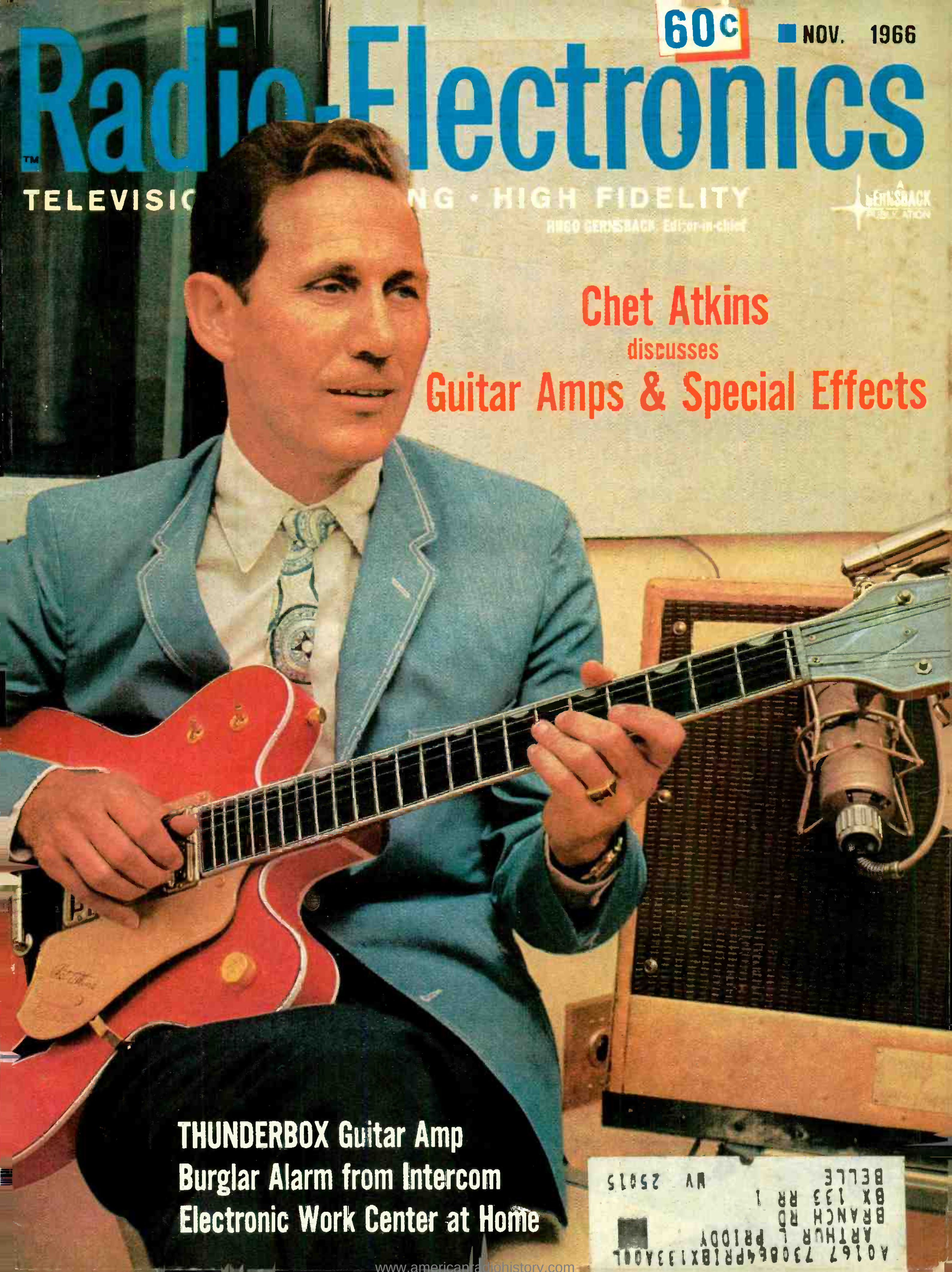
60c NOV. 1966

Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor-in-chief

A GERNSBACK PUBLICATION



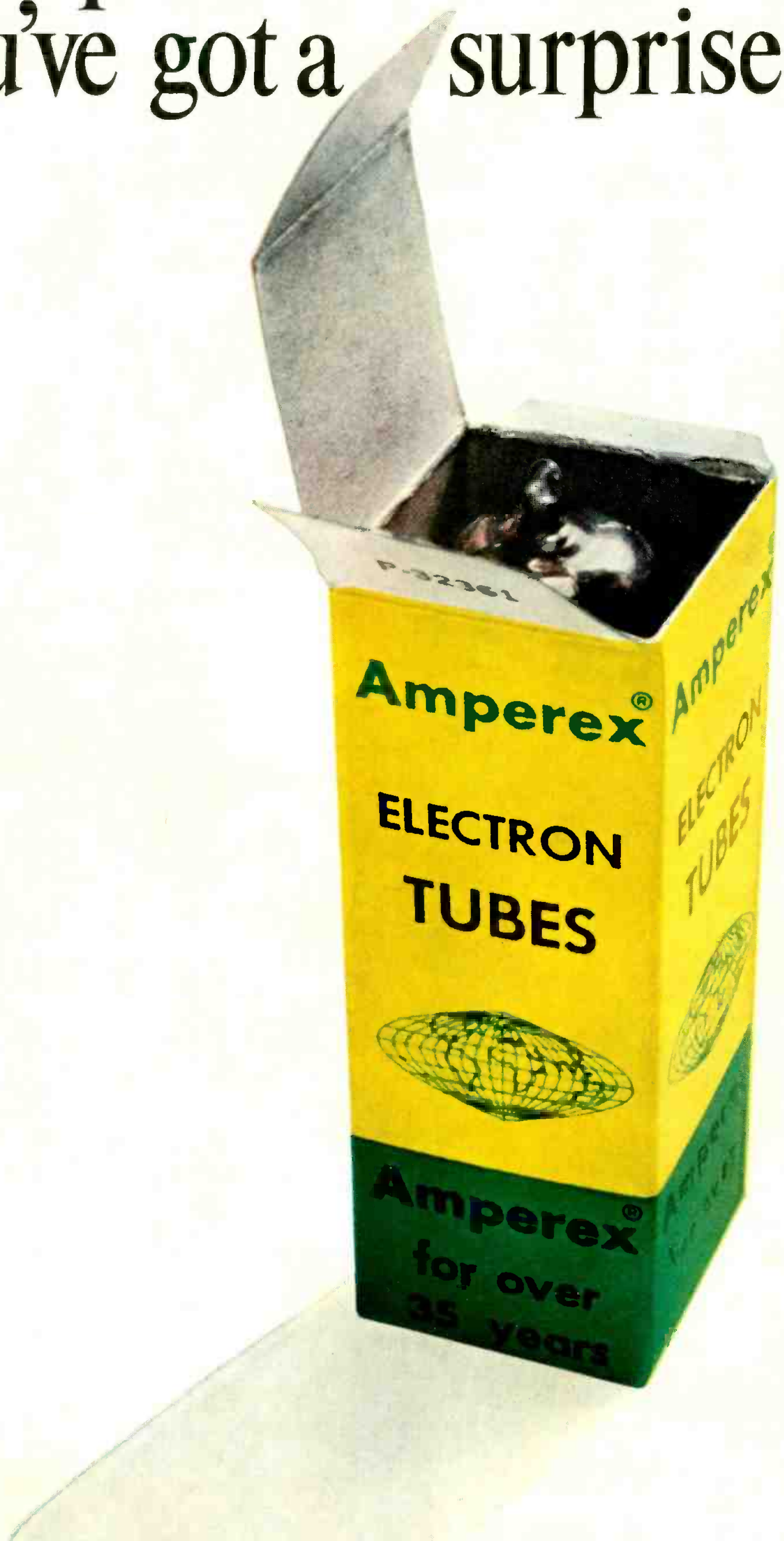
Chet Atkins discusses Guitar Amps & Special Effects

THUNDERBOX Guitar Amp

Burglar Alarm from Intercom

Electronic Work Center at Home

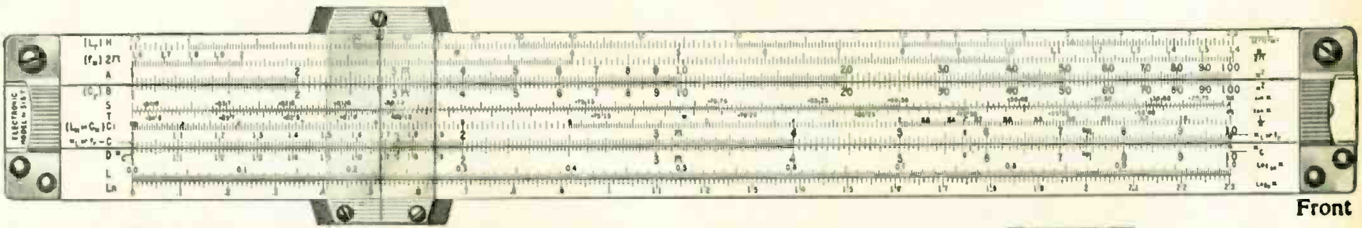
If you think all replacement tubes are alike, you've got a surprise coming



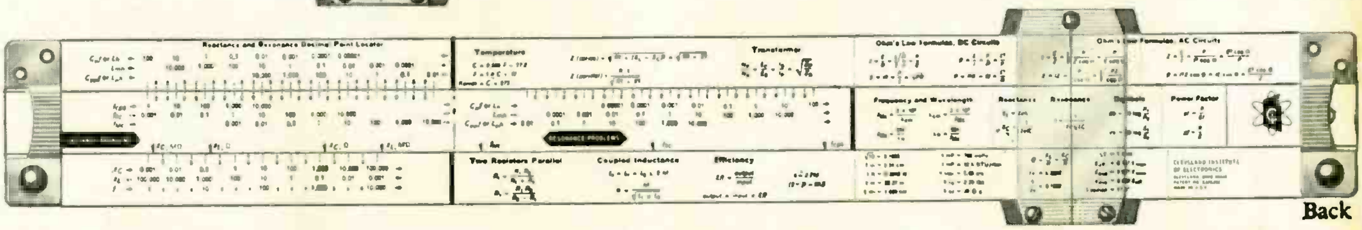
Circle 7 on reader's service card

LOOK!

A New Electronics Slide Rule with Instruction Course



Front



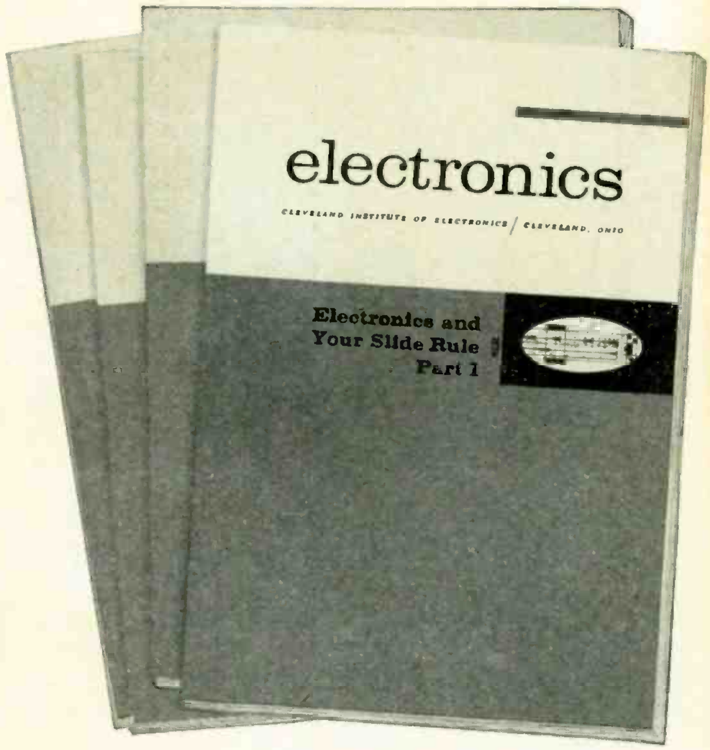
Back

This amazing new "computer in a case" will save you time the very first day. CIE's patented, all-metal 10″ electronics slide rule was designed *specifically* for electronic engineers, technicians, students, radio-TV servicemen and hobbyists. It features special scales for solving reactance, resonance, inductance and AC-DC circuitry problems . . . an exclusive "fast-finder" decimal point locater . . . widely-used formulas and conversion factors for instant reference. And there's all the standard scales you need to do multiplication, division, square roots, logs, etc.

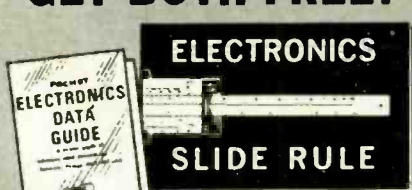
Best of all, the CIE Slide Rule comes complete with an Instruction Course of four AUTO·PROGRAMMED* lessons. It includes hundreds of illustrations, diagrams and practice problems. You'll learn ingenious short cuts...whip through exacting electronics problems quickly and accurately. This course alone is worth far more than the price of the entire package!

Electronics Slide Rule, Instruction Course, *and* handsome, top-grain leather carrying case . . . a $50 value for less than $25. Send coupon for FREE illustrated booklet and FREE heavy vinyl Pocket Electronics Data Guide. Cleveland Institute of Electronics, 1776 E. 17th St., Dept. RE-130, Cleveland, Ohio 44114.

*TRADEMARK



GET BOTH FREE!



Send coupon today →

Cleveland Institute of Electronics

1776 E. 17th St., Dept RE-130, Cleveland, Ohio 44114

Please send FREE Illustrated Booklet describing your Electronics Slide Rule and Instruction Course.

SPECIAL BONUS! Mail coupon promptly . . . get FREE Pocket Electronics Data Guide too!

Name____

(PLEASE PRINT)

Address____________________________County__________

City____________________State____________Zip______

A leader in Electronics Training . . . since 1934.

Circle 8 on reader's service card

FROM THE EDITOR

The $ound of Music

Every now and then, an important segment of an industry gets passed by with little notice, until a careful look in wide perspective brings it to light. In preparing this month's oversized issue for you, with its planned emphasis on audio, high fidelity, and tape, we recognized that one segment of electronics has taken huge strides in recent months, almost unnoticed by those not directly involved: That segment is *music*.

I don't mean just glamorous music devices. There have been computers that compose their own musical scores, unusual devices such as Theremins and music synthesizers, and odd effects created by plain instruments. But have you noticed lately how many ordinary instruments are amplified? Or how many have a special electronic-"ized" version?

Even more than that, though. There are many, many different *types* of music instruments that now employ electronics for amplification and special effects, but an astonishing thing is the huge *number* of instruments being sold—especially guitars, the fastest-selling instrument around right now.

Here are some figures. Total factory sales* of electronic musical instruments, including organs, were $109 million during 1965 and have spiraled upward all through this year. You can estimate what that amounts to, retail.

Speaking of guitars, $140 million worth of guitars and amplifiers were sold† in 1965 (counting non-electric types). The 1965 figure is 50% above 1964, and the 1966 total will likely go another 50% higher (over $200 million). Consider all the additional money spent for tape recorders so these strumming enthusiasts can listen to their own performances, for microphones to sing and record through, and for amplifiers to reinforce the sound of everything from drums to harmonicas, accordions to zithers. Add to that the dollars spent for special-effects devices and for accessories to various amplifiers, recorders, and instruments. You're talking big business.

Still, even that is only the surface. Where there's that much electronics gear, there have to be technicians who keep it repaired. And salesmen to sell more of it. And distributors to supply the instruments, amplifiers, accessories, and parts.

We've kept you up-to-date on most developments in musical electronics. News stories, product reports, construction articles, etc. For this special issue, just before year's end, when Christmas buying is starting (and a good part of it will involve electronics and music instruments jointly), we have put a little extra excitement into RADIO-ELECTRONICS for you. The extraordinary lead story, our colorful cover, the power-boosting amplifier you can build, the article telling how to service high-power amplifiers—all emphasize that there's something in this booming music field for everyone, even in the narrow though popular field of guitars.

If you're not already a part of the music movement, read and join. You may benefit financially as well as culturally.

Forest H Belt

*Source: *Electronic Industries Association*
†Retail value. Source: *American Music Conference*

Radio-Electronics

NOVEMBER 1966 VOL. XXXVII No. 11
Over 55 years of Electronic Publishing

EDITORIAL

AUDIO-HIGH FIDELITY-STEREO

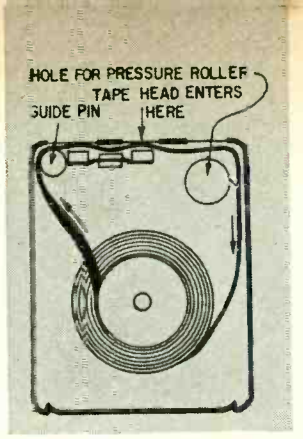
GENERAL

RADIO

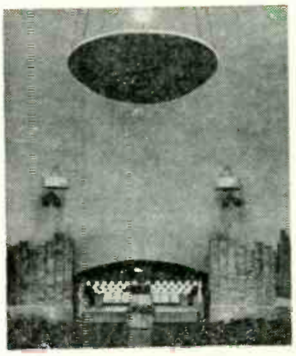
TELEVISION

TEST INSTRUMENTS

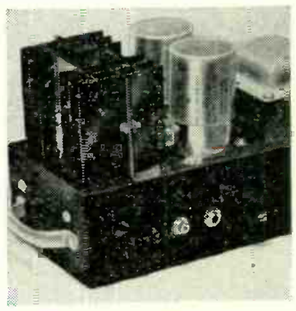
THE DEPARTMENTS



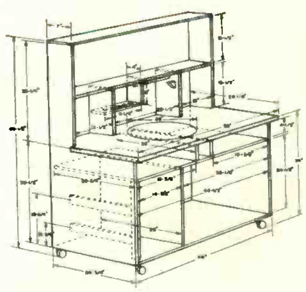
p 38—CAR-TAPE BOOM



p 44—PA ACOUSTICS

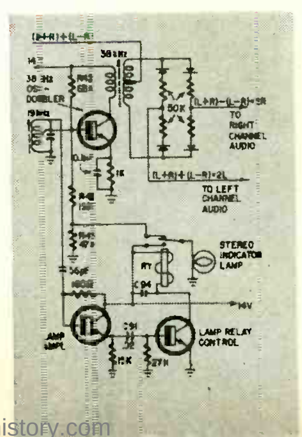


p 56—B-I-I-G SOUND



p 52—BENCH YOUR DEN

p 58—FM ON THE ROAD



RADIO-ELECTRONICS, NOVEMBER 1966, Volume XXXVII, No. 11. Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302. Editorial, Advertising, and Executive offices: 154 West 14th Street, New York 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.

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

***COVER FEATURE**

p 32—The editorial (p 2) and several articles put emphasis this month on sound—the musical sound. Featured guitarist Chet Atkins puts this huge field into perspective.

p 42—SECRET SENTRY

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

NEWS BRIEFS

WHERE DO THE EELS GO? SATELLITES WILL TELL

Biologists have used radio to solve such problems as how much territory a badger covers, or whether a rabbit taken a few miles from its home returns immediately. The procedure is simple. The scientists attach a small transmitter to the animal and listen with one or more directional receivers. But for larger problems—the route of migrating caribou, for example—the limited range of practical equipment prevents the observers from obtaining much useful information. Bolder spirits among biologists have suggested that a satellite would be the ultimate in tracking equipment.

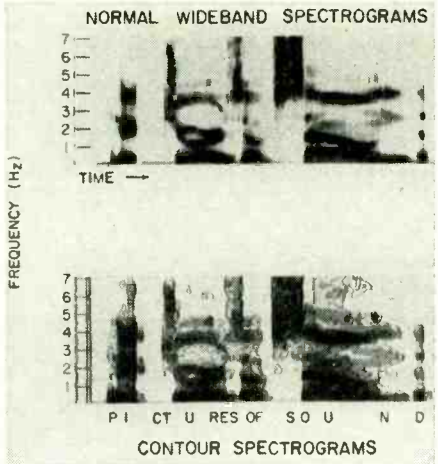
Now the scientists are about to get their wish. Nimbus 3 will carry equipment to track large animals. which will be fitted with transmitters by biologists working with the Smithsonian Institution. The scientists are concerned chiefly with extending their knowledge of nature, but they point out that there should be considerable practical fallout from their investigations. Submarine navigators may have something to learn from the navigation system of the sea turtle, and the gray goose may be able to teach the avigation engineer. Probably these practical arguments did much to assure the biologists a place on Nimbus 3 for their transmitters.

The first transmitters will weigh about 25 pounds, which limits their use to large animals like whales or caribou. The equipment on Nimbus will report the position of the tracked animals within 1 to 2 miles, at least twice every day, upon command.

What about the eel, whose migration between North Atlantic coasts and the Sargasso Sea has been one of science's great puzzles? It seems that the eel's swimming habits and small size destine him to remain a puzzle for a time, at least. But biologists hope that the sea turtle is big enough and spends enough of his time on the surface to permit the mystery of his navigation system (*Newsweek*, Sept. 12, page 59) to be investigated electronically.

NEW SOUND SPECTROGRAPHS FROM TAPE IN 80 SECONDS

Bell Laboratory scientists have devised a way of making sound spectrograms almost four times as fast as was hitherto possible. The spectrograms can also be made directly from magnetic tape. Earlier techniques required that the information had to be



The words "Pictures of Sound" are graphically displayed above on an ordinary wideband and on a contour-type spectrogram. Other spectrograms include narrowband—used to improve frequency resolution—and cross-sectional spectrograms, which give a detailed picture of relative amplitudes at many different frequencies.

transferred from the tape to plated drums or metal loops.

Sound spectrographs (RADIO-ELECTRONICS, August 1962, page 6) are coming increasingly into use in a wide variety of applications: vibration testing, jet engine analysis, cardiac diagnosis, and to identify voices, ships, aircraft or subs. Only recently (RADIO-ELECTRONICS, June 1966, page 4) was a voiceprint (one form of spectrograph) accepted in court to identify the voice of a defendant.

The new spectrograph analyzer scans the tape in narrow bands of successively higher frequencies, making 400 scans to analyze frequencies up to 7,000 Hz.

The amplitude of the sound at any instant is shown by the darkness of the trace. A "contour" type shows changes in amplitude as bounded areas, much like those of a contour map.

MAGNETOHYDRODYNAMIC SUB?

An experimental unmanned 10-foot submarine propelled entirely by electromagnetic forces, with no moving parts, has been demonstrated by a team of University of California (Santa Barbara) students and their professor, Stewart Way.

The submarine's method of propulsion is the converse of the magnetohydrodynamic method of generating electricity. Five lead-acid batteries in the sub supply current to a coil, which in turn sets up a magnetic field in the sea. The same source sends a current, perpendicular to the magnetic field, through the water. The water acts like the armature of a dc motor and is driven toward the rear, propelling the boat forward.

Professor Way believes the principle may be practical on a large scale and that a cargo carrier, cruising at 20 knots with 75% efficiency, could be built eventually.

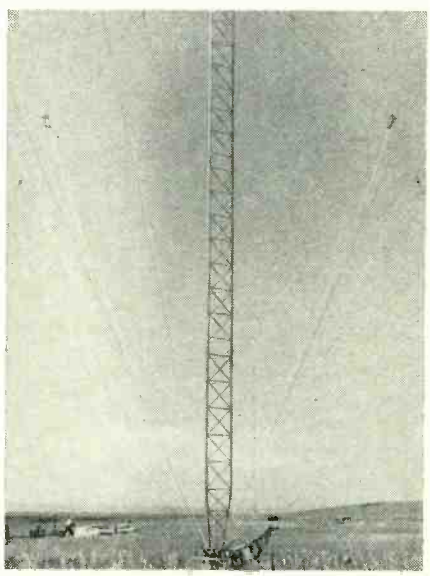
WWV MOVES TO COLORADO

The National Bureau of Standards time- and frequency-standard station WWV will start transmitting from Fort Collins, Colo., on or about December 1, 1966. At the instant transmissions start at Fort Collins, signals of the present WWV at Greenbelt, Maryland, will be cut off so there will be no interruption or overlapping of emissions from the two locations.

