its atmosphere through simple experiments, covering such subjects as the essentials of meteorology (the science of weather and the atmosphere); geology (the study of the earth's crust and interior); oceanography (the science of the seas); and astronomy (the science of the stars). Describes 60 experiments in each of the four areas covered, using readily available materials; includes construction-type experiments for building models. \$2.50
128 pages; 5 1/2 x 8 1/2". Order 20601, only.....

Practical Problems in Number Systems, Logic and Boolean Algebra

by Edward Bukstein. This workbook is a 62-lesson introduction to digital computer mathematics. Begins with the various number systems (binary, trinary, octal, decimal converting numbers from one system to another, and some common codes). Then develops the binary and octal arithmetics as a basis for introducing Boolean algebra. The latter, with its relations of AND, OR, and NOT, is elaborated by a variety of tables, diagrams, and maps. Also covers the implementation of Boolean algebra in electronic gating and inverting circuits. The workbook is suitable for either classroom or individual use. No special background in mathematics is required for understanding. \$2.95
128 pages; 8 1/2 x 11". Order 20609, only.....

These and over 300 other SAMS Books are available from your local Electronics Parts Distributor . . .

HOWARD W. SAMS & CO., INC.
4300 WEST 62nd ST. • INDIANAPOLIS, INDIANA 46268

Circle 19 on reader's service card

In the Shop . . . With Jack

(continued from page 16)

went pink, lost focus and bloomed very badly.

The 12BY7 video output tube was shorted and drew high current; the plate voltage went down (less positive), which brought the CRT cathode voltages nearer to the control-grid voltages. In other words, closer to zero bias, producing maximum conduction.

In old chassis like this you can duplicate the condition by turning the brightness control full on. Note that you get a very bright, slightly bloomed and defocused picture, which is usually pinkish.

There's a good quick check for this kind of trouble. Just pull the video output tube. The normal reaction is for the raster to go out. (The plate voltage goes up, more positive, with no load, and the CRT should cut off. If it does not, then you've probably got a shorted CRT.) In some cases, you can bring back a one-color raster by turning up the screen control, as a quick check.

The best "final test," of course, is tube substitution. If the raster comes back, you won't have to go into the high-voltage regulator and rectifier, and so on.

If the tubes are all good, and you still have trouble, check the bias voltages on the video amplifiers. In the typical color set, you'll find blanker amplifiers and other stages connected in the same circuit as the video amplifiers. Most of these work in the grid circuits. One instance (Fig. 2): The grid circuit of the output tube is connected through the brightness control, to the grid of the blanker tube. Any trouble in this circuit can cause incorrect bias to be applied to the video amplifier, and away we go again.

The blanker-amplifier plate also goes to the CRT cathodes and other parts, not shown. Therefore, this tube too can affect the CRT bias if anything

happens to it. The blanker grid circuit eventually winds up at the -56-volt control grid of the 6JE6 horizontal output tube. This negative voltage is actually a part of the "supply circuit" for the blanker grid! So, don't forget to check all these things if you run into oddball troubles in this circuit.

Remember, when you see an odd symptom such as we've described—the cause doesn't have to be in the high-voltage supply, the picture tube and so on. (Incidentally, remember that real CRT troubles usually show up as "one-color" symptoms; the symptoms you'll find here are very obviously "all-colors.") You will find trouble in those circuits, just as we have for the last ten years. But remember that the video amplifier(s) can show practically the same effects, with what looks like identical symptoms; no raster, etc. Video trouble is a lot easier to fix and you don't have to mess around with those high voltages!

TV field strength

What's the average field strength of a TV signal, at about 100 miles from the station?—B.L., Baudette, Minn.

Some time ago, I assisted in making some field-strength measurements of a channel-6 station. We used a resonant-dipole antenna and an accurate field-strength meter. At a location approximately 100 miles from the transmitter, we got a resounding 6 μ V! This reading was taken with the antenna two wavelengths above ground.

However, at the same location, on a large deep-fringe area antenna, equipped with a booster, we read almost 400 μ V at the TV receiver! This antenna was on a 30-foot tower and the booster stepped up the signal voltage, of course.

From a channel-5 station at the same location, we got 15 μ V at the antenna. We used the channel-6 dipole, but there wouldn't be too much difference.

There are so many variables in terrain, atmospheric conditions, station antenna height and power, that there is no practical way to predict field strength at any location on a given day. There's only one sure way to find out: Go there and measure it!

Color but no screens

I've got a Zenith 24NC31Z color chassis in the shop, and the blasted screen controls won't work! I set the Service switch to "service," and the raster goes out; can't get a line at all; bias control

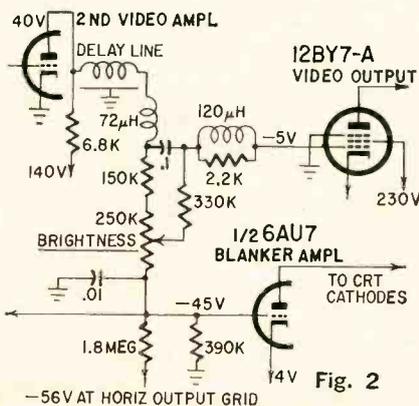


Fig. 2

COLOR GENERATORS FOR EVERY NEED

4 reasons why Sencore is your best buy
in professional test instruments

1

LOBOY CG10

America's lowest priced professional quality standard color bar generator. All solid state. Battery powered for maximum portability.

\$89.95



2

LOBOY CG12

AC operated version of the CG10. Also has 4.5 MHz crystal controlled signal for fine tuning adjustment.

\$109.95



3

COLOR KING CG141

Absolute stability assured by exclusive "Temp Control" and new timer circuitry. All standard patterns, plus new movable single dot and single cross. Analyzing features too.

\$149.95



4

COLOR ANALYZER CA122B

The complete analyzer for color and B&W—far more than just a color generator. Has variable RF and IF outputs, composite video, chroma, and horizontal and vertical sync pulses.

\$187.50



Whatever the need, Sencore has the color generator that is just right for you. Each has the built-in quality you expect from Sencore. Each has standard RCA licensed color bar patterns.

Each is triple tested for guaranteed accuracy. Each is steel encased with chrome panel. See your distributor for more reasons why Sencore is your best buy, always.



SENCORE

NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT
426 SOUTH WESTGATE DRIVE, ADDISON, ILLINOIS 60101

Circle 20 on reader's service card



6JE6C

The cool new "C" It has more life.

When the horizontal deflection tube in a color TV set goes dead, chances are you've been replacing it with our 6JE6-A.

(You learn by hard experience what's best. Who needs callbacks?)

But this doesn't mean that what's best can't be made even better. At least it doesn't to Sylvania electronic engineers.

That's the reason for our third-generation 6JE6-C. (We skipped "B" altogether.)

The "C" is the new workhorse of color television. We've given the plate wings.

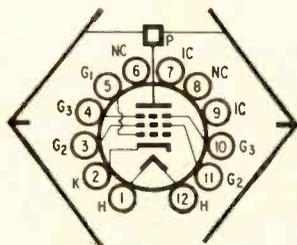
It's been so designed that it acts as a superior heat sink. It holds more heat. Radiates it out from a larger surface. Dissipates it more quickly.

The new tube runs cooler and has longer life.

And it still costs the same as the "A".

It should mean fewer replacement calls.

Try the "C" and see.



Big plate fins
absorb heat
and radiate it
out of the tube.

SYLVANIA
A SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

Circle 21 on reader's service card

EXHIBITS
NEW YORK COLISEUM

TECHNICAL SESSIONS
NEW YORK HILTON

Monday through Thursday

PROGRESS IN AN EXPLODING TECHNOLOGY

- 48 GENERAL SESSIONS at the New York Hilton. Hours: 10:00-12:30; 2:00-4:30.
- FOUR FLOORS OF EXHIBITS at the N. Y. Coliseum including over 750 firms. Hours: 10 a.m.-8 p.m. 4 Days.
- GALA ANNUAL BANQUET—Wednesday 7:15 p.m. N. Y. Hilton Grand Ballroom—\$16.00.
- FREE SHUTTLE BUSSES between the Hilton and the Coliseum—every few minutes.
- REGISTRATION—Good all days—General Sessions and exhibits. In and out privileges.—IEEE Members \$3.00. Non-members \$6.00. Ladies \$1.00. High School Students \$3.00 if accompanied by an adult—One student per adult; Thursday only—limit of 3 students per adult.
- REG-IDENT CARD speeds request for exhibitors' literature. Ask for one when registering.
- ESCALATORS/EXPRESS ELEVATORS to the Fourth Floor.

IEEE Exhibition MARCH 18-21, 1968

Now...the most enjoyable, most rewarding electronic kit project of your life



a Schober Electronic Organ!

The Schober Organ Corporation
43 West 61st Street, New York, N. Y., 10023

HAD YOUR FILL of amplifier kits, receiver kits, meter kits, all the conventional kits? Then go to work on the biggest, most fascinating kit of them all—and end up with a finer musical instrument than you could buy for twice the price. The Schober Theatre Organ at left, for example, plus Schober's self-teaching music courses, lets you *participate* in music, not just listen to it. This is one electronic project the wife and kids will encourage—because it's for them, too! It contains the best components available—thousands of them—plus the kind of unmistakable, step-by-step instructions you've dreamed of and Schober is famous for.

The Theatre Organ (left) costs just \$1550 if you use your own amplifier and speaker system, and you can pay as you build to spread out the cost. There are three other Schober Organ models, too, starting at \$645. Each one includes every bit and piece you need, including a magnificent walnut console—unless you want to build your own woodwork and save even more. And each model has the kind of pipelike tonal variety you don't often find in electronic organs. The free Schober color catalog has lots of pictures and data; and for 25¢ we'll send you 72 pages of schematics and tech specs so you can see just what you're buying.

FREE INFORMATION AND DEMONSTRATION RECORDING
Send today for your free copy of Schober's 16-page, full color booklet, plus 7" free recording.

The Schober Organ Corp., Dept. RE-53
43 West 61st Street, New York, N. Y. 10023

Please send me Schober Organ Catalog and free 7-inch "sample" record.

Enclosed please find \$1.00 for 12-inch L.P. record of Schober Organ music.

Enclosed is 25¢ for schematics and tech specs.

NAME

ADDRESS

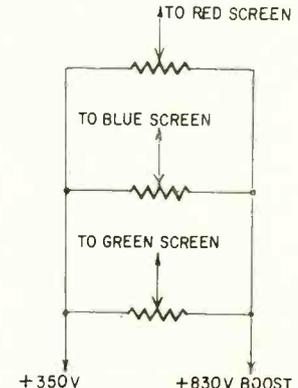
CITY..... STATE..... ZIP NO.....

In the Shop . . . With Jack
(continued from page 22)

all the way up, etc. With a picture, the screen controls have no effect!

What wipes me out is that the picture is good, both in b-w and color! High voltage is okay, and all that. It beats me!—J.G., Grand Rapids, Mich.

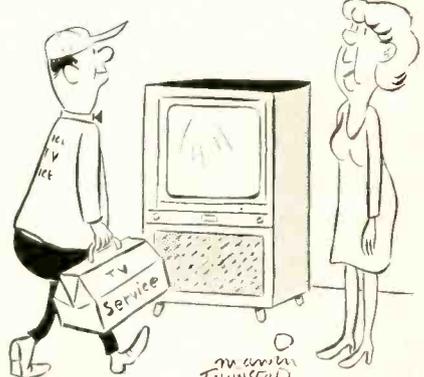
Beats me, too! However, a crystal-ball diagnosis would seem to say that while there *must* be something open in the screen-control circuits, the screens of the CRT have very near the right voltages! They'd have to, if the set's working this well.



The diagram shows the screen supply circuit. Note that the controls are connected between B+ (350 volts) and boost (830 volts). One of these connections must be open; it is most apt to be the B+ 350-volt end, since the normal operating voltage on the three screens is up around 590-640. You couldn't get that from the B+; it'd have to come from the boost.

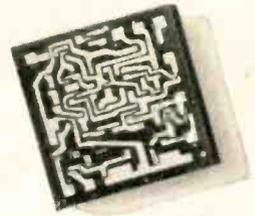
Because the cathode and grid bias voltages are variable, it is possible to get a raster on the tube. If your screen voltage was *low*, it wouldn't. Therefore, your screens must be (accidentally) somewhere very close to the right value. But the complete circuit from boost to B+ must be open somewhere so that the controls have no effect. Since this affects all three screen controls, it'll have to be in the "supply" somewhere.

R-E

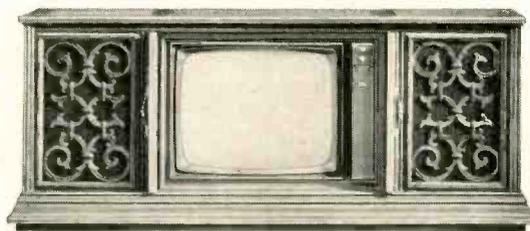


"To save you time, I've already shook, kicked and jiggled it."

The hottest thing in electronics hardly gets hot at all



(RCA's solid integrated circuit, that is)



With the tiny chip there are few heat problems and low power consumption. And because integrated circuits run cooler, parts can be placed closer together to enhance design convenience. One day you may see stereo cabinets with more real storage space, and color TV sets the size of a transistor radio. At RCA Victor we've taken a

step into tomorrow by using integrated circuits now in new color and black and white TV and in stereo phonographs. They're not only the most advanced products of their kind, they are more reliable than ever before.



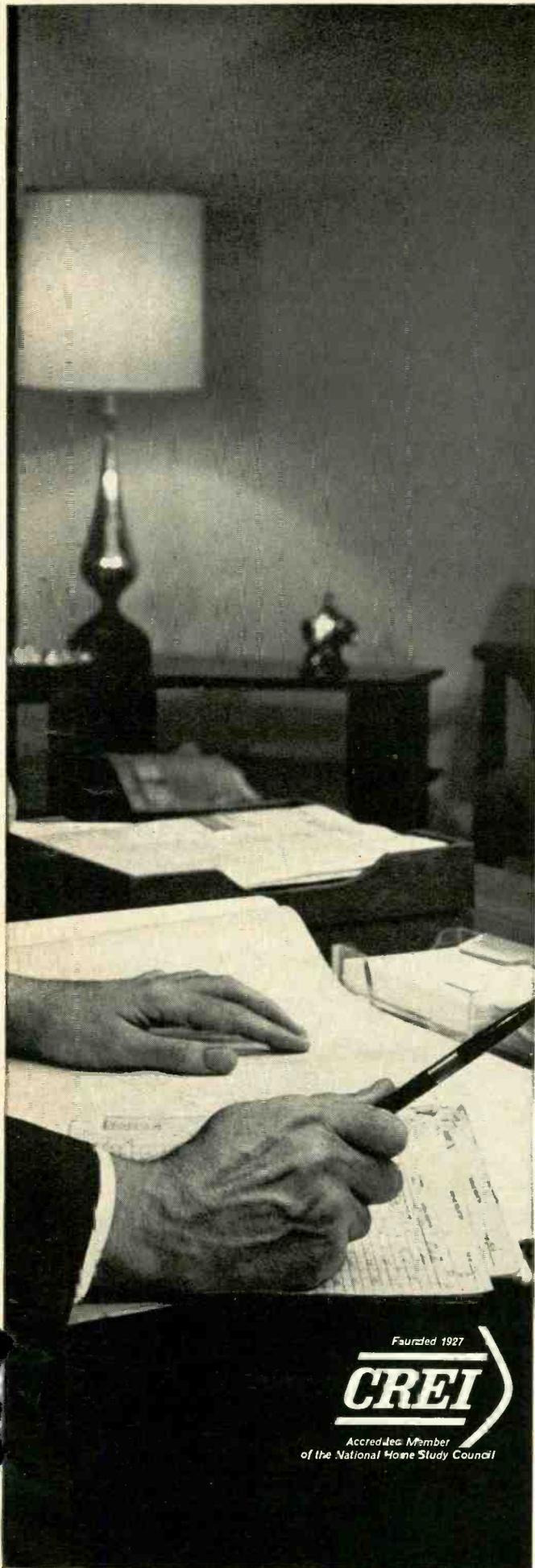
The Most Trusted Name in Electronics

Tmk(s)®

600
cover III

**“Get more
education
or
get out of
electronics
...that’s my advice.”**





Founded 1927
CREI
 Accredited Member
 of the National Home Study Council

Ask any man who really knows the electronics industry.

Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

But, if you supplement your experience with more education in electronics, you can become a specialist. You'll enjoy good income and excellent security. You won't have to worry about automation or advances in technology putting you out of a job.

How can you get the additional education you must have to protect your future—and the future of those who depend on you? Going back to school isn't easy for a man with a job and family obligations.

CREI Home Study Programs offer you a practical way to get more education without going back to school. You study at home, at your own pace, on your own schedule. And you study with the assurance that what you learn can be applied on the job immediately to make you worth more money to your employer.

You're eligible for a CREI Program if you work in electronics and have a high school education. Our FREE book gives complete information. Airmail post-paid card for your copy. If card is detached, use coupon below or write: CREI, Dept. 1401G, 3224 Sixteenth Street, N.W., Washington, D.C. 20010.



The Capitol Radio Engineering Institute

A Division of McGraw-Hill, Inc.
 Dept. 1401G, 3224 Sixteenth Street, N.W.
 Washington, D.C. 20010

Please send me FREE book describing CREI Programs. I am employed in electronics and have a high school education.

NAME _____ AGE _____

ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____

EMPLOYED BY _____

TYPE OF PRESENT WORK _____ G.I. BILL

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

APPROVED FOR TRAINING UNDER NEW G.I. BILL

HOW TO KILL COLOR GHOSTS

Tolerable ghosts on black-and-white TV sets can set up intolerable color problems which cause color shift and fringing By LON CANTOR

AS COLOR TV HAS COME OF AGE IT HAS put the spotlight on one of our most perplexing reception problems—multiple images. Ghosts mildly annoying in black-and-white are usually intolerable in color. And they're simple to avoid if you know how.

In general, any one or all of three things can cause ghosts: multipath reception, standing waves on the lead-in, and nonuniform frequency response somewhere in the system. All distort the signal; otherwise they are different phenomena.

Multipath reception

When signals leave the TV transmitter, they travel in all directions. In addition to a direct signal, a receiving antenna therefore often picks up a reflected signal (Fig. 1).

Since the reflected signal travels a longer distance to the receiver, it arrives a split second after the direct signal. Because TV signals travel at 186,000 miles per second, you might think that a slightly longer path would make no difference. But, remember, the horizontal oscillator is sweeping the electron beams across the face of the picture tube pretty rapidly, too. The linear velocity of the scanning spot sweeping a 23-inch picture tube, for instance, is approximately 350,000 inches per second. Therefore, a reflected signal path only 1,000 feet longer than the direct path can cause an image displacement of nearly 1/2 inch on the TV screen.

If the reflected signal is relatively weak, the ghost will be very faint, perhaps hardly noticeable on a b-w receiver. Your eye can tolerate a certain amount of fuzziness, if there's only

a change in contrast. But color is a different story.

The most striking characteristic about color TV is color difference. A girl in a white dress against a black background (b-w) may make a pretty scene. But view that same girl in a red dress against a blue background color and you immediately notice a vividness, a near reality. This lifelike quality is what makes color TV so fascinating and entertaining.

Unfortunately, a small ghost can wreck that beautiful picture. Assume you're watching a ghosted color TV picture of a red chimney against a blue sky (Fig. 2). As you can see, the reflected signal is displaced to the right of the direct signal. Thus, the red and blue overlap at the leading and trailing edges of the chimney. These edges are a mixture of blue and red, producing a color that isn't a part of the transmitted picture. The result? The picture looks sloppy.

There is only one way to eliminate color ghosts caused by multipath reception. You need a very directional antenna, properly oriented. Fig. 3 shows the response (at one frequency) of an ordinary bidirectional dipole (A) vs that of a relatively unidirectional antenna. Notice that (B) accepts signals principally from angles between approximately 160° to 200°. In other words, A has a beamwidth of 100° while B has a narrow beamwidth—only 40°. Hence B rejects many multipath signals that A does not.

Of course, beamwidth (of lobe narrowness) depends on the type of antenna. In general, the higher the antenna gain the narrower the lobe.

There are two notable exceptions to this generalization. First some high-

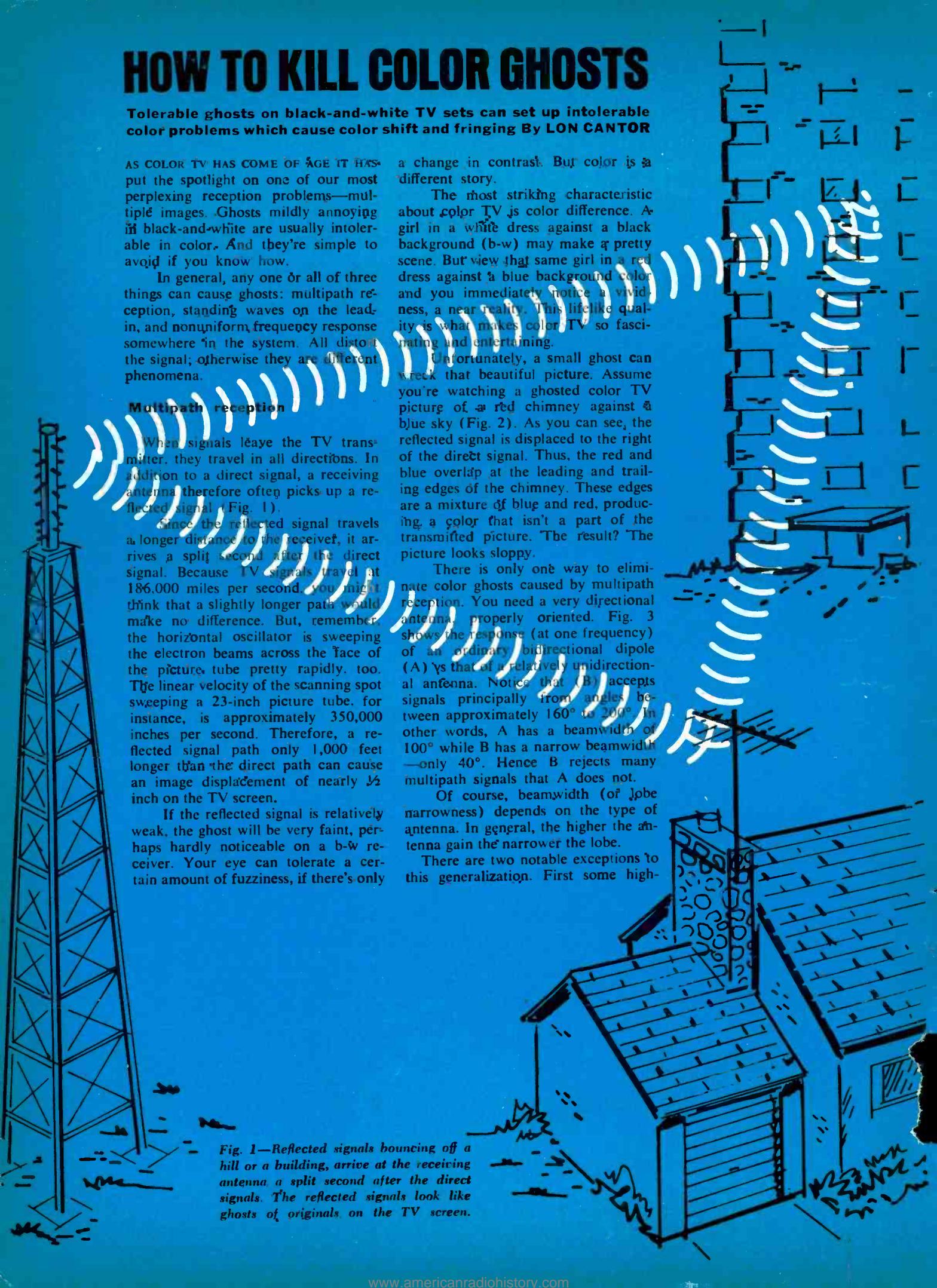


Fig. 1—Reflected signals bouncing off a hill or a building, arrive at the receiving antenna a split second after the direct signals. The reflected signals look like ghosts of originals on the TV screen.

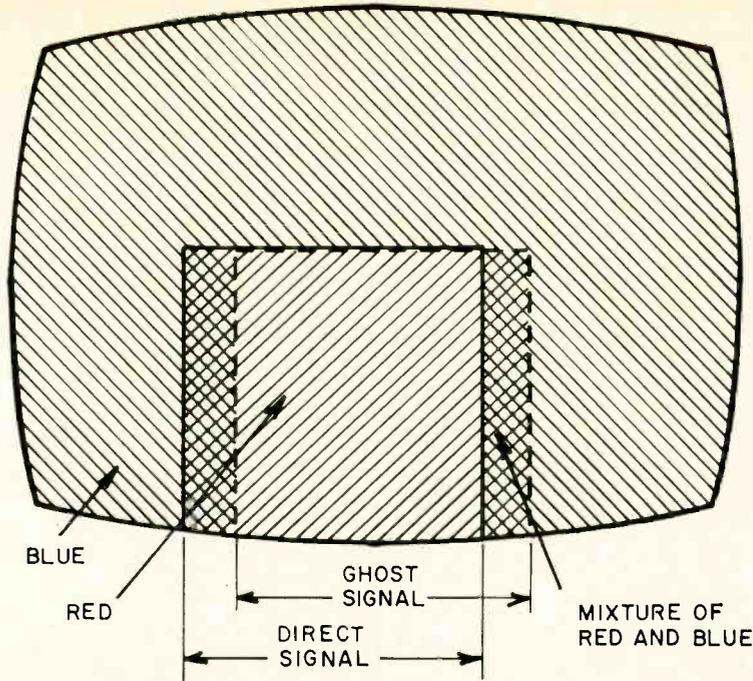


Fig. 2—In a color CRT, a ghost not only blurs the image, it produces new colors. Blurring red and blue, for instance, produces violet or purple and ruins picture.

gain antennas include very substantial side lobes. Naturally, these aren't too effective at eliminating ghosts. Second, a new type of low-gain antenna has recently been developed for metropolitan areas. Such an antenna uses two folded-dipole radiators with a special phasing harness to achieve an excellent front-to-back ratio. Because they are less expensive than high-gain antennas, they are preferred in strong-signal areas—where ghosts are most likely to be prevalent.

Really persistent ghosts can often be eliminated by stacking antennas horizontally. This simply means adding more elements side by side, to narrow the beamwidth still more. (Stacking antennas vertically increases gain, but doesn't usually reduce multipath pickup.)

Lead-in ghosts

If there's a line mismatch anywhere between the antenna and the TV set, ghosts are caused. This is easy to demonstrate: Tune in a clear color picture on a color TV receiver. Connect a 6-foot stub of lead-in to the antenna terminals. Then snip off the wire a few inches at a time. You'll see color changes and perhaps even snow and ghosts at a certain length of lead-in. You have made a trap with the lead-in stub, by cutting it to a certain length and causing standing waves.

These standing waves can also be caused by standoff insulators and staples. The point at which a standoff insulator encircles the lead-in is actually a point of mismatch; the wire pair no

longer has 300 ohms of impedance. The same is true for the point at which a staple pierces the lead-in, or where the wire gets wet or coated with smog.

Remember the law that says maximum transfer of energy is possible only when impedances are matched? The signal traveling down the lead-in (called the *incident* wave, or wave leaving the source) sees mismatch points as *lumps* (points of a change in line impedance). Not all the signal energy goes through each lump; some reverses direction and becomes a *reflected*

wave. (The reflected wave goes back toward the source, or antenna.)

Standing waves are produced when incident waves meet reflected waves in passing. Both move, but they always cross at the same points (Fig. 5-a). Thus, the resulting pattern, formed by addition and cancellation of signal voltages, is stationary, or standing (Fig. 5-b).

Of course, the reflected signals in standing waves eventually reach the receiver antenna terminals, but a little late. Since the time delay is short and the reflected signal is generally weak, you don't generally see a distinct ghost. (In severe cases, however, you can see ringing or multiple ghosts across the face screen.) Usually, you simply see indistinct smears.

In black-and-white pictures, these smears are almost invisible. But reflected signals are not only delayed in time, but shifted in phase. Also, the color subcarrier, unlike the sound or picture carriers, is detected in phase. Thus, the reflected signal causes a very annoying color change around the picture edges.

Uneven frequency response

When colors aren't true or shift in hue when they shouldn't, the cause is often frequency ghosting. Although nonuniform response anywhere in the system can cause such ghosts, the trouble is usually up on the roof. An antenna designed for black-and-white reception has usually been peaked for maximum gain. The "area special," in particular, is tuned to one or two spe-

continued on page 94

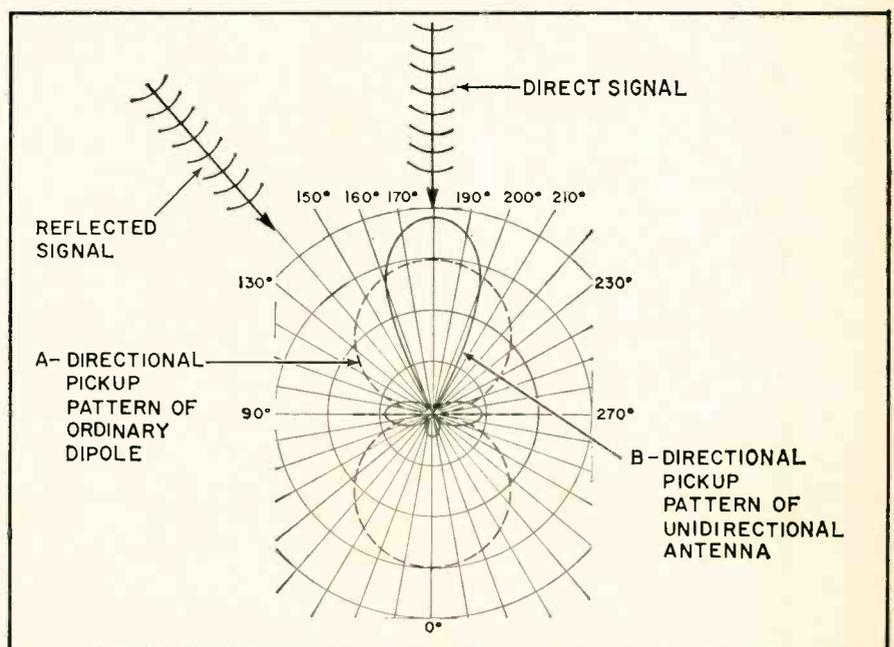
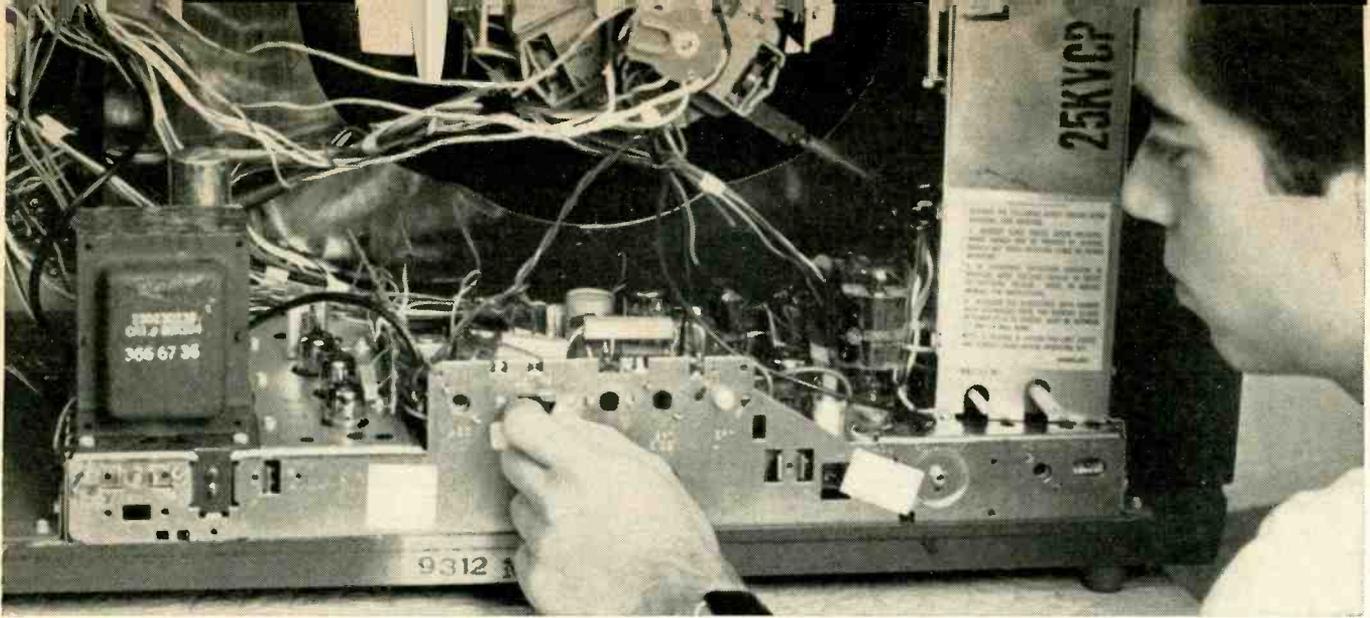


Fig. 3—The common dipole (A) isn't much good at avoiding multipath reception. Unidirectional antenna (B) is generally sensitive principally to the desired TV signal.



ABC's of Color Purity

Purity is virtuous; or, not all troubles are due to defective components

By WAYNE LEMONS

A VITAL, BASIC COLOR TV ADJUSTMENT—that's purity. It outranks convergence (though there is certainly a great deal of interaction between the two), as well as linearity, high voltage, height and width.

People may tolerate a red, green or blue outline around a picture caused by poor convergence, since it is not so noticeable on color pictures. They'll indulge a pointed head or dwarfed legs, and even overlook slight defocusing or some loss of width. But it takes a rare bird indeed to ignore his favorite girl dancer if she has one chartreuse and one pink leg. And nobody likes to have the face of his favorite comedian change from blushing pink through bruised blue or gruesome green as he moves across the screen.

The cause of these effects? Poor purity. The fellow who wrote: "I never

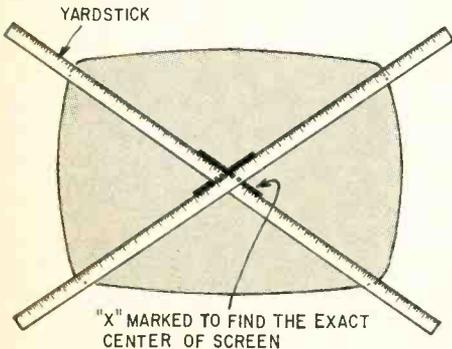


Fig. 1—You must adjust the purity tabs to center the red "fireball" on the CRT screen. Locate the screen's center with a yardstick and mark with a soft crayon.

saw a purple cow and never hope to see one . . ." could easily be in for a jolt if his new color set were not properly adjusted for best purity.

Good purity means, of course, that with only the red gun on (BLUE and GREEN SCREEN controls turned down) the CRT screen is *totally* red. (Blue and green fields should also be pure but they normally will be if the red field is.)

Setup techniques

The test for purity needs a blank raster with no video. You can remove the video by pulling an i.f. tube; on some sets a third position on the service switch provides a "Purity" or "Raster" position.

Color bar/dot generators can be used to blank the screen for purity adjustments. Some generators have a position which provides only rf without modulation. If your generator has no such position you can use the dot function and just ignore the dots.

After getting a blank screen by whatever method, turn down the BLUE and GREEN SCREEN controls, leaving only RED turned on. If anywhere on the picture tube face there is any other color except red, even patches of pink, then purity adjustments are needed.

What's first? Degauss . . . degauss . . . degauss! Don't be skippy about it. Take two or three minutes. Go over the face of the tube . . . under the chassis . . . around the sides of the chassis . . . even inside the cabinet. Special notes: Don't depend on automatic degaussers to demagnetize the set! They are de-

signed to *keep* the colors pure, not to *make* them pure.

Something else: degaussing may appear to make impurities worse. That's especially true if someone has tried to set the purity earlier without first degaussing.

Once you are sure that degaussing is complete, move the degaussing coil away from the set as far as possible and then turn it off. Remember that a collapsing ac field is dc! And this dc can "set" an impurity sometimes hard to remove. So get the coil away from the set before you kill the ac.

If you still have impurity after degaussing, see if the off-color areas are near the outer edges of the raster. If so, all that may be necessary is a slight adjustment (forward or backward) of the deflection yoke to clean up the raster satisfactorily.

If this fails, however, you have to go further and do the complete purity-adjustment procedure:

1. Pull the deflection yoke back against the convergence yoke. This will

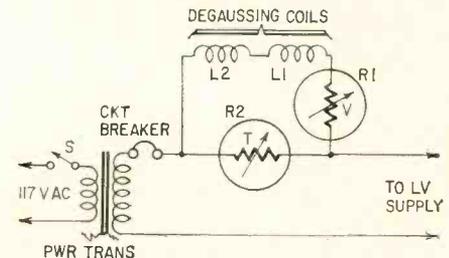


Fig. 2—In typical auto-degausser the resistance of varistor R1 rises sharply and thermistor R2's resistance drops a few seconds after the power has been applied.

leave the screen badly out of purity but there should be a rather large red "fireball" splotch somewhere near the center of the screen.

- Adjust the purity ring tabs, by spreading them apart or pushing them closer together. Or rotate both rings until the fireball is centered. And this means as near exactly center as you can get it. Use a measuring stick and mark the exact center if necessary. (See Fig. 1—and don't think that you can't be deceived about the screen center, especially on large rectangular tubes.)
- With the fireball centered, move the deflection yoke forward until the raster is pure. (On most sets the yoke will not be all the way against the bell of the CRT.)

That's all there is to it, *unless* you still don't have good purity. If you don't, go through the adjustments again—starting with another *thorough* degaussing.

Still impure? Check the convergence adjustments. They don't have to be perfect but if they are too far off you won't be able to get purity. Use a crosshatch and rough in both the dc (static) and dynamic adjustments. Then go through the purity adjustments again.

Changing purity problems

Moving a set may upset purity. (This is more critical, of course, on old chassis than on new ones.)

Turning a set over on its side for service will just about always upset the purity, often so severely that you can't even get color or, at best, only washed-out color. The cure: degaussing.

Any electrical device that uses a motor, transformer or other changing magnetic field can cause impurities if operated near a color set. Rotator controls, some clocks and other electrically operated equipment should not be placed on top of a color set.

The lady of the house should be cautioned not to turn off her electric vacuum cleaner under the TV set though it is perfectly okay to use the cleaner if she keeps it running.

Circuit troubles

Fig. 2 is a typical automatic degaussing circuit. The degaussing coils utilize the initial charging current of the power-supply filter capacitors to supply a strong ac magnetic field.



Before you do any setup adjustments in a color-TV set, always degauss the CRT, chassis and cabinet if it is metal.

When the set is first turned on, thermistor R2's resistance is high (about 120 ohms) and about 60 volts ac appears across the degaussing coils (L1 and L2) and the varistor (voltage-sensitive resistor R1) in series. The resistance of R1 drops and about 2 amps flows in the circuit. Current through R2 heats it, causing its resistance to drop and reduce the voltage applied to the coils and R1. The varistor's resistance increases as the thermistor's resistance decreases. Within a matter of seconds, the power in the degaussing coils drops from a maximum of 60 volts at 2 amps to around 1 volt at 0.5 mA.

Either of these resistors can fail to reduce the automatic degaussing field sufficiently, in which case they should

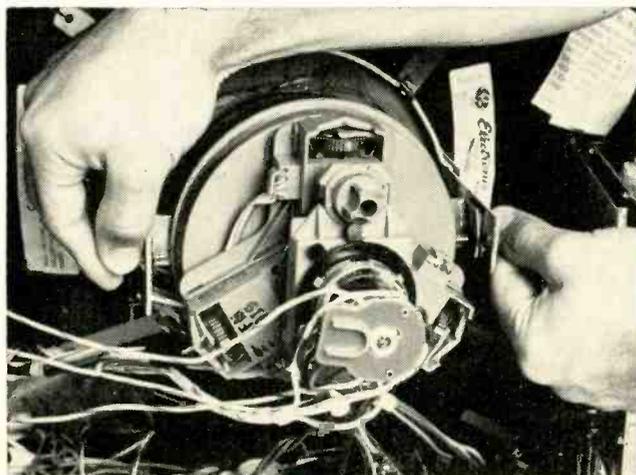
be replaced. The usual symptom is a weaving or bending picture which you may at first suspect as sync or filter trouble. To check, simply short across the coils or unplug them. If the bending stops, either (or both), R1 or R2 is probably defective.

On sets with automatic degaussing and bridge rectifiers in the power supply, a misleading symptom sometimes happens. The set is always impure when turned on. This impurity can be removed with an external degaussing coil; the set will then stay pure until turned off and back on again. If you have this trouble look also for insufficient width or just barely enough width. The cause is probably a defective silicon rectifier in the power supply.

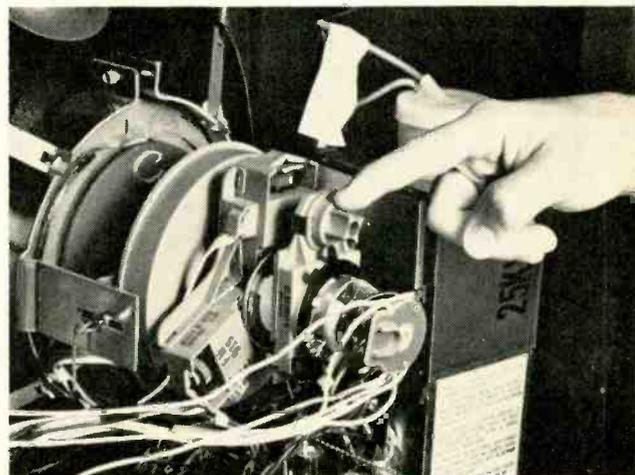
One thing you should keep in mind is the *post purity* adjustment used in some Zenith models. These sets have the purity rings in *front* of the deflection yoke. Because of this you must degauss the CRT *every time* you adjust the purity rings.

One final word—although instruction books often insist that impurity is always noticeable on black-and-white pictures, this may not be true. Sometimes impurities are only discernible by a change in tint of an object in a color picture as it changes position on the screen. So always check the red field for purity by first noting the positions of the BLUE and GREEN SCREEN controls and then turning them down. If purity is good, return the controls to their original positions. It takes just a few seconds and it can save you having to work on the set again.

Something else: Lights—especially fluorescent lights—shining on the CRT face, can make you think the purity is poor at the corner or the edges when it isn't. There is nothing quite so embarrassing as having a customer who knows nothing about electronics say: "I believe that's the light shining on the screen" and be right! **R-E**



Beginning of the purity-adjustment procedure: You must pull the deflection yoke back against the convergence yoke. The screen then becomes impure, but a red "fireball" appears.



Do not make any convergence adjustments until you are satisfied that purity adjustments have been properly made. If convergence adjustments are made, do recheck for proper purity.

High Voltage Shunt Regulators for Modern Color TV Sets

High-voltage power-supply regulation is critical . . . here's how to set it up

By **BOB BARKLEY**

AMONG THE CRITICAL COLOR CIRCUITS that cause major trouble, the high-voltage regulator is often overlooked. When pictures start blooming, tube and flyback failures may be next. Not only do components fail and cause trouble, regulator misadjustment can also make for poor operation.

Some technicians don't realize how critical proper adjustment is in the power-handling horizontal and high-voltage sections. The horizontal output, damper, HV rectifier and shunt regulator all carry considerable current. If

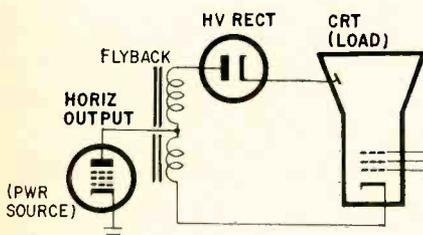


Fig. 1—In any TV receiver, the picture tube is a load across the HV supply.

these tubes are operated beyond their design limits, they'll fail before long.

To understand troubleshooting the shunt-regulator circuit better, it's important to learn why it's needed. Since regulators are seldom used in b-w receivers, a color set must therefore have a special requirement for high-voltage regulation.

HV supply for color

It does; more high voltage (than in b-w) is needed to attract the three electron beams in a color CRT. The beams must penetrate the shadow mask; this requires more "push." Also, since a color tube uses *three* electron beams (rather than one as in b-w) more power is required from the HV supply.

In a b-w set the HV power is a small fraction of the total horizontal-output stage power. Hence even appreciable changes in scene brightness (HV current drain) don't change the voltage value much, since such current changes are small compared to the total load. This means the b-w picture seldom blooms, as the HV is substantially constant.

In a color set, however, the HV power required by the three-gun CRT is much greater—a major portion of the total load. Thus changes in scene brightness (which change electron-beam current) could vary the value of high voltage and cause picture blooming.

The color HV supply is designed to furnish approximately 25 kV at about 750 μ A. By Ohm's law, therefore, its internal dc impedance is approximately 33 megohms. A high-impedance supply has inherently poor voltage regulation; it's really a constant-current, variable-voltage source.

To improve regulation and hold the HV potential relatively constant, a shunt-regulator tube is used in color sets. The regulator acts as a variable load across the HV supply.

To illustrate what's been explained so far, Fig. 1 shows a simplified version of the horizontal output and HV circuit in a color set (without a regulator). The circuit can be redrawn as in Fig. 2, showing the horizontal-output stage

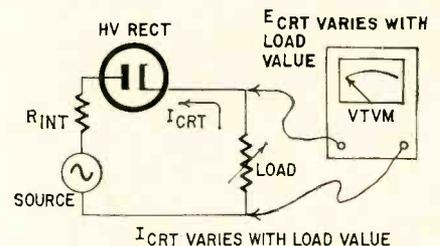


Fig. 2—Voltage output of an unregulated supply varies with resistance of load.

(and flyback) as the source of low-current high voltage, and consequent high internal resistance. The CRT has been replaced by a variable resistor constituting a load on the supply. Note that the high voltage varies with the value of this resistor. (This is another way of representing current variations.) Since the supply can furnish only a constant current value, varying the load causes the voltage across that load to change.

The solution to the problem is shown in Fig. 3; here a shunt regulator consisting of another variable resistor

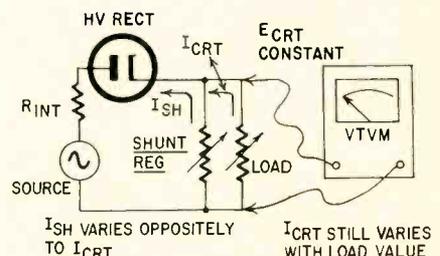


Fig. 3—Changing the shunt resistance compensates for load changes. Result is that voltage across load is constant.

has been added to the circuit. If the load resistance increases, the shunt resistance is decreased until the total resistance is the same as before the load increased. Thus the load voltage remains the same.

Another way of analyzing the situation is to consider current flow. Load (or CRT) current varies with picture (or scene) brightness. Regulator current varies oppositely, to compensate for load variation. Thus total current flow from the source (and through the HV rectifier) remains constant. So *does the high voltage at the CRT.*

The actual regulator and HV circuit is shown in Fig. 4, a partial schematic of an RCA CTC24 chassis. Regulator V102 is connected between the HV bus and the 400-volt B+ bus, which is relatively immune to changes in CRT beam current. A voltage divider (R106A, R106B, R110 and R105) is placed from the boost line to ground, and the grid of the regulator tube fed from a point in the divider.

through the yoke properly and produce linear scanning, the entire yoke, flyback and HV circuit is designed as a parallel-resonant circuit at about five times the horizontal scanning frequency, or around 75 kHz. Because of slight component differences from chassis to chassis, an adjustment is provided to set the horizontal output tube to maximum output voltage. This adjustment is usually called HORIZONTAL EFFICIENCY (L708 in Fig. 4). It allows fine adjustment of current through the horizontal output tube.

The parallel-resonant circuit formed by the HV components offers high impedance to current flow when tuned to resonance. (In other words, it offers the maximum available voltage drop across it, and maximum HV output.) This high impedance means that minimum current will flow through the horizontal output tube. And this fact makes it easy to adjust the HORIZONTAL EFFICIENCY control. The simplest way is to insert a milliammeter in series

- 2) **Screens**—Set for a *dim*, white line on the screen.
- 3) **CRT bias**—Set only to bring up the *least* dominant gun with that gun's screen set at maximum (otherwise set CRT bias *off*—counterclockwise).

- 4) **Customer brightness control**—Set at 75% to 90% clockwise while adjusting the screens and CRT bias.