There will be eight new transmitters for WWV at Fort Collins. Three will operate with 10 kW at 5, 10 and 15 MHz. Another three—with 2.5 kW power—will operate at 2.5, 20, and 25 MHz. All six will be on the air continuously. The last two transmitters will serve as standbys.

The six regular antennas are half-wave center-fed vertically polarized modified sleeve antennas. The standbys are monopole types that can be operated on any of the WWV frequencies.

NBS stations WWVL (20 kHz) and WWVB (60 kHz) were built at Ft. Collins some time ago. Their transmissions can be received in most parts of



Part of the antenna system of the new WWV standard-frequency station.

DEVRY TECH NOT ONLY TRAINS YOU . . . BUT HELPS YOU GET STARTED AT NO EXTRA COST IN THE BIG-MONEY FIELD OF

ELECTRONICS!

PREPARE AT HOME

Whether you want to prepare for a good-paying new job or for advancement in Electronics with your present employer, DeVry Tech offers specialized educational programs designed to meet your needs. You set up your own HOME LABORATORY and work over 300 construction and test procedures to develop on-the-job type skills. You build a quality Transistorized Meter, a 5-inch Oscilloscope and a special Design Console. DeVry also includes modern "programmed" texts, instructive motion pictures, Consultation Service. Effective? Yes!

RESIDENT SCHOOL

If you prefer you may get all of your training in DeVry's U.S. or Canadian resident schools under the close guidance of friendly, experienced instructors. You work with a wide variety of commercial equipment similar to that actually used in industry as you prepare in our laboratories for a technician's job in Communications, Microwaves, Radio-Television, Automation, Radar, Computers, or other branch of Electronics. DeVry even provides part-time job placement service to those who wish to earn extra money while attending day or evening classes.

PLACEMENT SERVICE

Meet W. E. Bartz, who has helped thousands of DeVry men toward exciting, profitable careers in Electronics. When YOU complete your program, he will help you too. As Placement Manager in touch with business and industry across the nation, Bartz knows the employer demand for DeVry-trained men. He has cooperated in placing our graduates with thousands of firms!

Men 18-45, start preparing NOW for this vast opportunity field. Soon you should be ready for DeVry's valuable employment help!

MAIL COUPON TODAY!

No Advanced Education or Previous Technical Experience Needed to Get Started

Your ambition and desire to succeed are more important! DeVry guides you every step of the way toward success.

Free

Send coupon for these two factual booklets NOW!

DEVRY TECHNICAL INSTITUTE
4141 Belmont Avenue • Chicago, Illinois 60641
Accredited Member of National Home Study Council

DeVRY TECHNICAL INSTITUTE
4141 Belmont Avenue, Chicago, Ill., 60641 Dept. RE-11-W

Please give me your two free booklets, "Pocket Guide to Real Earnings," and "Electronics in Space Travel"; also include details on how to prepare for a career in Electronics. I am interested in the following opportunity fields (check one or more):

- ☐ Space & Missile Electronics
- ☐ Television and Radio
- ☐ Microwaves
- ☐ Radar
- ☐ Automation Electronics
- ☐ Communications
- ☐ Computers
- ☐ Broadcasting
- ☐ Industrial Electronics
- ☐ Electronic Control

Name__________ Age______

Address__________ Apt.______

City__________ State______ Zip Code______

☐ Check here if you are under 16 years of age.

2103 HOME STUDY AND RESIDENT SCHOOL TRAINING AVAILABLE IN CANADA

Circle 9 on reader's service card

the continental US with less time error due to propagation than WWV signals. The two low-frequency stations will continue operations as before. WWV's new central location in Colorado will reduce propagation error in the reception of its high-frequency emissions. No additional services are planned by NBS for the immediate future.

BOTH SERVICEMEN'S NATIONAL ASSOCIATIONS HOLD CONVENTIONS

A week apart, national conventions were held by National Electronic Associations (NEA) and National Alliance of Television and Electronic Service Associations (NATESA).

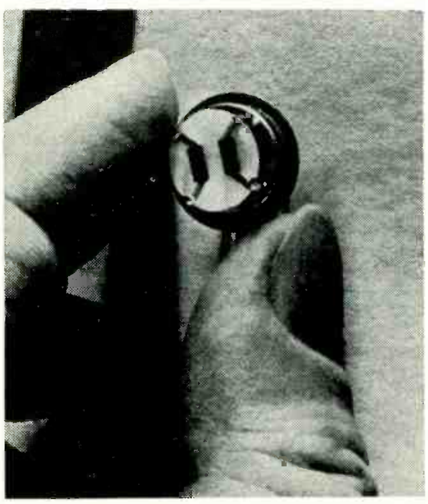
The NEA convention was held at Winston-Salem, North Carolina August 18–21. Forest H. Belt, Editor of RADIO-ELECTRONICS, was on the program as moderator of one panel and panelist on another. Attendance was good, although no figure had been given us at press time. New officers were elected; Jack Betz, former president of the Iowa NEA affiliate, was chosen president of the national association.

The NATESA convention was held in Chicago August 26–28. As we go to press, we haven't received any other information about this second convention.

SIMPLE BANDPASS FILTER IS SINGLE QUARTZ WAFER

Scientists Roger A. Sykes and Wm. D. Beaver of the Bell Telephone Labs at Allentown, Pa., have made a narrow-bandpass filter in which a single wafer of quartz with two gold electrodes does the work of eight components. The filter's maximum bandpass is about 0.1% of the midband frequency,

continued on page 12



This simple bandpass filter—a single wafer of quartz with two gold electrodes —is doing a job that previously required two hybrid transformers, four variable capacitors and two crystal resonator units.

Radio-Electronics

154 WEST 14TH STREET
NEW YORK 10011

HUGO GERNSBACK, *editor-in-chief*
M. HARVEY GERNSBACK, *publisher*
FOREST H. BELT, *editor*
Bruce Ward, *production manager*
Robert F. Scott, W2PWG, *technical editor*
Thomas R. Haskett, *associate editor*
Jack Darr, *service editor*
I. Queen, *editorial associate*
Wm. Lyon McLaughlin, *technical illustration director*
Nancy Gitchel, *editorial assistant*
Adelaide Cassity, *production assistant*
G. Aliquo, *circulation manager*
Joseph L. Bund, *newsstand director*

Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
Chairman of the Board: Hugo Gernsback
President: M. Harvey Gernsback
Vice President-Secretary: G. Aliquo
Vice President-Treasurer: Charles A. Raible
Director of Sales: Don V. Howard

ADVERTISING REPRESENTATIVES

EAST
John J. Lamson, RADIO-ELECTRONICS, 154 West 14th Street, New York 10011, 212-255-7755

MIDWEST
P. H. Dempers Co., 5555 N. Lincoln Ave., Chicago, Ill. 60625, 312-561-0220

WEST COAST
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

STOP THROWING AWAY MONEY WHEN YOU BUY RECORDS.

There are two ways you can throw away money on records. The more popular way is to buy records at full price. That's fine if you enjoy paying several dollars more per record. But the money you've thrown away could have gone towards better things. Like more records.

Then why pay full price? Necessity. Many towns don't have discount stores. And most discount stores don't have every recording in stock. That's where record clubs come in.

Some Record Clubs Can Make You Throw Your Money Away.

Record clubs can be one of the least expensive ways of buying records. They can be a means of getting the record you want by the artist you want. But they can also be the second way you throw away money.

Why? Because of the very nature of some record clubs. These clubs give you an obligatory number of records to buy during a period of time. With each unwanted record you're forced to buy, you're forced to throw away money.

Some record clubs give you discounts only on a chosen category of records. Or discounts only on their own label. A record club that saves you money only sometimes wastes your money the other times.

Citadel Saves You Money.

Then there's Citadel. Citadel is a straightforward record club. There are no obligatory records to buy. No records sent to you that you didn't ask for. No cards to return or else you get the record. You buy the records you want. Only the records you want. And as few or as many as you want. In fact, once you join the club, you don't have to buy any records at all.

And your choice in records is limitless. You can choose any record you want. By any artist. On any label. Citadel club members have well-rounded musical tastes. So there are no record categories. And even if a record is obscure, we'll find it for you. At no extra charge. If you collect 4-track stereo tapes, we've got every tape in print, including auto tapes.

We'll also give you the best discounts around. Always a minimum of 35%. That goes for always. There are never any sudden rises in cost. Never any list price purchases. In fact, we'll regularly give you discounts on the discounts. When we ourselves get records at lower prices, we pass the savings on to you. That can save you more than half the listed price.

Citadel Has Jet-Speed Service.

Citadel has faster service than any other record club. Once we've received your order, we send you your records immediately. Often on the same day as received. If you've ordered a record that's hard to find, we'll send it as soon as we find it. Your other orders will go on ahead. Since there are no records you *must* buy, obviously you're eager to hear those you've chosen. And you get to hear them almost immediately.

Once your records come, they'll be factory fresh and free from defects or damage of any sort. That we guarantee. But if by any chance a defective record does get through our inspection, we'll immediately replace it free of charge.

Citadel Offers Life Membership.

That's what we mean by being straightforward. There's no red tape. We like giving you the best deal possible in the nicest possible way. And that's to give you all the benefits of our record club for life. Records, discounts, super-speedy service for the rest of your life...all for $5.00. (Add $1.00 for tape.)

And the very minute you become a life member in the Citadel Record Club, we'll send you a free Schwann Record Catalog, listing over 30,000 recordings by artist, label and title. If you collect tapes, we'll also send you a free Harrison catalog listing all available tapes.

Send us your $5.00 now for record membership or your $6.00 for tape and record membership. It's the only fee you'll ever have to pay. You'll never have to buy a single record or tape from us. But you'll know Citadel's "there." Just in case you don't feel like throwing away any more money on records.

CITADEL RECORD CLUB, 545 Fifth Ave., New York, N.Y. 10017

Please enroll me as a lifetime member of the Citadel Record Club. I understand that I am entitled to all membership privileges without any obligation to buy anything, ever. If, after 30 days, I am not fully satisfied, I understand that my membership fee will be immediately refunded.

- ☐ I am enclosing $5.00 for Record Division membership. Send Schwann Catalog.
- ☐ I am enclosing $6.00 for Record and Tape Division membership. Send Schwann and Harrison Catalogs.

NAME____________________

ADDRESS____________________

CITY________ STATE________ ZIP_____

RE-116A

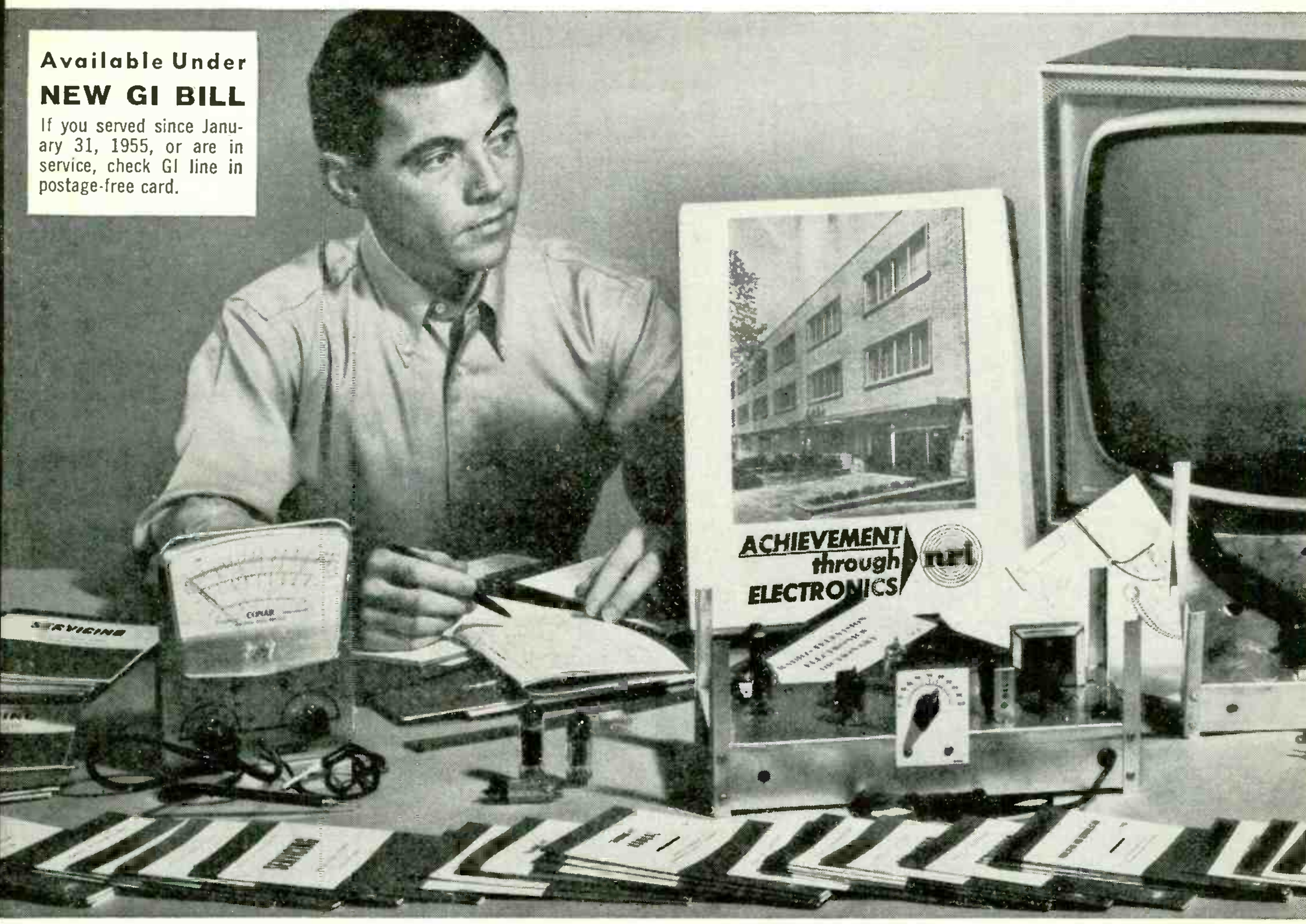
Circle 11 on reader's service card

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.



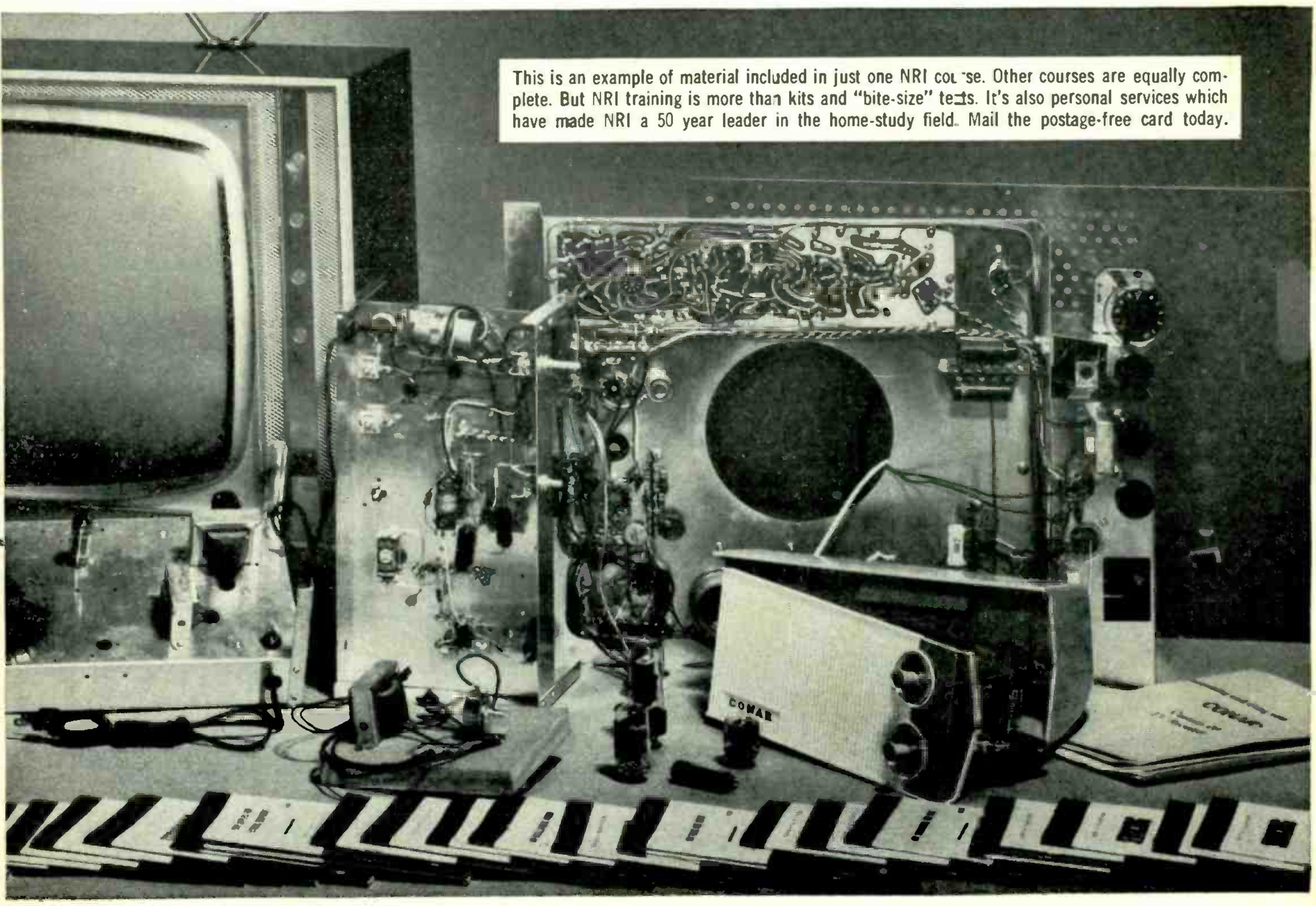
GET A FASTER START WITH NRI'S NEW EXCLUSIVE ACHIEVEMENT KIT

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.

LEARNING BECOMES AN ABSORBING ADVENTURE WITH NRI TRAINING KITS

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



This is an example of material included in just one NRI 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.

and it can be made for frequencies ranging from 1 to 150 MHz. The quartz wafer is approximately 10 mm in diameter.

Such a crystal device has the transmission properties of a conventional filter network, if the electrodes and the spacing between them are properly designed. The device is designed so the quartz under both electrodes has a single resonant frequency, determined partly by the crystal's properties and partly by those of the electrodes. When it is used as a filter, the crystal resonates at two different frequencies: one below the original design resonance and one above the original resonance. This property of dual resonance, which is necessary for the device to operate as a band filter, is due to mechanical coupling of energy between the resonators. The amount of the coupling is determined by the mass of the electrodes and the spacing between them.

The two resonant frequencies determine the upper and lower cutoff frequencies of the filter. When a signal is applied to the filter, all frequencies between the resonant frequencies pass unimpeded, while all other frequencies are attenuated.

ELECTRIC SHOCK DAMAGES BONE

Persons who have apparently recovered unharmed from serious electrical shock may have suffered permanent bone and tissue damage.

Such damage was found in a patient who had apparently recovered completely from the effects of a 2,500-volt hand-to-hand shock. Eighteen months after the accident, he complained of shoulder stiffness. X-rays revealed deformed upper arms, a shortened right arm and bone fractures.

Drs. Louis B. Brinn and John E. Mosely, of Mount Sinai Hospital in New York, found the the arm bones were thinner and the marrow cavity larger than normal. They believe the intense heat produced by the electric current "killed" the bone cells near the surfaces.

This is believed to be the first time that this particular effect of electric shock has been reported. END

CORRECTION

Some words were omitted in the article "Color Television Systems" on page 68 of the July issue. The original manuscript read: "The subcarrier frequency is about 3.58 MHz for 525-line and 4.43 MHz for 625-line TV." Omission of the words "for 525-line and 4.43 MHz" incorrectly ascribed the United States standard to the European systems.

How much do you have to spend for a really good stereo system?

AR turntable, Shure M7/N21D cartridge, Dyna SCA-35 amplifier, and AR-4ˣ speakers (hung on ordinary picture hooks)

THE KEY to the answer is the price of a really good loudspeaker, a price that has changed radically in the last twelve years.

In 1954 high quality speakers were of giant size and cost $400 and up. AR changed all that with its acoustic suspension speaker, more natural sounding than previous speakers and at the same time much smaller and less expensive. This AR design revolutionized high fidelity, and is widely copied to-day.

AR's latest technical breakthrough – the $57 AR-4ˣ speaker – has again reduced the cost of high-fidelity sound. The stereo system shown above, built around AR-4ˣ's, lists for about $350. It will outperform a $1000 hi-fi system of 1954.

Equipment reviews don't often single out one product as the best of its kind without ifs, ands, or buts. *Hi-Fi/Stereo Review* did, when it said of the AR-4ˣ: "We know of no competitively priced speaker that can compare with it." And other reviews went even further, rating the AR-4ˣ as one of the great speakers at *any* price.

It is the speakers in a high-fidelity system that are most likely to be the weak link, to choke off the potential quality of the other components. Choose the speakers first.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge, Massachusetts 02141

- ☐ Please send me literature on the AR-4ˣ, and on the AR-Dyna-Shure Stereo system shown above.
- ☐ Please send me free plans for building the equipment shelf in the photo.
- ☐ I enclose $1.00. Please send me Roy Allison's book *High Fidelity Systems: A User's Guide,* reviewed as "the best basic book now available on high fidelity."

NAME ____________________

ADDRESS ____________________

Circle 14 on reader's service card

Correspondence

AUTHOR CORRECTION

Dear Editor:

I've just scanned my article "Poor Man's Digital Voltmeter" (RADIO-ELECTRONICS, August 1966). Overall, it looks pretty good, but I was disappointed that some corrections I sent you did not find their way in.

In Fig. 4 you left off the polarity marking on POLARITY switch S2. You can correct this merely by adding — and + markings to S2 positions. S2 in your published drawing is in the *negative* input position.

The schematic lists 1N34 diodes, although the parts list shows *the correct* IN270. Also, the correct part number for S3 is 29306-L. The suffix "L" indicates a locking-type switch.

Oh, well, you can't win them all!

CARL DAVID TODD, P.E.
Costa Mesa, California

[We sure can't, Carl. Thanks for the fill-in.—Editor]

DEPT. OF STRANGE SIGHTS

Dear Editor:

Here's something unusual I saw on the way home from vacation. I thought maybe your readers would be interested. Can you figure it out?

LEON A. WORTMAN
Palo Alto, California

[Looks to me as if eagles watch TV, too! Probably eyeing the NBC peacock.

Can anyone top this? We'll pay $$$ for unusual photos.

Incidentally, the answer is with What's Your EQ? *answers on page 105.—Editor]*

OTHER SIDE OF THE COIN

Dear Editor:

As an Army electronics technician now serving in Vietnam, I found your July article about the shortage of qualified electronics technicians of great interest. The facts and figures were no doubt true and presented a serious picture to the average person, but I feel the article was lacking in research.

True, the Army does need these people and I suppose it is true of the other services as well. I have been in the Army long enough to see why this need is not being alleviated. First of all, those people the Army does train are fed up with the harassment and treatment they receive. Second, the pay is a factor. The article indicated possibly some legislation to increase pay in these fields, but the advantages of a civilian job may still outweigh the increase. Third, 80% of the personnel school-trained in this field are in units where

"Sometimes I miss the good old days when we roughed it on golf carts."

they are not even working in their technical capacity.

After basic training, I was assigned to work in an avionics shop, which I did only two days a week. The remainder was spent pulling details from painting to picking up trash along the post's roads. It was not from lack of work. There was enough of a backlog to keep ten people busy.

I suggest that next time you print such an article you do some research at the level of enlisted personnel.

NAME WITHHELD

U. S. Army
Vietnam

FOREIGN AID

Dear Editor:

It is indeed very good of you to have invited your readers to be introduced to you through their letters. I have been a fervent reader at least for 6 years. RADIO-ELECTRONICS will go a long way to help overseas readers if it somehow manages to supply parts for the circuits described in the magazine. I am sorry to state, the American manufacturers are very proud and do not cater to the requirements of overseas buyers. They do not, in many cases, reply to our letters, not to speak of sending catalogs, etc.

I hope you will try to help us in procuring the necessary parts.