Determine the proper value of high voltage for the chassis. (The CTC24 shown in Fig. 4 takes 24 kV.) You must set HV at this value with a black picture screen (in other words, with no current flow to the HV anode). Do this by turning the customer (front-panel) brightness completely counterclockwise. This leaves only V102 conducting, and the 6BK4 current must be a minimum value of 1 mA. Most modern circuits draw from 1 to 1.35 mA through the 6BK4 (1 to 1.35 volts across resistor R112).

The three electron guns in the CRT can then increase their current flow to 330 μ A each for a bright picture. This provides more than adequate brightness for normal viewing. If beam current exceeds that through the 6BK4, the regulator loses control. This means the picture blooms. If the controls are properly adjusted, no blooming should occur.

Troubleshooting procedures

In troubleshooting a color HV circuit, the three most important measurements are:

- 1) **Horizontal-output current**—Dip this reading with the HORIZONTAL EFFICIENCY coil. The maximum reading for a 6JE6 is 230 mA.
- 2) **Shunt-regulator current**—Monitor as a voltage drop across a 1000-ohm cathode resistor with a black picture. You should have a minimum reading of 1 volt.
- 3) **Shunt-regulator bias voltage**—Measure this from grid to cathode of the 6BK4. This bias should be about 10 to 25 volts (*not* with respect to ground). But check the schematic of the particular chassis first. The bias is the difference between two source voltages:

- A. **Cathode**—400-volt B+ supply.
- B. **Grid**—850-volt boosted B+ via a resistor divider network—the HV ADJ control being one of the resistors.

The current through the shunt regulator must be correct and is the first place to start the troubleshooting process.

If the 6BK4 current is too low—less than 1 volt drop across the 1000-ohm cathode resistor:

(continued on page 72)

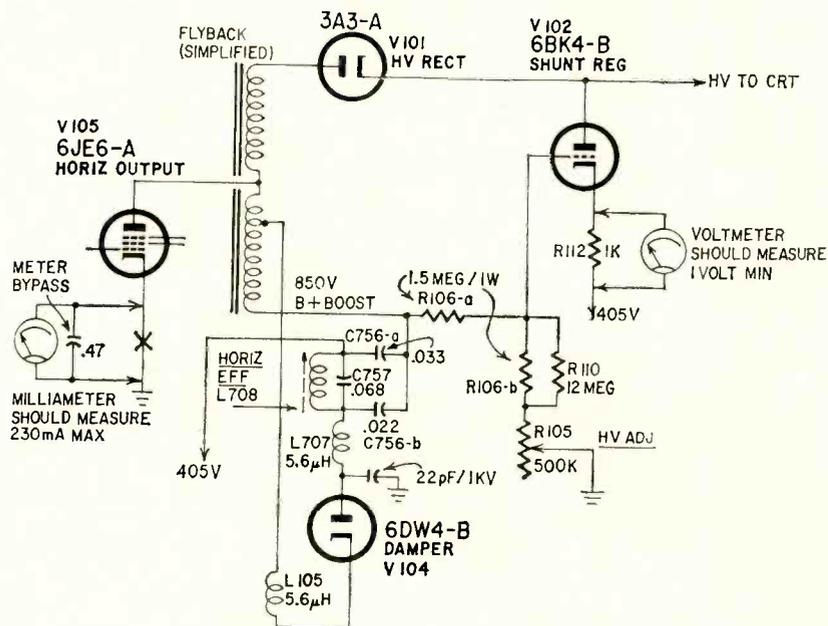


Fig. 4—Partial schematic of RCA CTC24 chassis shows test points for horizontal and HV section. Coil L708 affects current through V105; R105 controls V102.

R105 is adjusted until V102's grid is biased to cause the tube to draw slightly more current than the CRT.

Should the CRT now draw less current, the HV will rise, and so will the boost (because it's derived from the same flyback transformer). When the boost voltage rises, V102's grid voltage also rises, causing the 6BK4-B to conduct more current. This additional load on the HV supply pulls the voltage down to where it was before. Hence the output HV is regulated.

Efficiency-coil function

To shape the current waveform

with the horizontal output tube cathode, as shown in Fig. 4, and adjust the coil for minimum current.

Setup adjustments

The secret ingredient to proper regulation is that even at *maximum* brightness the CRT current will not equal the regulator current. Regulator current is easily monitored as a voltage drop across a 1000-ohm resistor in the 6BK4-B cathode circuit, where 1 volt equals 1 mA.

Set the various controls like this:

- 1) **Normal-service raster switch**—Set to SERVICE.

How To Fix Intermittent Color TV Sets

Learn which circuits to monitor to catch a trouble that comes and goes as it pleases

By MATTHEW MANDL

PRINTED CIRCUITS, MODULES, COMPACTRON tubes, and transistors, have all contributed to the development of color television. The old paper-envelope capacitors have been replaced with plastic-encased types that do a good job in keeping moisture out and holding the leads firmly in place. Despite all these advantages, however, the intermittent problems we have long endured with radio and black-and-white television are still with us. An elusive intermittent is aggravating, time-consuming, and costly, because there's very little that can be done to localize the trouble until the symptoms appear. If the trouble doesn't last long enough to make a good check, a set can be out of service a long time.

We've all run across cases where an intermittent—such as hum—stops as soon as test probes are applied to the suspected circuit. Even with high-impedance test equipment, enough loading often occurs to correct a critical fault temporarily. The trick here is to keep the test-equipment load constant on the suspected circuitry. Apply your vtvm, scope, and other available equipment, note the readings, and leave the probes in place. Then see which change when the trouble starts.

Another type of intermittent doesn't show up on the test bench but appears as soon as the set is put back in service. This calls for a thorough environmental check. See if the line voltage is the same in both locations; make sure the antenna is not defective; find out if the back of the set is too near a radiator, and check the wall plug for good contact.

A faulty circuit isn't too difficult to localize, though more trouble is involved to find the intermittent component. If the trouble doesn't appear often, or if it doesn't stay long enough to find the bad part, wholesale replacement of every component in the circuit may be the only answer. Many technicians swear by this procedure, claiming the cost of parts is more than offset by the extra labor it takes to pinpoint the exact part.

While this method is all right when

only resistors, capacitors, and other small parts are involved, it can become time-consuming and costly where transformers and coils are involved. In color sets, particularly, it would be out of the question in cases such as the convergence board, shunt regulating and focus-rectifier sections, etc. Thus, we must first localize the offending circuitry, then try to pinpoint the exact part by using our knowledge of circuit function and proper use of test equipment. It's helpful to study typical case histories, not because you might run across the exact trouble in the near future, but to become acquainted with the procedures used to pinpoint the fault.

Contrast changes

In a Sylvania DO-6 color chassis the contrast would abruptly change to a dark level momentarily (Fig. 1), changing back to normal and staying that way for long periods of time. This receiver uses a hybrid tube-transistor arrangement in the video-amplifier section, as shown in Fig. 2. Since any stage could be involved from tuner to picture tube, it was decided that the initial tests should try to establish whether the trouble was before or after the video detector. With the set on and tuned to a station, scope leads were placed between the grid of the first video amplifier and ground. The scope HEIGHT control was adjusted to

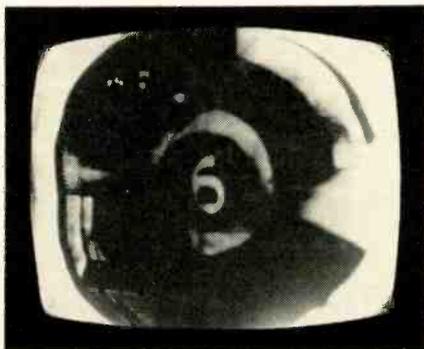


Fig. 1—A change in grid bias on the video amplifier caused this overload. A scope was used to track it down.

provide a full-screen view of the pattern shown in Fig. 3.

When the intermittent trouble occurred, there was no perceptible change in the scope pattern, so the scope leads were placed at the collector output of the second video amplifier shown in Fig. 2. Now when the intermittent occurred, the scope pattern expanded and overshot the screen face, indicating the trouble was before this test point. Next the scope leads were placed between the first video amplifier plate and ground; as an extra check a vtvm was placed between cathode and ground to observe bias changes, if any. Next time the intermittent occurred it was noticeable in the scope pattern and also in the vtvm. The cathode voltage dropped to zero, indicating either a loss of tube conduction or a short between cathode and ground.

If the tube had stopped conducting, there would have been a decrease in signal output, not an increase. Hence, the trouble was in the bias change. Because capacitors are often the worst offenders in intermittents, the 0.0056- μ F capacitor in the cathode circuit was replaced and the set checked again with the test setup. During an extended test run no more trouble showed up and the set was returned to the customer. A more likely capacitor trouble is an open circuit, in which case the unbypassed 33-ohm cathode resistor would have caused some degeneration and possibly low contrast.

In an earlier version of this color receiver (DO-5 chassis) a 25- μ F capacitor was included in the collector circuit of the second video amplifier. When this capacitor became leaky, similar conditions of poor quality occurred, with intermittent picture flicker.

No mention has been made regarding tube and transistor checking. When it comes to intermittent troubles, there is no use wasting time doing this, because a quick check on cold tubes and transistors (out of the circuit) means little. If the trouble symptom is present continuously and the fault is in

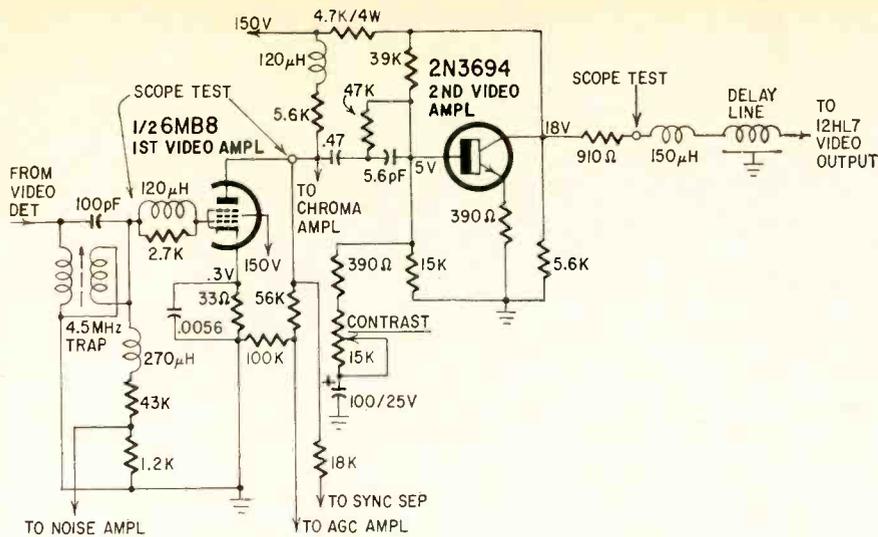


Fig. 2—Partial schematic of hybrid video amplifier used in Sylvania DO6 chassis. Overload was caused by open cathode bypass capacitor upsetting bias on the 6MB8.

a tube or transistor, the checker will show it.

Vertical jitter

In a Magnavox T922 chassis color receiver there was an intermittent vertical jitter. The raster was displaced by only a fraction of an inch, at a rapid rate and then returned to normal.

The effect appeared as a change in height because of the rapid picture shift. Close inspection of the screen during the trouble, however, showed that the vertical scan did not change, only the position. Thus, the trouble was not caused by sweep amplitude changes; the most likely cause was a change in the dc idling voltage in the vertical deflection coils. This could have been proved by placing a scope at the vertical output and observing that the peak-to-peak pattern did not change (Fig. 4).

Initially the centering control was checked with an ohmmeter and found to be operating smoothly, with no sudden resistance change as the arm was rotated. A voltmeter reading across the control, however, indicated a voltage drop and some needle flicker during the intermittent. Because the 25- μ F capacitor shunted the control this capacitor was replaced and the trouble corrected. The capacitor appeared good in a checker, but obviously developed an intermittent condition when in the circuit for a time. The capacitor was developing either a partial, or a full, momentary short. Since the condition occurred so rapidly, however, the meter needle did not drop to zero during the readings. With such few components in this circuit, the capacitors could have been replaced without worrying about the cost factor, and without waiting for the trouble to show up on a meter test. It was unlikely that the capacitor at the lower end of the out-

put transformer primary was at fault; this would have caused a change in sweep output and hence height, not vertical centering.

Intermittent focus

In an Admiral chassis there was an intermittent defocusing which happened about every two minutes or so. As shown in Fig. 5, the 5-kV focus voltage is applied to pin 9 of the picture tube through a 1.8-megohm resistor.

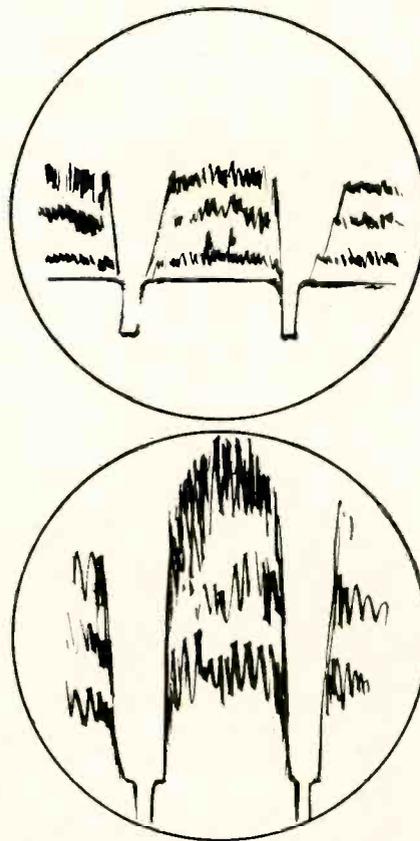


Fig. 3—Normal video output as seen on scope (top); the intermittent caused increased stage gain and increased video.

The 15-megohm FOCUS control is part of the bleeder network. The 47-megohm section is made up of 10 4.7-megohm resistors in series. A high-voltage probe placed between pin 9 of the picture tube and ground showed a voltage decrease of several thousand volts when the focus became faulty. With the receiver shut off, each resistor was checked but found to be within the specified tolerance. A new focus rectifier tube did not cure the trouble and the horizontal output system checked out all right.

A resistance change in the bleeder section appeared unlikely as the cause of the trouble, because an open circuit or a higher resistance would raise output voltage, not drop it. Replacement

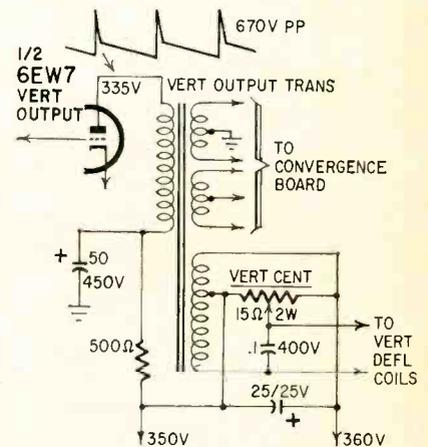


Fig. 4—Bad electrolytic shunting the centering control in this Magnavox T922 caused intermittent vertical jitter.

of the 1.8-megohm resistor was indicated, because a poor connection or an increase in resistance would decrease the focus electrode voltage. Out of curiosity, however, both connections of the resistor were resoldered to see if a poor joint was causing the trouble. Now a high-voltage probe check and screen inspection no longer showed intermittent focus and the original resistor was left in the circuit.

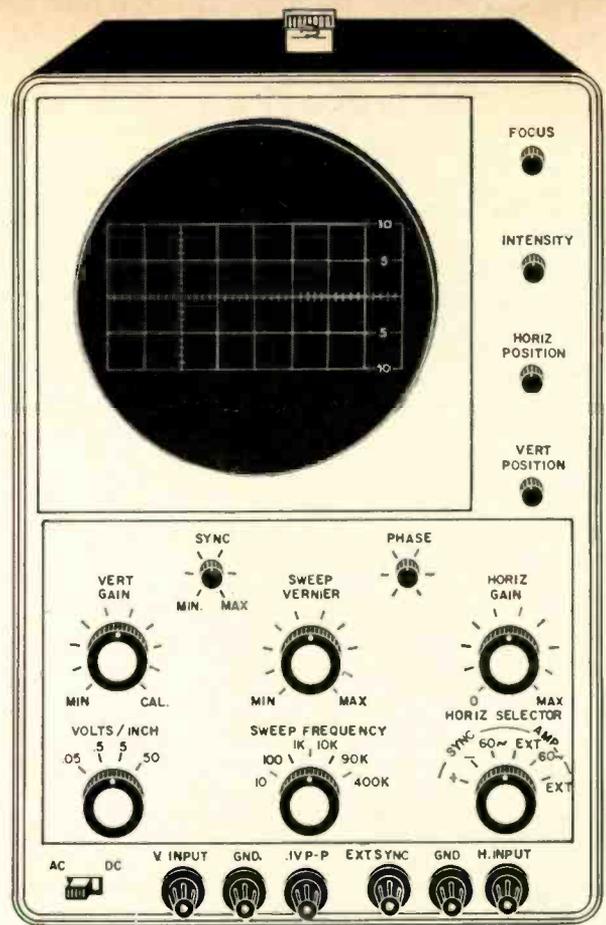
Miscellaneous intermittents

In an RCA CTC-20 color receiver a loud, intermittent noise would be heard for as long as half a minute, overriding the normal audio. After the noise stopped it wouldn't be heard again for almost an hour. Since no streaks were visible on the screen it seemed likely that the noise was not the result of high-voltage arcs, but was confined to the audio section after the detector. When the volume control was turned down completely the noise still returned with about the same volume level as before. Thus, the source was isolated to the section following the volume control, and lengthy signal (continued on page 63)

YOUR SCOPE: A GUIDED TOUR

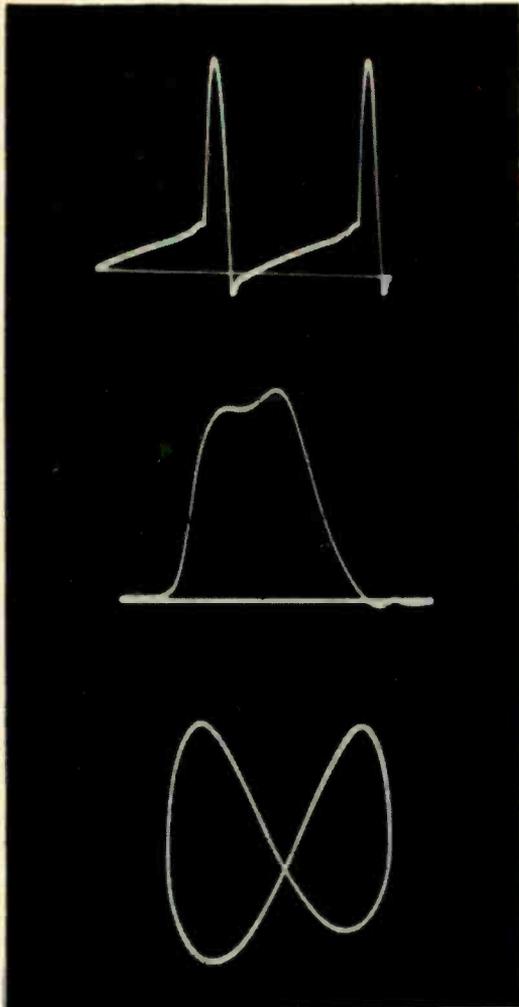
By ROBERT G. MIDDLETON

An oscilloscope is one of the most valuable instruments found in electronics for it lets you observe electrons at work. The scope also has more controls than any other common troubleshooting instrument, hence often bewilders and confuses. Here are a few tips on what some of the controls do and how to use them properly for best operation. Try these on your own scope.

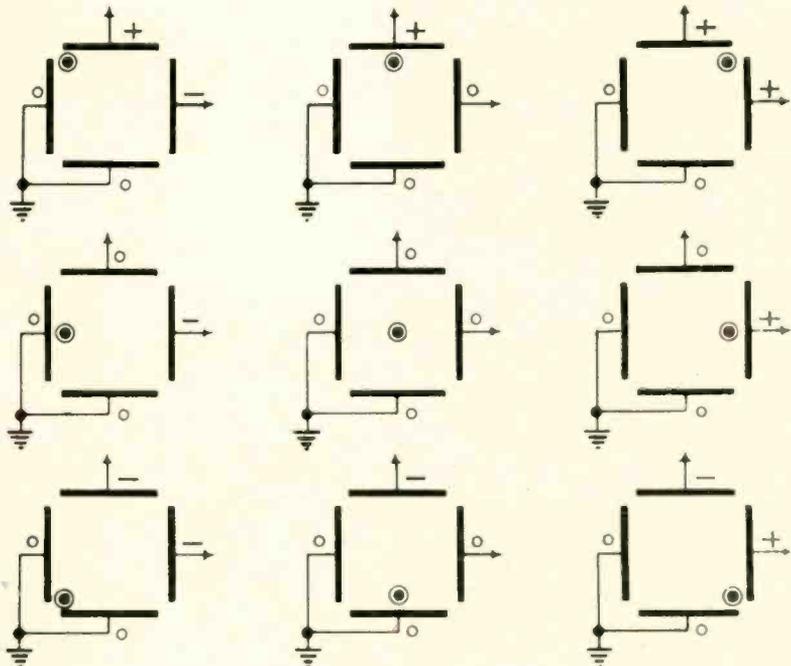
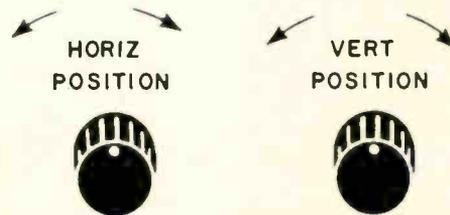
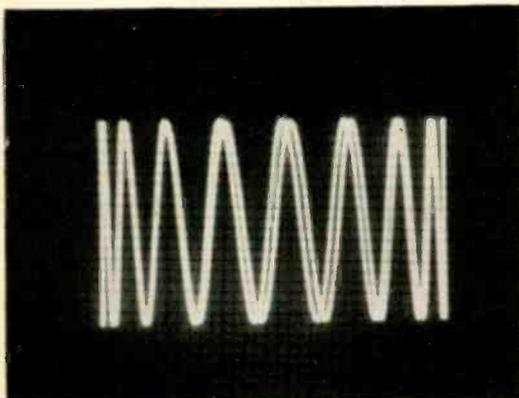


◀ Three basic types of displays:

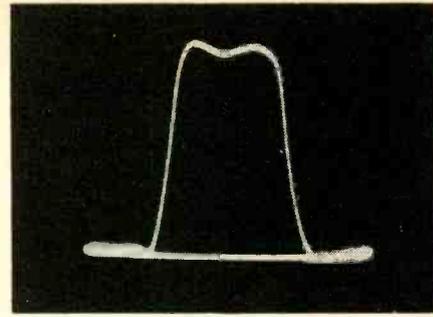
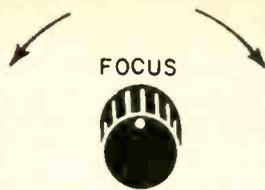
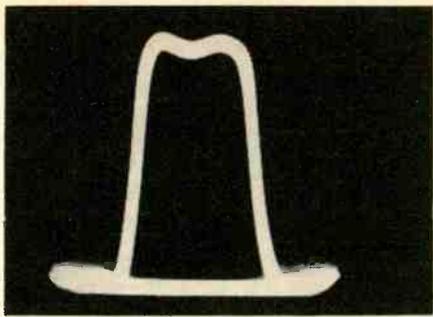
(Top) Complex wave displayed on linear time base (sawtooth deflection). (Middle) Frequency-response curve displayed on a sine-wave time base (60-Hz ac). (Bottom) Cyclogram displayed on signal time base (circuit voltage).



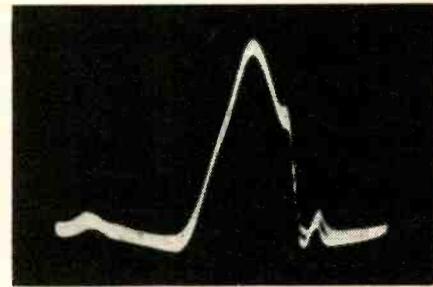
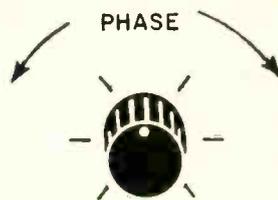
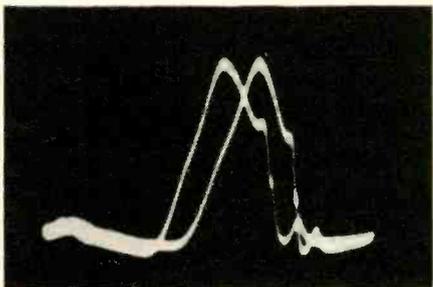
▲ A Lissajous pattern (one form of cyclogram) obtained by feeding one sine-wave voltage to the vertical input and another to the horizontal. ▼



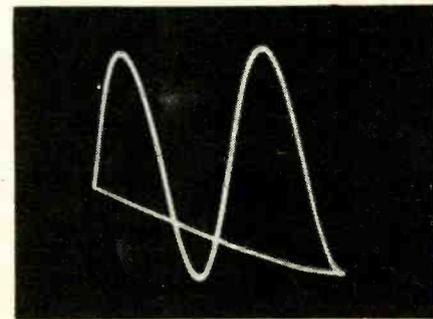
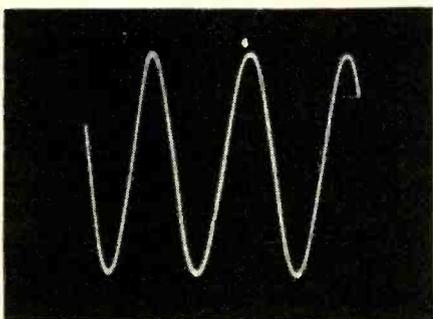
▲ The voltage (or potential) difference between deflection plates (shown as heavy black bars above) moves the electron beam (shown as black dot) across the face of the scope. These voltages are adjustable by means of the horizontal and vertical positioning (or centering) panel controls.



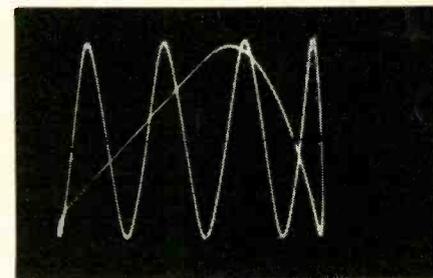
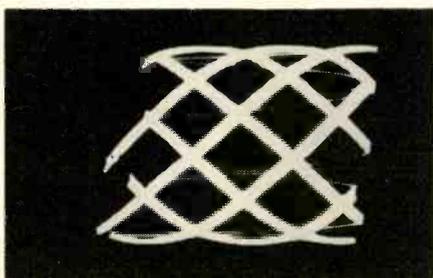
The focus control should always be set for the brightest, sharpest trace. It is most valuable when viewing complex waveforms. It interacts with astigmatism control a bit.



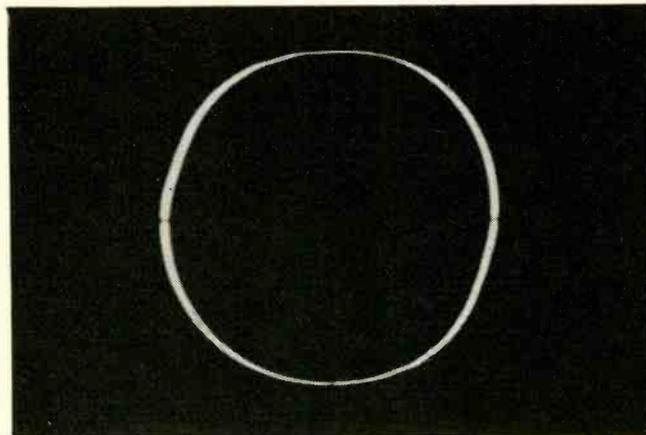
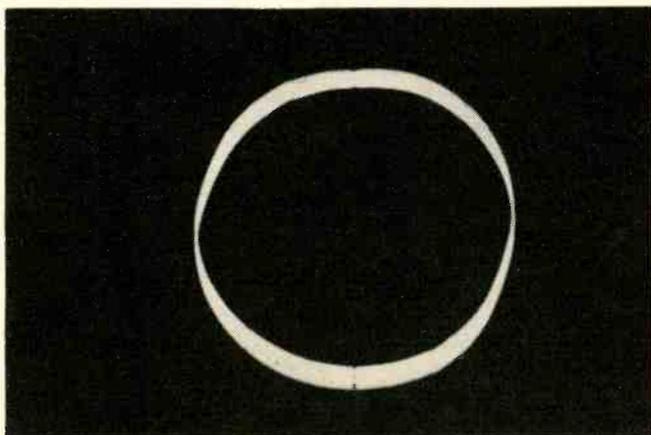
When operating with sine-wave deflection (either internal, ac, or external) you must adjust the phasing control to merge the trace and retrace (on some scopes).



Number of cycles displayed depends on the setting of sweep frequency and vernier controls, with vernier setting exact number.



Horizontal deflection oscillator must be locked with that of signal viewed. If not waveform may not stand still (left).



The astigmatism control also affects the sharpness of the trace. It is often an internal adjustment, and is set for best focus . . . reset focus control if necessary.

New Color TV Tuning Indicator

On-screen bars pinpoint tuning

By **ROBERT F. SCOTT**

VARIOUS FORMS OF TV TUNING INDICATORS have been proposed or developed to aid the TV viewer in setting the fine-tuning control for best reception. However, Westinghouse is perhaps the first manufacturer to provide an "On-Screen Tuning Bar" configuration (patent pending). A display of 2 bars on the picture-tube screen serves as an indicator to show the degree of mistuning and the direction the fine-tuning control must be turned to obtain best color or monochrome reception.

To check or adjust tuning, the viewer presses a TUNING BAR on the panel. If the set is mistuned, two vertical black bars appear on the picture as shown in the photo. One bar is fixed and serves as a reference; the other appears on either side of the reference bar, in accordance with the setting of the fine-tuning control.

The "direction" of mistuning is indicated by the displacement of the movable bar (left or right) from the reference bar. The degree of mistuning can be predicted by the size of the space between the bars. The wider the space the greater the mistuning. The

bars coincide with each other when the tuning is correct.

Except for the video gate circuit all of the circuits represented by the block diagram (Fig. 1) are combined on one small printed circuit board which is attached to the main color TV chassis. A push-on/off type TUNING

BAR switch (Fig. 2) is located on the control panel to activate or deactivate the multivibrator circuits to turn the lines on and off, respectively.

However, the control signal portions of the circuitry are continuously activated. If the transistors in the control circuits were turned off there

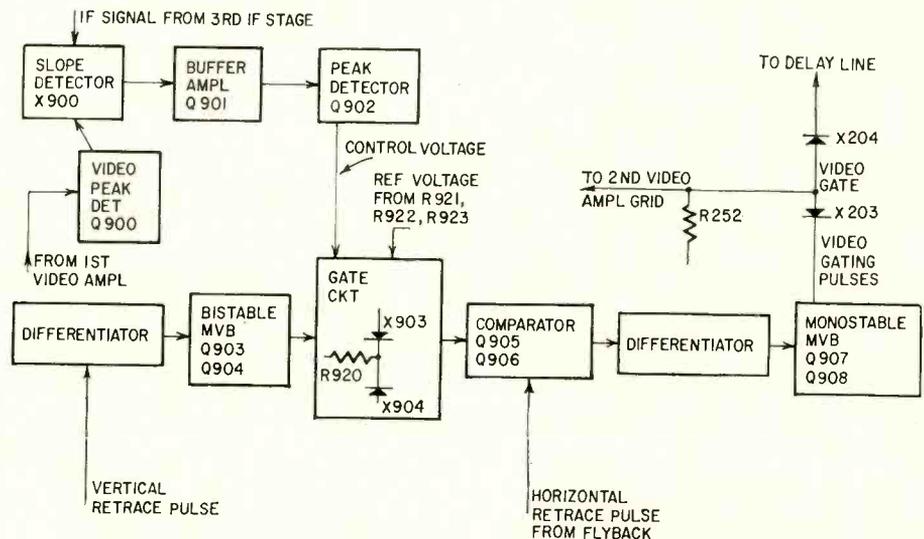
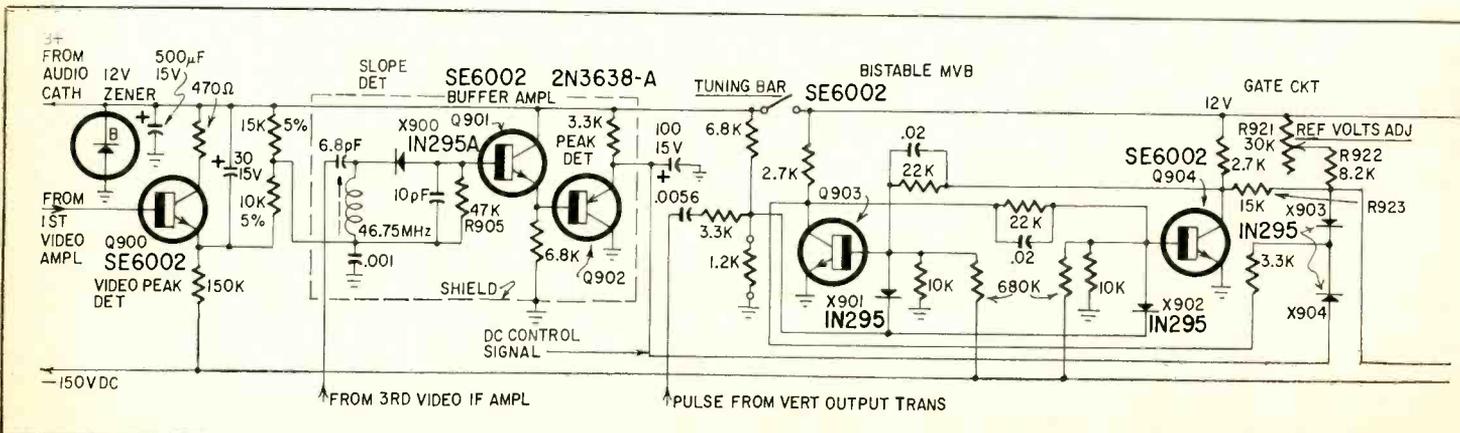
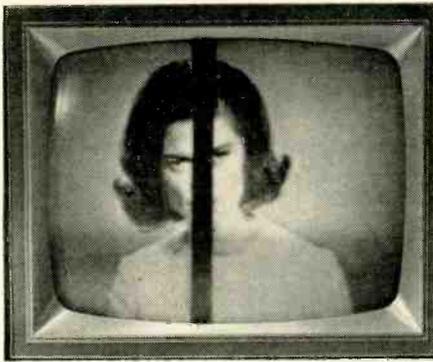


Fig. 1—Block diagram of circuits used to produce the "On-Screen Tuning Bars"—a feature in Westinghouse 1968 color TV sets. Control circuitry is on a small PC board.

Fig. 2—Tuning-bar circuit. Two bars are produced on the CRT screen by blanking pulses generated in the monostable multivibrator. Comparator supplies the tuning-bar trigger pulses.

One set of pulses is controlled by a fixed voltage; the other by a voltage that varies with fine-tuning adjustment. Circuits left of the comparator generate and gate the control voltages.





How tuning bars look on the screen. The single bar indicates optimum tuning. In right-hand photo movable bar is on the right. Fine-tuner should be rotated counterclockwise.

would be a detrimental loading on the video circuits and also a possibility of harmonic generation (tweet) in the slope detector portion.

How it works

Both lines are generated in a time-sharing system in which the reference line is generated during one picture field and the other line is generated during the next field. The required signals needed to generate the lines are a series of narrow video gating pulses of about 1 or 2 microseconds duration and are synchronized at the horizontal scan rate. Figure 3 shows the video gating pulses in time reference to the horizontal retrace pulses.

You can follow the block diagram or the schematic or both (whichever is easier for you) to get a better idea of what's taking place. Video gating pulses are generated in the monostable multivibrator Q907 and Q908. Transistor Q908 is normally in the "off" state and Q907 is normally in the "on" state. These transistors change state when a negative trigger pulse is received from the comparator. This pulse is sharpened by a differentiator network to make the triggering action more reliable.

The comparator Q905 and Q906 is also a monostable multivibrator. It

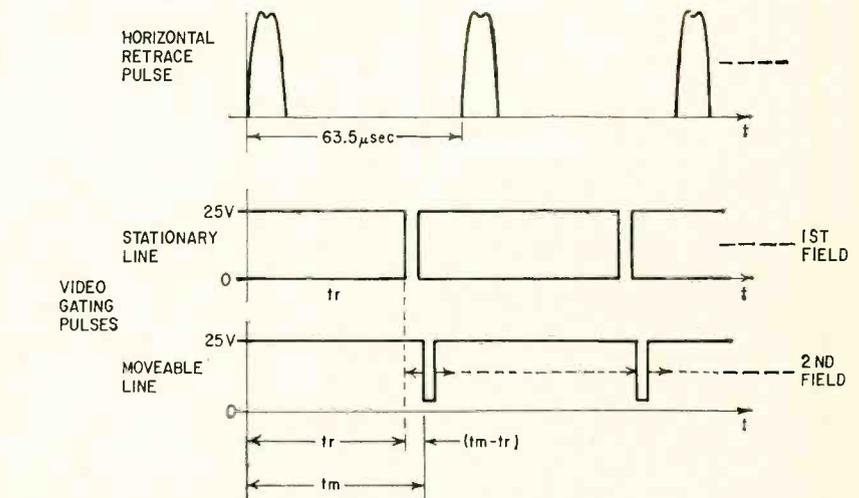


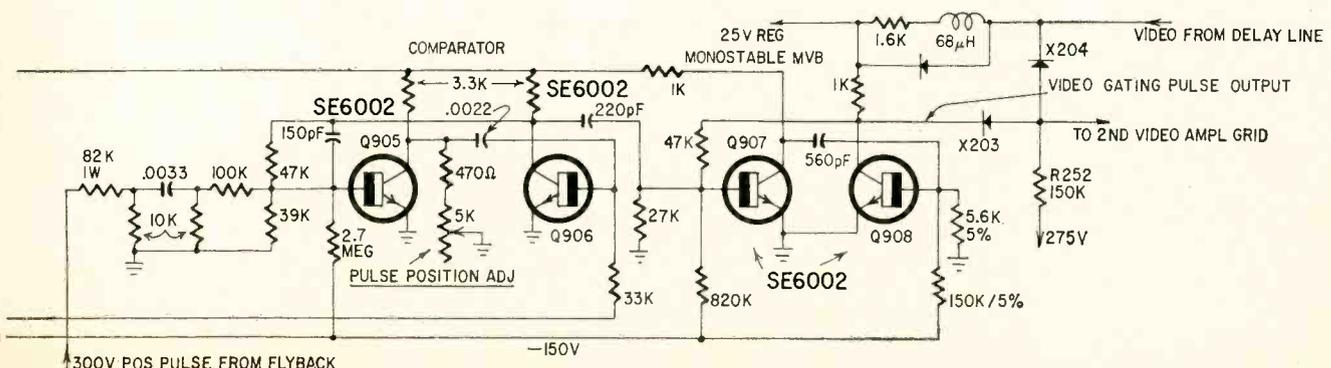
Fig. 3—Video gating pulses are referenced to the horizontal-retrace pulse to determine their relative screen positions. Interval $t_m - t_r$ is zero for correct tuning.

supplies two sets of trigger pulses: one set, derived from a fixed reference voltage for the stationary reference bar, and the other set from a variable voltage source which serves as a control voltage for the movable tuning bar. This control voltage varies as the fine-tuning control is adjusted. Both the trigger and the timing pulses are "locked in" with the horizontal retrace pulse.

Control voltage for the movable bar is derived from the position of the video i.f. signal on the slope of the

slope detector. A part of the i.f. signal is tapped off the i.f. output stage and fed to the slope detector. The video signal rides up and down the slope of the detector response curve (the detector is peaked at about 46.75 MHz) as the tuning control is varied. (Video i.f. carrier is 45.75 MHz.) The detected video signal (negative-going) varies from about 0.5 to 4 volts p-p as the fine tuner is varied from either side of the correct tuning point. The signal

(continued on page 91)



HOW TO SERVICE

Simple procedures you can follow to "tune up" and repair telephone and other type relays

By LEO G. SANDS

MILLIONS OF RELAYS ARE IN USE IN SUCH widely different places as telephone systems, pinball machines, control systems and radio equipment.

A basic relay is actuated by an electromagnet, which pulls in a movable armature. The armature "swings" one or more sets of electrical contacts to switch one or more circuits or devices. Some very simple contact arrangements are shown in Fig. 1. The voltage at which the armature pulls in is the "pull-in" voltage. At a somewhat lower voltage the armature opens or drops out. This is the "drop-out" voltage.

Relays usually suffer from one or more typical types of trouble. They can fail to pull in, they can hang on after the voltage has dropped below drop-out and they can fail to make proper contact.

Failure to pull in can be due to inadequate applied voltage, to dirt, to worn or broken parts and to improper adjustment.

If the armature does not drop out "cleanly" look for voltage that does not drop enough to reach the rated drop-out voltage, sticky contacts, improper adjustment and worn parts.

If the relay does not make proper contact, look for dirty, worn, pitted or burned contact surfaces and improper adjustments. In circuits carrying very little current the contacts are especially likely to become oxidized. Contacts that are seldom used are also more likely to become oxidized.

Use a relay contact burnishing tool to clean dirty or oxidized contacts. A file or sandpaper will remove some of the protective plating material and subject the contact to more rapid deterioration. Carbon tetrachloride should not be

used as a cleaning agent. It leaves a film which can adversely affect and in some instances prevent electrical contact. Besides, the fumes can be harmful.

Cleaning

To use the burnishing tool, insert it between the contacts, gently support the armature or contact springs by hand to apply a slight amount of pressure and "wipe" the contacts with the tool. Do not apply enough pressure to distort the springs or contact assembly.

Armature adjustment

Relays do lose spring tension after long periods of use. However, do not be too hasty, do not adjust the armature until you are certain that there is nothing else wrong with the relay or its working voltages.

Don't let the complex appearance of some relays discourage you from working on them. Just don't rough handle them. Consider the telephone relay shown (partially) in Fig. 2.

The first step is to check the residual air gap; the gap between armature and core when the relay is energized. If the armature and core (both of magnetic metal) touch they are likely to stick together, therefore a slight air space is normally maintained between them. This air space is determined by the setting of the residual adjust screw on the relay.

The residual adjustment can be used to make the relay drop out at a higher or lower voltage. The wider the gap, the higher the voltage at which the relay will drop out. Use a set of relay contact thickness gauges. In manufacturers' specifications for relays, most residual adjustments in this type of relay call for .001 to .004 inch; most common is .0015 inch.

Note well that the residual screw must be against the core while measuring the residual air gap. Don't let the gauge get under the screw.

The magnetic circuit through the armature is completed by the *heel piece*. Therefore the gap between armature and heel piece must also be adjusted. This, known as the *airline gap*, should be set between .001 and .008 inch, usually around .004. In checking the airline gap, watch that the gauge is not inserted far enough to come between the armature and core. See Fig. 3. To adjust the airline gap loosen the yoke-adjusting screw a little and gently tap the armature to fit snugly up to the gauge. See that the gap

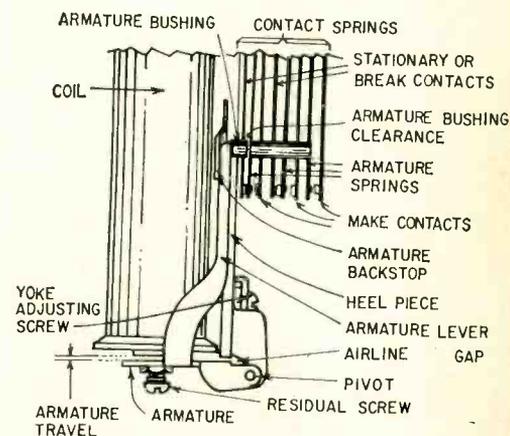


Fig. 2—Typical telephone-type relay.

is even all the way across the length of the gap before tightening the yoke-adjusting screw.

Contact adjustments

Before adjusting the contact assembly be sure that all springs are straight, aligned and properly tensioned. If springs are bent, straighten them with a relay spring-adjusting tool. Be careful not to make any sharp bends or kinks.

I wish to acknowledge special indebtedness to Mr. P. K. Neuses, pioneer in relay adjustment education and the development of relay adjusting tools, from whose little book I obtained most of the information in this article.

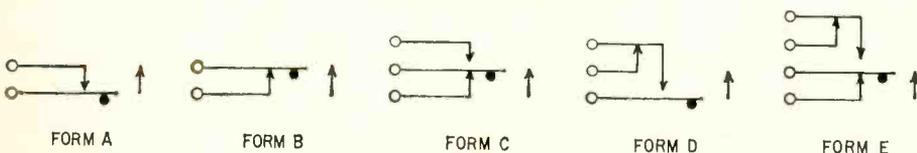


Fig. 1—Basic contact assemblies: Form A, normally open, or make; Form B, normally closed, or break; Form C, double throw, or break and make; Form D, make-before-break; Form E, break and make-before-break. Sections can be stacked to suit jobs.

AND ADJUST RELAYS

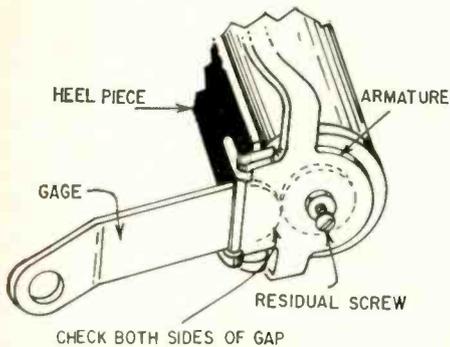


Fig. 3—Airline gap between armature and heel piece should be even and in accordance with manufacturer's specifications.

Tilted bushings due to bent springs can be straightened with a spring-straightening tool, as shown in Fig. 4. Misaligned contacts can be a more serious problem. Sometimes the assembly contact screws can be loosened and the springs shifted slightly to line up the contacts.

If it is suspected that the spring tension is not right, it is important to tension the spring before doing any further adjusting. Use a gram gauge to measure the tension. Each spring should be adjusted to have a tension of 25 to 35 grams, at the point where the contacts just break. Other springs should be lifted off the one being measured.

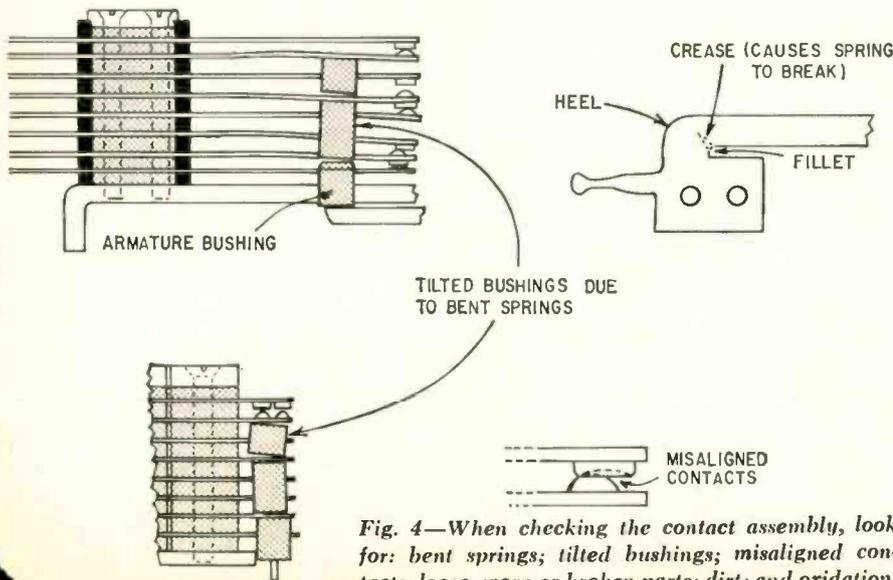


Fig. 4—When checking the contact assembly, look for: bent springs; tilted bushings; misaligned contacts; loose, worn or broken parts; dirt; and oxidation.

A spring-bending tool can be used to adjust spring tension. To increase the tension place the tool on the rear portion of the spring, tilt the tool judiciously toward the heel piece and draw slowly along the spring toward the armature bushing, leaving a slight bow (not more than $\frac{1}{32}$ inch) in the spring. Apply the spring bender again near the rear and bend until the bow is flattened. Check the spring tension. To reduce spring tension (very rarely necessary) bow the spring slightly in the opposite direction.

Now we come to the actual setting of the contact springs to the proper spacing. Note the specs in Fig. 5. With a .0015-inch feeler gauge between the core and residual screw, a normally closed contact should just break. With a gauge .001 inch thicker it should not break. Contacts that make when the relay is actuated should just make on the specified value and should not make with a .001-inch thicker gauge. The figure .0015 inch is general. If you have exact specifications from the manufacturer, use them for any given relay.

To set the armature lever arm when the first contact breaks in the actuating position, insert the correct feeler gauge between the residual screw and the core as before. With the armature in the en-

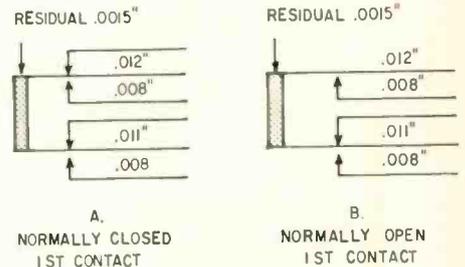


Fig. 5—Typical relay contact settings.

ergized position, bend the lever arm so the first contact just breaks. Now adjust the armature backstop so that there is .004- to .008-inch clearance between the armature bushing and the first spring when the lever arm is resting against the stop. If the first contact is make, bend the backstop, with the armature in the energized position, .0015" gauge between core and residual screw) to where it just touches the lever arm.

It's better not to try to move the armature by hand—energize the relay electrically for gauging contacts.

Now, having set the armature lever and backstop, you can start with the contacts. With the gauge again set between the core and the residual screw, energize the relay and note the first set of contacts. They should just break or make, as the case may be. If they don't, bend the spring slightly (Fig. 6) until they do. Having adjusted the contacts correctly, try a feeler gauge .001 inch thicker than the one specified for the relay. The contacts should not make or break—as the case may be—with the thicker gauge. (You may have to use a mirror to check the opening and closing of contacts in tight places.)

Remember that, in general, relays fail because of dirty or oxidized contacts. It is usually not necessary to gauge, adjust or bend springs. **R-E**

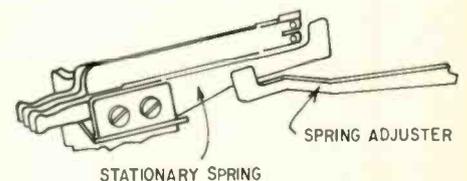
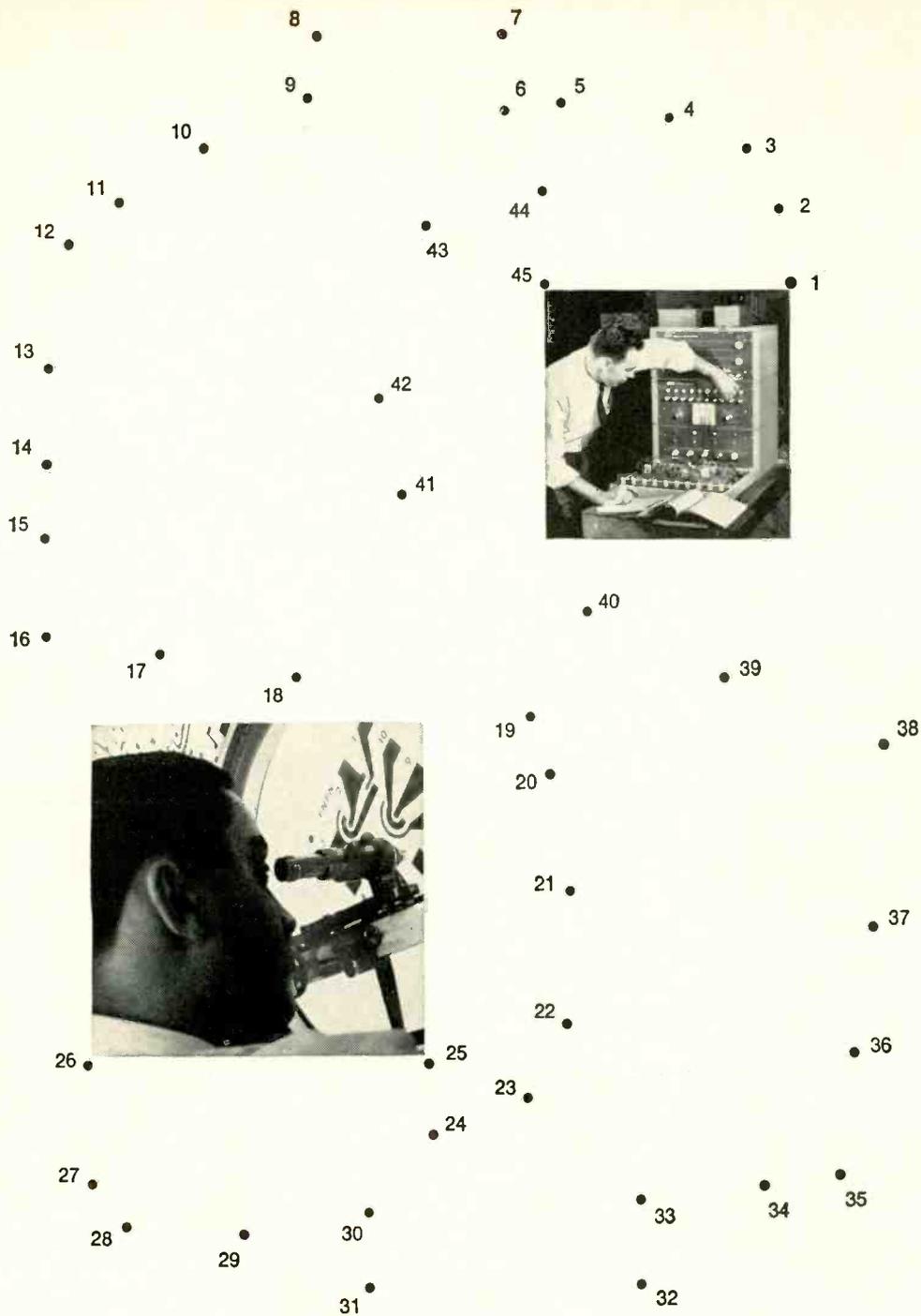


Fig. 6—Use a spring bender carefully to straighten springs and to adjust tension.



Connect the dots
and find out what RCA Institutes
Home Training in Electronics
can do for you!

Learn electronics at home faster, easier, almost automatically— with RCA AUTOTEXT

Are you just a beginner with an interest in the exciting field of electronics? Or, are you already earning a living in electronics and want to brush-up or expand your knowledge in a more rewarding field of electronics? In either case, AUTOTEXT, RCA Institutes' own method of Home Training will help you learn electronics more quickly and with less effort, even if you've had trouble with conventional learning methods in the past.

THOUSANDS OF WELL PAID JOBS ARE OPEN NOW TO MEN SKILLED IN ELECTRONICS!

Thousands of well paid jobs in electronics go unfilled every year because not enough men have taken the opportunity to train themselves for these openings. RCA Institutes has done something positive to help men with an aptitude and interest in electronics to qualify for these jobs.

HOME STUDY CAN TRAIN YOU FOR REWARDING CAREER OPPORTUNITIES

To help fill the "manpower gap" in the electronics field, RCA Institutes has developed a broad scope of Home Training courses, all designed to lead to a well paying career in electronics in the least possible time. You also have the opportunity to enroll in an RCA "Career Program" exclusively created to train you quickly for the job you want! Each "Career Program" starts with the amazing AUTOTEXT Programmed Instruction Method. And, all along the way, your program is supervised by RCA Institutes experts who become personally involved in your training and help you over any "rough spots" that may develop.

VARIETY OF KITS ARE YOURS TO KEEP

To give practical application to your studies, a variety of valuable RCA Institutes engineered kits are included in your program. Each kit is complete in itself, and yours to keep at no extra cost. You get the new Programmed Electronics Breadboard for limitless experiments, including building a work-

ing signal generator, multimeter, and a fully transistorized superheterodyne AM receiver.

ONLY FROM RCA INSTITUTES— TRANSISTORIZED TV KIT— VALUABLE OSCILLOSCOPE

All students receive a valuable oscilloscope. Those enrolled in the Television program receive the all-new transistorized TV Kit. Both at no extra cost and only from RCA Institutes.

CHOOSE THE "CAREER PROGRAM" THAT APPEALS MOST TO YOU

Start today on the electronics career of your choice. Pick the one that suits you best and mark it off on the attached card.

- Television Servicing
- Telecommunications
- FCC License Preparation
- Automation Electronics
- Automatic Controls
- Digital Techniques
- Industrial Electronics
- Nuclear Instrumentation
- Solid State Electronics
- Electronics Drafting

ADVANCED TRAINING

For those already working in electronics, RCA Institutes offers advanced courses. You can start on a higher level without wasting time on work you already know.

UNIQUE TUITION PLAN

With RCA Institutes Training, you progress at your own pace. You only pay for lessons as you order them. You don't sign a long-term contract. There's

no large down-payment to lose if you decide not to continue. You're never badgered for monthly payments. Even if you decide to interrupt your training at any time, you don't pay a single cent more.

CLASSROOM TRAINING ALSO AVAILABLE

If you prefer, you can attend classes at RCA Institutes Resident School, one of the largest of its kind in New York City. Coeducational classroom and laboratory training, day and evening sessions, start four times a year. Simply check "Classroom Training" on the attached card for full information.

JOB PLACEMENT SERVICE, TOO!

Companies like IBM, Bell Telephone Labs, GE, RCA, Xerox, Honeywell, Grumman, Westinghouse, and major Radio and TV Networks have regularly employed graduates through RCA Institutes' own placement service.

**SEND ATTACHED POSTAGE PAID
CARD TODAY. FREE DESCRIPTIVE
BOOK YOURS WITHOUT OBLIGATION.
NO SALESMAN WILL CALL.**

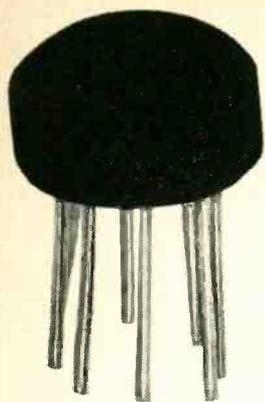
All RCA Institutes courses and programs are approved for veterans under the New G.I. Bill.

RCA INSTITUTES, INC. Dept. RE-13
320 West 31st Street
New York, N.Y. 10001

ACCREDITED MEMBER National Home Study Council



The Most Trusted Name In Electronics



30 BASIC IC PROJECTS

Part 2 of 2 parts to help you to work with IC components and their related circuits.

By R. M. MARSTON

IN PART I OF THIS SERIES (DECEMBER, 1967), you were introduced to Fairchild's μ L914 integrated circuit. Costing less than a dollar, it has many useful functions in many different applications.

As Fig. 1 shows, the μ L914 contains four silicon planar 2N708 transistors and six resistors, all encased in an epoxy block roughly the size of a TO-5 case. The transistors have an f_T of 450 MHz. Lead connections are shown in Fig. 2.

The secret to using an IC is to remember that it's merely a *package of gain*; all you have to do is juggle external components and connections to change circuit function. If you need only two transistors, for example, you short the two others base to emitter, and forget them. Simple, isn't it?

Now, let's check out some more applications.

Pulse inverter and gate circuits

The μ L914 can be used as a pulse inverter by cutting out (shorting base to emitter) all transistors except one, and then connecting the input to the base of the remaining transistor and taking the output from its collector. In the absence of a pulse (input grounded) the transistor is cut off and its collector output is fully positive. When a

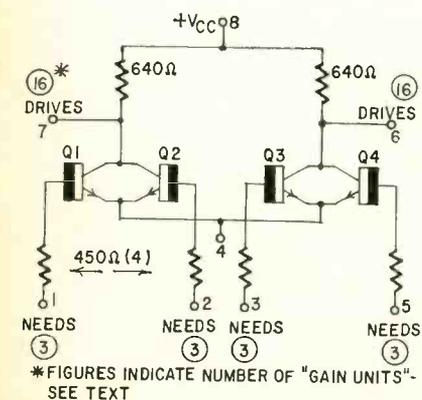


Fig. 1—Internal circuit of μ L914.

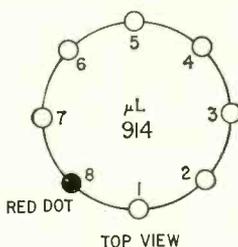


Fig. 2—Base lead connections of μ L914.

positive pulse input is applied, the transistor saturates and its collector is grounded.

Fig. 3 shows how to connect the IC as a pulse inverter, using only Q1, and Fig. 4 an alternative connection using Q4. Fig. 5 shows the connections for a dual pulse inverter, using both Q1 and Q4.

Incidentally, the 450-ohm resistors between the base junctions of the IC and the external connecting leads prevent excessive base currents when

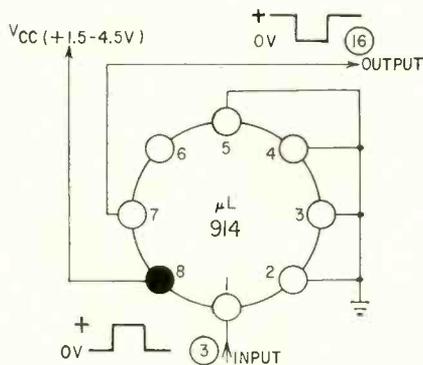


Fig. 3—Pulse inverter using only Q1.

the base leads are shorted to the positive supply line. This feature makes the IC almost indestructible, provided you don't use a supply potential greater than about 6 volts.

Fig. 6 shows how to connect the μ L914 as a pulse-disabling gate. Here, Q3 and Q4 are cut out of the circuit, and the output is taken from pin 7. When a pulse train is applied to pin 1 and pin 2 is grounded, an inverted pulse output is available via Q1, just as

in Fig. 3. If pin 2 is made positive by a gate signal, Q2 will saturate and pull the output down to ground, so no output will be available from the pin 1 input; the circuit is disabled.

Fig. 7 shows how to connect the IC as a dual pulse-disabling gate, using all four transistors.

The output of Fig. 6 is inverted relative to the signal input at pin 1. If you want a noninverted output, use the connections shown in Fig. 8.

An alternative type of gate circuit is the pulse-enabling gate of Fig. 9. Here, with an input signal applied to pin 1, there is no output if pin 3 is held at ground potential. If a positive gate

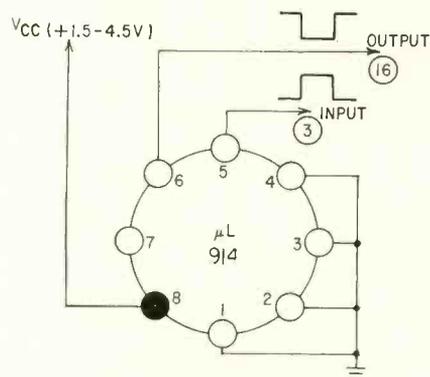


Fig. 4—Pulse inverter using only Q4.

signal is applied to pin 3, the pin 1 signal is made available at the output. The positive gate signal "enables" the gate to open.

The output of Fig. 9 is inverted. It can be made noninverted by wiring a circuit of the type shown in Fig. 3 between the input signal and pin 1.

Linear inverter and gate circuits

The circuits in Figs. 3 to 9 are suitable for use with pulse inputs only—the transistors are used purely as switches. These circuits are, nonetheless, useful to the hobbyist in test-gear circuits, tone generators and musical instruments.

See also p 6 + 12

The usefulness of some of these circuits can be increased by biasing the transistors so that they operate in the linear mode. They then pass sine-wave and other signals with negligible distortion.

Fig. 10 shows how to connect the μ L914 as a linear inverter, giving near unity voltage gain between input and output. This diagram, like Fig. 3, shows just one of four alternative ways in which the inverter can be connected. If you want exactly unity voltage gain from this circuit, replace R3 with a 270-ohm resistor and 250-ohm potentiometer in series, and adjust for correct output amplitude.

Fig. 11 shows how to wire the circuit as a linear disabling gate. For a linear enabling gate connect a Fig.-3 type inverter between the gate-pulse input and R4.

Figs. 10 and 11 have useful applications in audio and sound distribution systems, and in oscilloscope trace doublers and various kinds of frequency-measuring gear.

Logic circuits

The μ L914 can perform all the basic functions used in computer logic. Before looking at the different IC connections, let's make sure we know what the basic logic terms mean.

In logic work, inputs and outputs are either fully on (positive) or off (zero or grounded). The state of the output depends on the way the different inputs are connected. If a two-input circuit (with inputs A and B) operates so that an output becomes available when either A or B is connected, we call that an OR logic circuit. If the output appears only when both A and B are connected, we call it an AND logic circuit.

If the gate's inputs and output are in the same state (both positive or both zero) the gate is simply called an AND or an OR logic circuit. If, on the other hand, the input and output state is opposite (input zero and output positive, or input positive and output zero) the name of the gate takes on an "N" prefix and is called a NAND or a NOR logic circuit.

Because each of these four circuits has two variations (an AND circuit, for example, can give a positive output when both inputs are positive, or it can give zero output when both inputs are zero) there are eight variations of logic operation or mode.

Another complication is that each practical circuit can be known by either of two names. If, for example, our AND circuit gives a positive output only when A and B are positive, it follows that the output will be zero when A or B is zero, so the circuit can

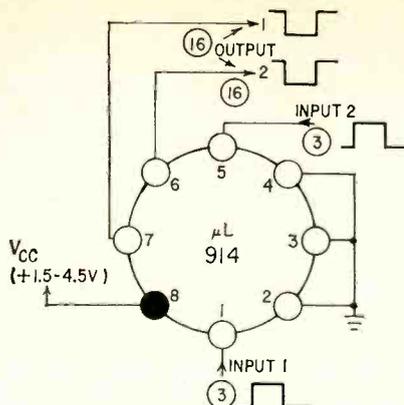


Fig. 5—Dual inverter using Q1 and Q4.

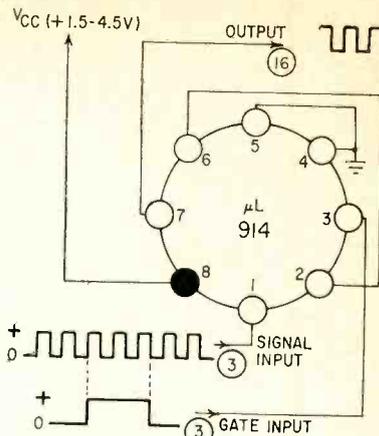


Fig. 9—Pulse-enabling gate (inverting).

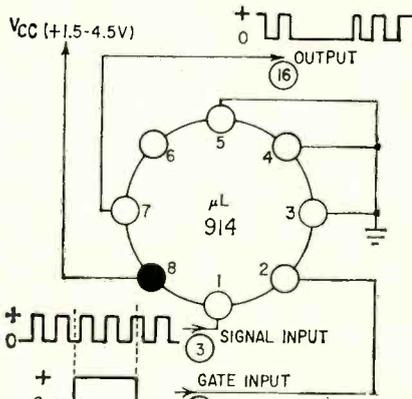


Fig. 6—Pulse-disabling gate (inverting).

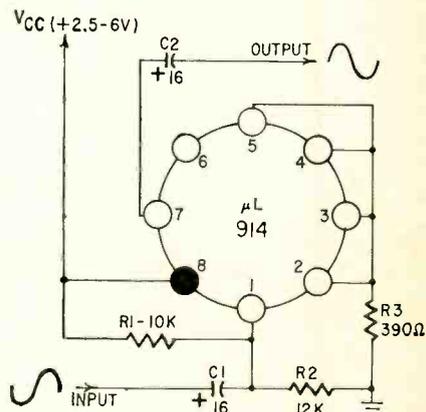


Fig. 10—Linear inverter.

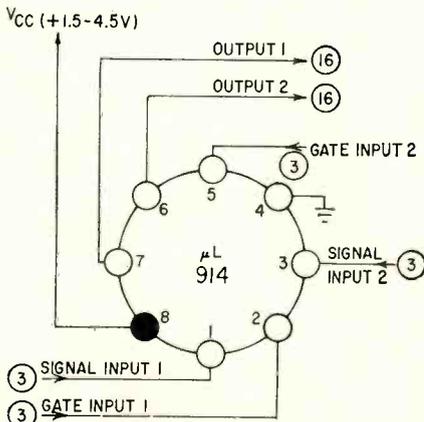


Fig. 7—Dual pulse-disabling gate (inverting).

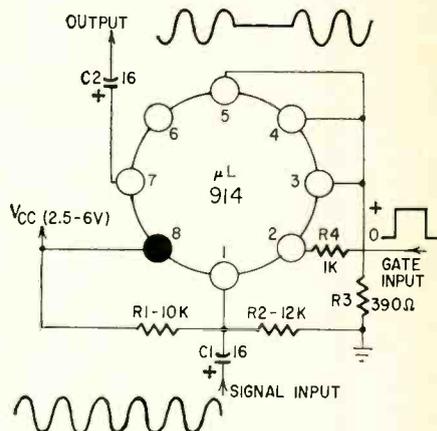


Fig. 11—Linear disabling gate.

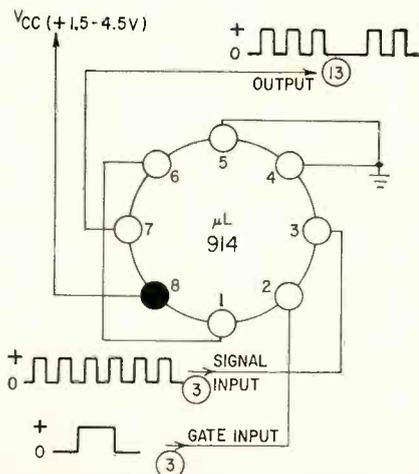


Fig. 8—Pulse-disabling gate (noninverting).

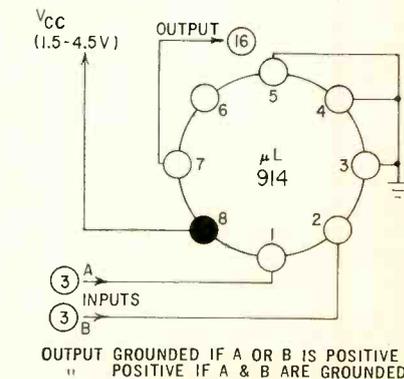


Fig. 12—NOR/NAND logic circuit.

also be used to perform OR logic functions.

This situation can be clarified by looking at Figs. 12 through 15, which show the four circuits that can be used to perform the eight basic logic functions.

Fig. 12 shows a NOR/NAND circuit. Its output is zero if A or B are positive, so NOR logic is performed. The output is positive only if A and B are zero, so NAND logic is also performed.

Fig. 13 performs OR/AND logic, while Figs. 14 and 15 perform AND/OR and NAND/NOR logic, respectively. Both Figs. 14 and 15 require the use of two $\mu\text{L}914$ IC's.

Multivibrators and trigger circuits

By using only one transistor from each side of the IC and using cross-coupling between these two stages, the $\mu\text{L}914$ can be made to perform as any one of the three basic multivibrator types. It can work as a free-running or astable multivibrator, as a monostable multivibrator or triggered pulse generator, or as a bistable multivibrator or memory unit.

Fig. 16 shows how to connect the $\mu\text{L}914$ as a 1-kHz astable multivibrator or waveform generator. Capacitors C1 and C2 are the cross-couplers, and R1 and R2 are the capacitor-discharge resistors. The operating frequency of the multivibrator can be increased by reducing the values of C1 and C2, or reduced by increasing their values.

If the values are reduced by a factor of 10 (to 0.01 μF), the frequency will increase by a factor of 10 (to 10 kHz). The output waveform which can be taken from pins 6 or 7 is approximately rectangular, but has a slightly rounded leading edge.

This rounding of the leading edge, which occurs with all astable multivibrators, is caused by the fact that, at the moment the circuit switches between one state and the other, the collector of the *off* transistor is pulled down toward the base of the *on* transistor via the cross-coupling capacitor.

This rounding can be eliminated by disconnecting the output from the capacitor at the moment that the circuit changes state. You can do this by using the circuit connections shown in Fig. 17.

The circuit of Fig. 17 generates a near-perfect square wave, with no rounding of the leading edge. Using the component values shown, the circuit operates at a frequency of about 1 kHz. The frequency can be altered by changing the values of C1 and C2.

Fig. 18 shows how to connect the $\mu\text{L}914$ as a bistable multivibrator or

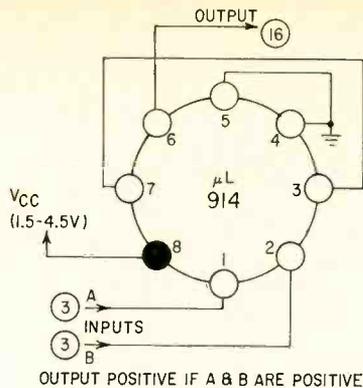


Fig. 13—OR/AND logic circuit.

memory unit. If a positive pulse is applied to pin 2, the output at pin 6 will go positive and at pin 7 it will go to zero. Furthermore, the outputs will remain in this state until a positive reset pulse is applied to pin 3. At this point pin 6 will go to zero and pin 7 will go positive, the circuit remaining in this state until another positive pulse is applied to pin 2.

Fig. 19 shows a monostable multivibrator or triggered pulse generator. The output is normally near ground potential. When a positive pulse is applied to the input, however, the output goes positive and remains in that state for approximately 5 seconds. After that the output automatically returns to zero. The length of the output pulse

is controlled by C1, and can be varied from a few microseconds to several seconds by selection of this component.

The monostable multivibrator of Fig. 19 can be used as a noiseless pushbutton by adding R3 and S1 (shown in dashed lines). A normal pushbutton, of course, generates a good deal of noise due to contact bounce, which may be harmful in some applications.

The $\mu\text{L}914$ can also function as a voltage level or Schmitt trigger. Fig. 20 shows the connections for a direct voltage trigger. Its output goes positive when the input rises to approximately 1.5 volts, and drops to ground again when the input falls to about 1.25. The precise trigger points vary with supply-line potential, and the values quoted apply to a 3.5-volt supply.

The Schmitt trigger can be used as a sensitive sine-square converter by using the connections of Fig. 21. This circuit gives an output of approximately square waveform when a sine wave of amplitude greater than about 150 mV is applied to the input.

Both circuits shown in Figs. 20 and 21 can be operated at frequencies up to several hundred kilohertz. At frequencies above a few tens of kilohertz, the output waveform can be improved by connecting a small capacitor (shown in dashed lines) across R3. The value of this capacitor should be found by trial and error to give the

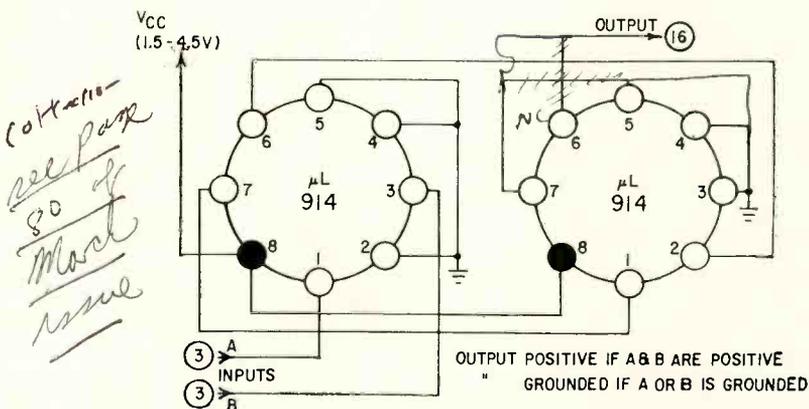


Fig. 14—AND/OR logic circuit.

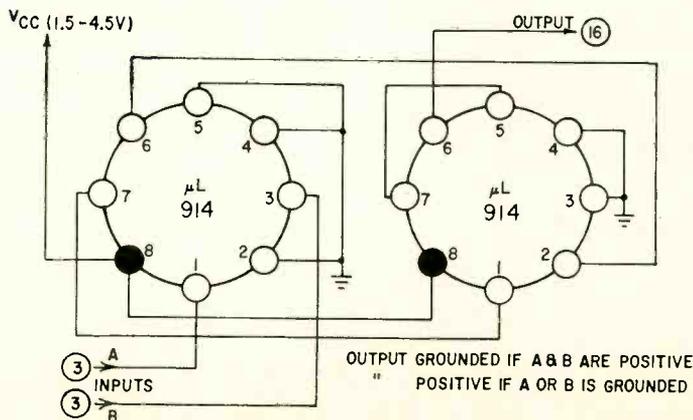


Fig. 15—NAND/NOR logic circuit.

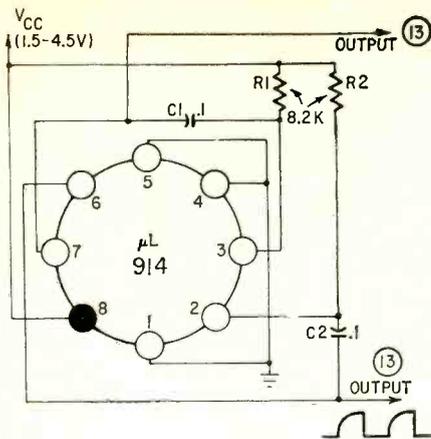


Fig. 16—1-kHz astable multivibrator.

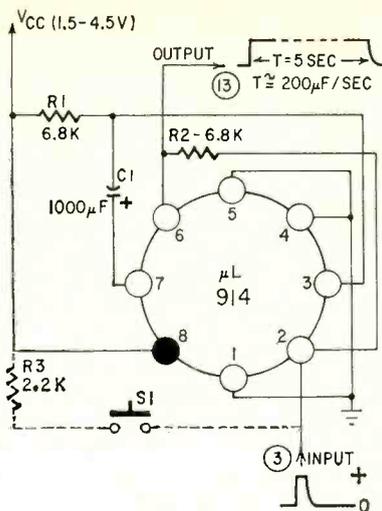


Fig. 19—Monostable multivibrator.

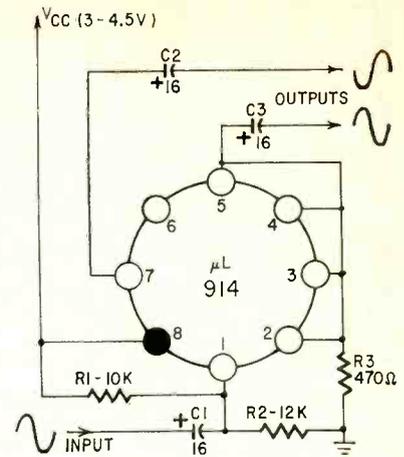
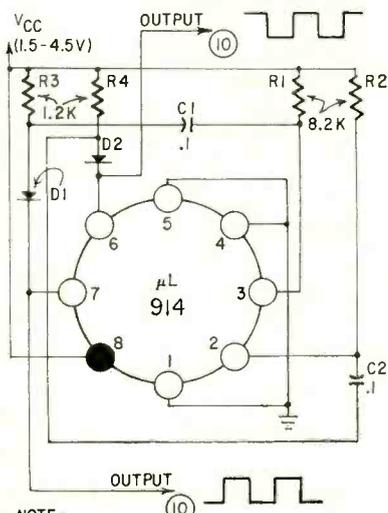


Fig. 22—Phase splitter.



NOTE -
D1, D2 = ANY GERMANIUM DIODE

Fig. 17—1-kHz square-wave generator.

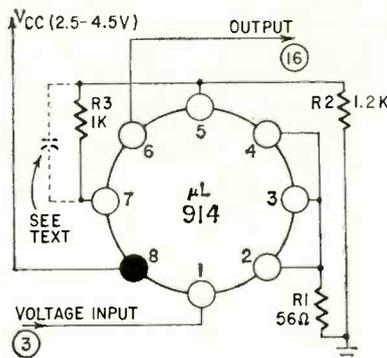


Fig. 20—Schmitt trigger.

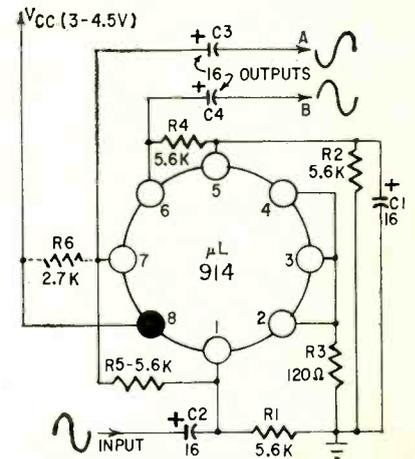


Fig. 23—Balanced (differential) phase splitter.

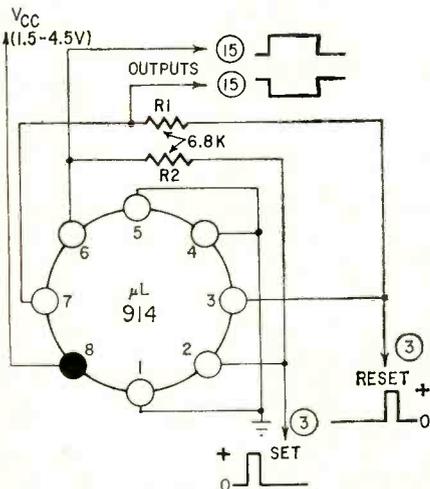


Fig. 18—Bistable multivibrator.

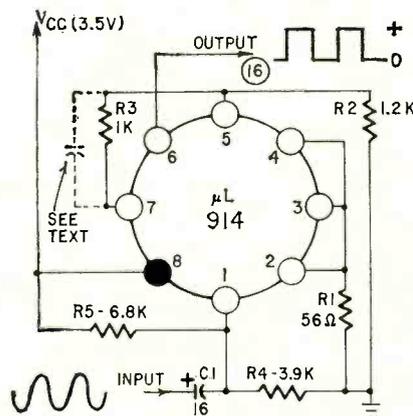


Fig. 21—Sine-square converter.

best output wave shape. Generally you will require a value around 100 pF.

Linear phase splitters

We've already seen that the μ L914 can be used as a linear amplifier by applying suitable bias networks to the transistors in the IC. This feature makes the μ L914 suitable for

many applications in amplifier and oscillator circuits.

Fig. 22 shows how to wire the IC as a simple phase splitter, giving near unity voltage gain. Only one of the internal transistors is used; it is wired as a common-emitter amplifier with emitter degeneration provided by R3. The two output signals of the unit are roughly equal in amplitude and oppo-

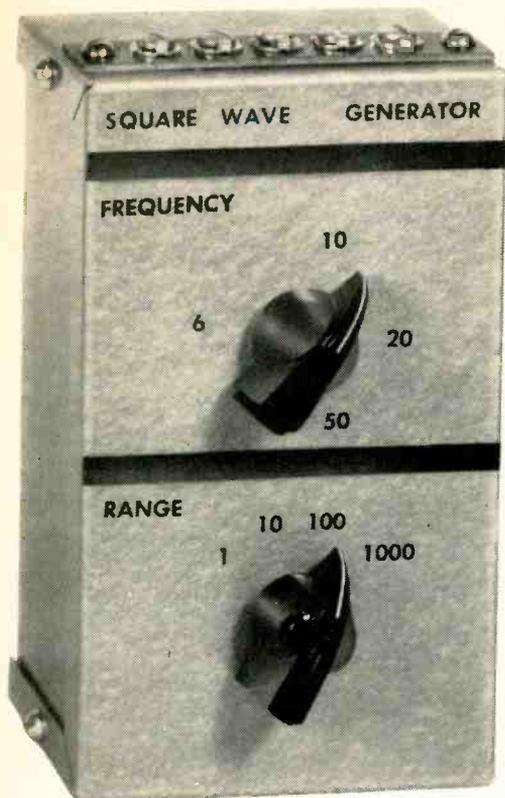
site in phase, but different in impedance.

If the two outputs must be exactly equal in amplitude, R3 should be replaced by a 390-ohm resistor and a 250-ohm preset potentiometer in series, the control then being adjusted for an exact output balance. Peak-to-peak input signals of about 1 volt can be handled by this circuit when a 3-volt supply is used.

Fig. 23 shows the connections for a balanced or differential phase splitter, using two of the transistors in the μ L914. This circuit gives a voltage gain of about 8. The two output signals have equal impedances, but there is approximately 10% to 15% difference in their amplitudes. If identical output amplitudes are needed, R6 (shown in dashed lines) should be connected as indicated. In this case, however, there will be about 15% difference between the output impedances of the two signals.

We've looked at 31 applications (no charge for extra one)—all using a single low-cost IC. Dozens more exist for this same unit, the final number being limited only by your imagination.

R-E



BUILD

LOW-COST IC SIGNAL GENERATOR

Using a minimum of components, this signal source provides square waves from 5 Hz to 50 kHz for tests

By JACK ALTHOUSE

INTEGRATED CIRCUITS, IC'S FOR SHORT, are revolutionizing the electronics industry. They've taken over the computer field and are moving into industrial and consumer products faster than anyone dreamed possible. If you are interested in electronics you should be using IC's now.

As an example of the ease with which IC's can be used, this wide-range signal generator is built around one 80-cent component. The generator puts out square waves from 5 Hz to 50 kHz and runs from a single 3-volt battery. It's useful for measuring gain and frequency response of audio and ultrasonic equipment, as an interpolation oscillator for checking frequency, and in a host of other lab and workshop applications.

The active component is Fairchild's μ L914 . . . a plastic-encapsulated IC in a TO-5 transistor-size case. Inside the case (Fig. 1) you will find (with a microscope) 4 transistors and 6 resistors. The transistors are designed to operate as switches; cutoff or fully-on.

How It Works

Consider pair Q1 and Q2. They form an OR gate. If leads 1 and 2 are left open or are grounded, neither Q1 nor Q2 will draw any current. Thus the voltage at the output lead 7 will be the same as the supply: 3 volts.

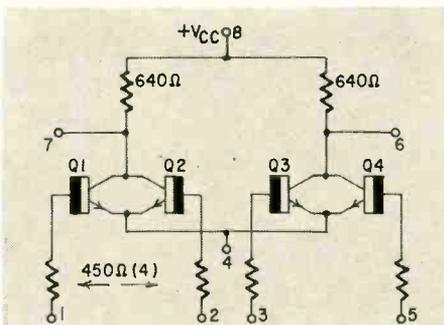


Fig. 1—The μ L914 integrated circuit has 4 transistors, 6 resistors and 8 leads.

If lead 1 is connected to 3 volts, Q1 will saturate and the voltage at lead 7 will drop to 0.2. Similarly, if lead 2 is connected to the 3 volts, Q2 will saturate and voltage at lead 7 will drop to 0.2. Furthermore, if both leads 1 and 2 are connected to 3 volts, lead 7 still will

have 0.2 volt on it. In one sentence: "If lead 1 or lead 2 or both are connected to 3 volts, the voltage at lead 7 drops."

Transistors Q3 and Q4 form another OR gate with inputs at 3 and 5 and output at lead 6, which operates identically to the first.

The circuit of Fig. 1 is useful to explain how the IC works but cumbersome to use in ordinary circuit schematics. So it's customary to use the simplified triangular block symbols shown in Fig. 2. Here, the two OR gates of the IC are shown as triangles with their input and output leads numbered.

Fig. 2 is a complete schematic of the IC square-wave generator. Note that leads 2 and 3 of the IC are not used.

At any given time one IC gate is on, the other off. Operation is as follows, beginning from the instant power is applied.

1. IC1-a comes on. Its output (lead 7) drops from 3 volts to 0.2.
2. This negative-going pulse couples through C1 to the input (lead 5) of IC1-b and turns it off.
3. After a definite length of time, C1 discharges enough through R1 and R2 to let IC1-b turn on.
4. The resulting negative pulse at lead 6

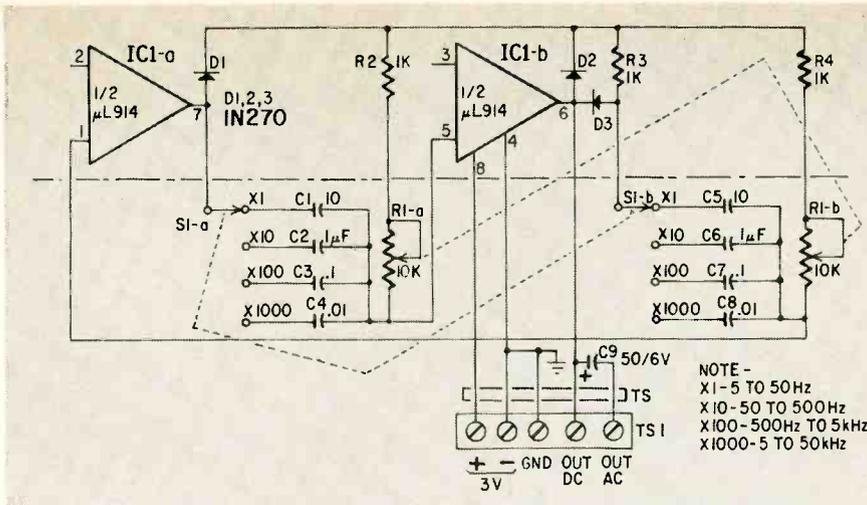


Fig. 2—A single 3-volt battery is all the power supply needed for the generator.

Parts List

- C1, C5—10- μ F, 6-volt electrolytic capacitor (Sprague TE-1087 or similar)
- C2, C6—1- μ F, 200-volt metallized paper capacitor
- C3, C7—0.1- μ F, 200-volt Mylar capacitor
- C4, C8—0.01- μ F, 200-volt Mylar capacitor
- C9—50- μ F, 6-volt miniature electrolytic capacitor
- D1, D2, D3—1N270 germanium diode
- R1—Dual potentiometer, 10,000 ohms each section, linear taper

- R2, R3, R4—1000-ohm, 10%, 1/2-watt, carbon resistor
- S1—3-circuit, 4-position, nonshorting switch. Only 2 circuits are used (Mallory 3234J or similar)
- TS1—Terminal strip
- IC1— μ L914 dual 2-input gate (Fairchild)
- MISC—Aluminum box (LMB TF-780 or similar); perforated board (Vector 85G24EP or similar); terminals (Vector T-28 or similar).

is coupled through C5 to lead 1 and turns IC1-a off.

This entire action keeps on going to produce continuous square waves as long as 3-volt power is applied. Frequency is controlled by the size of the capacitors

strip, so the strip can lie flush across the end of the box.

Next, cut a piece of perforated board 2 1/2 x 1 3/4 inches and mount it on standoffs inside the box, at the other end. Two screws are adequate to hold it in place in the box.

Capacitors C1 through C8 are wired directly from S1 to R1, supported by their own leads. On each section of dual potentiometer R1, two terminals are jumpered together; these are the center arm and the terminal that the wiper moves to when the front panel knob is turned fully counterclockwise. Similarly, C1 and C5 connect to the switch terminals that are contacted when the switch knob is fully counterclockwise.

After the capacitors are wired, remove the perforated board from the box.

It is more easily wired as a separate sub-assembly. It holds the three diodes, three resistors, and the IC.

The leads of the IC should be bent outward like the spokes of a wheel (Fig. 3). It is best to hold the leads with long-nose pliers when bending them, so the bend starts about 1/16 inch below the plastic case.

A bottom view of the IC is also shown in Fig. 3. Looking at this end, the leads are numbered clockwise and a flat on the plastic case shows the location of lead 8. Many of these IC's were made without the flat. If yours is one of these, lead 8 is indicated by a dot or strip of brown paint on the side of the case.

Place the IC on the perforated board and mark the locations of the six terminals needed to wire it in to the circuit. Leads 2 and 3 are not used. The IC will be supported by its leads after they are soldered to the terminals. If the leads are left straight and held to the terminals only by solder, it is easy to remove the IC at any time.

Next, mount the other components on the board and complete its wiring. Nine wires come off the board to other parts of the circuit. Be sure they are long enough, and tag them.

Mount the completed board in the box, making certain that none of its leads short to the box. The wiring can now be completed. Capacitor C9 is connected between two pins of the terminal board and is supported by its own leads.

After carefully checking the wiring, connect a 3-volt battery or power supply. Current drain will be about 10 mA. A square wave of about 2.5 volts peak to peak should appear between ground and the dc-coupled output terminal and between ground and the ac-coupled output terminal.

Use the ac-coupled output for calibration. The frequency range depends on the tolerance of the capacitors and resistors but should be close to that shown

(continued on page 62)

Table I—Frequencies of Some Piano Keys

Key	Frequency (Hz)
A above middle C	440
A below middle C	220
2nd A below middle C	110
3rd A below middle C	55

selected by S1 and by the resistance setting of the two ganged pots R1.

The 3 volts needed at the junction of R2 and R4 to hold one or the other of the gates on is supplied from the output of the off gate through D1 or D2.

Construction

The square-wave generator fits comfortably into a 5 1/4 x 3 x 2 1/8-inch aluminum box. The first step is to mount the switch and the dual potentiometer as shown in the photograph.

The terminal strip mounts on one end of the box and a soldering lug is placed under one of its mounting screws. Holes must be drilled to accept the soldering lugs on the rear of the terminal

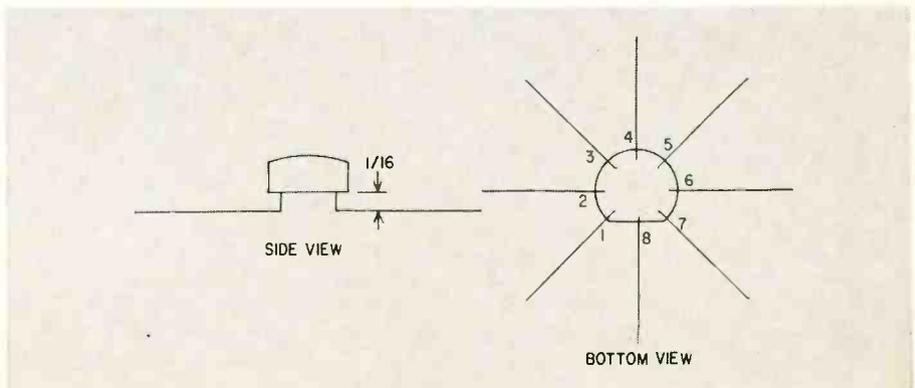


Fig. 3—Basing of the μ L914. Be sure to bend the leads carefully as shown, and don't put any strain on the case. Heat sink and avoid overheating when soldering the leads.

N.Y.C. SUBWAY RADIO

KEEPING IN TOUCH UNDERGROUND

**What? A two-way radio system in a subway tunnel?
Story of rf communications in world's most
extensive subway system**

By **PETER E. SUTHEIM**

Photos courtesy
New York City
Transit Authority

WITH A LOUD WHOOSH OF ITS AIRBRAKES, A 10-CAR INDEPENDENT F express shrieked suddenly to a stop between Forest Hills and Jackson Heights. The time was 8:42 on a Wednesday morning. The train was jammed with nearly 1500 passengers bound from the suburbs to their jobs in Manhattan. It was stopped for 15 minutes; nearly all the commuters were late to work. Not one of them knew why the train had been delayed. There was no way to get information to them.

During the great Northeast power blackout in November 1965, subway trains were stalled for hours. Only emergency batteries in each car kept the dim safety lights going. Rumor flew like leaves in a wind. No one knew what had happened.

At 1:30 am on a Brooklyn-bound Brighton BMT local, three teenagers began making nuisances of themselves, and 10 minutes later were annoying a few dozen other passengers in one of the six cars. A Transit Authority patrolman assigned to the train ushered the boys off at the Prospect Park station without serious incident. But suppose there had been six young hoodlums? Armed? Suppose someone had been hurt? The TA cop had no way to send for any help.

Fortunately for us who use the subways in New York, things like that don't happen often. But they do happen, and passengers react with anything from sweaty irritation to anger and panic.