J. P. SAXENA

Katmandu, Nepal

[*We can't supply the parts, but we'll call your letter to the attention of some of those proud American manufacturers.—Editor*]

HERTZ NOT NEW

Dear Editor:

I have read with some surprise the letters on the adoption of the term "hertz" by RADIO-ELECTRONICS. It is not the resistance to change that surprises me. The technical magazines long had difficulty when the term "K" (now part of every technician's language) was introduced, and "pico" took 40 years to get into general use. Hertz was first (to my knowledge) referred to in the U.S. Signal Corps manual in 1921, as "coming into use," and was actually adopted (and later abandoned) by QST in 1926.

What *is* surprising is that so many think of "Hz" as a *new* term. The reason it was accepted so quickly by the technical world was that most editors felt it was about time we got in step with the rest of the world, which has been using the term for decades. The editor of *Toute l'Electronique* (Paris, France) says "When *Toute la Radio* started in 1934, we were the first to introduce the term in France." He also points out that "cycle" is incorrect: it refers to a period, and is thus "the exact inverse of a unit of frequency." (Our English friends and a few pedants in the United States solve this problem by saying, correctly, "cycles per second," or cps.)

Whatever arguments may be used against "hertz," newness is not one of them. It has for years been the standard term in the whole non-English-speaking world. And I personally would rather use it than the correct equivalent "cps." I even wonder if we should go further, and get rid of the hiccup we use in describing tape speeds. Why not replace "ips" with the *Poulsen*, which would probably be defined as 1 centimeter per second?

ERIC LESLIE
New York City

PROJECT SUGGESTIONS

Dear Editor:

I read the article "CB'ers Crystal Calibrator" (RADIO-ELECTRONICS, September 1966). This appears to be an excellent unit. However, I have two suggestions to make.

First, the polarized plug can be eliminated and the chance for error and possible shock reduced by using a transformer with 120-volt and 6.3-volt secondaries. The B supply is then fed from the 120-volt secondary, rather than the ac line. All parts are the same as shown in Mr. Greenlee's article, except for T1. Current ratings for T1 are 6.3 volts at 0.15 amp or more and 120 volts at 15 mA or more. Cost of this transformer is little more than that of a 6.3-volt filament transformer. Allied Radio Corp. lists a suitable transformer for $2.18, and surplus units are available for about a dollar (McGee Radio Co.; Olson Electronics).

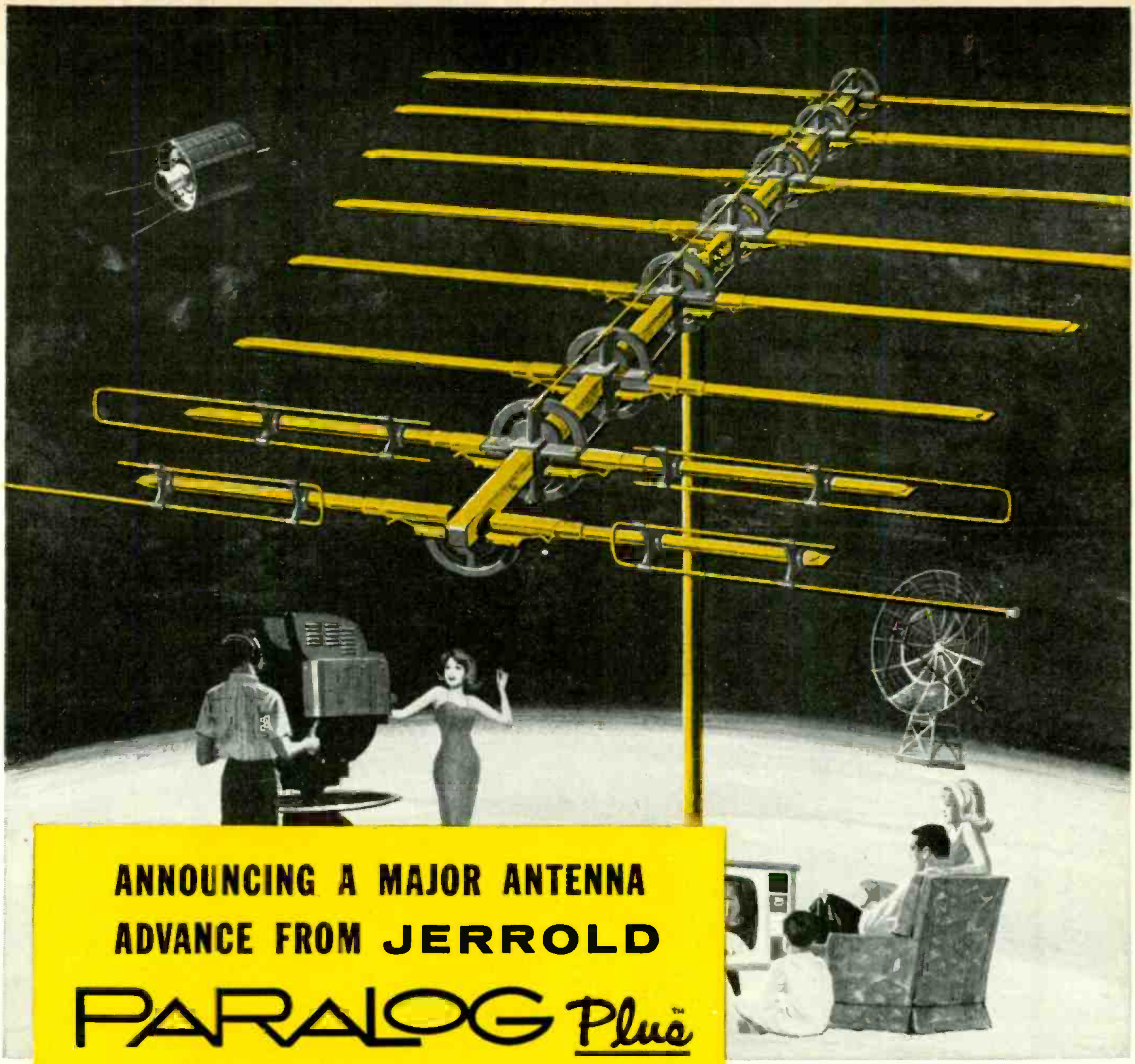
My second suggestion applies also to "Heavy-Duty 5-Amp Supply" on page 59 of the same issue, as well as to other construction projects. We all want our home-built equipment to be as good-looking as commercial equipment, if possible. The handle shown in both articles is strong, but its appearance is not all I desire. I have used the handles (pulls) made for kitchen cabinets on several of my projects. They are available in any hardware or building supply store. These handles are strong, all metal, have concealed mounting screws, and come in a variety of sizes, styles, and finishes to match almost any design.

W. J. STILES
Wentzville, Mo.

END

Radio-Electronics Is Your Magazine!

Tell us what you want to see in it. Your suggestions may make it a better magazine for the rest of the readers as well as yourself. Write to the Editor, RADIO-ELECTRONICS, 154 West 14th St., New York, N. Y. 10011.



ANNOUNCING A MAJOR ANTENNA ADVANCE FROM JERROLD

PARALOG Plus™

Plus GAIN ▪ Plus FLATNESS ▪ Plus MATCH

Why is color harder to receive than black & white? Because color detecting circuits cannot tolerate phase shifts caused by multipath reception, tilted response, or mismatch.

The new Jerrold Paralog-Plus improves color reception three ways:

1. **Plus Gain**—to provide sharper directivity to eliminate multipath reception.
2. **Plus Flatness**—to eliminate tilts which cause incorrect colors on the TV screen. Industry experts say that color antennas must be flat within ±2 db. Paralog-Plus antennas are flat within ±1 db per channel.
3. **Plus Match**—to prevent color-distorting phase shifts.

How does Paralog-Plus give you these exclusive color features? A unique Bi Modal Director system actually works on high and low band channels simultaneously, making each element serve double duty.

Also, you get choice of 75 and 300 ohm coaxial outputs, plus excellent gain over the entire FM band.

For life-like color in your home, try the Paralog-Plus.

DISTRIBUTOR SALES DIVISION
401 Walnut St., Philadelphia, Pa. 19105

JERROLD

Circle 19 on reader's service card

You can earn more money if you get an FCC License

...and here's our famous CIE warranty that you will get your license if you study with us at home

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

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

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

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

Coming Impact of UHF

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

Opportunities in Plants

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

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

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

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

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

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

In a Class by Yourself

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

It Really Works

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

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

Once he could show his FCC License, CIE graduate Calvin Smith of Salinas, California, landed the mobile phone job he'd been after for over a year.

Mail Card for Two Free Books

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

THESE CIE MEN PASSED... NOW THEY HAVE GOOD JOBS

Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE

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

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

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

Glenn Horning, Local Equipment Supervisor, Western Reserve Telephone Company

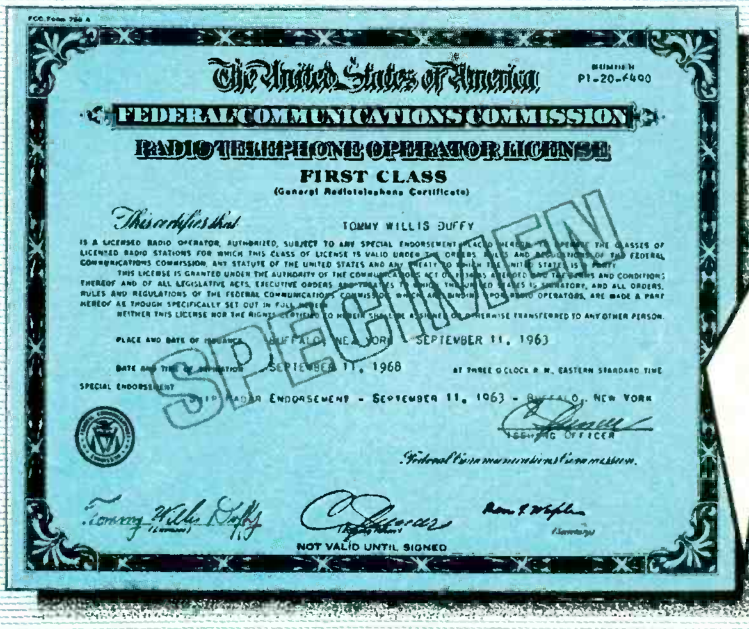
"There's no doubt about it. I owe my 2nd Class FCC License to Cleveland Institute. Their FCC License Course really teaches you theory and fundamentals and is particularly strong on transistors, mobile radio, troubleshooting and math. Do I use this knowledge? You bet. We're installing more sophisticated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

NEWS FOR VETERANS: New G. I. Bill may entitle you to Government-paid tuition for CIE courses if you had active duty in the Armed Forces after Jan. 31, 1955. Check box on reply card for complete information.

CIE Cleveland Institute of Electronics

1776 E. 17th St., Dept. RE-26, Cleveland, Ohio 44114

Accredited by the Accrediting Commission of the National Home Study Council, and the only home study school to provide complete coverage of electronics fundamentals plus such up-to-date applications as: Microminiaturization • Laser Theory and Application • Suppressed Carrier Modulation • Single Sideband Techniques • Logical Troubleshooting • Boolean Algebra • Pulse Theory • Timebase Generators...and many more.


The United States of America
FEDERAL COMMUNICATIONS COMMISSION
RADIOTELEPHONE OPERATOR LICENSE
FIRST CLASS
SPECIMEN
TOMMY WILLIS DUFFY
SEPTEMBER 11, 1963
SEPTEMBER 11, 1968
NOT VALID UNTIL SIGNED

Better than 9 out of 10 CIE men win their "ticket" the very first time they try

(NATIONAL AVERAGE IS ONLY 1 OUT OF 3)

Cleveland Institute of Electronics

WARRANTY

of success in obtaining a Government FCC License

The Cleveland Institute of Electronics hereby warrants that upon completion of the Electronics Technology, Broadcast Engineering, or First-Class FCC License course, you will be able to pass the FCC examination for a First Class Commercial Radio Telephone License (with Radar Endorsement);

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

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

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

G. O. Allen
President

SERVICE CLINIC

By **JACK DARR** Service Editor

Ping-Pong and Guinea Pigs

IN THE EARLY DAYS OF STEREO, THE ping-pong game record was very popular (for a while, until everyone got sick of it!) We can use the same basic method to find trouble in any stereo system.

My little friend said the other day, "I've got trouble in this stereo amp, and no schematic!"

"Don't need one!" I said. (I can be pretty smug at times, and with a bit of effort, completely insufferable.)

"How come?" he asked.

"Y'got one!" I said. "Right on the other side of the chassis—the other channel. It's still working, isn't it?" Sure enough, it was.

This is true in all cases of this kind. If you have difficulty of any kind—gain, distortion, etc., in only one channel of a stereo amplifier, you can use the other channel as a "live schematic" to find the trouble. All you have to do is go down the line like a squad of recruits, "left, right, left, right," checking the same stage in each channel and comparing the readings. Grab a voltmeter and go "ping, pong, ping, pong" from plate to plate and grid to grid, or base to base and collector to collector. As soon as you find a *difference,* there's the trouble.

If the trouble is distortion, use a scope and audio generator. Tie both amplifier inputs together, and feed in a signal. Then, ping, pong until you find a stage where one signal is nice and clean and the other distorted. You've got a direct-comparison standard—what more could you ask?

To check separation, feed a signal into one channel only, and read the output on an ac voltmeter hooked across a terminating resistor (it should be the same value as the voice-coil impedance). It would probably be best to terminate the open input with a resistor of about the same size as the normal input impedance, to get away from stray pickup. Now, note the output reading of the channel you're driving. Move the output meter to the other channel, and see what you get there. Subtract one from the other, and you can figure out the separation in volts, dB or whatever you want. Don't overdrive the amplifier; keep the input signal as low as possible. The normal input voltage from a phono cartridge or tape head, is pretty small, and jamming 5 or 10 volts of signal into an amplifier could give you a false reading of separation, from simple coupling between channels.

If neither channel works, the answer is even simpler. This has to be something common to both channels, and there's only one thing that meets that description—the power supply. Lack of voltage, excess voltage in some cases, hum, feedback or oscillation—all of these must have a common cause if they affect both channels. Distortion which shows up to about the same extent in both channels must be from the same cause; possibilities here would be an odd feedback through the power supply, low operating voltages, complete loss of a bias-supply voltage and things like that.

This method can be used on any kind of two-channel equipment—record players, stereo tape recorders, and the lot. To check a stereo record player, put on a test record which has equal output on both channels. If you think this sounds like a mono record, you're correct! Lots of stereo test records have grooves with equal output on both channels for speaker-balance tests and so on.

Now, check the gain on each channel, and see if it is the same. The balance control (if any), should be centered for this test. If the outputs aren't the same, unhook the cartridge, and tie the hot leads together; feed in a low-level audio signal, and repeat the test. If the amplifiers are balanced, then the cartridge must have low output on one side. Check the cartridge wiring and all input plugs and cables, before replacing the cartridge, just to make sure. By feeding your test signal in at the cartridge leads, you can save time, for this will check the wiring and plugs automatically.

Stereo tape heads can be checked in the same way. Check the amplifiers for equal output with a test tape. If they're unequal, pull the connectors at the tape head, and feed in your test signal. If this shows a balanced output, there's nothing left but the head. Clean it up before changing it; there's always

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.

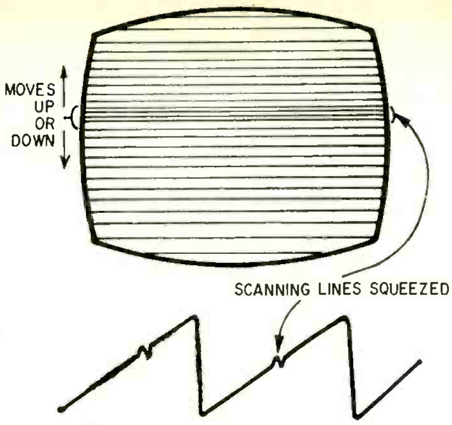
a chance that dirt has built up so it bothers one channel more than the other.

If this has happened, check the tape alignment. It could be running slightly skewed, or the head itself could be badly out of azimuth adjustment (tilted back or forward). A bad pressure pad could be responsible, so don't overlook them either.

In the old days of radio and TV, when we ran into an unknown chassis, we looked for a "look-alike" schematic —one that could have been made by the same manufacturer. The circuits we needed were usually close enough to give us something to go on. Or, if we found an oddball trouble in one set, we got another one just like it and cross-checked. We called this "guinea pigging" it. (We fixed many an SCR-522 like this during the war!) We could cross-check between the bad set and the good one, and find out where the *difference* was. In all stereo amplifiers or systems, we've got a nice "built-in guinea pig," and it makes things a lot easier!

White line in raster

In a Sylvania 614M, a horizontal white line moves from bottom to top of the raster, sometimes stands still. Everything else OK. What is it?—J.A.C., Spartanburg, S. C.



Not too uncommon. This is caused by the scanning lines bunching (see figure). This, of course, is due to a wrinkle in the upstroke of the vertical scanning sawtooth.

Several things can do this. One, in this set, is a defective Halolight. Disconnect it and see. Another, an open electrolytic capacitor in the B+ feed to the vertical output stage, or in the output filter of the B+.

You can get a similar symptom in sets with silicon rectifiers, due to a small "peak" in the rectifier output. Cure: add line bypasses from the rectifiers to chassis. About .05 μF will usually do the job.

Transistor numbers

We bought a batch of assorted transistors; we can't find the numbers on them anywhere. Can you help?—R. C., Rolling Prairie, Ind.

Not a lot. There are so many transistor numbers, and such a lack of uniformity in the numbering systems used, that it's rough. Perhaps your best bet would be to get one of the very large lists put out by RCA, G-E, and other companies making a line of "general replacement" transistors. These lists contain many numbers, and they're about as complete as any that I know of.

Tapes erased in the mail?

Here's a wild one for you! One of my customers bought two small tape recorders; they gave one to their daughter, in Germany, and they send tapes back and forth. All of a sudden, the tapes started coming through blank! They are getting erased in the mail (air mail)! What causes this, and what can we do about it?—S. P., Webster, Mass.

Well, you're right; this is a wild one! I've heard of photographers having trouble with color films being sent off for processing, which turned out to be due to the mail sacks being left out in the hot sun at airports. (They got away from this by timing their mailing

Circle 23 on reader's service card

Circle 24 on reader's service card →

Sony has developed the world's finest audio transistors...

here's the proof

Many manufacturers have made fairly good transistor amplifiers. Until now nobody has made a great one. And everybody knows the reason: distortion. Unfortunately, most transistor amplifiers distort in a very special way. Not so much at top power, but rather more at normal listening levels where it hurts most.

The Sony TA-1120 integrated amplifier and TA-3120 power amplifier are the first high-powered transistor units to really overcome the problem of distortion. At all power levels, at all frequencies distortion is kept below that of the finest tube amplifiers. The TA-1120 and TA-3120 both provide 120 watts IHF at 8 ohms, both channels operating. Distortion, at rated output, is 0.1%. And at normal listening levels it is even less, 0.05% at ½ watt. In addition, they have achieved an extraordinarily high damping factor, better than 70 at 1000 cps to assure clean, low-frequency power response. Frequency response is practically flat from 10 to 100,000 Hz (+0 db/−1 db). For safety's sake, an SCR (silicon controlled rectifier) protects the power transistors against accidental shorts and other overloads.

The integrated amplifier, the TA-1120 features a sensible arrangement of the front-panel controls for the greatest versatility and ease of operation.

We believe that these are the first great transistor power amplifiers. How can Sony do what other manufacturers couldn't? Sony is a pioneer in transistors. With first after first. Such as the tunnel diode Transistor television. And the all transistor video tape recorder. The point is that Sony knows transistors. To the 'n'th degree. And designed new, advanced types especially for the driver and output stages of these amplifiers. And silicon transistors are used throughout. They are the most stable. The TA-1120 integrated amplifier, $399.50. A handsome oil-finish walnut enclosure is optional. The power amplifier TA-3120, $249.50.

Visit your Sony high fidelity dealer and make him prove that Sony is worth the money. Make him compare it with the finest tube amplifiers. We think you'll end up with a Sony. For a free brochure write:

All prices suggested list.

SONY® Corp. of America, 47-37 Van Dam St., Long Island City, N.Y. 1110_ Dept. H so the films traveled at night!) But your problem is different indeed.

Let's analyze: The only thing that will erase a tape is being passed through a strong magnetic field (usually ac). A tape that's shipped in a cardboard box, or any kind of nonferrous container, could be erased this way.

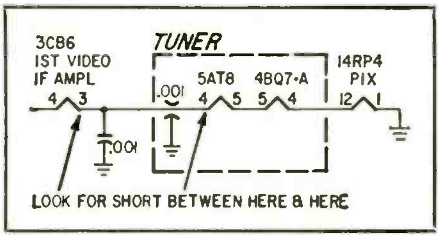
The most likely cause would be a tape passing through a strong magnetic field during the process of mail being sorted or put on the plane. Example: Going up a conveyor belt past a big ac motor. There is also the chance of a tape package being stored somewhere near a motor or solenoid in the plane. While there usually isn't much active machinery in the baggage compartment, most aircraft gear works on 400 Hz, so this could be it.

Best "cure" is to ship the tapes in antimagnetic containers made of iron or steel. You could make up two copies of the same tape letter, sending one in each type of container, to see which one arrives in the best shape. For a test, put a tape in one of the containers, and pass a strong ac field over it (from your degaussing coil). See if this erases the tape. If not, ship it and see. Last resort: Ask the post office department if they can solve the problem.

Picture tube won't light in series string

The picture tube and the tubes in the tuner won't light up in an Emerson 1255 portable. Other tubes light up okay. The tuner doesn't seem to work well, either. Tubes checked out.—L. R., Bronx, N.Y.

You've got a short to ground in your heater circuit. This must be in one of two places—either the first video i.f. amplifier (3CB6), or in the wiring between there and pin 4 of the 5AT8 in the tuner (see diagram).



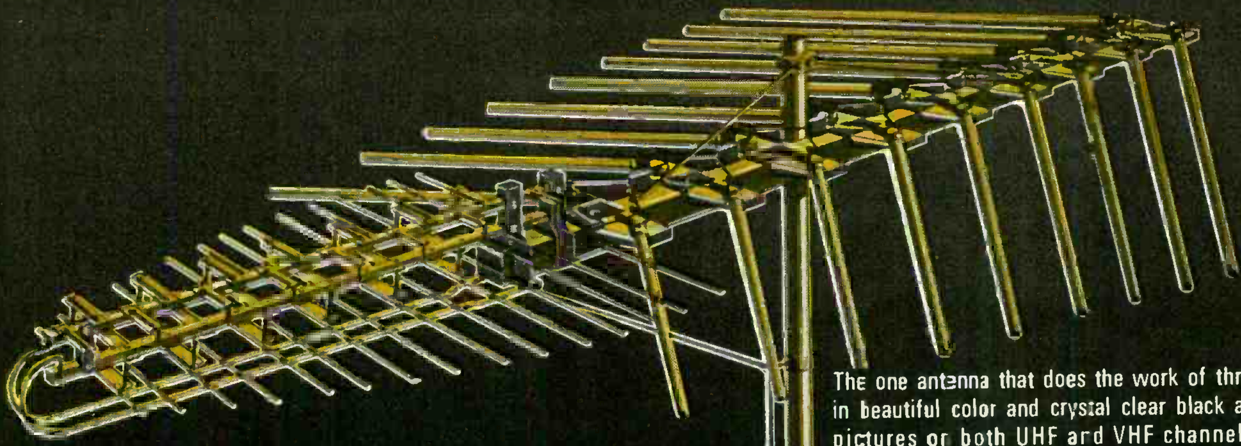
There has to be a short; otherwise the remaining tubes wouldn't light up. A common cause is a heater bypass on the PC board or the little "pass-through" capacitors in the tuner. So, take the cover off the tuner, get a big magnifying glass and the ohmmeter, and have at it.

Vom or vtvm in transistor measurements?

I notice that Philco recommends a vom for setting the bias voltage on replacement power transistors, in their MoPar radios. Why?—C. P. Brooklyn, N. Y.

For several possible reasons. For one thing, the average good-quality vom is a pretty accurate instrument. Vtvm's now and then have a tendency to get a bit off in the very low voltages such as you're reading. The set manufacturer probably specified a vom so that he would get a constant meter impedance across this circuit, and thus get a more consistently accurate setting of this important voltage, since it's very small—only a few tenths of a volt.