Subway communication problem

Running a city railroad with 6700 cars, some 1.25 billion passengers a year, with a rush-hour train interval of 90 seconds, about 240 route miles of track and 481 stations, is no small job. There has always been a crying need for fast, reliable communications between trains and signal and dispatching towers and, sometimes more important,

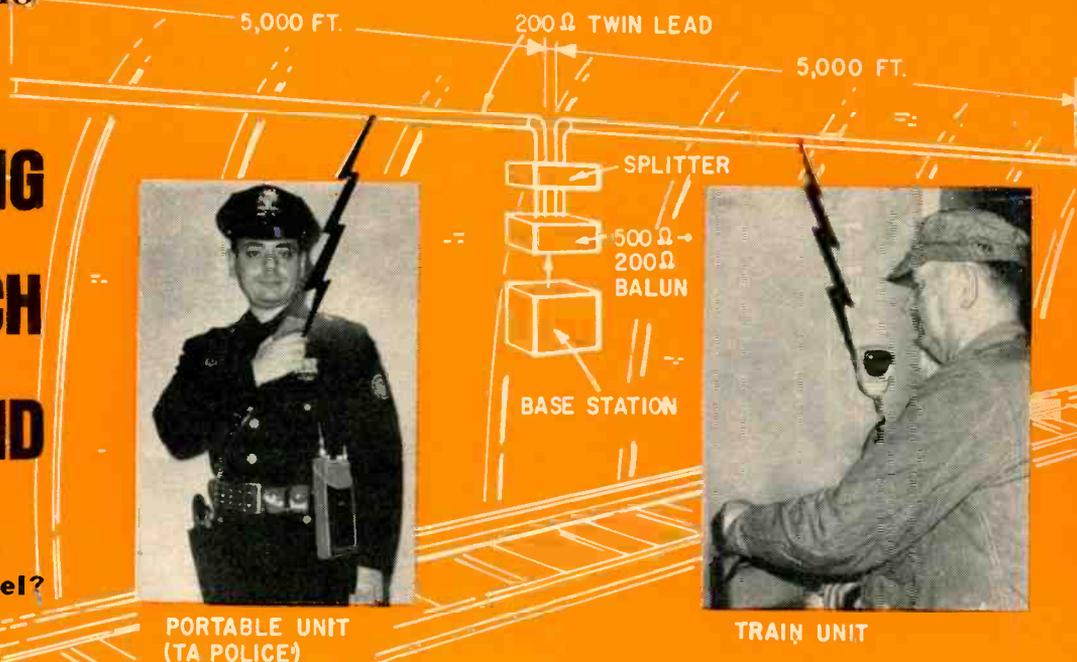
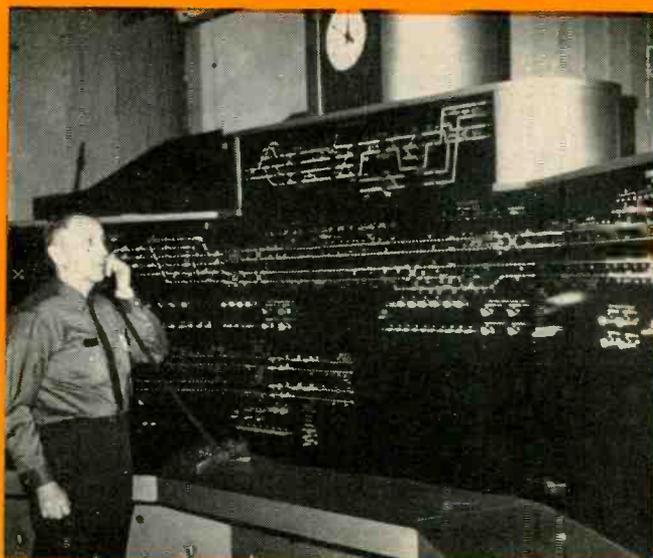


Fig. 1—Basic subway radio system uses a single station driving two lines—in both directions through tunnel. Portables are tuned to one frequency, trains to another.

between Transit Authority policemen along the lines and central control points.

Ever since the first New York subway opened in 1904, transit operations have relied heavily on telephones and intercom systems. Telephones—2000 of them—are spaced about 600 feet apart along every tunnel in the New York rapid-transit system, yet until recently there was no way to communicate with conductors or motormen in moving trains, or to make announcements to passengers.



Grand Central Station interlocking tower is just about the midpoint of the present radio installation on Lexington Avenue subway line. Dispatcher talks to motorman on train.

As long ago as 1950, the Transit Authority experimented with 80-kHz FM carrier-current radio superimposed on the 600-volt dc "third rail" which powers the trains. The equipment was cumbersome (it used vacuum tubes) and the cost of equipping every car in the system would have come to nearly \$7 million.

(Trains in the New York subways are made up of single, separate cars, or permanently joined units of two cars. Trains are continually broken up and the cars shuffled. Every car will sooner or later be the lead car of a train, and so every car would have to be equipped with radio. In 1950, vacuum tubes and power supplies made removable, transferable transceivers impractical.)

Transistors and high frequencies

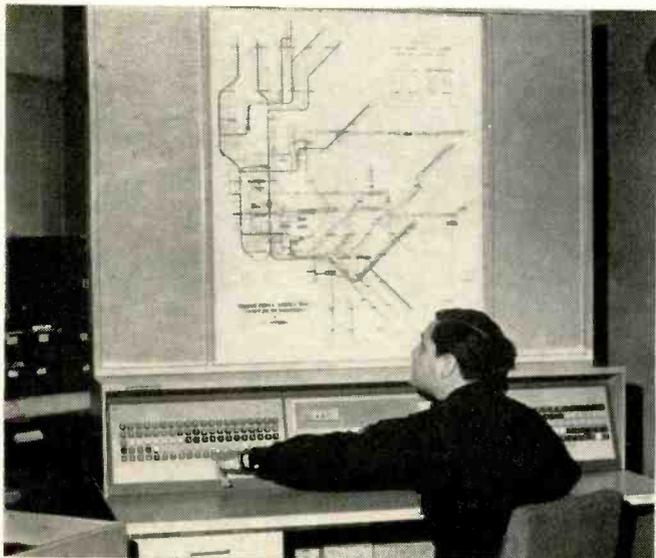
Ten years later, the transistor had come of age. It was now possible to consider using compact, lightweight portable transceivers that a motorman would carry onto his train at the beginning of his run and slip into a bracket in his cab on the lead car. Electrical connections would be made automatically. Power would come from the 28-volt dc system in each car.

Instead of a carrier-current system, it was decided to use conventional narrow-band FM radio, so that transit policemen on foot in station areas well away from the tracks could communicate also, with portable transceivers.

To permit using small antennas (there isn't much clearance between trains and tunnel walls), TA engineers settled on the high vhf land-mobile band (150 MHz). That band is a bit less crowded and less prone to sporadic long-distance "skip" reception than the low vhf band.

Initial experiments turned up an interesting phenomenon. With an omnidirectional antenna, maximum reliable ranges using portable units were only about 500 feet. The steel columns and reinforced-concrete tunnel construction absorbed rf at that frequency at a rate of about 10 dB per 100 feet! Increasing power from 1 watt to 10 watts brought only another 100 feet of range. And 10 watts from a portable transceiver calls for a lot of weight in batteries, so the omnidirectional approach had to be discarded. Directional antennas were obviously out, because it is, in general, impossible to keep a line-of-sight between portable units and a base station.

The solution turned out to be an adaptation of a



At the console in Transit Authority headquarters in Brooklyn, the operator can "punch up" the last reported location of each transit patrolman. At a glance, the entire force is pinpointed.

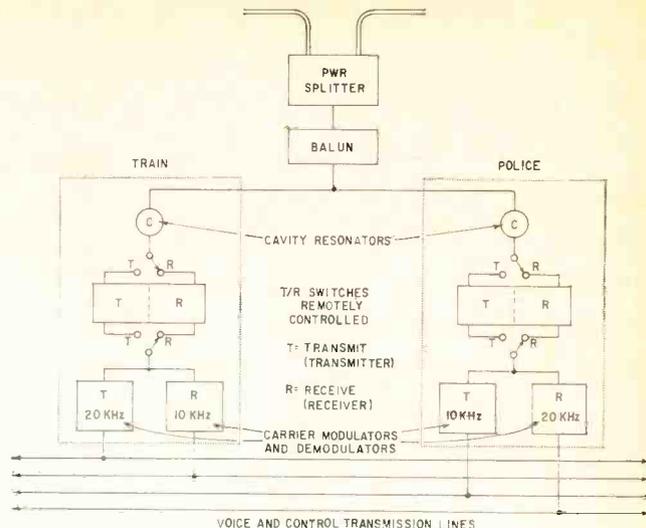


Fig. 2—Block diagram of a single base station in the present subway radio system. Each station consists of two transmitters and receivers, with separate channels for police and trainmen.

method used for vhf paging systems. We might call it the "leaky twin-lead" method. There is a certain amount of radiation from twin-lead—usually an undesirable loss when the twin-lead is used to convey power from a transmitter to an antenna or from an antenna to a receiver. For the Transit Authority's purpose, the radiation from a long run of twin-lead was exactly what was needed.

The twin-lead also acts as a combined receiving antenna and lead-in for picking up signals from the low-powered police and train transceivers and routing the signals to the base-station receivers. In effect, the twin-lead acts as a two-way conductive rf link, guiding the rf energy where it is wanted and keeping undesired radiation and power loss as low as possible.

Tests with this method were conducted during 1961. About 11,600 feet of RG-86/U 205-ohm twin lead was fed at one end by a conventional 25-watt transmitter-receiver unit. That was the base station. The train and portable units were conventional, commercial devices.

To determine the radiation characteristics of the twin-lead, men were assigned to "walk the line" with a portable transmitter and a calibrated receiver. They found "solid" two-way communication possible within 40 feet of the twin-lead antenna at any point up to 6000 feet from the base station. The signal from the base station was readable at 7000 to 8000 feet.

By feeding two diverging transmission lines from the same transmitter, the method could cover a total span of about 2 miles underground (allowing for the 3-dB power loss that results from splitting the signal in two). See Fig. 1.

Working test

It was time for a real working test. TA engineers selected an 8-mile stretch of four-track route on the Lexington Avenue (East Side) line of the IRT division from Bowling Green near the southern tip of Manhattan Island to 125th St. For about half the distance, the two express tracks run side by side in a separate tunnel below the two local tracks. Though that stretch is only about 5% of the total New York transit trackage, it is one of the most heavily traveled lines in the city.

The contract was awarded to Motorola, and construction began. Except for the baluns used to transform the 50-ohm unbalanced outputs of the base stations to 200 ohms

balanced, and some cavity resonators and power splitters, all the equipment, including the train and portable units, was "stock". Operation was completely satisfactory almost from the very beginning.

Up to this point, the system is pretty straightforward. The only peculiarity is the method of propagating the signals from the transmitters.

One of the principal purposes of the radiocommunications system is to maintain close contact with transit policemen on their beats throughout the trains and stations of the subway. It was decided that police communications could be handled better on a separate channel. As a result, each base station consists of two vhf transmitters and receivers on slightly different frequencies, both feeding the same twin-lead antenna. Resonant cavities isolate all of the units from each other.

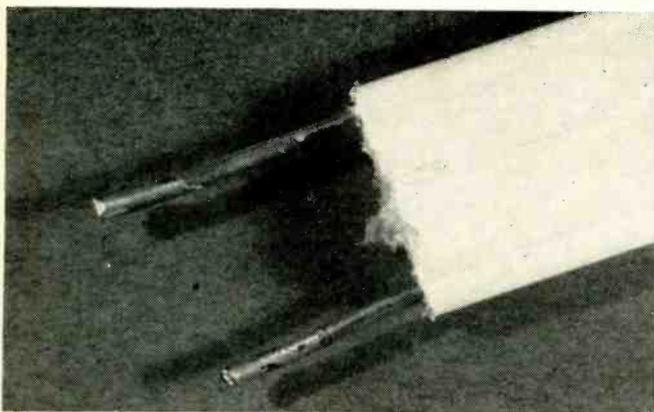
The "program"—the intelligence that modulates the transmitters—comes, not from microphones at each base station (except in emergencies), but via lines from TA headquarters in Brooklyn, where train- and police-control facilities are centered, and from a "command post" at the Grand Central Station interlocking tower. A block diagram of the typical base station is shown in Fig. 2.

Transmitter spacing

Six base-station installations are spaced along the IRT stretch from Bowling Green to 125th St. Five are remote-controlled; the sixth, at Grand Central Station, roughly half-way along the line, is part of the control center which commands all six base stations. The trainmaster there can control all six base transmitters if directed to do so by TA headquarters in Brooklyn. Normally, all six base-station transmitters operate simultaneously. They are fed audio in parallel and operated by remote control.

All New York subway cars built since the early 1950's have public-address systems, normally operated by the conductor, who also opens and closes the train doors at each station. Generally the PA system is used to announce stations and to broadcast admonitions like "Please let go of the door!" The motorman and conductor can also inter-communicate via the PA system. In emergencies, it has been used to instruct passengers.

But a PA system is of little use unless the motorman or conductor knows what's happening. Often, he finds himself forced to halt at a red signal and remain there for many minutes without knowing why he had to stop. Red signals are not uncommon during congested rush hours, but passengers in a train that's been waiting in the tunnel for more than, say, 5 minutes, are entitled to know *something*.



The "leaky" antenna/feeder line: Rulan-jacketed, foam-filled twin-lead forms the long-line antenna for the New York subway communication system. Wires are No. 8 copper, spaced 1.4 inches. Line is unterminated simply because it works better that way.

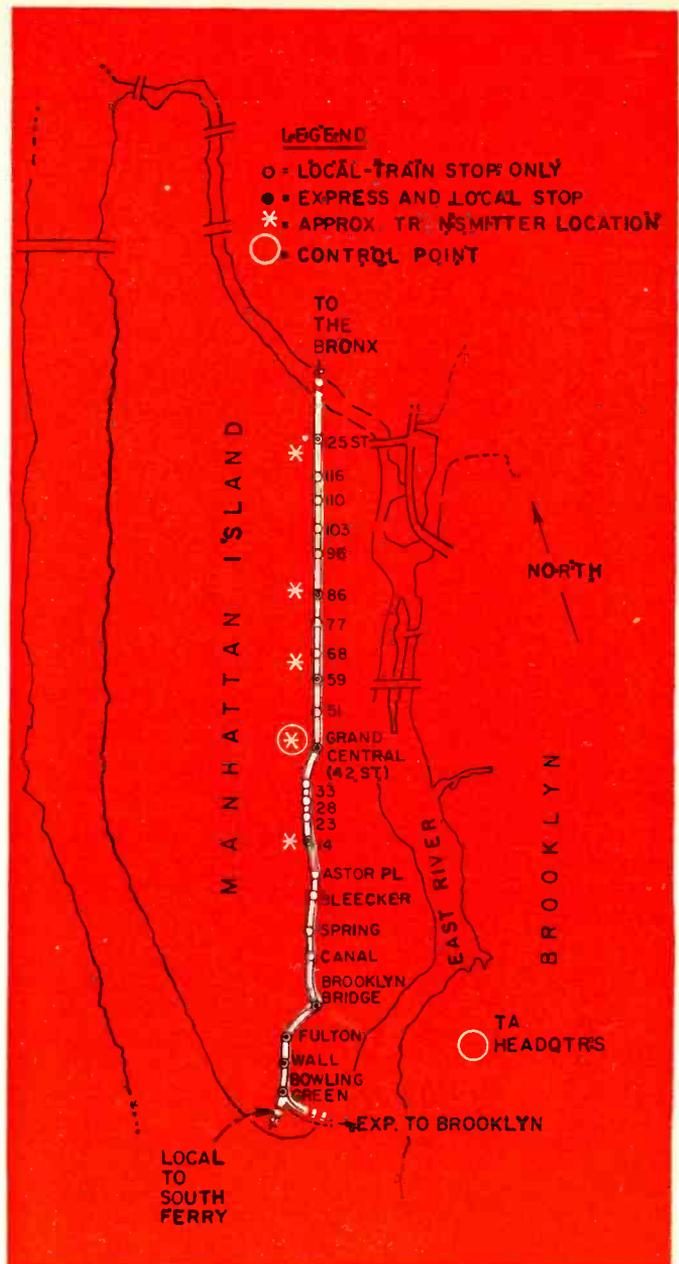


Fig. 3—Simplified map shows location of subway transmitters. Although subway route runs between The Bronx, Manhattan and Brooklyn, present base stations cover only that portion of route in Manhattan. All stations are located below the surface.

Now the motorman can get information from the outside world. If he is ordered to do so—by radio—he can switch the output of his receiver into the train PA system so that an official up the line can make an announcement to all the passengers on the train.

"A train in the 68th St. station is having door trouble. We expect a delay of approximately 10 minutes. Please be patient." An announcement like that from someone in a position to know can do great things for passenger morale. For the first time in more than 60 years of New York subway operation, travelers will feel a little less like isolated inmates of a rumbling, hurtling steel cage. The technology is here; it is now up to harassed subway officials to use the facilities to comfort the passengers.

The radiocommunications system is now being expanded throughout the IRT division, and is expected soon to include the transit system's other two divisions, the BMT and IND subways.

R-E

j

Imaginary numbers are a cinch

Part 2 of a series—More about some handy math tools—
including operator *j*—and how they're used to design
electronic filters. (Part 1 appeared May 1967)

By NORMAN H. CROWHURST

A FEW DAYS AFTER OUR LAST DISCUSSION, George phoned to ask if I could come over and continue where we left off. I arrived at his lab in time to join him for midmorning coffee.

He had been trying to figure things out himself since our last talk. Remembering that $j \times j$ makes -1 , he had deduced that $+j \times -j$ makes $+1$. Was

$$\begin{array}{r} 9+j7 \\ \times 7+j5 \\ \hline 63+j49 \\ \quad j45-35 \\ \hline 63-35+j94 \end{array} \quad 28+j94$$

Fig. 1—It's not hard to multiply imaginary numbers; plus *j* times plus *j* equals minus 1.

that right? I assured him it was. Then he wrote down a compound multiplication (Fig. 1): $9 + j7$ to be multiplied by $7 + j5$ and came up with the answer: $63 + j94 - 35$.

"You can subtract the 35 from the 63, can't you?" he wanted to know. I nodded. "So the result of multiplying $9 + j7$ by $7 + j5$ is $28 + j94$. Is that right?" he asked.

"Certainly," I said. "I'm surprised you've figured all that out on your own. So why did you call for help?"

"I was following up with what you said about division. I tried to check that multiplication by dividing $28 + j94$ by $7 + j5$, thinking I knew the answer. But I couldn't get very far. Tell me, how do you do it?"

Rationalizing

"Division isn't so easy. But there's a way to make it easier. It's a process called *rationalizing*."

"So show me rationalizing."

"Do you remember what you get by multiplying together $A + B$ and $A - B$?" I asked him.

"Sure do. That's one bit of algebra I'll never forget. It's A squared minus B squared."

"Good. So now suppose you multiply $A + jB$ by $A - jB$. What does that make?"

"That would be A squared minus jB all squared." He thought a moment, then went on: "But j squared is minus 1, so that's A squared minus minus B squared. As minus minus makes a plus, I guess it's A squared plus B squared. Is that right?"

"Correct," I assured him. "Now what's happened to the imaginary part of these numbers?"

"There isn't any in the result," he said. "That's interesting, but how does it help with dividing?"

"Let's take that division you wanted to do—what was it, $28 + j94$ divided by $7 + j5$?" I wrote it down as a fraction. "Can you tell me how I could make the divisor, or denominator as it is called in a fraction, just a simple whole number, without changing the final value in any way?"

"Oh!" said George, "light's beginning to dawn. If you multiply $7 + j5$ by $7 - j5$, the imaginary part will disappear. And if you multiply both top and

$$\begin{array}{l} \frac{28+j94}{7+j5} \times \frac{7-j5}{7-j5} = \frac{(28+j94)(7-j5)}{49+25} \\ \frac{196+j658-j140+470}{666+j518} \\ \frac{666+j518}{666+j518} = \frac{28+j94}{7-j5} \\ \frac{74\sqrt{666}}{666} \frac{7\sqrt{518}}{518} = \frac{74}{74} \frac{28+j94}{7-j5} \\ \frac{74\sqrt{666}}{666} \frac{7\sqrt{518}}{518} = \frac{74}{74} \frac{28+j94}{7-j5} \end{array}$$

Fig. 2—To divide imaginary numbers, you first write them as a fraction. Then you rationalize the denominator to simplify.

bottom by $7 - j5$, overall value is unchanged. Is that right?" He was already doing it (Fig. 2).

"So now I only have to divide $666 + j518$ by 74 ." He found it easy, because he knew the answer to expect, which was $9 + j7$. He was delighted.

"Is that rationalizing?" he asked me next.

"Rationalizing is the process of making the denominator into a real number, so the numerator can be divided by it to get rid of the complex fraction. What you want is a simple complex number, of the form $A + jB$."

Vector basics

Then I drew approximate scale sketches (Fig. 3) to show a basic result of vector calculations. In every case, multiplying complex numbers produces an amplitude that is the *product* of the

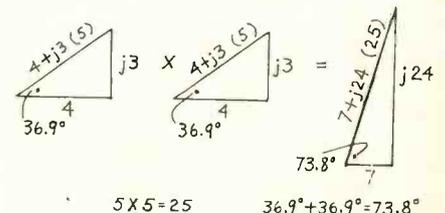


Fig. 3—Vector diagrams show the effects of using operator *j*. The angles are added, while amplitudes are multiplied.

individual amplitudes. The resultant phase angle is the *sum* of the individual phase angles.

"Hey, that's neat," was his enthusiastic comment.

Then I showed him how division reverses the process: the amplitude of the result follows normal division, while

Imaginary Numbers Are a Cinch

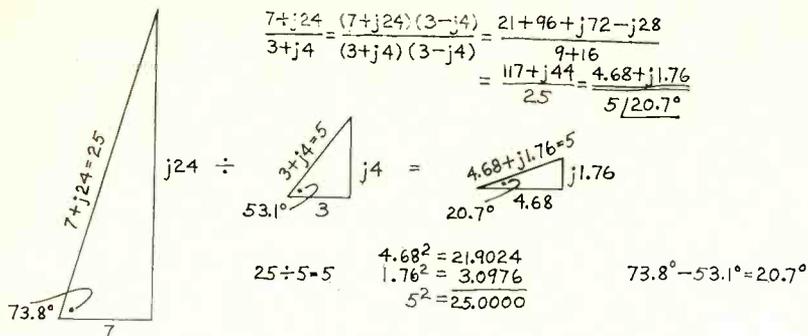


Fig. 4—To divide one vector quantity by another, it's necessary to rationalize the *j*. Amplitudes follow normal division, but phase angles subtract instead of add.

the phase angles *subtract*, instead of adding.

He worked out an example for himself, using the numbers I picked (Fig. 4). "I'm beginning to see how imaginary numbers will make calculations easier. Now can you give me an example how to use them in a circuit calculation?"

"Right you are. And while we're about it, I'll show you *normalizing*, another trick that makes math easier. Suppose we want to make a low-pass filter of the kind used in crossovers," and I sketched out what I had in mind (Fig. 5). "We normalize to the working impedance and the cutoff frequency."

"Eh? Come again? That sounds awfully complicated."

Normalizing

"Well, instead of putting in values for working impedance and cutoff frequency, you assume for calculations that they are both 1. You can put in the actual figures for frequency and working impedance later. But it's easier to show you than to try explaining what to do.

"First, we assume the filter is terminated with unity impedance. It is shunted by a capacitance that has susceptance of *b* units and has in series an inductive reactance of *a* units at cutoff frequency. To design the basic filter, we solve for *a* and *b*. Then we can look up values for a particular impedance and frequency on a reactance chart."

"That sounds simple and quick," said George. "Let's try it."

"Working at the output end, we assume unity voltage and current are delivered to the unity load impedance. This won't happen in a working filter, it's true; the filter will give full output in the pass range, and diminishing output beyond cutoff. Assuming constant output, we must increase input to maintain it. The increase needed (expressed as a ratio or its logarithm) is the same as the attenuation produced in the output when

the input is constant. Do you follow all that?"

"Yes," George said. I wasn't too sure he did, but he was anxious to see what came next.

What susceptance is

"Right. So we have unity voltage across the capacitance of susceptance *b*," I went on. "What current will go through this susceptance?"

At the word "susceptance" I drew a blank expression from George. I decided to refresh his memory with a few symbols from elementary electronics. I wrote:

$$Z = R + jX$$

$$Y = \frac{1}{Z} = \frac{1}{R + jX} = \frac{R - jX}{R^2 + X^2}$$

Then I reminded him that these 2 components of the admittance (*Y*) are given the names conductance (*G*) and susceptance (*B*).

$$Y = G + jB \quad G = \frac{R}{R^2 + X^2} \quad B = -\frac{X}{R^2 + X^2}$$

"Now," I asked again, "what current will pass through this susceptance?"

"*b* units, I suppose," volunteered George.

"That's right, at cutoff frequency. What about at other frequencies? Does the current increase or decrease with changing frequency?"

"Current in a capacitor increases with frequency," George replied. "So the current in the capacitance will be *bf*. Is that right?"

"Nearly. But if you use *f* for frequency, you have to remember that cut off frequency is 1, because we're normalizing. You'll avoid confusion if you write *x* for normalized frequency, which means *x* is actual frequency divided for the cutoff frequency.

$$x = \frac{f}{f_c}$$

"This makes *x* = 1 at cutoff frequency. That is what we mean by *normalizing*."

Putting *j* in

"So current in the susceptance is *bx*. Is that right?" asked George.

"Except for one thing—phase angle," I replied.

"Oh. We put a *j* in," he said. "But is it *+j* or *-j*?"

"The important thing is to be consistent. Assume this one is *+j*. It represents the current in a capacitance. Does this lag or lead the voltage?"

"Let's see. It leads, doesn't it?"

"Right. So *+j* means leading and *-j* means lagging, for this calculation. We write current in the capacitor as *jbx*. Add this to the output current and tell me what current must flow through the series inductance?" I asked.

"Is it *1 + jbx*?" asked George in return.

"Correct. Now, what is the reactance of the inductance?"

"Is it *ax*?" asked George.

"Yes, because inductive reactance

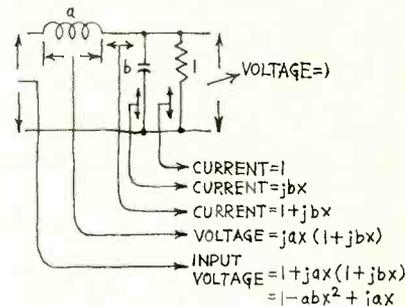


Fig. 5—Operator *j* and the other math tools become useful when you're designing a low-pass filter for a crossover network. Result is a formula for plug-in values.

is directly proportional to frequency, or *x*," I answered. "And the voltage drop due to this reactance will be in quadrature with the current through it. Which way?" I asked further.

"Leading." George was getting more sure of himself by the minute.

"So the voltage drop across the inductance element will be the current through it, multiplied by its reactance," I went on.

"That's $(1 + jbx)$ multiplied by *jax*," cut in George.

"So what's the input voltage required to get unity output voltage, which you remember we assumed as a starting point for our calculation?"

I'd apparently got a little ahead of George, so he waited for me to explain. "You have the unity voltage at the output, plus the drop in the reactance." I wrote it out.

George multiplied this out and re-

arranged it. He was getting the hang of using imaginary numbers. He had even remembered that (jbx) multiplied by (jbx) equalled $-abx^2$. "Now, what does all that mean?" he wanted to know next.

Phase angle

"Let's see what the expression tells us about this network," I suggested. "First, what's the phase angle?"

"We did that the last time. It's the ratio of the imaginary part to the real part, and then you find the tangent on the slide rule. Isn't that it?"

"Correct. Now, how does this angle change as frequency, represented by x , varies? At some frequency, when $abx^2 = 1$, the denominator goes through zero. What angle is that?"

"90°," volunteered George, "because the real part is zero—it's all imaginary, or in quadrature."

"How can we make this happen at cutoff where $x = 1$?"

"By making $ab = 1$?" suggested George.

"Right. Now, when x is much smaller than 1, meaning that frequency is well below the reference cutoff frequency, x squared will be a still smaller fraction. For example, if x is half, x squared is quarter; if x is one fifth, x squared is one twenty-fifth."

George was with me. "Now assume that a is slightly larger than unity. Then abx^2 will be much smaller than 1," he said. "The real part will be nearly 1 and positive, and the imaginary part will be smaller than 1, so. . . ." He didn't quite know what this proved.

I said, "Because both real and imaginary parts are positive, the angle is something less than 45°, because the ratio is fractional—less than 1." He saw that (Fig. 6). I went on, "As x ap-

$$\phi = \text{ARCTAN} \frac{ax}{1-abx^2}$$

WHEN $X=1$, & $ab=1$, WE HAVE $1-abx^2=0$

$$\textcircled{1} \quad X \ll 1 \quad \phi \cong \text{ARCTAN} \quad ax < 45^\circ$$

$$\textcircled{2} \quad X \rightarrow 1 \quad \phi \rightarrow 90^\circ$$

$$\textcircled{3} \quad X \gg 1 \quad \phi \cong \text{ARCTAN} \left(-\frac{a}{x}\right) \rightarrow 180^\circ$$

Fig. 6—The phase angle of the circuit changes as the operating frequency does.

proaches 1, abx^2 will still be less than 1, and ax will get bigger than $(1 - abx^2)$, so the angle will approach 90°. Then we pass through 90° when $(1 - abx^2)$ is zero. Beyond that, $(1 - abx^2)$ is negative, so the tangent ratio is negative, indicating an angle over 90°. As x gets larger than 1, x^2 gets much larger than 1, so the ratio is almost the same as x/x^2 , or $1/x$."

George had followed this and saw the value of approximating in this way,

to see where the angle "goes" without detailed calculations.

I went on. "Now about amplitude. For the 3-dB point to coincide with the 90° phase point and cutoff or crossover frequency, where x equals 1, what else must we fix?"

"Is this expression," George pointed to $(1 - abx^2 + jax)$ in Fig. 5, "in voltage, current, or power?"

"We decided, when we started, that it represented input voltage needed to produce unity output voltage," I replied.

"So the 3-dB point means we need the input voltage to be root two, or 1.414 times output voltage. Is that right?"

"Yes."

"Then with $(1 - abx^2)$ as zero, the jax part must be 1.414. The j merely identifies the 90° phase shift; also x is 1 at cutoff or crossover, so a must be 1.414. Right?"

$$\begin{array}{l} \text{INPUT VOLTAGE} = 1 - abx^2 + jax \\ \hline \begin{array}{l} \text{REAL PART} \\ 1 - abx^2 \\ 1 - abx^2 \\ 1 - abx^2 \\ -abx^2 + a^2b^2x^4 \\ 1 - 2abx^2 + a^2b^2x^4 \\ \text{add } \rightarrow a^2x^2 \\ \hline 1 + (a^2 - 2ab)x^2 + a^2b^2x^4 = \text{INPUT VOLTAGE SQUARED} \end{array} \\ \begin{array}{l} \text{IMAG PART} \\ ax \\ \frac{ax}{a^2x^2} \end{array} \end{array}$$

FOR 3 db AT $X=1$, $a=1.414$ & X^2 DISAPPEARS

Fig. 7—When the phase angle is not 90°, figuring the value of input voltage to the filter requires these calculations.

"It certainly is. This means the reactance of the inductor must be 1.414 times the output load impedance at cutoff or crossover frequency."

"Well, that's not too hard to figure," said George. "Now what about the capacitor value?"

"Just remember that b is in susceptance at cutoff frequency. So reactance would be $1/b$."

George was figuring this out. "If ab has to be 1, then b must be $1/a$, or 0.707. But then we'll use a reactance chart to find it, so we'll use $1/b$, which is a , or 1.414. So both a and b are reactances of 1.414 times the output load value, at crossover frequency. Is that right?"

I nodded. George was already showing a flair for taking shortcuts, which was fine.

Filter design

"It's beginning to make sense," he said. "But the filter that started all this discussion is much more difficult to figure out, isn't it?"

"Not so hard," I told him. "We've already got the configuration. But be-

fore we go further, we should explore the response of this simple filter in a little more detail. In that quick calculation, we did two things for the sake of convenience:

"1. We assumed it is what we call a constant-resistance type—by which we mean, among other things, that the 3-dB and half-phase points coincide at cutoff frequency.

$$\begin{aligned} \text{VOLTAGE ATTENUATION RATIO} &= 1 + (a^2 - 2ab)x^2 + a^2b^2x^4 \\ \text{db} &= 20 \text{ LOG} \sqrt{1 + (a^2 - 2ab)x^2 + a^2b^2x^4} \\ &= 10 \text{ LOG} [1 + (a^2 - 2ab)x^2 + a^2b^2x^4] \end{aligned}$$

Fig. 8—The product of Fig. 7 can be simplified into this decibel expression.

"2. We considered attenuation only at one frequency. To provide background for more work, we need to figure out more details of the phase and amplitude responses at some other frequencies.

"For example, what is the amplitude of the input voltage, or attenuation factor, when the phase angle is not conveniently 90°, and maybe when this doesn't happen to coincide with the 3-dB point?"

George didn't know where to begin, now, so I continued.

"It's the vector sum of the quadrature components, $(1 - abx^2)$ for the real part and jax for the imaginary or quadrature part. That's the square root of the sum of the squares, remember?"

That set George off, squaring $(1 - abx^2)$ and ax , and adding the parts together, according to terms of x^2 and x^4 (Fig. 7). Then he put the whole thing under a radical sign.

"Actually, if you're working in dB you don't have to go that far," I told him. "The magnitude of the resultant vector is a voltage attenuation ratio, which converts to dB as 20 times the log of this ratio. So don't bother taking the square root. The vector is simply 10 times the log of this sum of the squares." (Fig. 8)

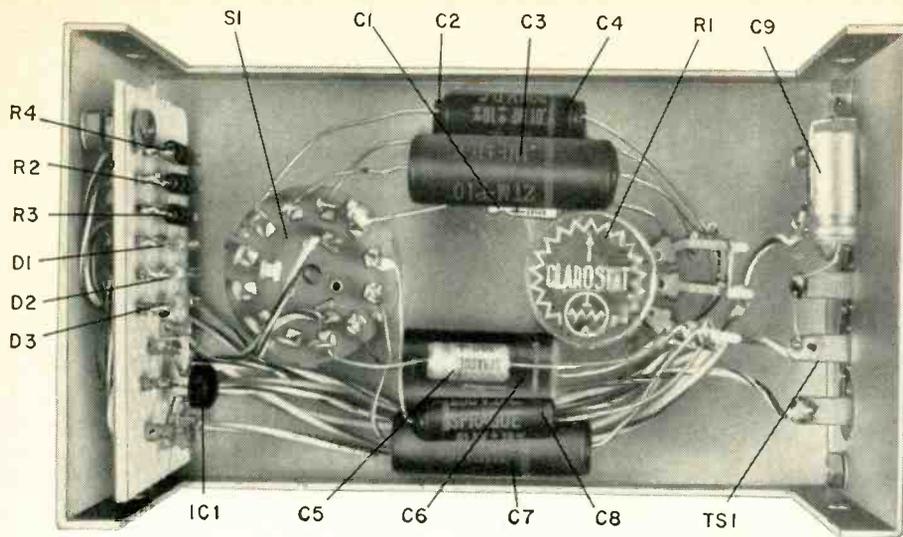
Another problem

I noticed that time was creeping up on us. I had to leave.

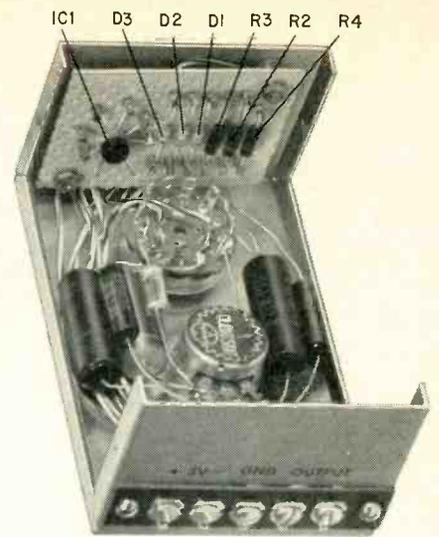
"Time for me to get going, George. See if you can figure out what makes the 3-dB point come at $x = 1$ and also the conditions which would make the response show a peak or a loss greater than 3 dB when $x = 1$. Did you do any calculus in school?"

"Yes, I did," replied George. "It's rusty, because I've never used it since. You mean I'm going to put it to use at last?"

"Yes," I said as I pulled on my coat. "Next time." TO BE CONTINUED



There's plenty of room in the box for all components, including the battery and an on-off switch. Using a perforated board and push-in terminals eases construction.



Terminal strip is convenient, but you can substitute a plug and jack arrangement.

Build Low-Cost IC Signal Generator

(Continued from page 55)

on the schematic.

The easiest way to calibrate is to compare the output of the square-wave generator with that of a calibrated audio oscillator by using Lissajous patterns on an oscilloscope. If you don't have an oscillator and scope available, use a pair of headphones and a piano. Listen to the

square-wave generator on the headphones and tune it to several notes of the piano. The table will help.

Calibration on the X10 range will hold reasonably well for the X100 and X1000 ranges. The X1 range, which depends on electrolytic capacitors, may need separate calibration for accuracy.

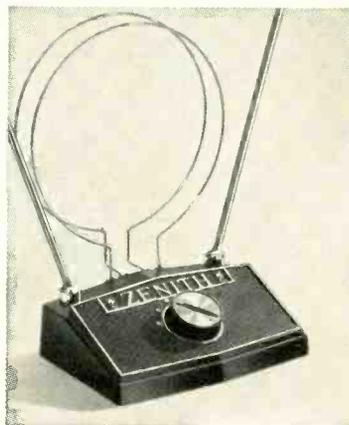
In using the unit for most audio work, the ac-coupled output is best. No dc flows to the driven circuit.

At frequencies in the X1 range, coupling capacitor C9 may cause the top and bottom of the square wave to tilt. Using dc output corrects this problem.

This square-wave generator is a fast-starting chirp-free oscillator. A key in the 3-volt line turns it into a good code-practice oscillator. **R-E**

Why not sell the best

**3 ZENITH
WAVEMAGNET®
INDOOR TV ANTENNAS**
built to the quality
standards of Zenith
original parts



**DELUXE
ALL-CHANNEL**
Part No. 973-56

Two full-size UHF loops develop high front-to-back ratios equal to many outdoor antennas.



**ECONOMY
ALL-CHANNEL**
Part No. 973-55



VHF ONLY
Part No. 973-58

Zenith has designed these Wavemagnet antennas for sensitive reception in color or B/W. Fully adjustable telescopic dipoles. Six-position selector switch for top performance on each channel. Handsome molded base of high-impact styrene. Individually packaged for effective sales display. Order now from your Zenith distributor.

ZENITH®
The quality goes in before the name goes on

Circle 23 on reader's service card

How To Fix Intermittent Color TV Sets
(continued from page 39)

tracing and checking were eliminated.

Tube and component checks showed nothing wrong, though a new tube was left in the set to make sure the old one was not at fault. Nevertheless, the noise returned. A universal-type output transformer was hooked to the anode of the output tube, and a test speaker was used. Now the intermittent disappeared, pinpointing the trouble to the output transformer. (It is highly unlikely that the condition could be caused by the speaker.) A replacement transformer cured the trouble.

In a Silvertone color receiver the convergence changed after the set was in operation for an hour, with red fringes overlapping white-to-dark picture areas. After another half hour's operation the convergence would sometimes return to normal. After the set cooled off for about an hour and was turned on again, the intermittent convergence condition would not always return. Obviously the convergence settings need not be reset, because if the misconvergence was corrected, they would not hold when the intermittent condition reversed itself. Certain settings of the BRIGHTNESS control caused picture blooming, indicating trouble in the high-voltage regulator section. A new 6BK4-B shunt regulator tube cured the trouble.

In a Motorola receiver, intermittent loss of color and picture deterioration were traced to a make/break contact at the antenna. One side of the twin-lead was periodically losing contact. This trouble emphasizes the importance of checking the antenna system. Misorientation can also cause color loss—just watch a color picture while an antenna is being rotated.

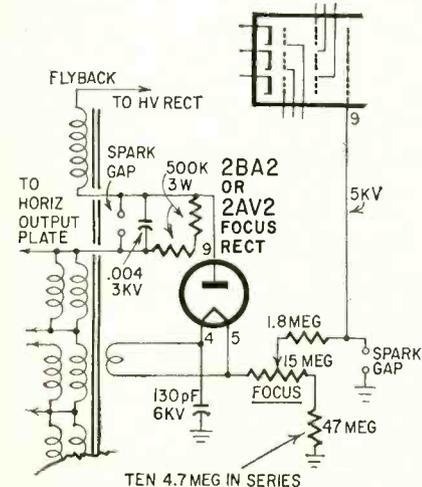


Fig. 5—Complaint was defocusing in this Admiral TV set. Cause was a bad 1.8-megohm resistor connected to CRT pin 9.

In several receivers intermittent color levels were noticed on the high vhf channels (7 to 13), but not on the lower. While a defective oscillator tube in the tuner could cause this, the trouble was traced to intermittent contacts in the station selectors. On occasion the tuner detent failed to position properly and the result was a slight detuning, just as though the fine-tuning control was misadjusted. Cleaning the tuner contacts and adjusting the detent spring cured the troubles.

Logical approach

Because there are so many more

circuits in a color set, more intermittent troubles can be expected than in black-and-white receivers. The examples we discussed are, of course, not all-inclusive, but only serve as a guide to the types which might be encountered and the thinking that goes behind the localization procedures. Intermittents can occur almost anywhere in the receiver and each case must be tackled from the standpoint of the circuitry involved and the nature of the symptoms. Each is a different case.

As an electronic technician, what you need most of all to deal with intermittents is *patience!* **R-E**

NO MORE GUESSWORK!

AMERICA'S MOST RELIABLE TUBE ANALYZER

CONTINENTAL

You don't need three guesses to tell if a tube is bad—or why. With the new Sencore MU140 Continental, you **know**. Right now. And you simply can't go wrong. Because it's a complete tube analyzer for 4-way testing—true mutual conductance (using exclusive 5000 hertz square wave), full cathode emission, 100 megohm grid leakage, and internal shorts. Tests all tubes, including foreign—over 3000 in all. Obsolete-proof, too—with "new socket" panel, and controls so standard the switch numbers correspond to the pin numbers in any tube manual.

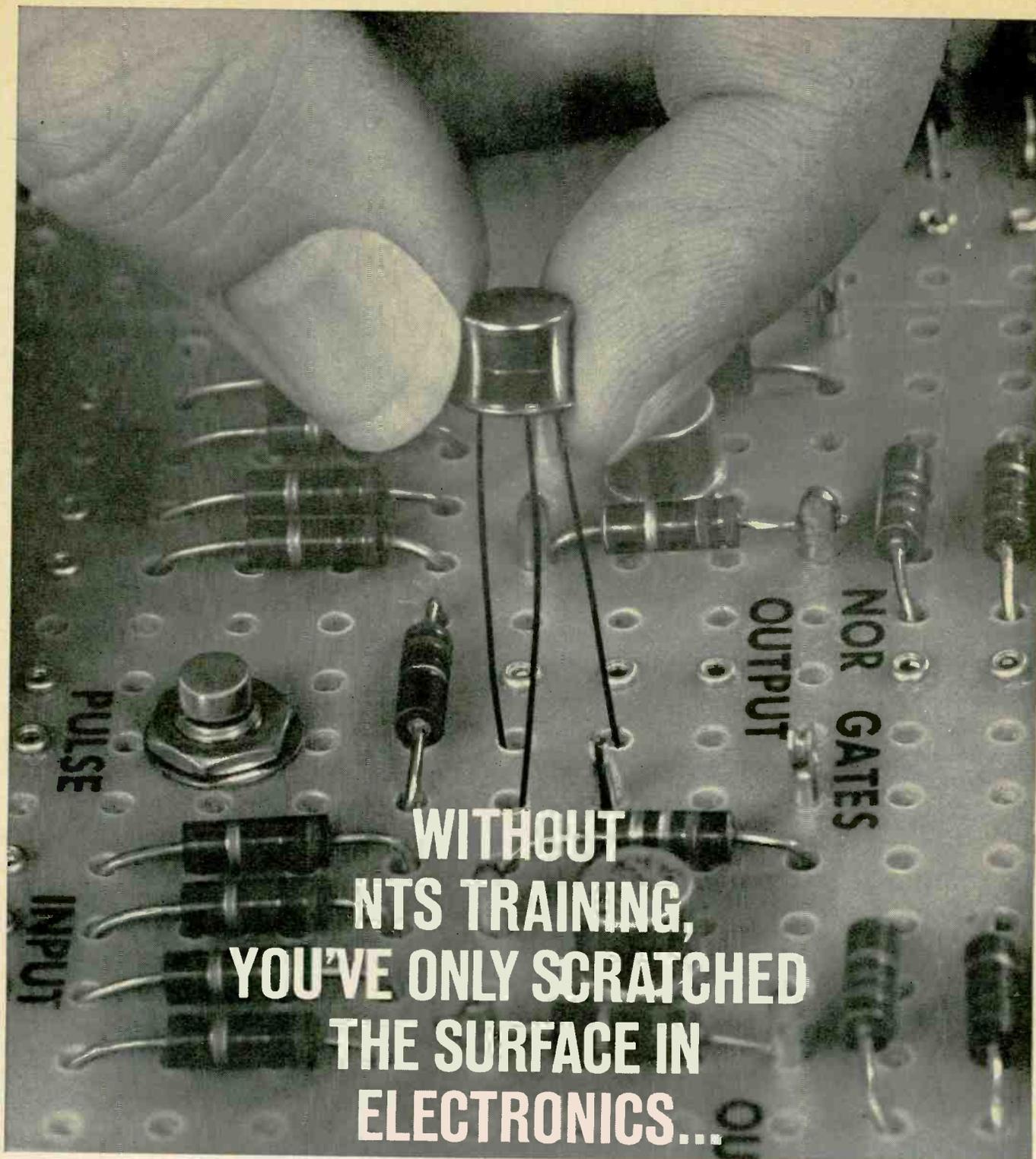
If it's reliability you want—for years to come—you need the Continental. It's the best way to be sure—

for only \$179⁵⁰

See America's most complete line of professional test instruments—at your Distributor now.

SENCORE
NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT
426 SOUTH WESTGATE DRIVE, ADDISON, ILLINOIS 60101

63



Only NTS penetrates below the surface. Digs deeper. Example? Take the above close-up of the first transistorized digital computer trainer ever offered by a home study school.

It's called The Compu-Trainer®—an NTS exclusive. Fascinating to assemble, it introduces you to the exciting world of computer electronics. Its design includes advanced solid-state NOR circuitry,

flip-flops, astable multivibrators and reset circuits. Plus two zener and transistorized voltage-regulated power supplies. The NTS Compu-Trainer® is capable of performing 50,000 operations per second.

Sound fantastic? *It is!* And at that, it's only one of many *ultra-advanced* kits that National Technical Schools offers to give you incomparable, in-depth career training.

PROVE IT YOURSELF. SEND FOR OUR NEW CATALOG. SEE THE LATEST, MOST ADVANCED KITS AND COURSES EVER OFFERED BY A HOME STUDY SCHOOL.

NTS...THE FIRST HOME STUDY SCHOOL TO OFFER LIVE EXPERIMENTS WITH INTEGRATED CIRCUIT KITS

You build a computer sub-system using the new, revolutionary integrated circuits. Each one, smaller than a dime, contains the equivalent of 15 resistors and 27 transistors.

And your kits come to you at no extra cost. These kits are the foundation of the exclusive *Project-Method* home study system...developed in our giant resident school and proven effective for thousands of men like yourself.

With Project-Method, all your kits are carefully integrated with lesson material. Our servicing and communication kits are *real* equipment—not school-designed versions for training only. As you work on each of the projects, you soon realize that even the most complicated circuits and components are easy to understand. You learn *how* they work. You learn *why* they work.

NTS Project-Method is a practical-experience approach to learning. The approach that works *best!* An all-theory training program can be hard to understand — difficult to remember. More than ever before you need the practical experience that comes from working with real circuits and components to make your training stick.

NTS SENDS YOU KITS TO BUILD THESE IMPORTANT ELECTRONICS UNITS!

- ◆ 25" COLOR TV
- ◆ 21" BLACK & WHITE TV
- ◆ SOLID-STATE RADIO
- ◆ AM-SW TWIN-SPEAKER RADIO
- ◆ TUBE-TESTER
- ◆ TRANSCEIVER
- ◆ COMPU-TRAINER®
- ◆ VTVM
- ◆ SIGNAL GENERATOR

See them all illustrated in
the new NTS Color Catalog.

CLASSROOM TRAINING AT LOS ANGELES: You can take classroom training at Los Angeles in sunny California. NTS occupies a city block with over a million dollars in facilities devoted exclusively to technical training. Check box in coupon.

NATIONAL TECHNICAL SCHOOLS

WORLD-WIDE TRAINING SINCE 1905

4000 So. Figueroa Street, Los Angeles, Calif. 90037

APPROVED FOR VETERANS



Accredited Member: National Home Study Council
Accredited Member: National Association of
Trade and Technical Schools

JANUARY 1968

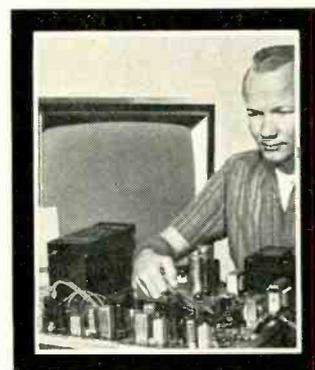


COMMUNICATIONS

This transceiver is included in Communications courses. You build it. With it, you easily prepare for the F.C.C. license exam. You become a fully-trained man in communications, where career opportunities are unlimited.

25" COLOR TV ▼

Included in Color TV Servicing Courses. With it you advance yourself into this profitable field of servicing work. Color is the future of television, you can be in on it with NTS training.

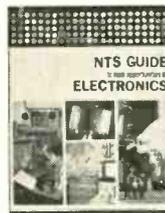


YOUR OPPORTUNITY IS NOW

New ideas, new inventions, are opening whole new fields of opportunity. The electronic industry is still the fastest growing field in the U.S. There's a bigger, better place in it for the man who trains today. So, whatever your goals are — advanced color TV servicing, broadcasting, F.C.C. license, computers, or industrial controls, NTS has a highly professional course to meet your needs.

GET THE FACTS! SEE ALL NEW COURSES AND KITS OFFERED IN THE NEW NTS COLOR CATALOG. SEND THE CARD OR COUPON TODAY!

There's no obligation. We have no salesmen. That means lower tuition for you.



NATIONAL TECHNICAL SCHOOLS

DEPT. 206-18

4000 S. Figueroa St., Los Angeles, Calif. 90037

Please rush Free Color Catalog and Sample Lesson, plus information on field checked below. No obligation.

- | | |
|---|--|
| <input type="checkbox"/> MASTER COURSE IN COLOR TV SERVICING | <input type="checkbox"/> PRACTICAL TV & RADIO SERVICING |
| <input type="checkbox"/> COLOR TV SERVICING | <input type="checkbox"/> FCC LICENSE COURSE |
| <input type="checkbox"/> MASTER COURSE IN TV & RADIO SERVICING | <input type="checkbox"/> INDUSTRIAL & COMPUTER ELECTRONICS |
| <input type="checkbox"/> MASTER COURSE IN ELECTRONIC COMMUNICATIONS | <input type="checkbox"/> STEREO, HI FI & SOUND SYSTEMS |
| | <input type="checkbox"/> BASIC ELECTRONICS |

NAME _____ AGE _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Check if interested in Veteran Training under new G.I. Bill.

Check if interested ONLY in Classroom Training at Los Angeles.

Weller®

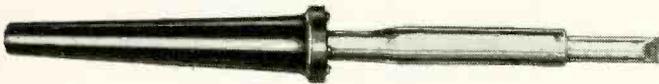
**makes first class
soldering the easiest
part of any job**



NEW Weller
BATTERY OPERATED
Iron for field servicing

Now get controlled 700°F tip temperature from a battery! Lightweight TCP-12 iron features Weller's patented "Temperature Sensing" system, clips to any 12-volt battery or 12-14 volt AC/DC source. Also available for 24-28 volt operation (Model TCP-24). A must for mobile communications work.

Efficient MARKSMAN Irons
for continuous-duty soldering



Ideal for the bench or caddy, Marksman irons outperform others of the same size and weight. Five models feature long-reach, stainless steel barrels and replaceable tips.

- 1¼-oz, 25-watt Model SP-23
- 4-oz, 80-watt Model SP-80
- 2-oz, 40-watt Model SP-40
- 10-oz, 120-watt Model SP-120
- 16-oz, 175-watt Model SP-175



Dual Heat Soldering Guns for dependable maintenance and repair

The most widely used gun in the electronics field. Available in three wattage sizes, each with Weller's exclusive trigger-controlled dual heat, pure copper tip, and spotlight.

- 100/140-watt Model 8200
- 145/210-watt Model D-440
- 240/325-watt Model D-550

25-watt Technician's Iron for intricate circuit work



Industrial rated pencil iron weighs only 1¾ ounces, yet delivers tip temperatures to 860°F. Cool, impact-resistant handle. All parts readily replaceable. Model W-PS with ¼-inch tapered tip.

Complete Weller Line at your Electronic Parts Distributor

WELLER ELECTRIC CORPORATION, Easton, Pa.
WORLD LEADER IN SOLDERING TECHNOLOGY
Circle 25 on reader's service card

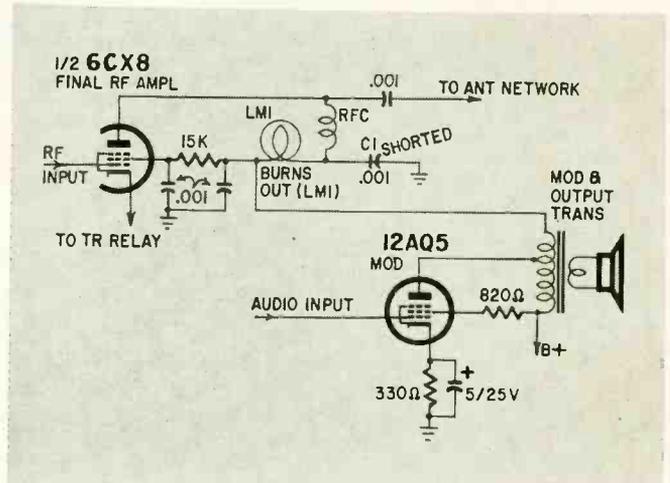
CB Troubleshooter's Casebook

Compiled by
Andrew J. Mueller

Case 1: No transmit but receive is okay.

Common to: Knight C-22.

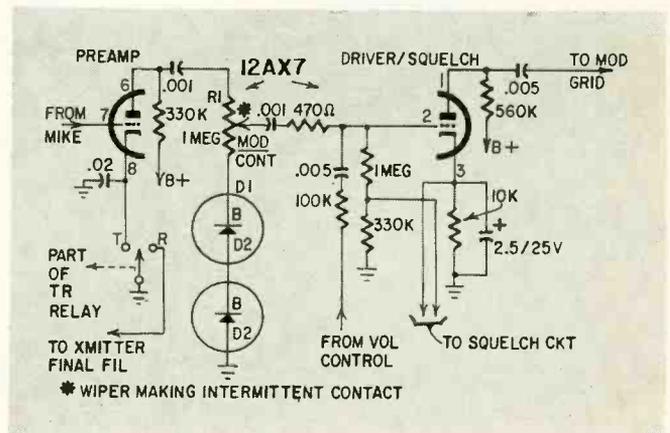
Remedy: Replace shorted rf bypass capacitor C1, lamp LM1 and the 6CX8.



Reasoning: When C1 shorts, a large current is drawn through lamp. This burns out the lamp. If you don't replace or check C1 before replacing the lamp, it will burn out as soon as power is applied to the unit. The pentode section of the 6CX8 will have been damaged due to excessive screen current drawn when the tube was operated with the plate circuit open.

Case 2: Intermittent modulation, receive is okay.

Common to: International MO-23.



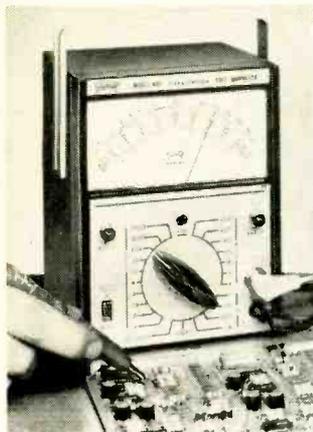
Remedy: Replace modulation control R1.

Reasoning: With R1 intermittently open, the audio signal will not get from the mike preamp stage to the driver stage. Replacement and proper adjustment of R1 will cure this problem.

EQUIPMENT REPORT

Triplet Model 600
Transistorized Volt-Ohmmeter

Circle 42 on reader's service card



MANUFACTURER'S SPECIFICATIONS

Dc Voltmeter
Ranges: 400 mV to 1600 volts full scale
Accuracy: $\pm 3\%$ of full scale
Input resistance: 2.75 megohms at 0.4 volt; 5.5 megohms at 0.8 volt; 11 megohms other ranges.

Ac Voltmeter
Ranges: 4 volts to 800 volts full scale
Accuracy: $\pm 3\%$ of full scale
Input impedance: 750,000 ohms minimum

Ohmmeter
Ranges: 10 ohms to 1 megohm center scale
Size: 3 3/16" x 5 1/8" x 6 1/2"
Weight: 2 1/2 lb
Price: \$82.00

WHEN TRANSISTORS CREPT INTO TEST INSTRUMENTS A FEW years ago, they didn't help much in voltmeters. A vom uses no amplifiers, hence can't be transistorized. The vtm's chief advantage is its high input impedance (a vacuum-tube grid circuit), and the low impedance of a conventional bipolar junction transistor is poorly suited to that application.

Now the field-effect transistor comes along and all of a sudden you have a new kind of voltmeter. Triplet calls their model 600 a TVO—for transistorized volt ohmmeter. Self-contained, portable and battery-operated, it's an ohmmeter and ac-dc voltmeter with the input impedance of a vtm.

Good "human engineering" is evident in the model 600. It uses four batteries (one for the ohmmeter and three for the amplifier power supply). To replace batteries, you need only unscrew a single captive thumbscrew and the chassis slides out of the case. Inside, you find most components are mounted on a rugged, military-type PC board. The ZERO ADJUST control is a geared-down potentiometer, providing greater resolution in adjustment than an ordinary type. Also, the meter movement is protected by a fuse, and a spare is included in a little retaining notch inside the front panel. (But the instruction manual says nothing about either fuse.)

It is, however, a nuisance to take the case off, so Triplet has provided an external battery-test procedure. You simply short the test leads and measure the resistance of the 1% precision probe resistor: a meter scale mark lets you know when to replace batteries.

The handle is rigid and can be used to prop the instrument at about a 25° angle for easy viewing on a flat surface. The meter scale is simple to read—red for ohms, black for volts (both ac and dc). The solid-state amplifier is linear, so the voltage scale is, too (no crowded low-voltage ac scale).

Like other Triplet voltmeters, the model 600 has an OFF position which, not only unpowers the amplifier, but also shorts the meter movement. This makes the pointer and coil self-damping, protecting them during transit.

If you have to troubleshoot this instrument, you'll do better to trace out the actual PC board than to refer to the instruction manual. The schematic is nonstandard and hard to understand. But the board and chassis wiring are simple, and parts replacement should be no problem.

I found the model 600 a pleasure to use. It has con-

NEW! LAFAYETTE HB-525C Solid State 2-Way Radio

WITH



99-3156WX

- Size: 2 3/8" by 6 1/4"

149⁹⁵

No Money Down

23 CB Crystal Controlled Channels All Crystals Supplied!

FCC Type Accepted + D.O.T. Approved

- 32 Semiconductor Performance with IC, 18 Transistors, and 9 Diodes
- Dual Conversion for High Selectivity
- Full 5-Watt Input
- Range Boost™ Circuitry for Added Power
- 3-Position Delta Tune—Provides Accurate Fine Tuning
- Mechanical 455KC Filter for Superior Selectivity
- Front Panel "S/Prf" Meter • Variable Squelch Plus ANL
- Public Address System (with external speaker)
- 12-Volt DC Operation (pos. or neg. ground) 6-Volt DC (with optional DC Power Supply)
- Accepts Priva-Com® Plug-in Tone Caller

*Imported



FREE

JUST OFF PRESS!

**1968
CATALOG 680
Over 500
Pages**

Featuring Everything in Electronics for
• HOME • INDUSTRY • LABORATORY
from the "World's Hi-Fi & Electronics Center"

LAFAYETTE Radio ELECTRONICS
Dept. JA-8 P.O. Box 10
Syosset, L. I., N. Y. 11791

Send me the FREE 1968 Lafayette Catalog 680

JA-8

Name _____

Address _____

City _____ State _____ Zip _____

Circle 26 on reader's service card



TEST TRANSISTORS IN SECONDS in circuit

TR139
89⁵⁰



Also check all transistors, diodes, and rectifiers out of circuit for true AC beta and Icbo leakage.

Your best answer for solid state servicing, production line testing, quality control and design.

Sencore has developed a new, dynamic in-circuit transistor tester that really works—the TR139—that lets you check any transistor or diode in-circuit without disconnecting a single lead. Nothing could be simpler, quicker or more accurate. Also checks all transistors, diodes and rectifiers out of circuit.

BETA MEASUREMENTS—Beta is the all-important gain factor of a transistor; compares to the gm of a tube. The Sencore TR139 actually measures the ratio of signal on the base to that on the collector. This ratio of signal in to signal out is true AC beta.

ICBO MEASUREMENTS—The TR139 also gives you the leakage current (Icbo) of any transistor in microamps directly on the meter.

DIODE TESTS—Checks both rectifiers and diodes either in or out of the circuit. Measures the actual front to back conduction in micro-amps.

COMPLETE PROTECTION—A special circuit protects even the most delicate transistors and diodes, even if the leads are accidentally hooked up to the wrong terminals.

NO SET-UP BOOK—Just hook up any unknown transistor to the TR139 and it will read true AC beta and Icbo leakage. Determines PNP or NPN types at the flick of a switch. Compare to laboratory testers costing much more. . . . \$89.50

See America's Most Complete Line of Professional Test Instruments — At Your Distributor Now.

NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT
SENCORE
426 SOUTH WESTGATE DRIVE, ADDISON, ILLINOIS 60101

Circle 27 on reader's service card

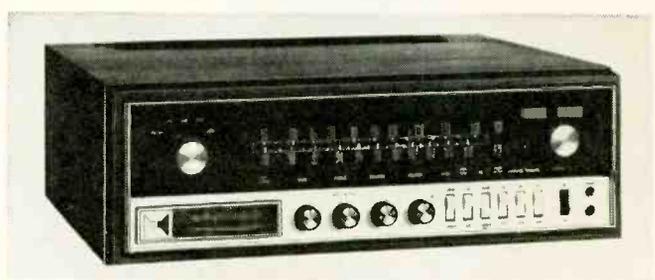
EQUIPMENT REPORT *continued*

venient, well-spaced scale ranges, and it checked out within the specified 3% accuracy. The 0.4-volt dc range is especially useful for troubleshooting transistor circuits.

One caution: Like a vom, the TVO is not shielded. But, like a vtm, it has amplifiers. This could mean stray pickup if you aren't careful when using it around a transmitter or high rf field. I took the model 600 to a vhf TV station and walked around the transmitter room with it. I could get spurious pickup only by "floating" both test leads; when I shorted them or connected them to a load the TVO worked fine. Still, it's a good idea to remember there's no shield—just in case you get erratic readings.—Ray Clifton

Heathkit AR-15
AM-FM-Stereo Receiver
Circle 43 on reader's service card

522
APRIL
p 12+14



A COMPLETE STEREO RECEIVER WITH BOTH FM AND AM, an output power of some 70 watts per channel, a full complement of controls and function switches, is no simple little thing. When a machine like that is sold as a kit, it had better be worth the time and effort it takes to assemble.

After living with the AR-15 for a couple of weeks (I didn't build it) I can say quite candidly that I would be pleased and proud to build a stereo system around it. In several ways it is the best-looking, best-performing component (never mind *kit*) of its kind that I have seen for a long time.

The AR-15 is astonishingly sensitive and selective. One of my favorite tests in the New York City area is to wiggle between WQXR-FM on 96.3 MHz and WNBC-FM on 97.1 (both high-power locals) and see how well I can receive the relatively weak 96.7-MHz signal of WSTC-FM—a station in Stamford, Conn., about 35 air miles from where I live. (All this with indoor rabbit-ears on the ground floor.) Not many tuners come off well on *that* test. The AR-15

MANUFACTURER'S SPECIFICATIONS

- AMPLIFIER SECTION**
- Continuous power output, per channel: 8-ohm load, 50 watts. (mV reference) —65 dB.
 - Power bandwidth for constant 0.5% total harmonic distortion: 6 Hz to 25 kHz. Channel separation: PHONO, 45 dB; TAPE and AUX, 55 dB.
 - Frequency response (1-watt level): ±1 dB, 6 to 50,000 Hz, ±3 dB, 4 to 70,000 Hz.
 - Harmonic distortion: Less than 0.5% from 20 to 20,000 Hz at 50 watts output; less than 0.2% at 1000 Hz with 50-watts output; less than 0.2% at 1000 Hz with 1-watt output.
 - IM distortion: (60 Hz: 6000 Hz, 4:1): Less than 0.5% with 50 watts output; less than 0.2% with 1 watt output.
 - Damping factor: 45
 - Hum & noise: Volume control at minimum position, —80 dB. PHONO (10-mV reference) —60 dB. TAPS and AUX (200 mV reference) —65 dB.
- FM SECTION (MONO)**
- Selectivity: 70 dB
 - Image rejection: 90 dB
 - I.f. rejection: 90 dB minimum
 - Capture ratio: 1.5 dB
 - AM suppression: 50 dB
 - Sensitivity: 1.8 μV
- FM SECTION (STEREO)**
- Separation: 40 dB or greater.
 - 19- and 38-kHz suppression: 55 dB or greater.
 - SCA suppression: 50 dB
- AM SECTION**
- Sensitivity: 12 μV at 1000 kHz
 - Image rejection: 60 dB at 600 kHz; 40 dB at 1400 kHz.
 - I.f. rejection: 70 dB at 1000 kHz.
 - Power: 105–125 or 210–250 volts, 50/60-Hz ac.
 - Size: 16 7/8" x 4 3/4" x 14 1/2"
 - Price: \$329.95 kit, \$19.95 for cabinet.

received WSTC-FM almost perfectly, with no hiss and only an occasional faint crackle from the ignition of a passing car. There was no breakthrough from the neighboring New York stations.

This performance is due partly to the use of low-cross-modulation FET's in the AR-15 front end, and to the excellent limiting provided by the integrated-circuit i.f. amplifiers and their crystal filters.

The muting system is not completely satisfactory. If you adjust it so that it cuts out only interstation hiss, but not weak signals, there is a jarring burst of badly distorted sound-plus-hiss as you tune from between-station silence into the center of a channel. To eliminate that, you have to turn the squelch threshold higher, and then the tuner will pass over some weak signals without a peep. The muting works at least as well as on most other tuners, but there are designs in which stations emerge smoothly from complete silence after you have tuned to the center of the channel.

The AR-15 has two tuning meters—one is a relative-signal-strength indicator, which can be helpful in orienting an antenna, and the other is a center-of-channel indicator, which is more useful for precise tuning. Only the signal-strength meter operates on AM. These meters are used during assembly to check voltages and resistance as construction moves forward. The AR-15 does about the best it can with AM reception, although it compromises between wide bandwidth (nice for good-quality local stations, of which there are few), and really sharp selectivity (necessary for distant stations with considerable interference).

There are screwdriver-adjustable level controls for each program source. That such controls were included at all is nice enough, but to have them accessible from the front is marvelous. The level trimmers are separate for left and right, so you can feed the remainder of the receiver's audio circuitry with a perfectly balanced stereo signal.

Heath gives unusually complete specifications for the AR-15. Almost everything that can be measured and stated in numbers has been included, which is a healthy sign. For example, along with sensitivity figures for various inputs, the overload levels are given. There's a margin of some 20 dB between the input level that produces full output and the level at which the *input* stages overload. Very good.

FM sensitivity and capture ratio are as good as those of any tuner available. The Heath AR-15 is well worth what it costs—in money and in time, unless you need to measure your time as money. It may well be the best receiver on the market now, kit or wired.—*Peter E. Sutheim*

Knight-Kit KG-663 DC Power Supply

Circle 44 on reader's service card

TODAY'S EXPERIMENTERS AND HOBBYISTS—NOT TO MENTION service technicians—work with transistors, IC's, SCR's and Zeners. When you breadboard a circuit or troubleshoot a chassis, you need a low-voltage, high-current bench supply. Here's one that's versatile and protective.

Being slow and careful, I took nearly 12 hours to assemble the KG-663. Components are easily mounted on tie strips, and the hookup wires furnished are color-coded and sized for each specific job. The construction manual is easy to follow; parts are conveniently identified.

This power supply is useful in several ways. It can furnish either voltage or current regulation, depending on what you need for a particular application. You can connect two or more KG-663's in series (for higher voltage) or in paral-

MANUFACTURER'S SPECIFICATIONS

Output Voltage: 0–40 volts
Output Current: 0–1.5 amps
Input Voltage Range: 110–130 volts, 50/60 Hz
Output Load Regulation: Less than 0.06 volt from no load to full rated load.
Line Regulation: Less than 0.3 volt change under all load conditions.
Current Limiting: Continuous, adjustable from front panel.
Short-Circuit Protection: Continuous dissipation type.
Output Impedance: Less than 0.1 ohm from dc to 10 kHz; less than 0.5 ohm to 100 kHz.
Power: 110–130 volts, 50/60 Hz; 20 watts no load; 110 watts at full rated load.
Ripple (full load): Less than 0.6 mV rms
Semiconductors: 11 diodes and 6 transistors
Size: 7 3/4" x 7 1/2" x 10 3/4"
Weight: 16 lb
Price: \$94.50 kit, \$140.00 wired



lel (for higher current). Put the supply on a bench and, with its remote-control facility, you can control it from across the room. There's also provision for remote error sensing—to overcome voltage drop in long test leads.

I said the KG-663 is protective. True—you can't damage anything by putting a dead short on the output terminals; a monitor circuit limits short-circuit current to a safe value.

Two meters monitor output voltage and current. In the STANDBY mode a red panel lamp comes on; in OPERATE a green one lights. Oh yes—the output floats above ground—with the chassis brought out to a separate binding post.

The KG-663 is easy to build, useful and worth the price.—*Thomas R. Haskett* **R-E**

FREE!



BRAND NEW EDITION FALL AND WINTER RADIO-TV ELECTRONICS CATALOG

THE WORLD'S MOST
FAMOUS CATALOG OF
ELECTRONIC EQUIPMENT!

YOUR BUYING GUIDE FOR:
 • Stereo & Hi-Fi Systems & Components
 • Tape Recorders
 • Electronic Parts, Tubes, Tools
 • Phonos & Records
 • Ham Gear
 • Test Instruments & Kits
 • Cameras & Film
 • PA
 • Citizens Band
 • Radio & TV Sets
 • Musical Instruments

SEND FOR YOURS TODAY!

MAIL TODAY TO:



BURSTEIN-APPLEBEE

Dept. R M, 1012 McGee, Kansas City, Mo. 64106

Name _____
 Address _____
 City _____ State _____ Zip Code _____

DO YOUR FRIEND A FAVOR... ALSO INCLUDE HIS NAME AND ADDRESS IN ENVELOPE WHEN MAILING YOUR REQUEST

Circle 28 on reader's service card

WORTH WAITING FOR!



DYNACO PAT-4

Kit—\$89.95; Assembled—\$129.95

A transistorized version of the famous Dynaco PAS-3X pre-amplifier with equivalent performance and many added features.

- Extraordinary versatility with simplicity
- Dynaco's patented center-flat tone controls with independent concentric knobs
- 4-position high filter
- Low filter
- Front panel input for guitar or tape recorder, and output for headphones or similar 600 ohm or higher impedance loads
- Infinitesimal distortion and noise
- Modular design for easy kit assembly
- Matches the FM-3 tuner.

The waiting list is already thousands long, so there will necessarily be delays in meeting the demand. Please be patient if your dealer does not yet have the PAT-4. Meanwhile, the PAS-3X will give comparable noise-free, distortionless performance at a \$20 saving.

Specifications available

DYNACO INC.
3060 Jefferson St., Phila., Pa. 19121
IN EUROPE WRITE:
DYNACO A/S, HUMLUM, STRUER, DENMARK

Circle 29 on reader's service card

Shunt Regulators

(continued from page 37)

- 1) See if the set has too much brightness and possibly blooms, or retrace lines appear.
- 2) Set the CRT controls as outlined previously.
- 3) Check the boosted B+ and set the HV ADJ for proper current through the 6BK4 with a black screen.
- 4) Check the 400-volt supply and the cathode voltage of the shunt regulator.
- 5) Replace the 3A3 and 6BK4.

If the 6BK4 current is too high—more than 1 volt drop across the cathode resistor:

- 1) See if the set has adequate brightness.
- 2) Set the kinescope controls as outlined previously.
- 3) Dip the horizontal-output current with the HORIZONTAL EFFICIENCY coil.
- 4) Next see which part of the 6BK4 circuit—grid or cathode—has upset the bias. Check both the 850-volt boost and the 400-volt B+ source. Next check the resistor divider network (be careful of any resistor above 1 megohm). Set the HV ADJ control for the proper current flow through the 6BK4.

At no time is it absolutely necessary to measure the high voltage. The time and small effort, if taken, would give a valuable secondary check. If you have a vtm and an HV probe, by all means, use them. Note that this is a secondary measurement; the amount of 6BK4 current is more important.

Points to watch

Anytime the picture tube blooms—the set is *misadjusted* and high-voltage failures begin.

Anytime the CRT blooms—the shunt regulator has lost control, and the HV is unregulated.

The 1-volt minimum reading across the regulator cathode resistor is with a black screen.

Any of the CRT controls could cause the picture to bloom:

- 1) The RED, GREEN and BLUE SCREEN controls—Set for a *dim* white line.
- 2) The customer brightness control—Set at 75% to 90% of full clockwise rotation, then set screens.
- 3) The CRT bias or picture bias control—Set *only* high enough to bring in the least dominant gun with *full screen* on that gun.

Know the high-voltage and shunt-regulator circuits, and you'll find them easy to troubleshoot. Makes the difference between doing a good job and just a mediocre one. **R-E**

COMING NEXT MONTH

BUILD—Inexpensive but reliable scope and voltmeter calibrator to keep tabs on drift, deviation and other test equipment inaccuracies. Has calibration points of 1, 10 and 100 volts of ac and dc, with accuracy between 1% and 3%. Employs a neon lamp as a voltage reference.

SERVICE—Learn how to service solid-state TV receivers. Transistor circuits require logical, nondestructive troubleshooting techniques. Stay out of trouble—read about these practical tips.

AUDIO—Large convention halls and auditoriums present feedback and reverberation problems galore. Learn how an "impossible" problem was solved with new techniques.

YOU ASKED FOR IT—Build a Mini-Tenna, a solid-state FM antenna that fits into the palm of your hand. (This 4-transistor construction project was inspired by the Subminiature Integrated Antenna (SIA) which was designed for military use. The editors challenge you to have better luck with it than they did.

AUDIO—Recording live music on your stereo tape machine? Find out about "curtain-of-sound" miking techniques to achieve best stereo effect.

SERVICE—Ultrasound equipment is used for cleaning and other manufacturing processes. Learn how the equipment works and how to troubleshoot it. It isn't that much different from certain home type electronic equipment you've already worked with.

AND . . . an electronic tremolo you can build for guitar or organ . . . how to set up remote audio lines for a two-way radio system . . . tips on troubleshooting color TV picture tubes. Yes, all this and more . . . in the next issue

of **RADIO-ELECTRONICS.**

RADIO-ELECTRONICS

Build

Quickie Spectrum Sweeper

Phono motor drives local oscillator in AM radio . . . all over the band

By **FRED W. RODEY**

WOULD YOU BELIEVE THAT YOU CAN mix an old phono motor with an old radio and come up with a spectrum sweeper? You can sweep the broadcast band or produce a single 455-kHz i.f. signal. You can also modify the Spectrum Sweeper to work other frequencies.

A recent problem made necessary a spectrum analyzer that would cover a wide band of frequencies in the broadcast band to check harmonic sidebands on a 50-kW transmitter. Voltage-variable capacitors were tried, but their low Q and small capacitance change was a handicap.

Saturable-core inductors have been used to solve this problem, but none

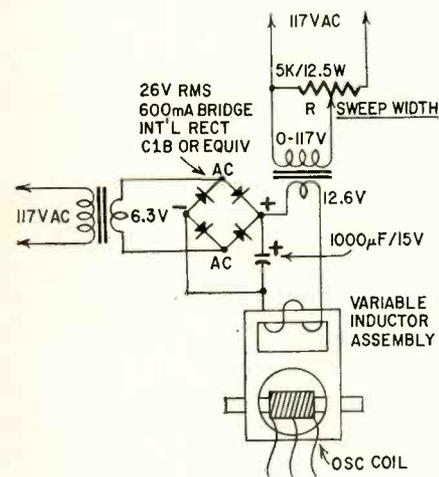


Fig. 1—Direct current establishes the average inductance and ac varies it. Both transformers are connected to the line.

Parts List

Silicon rectifier bridge, 600 mA, (International Rectifier C1B or similar)
 Capacitor, 1000 µF, 15 volts
 Potentiometer, 5000 ohms, 12.5 watts, (Ohmite Type E-0123 or similar)
 Transformers (2): Both with 117-volt primaries, one with 6.3-volt secondary, the other with 12.6-volt secondary.
 Phonograph motor: 117 volt, 60 Hz, ac, 2 pole

could be found on the dealer's shelves to satisfy me; so I decided to construct one. A saturable-core device can be made to work by passing both ac and dc through a control coil on the core. The dc level establishes the average inductance and

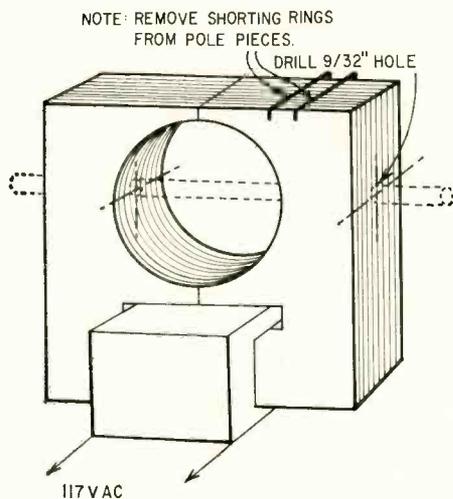


Fig. 2—Salvage the stator coil and frame from a phonograph motor. Discard the rotor and shorting rings and drill the holes.

the ac varies the inductance (at a 60 Hz rate). See Fig. 1. While both currents run through this coil, two separate transformers should be used.

The unit I built proved to be a very successful sweeper. It can be adapted to any variable-frequency application, so only the general details of construction are given.

The magnetic coil and frame are taken from a 117-volt 2-pole shaded-pole phonograph motor. Only the coil and frame are used. Discard the rotor assembly. Select a motor with a large diameter rotor (about 1 inch).

Mark off center lines and drill 9/32-inch holes through both pole ends.

The holes must be in line (Fig. 2). Clamp or bolt the pole ends together tightly while drilling, to hold the laminations in place.

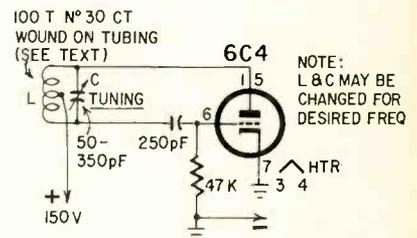
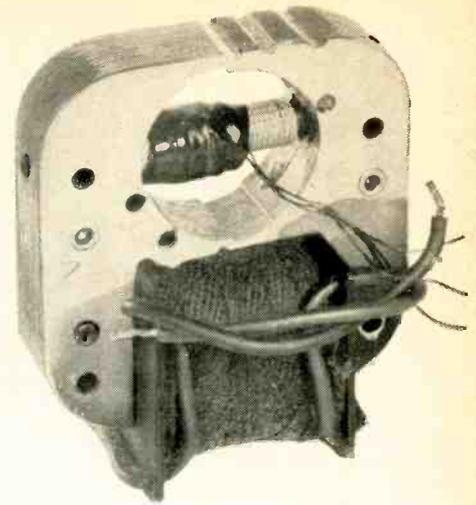


Fig. 3—A suggested oscillator circuit for use with the variable sweep device.

To make the rf coil, use a 1/4-inch ferrite rod 2 1/2 or 3 inches long. This is not critical. Cut a length of nonmetallic tubing that will slip easily over the ferrite rod. It should be just long enough to fit inside the motor frame between the poles. The rf coil is then wound on the tubing. Additional coils can be wound on similar pieces of tubing to cover other portions of the spectrum.

To assemble the unit, insert the ferrite rod into the holes in the pole ends and through the rf coil tubing.

Any type of oscillator circuit can be used. A center-tapped coil makes a simple arrangement, and eliminates the need for the rf chokes required in the usual two-terminal configuration. The oscillator in Fig. 3 has a center frequency of 1,150 kHz, ±50 kHz, with 12 volts ac on the control coil. By varying the Sweep Width control (Fig. 1) to reduce the control voltage to 6 volts, the circuit will sweep ±25 kHz. Check the oscillator with a wideband oscilloscope to be sure its output is flat over the entire range swept.

The sweep oscillator was used to replace the local oscillator in a receiver to sweep a spectrum. The rf stage had to be made broad enough to pass the entire band of frequencies to be observed.

You can broaden the passband simply by disconnecting the variable capacitor in the rf stage. If too much sensitivity is lost, reconnect the capacitor, tune it to the center frequency and shunt the circuit with a resistor. The lower the value of the resistor, the broader the band, and the lower the gain. **R-E**

RADIO-ELECTRONICS READER'S SERVICE

Here's how you can get manufacturers' literature fast:

1. Tear out the post card on the facing page. Clearly print or type your name and address.

Include zip code! Manufacturers will not guarantee to fill your requests unless your zip code is on the reader service card!

2. Circle the number on the card that corresponds to the number appearing at the bottom of the **New Products, New Literature or Equipment Report** in which you are interested.

For literature on products advertised in this issue, circle the number on the card that corresponds to the number appearing at the bottom of the advertisement in which you are interested. Use the convenient index below to locate quickly a particular advertisement.

3. Mail the card to us (no postage required in U.S.A.)

Advertisements in this issue offering free literature (see the advertisements for products being advertised):

ARCO ELECTRONICS (A Division of Loral Corporation) (Second Cover)	Circle 7
ARCTURUS ELECTRONICS CORP. (Pg. 98)	Circle 142
ARROW FASTENER CO., INC. (Pg. 80)	Circle 107
ARTISAN ORGANS (Pg. 86)	Circle 114
B & K (Division of Dynascan Corporation) (Pg. 7)	Circle 11
BROOKS RADIO & TV CORP. (Pg. 92-93)	Circle 125
BURSTEIN-APPLEBEE CO. (Pg. 71)	Circle 28
CASTLE TV TUNER SERVICE, INC. (Pg. 86)	Circle 113
CLEVELAND INSTITUTE OF ELECTRONICS (Pg. 5)	Circle 9
CLEVELAND INSTITUTE OF ELECTRONICS (Pg. 18-21)	Circle 18
CORNELL ELECTRONICS CO. (Pg. 100)	Circle 146
DELTA PRODUCTS, INC. (Pg. 85)	Circle 112
DELWYN (Pg. 14)	Circle 14
DYNACO, INC. (Pg. 72)	Circle 29
EDMUND SCIENTIFIC CO. (Pg. 99)	Circle 143
EICO ELECTRONIC INSTRUMENT CO., INC. (Third Cover)	Circle 149
ELECTRO-VOICE, INC. (Pg. 6)	Circle 10
FINNEY CO. (Pg. 13)	Circle 13
GC ELECTRONICS CO. (Pg. 82)	Circle 109
G/L ELECTRONICS BOOK CLUB (Pg. 87)	Circle 115
HEALD COLLEGES (Pg. 95)	Circle 121
HEATH COMPANY (Pg. 78-79)	Circle 106
INTERNATIONAL CRYSTAL MFG. CO., INC. (Pg. 102)	Circle 148

HELP US COMPLETE THIS PROFILE OF OUR READERS!

At the bottom of the Reader's Service Card, you'll find numbers from 1 through 6. Read the following questions and then circle your answers on the Reader's Service Card.

EQUIPMENT OWNED.

- 1 CB equipment
- 2 Tape Recorder
- 3 Component hi-fi system
- 4 Amateur Radio Station
- 5 Test equipment
- 6 Short-wave receiver

JUDSON RESEARCH AND MFG. CO. (Pg. 95)	Circle 119
LAFAYETTE RADIO ELECTRONICS (Pg. 69)	Circle 26
LECTROTECH, INC. (Pg. 88)	Circle 116
MOSLEY ELECTRONICS, INC. (Pg. 84)	Circle 111
MUSIC ASSOCIATED (Pg. 97)	Circle 124
OLSON ELECTRONICS, INC. (Pg. 96)	Circle 122
PERMA-POWER COMPANY (Pg. 81)	Circle 108
PERMOFLUX CORP. (Pg. 95)	Circle 120
POLY PAKS (Pg. 101)	Circle 147
READING IMPROVEMENT PROGRAM (Pg. 93)	Circle 118
S & A ELECTRONICS INC. (Pg. 4)	Circle 8
SAMS & CO., INC., HOWARD W. (Pg. 22)	Circle 19
SAMS & CO., INC., HOWARD W. (Pg. 83)	Circle 110
SCHOBER ORGAN CORP., INC. (Pg. 26)	Circle 22
SENCORE (Pg. 23)	Circle 20
SENCORE (Pg. 63)	Circle 24
SENCORE (Pg. 70)	Circle 27
SENTRY MANUFACTURING COMPANY (Pg. 92)	Circle 117
SOLID STATE SALES (Pg. 99)	Circle 144
SPRAGUE PRODUCTS COMPANY (Pg. 12)	Circle 12
SURPLUS CENTER (Pg. 96)	Circle 123
SYLVANIA (Subsidiary of General Telephone & Electronics) (Pg. 24-25)	Circle 21
WARREN ELECTRONIC COMPONENTS (Pg. 100)	Circle 145
WELLER ELECTRIC CO. (Pg. 68)	Circle 25
WINEGARD CO. (Pg. 17)	Circle 17
ZENITH (Pg. 62)	Circle 23

NEW COMMUNICATIONS PRODUCTS

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

CB BATTERY PACK, Model PAP-1, Port-A-Pak features a rechargeable battery which operates most solid-state CB rigs in receive position for 8 hours. Can be recharged while in standby position. In-



cludes a collapsible antenna, battery and battery meter, durable case, charging connector, mounting hardware, shoulder strap and microphone bracket. \$12.95—Courier Communications, Inc.

Circle 46 on reader's service card

CB AND MOBILE MICROPHONE, Model +350. Contains a transistorized preamplifier which provides improved transmission quality compared to carbon

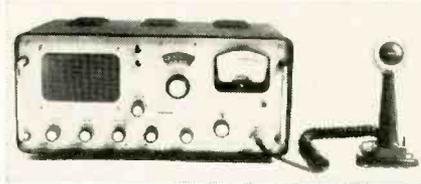


microphones. Output level is -38 dB below 1 volt per dyne per square centimeter. Response is 350-4,000 Hz. \$35.00—Turner Microphone Co.

Circle 47 on reader's service card

BASE STATION, Titan II. It is a single-sideband receiver and a double-

sideband suppressed-carrier transmitter. Mechanical filter produces 90-dB adja-



cent-channel selectivity. Input for 10 dB signal-plus-noise-to-noise ratio is 0.15 μ V, delivers 4 watts maximum output. Contains 23 transmit crystals. \$482.—Tram Corp.

Circle 48 on reader's service card

WIRELESS INTERCOM, Model AM-340. Hold in hand or hang on wall. Solid-state unit works between rooms,



apartments, offices or adjacent buildings. To operate, units are plugged into 117 Vac outlet. \$29.98—Olson Electronics, Inc.

Circle 49 on reader's service card

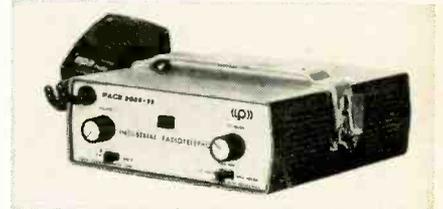
FM MONITOR RECEIVERS, Model FR-104 and Model FR-105. Adaptable for commercial and industrial applications, these solid-state units operate on 117 Vac, 50/60 cycles and 12 Vdc. Plug-in channel crystals allow instant frequen-



cy change. Model FR-104 operates in the 25-50 MHz band, sensitivity is 0.3 μ V, and selectivity 6 dB and model FR-105 (shown) operates in the 150-175 MHz band, sensitivity is 0.8 μ V, and selectivity 60 dB. \$140.—Sonar Radio Corp.

Circle 50 on reader's service card

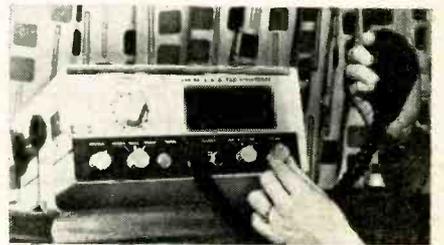
2-WAY MOBILE RADIO, PACE 2000. Comes in 3 frequency ranges: 25-35, 35-45, and 45-50 MHz and can be used as a base station or mobile installation. Features lifetime-guaranteed glass-



fiber circuit boards, double-conversion receiver, 12 Vdc or ac operation, full diode protection and Zener regulation. Use of silicon transistors permits operation in temperatures from -40°F to +155°F. Pace Communications Corp.

Circle 51 on reader's service card

MARINE RADIOTELEPHONE. Operates with static-free clarity in vhf bands. Can transmit at full power with an antenna as short as 20 inches and needs no ground plate attached to the boat's



hull. This 12-channel two-way radio can be used to talk with other boats, call for assistance, or talk with anyone ashore through a telephone company operator. 40-50-mile range. \$595.—Raytheon Company

Circle 52 on reader's service card

BASE STATION, Model DJ95. Operable on one to six channels in the 148-174 MHz band. Power output is 30 watts and receiver sensitivity is 0.35 μ V for 12



dB SINAD. Adjacent-channel selectivity is -70 dB and bandwidth is 13 kHz. Spurious response is down 100 dB. Three other Models also available.—Kaar Electronics Corp.

Circle 53 on reader's service card

14 NEW KITS FROM HEATH...

For The Whole Family . . .

New Deluxe "227" Color TV

Exclusive Heathkit Self-Servicing Features. Like the famous Heathkit "295" and "180" color TV's, the new Heathkit "227" features a built-in dot generator plus full color photos and simple instructions so you can set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting charts in the manual, and you put an end to costly TV service calls for periodic picture convergence and minor repairs. No other brand of color TV has this money-saving self-servicing feature.

Advanced Features. Boasts new RCA Perma-Chrome picture tube for 38% brighter pictures . . . 227 sq. in. rectangular viewing area . . . 24,000 v. regulated picture power . . . improved phosphors for brilliant, livelier colors . . . new improved low voltage power supply with boosted B+ for best operation . . . automatic degaussing . . . exclusive Heath Magna-Shield to protect against stray magnetic fields and maintain color purity . . . ACC and AGC to reduce color fade and insure steady, flutter-free pictures under all conditions . . . preassembled & aligned 1F with 3 stages instead of the usual 2 . . . preassembled & aligned 2-speed transistor UHF tuner . . . deluxe VHF turret tuner with "memory" fine tuning . . . 300 & 75 ohm VHF antenna inputs . . . two hi-fi sound outputs . . . 4" x 6" 8 ohm speaker . . . choice of installation — wall, custom or optional Heath factory assembled cabinets. Build in 25 hours.

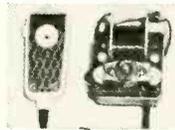
Kit GR-227, (everything except cabinet) . . . \$42 dn., as low as \$25 mo. . . 114 lbs. **\$419.95**

GRA-227-1, Walnut cabinet. . . no money dn., \$6 mo. **\$59.95**

GRA-227-2, Mediterranean Oak cabinet (shown above) . . . no money dn., \$10 mo. **\$94.50**



Kit GR-227
\$419.95 (less cabinet)
\$25 mo.



Kit GRA-27
\$19.95

New Remote Control For Heathkit Color TV

Now change channels and turn your Heathkit color TV off and on from the comfort of your armchair with this new remote control kit. Use with Heathkit GR-227, GR-295 and GR-180 color TV's. Includes 20' cable.



Kit GR-295
\$479.95
(less cabinet)
\$42 mo.

Deluxe Heathkit "295" Color TV

Color TV's largest picture . . . 295 sq. in. viewing area. Same features and built-in servicing facilities as new GR-227. Universal main control panel for versatile in-wall installation. 6" x 9" speaker.

Kit GR-295, (everything except cabinet), 131 lbs. . . . \$48 dn., \$42 mo. **\$479.95**

GRA-295-1, Walnut cabinet (shown above), 35 lbs. . . . no money dn., \$7 mo. **\$62.95**

Other cabinets from \$94.50



Kit GR-180
\$359.95
(less cabinet & cart)
\$31 mo.

Deluxe Heathkit "180" Color TV

Same high performance features and exclusive self-servicing facilities as new GR-227 (above) except for 180 sq. in. viewing area.

Kit GR-180, (everything except cabinet), 102 lbs. . . . \$36 dn., \$31 mo. **\$359.95**

GRS-180-5, table model cabinet & mobile cart (shown above), 57 lbs. . . . no money dn., \$5 mo. **\$39.95**

Other cabinets from \$24.95



Heathkit®/Thomas "Paramount" Theatre Organ

Save Up To \$500! Build in 80-100 hours. All Thomas factory-made parts . . . 15 manual, 4 pedal voices; instant-play Color-Glo; all-transistor circuit; 200 watts peak power; 2-speed rotating Leslie plus main speaker system with two 12" speakers; 44-note keyboards; horseshoe console with stop tablets; 28-note chimes; 13-note bass pedals; repeat & attack percussion; reverb; headset outlet; assembled walnut finish hardwood cabinet & bench; and more. 265 lbs. 7", 33 1/3 rpm demonstration record 50c.

FREE... 40-Lesson Record Course With Either Heathkit / Thomas Organ! A \$50 Value Includes four 33 1/3 rpm records, music book & leatherette album.

Kit TO-67
\$995
(including bench)
\$200 dn.,
as low as \$29 mo.

America's Lowest Cost Solid-State Organ

Kit GD-325B
\$394.90
\$40 dn., \$34 mo.

Save Up To \$205! Instant-play Color-Glo; 10 voices; 13-note bass pedals; repeat percussion; 37-note keyboards; 75-watt peak power; vibrato; assembled walnut cabinet & bench. 172 lbs. 7", 33 1/3 rpm demonstration record 50c.



Exclusive Band Box Percussion

Automatically or manually adds 10 percussion voices to any Heathkit/Thomas organ. Build & install in 12 hours.

Kit TOA-67-1, no money dn., \$14 mo. **\$145.00**

Exclusive Playmate Rhythm Maker

Adds 15 fascinating rhythms to any Heathkit/Thomas Organ. Requires Band Box percussion (above) for operation.

Kit TOA-67-5, no money dn., \$18 mo. **\$189.90**



Circle 106 on reader's service card

USE COUPON BELOW TO ORDER NOW

NEW! VOX "Jaguar" Transistor Combo Organ By Heathkit



Kit TO-68
\$349.95
\$35 dn., \$30 mo.

Save Up To \$150 on the world's most popular combo organ with this new Heathkit version. Features the most distinctive sound of any combo organ. Has a special bass output that gives a brilliant stereo effect when played through a separate or multi-channel amplifier, 4 complete octaves, vibrato, percussive effects and reversible bass keys. Includes hand crafted orange and black cabinet, fully plated heavy-duty stand, expression pedal and waterproof carrying cover and case for stand. Requires a bass or combo amplifier like Heathkit TA-17 (opposite page).

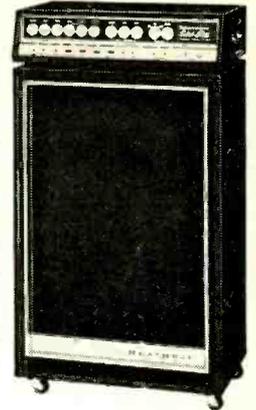
Kit TO-68, 80 lbs. . . \$35 dn., \$30 mo. **\$349.95**

NEW! Deluxe Solid-State Combo Amplifier & Speaker System . . . Choose Kit Or Factory Assembled

Amplifier
Kit TA-17
\$175
\$17 mo.
(Assembled
TAW-17 \$275)

Speaker System
Kit TA-17-1
\$120
\$11 mo.
(Assembled
TAW-17-1 \$150)

**Special
Combination Offer**
Amplifier & Two
Speaker Systems
Save \$20
Kit TAS-17-2
\$395
\$40 dn.
\$34 mo.
(Assembled
TAW-17-2 \$545)



All the "big sound" features every combo wants . . . tremolo, built-in "fuzz", brightness, reverb, separate bass and treble boost and more. Delivers a shattering 120 watts EIA music power (240 watts peak power) through two TA-17-1 speakers . . . or 90 watts through one TA-17-1 speaker. Features 3 independent input channels, each with two inputs. Handles lead or bass guitars, combo organ, accordion, singer's mike, or even a record changer. All front panel controls keep you in full command of all the action.

Speaker system features two 12" woofers, special horn driver and matching black vinyl-covered wood cabinet with casters & handles for easy mobility.