Actually, the maker should have specified the input impedance of the vom. Most shop vom's now are 20,000 ohms per volt. END



FINCO ALL-BAND UHF-VHF-FM ANTENNA
75 OHM Model CX-UVF-24 $72.10 List

FINCO ALL-BAND UHF-VHF-FM ANTENNA
300 OHM Model UVF-24 $59.95 List

The one antenna that does the work of three! Pulls in beautiful color and crystal clear black and white pictures on both UHF and VHF channels ... plus the finest stereophonic and monophonic FM sound reproduction.

300-ohm models for normal reception areas from $18.50 to $59.95

75-ohm models for poor reception areas from $42.65 to $72.10

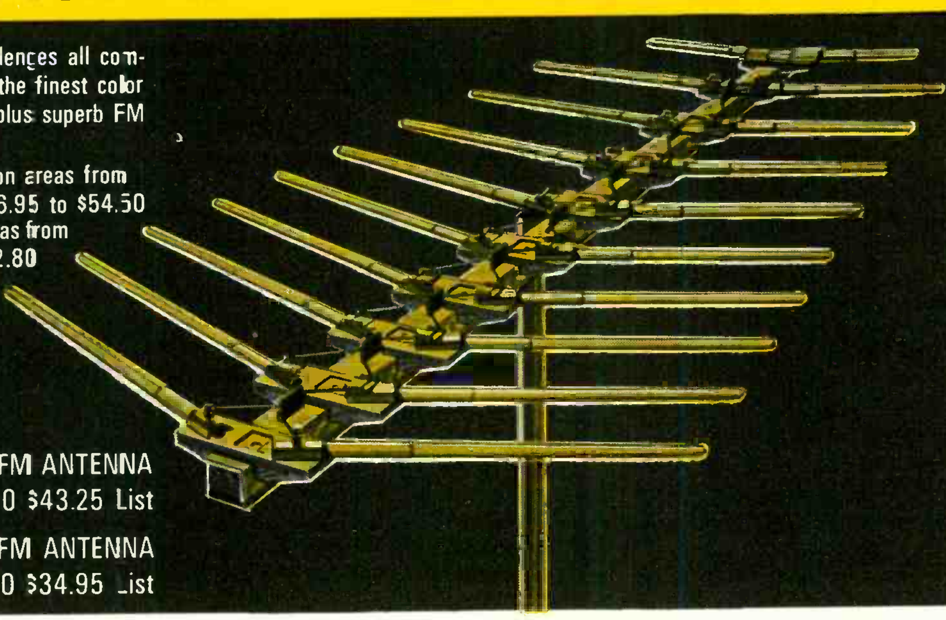
FINCO

introduces / 75-ohm COLOR VE-LOG ANTENNAS FOR UHF-VHF-FM RECEPTION

Finco's Swept-Element Antenna challenges all competition. Its unique design assures the finest color and black and white TV reception—plus superb FM and FM Stereo tone quality.

300-ohm models for normal reception areas from $16.95 to $54.50

75-ohm models for poor reception areas from $18.55 to $62.80



FINCO SWEPT-ELEMENT VHF-FM ANTENNA
75 OHM Model CXVL-10 $43.25 List

FINCO SWEPT-ELEMENT VHF-FM ANTENNA
300 OHM Model VL-10 $34.95 List

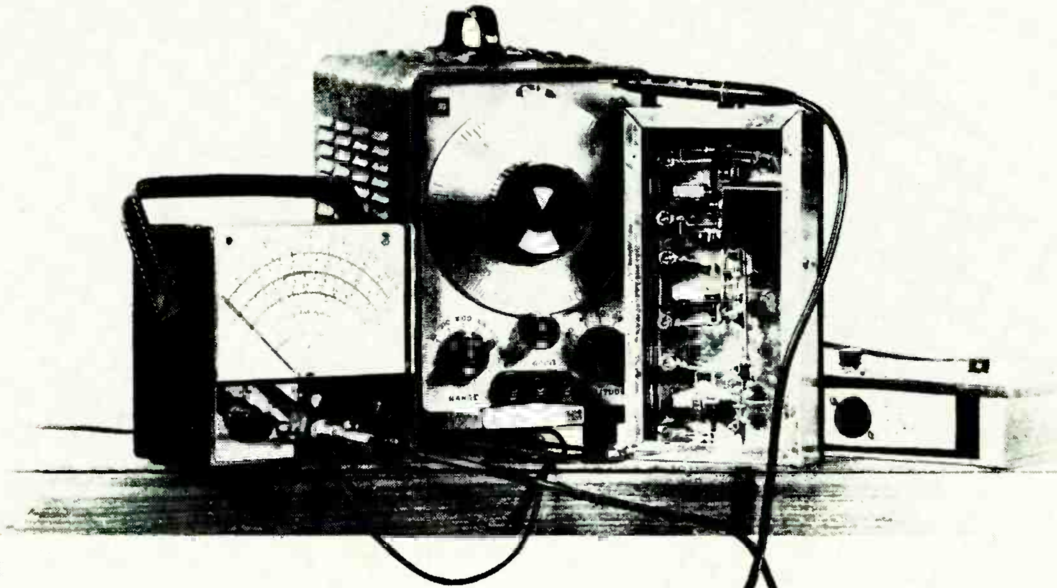
FREE! ALL FINCO CX-VL, CX-UVF AND UVF ANTENNAS COME WITH A FREE INDOOR SET-MOUNTED TRANSFORMER, VHF-UHF TRANSFORMER SPLITTER OR VHF-UHF SPLITTER.

MAKER OF THE WORLD FAMOUS COLOR FINCO BLACK / WHITE ANTENNA COMPONENTS AND ACCESSORIES

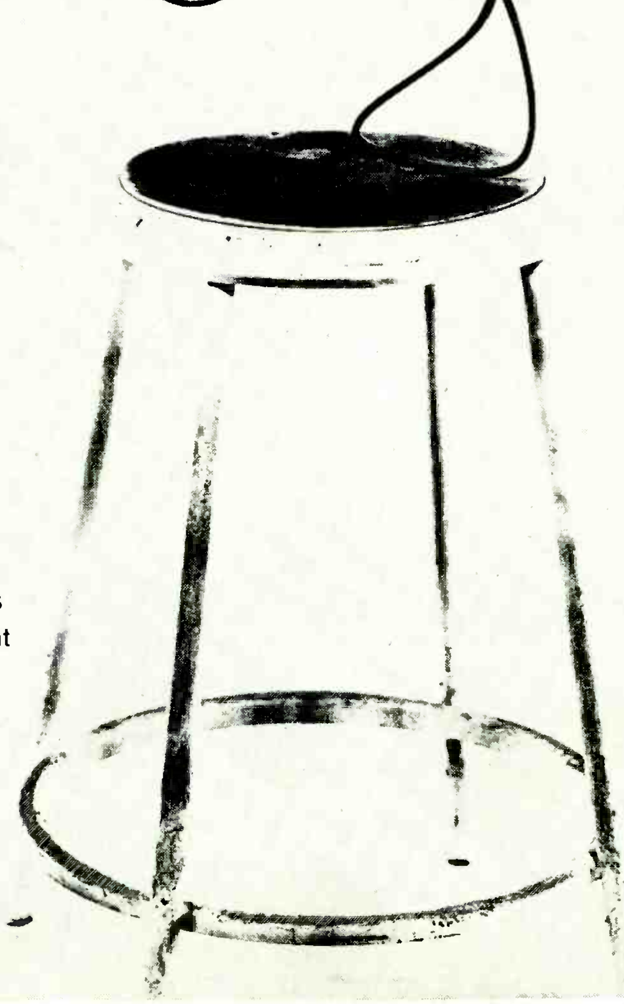
THE FINNEY COMPANY
34 WEST INTERSTATE STREET, DEPT. RE-11, BEDFORD, OHIO

Circle 26 on reader's service card

SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



RCA INSTITUTES DID!



Here is a whole new approach to learning electronics at home! RCA Institutes, one of the nations' largest schools devoted to electronics, has developed a faster, easier way for you to gain the skills and the knowledge you need for the career of your choice. Here for the first time, is a student-proved, scientifically designed way to learn. If you have had any doubts in the past about home training in electronics —if you have hesitated because you thought you might not be able to keep up—or that electronics was too complicated to learn—here is your answer! Read how RCA Institutes has revolutionized its entire home training ideas!

Guitar Amplification in the Atkins Style

Special sound effects, amplifier power and speakers, and professional recording methods are subjects of this interview with the world's top guitarist

By FOREST H. BELT

"FOR A REALLY MEANINGFUL story on guitar amplifiers and special effects, we should talk to an expert—someone who knows a lot about both."

That is part of a conversation that led me a few days later to be jetting my way to Nashville, Tenn., music-making center of the United States and headquarters of Chester B. (Chet) Atkins, the world's top guitarist.

Chet Atkins was a natural choice. As well as being master of the guitar, he is an expert in the electronics of guitars and recording. He's so good, in fact, that he's the artist and repertoire (A&R) director for RCA Victor Records in Nashville.

Photographer and art director Harry Schlack was with me, to shoot pictures for the story and hopefully to get a cover photo. We met Chet in his spacious and comfortable office in the new RCA Victor Recording Studios building a few blocks from busy downtown Nashville. He welcomed us and put us at ease with the real warmth of a true Southerner. A tall, quiet man, modest—even vaguely shy—he held a short cigar between his first two fingers, like a cigarette, and puffed it unobtrusively from time to time.

Chet settled into an upholstered desk chair and made small talk while I plugged the mike into my tape recorder. He assured us he'd do whatever he could to help develop a good guitar-amplifier story for RADIO-ELECTRONICS readers.

My first question was, "Do you have some preference regarding the output power of an amplifier you use with a guitar?"

"Well, that depends. In the recording studio, you don't need much power. If you play too loud you get in all the other microphones, and the recording engineer can't control it.

"At shows, if you use the public address system—that is, if you put your amplifier on a mike—you don't necessarily need a large amp." Chet puffed twice on his cigar, and continued: "But most of the kids don't do that. They get a lot of watts and a lot of speakers, and turn it up pretty loud. If it distorts, let it go. In fact, the kids seem to like a little distortion nowadays."

"Even in their singing," I joked.

"Yeah," Chet responded, and we both laughed.

"For your own use, Chet, do you prefer any particular type or size of amplifier?"

Another puff on the cigar. "Oh, the one I use most has 6L6's or 5881's, in push-pull parallel. Puts out about 50 watts, I guess. But I put a mike on it, anyway. You see, I play a 'finger' style and if you get the amp up too loud, it feeds back into the guitar pickups. So I always try to put a mike on it."

"You mean you connect the guitar to the guitar amp, then put a mike in front of the guitar-amp speakers, and play over the PA system?" I wanted to be sure.

"Yeah. That's it."

"Do you ever plug the guitar directly into the PA, or doesn't that work out very well?"

"No, I've never done that. I play concerts with Floyd Cramer and Boots Randolph all the time—we call ourselves the Festival of Music—and we've been talking about getting four or five good mikes and a bunch of plugs that will adapt to 'most any PA system, and using our own sound setup. I think we'd get a lot better sound if we did that. But then we'd probably have to take our own sound man, and get more involved."

"What about the speakers in a guitar amp?" I asked. "Do you have any special preference?"

"No, not really. The one I use on personal appearances has two 10-inch jobs in it. They seem to work pretty well . . . a little smoother, maybe. On recordings, I use an old amp I've had for years. It's a Williamson circuit and I like the sound of it . . . it's kind of a mellow sound that I like." Chet puffed again on the now-stubby cigar. "On recordings, a lot of times I don't use an amp at all. I wire into the control-board direct."

"You can do it that way?"

"Yeah, if you want a lot of presence on the recording, that's a good way to get it."

Chet blinked a few times to get rid of the effects of a flashbulb. The photographer was popping them all around.

I continued, "You design your own guitars, is that right?"

"Yes, I have a few I worked out myself and the Gretsch people made them up for me. This one in the stand here behind me is a brand-new one. Just got it yesterday." (The beautiful red guitar he indicated is on this month's cover.)

Chet went on: "Also, lately I use an acoustical guitar a lot. My last couple of records were made on an acoustical."

"Acoustical in what way?"

Chet puffed twice on his cigar . . .

"Well, it's a classical guitar—just the romantic type of guitar. And then, I have a guitar that came from Brazil—has a metal resonator in it, like a speaker cone. It's a terrific guitar."

"I've seen the ones with the metal cone," I said. "Fellow I used to know played one."

"Yeah? I've got one I picked up from the Indians—Los Indios Tabajaras. That's where I first heard it. It and the Brazil one, they're really great. A lot louder and real mellow-toned, penetrating. I prefer an acoustical guitar, but you can't use it on some things."

"Can't get the effects you want?"

"No. And if you've got a loud drummer, forget an acoustical guitar."

The phone jangled, and I used the break to check my tape recorder. Still running. When Chet turned back, I pursued the guitar-design question.

"I've seen guitars with two, three, and even four pickups under the strings. Why so many?"

Chet answered, "Well, it's like . . . when you play the guitar back close to the bridge, you get a sharper tone—more highs." He pointed on the guitar behind him. "So, you put a pickup back there and you get a lot of highs. The pickup up next to the fret board gets a lot of lows." He turned back to me. "Really, I just use one pickup most of the time—the one up next to the fingerboard, because I like a *pretty* sound. But most people want a variety of sounds, so they get a guitar with two or three

"This one behind me is a new one I just got yesterday"

pickups. I think you can get almost any sound you want with two pickups."

I had an idea. "Has anyone ever thought of feeding the separate pickups into separate amplifiers or channels, with tone filters to accentuate the effect of each pickup?"

"Yes, I've done that myself. I wired one up at home one time. The first three strings were on one pickup and the last three on another. I did it so I could get a lot of bass or a lot of treble whenever I wanted."

"How'd it work out?"

"I've listened to some of the records I made with that setup, and they sound pretty bad. I used too many highs. That was back when Les Paul was the thing, and he got a lot of highs. I was trying to get something similar to that. But, you know, your taste changes as you move along. . . ."

Chet almost blushed at the compliment, fidgeted with slight embarrassment, murmured "Thank you"

"As you grow older. . . ."

"Yeah. Les Paul never played anything in bad taste in his life, but he did use a lot of highs and it's hard to do without sounding twangy."

"I've admired the pureness of your notes on records."

Chet almost blushed at the compliment. He fidgeted with slight embarrassment, and murmured, "Thank you."

I hurried on. "Do you have any special effects you like? Echoes, vibrato, reverb, that sort of thing?"

"Dead-string on this one is with a rubber damper"

"I've fooled around with about every kind of special effect there is. About six or eight years ago, a very smart engineer friend of mine, Bob Farris, and I worked some with dividers. We had separate pickups on the fifth and sixth strings, and fed them through dividers so that when I would play a note, you could hear another note an octave lower along with it. Made it sound like a bass. We perfected that pretty well. But then we checked the patent office and found out a guy in England had done it about 1946. He was 'way ahead of us, so we finally forgot about it. It's home in my basement somewhere—sure looks like a rat's nest."

The phone rang again. Chet talked a few moments, then turned back to our conversation.

"We took this effect with the divider and filtered it . . ."

"This was a *frequency* divider?" I interrupted.

"Yes . . . and filtered it so it sounded like a bass guitar, or very similar. And we also filtered it less and got a great sax-type sound—very raspy, like a baritone sax. Funny thing, some of the boys here in town stumbled on this later because something went wrong with an amplifier—got to distorting so badly that it got the same sax-type sound. They made some hit records with it. Somebody puts out a gadget now that does it—called FuzzTone."

"What else have you experimented with?"

"I've fooled with a foot pedal, too. I had a foot volume control, and I wired it up so it would accentuate the highs or the lows. You can get dramatic effects with it. I used it on a couple of albums."

"How about vibrato? Do you use it for anything?"

"Vibrato? Yes. I had a good engineering friend of mine up in Illinois build me an amplitude *and* frequency vibrato—a thing that'll do both. We used it on some recordings here. It's a high quality thing. Has high- and low-impedance inputs on it, and you can put a voice on it . . . get vibrato in the singer's voice. Or, you can put it on a sax . . . or trumpet."

I wondered aloud if it was patented.

"No. It's just like a guitar amp, only better quality. And you can use it on any instrument. It's a phase-shift thing, actually raises and lowers the frequency slightly. It's not anything new; some companies have had it in their guitar amps."

Chet dismissed vibrato with a wave of the hand. "I also started experimenting with tape reverberation back about 1953."

"Head-to-head?"

"Yes. A friend of mine built this reverb unit into an amplifier. It was one of the first with a tape loop. I still have it, but I don't use it much any more. You can get some novel effects."

Chet paused to reminisce for a few seconds, then: "I was trying to put reverberation into an amp years ago. Of course, they have it now with the springs unit. One I had back then was a rubber medical hose about 50 feet long, with a microphone at one end and a speaker at the other. And it worked! But it was pretty big, and the novelty soon wore off and I forgot about it. It's still around somewhere."

I asked Chet. "There are other ways of getting reverberation, aren't there? Room echoes and all that?"

"Oh, yes. I have a unit I got in Italy. It uses a metal flywheel instead of tape. It doesn't flutter nearly as bad and it doesn't wear out like tape."

I asked who makes it.

"Benson, in Milano, Italy. I use mine when we play out in the open. It's great, because you don't get any natural reverberation at all outdoors."

"What about tape reverberation—does anyone use it much?"

"Yes, a lot of the boys here in town do. You know, one of the problems of tape reverberation is that it has rhythm effect that's inherent. Some people in Ohio developed a little unit, called Echo-Plex, that has an adjustable head so that you can set the distance between playback and record heads and get it right in rhythm with any tune you're playing. You can get some great effects with it. Grady Martin uses one all the time."

"Chet, there is a guitar effect I call a 'dead-string' effect. It's done sometimes with the heel of the hand. The way it sounds on your records is so smooth, I wonder if it's electronic."

"No, I do it most of the time with my hand. Now, this guitar behind me has a damper on it—with a rubber cushion on a bar. Just pull the switch and it deadens all the strings. I've never had this on my guitar before, though. It gives a good effect, because you can play without having your hand back so far. I think that's the effect you're talking about. I haven't heard about anything different."

"On some of your records, it sounds like you're chiming the guitar, but you're playing tunes. Is this chiming sound made with the pickups?"

"No, I'm actually chiming the guitar. I play a lot of chimes."

"How do you get that sound on so many notes?"

"Well, you can chime anywhere on a string, and you do it with your right hand. You pluck the string and at the same time barely touch it. For example, if the string is open, you can touch it in the center with your left hand. If you note the string behind the first fret, that changes the center point on the string, and you've got to move the point you touch two frets down from where you touched with the string open. Here, I'll show you. . . ."

And he did. Taking down the guitar behind him, he treated us to a quick concert of the finest music you'd ever hope to hear on a guitar. Chimed scales and arpeggios, tunes of pure notes with harmonic chimes to accompany them. . . . As a long-time fan, I'd waited 15 years to sit like this and watch this master perform. A thrill I won't soon forget.

Chet pulled me back to reality by explaining, "It's just like in audio equipment. You have a main tone (the fundamental) and multiples thereof (overtones and harmonics). You have the same thing on the strings. A long time ago I developed a way to play other strings and play a harmonic with them. I thought it was brand-new and original, but since then I've found things that were written 50 years ago and they did that in them.

"So . . . that's how it's done," Chet said as he put the guitar back on its stand.

I watched with regret; I'd almost forgotten the interview. But . . . back to business. "Chet, somebody has an effect called the 'singing guitar.' Do you know who that is and what it is?"

"You're probably talking about Pete Drake, the steel-guitar player. He ran around here for years, wanting to make his guitar talk. I told him how Alvino Rey did it years ago. I even tried it a couple of times myself, but I never was very successful with it. Anyway, I told him, 'You've got to get the sound in your mouth and throat and form the words with your lips.' So he talked with some other people, and then he went over here and bought a piece of surgical hose and a speaker driver and put one end of the hose over the driver and the other end back in the side of his mouth . . . and it works great! He makes albums and sings the songs on the steel guitar, and is very successful with it."

"Yes," I said. "I've heard it's really an unusual effect."

"Sure is. It's very good. He also uses it to get 'doo-wah' effects on rock-and-roll records. And he can make a guitar sound like a horn or anything. It isn't the way Alvino did it, but it sure is successful."

Chimed scales and arpeggios, tunes with pure notes and chimes

I had still another question about special effects: "On an organ, there are all sorts of ways to change the sound to mimic almost any instrument. Are there any electronic ways of doing this with a guitar?"

"Yes, there are. You can do it with dividers, like I was talking about before."

"The frequency dividers?"

"Yes, and with multipliers and filters. There were some guys here from California the other day. They had developed the same thing my engineer friend and I had worked on a long time ago. But they'd developed it to a very high degree. And theirs is transistorized —ours was so bulky with the tubes and all. It'd be fine for studio work. It has a beautiful organ effect. But you know, it's not a guitar any more: it's an organ, because it sounds like one. Except when you push and bend the notes, and then it's a cross between a guitar and organ."

"And they did it with dividers, filters and multipliers?"

"Yes. They had separate microphones on each string, which you've got to have with dividers. They had it developed to a high degree."

I decided to turn the subject back to Chet himself. "I understand you have a studio and workshop at home. Did you do your own design and wiring?"

"Yeah, and it's pretty messy. I won't let anybody see it. It's pretty bad."

"So's my lab in New York," I admitted.

"My stuff is pretty well matched, though. I don't get much distortion. It works."

"I'd say that's the important thing."

"Yes. As long as it sounds all right, I hide the wires and let it work."

"What's in your studio?"

"I have an old RCA console that was built for radio stations. Since then, they've developed circuits a lot better, so I've rewired it. And I built a new power amplifier and a new line amplifier. The line amplifier has a limiter in it that I copied from a unit I borrowed; it works very well."

"You punched the chassis, wired it, and all?"

"Yes. If I've got a schematic, I can build 'most anything."

"You mentioned earlier having some low-impedance pickups. Guitar amplifiers have high-impedance inputs usually. Do you just plug them in and ignore impedances or do you match them?"

"Well, the amp I used them with had a 50-ohm mike input; I just plugged into that. But when I wanted to plug into anything else, high impedance, I used a matching transformer."

"Like this one, maybe?" I showed him the one in the mike lead of my portable tape recorder.

"Yeah. Say, they are making them smaller now. The one I used was a great big fellow. I just taped some wires to it and dragged it along the floor!"

"Tell me more about your studio at home."

"Well, it's just a little room in the basement. I have a couple of Ampex tape recorders, a three-channel for stereo and a full-track mono. I have some equalizers I built. I use a couple of big Altec-Lansing theater speakers. And I have some VU meters, tape erasers, and vtvm's and test equipment of various kinds—a distortion analyzer and audio generators. I have a lot of fun down there."