NEW! Lowest Cost Solid-State Stereo Receiver

Kit AR-17
\$72.95
(less cabinet)
\$8 mo.



Features wide 18-60,000 Hz response @ ±1 db at full 5 watts RMS power per channel . . . 14 watts music power . . . inputs for phono and auxiliary . . . automatic stereo indicator . . . outputs for 4 thru 16 ohm speakers . . . adjustable phase for best stereo . . . flywheel tuning . . . and compact 9 1/4" D. x 2 7/8" H. x 11 1/4" W. size. 12 lbs. Optional factory assembled cabinets (walnut \$7.95, beige metal \$3.50).

Kit AR-17, (less cab.) 12 lbs. . . . no money dn., \$8 mo. . . **\$72.95**
Kit AR-27, 7-Watt FM Mono Receiver (less cab.)
9 lbs. . . . no money dn., \$5 mo. **\$49.95**



Kit AR-15
\$329.95
(less cabinet)
\$28 mo.

Assembled
ARW-15 \$499.50
(less cabinet) \$43 mo.

World's Most Advanced Stereo Receiver

Acclaimed by owners & experts for features like integrated circuits & crystal filters in IF amplifier; FET FM tuner; 150 watts music power; AM/FM and FM stereo; positive circuit protection; all-silicon transistors; "black magic" panel lighting; and more. Wrap-around walnut cabinet \$19.95

Kit AR-15 (less cab.), 34 lbs. . . \$33 dn., \$28 mo. . . . **\$329.95**
Assembled ARW-15, (less cab.), 34 lbs. . . \$50 dn.,
\$43 mo. **\$499.50**

Professional 10-Band Shortwave Receiver

Kit SB-310
\$249
\$23 mo.



Covers 49, 41, 31, 25, 19 & 16 meter shortwave . . . 80, 40 & 20 meter ham . . . 11 mete CB Includes 5 kHz crystal filter for AM, SSB and CW listening. Features selectivity that slices stations down to last kHz; 11-tube circuit; crystal-controlled front-end and more. 20 lbs. SB-600 8 ohm 6" x 9" speaker in matching cabinet \$18.95.

NEW! Solid-State Portable Volt-Ohm-Meter

Kit IM-17
\$19.95



So Handy, So Low Cost we call it "every man's" meter. Just right for homeowners, hobbyists, boatowners, CBER's, hams . . . it's even sophisticated enough for radio & TV servicing! Features 12 ranges . . . 4 AC & 4 DC volt ranges, 4 ohm ranges; 11 megohm input on DC, 1 megohm input on AC; 4 1/2" 200 uA meter; battery power; rugged polypropylene case and more. Easy 3 or 4 hour kit assembly. Ideal gift for any man! 4 lbs.



NEW FREE 1968 CATALOG!

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, electric guitar & amplifier, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

HEATH COMPANY, Dept. 20-1
Benton Harbor, Michigan 49022
In Canada, Daystrom Ltd.

Enclosed is \$ _____, including shipping.

Please send model (s) _____

Please send FREE Heathkit Catalog.

Please send Credit Application.

Name _____

Address _____

City _____

State _____

Zip _____

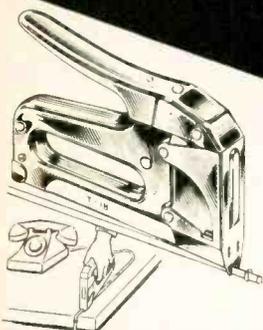
Prices & specifications subject to change without notice.

CL-310R

NEW PRODUCTS

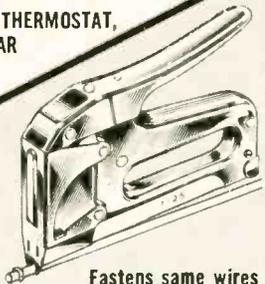
ARROW Automatic STAPLE GUN TACKERS

Specially designed for
SAFE — FAST — SECURE
WIRE & CABLE FASTENING



No. T-18
For wires up to
3/16" in dia.
Uses round crown
staples in
3/8" leg only.

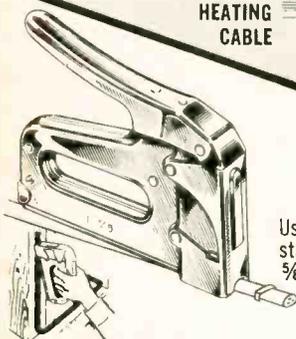
BELL, TELEPHONE, THERMOSTAT,
INTERCOM, BURGLAR
ALARM and other
low voltage
wiring.



No. T-25
For wires up to
1/4" in dia.
Uses round crown
staples in 9/32",
3/8", 7/16", and
9/16" leg.

Fastens same wires
as No. T-18

Also
used for
RADIANT
HEATING
CABLE



No. T-75
For wires and
cables up to
1/2" in dia.
Uses tack-pointed
staples in 9/16",
3/8" and 7/8" leg.

SHEATHED CABLE, RADIANT
HEATING CABLE, WIRE
CONDUIT, COPPER
TUBING, DRIVE
RINGS, ETC.

- All-steel, chrome finish.
- Jam-proof mechanism for trouble-free operation

SAFE! Driving blade automatically halts staple at right depth of penetration! Can't cut or injure wires and cables.

FAST! Powerful single stroke action shoots staples in 1/1000 of a second! Saves 70% in time, effort and efficiency!

HOLDS! Staple points diverge to imbed firmly in wood. Rosin-coated for tremendous holding power!

Write for catalog and information.

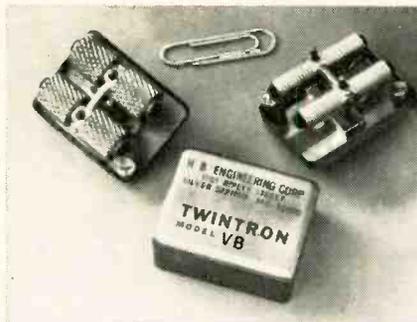
ARROW FASTENER COMPANY INC.

Saddle Brook, New Jersey 07863

"Pioneers and Pacemakers
For Almost A Half Century"

Circle 107 on reader's service card

AF RESONATOR. *Twintron*, a tunable electromechanical resonator available in 100–700 Hz, 300–3000 Hz and 700–8000 Hz frequency ranges. The Q is adjustable from approx. 50 to over 200. Thermal stability is 0.05% from –30 to



+60° C. It can be used by experimenters and builders of radio controls for model aircraft and boats and as audio oscillators, narrow-band pass or reject filters and tone echo reflectors.—H. B. Engineering Corp.

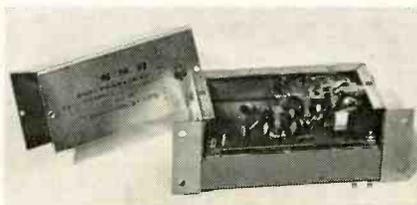
Circle 54 on reader's service card

AM/FM TABLE RADIO, Model S-214. Covers the 19-, 25-, 31- and 49-meter overseas bands plus standard AM/FM broadcasts. Uses 10 transistors and 6 diodes. Has only 5 controls for simple operation. Automatic gain control reduces



fading and blasting. Tuning range is 540–1600 kHz, 5.9–6.25, 11.5–12.0, 15.05–15.55 and 88–108 MHz. There are 3 separate antennas for AM, FM and SW. Encased in a die-cast chromed front and walnut grained-vinyl-covered metal cabinet. \$89.95—Hallicrafters Co.

Circle 55 on reader's service card



SSB-1 RADIO ADAPTER. Designed for one-way mobile communication, the unit is applicable to fire, police, civil defense, marine and commercial uses. A complete FM communications tuner that

feeds an af signal to the automobile radio. Incorporates a squelch system which eliminates all noise. Features FM limiters, advances circuit design and simple mounting. This compact unit has 7 transistors and 5 diodes and is available from 30 through 175 MHz range. Technical data sheet available.—SSB Electronics Co., Inc.

Circle 56 on reader's service card

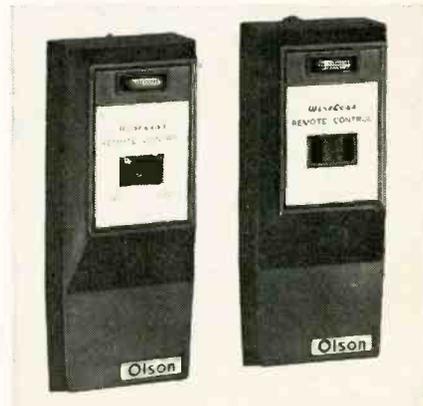
VHF CONVERTER, Weather Watcher. Receives U.S. Weather Bureau forecasts on 162.55 MHz and converts them to play through an AM radio, either



battery or ac-powered. No wired connections are necessary. Kit, \$14.95; finished set, \$18.95.—Executive Research, Inc.

Circle 57 on reader's service card

WIRELESS REMOTE CONTROL SWITCH, Model SW-394. Turn any electric appliance up to 500 watts off and on from anywhere in your home. Appliance is plugged into the receiver



and receiver is plugged into wall outlet. The remote control transmitter plugs into any other outlet in the house. No wires are used. Operates on 110 to 120 volts ac. Transmitter and receiver \$14.95.—Olson Electronics, Inc.

Circle 58 on reader's service card

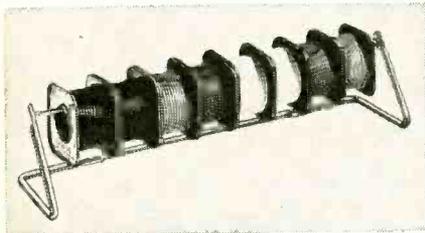
COLOR TV RECEIVER KIT, Model 600. Table model has a 180-sq.-in. picture area and comes with a wood-tone vinyl-clad steel cabinet. Designed for training use, printed circuit boards are used throughout. Incorporates 21



tubes, solid-state uhf tuner and noise cancellation circuit and 16 diodes. Separate gun killer switches and a cross-hatch generator are built in for easy maintenance.—Conar Div. of National Radio Institute.

Circle 59 on reader's service card

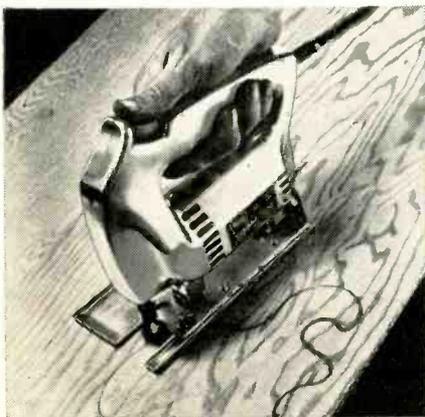
8-SPOOL HOOK-UP WIRE KIT, No. 8816. Features eight spools of 18-gauge stranded vinyl wire on a portable metal rack dispenser, which is easily



mounted on workbench or wall. Each spool holds 25' of wire. Available in brown, red, orange, yellow, green, light blue, white and black.—Belden Corp.

Circle 60 on reader's service card

VARIABLE SPEED SABRE/JIG SAW, Model 521. Thumb pressure controls speed from 0 to 2800 one-inch strokes per minute. Features retractable



shoe plate and man-size handle. Powered by ½-hp 4-amp ac motor and weighs 4½ lbs. Operates on 110-120 Vac. Comes with seven cutting blades. Guaranteed 1 year. \$34.95.—Wen Products, Inc.

Circle 61 on reader's service card



COMMUNICATIONS RECEIVER, DX-150. Operates on either 117 Vac or

12 Vdc. Covers shortwave, ham and CB frequencies from 535 kHz to 30 MHz. Provides AM, SSB and CW reception. Features a product detector, variable pitch bfo, fast/slow avc, built-in monitor speaker, 11 front-panel controls including rf gain control and antenna trimmer. Sensitivity is 0.5 μ V at 30 MHz. Uses 19 transistors, 13 diodes and 3 thermistors. Enclosed in a silver-grey metal cabinet. A 12-volt dc portable power pack and exact-match external communications speaker (SP-150) are optional, \$7.95 each. Receiver is \$119.95. Additional information available.—Radio Shack Corp.

R-E

Circle 62 on reader's service card

New
Perma-Power
Solutions

to these
common
color TV

problems
problems
problems
problems

washed-out
unclear color pictures
from loss of
the black-and-white



color-brite

ISOLATION BRITENER
(NO BOOST)

CORRECTS FOR
CATHODE-TO-FILAMENT
SHORTS—RESTORES
BLACK & WHITE—
REVIVES COLOR QUALITY

MODEL C-502
for round tubes
\$7.25 net

MODEL C-512
for rectangular tubes
\$7.25 net

picture distortion
shrinking, flutter, flop-over,
dullness
from low line voltage



avR

400 WATT
AUTOMATIC
VOLTAGE REGULATOR

Automatically boosts voltage 10 volts when line drops below 110 V—automatically cuts out when line is normal—Maximizes color TV set performance

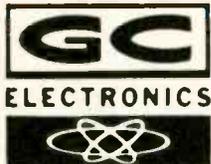
MODEL D-210
400 watt AVR
\$14.95 net

These units are now available from your Perma-Power distributor. Write for Catalog LCB-68 on the full line of Perma-Power products for color and black and white TV service.

**Perma-Power
COMPANY**

5740 North Tripp Avenue
Chicago, Illinois 60646
Phone (312) 539-7171

Circle 108 on reader's service card



has
everything
in

service aids

Every job becomes easier, faster, more efficient with the right equipment, and GC has the right equipment to do the job correctly.

Whether for service or industrial use, choose from an infinite variety of service aids including TV service mirrors, degaussing coils, wire strippers, solder aids, fuse and tube pullers . . . all service designed, and made to rigid GC quality standards for the ultimate in reliability and service life. And, whether you need one or a thousand, all are available from stock for immediate shipment . . . today.

Insist on GC . . . and you'll get the best!

Write for your Giant FREE GC Catalog today . . . over 12,000 items including TV Hardware, Phono Drives, Chemicals, Alignment Tools, Audio, Hi-Fi, Stereo & Tape Recorder Accessories, Nuts & Bolts, Plugs & Jacks, Service Aids, and Resistive Devices.

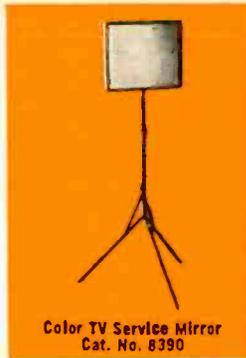
*only GC gives you
everything in electronics.
.....for almost 40 years!*



GC ELECTRONICS COMPANY

400 South Wyman Street
Rockford, Illinois 61101
A DIVISION OF HYDROMETALS, INC.

Circle 109 on reader's service card



Color TV Service Mirror
Cat. No. 8390



NE-O-LITE Circuit Tester
Cat. No. 5100



Strip-Er-Clip Wire Stripper
Cat. No. 760



Color TV Degaussing Coil
Cat. No. 9317

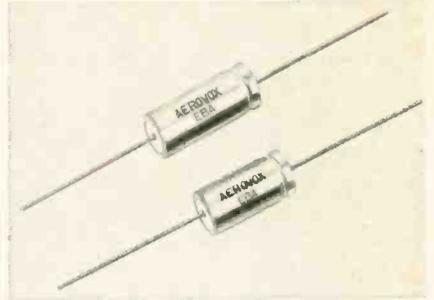


Radio-Phono Chassis
Repair Cradle
Cat. No. 5212



NEW COMPONENT PRODUCTS

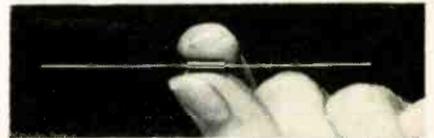
MINIATURE ELECTROLYTIC CAPACITORS. Cased in aluminum and reduced in size, these capacitors are suitable for use in personal radios, microphones, wire recorders, miniature TV re-



ceivers and tape recorders. Eliminate variable or high-resistance connections. 32 types available with ratings from 1 to 1000 μ F, and dc ratings of 3, 6, 10, 15, 25, 35, 70, and 100 volts.—Aerovox Corp.

Circle 63 on reader's service card

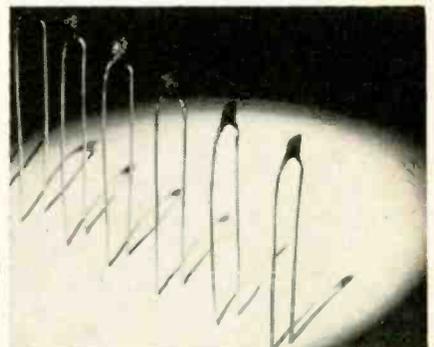
METAL FILM RESISTORS. MAF-60 Series. $\frac{1}{4}$ -watt (at 70°C) and $\frac{1}{8}$ -watt (at 125°C) precision. Change in resistance after 1000-hr. load life is less than



$\pm 0.5\%$. Standard temperature coefficient is 100 PPM/°C. Undercoated with silicone and final-coated with molded epoxy resin. Solder-coated copper axial leads are standard.—P. R. Mallory & Co. Inc.

Circle 64 on reader's service card

SMALL CERAMIC CAPACITORS, Types TMD5 and TMD6. Phenolic-coated with radial-lead construction. Combines multilayer technology with



dipped encapsulation. For conventional or printed wiring assemblies in tuned circuits, delay lines and filter circuits. Standard ratings are from 10 to 100,000 pF.—Cornell-Dubilier Electronics R-E

Circle 65 on reader's service card

THE COLOR TV SERVICING BOOM IS ON!

BE IN ON THE PROFIT PICTURE *with the know-how you get in*
COMPLETE PHOTOFACT® COLOR TV COVERAGE

283 Here are the PHOTOFACT sets with Color TV coverage from the beginning in 1954 through 1967:

1	31	61	91	121	151	181	211	241	271	301	331	361	391	421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871	901
2	32	62	92	122	152	182	212	242	272	302	332	362	392	422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872	902
3	33	63	93	123	153	183	213	243	273	303	333	363	393	423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873	903
4	34	64	94	124	154	184	214	244	274	304	334	364	394	424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874	904
5	35	65	95	125	155	185	215	245	275	305	335	365	395	425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875	905
6	36	66	96	126	156	186	216	246	276	306	336	366	396	426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876	906 Sept
7	37	67	97	127	157	187	217	247	277	307	337	367	397	427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877	907 Sept
8	38	68	98	128	158	188	218	248	278	308	338	367	398	428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878	908 Sept
9	39	69	99	129	159	189	219	249	279	309	339	369	399	429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879	909 Sept
10	40	70	100	130	160	190	220	250	280	310	340	370	400	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880	910 Sept.
11	41	71	101	131	161	191	221	251	281	311	341	371	401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851	881	911 Sept.
12	42	72	102	132	162	192	222	252	282	312	342	372	402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852	882	912 Oct.
13	43	73	103	133	163	193	223	253	283	313	343	373	403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853	883	913 Oct.
14	44	74	104	134	164	194	224	254	284	314	344	374	404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854	884	914 Oct.
15	45	75	105	135	165	195	225	255	285	315	345	375	405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855	885	915 Oct.
16	46	76	106	136	166	196	226	256	286	316	346	376	406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856	886	916 Oct.
17	47	77	107	137	167	197	227	257	287	317	347	377	407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857	887	917 Oct.
18	48	78	108	138	168	198	228	258	288	318	348	378	408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858	888	918 Nov.
19	49	79	109	139	169	199	229	259	289	319	349	379	409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859	889	919 Nov.
20	50	80	110	140	170	200	230	260	290	320	350	380	410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860	890	920 Nov.
21	51	81	111	141	171	201	231	261	291	321	351	381	411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861	891	921 Nov.
22	52	82	112	142	172	202	232	262	292	322	352	382	412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862	892	922 Nov.
23	53	83	113	143	173	203	233	263	293	323	353	383	413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863	893	923 Nov.
24	54	84	114	144	174	204	234	264	294	324	354	384	414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864	894	924 Dec.
25	55	85	115	145	175	205	235	265	295	325	355	385	415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865	895	925 Dec.
26	56	86	116	146	176	206	236	266	296	326	356	386	416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866	896	926 Dec.
27	57	87	117	147	177	207	237	267	297	327	357	387	417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867	897	927 Dec.
28	58	88	118	148	178	208	238	268	298	328	358	388	418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868	898	928 Dec.
29	59	89	119	149	179	209	239	269	299	329	359	389	419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869	899	929 Dec.
30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870	900	930 Jan.

Order Your PHOTOFACT COLOR TV LIBRARY Now!

3 SPECIAL OFFERS:

- ① 1954 up to 1964—full coverage in 60 PHOTOFACT Sets
- ② 1954 through 1966—full coverage in 180 PHOTOFACT Sets
- ③ 1954 through 1967—full coverage in 240 PHOTOFACT Sets

FREE 1-drawer file cabinet with 60 Set Offer; 4-drawer file cabinet with 180 Set Offer; 4-drawer cabinet plus 1-drawer cabinet with 240 Set Offer

USE THE SPECIAL EASY-PAY PLAN

- No interest or carrying charges
- Only \$20 down
- From 12-30 months to pay
- Prepaid transportation
- Save 25¢ per Set—special \$2.25 Set price applies on Easy-Buy (instead of the regular \$2.50 price)

ASK ABOUT THE PHOTOFACT "TRADE-IN" DEAL
(offer available through June 30, 1968)

SEE YOUR SAMS DISTRIBUTOR FOR FULL DETAILS OR MAIL COUPON BELOW TODAY

**GET GOING IN
 COLOR TV!**

JOIN THE PHOTOFACT-OF-THE-MONTH CLUB:



NOW! Only \$10 per month brings you 20% MORE Photofact coverage to keep you current—saves you over \$60 per year!

- Get 6 new Photofact Sets each month
- Covers at least 50 new chassis
- At least 6 Color TV Folders monthly

NEW BONUS: MINIMUM OF 10 "ADVANCE" TV SCHEMATICS (MOSTLY COLOR) WITH EACH MONTH'S ISSUE—PLUS GREAT FILE CABINET DEAL WITH TRIAL 6-MONTH SUBSCRIPTION TO P.O.M. (PHOTOFACT-OF-THE-MONTH CLUB).

HOWARD W. SAMS & CO., Dept. REF-1
 4300 W. 62nd St., Indianapolis, Indiana 46206

- Send full details on Library Offer and Easy-Buy Plan
- Send Photofact-of-the-Month Club details
- Send FREE 1968 PHOTOFACT Cumulative Index

My Distributor is _____

Shop Name _____

Attn.: _____

Address _____

City _____ State _____ Zip _____

Circle 110 on reader's service card

Color TV COAX ACCESSORIES

For 75 Ohm VHF/FM Stereo

by **Mosley**

NEW!

COAX WALL TAPS
DESIGNED TO MEET
YOUR COAX LEAD-IN
NEEDS.



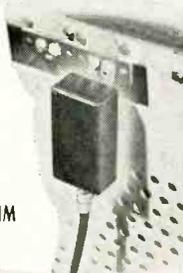
NEW!

COAX LINE SPLITTERS
FOR HIGHLY
EFFICIENT
SIGNAL
DISTRIBUTION

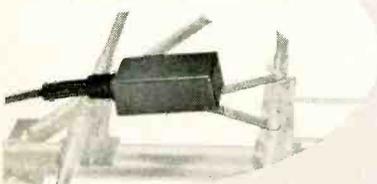


NEW!

COAX
MATCHING
TRANSFORMER
for 300/75,
75/300 OHM



ONE PRODUCT
TO BE USED
INDOOR OR OUTDOOR



For Detailed Brochure Write DEPT 156

Mosley Electronics Inc.



4610 N. Lindbergh Blvd.,
Bridgeton, Mo. 63042

Circle 111 on reader's service card

NEW TEST EQUIPMENT

COLOR GENERATOR, Model 680. Four crystal-controlled oscillators can be operated on ac or battery. Compact, solid-state and portable, it incorporates a wide range of test patterns, including sin-



gle and multiple vertical bars. Uses 26 semiconductors and features nine video patterns and printed circuitry. Available in kit and wired versions.—Conar Instruments

Circle 66 on reader's service card

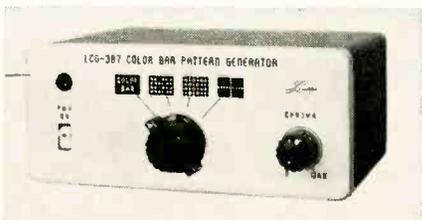
TRANSISTOR ANALYST, Model 161. Checks transistors, diodes and rectifiers out-of-circuit for ac beta and I_{cbo} leakage. Beta ranges are 2 to 100 and 10



to 500, and leakage range is from 0 to 5000 μA . Comes with transistor spec handbook and an instruction manual. \$89.95.—B & K Div., Dynascan Corp.

Circle 67 on reader's service card

COLOR-BAR PATTERN GENERATOR, LCG-387. Rf output: channels 5 and 6, selectable; 10 mV open circuit from 300-ohm source. 10 color bars; chroma level 0% to 200% of sync-pulse

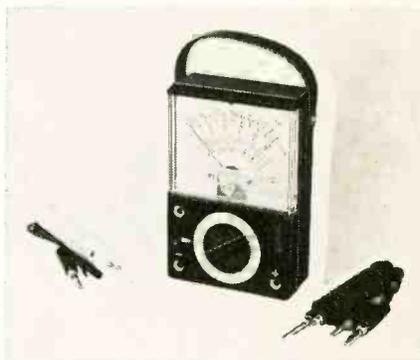


amplitude, continuously adjustable. Cross-hatch: vertical: 14 lines, 0.2- μsec width and 4- μsec spacing. Horizontal: 11 lines, 1 scan line with return trace blanking; 24H spacing (1H = 63.5 μsec .). Dots: at

intersections of crosshatch. Single cross: centered on standard raster. Comes with carrying case, 300-ohm cable with connector and insulated clips. \$140.—Leader Electronics Corp.

Circle 68 on reader's service card

MULTITESTER, Speco Model P-100-L. Includes ample ranges in dc voltages (10,000-ohms/volt sensitivity), ac voltage (5000-ohms/volt sensitivity), direct current and resistance, all selected with one knob. Features carrying strap,



1% precision resistors, printed-board construction and meter fuse protection. Comes with batteries, test leads and instruction manual. \$21.95. Model LP-1 probe with light available for \$2.69.—Components Specialties, Inc.

Circle 69 on reader's service card

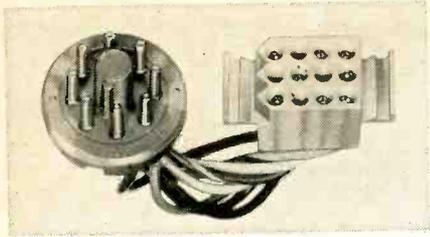
MULTIMETER, Model TE-216. 100,000 ohms/volt. Dc volts; 0.3, -12, -60, -120, -300, -600, and -1200. Ac or output voltage: 0-6, -30, -120 and -300



volts. Dc resistance: 0-2000, 200,000, 2 meg and 200 meg. Direct current: 0-12 mA, 6 mA, 60 mA, 300 mA, and 12 amps. \$39.98.—Olson Electronics, Inc.

Circle 70 on reader's service card

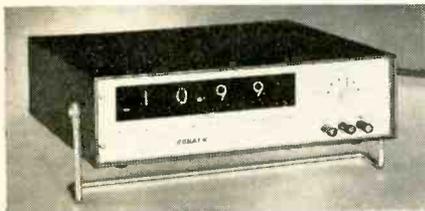
UNIVERSAL YOKE ADAPTER, YA Series. Makes possible the replacement of yokes for various TV makes and models. The various adapter combina-



tions substitute the *DY 91-AC* yoke and four adapter plugs (*YA-1*, *YA-2*, *YA-3* and *YA-4*) for the five yokes previously needed on hand.—Stancor Products, Essex Wire Corp.

Circle 71 on reader's service card

DIGITAL VOLTMETER, Model 304. Polarity is automatically selected and displayed. Overload protection to 100 volts on the 100- μ V, 1- and 10-volt ranges, and to 1200 volts on the 100- and



1000-volt ranges is provided. Input resistance is 10 megohms (1 meg on the 100-volt and 1000-volt ranges). Power rating is 115/230 volts \pm 10%, 50-400 Hz, 22 watts. \$375.—The Roback Corp.

Circle 72 on reader's service card

TROUBLESHOOTING TESTER, Trantracer. Low current enables the tester to locate open transistors quickly and to determine diode polarity in circuit



boards and assemblies. Can be used as a continuity tester for circuits up to 400,000 ohms resistance and is unique in that the current through the circuit is less than 50 μ A.—Desco Manufacturing Co. R-E

Circle 73 on reader's service card

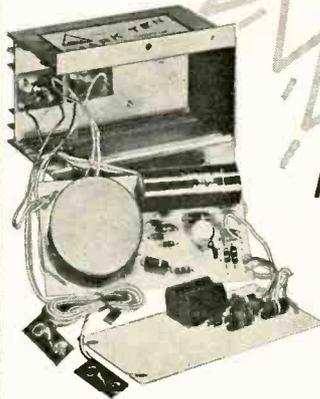
Get Top **PERFORMANCE** from your Car! **Buy The Best!**



DELTA'S Remarkable, Proven

MARK TEN CAPACITIVE DISCHARGE IGNITION SYSTEM

ONLY
\$44.95
ppd.



Available in Easy-to-Build

DELTAKIT ONLY

ASSEMBLE IT YOURSELF!

\$29.95
ppd.

You've read about the Mark Ten in Radio Electronics, Electronics World, Mechanix Illustrated, Electronics, Popular Mechanics and other leading publications! Now discover what dramatic improvement in performance with capacitive discharge ignition is yours for your car, truck, jeep, boat—any vehicle! Delta's remarkable electronic achievement—on the market since 1963 and so unique that a patent has been granted—saves on gas, promotes better acceleration, gives your car that zip you've always wanted. Even Detroit has finally come around. Delta's Mark Ten, the original, the proven winner from Sebring to Suburbia, has set new records of ignition benefits attested to by thousands of satisfied purchasers. No re-wiring necessary. Works on literally any type of gasoline engine. Satisfaction guaranteed.

Order from coupon below, specifying car make, voltage and polarity. Like to build your own? Order a Deltakit® and save!

COMPARE THESE PROVEN BENEFITS!...

- ▲ DRAMATIC INCREASE IN ACCELERATION
- ▲ LONGER POINT AND PLUG LIFE
- ▲ IMPROVED GASOLINE MILEAGE
- ▲ MORE COMPLETE COMBUSTION
- ▲ SMOOTHER PERFORMANCE

Order Your Mark Ten Today! Shipped Postpaid at Once.



DELTA PRODUCTS, INC.

P.O. BOX 1147 RE — GRAND JUNCTION, COLORADO 81501

Enclosed is \$ _____ Ship prepaid. Ship C.O.D.
 Mark Tens (Assembled) @ \$44.95 Mark Tens (Deltakit®) @ \$29.95
(12 volt positive or negative ground only)

Specify 6 Volt: Negative Ground only.
 12 Volt: Specify Positive Ground Negative Ground

Car Year _____ Make _____

Name _____

Address _____

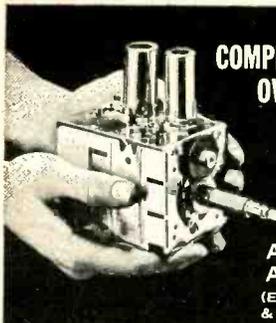
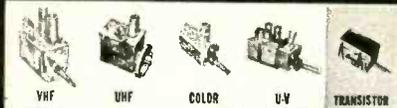
City/State _____ Zip _____

Circle 112 on reader's service card

COMPLETE TUNER OVERHAUL

9⁹⁵

ALL LABOR AND PARTS (EXCEPT TUBES & TRANSISTORS)*

COLOR TUNERS

GUARANTEED ALIGNMENT ADDITIONAL CHARGE COLOR NO CHARGE

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.

UV combination tuner must be single chassis type; dismantle tandem UHF and VHF tuners and send in the defective unit only.

Exact Replacements are available for tuners unfit for overhaul. As low as \$12.95 exchange. (Replacements are new or rebuilt.)

And remember—for over a decade Castle has been the leader in this specialized field . . . your assurance of the best in TV tuner overhauling.

CASTLE TV TUNER SERVICE, INC

5715 N. Western Ave., Chicago 45, Illinois
41-96 Vernon Blvd., Long Island City 1, N. Y.

For service in Canada write to Chicago or use reader service card in this magazine.

*Major parts are charged extra in Canada.

Circle 113 on reader's service card

Yes, you can



YOU CAN BUILD

AN ARTISAN TRANSISTORIZED ORGAN WITH KITS AND SUB-ASSEMBLIES

save \$2000 or more

Easy enough to be fun. Difficult enough to be challenging.

Relax with one of the world's most rewarding hobbies . . . build a full-size, concert quality transistorized organ. The Artisan Kit Organ has the same rich pipe-like tones, the same features, as the famous Artisan Custom Organ. There's not one bit of difference in tonal beauty, console style, high quality.

10 styles for home, church, school



Write for brochure

Dept. RE
1372 East Walnut Street
Pasadena, Calif. 91106

Circle 114 on reader's service card

NEW LITERATURE

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

SPEAKER CATALOG, 12 pages. Comments of well-known authorities and specs on AR-2, AR-2a, AR-3, AR-4 and AR-4x speakers. Also includes AR line of 33½ and 45-rpm turntables and other components and guides. Prices and order blank provided.—Acoustic Research, Inc.

Circle 74 on reader's service card

STEREO COMPONENTS. 20-page 1968 brochure covers components and speaker systems, including new furniture styles for cabinets and speaker systems. Brochure AL-1368 gives specs and features of all equipment.—Altec Lansing

Circle 75 on reader's service card

INSTRUMENT MOTORS. 8-page catalog covers servo-control, induction, reluctance and hysteresis synchronous motors. Each of the four types of motors are available with one of 20 gear trains from 0.67 to 1800 rpm, dual bearing-shaft support and epoxy-insulated stator.—Amphenol Controls Div., Amphenol Corp.

Circle 76 on reader's service card

PLASTIC POWER TRANSISTOR, Engineering Data Sheet B-5001. 6 pages. Provides technical specs, safe operating area (SOAR) charts and engineering parameters. Electrical characteristics are also given for this silicon npn transistor type B-5001, along with a list of area stores for easy ordering.—Bendix Semiconductor Div.

Circle 77 on reader's service card

TECHNICAL BOOKLET, Recording High Off-Ground Signals, 20 pages. Gives solutions to problems encountered in recording test or troubleshooting data from automatic systems in which dc voltages of 500 to 1000 are operational, or where control-loop signals are maintained at high off-ground potential.—Clevite Corp.

Circle 78 on reader's service card

"10 WAYS TO INCREASE PROFITS with Concord Video Tape Recorders" is an 8-page booklet that tells how profit results from use of video tape recorders in business. It gives features and names applications in which this instrument can be useful.—Concord Electronics Corp.

Circle 79 on reader's service card

SCIENCE CATALOG, No. 681. Pages of good reading for people in engineering, design, production and research and development. More than 4,000 items cover the fields of science, math and optics for hobbyists, schools and industry. 147 pages chock full of bargains.—Edmund Scientific Co.

Circle 80 on reader's service card

1968 CATALOG is a 108-page kit-builder's treasure listing over 300 kits for every interest, every budget. All are available at 50% savings over comparable factory-built models. There is something for the music enthusiast, shortwave listener, camera bug, car fan and many more.—Heath Co.

Circle 81 on reader's service card

SLIDE RULE AND CALCULATOR CATALOG. 16 pages of special-purpose slide rules, calculators, slide charts, and kits geared to the fields of electronics and mechanics. Features two new calculators. Prices and order information included.—Info Inc.

Circle 82 on reader's service card

BELLS, BUZZERS AND CHIMES, a 19-page catalog including audible signals, transformers, pushbuttons, electrical specialties, fire and burglar alarm systems and other devices. Gives specs, features and use.—Lee Electric, Inc.

Circle 83 on reader's service card

RECHARGEABLE ALKALINE BATTERIES. Batteries can be recharged 50 times and require no water. Used in TV receivers, ac/dc radios, portable phonos, tape recorders, cameras, small appliances, flashlights, etc., these D, C and AA size batteries can be stored for 2 years under normal temperatures. They are capable of giving full primary capacity and have a large reserve for emergency use. 5-page booklet gives specs and information.—Mallory Battery Co., Div. P.R. Mallory & Co., Inc.

Circle 84 on reader's service card

1967/68 ANTENNAS, No. AT-218. 16-page catalog describes TV/FM antennas and audio accessories. Gives specs, features and model numbers and lists nearest stores for ordering convenience. Flyers also available.—Mosley Electronics Inc.

Circle 85 on reader's service card

TUBE BRITENERS, LCB 68. 4-page catalog covers and TV Briteners for b/w and color TV, automatic voltage regulators and color products and accessories. Quick selector chart shows at a glance which Briteners are right for any given tube. Includes model C-502 for cathode-to-heater shorts in round tubes, model C-512 for rectangular tubes and model D-210 automatic voltage regulator for color sets and other appliances.—Perma-Power Co.

Circle 86 on reader's service card

STEREO BULLETINS (two) which describe stereo components, stereo compacts and stereo consoles. Both give specs and model numbers. Charts provide features and specs of all models at a glance.—H. H. Scott, Inc.

Circle 87 on reader's service card

SEMICONDUCTORS, Catalog B-9418. 16 pages. Describes semiconductor devices ranging from the largest commercially available transistor (250 amps) to a line of low-cost plastic-case rectifiers. Includes spec charts and dimensional diagrams for transistors, thyristors and rectifiers. Westinghouse Semiconductor Div.

Circle 88 on reader's service card

NUTDRIVER SET, Bulletin N867. Describes hollow-shaft nutdriver set No. HSC-1 which features a drilled handle and speeds lock-nut/screw adjustments. Gives specs for the 8 shafts with hex openings from 3/16" through 9/16".—Xcelite Inc.

Circle 89 on reader's service card

Write direct to the manufacturers for information on the item listed below:

SHIELDING FOR ELECTROMAGNETIC COMPATIBILITY. 40-page design manual gives basic information including permeability and attenuation curves for commonly used ferromagnetic alloys. Provides design data on selection of materials, heat treatment, effect of shield configuration and thickness on magnetic shielding performance, and formulas for calculation of field attenuation in decibels. \$1.50 per copy.—Magnetic Metals Co. 2108 Hayes Ave., Camden, N. J. 08101

Why is a Vectorscope essential for Color TV servicing?

- 1 Check and align demodulators to any angle . . . 90°, 105°, 115° . . . accurately and quickly. No guesswork. New color sets no longer demodulate at 90°. Only with a Vectorscope can these odd angles be determined for those hard-to-get skin tones.
- 2 Check and align bandpass-amplifier circuits. Eliminate weak color and smeared color with proper alignment. No other equipment required. Only a V7 Vectorscope does this.
- 3 Pinpoint troubles to a specific color circuit. Each stage in a TV set contributes a definite characteristic to the vector pattern. An improper vector pattern localizes the trouble to the particular circuit affecting either vector amplitude, vector angle or vector shape. Only a V7 Vectorscope does this.



EXCLUSIVE FEATURES:

Color Vectorscope: Until now, available only in \$1500 testers designed for broadcast use. Accurately measures color demodulation to check R-Y and B-Y, for color phase and amplitude. A must for total color and those hard-to-get skin tones. **Self-Calibrating.** Adjust timing circuit without external test equipment. **Dial-A-Line.** Adjust horizontal line to any width from 1-4 lines. **Solid State Reliability** in timer and signal circuits. **Plus:** All Crosshatch, Dots, Vertical only, Horizontal only and Keyed Rainbow Patterns. RF at channels 3, 4 or 5. Video Output (Pos. and Neg. adjustable) for signal injection trouble-shooting. Red-Blue-Green Gun Killer. All transistor and timer circuits are voltage-regulated to operate under wide line voltage ranges. Lightweight, compact—only 8¼x7½x12½". **NET 189.50**

ONE YEAR WARRANTY

V6-B New, improved complete color bar generator with all the features of the V7 except the Vectorscope. Only **99.50**



For the full story, see your distributor or write for literature.
Dept. RE-1
LECTROTECH, INC.
1221 W. Devon Ave., Chicago, Ill. 60626

Circle 116 on reader's service card

TECHNOTES

ADMIRAL RECORD CHANGERS

Complaint: Changer stalls in cycle.

Remedy: A thorough cleaning.

1. Wipe the entire inside flange of the turntable with a clean white cloth wet with trichlorethane (you can use carbon tetrachloride in a well-ventilated area). Do not use any other solvent.
2. With the idler wheel lightly pressed against the rotating motor shaft, clean its rim with 400-grit sandpaper until its working surface is uniformly black.
3. Use a clean white cloth wet with trichlorethane to wipe all surfaces of the motor shaft that contact the idler wheel in any function.
4. Carefully replace the turntable, rotating it clockwise to ease installation.—*Admiral Service News Letter*

SYLVANIA DO1-2 COLOR CHASSIS

Complaint: Insufficient width.

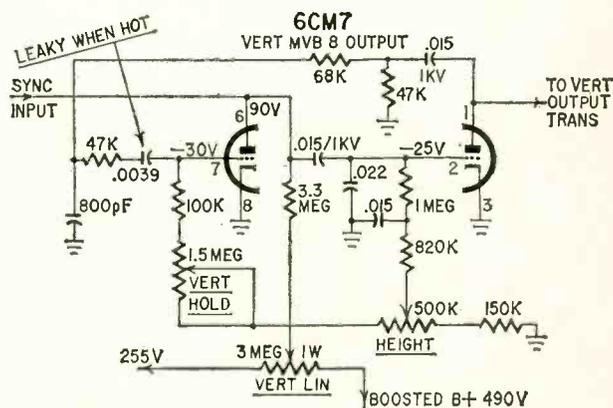
Remedy: Replace horizontal-oscillator coupling capacitor C420 (.0015 μ F). It is probably shorted. When it shorts it produces the following symptoms:

1. High-voltage adjustment control inoperative.
2. High voltage only 23 kV; should be 25 kV.
3. High-voltage regulator inoperative.
4. Horizontal output tube bias low.—*Sylvania Service Notebook*

HAIR DRYER FINDS LOST VERTICAL SYNC

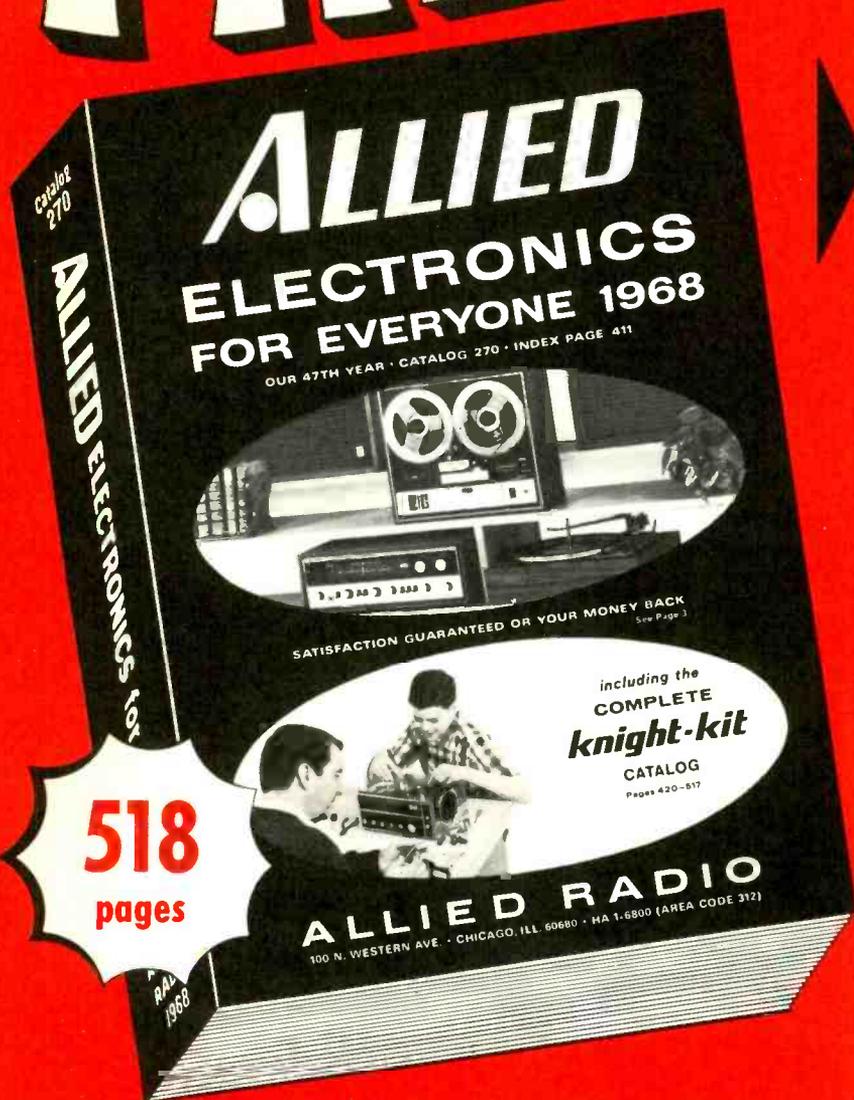
Complaint: The vertical-hold control had to be readjusted several times to maintain sync during the first 45 minutes or so after the set was turned on. Soon the end of the control range was reached and sync was lost.

Symptoms: All parts in the vertical oscillator and sync circuits checked OK. The set worked OK with the back off but soon lost sync when the back was replaced.



Remedy: The problem was obviously caused by a temperature-sensitive component. I used a small hair dryer to direct a stream of warm air over the various parts in the vertical oscillator circuit. The culprit was the .0039- μ F capacitor connected to the grid of the input section of the 6CM7 (see diagram). When heated, it became leaky and provided a temperature dependent resistive path in parallel with the vertical hold control to ground. Replacing this capacitor cured the trouble.—*Stan Thomas* **R-E**

FREE



New 1968 Allied Catalog

Here it is! The brand-new 1968 edition of the world's most famous catalog of electronic equipment.

518 pages, including the complete Knight-Kit Catalog—picturing, describing and pricing thousands of items—the most complete inventory ever assembled of hi-fi, radios, tape recorders, CB, electronic equipment, parts and tools—all at money-saving low prices.

You'll want your own personal copy of the Allied Catalog. It's free. So tear off, fill out, and mail a card. Do it now!

NO MONEY DOWN—24 MONTHS TO PAY!
Low Monthly Payments to fit your budget.

DO A FRIEND A FAVOR—give him this card to send for his FREE ALLIED CATALOG

NAME—PLEASE PRINT

ADDRESS

CITY

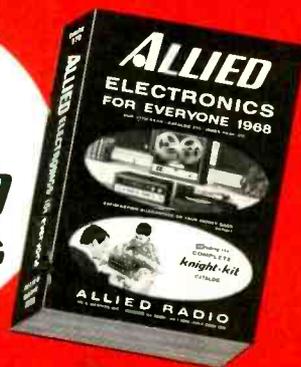
STATE

2A

ZIP

FILL THIS CARD OUT—MAIL IT NOW!

FREE
ALLIED
1968 CATALOG



WORLD'S LARGEST SELECTIONS. SATISFACTION GUARANTEED OR YOUR MONEY BACK

NAME—PLEASE PRINT

ADDRESS

CITY

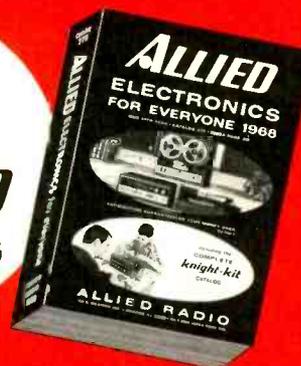
STATE

2A

ZIP

FILL THIS CARD OUT—MAIL IT NOW!

FREE
ALLIED
1968 CATALOG



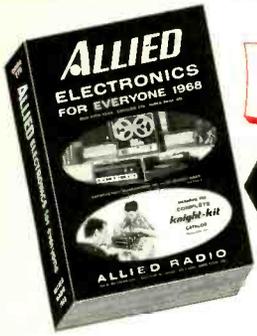
WORLD'S LARGEST SELECTIONS. SATISFACTION GUARANTEED OR YOUR MONEY BACK

RUSH THIS CARD TODAY!

for your

FREE

**1968
ALLIED
CATALOG**



TO:

ALLIED RADIO

P.O. BOX 4398

CHICAGO, ILLINOIS 60680

PLACE
STAMP
HERE



Why Buy by Mail from **ALLIED?**

Each year Allied fills more than a million orders by mail. Only the complete facilities of the world's largest electronics supply house can satisfy all the needs of hi-fi enthusiasts, CB users, engineers, "Hams" and experimenters.