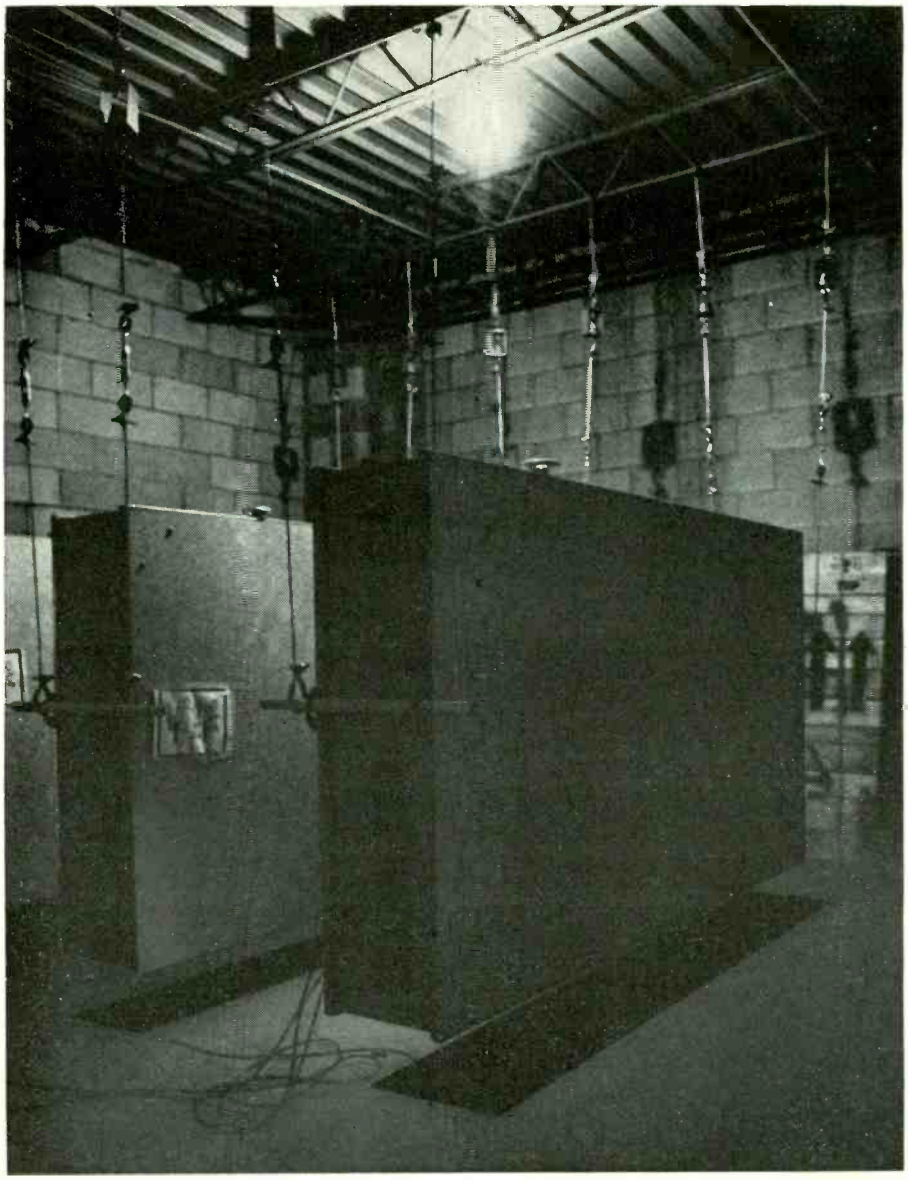
"Do you repair your own studio equipment?"

"Oh, yes. I check all of the things out with the distortion analyzer and audio generator every once in a while to make sure they're up to specifications. If they aren't, I try to find out what's wrong. I'm usually able to fix them."

Chet looked around, probably for another cigar, gave up and went on talking.

"I have an echo room at home, too. It works very well, but not as good as our echoes here at the studio. So, if I record anything at home I just bring it in and remix it and add the echo here. My room could be mellowed to give a good echo, but my wife's always putting a chair in there, or something." He grinned.

I asked, "How do you make an echo room, acoustically?"



"EMT reverberation boxes suspended by rubber things"

"Well," he answered, "when we built the house, we had this vacant space in the full basement. So I said, 'Plaster that, and varnish it, smooth it down real smooth.' Turned out to be a pretty good echo room."

"What size is it?"

"About 14 by 16, I guess."

"That gives a pretty good length of reverberation," I said.

"Yes, but it's square, and it shouldn't be for a good echo chamber. You get standing waves. The walls shouldn't be square. What do they call that, when they're not square? There's a word for it."

"Splayed walls?" I volunteered. "Where no two surfaces are parallel?"

"Yeah, some kind of screwed-up rectangle."

"Speaking of acoustics, you said that when you're recording you use the guitar amp and put a studio mike in front of it."

"That's right," Chet agreed.

"Doesn't that introduce a certain amount of studio reverberation?"

"To some degree. But not too much, because our studios are fairly dead. Not completely dead, because then the musicians can't get any feeling going and they lose interest. Some of the musicians on our recording sessions add the reverb in their amps, but I prefer the studio reverberation myself."

"You mean just space the mike far enough from the amplifier to get the studio reverberation you want?"

"Yeah, but not necessarily. We have some German echo units that add a real good reverb effect, so we can leave the mike pretty close to the amp, 6 or 8 inches away."

"What are those German units?"

"They're called EMT units, stands for some German word [Electromesstechnik]. Each one is a big sheet of steel suspended by springs inside a big crate. At one end is a driver and at the other is a pickup. It's about as big as a bedspring stood upright—about 6 feet high, 8 feet long, and 8 inches thick. It's a great echoer, as good as any room, I think. We altered ours a little, and they work great. We have six or eight of them."

"Don't you have regular echo rooms?"

"Yes, we have three, but we don't use them too much yet. We've only been in this building a short time and haven't had time to experiment with everything yet."

"So you use these EMT units for echo."

"That's right. We had to suspend them from the ceiling by rubber things because noise from the air conditioning was getting into them. We were getting a low-frequency rumble in the mixing."

"I hadn't thought of getting reverberation or echo by vibrating steel and picking up the vibration after the delay of moving through the steel."

"I'm getting a little more confidence or something"

"It's very expensive. You won't see them in any homes. They cost a couple thousand or more I suppose, by the time you install them."

"What else do you think would interest our readers about your RCA studios here?" I asked, leading toward an ending.

"Well, we use condenser microphones, mostly. Of course, on the bass fiddle we use an RCA model 44 ribbon mike, because you don't need a lot of highs.

"Our mixing console is 15 or 20 channels, all transistorized. And we have all sorts of tape recorders—a four-channel, a bunch of three-track stereo machines, some mono units, and some two-tracks.

"We also have a little isolation room in the studio where we can put a singer who sings so softly that the band gets into his mike too much. Seldom use it; I think the last guy we used it on was Vic Damone. I think Sinatra uses something like that, too.

"We have one of the largest studios in the country—75 x 50 x 35 feet. If we want a smaller sound, we have these baffles 8 feet high and 10 feet wide. We move them around and isolate one instrument or one microphone from another.

"We don't have much trouble with outside noise, although we have busy streets on both sides of us. Once in a while we've had electrical storms with thunder so loud we'd have to do another take."

I interjected, "Does the studio have its own power system?"

"No, but we use voltage regulators on all the equipment. We used to blow a lot of fuses, so we added regulators."

"One more thing, Chet. I've heard that you record your own part of an album, alone, at home, and then add it to what's done in the studio by the other musicians."

"That has never been the rule. I do it sometimes when my playing doesn't satisfy me. I'm on the center track of the three-track stereo machines, so if I want to improve on my part I can. With the self-sync method Ampex utilizes, you can play back and record at the same time. I'll take a tape and do my part over if I don't like what I did.

"It's a great thing to be able to do that, because I'm a pretty shy person. If someone walks in while I'm recording and I think maybe he doesn't dig me . . . well, it's like your golf game: somebody says something and your swing goes all to hell.

"I do my recording separately once in a while, but to no great extent any more. Guess I'm getting a little more confidence or something."

And I added, "With good reason."

END

AUTO TAPE PLAYERS

More people are using cartridge-tape players in their automobiles today. Learn how these tape machines operate and how to install and service them **By JACK DARR**

THE MARKET FOR AUTO TAPE players has literally exploded. Since our last report ("Tape Players for Your Car," RADIO-ELECTRONICS, September 1965), in which we listed 17 manufacturers, the number has increased so rapidly that it it is difficult to keep up with it. For a moving car, the convenience of "plug-in" cartridge operation, the ease of getting true stereo sound, and playing times up to 80 minutes in a single cartridge are features that have given auto cartridges a real boost.

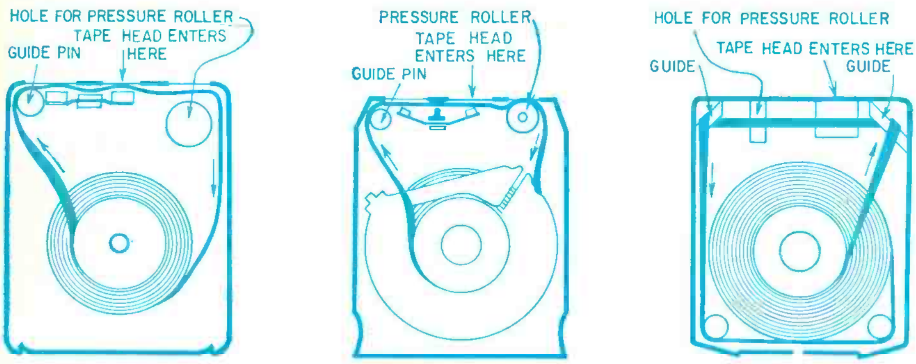
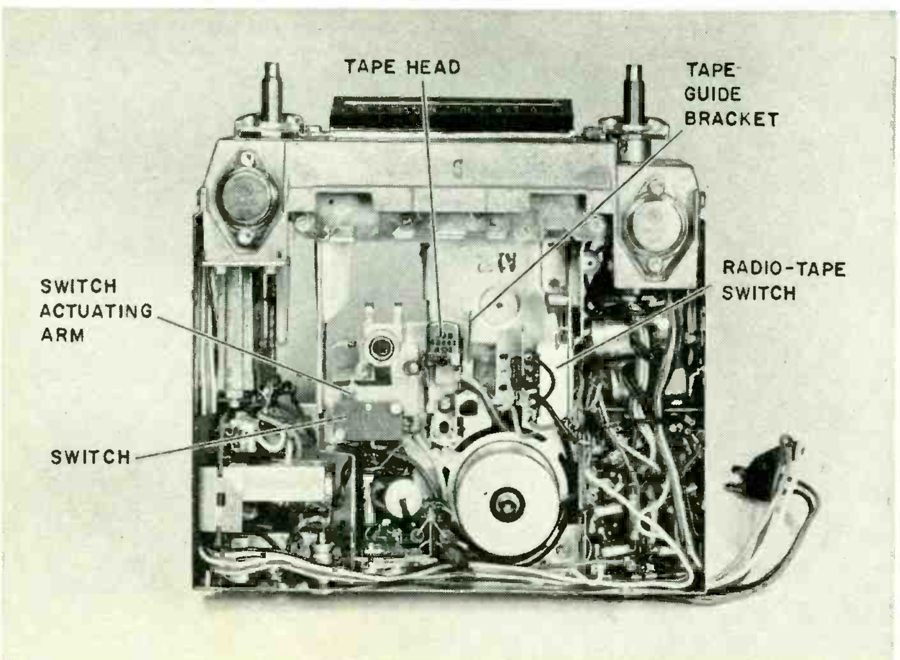


Fig. 1—The three main cartridge types: a—Fidelipac; b—Lear-Jet, and c—Orrtronics.



Top view of a combination radio-tape player. Note output transistors at corners.

A great many tape units are being sold by car dealers; Ford, General Motors and Chrysler all have custom units. Although these units have long warranties—up to 3 years in some cases—the auto dealers are farming out the service work, mostly to independent service shops, just as they have been doing with radio work. And, once out of warranty, the players will be brought to service shops the same as auto radios are.

We hear predictions such as "2.5 million players in use by the end of 1967" and that figure may very well be right! One major car maker reports the sale of 60,000 tape units in 8 months. So, it's about time to take up the details of installing and servicing them. This is going to be profitable business, and simpler than auto-radio work, from the way it looks now.

There are two basic types of tape unit: the combination radio–tape player and the self-contained player. Like modern auto radios, all are transistorized. In most combinations, the tape circuits are stereo; they are switched to mono when the radio is used. (FM stereo is also becoming a factor in the field.) Output power goes as high as 10 watts per channel, the usual being about 5 watts each. This is enough for ample volume, even in a fast-moving car!

Only a very few of the units are actually tape *recorders* although we will probably call them all by that name for a good while. The recording types are meant for use mainly by traveling salesmen and executives, and all seem to be monophonic. The big boom now is in the field of prerecorded tapes of music, and these are all stereo. A tremendous program variety is available; mostly music, of course, but there are even recorded language lessons! Drive

Norelco Carry-Corder (it plays through car radio) and mounting.

Typical underdash mounting. Bracket inverts for floor mount.

down the highway and learn French at the same time!

The tapes used in auto players are all cartridge types using a continuous loop that comes up from the center of the reel, plays and then rewinds on the outside. The tape travels in the same direction at all times; there is no conventional rewinding at all.

Three types of cartridge (Fig. 1) are on the market now; they are not interchangeable, although they operate basically alike. Fig. 1-a is the Fidelipac, which uses a four-track tape (two tracks of two channels). For this cartridge, the pressure roller is on the tape player; it comes up inside the cartridge for playing. Fig. 1-b is the eight-track Lear-Jet cartridge (four tracks of two channels). Here, the pressure roller is in the cartridge itself.

Fig. 1-c shows the Orrtronics cartridge, also an eight-track type. This cartridge turns the tape to a horizontal position over built-in guides. As with the Fidelipac, the pressure roller is a part of the player.

There is too much confusion right now to tell which cartridge will win out, but the record companies show a preference for eight-track tape (the Lear-Jet cartridge is the present leader).

Fig. 2 shows the Lear-Jet cartridge in more detail. Note the pressure pads for the tape head and the track-changing switch, and the apertures that allow the capstan, tape head and track switch to engage the tape.

The makers say not to open the cartridges, but some will probably try it anyhow. After all, if the tape is broken, the cartridge will have to be thrown away; what's the harm in trying to splice it? None of the sloppy splices we find in home tapes, though! If the sticky splicing tape hangs over the edge of the recording tape, it will foul up the whole works, but good.

Tape life ought to be very good. The tape is completely enclosed, and is never handled or subjected to the shock of sudden braking or fast rewinding.

Let's see what some of the player units look like inside. Since we're mainly interested in the tape-player part of the mechanism right now, we won't worry about the differences between combinations and straight players. The most important difference, as far as the tape player is concerned, will be the addition of a tape–radio selector switch.

All the player units use plug-in tape cartridges. The cartridge slides into the front of the case, between guides, until it hits a stop. The end of the cartridge trips a sensitive switch that starts the drive motor and, in combination models, also operates a switch to change over automatically to tape. The capstan is in the player. The pressure roller, or pinch roller, is in the cartridge in some cases, in the player in others, as we have already mentioned. The tape head is mounted on the chassis, so that the exposed segment of the tape is pushed against it when the cartridge is all the way in.

A track-selector mechanism is used on all players. In the eight-track Lear-Jet system, a ratchet-type movement, operated by a small solenoid, moves the tape head up and down to play the desired pair of tracks. The tracks can be changed manually by pushing one of the control knobs. When the tape reaches the end of the music, a conductive metallic strip on the tape shorts out a pair of contacts near the head, and the solenoid moves the head down to play the next pair of tracks.

Fig. 3 shows the tape head, tape and the track-changing ratchet used in one Motorola model. A flywheel helps hold tape speed constant. A dc motor is used, its speed regulated by a special transistor circuit (more on this later). Since the tape is self-rewinding, it always runs in the same direction. The player has no regular rewind or fast-forward as on home tape machines.

The photo on page 38 shows the Motorola unit with the flywheel removed so that you can see the parts underneath. This particular model is a radio–player combination, but the players look just the same except for the dial scale.

A very interesting alternative to the radio–tape combination is made by Norelco. The basic unit is a transistorized monophonic recorder–playback unit called the Carry-Corder model

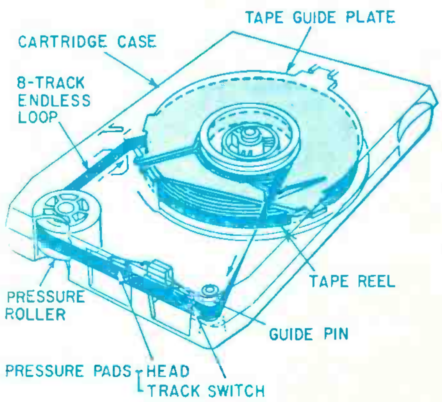


Fig. 2—Inside view of Lear-Jet cartridge. Pressure roller pulls tape from center.

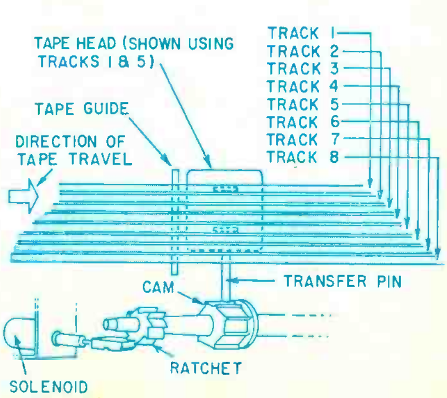


Fig. 3—Tape drive and head positioning for Motorola unit (Lear-Jet cartridge).

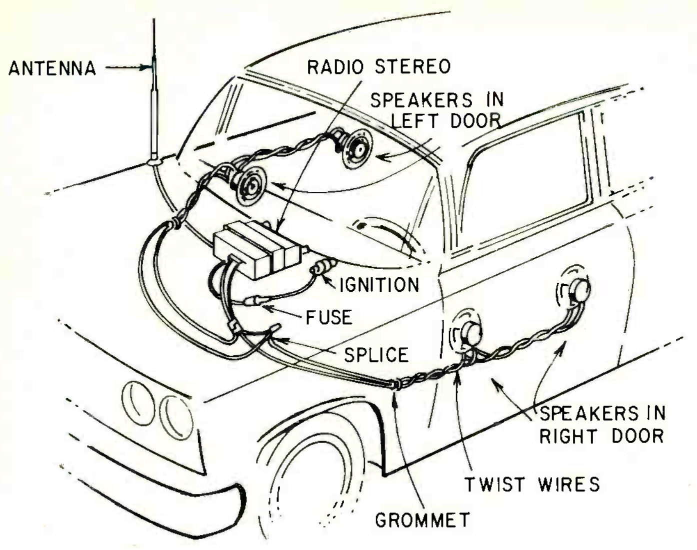


Fig. 4—Manufacturer's recommended method of installing stereo speakers in existing autos. Front speakers serve the front passengers, while rear speakers do the same for those in the back seat. Leads to speakers are fed down from dash, behind kick panels and through insides of doors. Antenna and power wiring are conventional. Speakers are paralleled and in phase.

150. It uses a special reel-to-reel tape cartridge, with an elapsed-time indicator dial on it. Prerecorded Norelco cartridges can also be played.

To use the Carry-Corder in a car, a special track-type mounting bracket is fastened under the dash. Built into this unit is a small oscillator, like the wireless phonograph oscillators of long ago. The car-radio antenna is disconnected and plugged into a T-adapter, which is then plugged into the car-mount rack. A power-and-audio cable connects the oscillator circuits into the Carry-Corder through a special plug.

The photo at top left, page 39, shows the recorder in place and a tape cartridge inserted (the cartridge lies flat in the top of the unit). The rack is pulled out from under the dash for loading, and then may be pushed back out of the way.

The oscillator takes its power from the internal battery of the Carry-Corder. There is no electrical connection to the car's battery. Normal battery drain of the recorder on its own audio system is about 140 mA. The oscillator draws only 2 mA. In this kind of service, the volume control of the recorder can be turned all the way down, cutting the battery drain to less than 80 mA, including the oscillator drain.

The rf oscillator is modulated by the signal from the output of the recorder, and is ordinarily tuned to about 1000 kHz. However, it can be tuned anywhere between 800 and 1200 kHz, if a radio station is operating on 1000 kHz. The signal is coupled into the antenna circuit of the car radio by the adapter plug; this does not interfere with normal operation of the radio. Incidentally, you don't need to hunt a "dead spot" on the radio dial unless you want to. The 20-μW output will drown out fairly powerful radio stations.

Installation of tape players will be exactly like that of car radios, in custom models, except for speaker placement. In cars with radios already installed, the tape player can be mounted under the edge of the dash, as shown at top right, page 39. All "universal" players, and even some custom units, come with reversible brackets which allow mounting either under the dash or on top of the drive-shaft tunnel on the floor. Even if reversible brackets aren't available, you can easily make up a set of straddle brackets that will hold the unit firmly. Some players have a case already built to straddle the drive-shaft hump, with a speaker housing on each side. Although this type of unit doesn't give the stereo separation that side-mounted speakers do, it is much easier to install!

The biggest labor problem will be mounting the speakers. Some units have speakers in two pairs! They can be installed in the kick panels on either

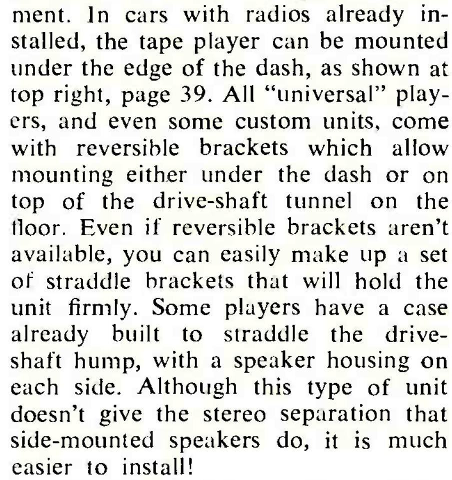


Fig. 5—Height and azimuth adjustments for tape head of eight-track Motorola.

side of the front doors, or in the doors themselves (the recommended method). One is placed near the front edge of the front door, the other at the back; this is intended to get better sound into the back-seat area. The wires are brought out through the front edge of the door and behind the kick pad up to the player unit. Fig. 4 shows a typical layout of a dual door-speaker installation.

It would be possible, of course, to make a speaker installation for these units (if there isn't a radio in the car) by using the dash grille for one speaker and the rear-seat speaker cutout for the other. This would give a sort of "in-line" stereo effect, instead of the more desirable "side-to-side" effect—but it would save a lot of work!

Speaker phasing is very important in multiple-speaker hookups. Speakers usually have phasing dots on the frame, but if they do not, or if non-standard speakers are used, they can be phased with the old flashlight-battery method.

Repairing auto tape units will be a combination of car-radio problems and tape-player problems. None will be either new or difficult. From our preliminary field reports, there seem to be only standard problems: shorted power transistors, tape slippage, loose wires on the heads and, of course, the oldest problem in car-radio work—dirt. Even though the cartridges are sealed, there is some chance of dust and dirt getting in through the apertures provided for the tape head, capstan, etc. The player mechanism is unavoidably open, unless a cartridge is in place. A good cleanup will probably be the most common service operation.

One almost essential tool will be a test tape. Motorola makes one (No. 99P43309A01) for units using the Lear-Jet cartridge. Full instructions are given on the label. One of these tests tapes will be very handy in eliminating crossmodulation or crosstalk—that is, sound from one channel being heard in another.

Crosstalk is almost always due to head misalignment. Fig. 5 shows how the heads of one player model are adjusted: Allen setscrews can be used to adjust height and azimuth. Crosstalk is primarily a height problem, and a very precise setting of height is possible with this tape and a scope. Connect the scope across the left-channel output, and set the track selector to 2-6. A special test track on the tape has a 1-kHz signal recorded, not in the track itself, but in the "guard bands" on either side of track 2. The signals are 180° out of phase, so the instructions say to adjust for a null. With this adjustment set correctly, all other channels will track properly.

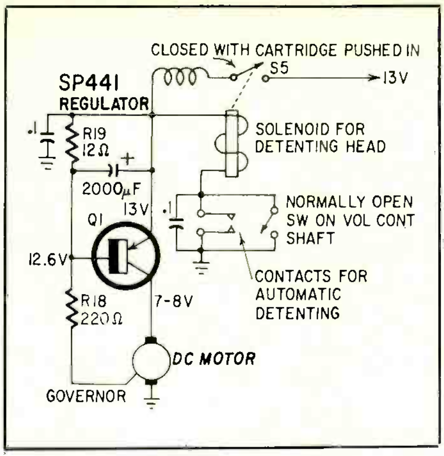


Fig. 6—One-transistor speed regulator used by Motorola. Note use of three-lead motor.

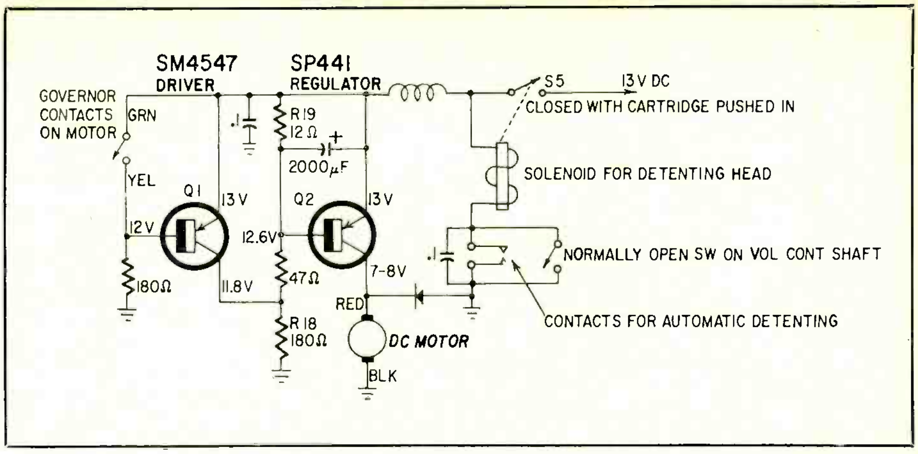


Fig. 7—A two-transistor speed regulator. A four-lead motor is required for this system (because of governor). The second transistor (a driver) provides superior speed control.

Even a prerecorded music tape of any kind will be useful in making a preliminary diagnosis. If the complaint is distortion, low volume, crosstalk, tape slippage, etc., it could be due to trouble in one or more of the owner's tapes! Plugging in a test tape that you know is good will tell you very quickly whether the trouble is tape or player, and whether the player will have to be pulled.

Before deciding you need to take a player out of the car, try cleaning the head and the drive capstan. Just as in any other tape player, a dirty or worn head can cause all kinds of "symptoms." Heads suffer mostly from oxide buildup from the tape itself, although dust and dirt can accumulate.

The head can be checked from the front of the player by removing the tape cartridge and looking through the slot. A small penlight is handy for this. To clean the head and capstan use only alcohol—never carbon tetrachloride—on a cotton swab. There are several other head-cleaner compounds on the market, as well.

If the complaint is tape slippage, and cleaning the capstan doesn't do the job, the capstan can be roughened slightly by wrapping a bit of fine sandpaper around the end of a lead pencil or stick and pressing it lightly against the revolving capstan. The motor can be started by pressing the switch with the end of another pencil. A supply of cotton swabs is handy for cleanup jobs.

Very little lubrication will be needed. Thinking of the very dusty environment, makers have used sealed bearings for most of the moving parts. Don't overlubricate. Excess oil anywhere will catch dust and cause dirt buildup.

The "electronics" are standard except for the motor-speed regulator. The tape is driven by a special dc motor, running at about 3,000 rpm. It uses an internal speed regulator, with transistor amplifiers. The basis of this is a centrifugal (governor) switch, which opens a pair of contacts when the rotor goes faster than the intended speed.

Fig. 6 shows the one-transistor regulator circuit used in Motorola players. When the tape cartridge is pushed in, switch S5 is closed, starting the motor. Initially, the governor contacts are closed. Bias network R18 and R19 goes to ground through the closed contacts, biasing the transistor to full conduction, and the motor runs. Motor current actually flows through the transistor.

When the motor reaches running speed, the contacts open. This places the base and emitter of the transistor at the same 13 volts, and the transistor is in effect zero-biased and cut off. Now no current can flow to the motor, and it slows down. As soon as the motor slows enough, the governor contacts close again, the bias is restored to its former value, and the transistor conducts again. This action repeats about 100 to 200 times a second, keeping the motor speed essentially constant.

The governor circuit might seem like a fruitful source of noise, but it contains a large capacitor to filter this out. The transistor acts as a variable resistor in series with the motor. The actual voltage across the motor measures between 7 and 8 volts, after regulation.

Fig. 7 shows a two-transistor motor regulator. The only difference lies in using a separate regulating transistor and completely isolating the contact points on the governor of the motor. (One governor contact of the motor in Fig. 6 is insulated, the other grounded or common. This gives a three-lead motor. The motor in Fig. 7 is a four-lead type, since each contact has a separate lead. They are tied to Q1's base and collector.)

Transistor Q2 supplies current to the motor, just as in the other circuit, while Q1 controls Q2. This arrangement gives better speed regulation. Below 3,000 rpm, the contacts are closed, shorting base and emitter of Q1. It is then cut off and looks like a very high resistance, having no effect at all on the motor transistor. When the governor contacts open, the base of the control transistor has nothing but a 180-ohm bias resistor left in it. It therefore develops a voltage between base and emitter, and conducts heavily. The resulting collector-current drop across R18, which is also the base-return resistor for the motor transistor, causes the motor transistor to be cut off, and the motor slows down.

A diode connected across the motor itself acts as a filter. It kills any sudden transient voltages that could show up because of switching action and the sudden starting or stopping of the motor.

These motors are so small and complex that adjustments in the field are not recommended. If a trouble can be definitely isolated to a bad motor, the motor should be replaced. A four-lead motor can replace a three-lead one, but not vice versa. The only difference between motors is in the isolation of the governor contacts. To replace a three-lead motor with a four-lead one, tie the green and black wires together. This simply puts the governor contacts into the same circuit used on the three-lead motor.

To quick-check regulator action, vary the input from 11 up to 16 volts while playing a tape. A single-tone test tape would probably be best for this. There should be no flutter in the speed, and no speeding up or slowing down.

All in all, these little machines ought to provide service shops with a pretty easy and profitable source of extra income. With only a few tools, they can be very simple to repair. END

Simple Silent Alarm

This little no-nonsense unit can't be foiled by a burglar. It even tells you when it isn't working!

By WAYNE LEMONS

AN INTERCOM CAN BE A HANDY DEVICE for detecting prowlers in unattended areas, but it has one serious disadvantage: the annoyance of continual background noise. The normal reaction is either to turn off the unit or develop the ability to listen without really hearing.

It was the noise problem that a local grocer consulted me about. Someone had recently broken into his store which is about four blocks from his home. The grocer's intercom units were interconnected by a line the local telephone company had installed. The intercom system worked fine, but the continuous background noise coming from the speaker was driving him and his entire family daffy!

He definitely had a problem, and wondered if there wasn't some way I could make his intercom work only when there might be a burglar in the store. At first it was amusing to think that any system could discriminate between good guys and bad guys, but after enough thought and a review of all the requirements, developing an alarm unit seemed very practical.

After some trial-and-error refinement of the circuits, the finished product eliminated background noise and provided an alarm that will sound if any of the following conditions occur: (1) There is an increase in noise from inside the protected building, such as would occur with intruders. (2) The interconnecting wires are cut. (3) The power is turned off. (4) A tube or component in the intercom goes bad. (5) The volume-control setting of the intercom is disturbed. All these features add up to a very tamper-proof unit.

The Burglar Alarm looks like any other speaker enclosure, but is ready in case of trouble.

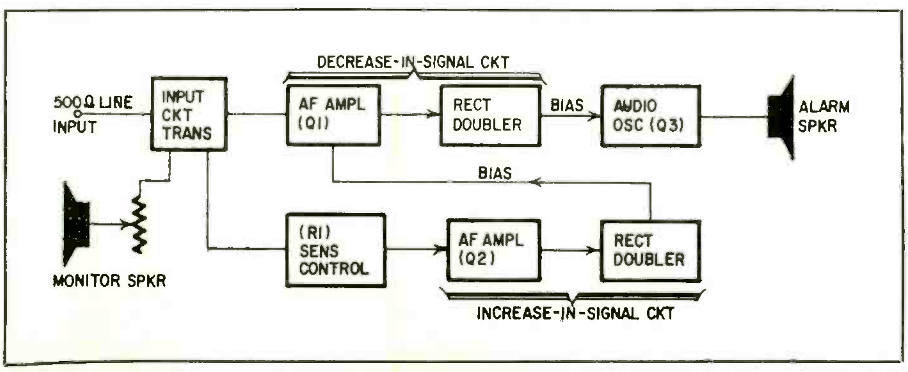


Fig. 1—Block diagram shows bias paths and circuit relationships to the common input.

How it works

A block diagram of the burglar alarm system is shown in Fig. 1. Noise input received from the intercom is transformer-coupled to transistor audio amplifier Q1. The input of this amplifier is rectified by a rectifier-doubler circuit which supplies a filtered positive voltage to a transistor audio oscillator and keeps the oscillator pnp transistor (Q3) reverse-biased to cutoff so that it cannot operate. This part of the circuit provides the fail-safe feature. Should the ambient-noise input decrease for any reason, the reverse bias is removed from the oscillator and the tone alarm sounds.

The input noise is simultaneously coupled through an input potentiometer to another transistor audio amplifier (Q2), the output of which is also rectified and filtered. This circuit, however, supplies a positive bias voltage to amplifier Q1. This voltage lowers its gain, which in turn counteracts the reverse-bias condition on the audio oscillator—again causing the tone alarm to sound. Thus, whether the input signal noise (from whatever source) increases or decreases, the tone alarm always signals the change.

A 500-ohm input is used in my original unit to match the impedance of the line between the store and the owner's home. For short distances, speaker voice-coil impedance values could be used and the input connected directly to the voice-coil winding of the monitor speaker and alarm-input transformer.

In the schematic (Fig. 2), input transformer T1 is a miniature 2,000-ohm line-to-voice-coil transformer, tapped at 500, 1,000, and 1,500 ohms for use with various line impedances.

The input from a balanced line transformer is fed from a tap through S1 and C1 to the base of Q1. S1 protects the transistors from possible line surges when the alarm is not in use. The signal is amplified by Q1, coupled through C5, rectified by D3 and D4, and then filtered by C6 and C7. This part of the circuit detects any decrease in the signal. The positive bias developed is fed through R8 to the base of Q3. This positive bias is sufficient to overcome the negative bias supplied by R9 to Q3, and pnp transistor Q3 is kept cut off. Since any lowering of the noise signal removes the positive bias, the tone alarm will sound. The purpose of R7 and D5 will be discussed later.

The circuits of Q1 and Q2 are almost identical, so when the signal input increases, Q2 also receives a greater input. This input, across sensitivity control R1, causes the rectified output of Q2 to increase in a positive direction. The gain of Q1 is lowered, thus reducing the positive bias on Q3 and sounding the alarm.

Obviously, as the input signal increases, the output of Q1 also tends to increase. This action would keep the tone oscillator cut off were it not for the forward-bias reduction on Q1 caused by Q2's rectified output. The addition of R7 and D5 insures immediate response of the alarm to short noises. Silicon rectifier diode D5 has a forward breakdown potential rated at about 0.5 volt. This means that it takes about 0.5 volt across the diode to make it conduct. That characteristic is used here to help prevent the bias voltage from rising above the point set by R7. D5 thus provides a clamping action on the bias line. Capacitors C6 and C7 do not charge to as great a value as they would without D5 in the circuit. If the output of Q1 is reduced even slightly, the tone alarm sounds. Although D5 and R7 limit the charge on C6 and C7, they and C3 are sufficiently charged to hold the tone alarm on several seconds.

Adjustment of the unit is easier when R7 is replaced at least temporarily with a 10K potentiometer. Set R1 for minimum resistance. Attach the line from the intercom to the unit. With the intercom set for normal noise pickup, adjust R7 (a 10K pot) until the tone stops. This sets the decrease-in-signal portion of the alarm circuit. Now, replace R7 with a fixed resistor—unless the normal background-noise level is expected to vary frequently. If this is the case, leave the 10K potentiometer in place.

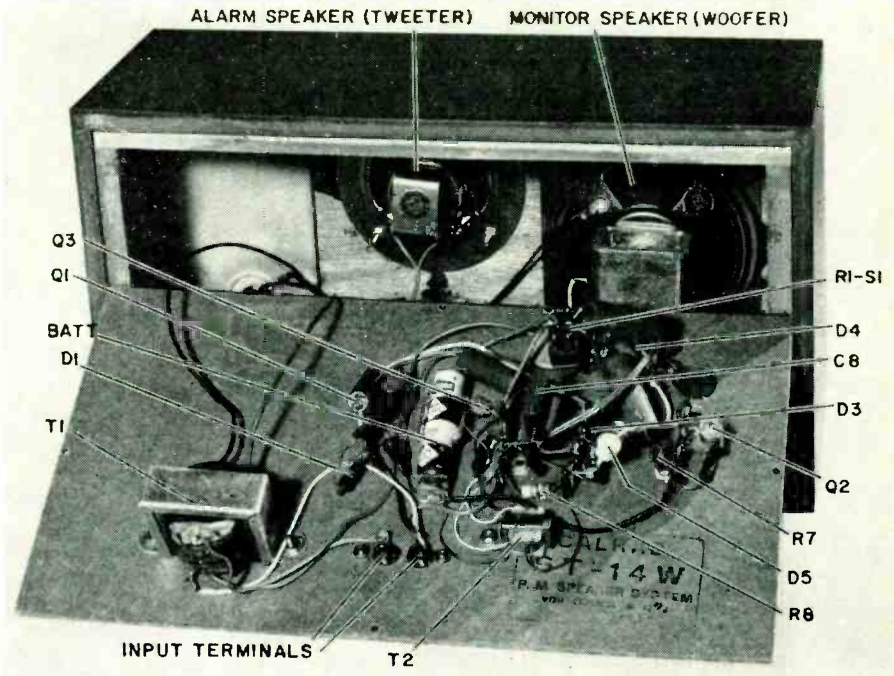
To adjust the increase-in-signal circuit, turn up R1 until the tone starts—then back it off until the tone stops. This will be R1's most sensitive position, and even a slight increase in noise will sound the alarm. The alarm may even respond to an increase in street noises outside the building. For less sensitivity, back off R1 a little.

All the parts in this burglar alarm are standard. However, bargain-type transistors work better for Q3 than the more expensive types. To choose the most stable transistor, build the circuit and pick one that will oscillate with R9 at least 100K. If a smaller resistor is necessary for oscillation, the transistor won't likely be sensitive enough to bias changes for satisfactory oscillator control in this circuit.

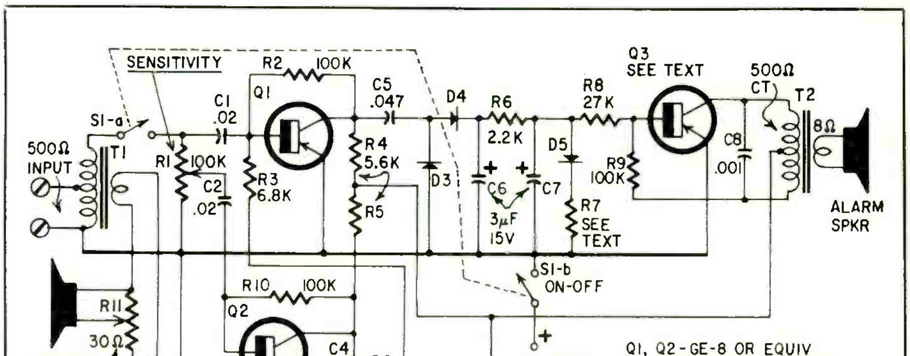
Oscillator inductor T2 is a 500-ohm center-tapped transformer with a secondary to match the alarm's noisemaker speaker. To change the oscillator tone, substitute other values of C8.

Potentiometer R11 can be an L-pad for the monitor's speaker. You can shut off the alarm's speaker or set its volume without disabling or affecting the alarm circuit.

Maybe this circuit could be more simple. D1 and D3 were replaced with 10K resistors and the alarm still worked. Development was by experimentation, and the alarm does the job and is reliable. In 8 months of use it has not required service except battery replacement. The owner is highly pleased with the unit's performance. He has detected early morning delivery trucks backing too enthusiastically into the loading dock and the night watchman shaking the doors too vigorously. And, though he hasn't had any burglars yet, he hopes to try that soon!! END



Simple point-to-point wiring and readily available parts make construction very easy.



R1—Pot, 100,000 ohms (see S1)
R2, R9, R10—100,000 ohms
R3—6,800 ohms
R4, R5—5,600 ohms
R6—2,200 ohms
R7—See text
R8—27,000 ohms
R11—8-ohm L-pad or 30-ohm 5-watt pot
C1, C2—.02 μF
C3—6 μF, 15 volts, electrolytic
C4—.068 μF
C5—.047 μF
C6, C7—3 μF, 15 volts, electrolytic
C8—.001 μF
T1—Line-to-voice coil transformer. Pri: 2,000, 1,500, 1,000, 500 ohms; sec: 6-8/3.2 ohms (Stancor A-7947 or Knight 54 A 1442 or equivalent)
T2—Output transformer. Pri. 500 ohms ct, sec. 8 ohms
S1—Dpst slide or toggle switch or on R1
D1 through D4—1N34, 1N-60, 1N64 or equivalent
Q1—G-E-8 or equivalent
Q2—G-E-8 or equivalent
Q3—See text
BATT—1.5 volts
Cabinet and speakers. The author built the alarm unit in a Calrad ST-14 speaker system that includes the cabinet, woofer, tweeter and volume control

Fig. 2—The circuit is simple, but some readers may find it an experimenter's dream.

Custom Equalization Enhances PA Sound

A new method for avoiding unwanted acoustic feedback—even in gigantic arenas

By DON DAVIS*

HI-FI TAPE RECORDING

"AT FIRST BASE. . . ."

The crowd at the Houston Astrodome, listening for the names of its favorite ballplayers, is not aware that Dr. Charles Paul Boner may have made the hearing "just a little better."

The Astrodome, current marvel of the sporting world, is one of the more dramatic examples of the application of the increasingly popular "Boner equalization" process to sound systems.

The process: "Tune" a sound system to a reverberant room in such a way as to avoid any destructive interaction between the sound system and the room. The result: added gain as high as 30 dB.

In 1917, Prof. Wallace Clement Sabine, a pioneer in modern architectural acoustics, described the effects of reflection, absorption and interference on sound in the same room with the sound source. It remained for Dr. Boner, past president of the Acoustical Society of America and currently an independent consultant in acoustics, to put this really fundamental advance in acoustics to work. Today, the equalization method provides the tools and techniques to do something about the problem.

Standard textbooks on acoustics have always treated "normal room modes" or "Eigenfrequencies" with elaborate theoretical mathematical equations. However, no practical method of dealing with them appeared in the literature. "Boner equalization" not only "forces" the room to reveal its modes, but also reveals them in the order in which they should be treated.

Before "Boner equalization" can be discussed intelligently, however, you must understand and know how to measure acoustic gain.

Do you know what the acoustic gain was on the last sound-reinforcement system you installed? Does the room in which it is installed hamper its intelligibility in any way?

Many of today's sound-system installers have never measured the acoustic gain of their systems. If they did, some would no longer be called reinforcement systems. In many of the systems, whatever gain is achieved negates itself by either reverberating excessively or interfering with itself by coming at the listener from too many secondary "sources."

To measure acoustic gain:

1. Place a high-quality 8-inch speaker—in an enclosure as small as 2 cubic feet—4 feet from the microphone used in the reinforcement system. Face it so the sound from the speaker passes the microphone on its way toward the audience area. (This 8-inch speaker in its enclosure will be referred to as the test speaker.)

2. Connect the test speaker to a 20–40-watt amplifier and a random-noise generator. (Interstation noise on an FM tuner without squelch will serve.)

3. Set this noise to a level about 80 dB SPL (sound-pressure level) measured by a sound-level meter placed near the sound-system microphone. (The auditorium's sound-reinforcement system at this point is not turned on.)

*Altec Lansing Corp., Anaheim, Cal.

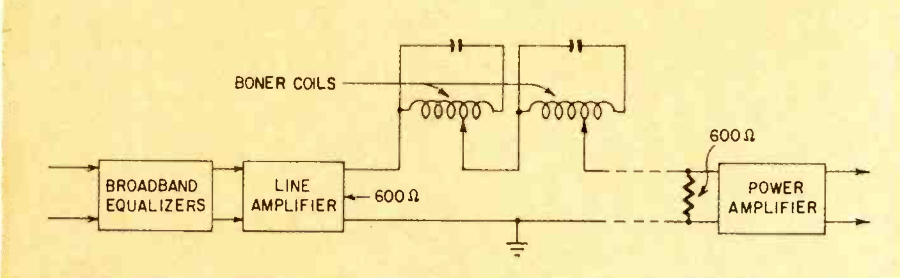


Fig. 1—Dr. Boner's equalization coils are made for a perfect match in 600-ohm circuits.

4. Take a small sound-survey or sound-level meter and go to the rearmost seat in the auditorium. Obtain the SPL reading from this position.

5. Having taken this reading, turn the sound-reinforcement system on. The reinforcement system should be preset to the highest gain possible without causing acoustic feedback. Random noise from the test speaker is picked up by the reinforcement-system microphone and amplified by the sound system. Again take the SPL reading at the rearmost seat. The first reading subtracted from the second equals the acoustic gain of the sound-reinforcement system.

Typical readings are 0 to 4 dB. Very rarely is 6 dB exceeded. Also, the sound system often does not yield good voice intelligiblity at this volume-control setting. For the measured gain to be considered usable, an articulation test should be made. A score of at least 90% can be expected from a well-designed and properly installed system.

Three main offenders cause lack of gain and loss of intelligibility:

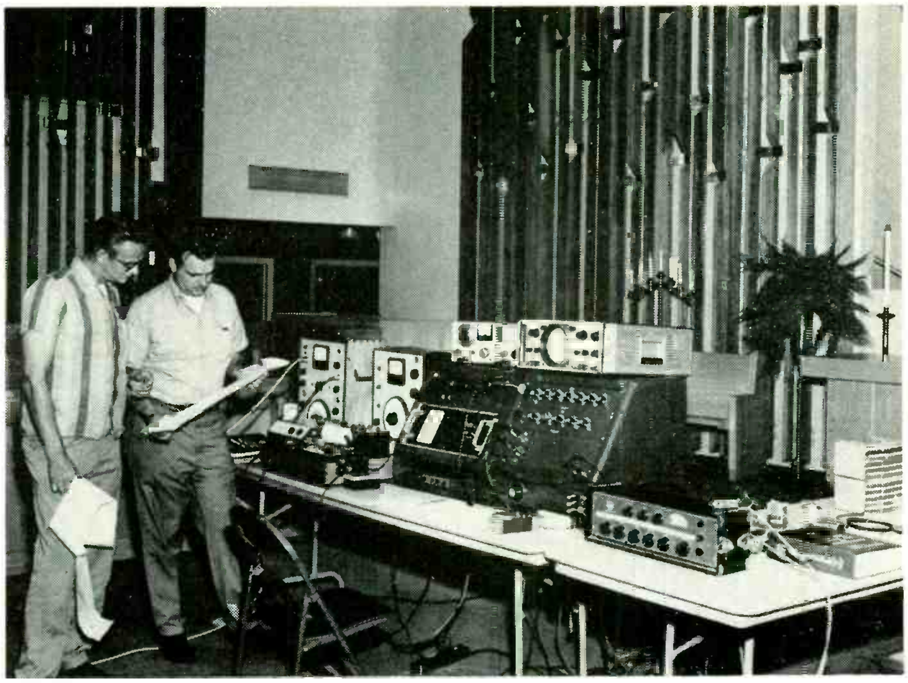
1. *Poor equipment.* The only answer is to find a professional supplier.

2. *Untrained installers.* Some manufacturers of highly engineered equipment offer training courses to apply, adjust, install and service their equipment correctly. Some of the worst sound-system failures occur when an installer uses equipment for which he is not trained.

3. *Poor acoustics* of the installation structure. Reverberation time is long at some or all frequencies; excessive noise is present; echos are bouncing about, and standing waves cause certain frequencies to stand out. When the sound system that has measured acoustically flat in an anechoic chamber is installed in such an auditorium, the system's frequency response may look like a profile of the Alps—sound-system interaction with the room has attenuated some frequencies and accentuated others.

Professor Sabine found the structural answer to be the use of absorptive materials to lower excessive reverberation times. Out of Sabine's thorough basic work grew the entire field of architectural acoustics. Well-designed components, carefully installed, still achieve poor results when set up in a room with detrimental acoustics.

The treatment of a room through the addition of acoustically absorbent materials can correct the problem.