WORLD'S LARGEST SELECTIONS

Imagine shopping for hi-fi where you can select from every model of 15 major manufacturers of receivers, tuners and amplifiers, 14 brands of tape recorders, 7 makes of turntables, nearly 100 speakers from a dozen manufacturers. Plus similar choices in every area of electronics—CB and Ham, test equipment, kits (including Knight-Kits), parts, supplies . . . almost anything you want.

MANY PRODUCTS NOT AVAILABLE ANYWHERE ELSE

As the world's largest supplier of electronics, Allied can afford to stock thousands of items not available elsewhere. In addition, many products are specially-designed and built to our specifications.

FIRST WITH THE LATEST FOR 47 YEARS

We have always been the first to offer the latest developments in electronics, as you will see when you receive your new 1968 catalog from Allied.

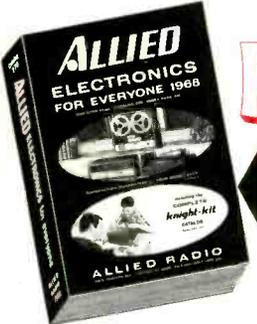


RUSH THIS CARD TODAY!

for your

FREE

**1968
ALLIED
CATALOG**



TO:

ALLIED RADIO

P.O. BOX 4398

CHICAGO, ILLINOIS 60680

PLACE
STAMP
HERE

WE QUALITY-TEST WHAT WE SELL

Among all electronics supply houses, only Allied has a continuous program of quality-testing to assure you that everything you buy meets the highest standards.

COUNT YOUR SAVINGS AT ALLIED

You always get the lowest prices at Allied. Check Allied prices and compare. Look for the special values—available only when you shop in the Allied catalog.

IMMEDIATE SHIPMENT

There's no delay when you deal with the world's largest electronics supply house. Orders are filled promptly—usually the day they're received.

NO MONEY DOWN — UP TO TWO YEARS TO PAY

You don't need cash at Allied. Make "add-on" purchases—even though you are already paying for something else. It's easy to be a credit customer at Allied.

SATISFACTION GUARANTEED OR YOUR MONEY BACK

You can buy with confidence from Allied. We guarantee satisfaction or your money back.

ENJOY "EASY-CHAIR" SHOPPING

Shopping's easy at Allied. More accurate, too! You always know *exactly* what you get. And *what a choice!* A selection of merchandise so vast that no store could ever assemble and stock it all.



90

New Color TV Tuning Indicator

(continued from page 43)

across R905 is about 3 volts p-p when the tuning is correct.

Video peak detector Q900, buffer amplifier Q901, and peak detector Q902 circuits insure that the control voltage level for correct tuning remains constant and "tracks" the incoming signal regardless of its strength. The dc control voltage at the emitter of the peak detector is a constant 4 volts at the correct tuning point and "swings" above or below this level when the set is mistuned. This control voltage is applied to diode X904 in the gate circuit.

Gate circuit X903 and X904 and bistable multivibrator circuit Q903 and Q904 allow the comparator to monitor 2 different signals in a particular time-sharing mode. During the first time period (1 picture field) the gate "passes" the reference voltage, and during the next field it "passes" the control voltage. The bistable multivibrator changes state on each vertical pulse so that the switching rate for each gate signal is 30 Hz, as shown in Fig. 4.

Assume for the moment that Q903 of the bistable multivibrator is on. Its collector is essentially at ground potential and therefore grounds R920 going to the junction at the gate diodes. Since Q904 is off, its collector is close to 12 volts. Also, the control volt-

age input (when turning is correct) is nominally about 4 volts. Both diodes are forward-biased. The gate output voltage is essentially the same as the control voltage input to the bottom diode because the control voltage is fed from a low-impedance source and the diode voltage drops tend to cancel out because the diodes are connected in opposite polarity.

When the bistable multivibrator changes state so that Q903 is off, both diodes become biased off; the junction of their cathodes goes close to 12 volts. The gate output voltage is now determined by the resistance divider R921, R922 and R923.

Finally, the video gate circuit consists of fast-switching diodes X203 and X204 and biasing resistor R252. This resistor feeds a positive voltage (somewhat less than 25 volts) to X204's anode and keeps it forward-biased when no gating pulse is applied to X203. This permits the transmitted video signal to reach the grid of the second video amplifier. Diode X203's cathode is at +25 volts so it is reverse-biased. When the negative-going gating pulse arrives, X203 conducts and X204 cuts off. The gating pulse passes through X203 and cuts off the video amplifier and picture tube just long enough to make the bars on the screen. **R-E**

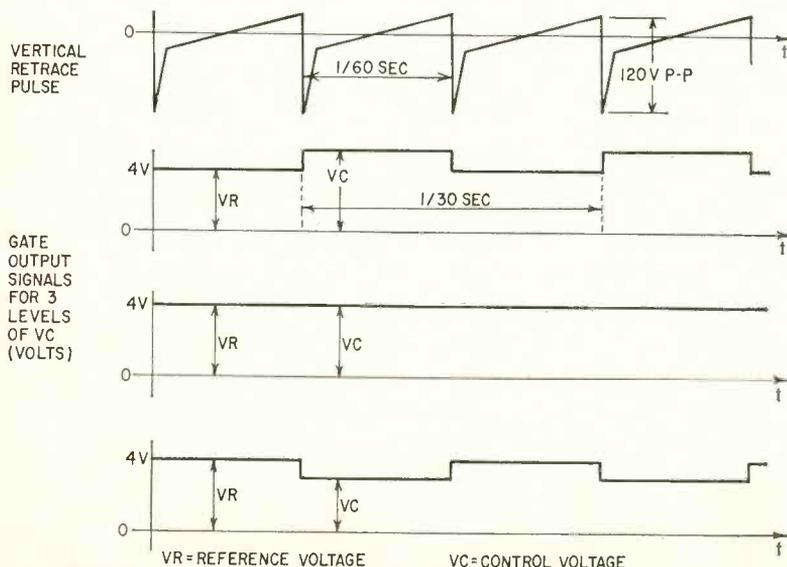


Fig. 4—Gate output voltages V_c and V_r are developed during alternate fields. The second thru fourth drawings show how V_c varies as set's fine-tuning control is adjusted.

FIRST WITH

- Digital Integrated Circuits
- 4 Crystal-Controlled Oscillators
- Battery & AC Operation Standard



The New Pace-Setting
CONAR Model 680

COLOR GENERATOR

KIT \$83.50 WIRED \$114.50

Until now, no commercially available color generator has offered so many quality features in a single instrument at such a low price. Only the CONAR SIGNAL GENERATOR has all these features at any price: exclusive digital integrated circuits; exclusive 4 crystal-controlled oscillators; exclusive AC or battery operation standard; completely solid state; color amplitude control; color phase adjustment; regulated power supply; stability control; TV station sync and blanking pulses; nine patterns; red, blue and green gun killers; compact; lightweight; portable.

For details write Dept. AC8C

CONAR instruments

DIVISION OF NATIONAL
RADIO INSTITUTE
3939 Wisconsin Ave.,
Washington, D.C. 20016



WRITE FOR
FREE CONAR CATALOG

"ELECTRONIC MUSICAL INSTRUMENTS" by RICHARD H. DORF

New Third Edition of the standard work on electronic organs is completely rewritten. In 19 chapters, the author explains objectives, principles, and practices, then analyzes 11 of the latest commercial instruments in electron-by-electron detail, with many schematics and photos. Thoroughly technical text is enlivened by many expressions of opinion and useful practical comments based on Dorf's experience as organ designer. The only complete and authoritative book on organs. 393 pages, 239 illustrations, hard cover. Price \$10.00 Order from your bookstore, or RADIOFILE, 43 West 61st Street, New York, N. Y., 10023

SPEED

24 HOUR DELIVERY

We guarantee that we will ship all orders for 10 crystals or less within 24 hours of receiving the order.



Buy The Best

SEND FOR OUR 1968 CATALOG OF PRECISION QUARTZ CRYSTALS AND ELECTRONICS FOR THE COMMUNICATIONS INDUSTRY

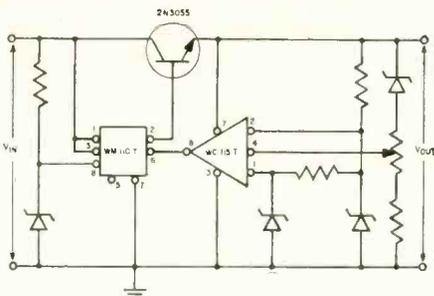
SENTRY MANUFACTURING COMPANY
1634 Linwood Boulevard - Oklahoma City, Oklahoma 73106
PHONE: 405-232-1431-TELEX: 071-361-TWX: 910-631-3178

Circle 117 on reader's service card

NEW SEMICONDUCTORS

NEW IC 350-WATT VOLTAGE REGULATOR

The Westinghouse WM 110 T integrated-circuit voltage regulator combines in a single TO-3 package a reference diode and sensing amplifier fol-



lowed by Darlington-connected series regulator power transistors, all on a single silicon chip.

The regulator provides regulation within 2% over a range of 8 to 48 volts

output at currents up to 2 amps. When fed from a constant-current source, regulation is within 0.2% and is further improved when the low-cost WC 115 T IC differential amplifier is used as a feedback element.

The diagram shows a typical 350-watt power supply using the WM 110 T driven by the differential amplifier. The regulated output of the WM 110 T is fed to the base of a 2N3055 series regulator transistor which delivers up to 350 watts of clean power to the load.

The IC voltage regulator is ideally suited to aircraft/aerospace, mobile and fixed applications requiring clean power in the 1-10-amp range from electromechanical, solid-state or battery sources. Its self-contained error-signal feedback loop has a gain greater than 10,000. This permits operation without external amplifiers. Further information can be obtained from Westinghouse Molecular Electronics Div., Elkridge, Md. 21227.

49th ANNIVERSARY SALE AND OUR 21ST YEAR OF STEADY ADVERTISING IN RADIO-ELECTRONICS WITHOUT MISSING A SINGLE ISSUE — A WORTHY GUARANTEE OF VALUE & RELIABILITY—

FREE \$1 BUY WITH EVERY 10 YOU ORDER Only applies to "\$1" Buys FREE GIFT WITH EVERY ORDER

- 3—ELECTROLYTIC CONDENSERS \$1
250/200/50mfd — 175/175/175v
- 3—ELECTROLYTIC CONDENSERS \$1
1000/1000/500mfd — 35/35/20v
- 1 — LB SPOOL ROSIN-CORE \$1
SOLDER 40/60 top quality
- 4 — 50' SPOOLS HOOK-UP WIRE \$1
assorted colors
- BONANZA "JACKPOT" not gold, \$5
not oil, but a wealth of Electronic Items—Money-Back-guarantee
- 100 — MIXED DEAL "JACKPOT" \$1
Condensers, Resistors, Surprises
- 10—ASSORTED SLIDE SWITCHES \$1
SPST, SPDT, DPDT, etc.
- 20 — EXPERIMENTER'S COIL \$1
"JACKPOT" assorted for 101 uses
- 20—ASST. PILOT LIGHTS \$1
#44, 46, 47, 51, etc.
- 50 — ASST. DISC CERAMIC \$1
CONDENSERS popular numbers
- 10 — ASST. RADIO ELECTRO- \$1
LYTIC CONDENSERS
- 50 — ASST. TUBULAR CON- \$1
DENSERS .001 to .47 to 600v
- 20 — STANDARD TUBULAR \$1
CONDENSERS .047-600v
- 3-1/2 MEG VOLUME CONTROLS \$1
with switch, 3" shaft

- UNIVERSAL 4" PM SPEAKER \$49¢
Alnico 5 magnet, quality tone
- 7 — ASST. TV ELECTROLYTIC \$1
CONDENSERS popular selection
- \$15.00 TELEVISION PARTS \$1
"JACKPOT" best buy ever
- 50 — ASSORTED MYLAR CON- \$1
DENSERS popular selected types
- 10 SETS — DELUXE PLUGS & \$1
JACKS asst. for many purposes
- 10 — SETS PHONO PLUGS & \$1
PIN JACKS RCA type
- 10 — SURE-GRIP ALLIGATOR \$1
CLIPS 2" plated
- 50 — RADIO & TV SOCKETS \$1
all type 7 pin, 8 pin, 9 pin, etc.
- 50 — ASSORTED #3AG FUSES \$1
popular ampere ratings
- 100 — STRIPS ASSORTED SPA- \$1
GHETTI handy sizes
- 100—ASSORTED RUBBER GROM- \$1
METS best sizes
- 50—ASSORTED PRINTED CIR- \$1
CUIT SOCKETS best types
- 10—ASSORTED VOLUME CON- \$1
TROLS less switch
- 7—ASSORTED VOLUME CON- \$1
TROLS with switch

RCA 110° FLYBACK TRANSFORMER

We scouted the Market Latest type — standard for all 110° TV's
RCA's design of large Coil produces 18KV— assuring adequate width
Incl Schematic Diagram application for any TV
List price \$13.90
Your price .. \$3
10% off in lots of 3

- 110° TV DEFLECTION YOKE \$3
for all type TV's incl schematic
- "COMBINATION SPECIAL" \$5
RCA 110° FLYBACK plus 110° DEFLECTION YOKE
- 90° FLYBACK TRANSFORMER \$2
for all type TV's incl schematic
- 90° TV DEFLECTION YOKE \$2
for all TV's incl schematic
- 70° FLYBACK TRANSFORMER \$1
for all type TV's incl schematic
- 70° TV DEFLECTION YOKE \$1
for all type TV's incl schematic
- 20—ASSORTED TV COILS \$1
I.F. video, sound, ratio, etc.

- \$25 TAPE RECORDER (6-Trans.) \$6
good, needs adjusting, complete less Mike—money-back guarantee
- MIKE special for this Recorder \$1.19
- MYLAR RECORDING TAPE \$1
3" — 225' .. 10¢ 7" — 1200' ..
- CASSETTE TAPE CARTRIDGE \$1
90 minutes .. \$2 60 minutes ..
- TV TUNERS asst. all new standard \$1
makes, less Tubes
- TV TUNERS asst. all new standard \$3
makes, including Tubes
- TV TUNERS VHF/UHF all new \$4
standard makes, including Tubes
- 40 — ASSORTED TV KNOBS \$1
all standard types, \$20 value
- 4 — TV ALIGNMENT TOOLS \$1
most useful assortment
- 100 — ASST. RADIO KNOBS \$1
all selected popular types
- 10 — STANDARD TRANSISTORS \$1
NPN & PNP 2N404, 2N414, etc.
- 10—ASSORTED DIODE CRYSTALS \$1
1N34, 1N48, 1N60, 1N64, 1N82
- 5 — TOP HAT SILICON RECTI- \$1
FIERS 500ma-400v — big value

IMMEDIATE DELIVERY . . . Scientific light packing for safe delivery at minimum cost.
HANDY WAY TO ORDER: Pencil mark or write amounts wanted in each box, place letter F in box for Free \$1 BUY. Enclose with check or money order, add extra for shipping. Tearsheets will be returned as packing slips in your order, plus lists of new offers.

Name

Address

TOTAL

Please specify refund on shipping overpayment desired: CHECK POSTAGE STAMPS MERCHANDISE (our choice) with advantage to customer

BROOKS RADIO & TV CORP., 487 Columbus Ave., New York, N. Y. 10024

TELEPHONE 212-874 5600

Circle 125 on reader's service card

AND MICROCIRCUITS

TWO NEW TUBES FOR COLOR TV

The General Electric 6JE6-B is an improved version of the 6JE6 designed for cooler operation and a lower primary beam-plate emission.

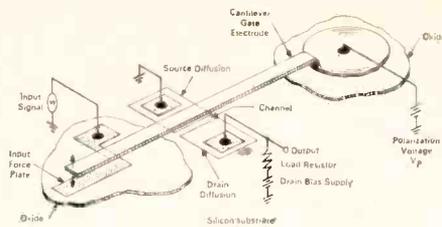
The 3BS2-A is a new compactron high-voltage rectifier with a 4-second warm-up time which makes it ideal for use in color sets designed to start operating within seconds after being turned on. The output current rating of this G-E tube is 2.2 mA. Heater current is 480 mA at 3.15 volts with a steady-state peak plate current rating of 110 mA.

RESONANT-GATE TRANSISTOR

The resonant-gate transistor (RGT)—until now, a laboratory curiosity—is now available for evaluation. It is a frequency-selective device with Q's ranging from 20 to 200.

Its operation results from a me-

chanical resonating beam or "tuning fork" set in motion by electrostatic forces produced by the input signal voltage. Vibration of the cantilever beam is



sensed by a conventional MOSFET for which the beam serves as a gate.

At present, the frequency range is limited to about 3 kHz to 30 kHz but higher frequencies can be obtained by using an overtone mode of vibration.

The RGT's are available for \$67 each from Westinghouse Molecular Electronics Division, Elkridge, Md. 21227. **R-E**

How Fast Can You Read?

A noted publisher in Chicago reports there is a simple technique of rapid reading which should enable you to double your reading speed and yet retain much more. Most people do not realize how much they could increase their pleasure, success and income by reading faster and more accurately.

According to the publisher, anyone, regardless of his present reading skill, can use this simple technique to improve his reading ability to a remarkable degree. Whether reading stories, books, technical matter, it becomes possible to read sentences at a glance and entire pages in seconds with this method.

To acquaint the readers of this publication with the easy-to-follow rules for developing rapid reading skill, the company has printed full details of its interesting self-training methods in a new booklet, "How to Read Faster and Retain More" mailed free to anyone who requests it. No obligation. Send your name, address, and zip code to: Reading, 835 Diversey Parkway, Dept. 684-011, Chicago, Ill. 60614. A postcard will do.

Circle 118 on reader's service card

CANADIANS: Ordering is easy . . . we do the paperwork . . . try a small order

SARKES TARZIAN TV TUNER 41mc

Latest Compact Model—good for all 41 mc TV's. BRAND NEW—MONEY BACK GUARANTEE



Best TUNER "SARKES TARZIAN" ever made—last word for stability, definition & smoothness of operation. An opportunity—to improve and bring your TV Receiver up-to-date.

COMPLETE with Tubes & Schematic . . . \$7.95

HIGHWAVE AM-FM PORTABLE RADIO



Elegance in Ebony & Chrome
14 Transistors — A Powerhouse of Quality Reception with AFC
Operates on 4 "C" Cells
22" Telescoping FM Antenna & Personal listening attachment
Money refund — if not better than any Known Brand selling for even twice the price

8" x 5 1/4" x 2 1/4" — 4 lbs
FREE — extra set of batteries
COMPLETE . . . \$19.50

IBM COMPUTER SECTIONS

8 assorted Units we sell for \$1 are loaded with over 150 valuable parts.

Incl. — Transistors, Condensers, Resistors, Heat Sinks, Diodes, Etc.

8 for \$1
100 for \$10

- | | | | |
|---|--|---|--|
| <input type="checkbox"/> 1000—ASST. HARDWARE KIT \$1
screws, nuts, washers, rivets, etc. | <input type="checkbox"/> HEARING AID AMPLIFIER \$1
incl. 3 Tubes, Mike, etc. (as is) | <input type="checkbox"/> 100—ASST 1/4 WATT RESISTORS \$1
stand. choice ohmages, some in 5% | <input type="checkbox"/> TAPE RECORDER — assorted types \$4
good, bad, broken, as-is, potluck |
| <input type="checkbox"/> 300 — ASSORTED HEX NUTS \$1
2/56, 4/40, 5/40, 6/32, 8/32 .. | <input type="checkbox"/> UNIV. 3" x 5" PM SPEAKER \$59¢
Best type for Radios, TV, Etc. . . | <input type="checkbox"/> 100 — ASST 1/2 WATT RESISTORS \$1
stand. choice ohmages, some in 5% | <input type="checkbox"/> 10 — 7" TV TAPE REELS \$1
all you want, 3000 in stock |
| <input type="checkbox"/> 250—ASST. SOLDERING LUGS \$1
best types and sizes | <input type="checkbox"/> 3—ELECTROLYTIC CONDENSERS \$1
most popular number 50/30—150v | <input type="checkbox"/> 70 — ASST 1 WATT RESISTORS \$1
stand. choice ohmages, some in 5% | <input type="checkbox"/> TRANSISTOR RADIO asst type \$1.50
good, bad, broken, as-is, potluck |
| <input type="checkbox"/> 250—ASST. WOOD SCREWS \$1
finest popular selection | <input type="checkbox"/> CLEAN UP THE KITCHEN "JACK-POT" \$1
Big Deal
only one to a customer | <input type="checkbox"/> 35 — ASST 2 WATT RESISTORS \$1
stand. choice ohmages, some in 5% | <input type="checkbox"/> 1 — SQ. YARD GRILLE CLOTH \$1
most popular brown & gold design |
| <input type="checkbox"/> 250 — ASST. SELF TAPPING SCREWS \$1
#6, #8, etc. | <input type="checkbox"/> CHAPT ZU DI MITZIA "JACK-POT" \$1
double your money back if not completely satisfied | <input type="checkbox"/> 50 — PRECISION RESISTORS \$1
asst. list-price \$50 less 98% .. | <input type="checkbox"/> 10 — TRANSISTOR RADIO EAR-PIECES \$1
wired complete with plug |
| <input type="checkbox"/> 150—ASST. 6/32 SCREWS and 150 6/32 HEX NUTS \$1 | <input type="checkbox"/> 50 — ASST. TERMINAL STRIPS \$1
all types, 1-lug to 6-lug | <input type="checkbox"/> 20 — ASST'D WIREWOUND RESISTORS, 5, 10, 20 watt \$1 | <input type="checkbox"/> 100 — ASST. TUBULAR CONDENSERS \$1
.001 to .47 to 600v . . . |
| <input type="checkbox"/> 150—ASST. 8/32 SCREWS and 150—8/32 HEX NUTS \$1 | <input type="checkbox"/> 25 — INSTRUMENT POINTER KNOBS \$1
selected popular types . . | <input type="checkbox"/> 100 — ASST. MICA CONDENSERS \$1
some in 5% | <input type="checkbox"/> 50 — BALL POINT PENS \$1
retractable, assorted colors |
| <input type="checkbox"/> 150—ASST. 2/56 SCREWS and 150—2/56 HEX NUTS \$1 | <input type="checkbox"/> 5 — I.F. COIL TRANSFORMERS \$1
sub-min for Transistor Radios | <input type="checkbox"/> TELEPHONE RECORDING DEVICE \$1
instant suction cup fit | <input type="checkbox"/> 10 — G.E. SAPPHIRE NEEDLES \$1
4G, VR-11, etc. (\$25.00 value) . . |
| <input type="checkbox"/> 150—ASST. 4/40 SCREWS and 150—4/40 HEX NUTS \$1 | <input type="checkbox"/> 5 — AUDIO OUTPUT TRANSFORM \$1
Sub-min for Trans Radios | <input type="checkbox"/> CRYSTAL LAPEL MICROPHONE \$1
high impedance, 200-6000 cps . . | <input type="checkbox"/> 15 — G.E. #NE-2 TUBES \$1
Neon Glow Lamp for 101 uses . . |
| <input type="checkbox"/> 150—ASST. 5/40 SCREWS and 150—5/40 HEX NUTS \$1 | <input type="checkbox"/> 4 — TOGGLE SWITCHES \$1
SPST, SPDT, DPST, DPDT | <input type="checkbox"/> 25' — MICROPHONE CABLE \$1
deluxe, 2 conductor, shielded . . | <input type="checkbox"/> 2 — G.E. PIECES OF EQUIPMENT \$1
stacked with over 200 useful parts |
| <input type="checkbox"/> 500—ASSORTED RIVETS \$1
most useful selected sizes | <input type="checkbox"/> 70—BRASS FAHNESTOCK CLIPS \$1
popular type & size, plated | <input type="checkbox"/> \$15.00 RADIO PARTS "JACK-POT" \$1
handy assortment | <input type="checkbox"/> 50 — TUBE CARTONS (colored) \$1
assorted sizes for Popular Tubes |
| <input type="checkbox"/> 500—ASSORTED WASHERS \$1
most useful selected sizes | <input type="checkbox"/> 32'—TEST PROD WIRE \$1
deluxe quality, red or black | <input type="checkbox"/> 5 — PNP TRANSISTORS \$1
general purpose, TO-5 case | <input type="checkbox"/> 10 — ASSORTED TUBES \$1
Radio, Television and Industrial . . |
| <input type="checkbox"/> 100—ASST. RUBBER BUMPERS \$1
for cabinet bottoms & other uses . . | | <input type="checkbox"/> 5 — NPN TRANSISTORS \$1
general purpose, TO-5 case | <input type="checkbox"/> ALL AMERICAN TUBE KIT \$2
Top Standard Brand — 12BA6, 12BE6, 12AV6, 50C6, 35W4 . . . |

MERCHANDISE WANTED in any quantity — TUBES (all types) — RADIO & TV PARTS — EQUIPMENT finished or unfinished — immediate cash. Please send samples, quotes & amounts — only new merchandise bought.

HOW TO KILL COLOR GHOSTS

(continued from page 33)

cific channels. A slanting frequency response across a TV channel can cause trouble to a color signal. For example, Fig. 6 shows the response of a poor b-w antenna to channel 6. The color information is received at unequal amplitudes by this antenna. This causes unequal phase delay over the range of color information, producing incorrect colors.

A modern color antenna is designed for maximum frequency flatness rather than maximum gain. A color antenna should be flat within 2 dB per TV channel and 1 dB is required for really excellent color pictures.



One way to minimize ghosts—use a flat-response directional antenna with a rotator. Then aim for the best picture.

Uneven frequency response can also be caused by lead-in, matching transformers or multiset couplers, but this is rare. More common is tilted response in the tuned circuits of the TV receiver. Technicians sometimes deliberately misalign certain receiver circuits in an effort to compensate for

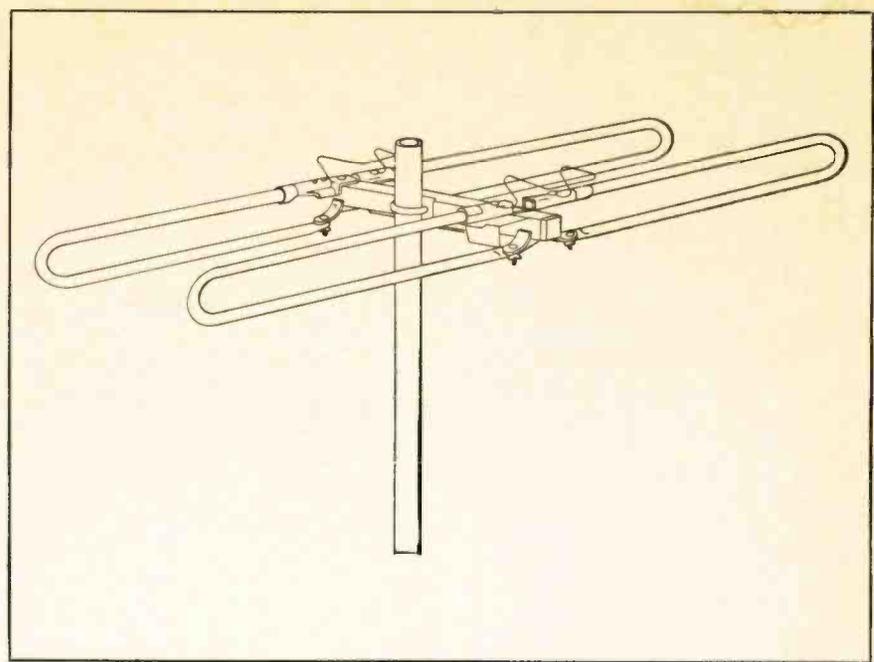


Fig. 4—Antenna elements can be connected or arranged to reduce sidelobes to reject multipath signals. Antenna has low gain but is useful for avoiding ghost pickup.

poor antenna response or for tilts caused by lead-in standing waves.

Misalignment is a poor compromise solution. For one thing, it's almost impossible to make all colors true at the same time. Generally, you can make the flesh tones look real, but the yellows or the greens will be a little off.

The best solution is to align the color receiver properly, according to the manufacturer's instructions, with a good color-bar generator. Use an antenna with flat frequency response. Lead-in should be carefully installed away from ac lines and metal elements. The type of lead-in depends on your location. For suburban locations without much interference, ordinary

twin-lead will do. Near the ocean where salt spray corrodes rapidly, a heavy-duty twin-lead is needed.

If noise pickup is a problem, you will need shielded lead-in. Two types are available: 72-ohm coax, and 300-ohm shielded twin-lead. Depending on the antenna and receiver, you may need baluns (matching transformers) with 72-ohm coax. Any balun used must have flat frequency response to preserve the color phase values.

With good quality equipment and a careful installation, you should be able to get faithful, ghost-free color reception on all channels—except possibly in the most unusual of reception conditions. **R-E**

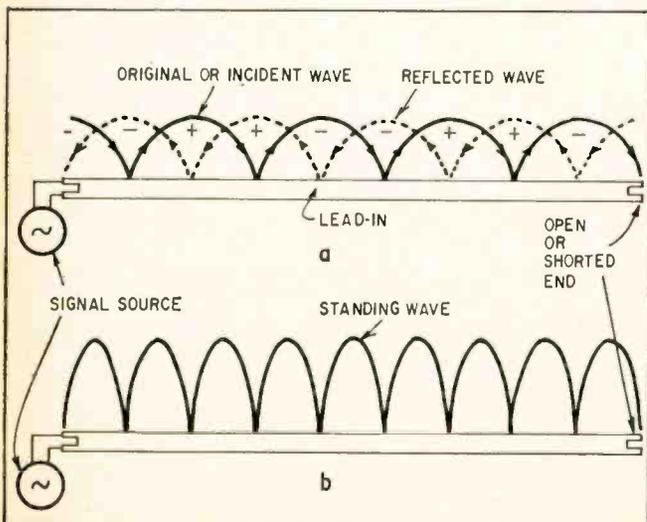


Fig. 5—Under certain conditions, the incident and reflected waves on the lead-in cross at the same points (a). The result is a series of standing waves (b) which usually cause ghosts.

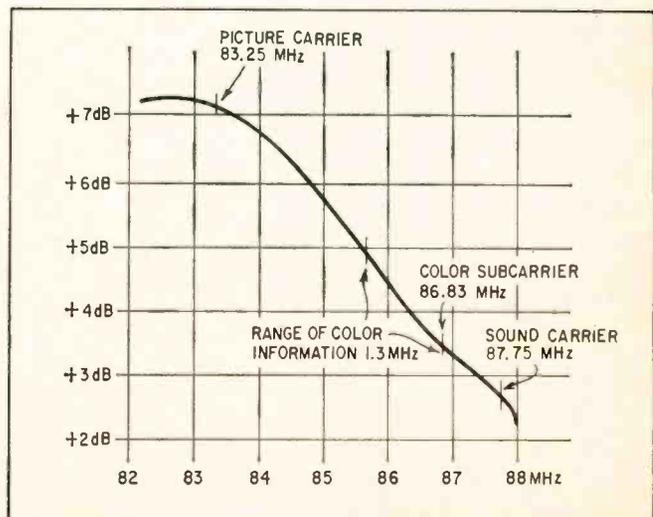


Fig. 6—Uneven frequency response across a TV channel (by an antenna) can cause undesirable color changes in the picture. Antenna should be flat within 2 dB across TV channel.

NEW BOOKS

ELECTRONICS MATHEMATICS, by Gregory J. Nunz and William L. Shaw. McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 10036. 9 x 6 in., 418 pp. Cloth, \$9.95

Two volumes in one book: Vol. I is designed for use either in a first course in electronics or concurrently with a non-mathematical introductory electronics course; Vol. II can be used concurrently with study of ac circuit fundamentals involving trigonometry and vector notation. Prepares the student for subsequent courses in active circuit devices, computer fundamentals, and other electronic equipment. Features slide-rule instruction as part of the text and computation tables in the appendix.

UNDERSTANDING SCHEMATIC DIAGRAMS, edited by Julian M. Sienkiewicz. Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680. 5½ x 8½ in., 112 pp. Paper, \$0.75

An introduction to electronics, this book explains in nontechnical language the functions of components, their uses in electronic circuits, and the symbols and techniques of schematic diagrams. The chapters cover such subjects as tubes and semiconductors, connecting devices and fundamental components. Material is made easy to understand with generous use of illustrations and diagrams. Two pages are used for drawings of the most commonly used schematic symbols.

LASERS AND MASERS, by Charles A. Pike. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Ind. 46206. 5½ x 8½ in., 176 pp. Paper, \$4.95

Presents the fundamentals of both gas and solid-state laser and maser devices. Also covers the early history and development of atomic structure and provides the framework on which laser and maser devices have been built. At the end of each topic and chapter is a set of questions and answers designed to help you learn by reinforcing the facts presented in the text. A final examination at the end of the book serves as a review and tests your comprehension. Fully illustrated and easy to understand.

YOUR FUTURE IN THE HIGH FIDELITY INDUSTRY, by Bernard Newman. Richard Rosen Press, Inc., 29 E. 21 St., New York, N. Y. 10010. 8½ x 6 in., 128 pp. Cloth, \$4.00

A definitive study of the field to help you select your life's work, this book will enable you to weigh your own capabilities and ambitions in light of the requirements, the advantages and the drawbacks of such a career. It is hoped that the book will attract the most capable young people to the challenging and rewarding career opportunities in the high-fidelity components industry. The book covers all phases of the art—origins, trends, factory, sales and retail operations, warranties and repairs, available jobs and financial rewards. **R-E**

WE DON'T CLAIM
OUR ELECTRONIC
IGNITION SYSTEM
IS BEST . . .



OUR
CUSTOMERS DO!

WRITE TODAY FOR FREE LITERATURE

JUDSON

RESEARCH AND MFG. CO.
CONSHOHOCKEN, PA., U.S.A.

Circle 119 on reader's service card



PERMOFLUX . . .
WILL GO TO
YOUR HEAD . . .
IF . . .

you're seeking the ultimate in frequency response, superior engineering and durability. Write today for the dealer nearest you. A demonstration will prove to you why Permoflux headphones are used by the leading experts in all professions where sound is foremost.

All ear speakers are fully warranted for life.

STANDARD OF THE WORLD

Permoflux Corp.

P.O. Box 6364, Dept. RE 1
GLENDALE, CALIFORNIA

Circle 120 on reader's service card

COMING NEXT MONTH The misunderstood but useful decibel—do you know how to use it? It's easy—try our painless dB's (no logarithms) and you'll find it simplifies electronic calculations. Practical examples show you how to use dB's—in next month's issue.

ELECTRONICS

Engineering-Technicians

Bachelor of Science Degree, 30 Months
Save Two Years' Time

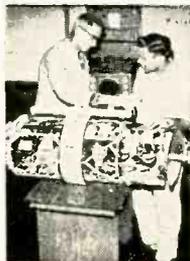
- Radio-Television Plus Color Technician (12 Months)
- Electronics Engineering Technology (15 Months)
- Electronics Engineering (B.S. Degree)
 - Electrical Engineering (B.S. Degree)
 - Mechanical Engineering (B.S. Degree)
 - Civil Engineering (B.S. Degree)
 - Architecture (B.S. Degree) (36 Months)

Approved for Veterans

DAY AND EVENING CLASSES

Write for Catalog and Registration Application.
New Term Starting Soon.

Your Name
Address
City
State



The Nation's increased demand for Engineers,

Electronic Technicians, Radio TV Technicians is at an all time high. Heald Graduates are in demand for Preferred High Paying Salaries. Train now for a lucrative satisfying lifetime career.



1215 Van Ness Avenue
San Francisco, California

Circle 121 on reader's service card

Olson



FREE

Fill in coupon for a **FREE** One Year Subscription to **OLSON ELECTRONICS'** Fantastic Value Packed Catalog—Unheard of **LOW, LOW PRICES** on Brand Name Speakers, Changers, Tubes, Tools, Stereo Amps, Tuners, CB, Hi-Fi's, and thousands of other Electronic Values. Credit plan available.

NAME _____
 ADDRESS _____
 CITY _____ STATE _____
 GIVE ZIP CODE _____

If you have a friend interested in electronics send his name and address for a **FREE** subscription also.

OLSON ELECTRONICS, INC.

791 S. Forge Street Akron, Ohio 44308

Circle 122 on reader's service card

U.S. GOV'T ELECTRONIC SURPLUS

Nationally Known-World Famous SURPLUS CENTER offers finest, most expensive, Government Surplus electronic units and components at a fraction of their original acquisition cost.

ORDER DIRECT FROM AD or WRITE FOR CATALOGS

STANDARD DIAL TELEPHONE

(ITEM #715) - Standard, commercial telephone same as used throughout U.S.A. Attractive polished black, like new condition. Use as extension phone to private systems or connect several phones together for local intercom system. Full instructions are furnished. Wt. 9 lbs. Original Cost \$24.50.



F.O.B. **\$7.50**

STEP-BY-STEP AUTOMATIC SWITCH

(ITEM #738) - Amazing "up-and-around" electro-magnetic telephone switch. Dial any bank pair from 1 to 100. Make your own telephone system. Can also be used to remotely control up to 100 circuits over a single pair of wires.



One of our F.O.B. STALL bargains. Comes complete with data, one dial and one line bank. Size: 5" x 7" x 13". Wt. 16 lbs. Cost Gov't Over \$13.00. Complete: Switch, cover, dial, line bank, instructions..... F.O.B. **\$9.95**

TYPICAL BUYS FROM OUR 1968 CATALOGS

- \$ 350.00 - Geared 2-hp Battery Golf Car Motor \$26.95
- \$ 15.00 - Westinghouse DC Ammeter, 0 to 300 \$ 7.11
- \$ 40.00 - Vacuum/Pressure Pump, 12-VDC \$11.95
- - - 80-MW Walkie-Talkies, Per Pair \$19.60
- - - Deluxe, Multi-Range, AC/DC Tester \$ 8.98

SPECIAL SALE

Correspondence Course In ELECTRICAL ENGINEERING



Sells For \$10.79 Outside U.S.A. **\$8.79** (postpaid in U.S.A.)

(ITEM #A181) - Wonderful chance to obtain technical training at Amazing Low Cost! Lincoln Engineering School has suspended its Correspondence Courses because of increased operating costs. We offer a limited number of the school's complete Electrical Engineering Course but without the examination paper grading service. The course consists of 14 lesson unit books. Each book has the regular exams, and in a separate section, "Standard Answers" to each exam question.

Course is well written, easy to understand, profusely illustrated. Reader's Digest size, easy to carry and study in spare time. Many Lincoln Engineering School students holding excellent jobs as a result of E.E.S. training. Course contains latest information on transistors, silicon diodes, etc. Additional book on how to build and operate a "Home Laboratory and Experimental Bench" furnished with each course.

SEND 25c COIN OR STAMPS FOR 3 MAIN CATALOGS

All Items FOB Lincoln Money Back Guarantee

SURPLUS CENTER

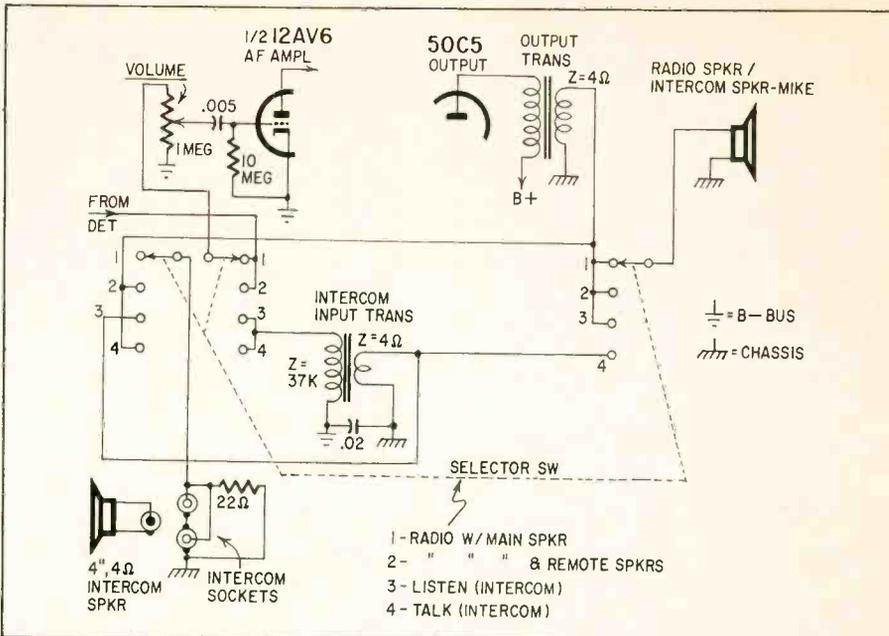
DEPT. RE-018, LINCOLN, NEBR. 68501

Circle 123 on reader's service card

NOTEWORTHY CIRCUITS

UNUSUAL CIRCUIT

(Radio-Intercom)

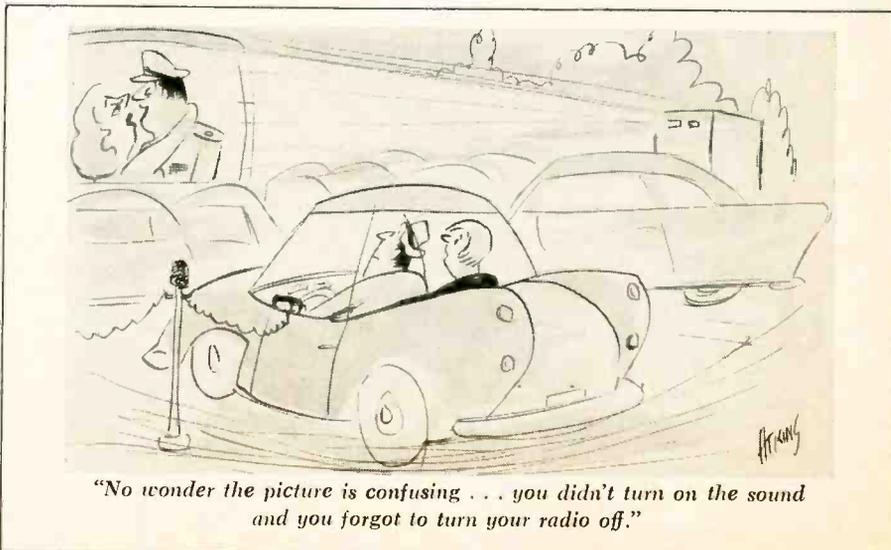


A radio that can be used as an intercom is very useful in any home. Programs can be piped into distant rooms so the volume at the set does not have to be pushed up to an uncomfortable level. A mother can call the kids up from the basement playroom or her husband from the garage. The intercom is useful also as a remote babysitter. Place a speaker near the crib, lock the master selector switch in the listen position and you are in business.

One of the simplest radio-intercom setups was that used in Sears' model 3039 Silvertone radio (a 1963 model).

The diagram shows the set's audio circuitry. The input transformer matches the voice coil to the af amplifier grid when the unit is used as an intercom.

(Gather up a 3-pole, 4-position switch, input transformer and a couple of small PM speakers and you are ready to hook up your radio as an intercom. Be sure to shield the high-impedance leads from the detector and to the high end of the volume control to minimize hum and feedback. The switch should have positive detents in the RADIO and LISTEN positions with a spring to return it to LISTEN.)—E. Wilhelm **R-E**



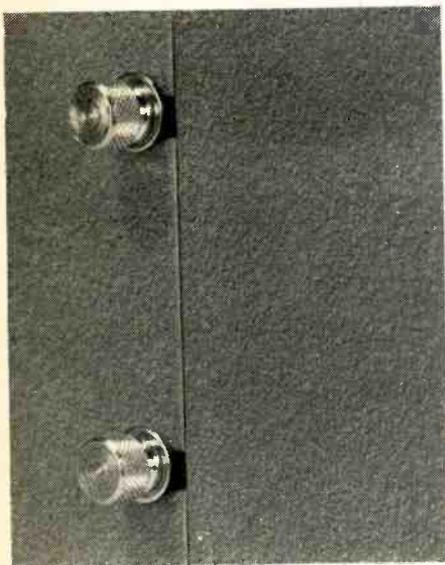
"No wonder the picture is confusing . . . you didn't turn on the sound and you forgot to turn your radio off."

TRY THIS ONE

RACK SCREW REPLACEMENT

Relay panels have been held in relay racks with oval-head machine screws and cup washers since Western Electric adopted the method about a half-century ago. This method of mounting is mechanically very satisfactory, but the sharp edges of the cup washers chew the finish of the panels, making equipment look old quite rapidly and reducing its salvage or trade-in value. This is particularly annoying with rack panels that must be removed and replaced periodically.

The conventional rack screw-and-cup-washer combination may be re-



placed conveniently with a thumb screw and flat washer as shown in the photo. This retains the mechanical strength of the older method, makes removal and replacement more convenient and eliminates panel scarring produced by cup washers.

I use 10-32 nickel-plated thumb screws (Herman H. Smith No. 2368). The washers are 1/2 in. in diameter, .049-in.-thick nickel-plated steel with a 1 3/4 in. hole (General Cement No. 6157-C). Similar parts from other manufacturers will work equally well.—
Ronald L. Ives **R-E**

Fight

Cerebral

Palsy

Enjoy the "music-only" programs now available on the FM broadcast band from coast to coast.

- NO COMMERCIALS •
- NO INTERRUPTIONS •

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 9". Shipping weight approx. 7 lbs.

KIT \$4950
(with pre-tuned coils, no alignment necessary)

WIRED \$7500 (Covers extra \$4.95 ea.)

Current list of FM Broadcast stations with SCA authorization \$1.00

MUSIC ASSOCIATED
65 Glenwood Road, Upper Montclair, N. J.
Phone: (201)-744-3387 07043

Circle 124 on reader's service card

SCHOOL DIRECTORY

ENGINEERING MATHEMATICS
NOW! A NEW WAY TO LEARN—I. H. S. I. WAY. A complete home study course in engineering math to help you get the position you want—**MORE MONEY—MORE RESPECT.**
COURSE PREPARED BY COLLEGE PROFESSORS who have lectured to thousands of men on math and engineering. You learn at home quickly, easily—**AS FAST** as you want.
YOU SIGN NO CONTRACTS
Pay only if satisfied—you owe it to yourself to examine the **INDIANA HOME STUDY INSTITUTE COURSE IN ENGINEERING MATH.**
FREE BONUS—if you join now, a refresher course in basic arithmetic.
Write for Brochure—No Obligation.
THE INDIANA HOME STUDY INSTITUTE
Dept. RE-1, P.O. Box 1189
Panama City, Fla. 32401

Learn Electronics for your **SPACE-AGE EDUCATION** at the center of America's aerospace industry

No matter what your aerospace goal, you can get your training at Northrop Tech. in sunny Southern California.

COLLEGE OF ENGINEERING. Get your B.S. degree in engineering in just 36 months by attending classes year round. Most Northrop Tech graduates have a job waiting for them the day they're graduated!

A & P SCHOOL. Practical experience on real aircraft. One-year course prepares you for F.A.A. A&P certificate. **WRITE TODAY FOR CATALOG.**

NORTHROP INSTITUTE OF TECHNOLOGY
1199 W. Arbor Vitae, Inglewood, Calif.

for a professional career

Tri-State graduates hold important engineering and business administration posts throughout the U. S. This professionally-oriented small college has outstanding placement record. Four-quarter year permits degree in three years. Excellent faculty. Well-equipped labs. Beautiful 300-acre campus. Accredited. Small classes. Modest costs. One-year Drafting Design Certificate program. Enter March, June, Sept., Jan. For Catalog, write Director Admissions. Approved for veterans.

TRI-STATE COLLEGE
2418 College Avenue, Angola, Indiana 46703

EDISON TECH *Graduates in Demand*

Why not? They are trained to be skilled technicians—in demand by industry since 1945. Industry-recognized courses in Electronics, TV, Drafting. Why not earn credits towards an Associate in Science degree while learning a vocational skill? Long-term USAF tuition loans start repaying ten months after graduation at only 3% interest. Veterans training under GI Bill also eligible. Investigate—no obligation. Catalog.

EDISON TECHNICAL COLLEGE RE-1
4629 Van Nuys Blvd., Van Nuys, California 91403

GET INTO ELECTRONICS

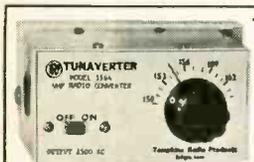
V.T.I. training leads to success as technicians, field engineers, specialists in communications, guided missiles, computers, radar and automation. Basic & advanced courses in theory & laboratory. Electronic Engineering Technology and Electronic Technology curricula both available. Assoc. degree in 29 mos., B.S. also obtainable. G.I. approved. Graduates in all branches of electronics with major companies. Start Feb., Sept. Dorms, campus. High school graduate or equivalent. Catalog.