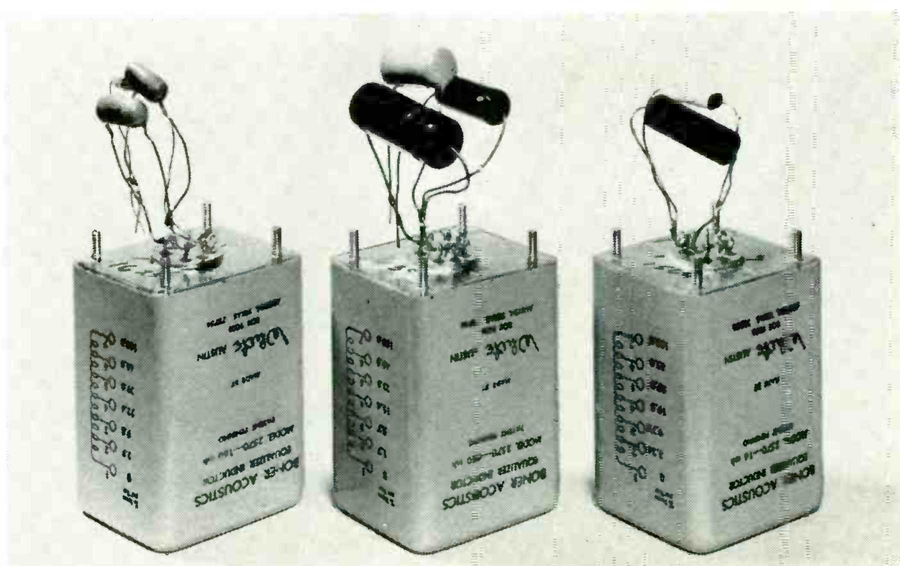


Inserting the equalization notch in a sound system requires the use of laboratory-type test equipment of high precision, as well as patience and careful attention to detail.

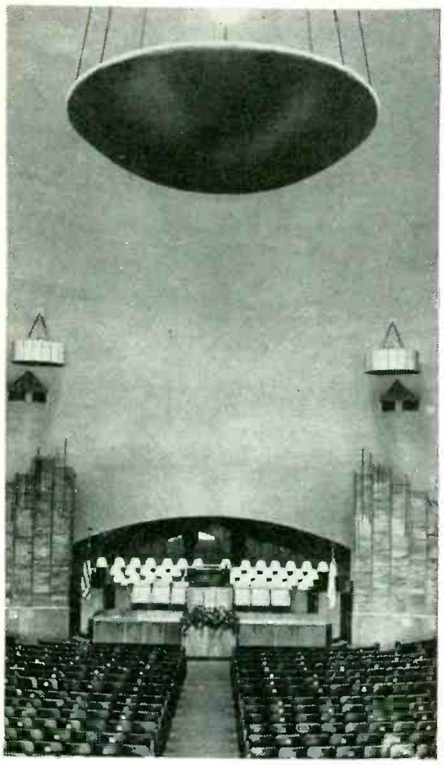
Enough absorption must be introduced to insure that reverberation time is below 1 second at 512 Hz if conditions conducive to high acoustic gain from the sound system are to be realized. This can be very expensive, especially when the absorbent materials are used as a correction for an existing problem. Often the cost is so extreme that the owner and/or user of the building is forced to live with the uncorrected problem.

Corrective measures, particularly in a dual-purpose auditorium, often improve speech qualities to the detriment of music reproduction.

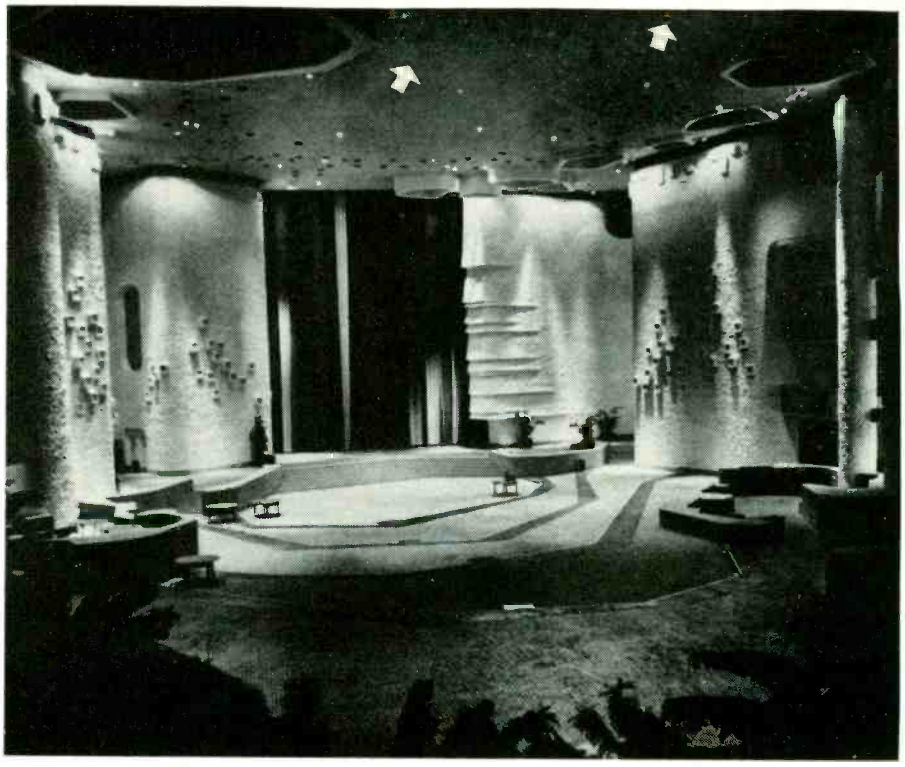
Dr. Boner, a talented organist as well as renowned physicist, developed a method of electrical, rather than acoustical, absorption. Observing that pipe organs could be adjusted to the characteristics of a room by varying the amount of energy used at different points on the musical scale, Dr. Boner reasoned that electronic amplification might also be amenable to such "tuning." Through exhaustive experimentation, and finally by actual correction of more than 200 auditoriums, Dr. Boner and his son, C. R. Boner, perfected the tools and techniques for "tuning" a sound-reinforce-



Each of these equalizer inductors covers a different frequency range. Exact notch frequency is set by parallel capacitors. Depth of notch is set by the coil output tap.



Spherical church dome made PA system practically useless without equalization.



The unusual architecture of this room caused many feedback peaks, reducing usable PA gain. Equalization removed peaks, restored gain. Arrows indicate ceiling speakers.

ment system to any acoustics.

In environments where, despite the installation of the finest sound equipment, only 1 or 2 dB of acoustic gain is realized due to room interference, Dr. Boner has succeeded in achieving up to 30 dB of acoustic gain using this method. Not only does he increase tremendously the available gain, but he also allows the use of the full frequency range from 50 Hz to above 10,000, thereby greatly increasing intelligibility and substantially lowering listening fatigue.

"Boner equalization" consists of very carefully bringing the sound system to a "flat" acoustic response through the use of broadband equalizers. Once this "acoustic flatness" is achieved, the system volume is turned up until it reaches acoustic feedback. An oscillator is used to zero-beat the feedback frequency, and the output of the oscillator is then used to "tune" a very narrow "notch" filter to the same frequency. The correct depth of the "notch" is determined by experimenting with the coil taps, and the filter is inserted into one of the 600-ohm transmission lines in the sound system.

When correctly adjusted, this notch will be tuned to f, the frequency of the room mode which caused the acoustic feedback. The notch will then attenuate the sound-system response at f by an amount equal to room accentuation at f. The result will be the removal of the feedback peak at f. This result may be verified by using an audio oscillator as the system signal source and sweeping its output across the audible frequency range while listening to the reinforcement-system loudspeaker installed in that room.

As soon as the first filter is inserted, the sound-system volume is turned up again until acoustic feedback occurs at another frequency. This is treated in the same manner as previously indicated. Zero-beat the oscillator to the same frequency, "tune" the coil, set its depth and insert it into the 600-ohm transmission line. This process is repeated until a gain of 15 to 25 dB can be achieved. In the case of the Astrodome, more than 100 filters were employed and over 30 dB gain was achieved.

Because all detrimental room interaction with the sound sytem is minimized through the use of these filters, all rooms with sound systems so treated tend to sound alike. The reinforced sound is best described "as if all four walls were knocked flat and you were hearing a really good outdoor system." And most important, the natural reverberation of the room is not affected for those times when no sound reinforcement is used—with the organ, choir or orchestra.

The Boner method can be employed to treat properly designed and placed high-level single-source systems or high-level distributed systems. In all feedback systems, whether electrical, mechanical or acoustical, the classic Nyquist criterion for stability applies. The Nyquist equations, while quite complex, can be simply stated: Stability is always dependent on either gain or phase relationships.

This is demonstrated vividly in the Boner process, since only first-class stable microphones, amplifiers and speakers remain "tuned." When the proper grade of equipment is chosen, the "tuning" remains quite stable. Many of the systems Dr. Boner has "tuned" have been in operation more than 3 years with complete stability.

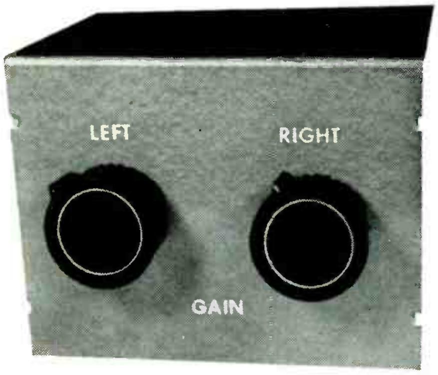
While this discussion and the accompanying illustrations reveal that the theory behind "Boner equalization" is relatively simple, actual implementation is anything but easy. Even those thoroughly conversant with both electroacoustics and architectural acoustics have found the development of a practical and efficient technique a lengthy educational process. As shown in the illustrations, a sizable expenditure of money, time and effort is required to master "Boner equalization" and to bring it to a commercially usable level.

It will be difficult to ignore this type of equalization in the years ahead, if for no other reason than that of extremely low expenditures in comparison (one-tenth the cost) with the older absorbent-material approach.

Full use of electroacoustic techniques can now either increase or decrease reverberation, overcome ambient noise, and—best of all—create fully controlled listening conditions. **END**

Solid-State and HI-Z Too

By DON M. WHERRY



IF YOU ARE AN EXPERIMENTER, TV or industrial technician, or audiophile, you have probably needed at some time to connect a device with a high-impedance output into a transistorized amplifier which has a low or medium input impedance. Results can range from poor to worse. Typical is the case of coupling a crystal pickup into a magnetic cartridge input. Or, you might want to connect a crystal pickup into a magnetic-cartridge amp. Problems encountered in such cases, as well as in other similar ones, result in poor operation of otherwise fine equipment—all because the transistorized input loads the signal source too heavily.

The two small devices described here overcome difficulties of this type. Costing little and easy to construct, they are handy little units to have around.

The first unit is basically a two-stage transistor amplifier in which gain of the first stage is sacrificed to raise the input impedance. This is helped by R2 in the input circuit (Fig. 1) and by using an emitter follower for the input stage. The emitter follower is highly degenerative and, added to the effect of R2, boosts the input impedance. The second stage is a standard amplifier stage in which the gain lost in the first stage is recovered and some more added. The entire unit has only moderate gain, but its prime objective is to be a matching device.

The two G-E 2N188-A transistors sell for approximately $1.50. Cheaper transistors may be used at possibly a small sacrifice in gain or noise figure. On the other hand, more expensive types such as the G-E 2N167 (or 2N167-A) at about $5 each can be used for better results. If you use transistors other than the two shown, it may be necessary to change the value of R5 somewhat. A little cut-and-try may be necessary—if possible, with a scope and af generator.

The amplifier is built on a printed-circuit board. Fig. 2 is the board layout for two of these amplifiers, to form a stereo matching unit. The layouts are mirror images of each other so you may use either half if you want only one channel. If you prefer to lay out your own, start by laying out the various components on a piece of blank paper and connecting them by pencil lines. Pay no attention to overall size as you can shrink the layout once you have the parts in proper order.

Once you've completed this phase, you are ready for masking and etching. You can buy adhesive material to stick on the copper side of your board to keep the connecting strips of copper intact while the rest is etched away. Or you can paint the connections on the copper with a small artist's brush and any paint or enamel you may have around. When you have covered the copper by either method, place the board in a glass tray or dish and cover with the etchant. Agitate the board to do a thorough job of etching.

Once the board is marked and etched, remove the paint with thinner, or remove the tape strips if you have used them. Drill holes for the component leads, and you're in business.

The board is mounted in a small box, 5 x 4 x 3 inches, with the input and output connections on the rear. The left and right gain controls, each with its own on–off switch, are on the front

Parts list for Fig. 1 (one channel only; double all items for stereo amplifier)
R1—Pot, 5 megohms spst switch
R2—1 megohm
R3—1 megohm
R4—33,000 ohms
R5—750,000 ohms, 5%
R6—33,000 ohms
R7—22,000 ohms
R8—680 ohms
All resistors ½ watt, 10% unless otherwise noted
C1—0.2 μF, paper (use good capacitor here as you don't want leakage to go through your pickup)
C2—50 μF, 15 volts, electrolytic
C3—2.0 μF, paper
C4—0.01 μF paper
Q1, Q2—2N188-A or 2N167 (G-E)

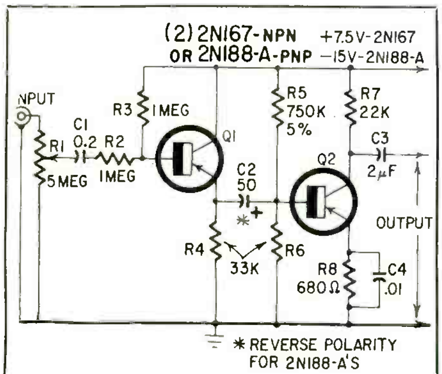


Fig. 1—Circuit of a high-Z solid-state preamplifier. 2N167's will help performance.

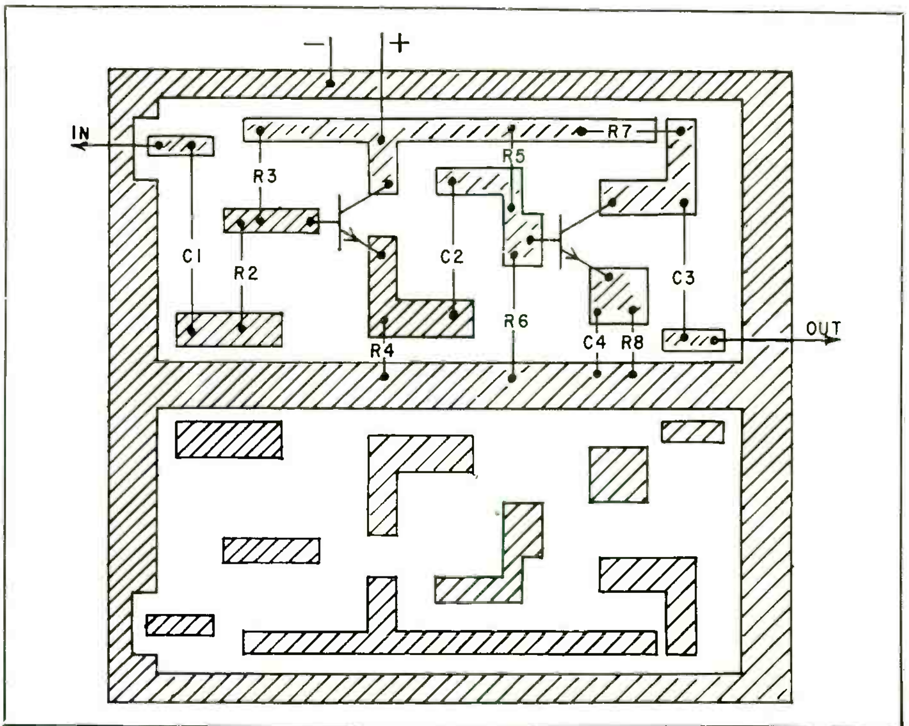
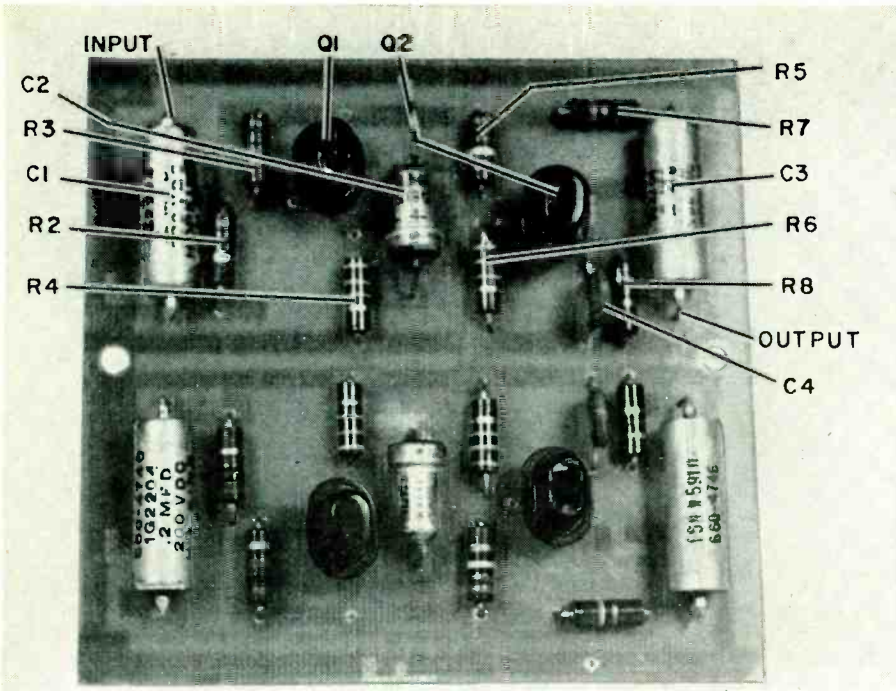
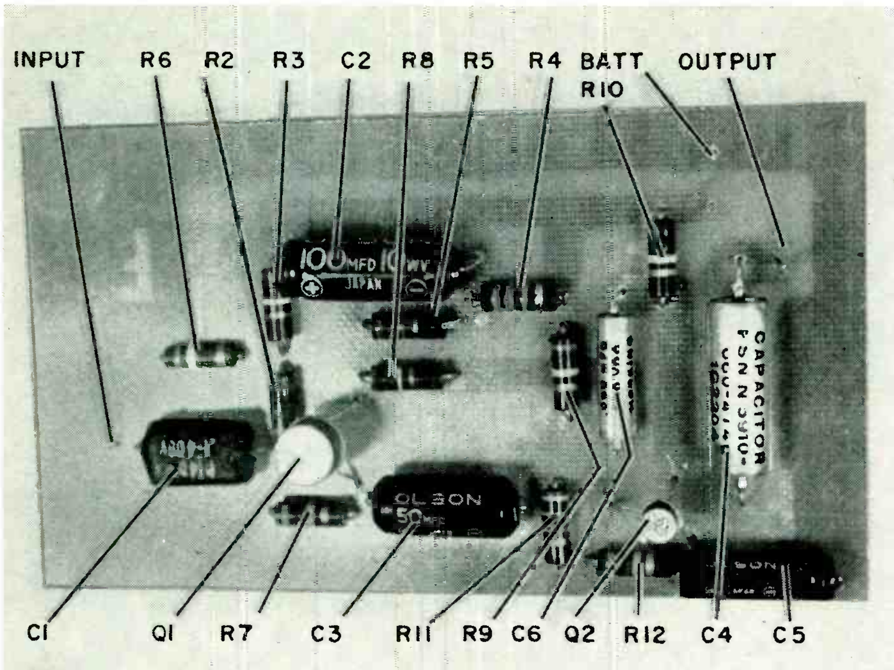


Fig. 2—Full-size drawing of PC board used for amplifier shown in Fig. 1. Component connections shown on top half for mono use. For stereo, bottom should mirror top.



The stereo version of Fig. 1 preamp. Components at bottom duplicate those at top.



Completed PC board contains single-channel version of preamp with FET input stage.

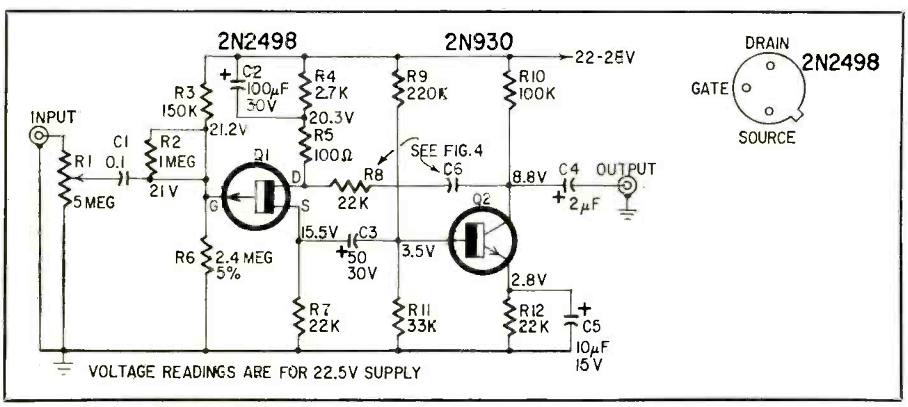


Fig. 3—An even higher input impedance is available with this preamp, which uses an FET at its input.

CHART 1

Specifications for type 2N188-A transistorized amplifier
Input impedance: above 1 megohm
Gain: 14.5 dB
Noise figure: 48 dB below 1 volt output
Response: ±1 dB from 12 to 75,000 Hz
Collector voltage: 15 volts
Collector current: 0.7 mA per section (channel)
Distortion: below 0.2%

Specifications—transistor types 2N2498 and 2N930
Input impedance: above 1 meg
Gain: 45 dB
Noise figure: 50 dB below 5 mV
Response: ±½ dB from 12 to 75,000 Hz with proper value of C6 (0.3 μF—see Fig. 5)
Source voltage: 24 volts
Current drain: 0.8 mA per channel
Bass boost: see Fig. 4
Feedback at 5 kHz: 17 dB
Distortion: less than 0.25%

panel (see photo p. 47). This is desirable if you wish to use the unit for other than stereo. The battery is mounted in the box. A small battery may be used, as the current requirements are low—0.7 mA per channel for the 2N188-A.

No special information on parts mounting is given, as you may prefer to use some different size box which you have lying around. In the unit described, the board is held inside by two small standoff insulators and the battery is secured by a small homemade aluminum mounting clip.

The specifications box shows the unit has moderate gain, good frequency response, low battery drain, and a good noise figure. The noise figure was meas-

Amplifier parts list for Fig. 3 (one channel only; double all items for stereo amplifier)
R1—pot, 5 megohms with spst switch
R2—1 megohm
R3—150,000 ohms
R4—2,700 ohms
R5—100 ohms
R6—2.4 megohms, 5%
R7, R12—22,000 ohms
R8—22,000 ohms, see text
R9—220,000 ohms
R10—100,000 ohms
R11—33,000 ohms
All resistors ½ watt, 10%
C1—0.1 μF, paper (use good quality)
C2—100 μF, 30 volts, electrolytic
C3—50 μF, 30 volts, electrolytic
C4—2.0 μF (use good quality electrolytic or, preferably, paper)
C5—10 μF, 15 volts, electrolytic
C6—feedback capacitor—see text and Fig. 4.
Q1—2N2498 (TI)
Q2—2N930 (TI)

ured against normal 1-volt output instead of at maximum output, as is usually the case. The 48 dB in the specifications would be greater if measured from full output.

While the unit described does a fine job of impedance matching, it does have relatively low gain and a rather unsophisticated circuit. There is another unit that overcomes these objections, provides bass compensation if desired, and has a better noise figure. It uses, for the input stage, a 2N2498 FET (field-effect transistor) whose properties make it possible to design solid-state amplifiers with input impedances equal to and greater than generally possible with tubes. For a background on FET's and their operation, see "Tube Impedances With Transistors" in the May 1965 issue.

The second transistor in the amplifier (Fig. 3) is a 2N930, a standard npn type. Any good npn could be used in this spot with probably no more change in the circuit than the value of R9. This would, however, require the use of a scope and audio oscillator for best results in determining the correct value.