VALPARAISO TECHNICAL INSTITUTE
Dept. C, Valparaiso, Indiana 46383

MARKET CENTER

GENERAL

CONVERT ANY TELEVISION to sensitive Big-Screen Oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans \$2.00. RELCO-A25, Box 10563, Houston 18, Texas



TUNAVERTERS
POLICE, FIRE, AIR-CRAFT, MARINE AND AMATEUR CALLS ON YOUR BROADCAST RADIO! Tunable RF converters. 6-1 reduction tuning.

See complete listing in Dec. 1967 RE
HERBERT SALCH & CO., WOODSBORO RE-1, TEX. 78393

"ARCTURUS" SALE

- Tube Bargains, to name just a few:
 - #6146... \$2.95
 - #6360... 3.50
 - #6688... 3.50
 - #6939... 3.50
 - #7025... .59
 - #7788... 3.75
 - #2D21... .49
 - #5725/8AS6... 59¢
 - #5842/417A... \$2.50
 - #5847/404A... 2.50
 - #1AX2... 49¢; 5 for 2.00
 - #6K7... 39¢; 3 for 1.00
 - #12BN6... 39¢; 3 for 1.00
 - #25L6... 59¢; 3 for 1.49
 - #6AQ5... 56¢
 - #6BQ7... 94¢
 - #6CG7... 59¢
 - #616... 49¢
 - #6T8... 84¢
 - #6U8... 77¢
 - #12AU7... 59¢

Any unlisted receiving tubes 75% discount off list prices.

- Tube Cartons: 6AU6 etc. size. \$1.75 per 100. GSN7 etc. size, \$2.10 per 100. 5U4GB size, \$2.50 per 100. 5U4G size, 63¢ each.

- Obsolete Tubes: #UX200, \$1.69; #80, \$1.20; #10Y, 69¢ etc.

- 7 inch 90 degree TV bench test Picture Tube with adapter. No ion trap needed. Cat. #7BP7, \$6.99.

- Silicon Rectifier octal-based long-life replacement for 5U4, 5Y3, 5AS4, 5AW4, 5T4, 5V4, 5Z4. With diagram. Cat. # Rect 1, 99¢ each.

- OZ4 Silicon Rectifier replacement, octal based. Cat. # Rect 2, 99¢ each.

- 10 Flangeless Rectifiers, 1 amp, 400 to 1000 p.i.v. Cat. # RS10, \$2.96.

- 10 Silicon Rectifiers, 750 AM., 50 to 300 p.i.v. Cat. # 330F, 99¢ each.

- Condensers: 50-30 MFD at 150 v., 39¢ each, 3 for \$1.00. Cat. # 80; 850-400-100-15 MFD at 16-16-4-115 v., 3 for 79¢. Cat. # 82Y.

- 2 Silicon Controlled Rectifiers, 1 amp, general purpose units with instructions. Cat. # SCR 1, \$1.00.

- 5 Transistor Circuit Boards containing up to 6 transistors, plus diodes, resistors, capacitors, etc. Cat. # TB10, 99¢.

- Needles: values such as # AS22 Sapphire, 39¢; Diamond, 99¢.

- Color Yokes. 70 Degree for all round color CRT's. Cat. # XRC70, \$12.95. 90 degree for all rectangular 19 to 25 inch color CRT's. Cat. # SRC90, \$12.95.

- Transistorized U.H.F. Tuners used in 1965 to 1967 TV sets made by Admiral, RCA, Motorola, etc. Removable gearing may vary from one make to another. Need only 15 volts d.c. to function. No filament voltage needed. Easy replacement units. Cat. # U.H.F. 567, \$4.95.

- General Electric U.H.F. miniature Transistorized Tuner. G.E. Part # ET85X-33. Cat. # GE85, \$4.95.

- F.M. Tuner, Hi-Fi amplifier tuning unit complete with diagram. 2 tubes. Sam's Photofacts # 620 lists 2 applications. Cat. # FM20, \$3.98.

- Flyback Transformer in original carton. Made by Merit or Todd. Most with schematic drawing of unit. Please do not request specific type. Cat. # 506, 99¢ each.

- Flyback Transformer Kits, 2 flybacks per kit. # 502E, Emerson; # 502Y, Silverstone; # 502W, Westinghouse; # 507, Philco; # 502, RCA. Any kit, \$2.99.

- Kit of 30 tested Germanium Diodes. Cat. # 100, 99¢.

- Kit of 10 NPN Transistors. Cat. # 371, 99¢. 10 PNP Transistors. Cat. # 370, 99¢. All tested.

Send for our Free Catalog listing thousands of similar best buys in tubes, parts, kits, transistors, rectifiers, etc. Orders under \$5.00, add 50¢ handling charge. Include 4% of dollar value of order for postage.

ARCTURUS ELECTRONICS CORP.

502-22nd St., Union City, N.J. 07087 Dept. MRE
Phone: 201-UN 4-5568

Circle 142 on reader's service card

TV SERVICE ORDER BOOKS for use with your rubber stamp. Duplicate or triplicate. Low cost. Write for FREE 32 PAGE CATALOG and Special Rubber Stamp Offer. OELRICH PUBLICATIONS, 6556 W. Higgins, Chicago, Ill. 60656

FREE ELECTRONICS (new and surplus) Parts catalog. We repair multimeters. BIGELOW ELECTRONICS, Bluffton, Ohio 45817

TREASURE HUNTERS! PROSPECTORS! Relco's new instruments detect buried gold, silver, coins. Kits, assembled models. Transistorized. Weighs 3 pounds. \$19.95 up. Free catalog. RELCO A25, Box 10839, Houston, Texas 77018

AC POWER FROM YOUR CAR OR BOAT BATTERY

Standard home electricity (60 cycle, 117 volts) for small appliances, record players, tape recorders, tools, etc.

Inverters from 25 to 600 watts, priced as low as \$15.95.

See your Electronics Parts Dealer, or write



1053 Raymond Ave., St. Paul, Minn. 55108

NAVY MARINE BAND WALKIE TALKIE

TRANS. & RECEIVER—Crystal controlled. can be operated on any one channel in freq. range 2.3 to 4.5 MC. Voice (A3) communication only; output of Trans. is 0.2 watts & satisfactory communication between units should be maintained up to approx one (1) mile. With tubes: 1/185, 1/115, 2/1T4, 3/384. Voltages required: 67.5 VDC 3 MA; 135 VDC 4 MA; 1.5 VDC 225 MA for REC—67.5 VDC 1.5 MA; 135 VDC 19 MA; 1.5 VDC 225 MA; & -8 VDC 30 MA for TRANS. Waterproof plastic case w/space for batt. or power supply. Telescoping antenna, 8 ft. has special loading coil. Complete w/tubes, antenna, 2 crystals FT-243 (no choice of freq.) headpieces, carbon mic, canvas cover, & manual. Size: 8 x 8 x 2 1/2". Wt.: 8 lbs. **\$9.95**

DAV MODEL—Same as above, but with direction finding loop circuit for homing & 1/2 mi. Ply-wood case w/ carrying straps. Wt.: 11 lbs **\$12.95**

Dry Charge Battery N-T-6 1/above Pow. Sup. \$3.95
Vibrator Power Supply 1/MAB & DAV—New \$6.95
Prices F.O.B. Lima, O. — 25% Deposit on COD's — BIG FREE CATALOG—Send for your copy now. Dept. RE

FAIR RADIO SALES

1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

World Famed BREVETTATA TEAR GAS PISTOL

Appearance of this fine tear gas weapon is similar to real gun. It is ideal for people who work in lonely dark locations and require protection. Men give this gun to wives and daughters for night security. Many industrial applications. Shooting of gun stops aggressor without permanently injuring him. It fires six cartridges without reloading. Each gun comes with six tear gas shells and six blanks for practice and is shipped prepaid. Gun unit prices include 12 shells and all shipping costs, and this pistol is not intended for sale or possession in any locality where it is prohibited by law. Not sold to minors.

- 1 Gun-unit at \$13.07
- 2 Gun-units at \$22.86 (\$13.43 ea.)
- 3 Gun-units at \$29.97 (\$9.99 ea.)
- 4 Gun-units at \$35.16 (\$8.79 ea.)

Extra boxes of ten tear gas shells at \$1.50 per box (prepaid with gun orders). Extra boxes of blanks at \$1.25 per box.

MEREDITH SEPARATOR CO.
Dept. REL. 310 W. 9th St., Kansas City, Mo. 64105

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume responsibility for any errors which may appear in the index below.

Allied Radio Corp.	89-90
Arco Electronics (A Division of Loral Corporation)	Second Cover
Arcturus Electronics Corp.	98
Arrow Fastener Co., Inc.	80
Artisan Organs	86

B & K (Division of Dynascan Corporation) ..	7
Brooks Radio & TV Corp.	92-93
Burstein-Applebee Co.	71

Capitol Radio Engineering Institute, The ..	28-31
Castle TV Tuner Service, Inc.	86
CLASSIFIED	98-101
Cleveland Institute of Electronics	5,18-21
Columbia Stereo Tape Club	1
Conar (Div. of National Radio Institute) ...	91
Cornell Electronics Co.	100

Delta Products, Inc.	85
Delyno	14
Dynaco, Inc.	72

Edmund Scientific Co.	99
EICO Electronic Instrument Co., Inc. Third Cover	
Electro-Voice, Inc.	6

Finney Co.	13
-----------------	----

GC Electronics Co.	82
G/L Electronics Book Club	87
Grantham School of Electronics	2

Heald Colleges	95
Heath Company	78-79

I.E.E.E.	26
International Crystal Mfg. Co., Inc.	102

Judson Research and Mfg. Co.	95
-----------------------------------	----

Lafayette Radio Electronics	69
Lectrotech, Inc.	88

Mosley Electronics, Inc.	84
Music Associated	97

National Radio Institute	8-11, 16
National Technical Schools	64-67

Olson Electronics, Inc.	96
------------------------------	----

Perma-Power Company	81
Permoflux Corp.	95
Poly Paks	101

Radiofile	91
RCA Electronic Components and Devices	
Tubes	Fourth Cover

RCA Institute	46-49
RCA Parts and Accessories	15
RCA Sales Corporation	27
Reading Improvement Program	93

S & A Electronics Inc.	4
Sams & Co., Inc., Howard W.	22, 83
Schober Organ Corp., Inc.	26
Score	23, 63, 70
Sentry Manufacturing Company	92
Solid State Sales	99
Sprague Products Company	12
Surplus Center	96
Sylvania (Subsidiary of General Telephone & Electronics)	24-25

Warren Electronic Components	100
Weller Electric Co.	68
Winegard Co.	17

Zenith	62
--------------	----

MARKET CENTER 98-101

Fair Radio Sales	98-101
Leed's Radio	
McGee Radio	
Meredith Separator Co.	
Salch & Co., Herbert (Marketing Division of Tompkins Radio Products)	
Terado Corporation	

SCHOOL DIRECTORY 97

Edison Technical College	
Indiana Home Study Institute, The	
Northrop Institute of Technology	
Tri-State College	
Valparaiso Technical Institute	

BACK-ISSUES, Electronic, Scientific Magazines. SEMCO, Box 130, Roxboro, Quebec, Canada

MAGNETS. ALL TYPES. Specials—20 disc magnets, or 2 stick magnets, or 10 small bar magnets, or 8 assorted magnets. \$1.00. MARYLAND MAGNET COMPANY, 5412-G Gist, Baltimore, Maryland 21215

ELECTRONIC ALARM. Remarkable new solid state device. Loud beeping signal controlled directly by low cost photo-cells in moonlight, current through distilled water, one degree temperature change in thermistors, tremendous applications. Requires only 1 to 15 volts supply, up to one megohm sensor, and range resistor. Mounts in 2 1/4 inch hole. \$12.95 postpaid. MINILERT COMPANY, Box 446 Buena Vista Station, Miami, Florida 33137

INTEGRATED CIRCUIT KITS: Computer Logic Kits; Others. Free catalog. KAYE ENGINEERING, Box 3932-D, Long Beach, Calif. 90803

MANUALS for surplus electronics. List 15¢. BOOKS, Box 804, Adelphi, Maryland 20783

WANTED

QUICK CASH . . . for Electronic EQUIPMENT, COMPONENTS, unused TUBES. Send list now! BARRY, 512 Broadway, New York, N. Y. 10012, 212 WALKER 5-7000

ELECTRONICS

BARGAINS in Canadian Electronic equipment and surplus. Send \$1.00 for giant catalogs. ETCO, Box 741, Dept. R, Montreal, Canada

TUBES. "Oldies", latest. Lists free. STEINMETZ, 7519 Mapiewood, Hammond, Indiana 46324

RECEIVING & INDUSTRIAL TUBES. TRANSISTORS. All Brands—Biggest Discounts. Technicians, Hobbyists, Experimenters—Request FREE Giant Catalog and SAVE! ZALYTRON, 469 Jericho Turnpike, Mineola, N.Y. 11501

Discharge IGNITION, PHOTOFASH. Free catalog parts, kits. TRANSPARK, Carlisle, Mass. 01741

RADIO & TV TUBES 33¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. CORNELL, 4217-E University, San Diego, California 92105

MESHNA'S TRANSISTORIZED CONVERTER KIT Converts car radio to receive police & fire. 35-50mc or 100-200mc. (one Mc tuning) with simple step instructions \$5.00. MESHNA, No. Reading, Mass. 01864

GIANT JAPANESE ELECTRONICS CATALOG. \$1. DEE, 10639A Riverside, North Hollywood, Calif. 91602

BRAND NEW TUBES. World's lowest prices on Radio, TV industrial-special purpose tubes. Write for free parts catalog. UNITED RADIO CO., Newark, N.J. 07101

CATHODIC protection instructions \$1.00. F. F. KNAPP, P. O. Box 854, Scottsdale, Arizona 85252

TV CAMERA KITS for experimental and industrial applications. Starter kits \$18.95 up! Catalog free. ATV RESEARCH, Box 453-R, Dakota City, Nebr. 68731

COMPONENTS—Resistors, Capacitors, Switches, Relays, All New, Dollar, Five and Ten, Assorted Boxes, Catalog 10¢. E.R.F. ENTERPRISES, P.O. Box 963 Miami, Florida 33138

AUDIO — HI-FI

RENT STEREO TAPES—over 2,500 different—all major labels—free brochure. STEREO-PARTI, 1616-R Terrace Way, Santa Rosa, Calif. 95404

WRITE for highest discounts on components, recorders, tapes, from franchised distributors. Send for FREE monthly specials. CARSTON, 1686-R Second Ave. N.Y.C. 10028

HI-FI COMPONENTS, Tape Recorders, at guaranteed "WE will not be undersold" prices. 15-day moneyback guarantee. Two-year warranty. NO Catalog. Quotations Free. HI-FIDELITY CENTER, 239R East 149th St., N.Y., N.Y. 10451

TAPE RECORDER SALE. Brand new, latest models, \$10.00 above cost. ARKAY SALES, 1028-E Commonwealth Ave., Boston, Mass. 02215

TAPEMATES makes available to you ALL 4-TRACK STEREO TAPES—ALL LABELS—postpaid to your door—at tremendous savings. For free brochure write TAPEMATES CLUB, 5727 W. Jefferson Blvd., Los Angeles, Calif. 90016

INSTALLERS! HAMMOND Reverberation mechanism—\$4. CAL'S, Box 234, Dearborn, Michigan 48121

STEREO TAPES, Save 30% and up; no membership or fees required; postpaid anywhere USA. FREE 70-page catalog. We discount batteries, recorders, tape/accessories. Beware of slogans, "not undersold", as the discount information you supply our competitor is invariably reported to the factory. SAXITONE, 1776 Columbia Road, N.W., Washington, D.C. 20009

SPEAKER REPAIR. Hi-Fi, guitar, organ speakers recond good as new at fraction of new speaker price. For details write WALDOM ELECTRONICS, INC. 9155-4, Dept. RE 4625 W. 53rd St., Chicago, Ill. 60632

INVENTIONS & PATENTS

INVENTIONS-IDEAS developed. Cash/royalty sales. Member: UNITED STATES CHAMBER COMMERCE, Raymond Lee, 230-U Park Avenue, New York City 10017

BUSINESS AIDS

JUST STARTING IN TV SERVICE? Write for FREE 32 PAGE CATALOG of Service Order books, invoices, job tickets, phone message books, statements and file systems. OELRICH PUBLICATIONS, 6556 W. Higgins, Chicago, Ill. 60656.

WE WANT YOU TO MAKE

THE SWITCH

JOIN OUR GROWING LIST

OF THOUSANDS OF

SATISFIED CUSTOMERS.

Our semiconductors have full factory length leads, are American made, unused, and in good physical condition. Our technical descriptions and pictures are accurate.

ZENERS

1 Watt 6-33V \$.50
10 Watt 6-200V \$.75
50 Watt 6-200V \$ 1.75

1 AMP

Top Hat & Epoxy

PRV	AMP	PRV	AMP
100	.07	1000	.35
200	.09	1200	.50
400	.12	1400	.65
600	.18	1600	.80
800	.22	1800	.90

TRIACS

TO-66
5 AMPS

PRV	AMP
100	.90
200	1.40
300	1.75
400	2.25
500	2.60



POST OFFICE BOX 74 D
SOMERVILLE, MASS. 02143
TELEPHONE (617)547-0005

Send For Our Fall Catalog Featuring
Transistors, Rectifiers And Components

Circle 144 on reader's service card

UNUSUAL BARGAINS

... MANY U. S. GOV'T SURPLUS

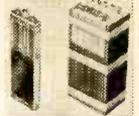


FLY 9-FT. HOT AIR BALLOON

9 Ft. tall. Rises to amazing heights on just hot air. Supplied with tether attached, so can be used over and over. Easy to make, launch, fly. Loads of fun. Great for celebrations, science fairs, plain fun. Will lift model gliders, parachutes, instruments, etc.—anything up to 1/2 lb. Approx. 5 ft. diam. when fully inflated. Kit contains 10 pre-cut red & white gores (No. 1 model paper), 6 ft. 14-gage wire for bottom ring, top, "tie-off" cord, complete instructions. Stock No. 60, 691EH \$2.00 Ppd.

NICKEL-CADMIUM BATTERY BARGAINS

Terrific value—used government surplus. Quick-charge, lightweight 6-volt nickel-cadmium battery, 4-amp. hour capacity. Almost unlimited life—thousands of discharge-charge cycles with minute deterioration. Charges fully in approx. 1 hr. with Edmund Charger Kit. Hundreds of uses for hobby, photography, model building, industry, etc. Only few drops of water yearly for full maintenance. Req. minimum of electrolyte-sealed to prevent loss. Delivers nearly 100% output at below freezing. Maintains constant voltage through major portion of capacity. Five vented 1.2 volt cells strapped in 3 polypropylene bands. 3 1/2" x 2 1/2" x 6".



10 & Jumbo! 275 Ampere Hour Batteries also available. Write for info.
Stock No. 70,942EH \$15.00 Ppd.
ONE NEW 1.2 VOLT NICKEL-CADMIUM CELL
Stock No. 40,798EH \$ 3.95 Ppd.
CHARGER KIT FOR 6-VOLT BATTERY
Stock No. 70,807EH \$ 8.00 Ppd.

Order by Stock No. Check or M. O.—Money-Back Guarantee.
EDMUND SCIENTIFIC CO. 300 EDCORP BLDG.
BARRINGTON, N.J. 08007

CLIP AND MAIL COUPON TODAY

EDMUND SCIENTIFIC CO. 300 EDCORP BLDG.
BARRINGTON, N.J. 08007

SEND FOR FREE CATALOG "EH"

Completely new 1968 edition. New items, categories, illustrations. Dozens of electrical and electromagnetics parts, accessories. Enormous selection of Astronomical Telescopes, Microscopes, Binoculars, Magnifiers, Magnets, Lenses, Prisms. Many war surplus items: for hobbyists, experimenters, workshop, factory. Mail coupon for catalog "EH".



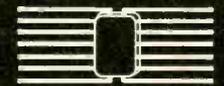
NAME

ADDRESS

CITY STATE ZIP

Circle 143 on reader's service card

MORE INTEGRATED CIRCUITS



SR FLIP FLOPS	\$.90
JK FLIP FLOPS	\$1.15
DUAL NAND NOR GATES	\$1.00
SR CLOCKED FLIP FLOPS	\$1.15
SRT FLIP FLOPS	\$1.15
8 INPUT NAND NOR GATES	\$1.00
DUAL AND GATE	\$1.00
QUAD NAND NOR GATES	\$1.00

TO-85 flat pack with holder. Guaranteed to work. They come complete with schematic, elect. characteristic sheet and some typical applications.

CADMIUM SELENIDE PHOTO CONDUCTIVE CELLS. Dark resistance of 500 megohms. Sensitivity of 1-4.99 μ a/ft candle \$1.25

Silicon Control Rectifiers TO-66 pack Studs

PRV	3A	7A	20A
50	.35	.45	.70
100	.50	.65	1.00
200	.70	.95	1.30
300	.90	1.25	1.70
400	1.20	1.60	2.10
500	1.50	2.00	2.50
600	1.80	2.40	
700	2.20	2.80	
1000		4.00	

Silicon Power Rectifiers

PRV	3A	12A	20A	40A
100	.09	.30	.40	.75
200	.16	.50	.60	1.25
400	.20	.70	.80	1.50
600	.30	1.00	1.20	1.80
800	.40	1.25	1.50	2.30
1000	.55	1.50	1.80	2.70

HIGH-VOLTAGE NPN 150V VBCBO at 2.5A, hi gain in TO-66 pack \$.75

SIM. to 2N2875 (PNP). Silicon 20 watts with 30 Mhz cut off \$.75

500 HFE PLASTIC TRANSISTORS (NPN) TO-18, S1 unit sim to 2N3565. 3/\$1.00

NEON LIGHT of NIXIE TUBE DRIVERS. An NPN, TO-18, Si Transistor with a V_{CEO} of 120 3/\$1.00

1000 PRV at 3A full wave bridge \$3.50

SILICON BILATERAL SWITCH. Replaces two SCR's by firing in either direction when breakdown voltage is exceeded. Used in light dimmers, etc. 2/\$1.00

SIM TO 2N3429 (NPN) S1, 7/8" stud, min Hfe of 30, 7.5 amps, 175 watts, V_{CE} of 75. \$2.75

SILICON RECTIFIER SALE

IMMEDIATE DELIVERY

FULLY GTD AMERICAN MADE  NEWEST TYPE FULLY TESTED

1 AMP SILICON "TOPHAT" & EPOXY DIODES
LOW LEAKAGE FULL LEAD LENGTH

PIV/RMS 50/35 .05 ea.	PIV/RMS 100/70 .07 ea.	PIV/RMS 200/140 .10 ea.	PIV/RMS 300/210 .12 ea.
PIV/RMS 400/280 .14 ea.	PIV/RMS 500/350 .19 ea.	PIV/RMS 600/420 .21 ea.	PIV/RMS 700/490 .23 ea.
PIV/RMS 800/560 .25 ea.	PIV/RMS 900/630 .30 ea.	PIV/RMS 1000/700 .40 ea.	PIV/RMS 1100/770 .50 ea.

ALL TESTS AC & DC & FWD & LOAD

SILICON POWER DIODE STUDS				
D.C. AMPS	50 PIV 35 RMS	100 PIV 70 RMS	150 PIV 105 RMS	200 PIV 140 RMS
3	.08 ea.	.12 ea.	.16 ea.	.22 ea.
12	.25	.50	.65	.75
35	.65	.90	1.25	1.40
100	1.00	1.20	1.50	1.75
160	2.50	3.00	4.00	3.75

SILICON POWER DIODE STUDS				
D.C. AMPS	300 PIV 210 RMS	400 PIV 280 RMS	500 PIV 350 RMS	600 PIV 450 RMS
3	.27 ea.	.29 ea.	.37 ea.	.45 ea.
12	.90	1.20	1.40	1.65
35	2.00	2.30	2.40	3.00
100	2.50	3.50	4.00	5.00
160	4.25	4.75	5.10	Ask

"SCR" SILICON CONTROLLED RECTIFIERS "SCR"

PRV AMP	7 AMP	16 AMP	25 AMP	PRV AMP	7 AMP	16 AMP	25 AMP
25	.50	.75	1.00	250	2.75	2.15	2.50
50	.60	.90	1.25	300	2.75	2.40	2.75
100	.80	1.25	1.50	400	2.40	2.75	3.25
150	.90	1.60	2.00	500	3.20	3.40	3.80
200	1.25	1.80	2.25	600	3.40	4.00	4.50

SPECIALS! SPECIALS!

Westinghouse 160 AMP, 500 PIV SILICON HI-POWER STUD RECTIFIER IN1666. Limited quantity. \$5.10 ea. 10 for \$45.00

100 Different Precision Resistors 1/2—1—2 Watt 1/2%—1% TOL \$1.25

Asst transistor Kit. P.N.P.—N.P.N. All popular types. Unchecked 100 for \$2.95 500 for \$9.95

Computer Grade Condenser 15,500 MFD 12 VDC American Mfg. .75 ea.

Type IN34 DIODE GLASS .07 ea 100 for \$3

Money Back guarantee. \$2.00 min. order. Include additional \$ for postage. Send check or money order. C.O.D. orders 25% down.

Warren Electronic Components

230 Mercer St., N. Y., N. Y. 10012 • 212 OR 3-2620

Circle 145 on reader's service card

MARKET CENTER

1,000 Business Cards, "Raised Letters" \$3.95 postpaid. Samples. ROUTH, 5717 Friendswood, Greensboro, N. C. 27409

TWO-WAY RADIO SERVICE INVOICE FORMS—Detailed. Free Sample Form No. 50 and Catalog. OELRICH PUBLICATIONS, 6554 W. Higgins, Chicago, Ill. 60656

Attention: TV Service Dealers. HIGHLY DETAILED TV SERVICE ORDER FORM STOPS PRICE COMPLAINTS BEFORE THEY START. FREE CATALOG AND SAMPLE NO. 206. OELRICH PUBLICATIONS, 6554 W. Higgins, Chicago, Ill. 60656

Attention: TV Service Dealers. TV SERVICE CONTRACTS FORMS. Free Catalog and Samples No. 105. OELRICH PUBLICATIONS, 6554 W. Higgins, Chicago, Ill. 60656

"PROFIT GUARD" BOOKKEEPING SYSTEM FOR TV SERVICE. Complete—easy to use. Free Catalog and Sample No. 1800 Page. OELRICH PUBLICATIONS, 6554 W. Higgins, Chicago, Ill. 60656

REGISTRY AND JOURNAL for TV APPLIANCE AND EQUIPMENT DEALERS. Keeps record of daily sales by make, model, serial, etc. Stops inside theft. Provides quick reference. Free catalog and sample page No. 1700. OELRICH PUBLICATIONS, 6554 W. Higgins, Chicago, Ill. 60656

TRANSISTOR BOARDS

#103 2EA 2N706, 6EA IN917 ... 6 Boards \$3.00
#101 6EA 2N711 ... 2 Boards \$3.00
#301 3EA 2N1411 ... 4 Boards \$3.00
Above, new, minimum salvageable lead length 1/2 in.

Audio Tape, 1/4 in. 1 1/2 mil, approx. 4000 ft., 2 reels \$7.50 Shipped Prepaid Continental U.S.A.

LEED'S RADIO, 57 WARREN ST., N.Y.C. 10007
Tel: (212)-267-3440

WRITE NOW FOR 1968 SENT FREE

McGEE'S CATALOG

1001 BARGAINS IN SPEAKERS—PARTS—TUBES—HIGH FIDELITY COMPONENTS—RECORD CHANGERS—Tape Recorders—Kits—Everything in Electronics

1901 McGee Street—Kansas City (RE), Missouri 64108



33¢

PER TUBE

100 TUBES OR MORE:
30¢ PER TUBE

Special!
With every \$10 Order

25¢

per tube
(No Limit) from this list

6AG5	6SN7
6AQ5	6CB6
6AU6	6J6
6S4	6W4

One Year TUBES Guaranteed

Tubes are new or used and so marked. Lab-tested. Individually Boxed. Branded and Code Dated.

OZ4	3BZ6	6AB4	6AT6	6BA6	6BQ6	6CG7	6EA7	6K7	6SN7	6X4	12AD6	12BE6	12SQ7	77
1B3	3DG4	6AC7	6AT8	6BC5	6BQ7	6CG8	6EM5	6Q7	6SQ7	6X8	12AE6	12BF6	25L6	78
1J3/1K3	5U4	6AG5	6AU4	6BD6	6BZ6	6CM7	6F6	6S4	6SR7	7A7	12AF6	12BH7	25Z6	84/6Z4
1H5	5U8	6AK5	6AU5	6BG6	6C4	6CZ5	6GH8	6SA7	6U7	7AB	12AT7	12BL6	35W4	5687
1L4	5V4	6AL5	6AU6	6B16	6C6	6D6	6H6	6SH7	6U8	7B6	12AU7	12BY7	35Z3	6350
1T4	5Y3	6AN8	6AV6	6B17	6CB6	6DA4	6J5	6S17	6V6	7C5	12AX7	12C5	50L6	6463
1U4	6A6	6AQ5	6AW8	6BN4	6CD6	6DE6	6J6	6SK7	6W4	7N7	12BA6	12CA5	24	7044
1X2	6AB	6AS5	6AX4	6BN6	6CF6	6DQ6	6K6	6SL7	6W6	7Y4	12BD6	12SN7	27	

Other tubes and CRT's at low prices—send for free list

NO SUBSTITUTIONS WITHOUT YOUR PERMISSION • YOUR ORDER FREE IF NOT SHIPPED IN 24 HRS.

TUBE CARTONS

HIGH GLOSS CLAY COATED RED & BLACK With Built in Diagonal Partitions

SIZE	FOR TUBE SIZE	PRICE PER 10 CARTONS	PRICE PER 100 CARTONS
MIN.	6AU6	.29	2.59
GT.	6SN7	.39	3.49
LG. GT	5U4GB	.59	5.29
G.	5U4G	.89	7.99

TRANSISTORS

FAIRCHILD SEMICONDUCTOR

FOR—RADIO—TV—HI-FI—REPAIRS

RF	MIXER OSC CONV	IF	IF DRIVER
PNP	NPN	PNP	NPN
PNP	NPN	PNP	NPN
PNP	NPN	PNP	NPN
PNP	NPN	PNP	NPN
PNP	NPN	PNP	NPN
PNP	NPN	PNP	NPN
PNP	NPN	PNP	NPN

79 79 69 69 69 69 79 79

Prestige & Success are yours as an ELECTRONIC EXPERT



COMPLETE RADIO SERVICING AND BASIC ELECTRONICS COURSE ONLY \$3.00
192 90 - 30 DAY TRIAL COURSE

NEW PRACTICAL TV TRAINING COURSE ONLY \$3.50
193 90 - 30 DAY TRIAL COURSE

Both above courses \$6.00

Send for CORNELL'S NEW 1968 CATALOG!!!

PICTURE TUBES!
MANY NEW ITEMS!!!

FREE

FREE

all purpose ELECTRONIC CLEANER 89¢



CORNELL Dept. RE-1—4217 UNIVERSITY AVE. SAN DIEGO, CALIFORNIA 92105

TERMS: ORDERS OVER \$5.00: Add 3c per tube shipping. Prepay in full and avoid C.O.D. charges. Send \$3.00 deposit on C.O.D. orders. No 24 hr. free offer on personal checks orders. ORDERS UNDER \$5.00: Add 3c per tube shipping plus 50c handling. CANADIAN AND FOREIGN ORDERS: Add appropriate postage. No C.O.D. orders. COMBINE VARIED ITEMS TO BRING YOUR ORDER OVER \$5.00

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services): 60¢ per word . . . minimum 10 words.
NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items) 30¢ per word . . . no minimum.
 Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for April issue must reach us before February 9th.
WORD COUNT: Include name and address. Name of city (Des Moines) or state (New York) counts as one word each. Zone or Zip Code numbers not counted. (We reserve the right to omit Zip Code if space does not permit.) Count each abbreviation, initial, single figure or group of figures or letters as a word. Symbols or groups such as 8-10, COD, AC, etc., count as one word. Hyphenated words count as two words. Minor over-wordage will be edited to match advance payment.

EDUCATION/ INSTRUCTION

LEARN ELECTRONIC ORGAN SERVICING. New home study course covering all makes electronic organ including transistors. Experimental kits—schematics—trouble-shooting. Accredited NHSC-GI Approved. Write for free booklet. **NILES BRYANT SCHOOL**, 3631 Stockton Blvd., Dept. F, Sacramento 20, Calif.

WANTED! TV-RADIOMEN to learn aircraft electronics servicing. Numerous job openings everywhere. Write: **ACADEMY AVIONICS**, Reno/Stead Airport, Reno, Nevada

HIGHLY EFFECTIVE HOME STUDY COURSE in Electronics Engineering Mathematics with circuit applications. Earn your Associate in Science degree. Free literature. **COOK'S INSTITUTE OF ELECTRONICS ENGINEERING**, P.O. Box 36185, Houston, Texas 77036 (Established 1945.)

HIGHLY EFFECTIVE HOME STUDY REVIEW for FCC commercial phone exams. Free literature. **COOK'S SCHOOL OF ELECTRONICS**, P.O. Box 36185, Houston, Texas 77036

FCC First Class License in six weeks—nation's highest success rate—approved for Veterans Training. Write **ELKINS INSTITUTE**, 2603E Inwood Road, Dallas, Texas 75235

"SLEEP-LEARNING." Send for free brochure, "What's It All About." **TAPES**, Box-190RE, Quincy, Mass. 02169

Top Paying Jobs—Guidance Manual \$1. **CANADIAN INSTITUTE OF SCIENCE & TECHNOLOGY**, 263E Adelaide St. W., Toronto

WATCH REPAIRING. Learn to repair American and Swiss watches in spare time at home. Tuition \$5 monthly. Diploma awarded. Free sample lesson. No obligation. **CHICAGO SCHOOL**, Dept. REN, Fox River Grove, Illinois 60021

ELECTRONICS/DRAFTING/COLOR TV Courses. Earn more with industry-recognized technician training. Long-term financial aid; veterans also eligible. Vocational credits transferrable towards Associate in Science degree. Our 23rd successful year. Free literature. **EDISON TECHNICAL COLLEGE**, 7621 Van Nuys Blvd., Van Nuys, Calif. 91405

GOVERNMENT SURPLUS

72 page illustrated Government Surplus Radio, Gadgeteers Catalog 25¢. **MESHNA**, Nahant, Mass. 01908

88-108 MC F.M. RECEIVER

10 TUBE CRYSTAL CONTROLLED F.M. RECEIVER WITH TUBES VOLUME TONE CONTROLS 4 WATT OUTPUT. 115 V 60 CYCLE. METAL CABINET 8H x 10D x 12W. WITH DIAGRAM LESS CRYSTAL AND SPEAKER. REMOVED FROM SERVICE BY STORECAST OUTFIT THAT WENT SOLID STATE. \$14.50 EA: 2 for \$25.00 PLUS SHIPPING.

LEED'S RADIO, 57 WARREN ST., N.Y.C. 10007

CLASSIFIED ADVERTISING ORDER FORM

For complete data concerning classified advertising please refer to box elsewhere in Market Center section.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

_____ { @ .30 Non-Commercial Rate }
 No. of Words { @ .60 Commercial Rate } = \$ _____

Total Enclosed \$ _____

Insert _____ time(s)

Starting with _____ Issue

Payment must accompany order unless placed through accredited advertising agency 18

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

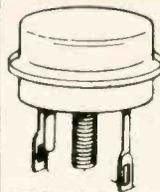
SIGNATURE _____

MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 154 WEST 14TH ST., NEW YORK, N.Y. 10011

"A POLY PAK EXCLUSIVE"

DOUBLE BONUS
\$25 WORTH OF
 TRANSISTORS
 RECTIFIERS
 RESISTORS
 CONDENSERS
 DIODES ETC.
 Add 25¢ for handling
BOTH FREE WITH ANY \$10 ORDER

PLUS CHOOSE ANY \$1 ITEM FREE



HIGH POWER

3 for \$1

PNP 100Watt/15 Amp HiPower
 T036 Case1 2N441, 442, 277,
 278. DS501 up to 50 Volts

FACTORY TESTED \$1 SEMI-KON-DUCTORS

- 2-85 WATT 2N424 PLANAR, silicon, TO-53 \$1
- 3-40W NPN SILICON MESA, 2N1648, transistor \$1
- 4 2N170 TRANSISTORS, by GE, npn for gen'l rf. \$1
- 15 3 AMP RECT's, studs, silicon, to 800V no test \$1
- 4-2N255 POWER TRANSISTOR EQUALS \$1
- 10 PNP SWITCHING TRANS'TRS, 2N4104, no test \$1
- 2N3088 "N" Channel FET'S Very High Input Z. \$1
- 5 2N107 TRANS'TRS, by GE, npn, pop. audio pak \$1
- 4-2N1613 NPN SIL. 120 mc. by "Rheem" TO-46 \$1
- 3-45 AMP POWER RECTIFIERS, stud, silicon \$1
- 5 2N706 500MW, 300 MC NPN transistors, TO-18 \$1
- 10PNP SWITCHING TRANSISTORS, no test, TO-5 \$1
- 25 TOP HAT RECTIFIERS, silicon. 750 ma, no test \$1
- 4 BIDIRECTIONAL TRANSISTORS, 2N1641 \$1
- 10 NPN SWITCHING TRANS'TRS, 2N338 no test \$1
- 15 NPN TRANS'TRS, CK722, 2N35, 107, no test \$1
- 15 NPN TRANSISTORS, 2N35, 170, 440, no test \$1
- 30 TRANSISTORS, rf, if, audio osc-ifs, T05 no test \$1
- 4-"EPOXY" TRANSISTORS 2N3563, 600 MC \$1
- 4-"EPOXY" TRANSISTORS 2N3643 by Fairchild \$1
- 3 EPOXY TRANSISTORS 2N4265 by Motorola \$1
- 4 EPOXY TRANSISTORS 400 HFE by Fairchild \$1
- 5-1 Amp 800 PIV EPOXYS, submini \$1
- 2 2N918 TRANSISTORS 1000MC npn TO18 \$1
- 3-5-WATT EPOXY B-5000 Bendix transistors \$1
- 2 PHOTO ELECTRIC CELLS by GE Very High Z. \$1
- 2 FETS FOR HOBBYIST, EXPERIMENTERS \$1
- 3-2 AMP 1000 PIV, axial leads silicon \$1
- 10-10-AMP SILICON RECTIFIERS, studs, asst \$1
- 4 GE 2N43 OUTPUT TRANSISTORS npn, T03 \$1
- 25 GERMANIUM DIODES, glass asst \$1

WORLD'S MOST POPULAR \$1 PARTS PAKS

- 4 TRANSISTOR TRANSFORMERS, asst. worth \$25 \$1
- 50 RADIO & TV KNOBS, asst. colors & styles \$1
- 60 CERAMIC CONDENSERS, discs, npo's, to .05 \$1
- 40 "TINY" RESISTORS, 1/10W, 5% too! \$1
- 10 TRANSISTOR SOCKETS for npn-npn transistors \$1
- 30 MOLDED COND'S, mylar, pore. black beauty \$1

Unbeatable Buy at This Low Price!

1 AMP TOP HATS		PIV	Sale
PIV	Sale	PIV	Sale
200	5¢	400	12¢
		800	16¢
		1000	23¢

- \$25 SURPRISE PAK: transistors, rect. diodes, etc. \$1
- 40 PRECISION RESISTORS, 1/2, 1, 2W, 1% values \$1
- 40 CORNING "LOW NOISE" resistors, 5% too! \$1
- 60 TUBULAR CONDENSERS, to .5mf, to 1KV; asst \$1
- 40 DISC CONDENSERS, 27 mmf to .05 mf to 1KV \$1
- 60 TUBE SOCKETS, receptacles, plugs, audio, etc. \$1
- 30 POWER RESISTORS, 5 to 50W, to 24K ohms \$1
- 50 MICA CONDENSERS, to .1mf, silvers too! \$1
- 10 VOLUME CONTROLS, to 1 meg, switch too! \$1
- 10 ELECTROLYTICS, to 500mf, asst FP & tubulars \$1
- 50 RADIO & TV KNOBS, asst. colors & styles \$1
- 10 TRANSISTOR ELECTROLYTICS: 10 mf to 500 mf \$1
- 50 COILS & CHOKES, if, rf, ant, osc, & more \$1
- 35 TWO WATTERS, asst incl: A.B., 5% too! \$1
- 65 HALF WATTERS, asst incl: A.B., 5% too! \$1
- 60 HI-Q RESISTORS, 1/2, 1, 2W, 1% & 5% values \$1
- 10 PHONO PLUG & JACK SETS, tuners, amps \$1
- 10 TUBULAR ELECTROLYTICS, to 500 mf \$1

AS ADVERTISED OR YOUR MONEY BACK

RETAIL STORE: 211 Albion St. Wakefield

10c FOR OUR 1968 BARGAIN CATALOG ON:
 Semiconductors ICs Parts

POLY PAKS TERMS: send check, money order, include postage—avg. wt. per pak 1 lb. Rated, net 30 days. CODs 25% **01940**

P.O. BOX 942 R
 SO. LYNNFIELD, MASS.

Circle 147 on reader's service card

NOW

A low cost Crystal for the Experimenter

International



type "EX"

\$3.75

Postage Paid

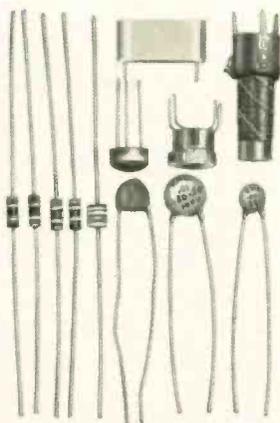
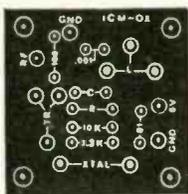
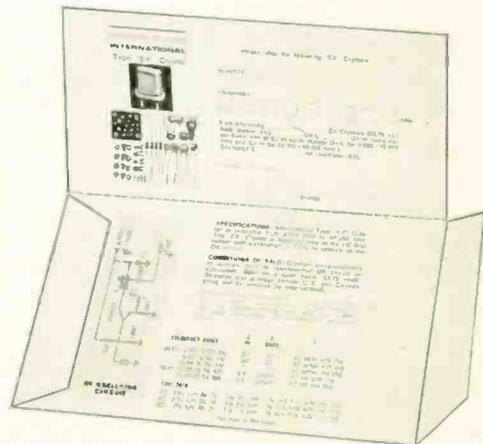
- LOW COST
- MINIMUM DELIVERY TIME

3,000 KHz to 60,000 KHz

SPECIFICATIONS: International Type "EX" Crystal is available from 3,000 KHz to 60,000 KHz. The "EX" Crystal is supplied only in the HC-6/U holder. Calibration is $\pm .02\%$ when operated in International OX circuit or equivalent.

CONDITIONS OF SALE: All "EX" Crystals are sold on a cash basis, \$3.75 each. Shipping and postage (inside U.S. and Canada only) will be prepaid by International. Crystals are guaranteed to operate only in the OX circuit or its equivalent.

MINIMUM DELIVERY TIME We guarantee fast processing of your order. Use special EX order card to speed delivery. You may order direct from ad. We will send you a supply of cards for future orders.



COMPLETE OX OSCILLATOR KITS

Everything you need to build your own oscillator. Two kits available. "OX-L" kit 3,000 to 19,999 KHz. "OX-H" kit 20,000 to 60,000 KHz. Specify "OX-L" or "OX-H" when ordering.

\$2.35

Postage Paid

ORDERING INSTRUCTIONS

- (1) Use one order card for each frequency. Fill out both sides of card.
- (2) Enclose money order with order.
- (3) Sold only under the conditions specified herein.



CRYSTAL MFG. CO., INC.
10 No. Lee • Okla. City, Okla. 73102

Circle 148 on reader's service card

EICO Makes It Possible

Uncompromising engineering—for value does it!
You save up to 50% with Eico Kits and Wired Equipment.



Cortina Stereo

Engineering excellence, 100% capability, striking esthetics, the industry's only **TOTAL PERFORMANCE STEREO at lowest cost.**

A Silicon Solid-State 70 Watt Stereo Amplifier for \$89.95 kit, \$129.95 wired, including cabinet. Cortina 3070.

A Solid-State FM Stereo Tuner for \$89.95 kit, \$129.95 wired, including cabinet. Cortina 3200.

A 70-Watt Solid-State FM Stereo Receiver for \$159.95 kit, \$239.95 wired, including cabinet. Cortina 3570.



Eicocraft The newest excitement in kits. 100% solid-state and professional.

Fun to build and use. Expandable, interconnectable. Great as "jiffy" projects and as introductions to electronics. No technical experience needed. Finest parts, pre-drilled etched printed circuit boards, step-by-step instructions.



Electronic Siren \$4.95, Burglar Alarm \$6.95, Fire Alarm \$6.95, Intercom \$3.95, Audio Power Amplifier \$4.95, Metronome \$3.95, Tremolo \$8.95, Light Flasher \$3.95, Electronic "Mystifier" \$4.95, Photo Cell Nite Lite \$4.95, Power Supply \$7.95, Code Oscillator \$2.50, FM Wireless Mike \$9.95, AM Wireless Mike \$9.95, Electronic VOX \$7.95, FM Radio \$9.95, AM Radio \$7.95, Electronic Bongos \$7.95.



Citizen's Band

Two years ahead! Model 7923
All Solid-State 23-Channel 5W Transceiver. 4 exclusives: dual-crystal lattice filter for razor-sharp selectivity; efficient up-converter frequency synthesizer for advanced stability; precision series-mode fundamental crystals; Small: only 3"H, 8"W, 8¼"D. \$189.95 wired only.

The best buy in tube-type CB—"Sentinel-Pro" 23-channel dual conversion 5W Transceiver \$169.95 wired only.



EICO Trans/Match (Model 715) is a professional test set designed for complete checking of ham and CB equipment. Kit \$34.95; Wired \$49.95.



Truvohm

Professional Portable Multimeters by EICO.
The industry's greatest V-O-M values. Designed, made to Eico's high standards of professionalism. Each complete with batteries & test leads. Backed 100% by famous EICO warranty.

- Model 100A4, 100,000Ω/V, \$34.95.
- Model 30A4, 30,000Ω/V, \$19.95.
- Model 30A3, 30,000Ω/V, \$15.95.
- Model 20A3, 20,000Ω/V, \$12.95.
- Model 4A3, 4000Ω/V, \$8.95.
- Model 1A1, 1000Ω/V, \$5.95.

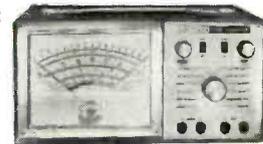


Automotive

EICO 888—Car/Boat Engine Analyzer.
For all 6V/12V systems; 4, 6, 8-cyl. engines.

Now you can keep your car or boat engine in tip-top shape with this solid-state, portable, self-powered universal engine analyzer. Completely tests your total ignition/electrical system.

Complete with a Tune-up & Trouble-shooting Manual. Model 888; \$44.95 kit, \$69.95 wired.



Test Equipment

100 best buys to choose from.

"The Professionals"
—laboratory precision at lowest cost.

Model 460 Wideband Direct-Coupled 5" Oscilloscope. DC-4.5mc for color and B&W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. input. Automatic sync limiter and amp. \$109.95 kit, \$149.95 wired.

Model 232 Peak-to-Peak VTVM. A must for color or B&W TV and industrial use. 7 non-skip ranges on all 4 functions. With exclusive Uni-Probe.® \$29.95 kit, \$49.95 wired.

FREE 1968 CATALOG

RE-1

EICO Electronic Instrument Co., Inc.
283 Malta Street, Brooklyn, N.Y. 11207
 Send me FREE catalog describing the full EICO line of 200 best buys, and name of nearest dealer.

Name _____

Address _____

City _____

State _____ Zip _____



Service your Color TV customers with confidence...
with RCA HI-LITE picture tubes!

Customer satisfaction... and consequently your service reputation... can very often depend on the quality of the replacement parts you use. When it comes to replacement picture tubes, you can depend on an RCA HI-LITE for picture brightness and color fidelity at its finest. Install them and you literally "up-date" your customer's set with the same quality... the same tubes... that go into today's original equipment sets.

Enjoy the confidence of offering the finest. Rely on RCA picture tubes to protect your service reputation. They are designed to protect the biggest reputation in the Color TV industry

RCA Electronic Components and Devices, Harrison, N. J.



The Most Trusted Name in Electronics