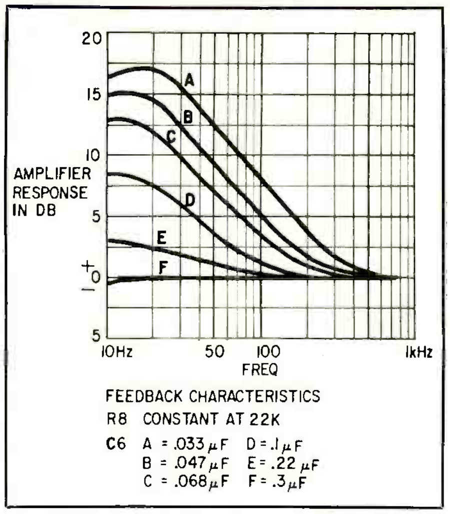


Fig. 4—Frequency response of FET preamp for various values of capacitor C6.

R8 and C6 in the schematic are feedback components. The value of R8 sets the total value of feedback voltage—the value given in Fig. 4 furnishing approximately 17 dB. The value of C6 determines the shaping of the feedback frequency characteristics or, in other words, the output frequency response. Fig. 4 shows the effect of various values of C6 on this response. If you prefer a high bass boost, you will select a low value of C6—A, for instance. If you prefer a lower bass boost, you will select a higher value of C6—B through F.

The unit—or units for a stereo version—is built on a printed-circuit board, as described previously. Fig. 5 is a scale drawing of the layout and can be copied directly on your own board if desired.

The cost of field-effect transistors has been exceedingly high; however, their price has been decreasing rapidly of late and they are not as out of reach as they were a year or two ago. Of the several ways to get a high-impedance input in a solid-state amplifier, the field-effect way is probably the simplest and best. It is difficult to obtain impedances in excess of 1 meg with the usual feedback and bootstrap techniques. If you need either of the matchers described, and want the best, give them a try—they're fine amplifiers. END

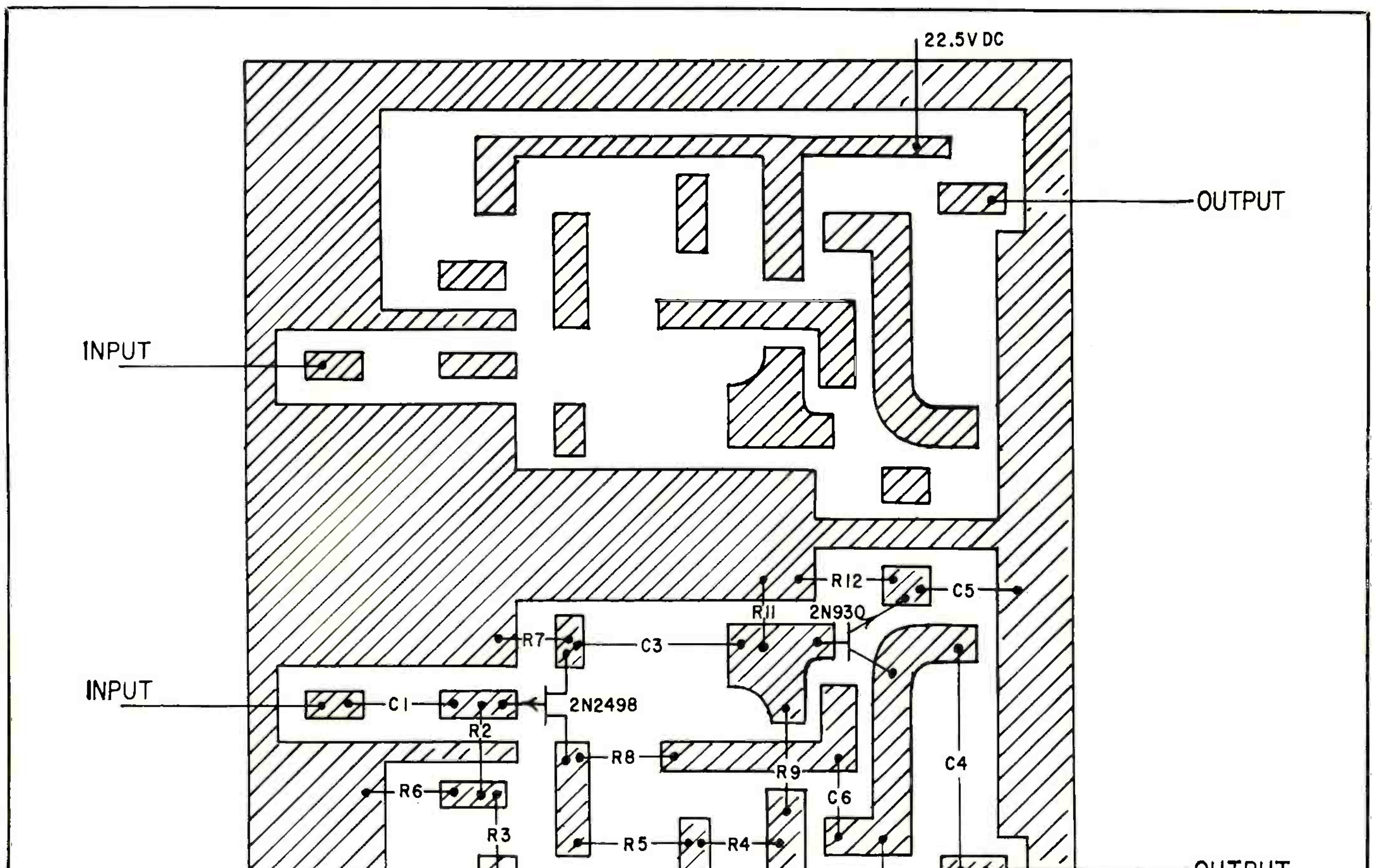


Fig. 5—Full-scale template of PC board for FET preamp. Use half of board for monophonic, entire board for stereo.

Secrets of Color Service

By ART MARGOLIS

ANY ELECTRONIC BUFF WORTH HIS SALT can change tubes in a color TV. Also, by using routine test techniques, he can locate some components that break down.

However, there is one area of color service that throws a lot of electronic technicians. It is the color display setup on the three-gun color picture tube. Yet, it is easy. All you need is briefing. I wouldn't even classify it as alignment. I call it adjustment, and I feel anyone interested can learn to perform these so-called secret rituals.

Here are four examples.

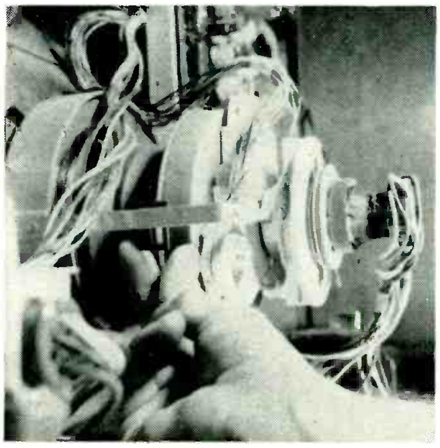
The case of the colored raster

As I drove up to the large home on the hill, I passed a stable. The owner, a lawyer who is also a horse fancier, greeted me at the door.

"Art, I was watching TV the other night. The sports program was in color, but the feature race must have been photographed in black and white. When they showed the winner's circle, the gray horse slowly turned purplish. Now the entire picture is purple-looking."

I nodded, went in and turned on the TV. Sure enough, the black-and-white picture had a purplish cast. A color commercial flashed on. It looked almost natural, which meant the color circuits were okay. The color CRT was misadjusted, causing the tinted raster. One of the three cathode rays had lost some intensity.

In the color CRT, there are three



Yoke of color CRT contains purity tabs and the three static convergence magnets. Blue lateral magnet is near the base of the CRT.

electron guns—one each for red, green and blue. The red beam lights up the red phosphor, the blue beam the blue phosphor, and the green beam the green phosphor. When the exactly right amount of red, blue and green light emanates from the screen, they add together to form a perfectly black-and-white picture. Should one of the rays lose intensity, that light source is diminished, destroying the delicate color addition, and a tinted raster remains. The cure? Readjust the guns to restore the balanced intensities.

Each gun has its own control grid and screen grid, complete with potentiometers that adjust cathode-ray intensity. All you have to do is adjust the correct control or controls. For instance, a purplish raster means there's not enough green. If I turn up the green-screen control slightly, green will be added and the purple will change to black-and-white. This is the way older color TV's are adjusted.

Fortunately, new color TV's do not have this ticklish adjustment problem. The lawyer's new set had a service switch on it. I flicked it. The picture disappeared, leaving a horizontal line across the screen. (The switch disables the vertical sweep.)

I turned all three screen controls down. There was no light at all, then. Next I tried turning each screen up individually. The red showed, the blue showed, but no green appeared. I turned the red and blue down altogether, and set the green at about midrange. Then I adjusted the CRT BIAS control, which turns them all up a bit. The green barely appeared. Next I turned up the red and blue till they barely appeared. Where all three touched, a low white appeared.

I flicked the service switch back on. Lo and behold, a black-and-white picture appeared. The lawyer was thrilled. The entire operation had taken about a minute.

"What happened?" he asked.

"Well, sir, due to wear and tear one of your guns lost a small amount of gain. There are controls to compensate, and I readjusted them."

He shook his head in admiration. I noticed a stopwatch in his hand. "Art, you are a real champ, you did the entire job in 1:12 and two-fifths."

The color TV housemother caper

My kid cousin Pete, who helps me on weekends when he's home from college, was out on a color service call in a nurses' dorm when my phone jangled. It was the chaperon at the dormitory.

"What do you mean sending this fresh young man here with all these girls?" she shouted.

"Hold on," I said. "What happened?"

"He made a fresh remark to the girls," she bellowed.

I asked. "Can I speak to him?"

Pete came on the phone, very flustered. "Art, you gotta tell this lady to let up on me. I don't even know what I did."

"Explain to me what happened."

"I came in and turned on the TV. There was a good black-and-white picture but one area near screen center, two areas in the lower left, and all around the rim were discolored slightly."

That meant that in those areas the cathode rays were not impinging correctly on the color phosphors. For instance, some of the red-gun electrons were hitting green or blue phosphors. These tinted areas indicated incorrect

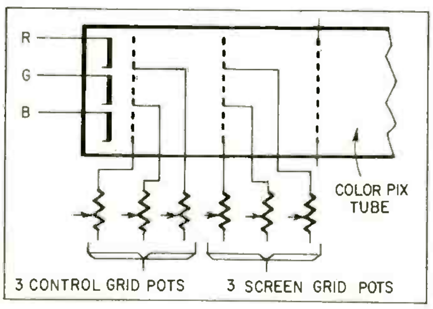


Fig. 1—Grid-pot settings make b-w picture.

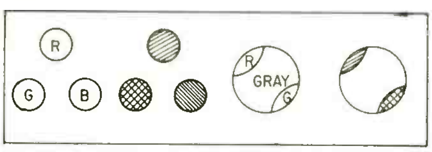


Fig 2—Three properly-registered beams at left; improper registration shown at right.

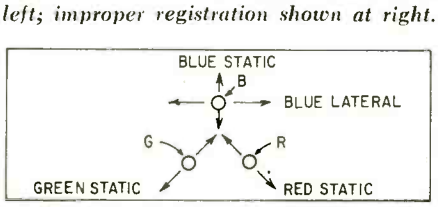


Fig 3—Effect of static beam adjustments.

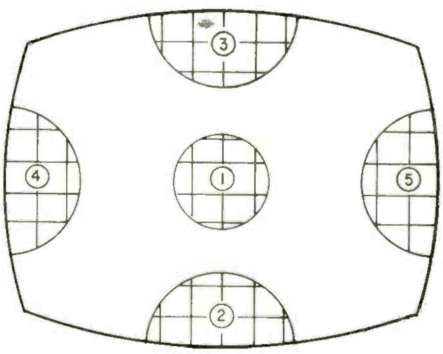
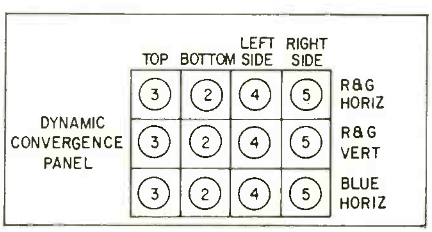


Fig 4—Area 1 on screen is adjusted statically, while areas 2-5 are adjusted by controls on the convergence panel, below.



beam alignment—poor purity.

The phosphor is arranged in dot triads. Each trio has one red, one blue and one green dot. There is one hole in the shadow mask for each trio. The three rays, each aimed at its own color, go through the one hole together from different angles.

If the deflection is not set exactly right, incorrect impingement will take place around the screen. It will take place at screen center, if the three cathode rays are not centered perfectly. If the picture tube becomes magnetized, the effect can take place at any spot on the screen.

To cure these tinting problems, all you have to do is demagnetize the CRT, pull the deflection yoke backward till you get rim effects and adjust purity tabs to center the red part. Then push the yoke back in.

Pete continued, "I degaussed the tube. Then I adjusted the deflection yoke and the centering rings. That cured the trouble."

"What about the girls?"

I could picture his grin. "I told them they had a purity problem and I would fix it for them," Pete answered.

I could hear a sputtering and the house mother came back on the phone, "Did you hear that fresh boy?"

"Ma'am," I said, "he wasn't talking about the girls, he was referring to the TV. It had a color purity problem."

"You're as bad as he is," she yelled, and the phone clicked off.

I was a bit concerned about her attitude till about an hour later, when she phoned.

"I'm sorry if I lost my temper. I looked up that word, and he really did fix color purity. I guess he is a good boy."

Pete arrived at the shop soon after. As he was writing receipts, I noticed he had a list. It was seven nurses' names and their telephone numbers.

The mystery of color ghosts

I walked in on one color service call and the set owner, a photographer, said, "I've seen this trouble before; that's the crazy thing about it."

I looked at the black-and-white picture on his color TV. It looked a mess. There were color ghosts all over the screen. However, when I analyzed closely, I saw the black-and-white picture was actually good. Color ghosts were fringing badly around the objects in the picture.

As the cathode rays travel from gun to screen, they must stick together and all go through the same shadow-mask holes together. If they separate and pass through different holes at the same time, the spot on the tube where this happens is going to have three separate colors, instead of black and white.

The photographer blurted, "It's just like a bad color development. The three colors are not registering on top of one another."

COLOR SETUP CHART

PROBLEM	CURE
Gray Scale Tinted Raster	Service Switch Screen & Drive Controls
Purity Tinted Edges	Degaussing Move Yoke
Tinted Center	Purity Tabs
Static Convergence Color Fringing in Center	Red, Blue, and Green Statics, Blue Lateral
Dynamic Convergence Color Fringing other than Center.	Crosshatch Pattern & Convergence Board Adjustments.

I nodded and took the back off the set. There are four adjustments that move the three pictures. There is the red static magnet that moves the entire red picture diagonally from upper left to lower right. There is the green static magnet that moves the entire green picture diagonally from upper right to lower left. There is the blue static magnet that moves the blue picture up and down. These three magnets are mounted on the convergence yoke. Also, mounted on the CRT neck like the once-familiar ion-trap magnet, is another magnet called the blue lateral. It moves the blue picture from side to side.

Rocking these four adjustments can make the pictures register one on top of another.

There is one trick to the procedure. When you watch the screen as you turn the adjustments, you ignore the outer edges of the picture. Concentrate on screen center. Register the picture at screen center only. The outer edges have separate adjustments.

I turned on our local educational channel. I was lucky; they were transmitting a test pattern. I moved all three static magnets off, then gradually worked them back into place by observing the center of the test pattern. I tucked all the colors in behind the black-and-white objects in the center of the pattern.

The photographer noted, "Those controls take the three transparencies and place them right on top of one another, right?"

I nodded, "That's just about what they do."

The model home TV

The phone rang Sunday morning. "Art," an excited voice said, "you promised you'd set up my old color set." It was the result of the deal I made when I sold him a new black-and-white TV.

I sleepily looked at the clock. "My gosh, Harry, it's 7 a.m."

He said pathetically, "I placed a big ad in the paper. Prospective home buyers will start coming in about 9. I mentioned the good TV reception they'll get living here. Please come out and set up this color TV."

I crawled out of bed and went to Harry's subdivision. He had his own color TV in the model.

There's one good thing about early Sunday morning. Most of the TV channels transmit test patterns, so I wouldn't need my crosshatch generator to check convergence.

I arrived at the model home and turned the TV on. After about 10 minutes of warmup, I got a test pattern with a crosshatch pattern in it. The red and green vertical bars on the left side were sticking out instead of mixing with the blue to make white. On the convergence board, I looked for LEFT SIDE, then came down the row of controls till I found R & G VERTICAL. I adjusted that control. The red and green bars merged with the blue to form white.

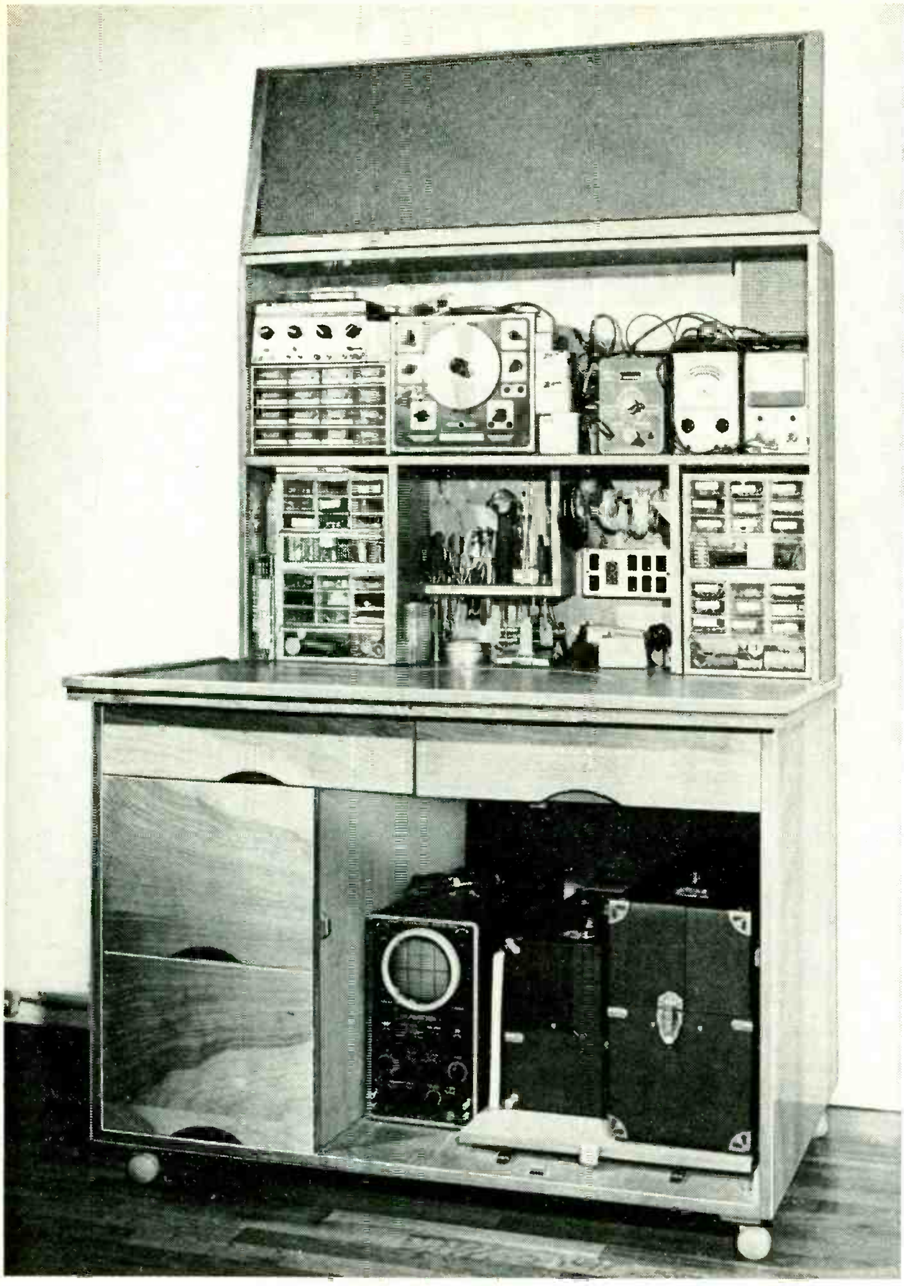
I noticed the blue horizontal bars on the top of the screen were misconverged. I located TOP, then came down the row of controls till I found BLUE HORIZONTAL. I adjusted that control. The blue slid in behind the red and green to form white.

That about did it. I rocked each control in turn, noting its area. They were all set rather well. I ended up with a perfect black-and-white test pattern.

I looked up, pleased. He glared back. I looked over the perfect picture again. Puzzled, I asked, "What's your problem? The picture is perfect."

He said, almost crying, "I let my wife talk me into getting rid of color TV, and all that was wrong was a few minutes' work." END

"When are you going to get color so I can use it for my makeup?"



Electronic Work Center

If you put a workbench in your living room, does that make the place look like a shop? Not if you build this one

By LEONARD SAMUELS

NO GARAGE? OR JUST STUCK FOR SPACE? You can build a workbench that holds electronic parts, tools, and test equipment at the ready, and yet blends into the decor of the most formal living area. You can empty the closets of cigar boxes and parts cabinets and have the pleasure of working with everything at your fingertips.

The materials for this project cost about $100. Your choice of hardwood, door and drawer treatment, fabric inserts and certain other options may put your costs above or below this figure.

The "hutch" at the top is intended for items you want within easy reach. The bottom left and right sections of this portion should be tailored to just fit a double tier of the particular parts boxes you will use. The 7-inch depth is sufficient for most boxes, but if those you have are deeper, you will not be able to cut both side panels of the workbench from the same 4 x 8-foot sheet of plywood. Either reduce the overall depth of the piece—and consequently your work surface—or buy new parts boxes.

In the bottom center of the hutch is the tool rack, with openings cut expressly for your selection of most-used hand tools. At its right is a removable spring-loaded dowel for spools of hookup wire and electrical tape. A tear-off edge is mounted nearby. Below the spools is an outlet panel equipped with a half dozen fused outlets, a switch and a neon indicator.

The two shallow drawers under the work surface hold additional tools and parts. The two deeper drawers were specifically designed as files for schematics. Because of the weight bearing on these drawers, phonograph slides were used for rigidity.

A multipurpose storage area is at the right of the base section. A built-in dolly handles heavy pieces.

The turntable on the work surface requires considerable work and care to install. But the convenience it provides is well worth the trouble—you will be able to rotate the chassis you are working on without lifting it, and you can raise the turntable about ¼ inch to prevent the chassis from scratching the work surface if it overhangs the edge of the turntable. If you decide you don't need this feature, or if the gap around the turntable is objectionable, no modifications are required to eliminate it, although the top drawers could be made wider in its absence.

How to use the materials

The plywood for the sides, drawer fronts and upper shelf and other hutch parts can be cut from a single 4 x 8-foot sheet of ¾-inch hardwood plywood, shown in Fig. 1. The panel should be good on two sides. I used birch for this part of the workbench.

The back requires a 4 x 8-foot panel of ⅜-inch fir plywood. Since the back will be partly exposed when the doors are open the perfectionist might substitute hardwood.

The bottom, the dividers between the drawers and the storage space and the turntable, the dolly and the turntable base are all cut from a 4 x 8-foot sheet of ¾-inch fir plywood, good on one face (Fig. 2).

Drawer sides are ½-inch pine. Drawer bottoms and the work surface are ¼-inch tempered hardboard (wood-grained plastic laminate may be substituted). The door frames are 1 x 2-inch solid hardwood. For strength, the bench top is made of 5/4-inch pine.

For ease of construction and rigidity, common furring strips are used for partial framing. Glue and screws are used throughout, but no screws are exposed on the outside.

Fig. 3 shows the construction of

the workbench. After the materials are cut, run ¾-inch dadoes, ⅜ inch deep, inside the side panels—one pair between 25¼ and 26 inches from the bottom edge and one pair between 15½ and 16¼ inches from the topmost edge.

The furring strips should be attached with white glue and fastened with countersunk 1¼-inch flathead screws. Attach strips flat at the rear edges of the side panels from 2⅜ inches from the lower edges to within 1⅝ inches of the lower dadoes, and along the lower edges of the side panels ¾ inch from those edges and from the rear edges. These strips should run forward to within 2⅜ inches of the left-panel front edge and within ¾ inch from the right-panel front edge.

On the surface of the bottom plywood panel, attach a furring strip on edge across the rear with screws through from the underside. In this strip, a ¾-inch gap should be left 15⅝ inches from the left edge. Do the same on the bottom of the rear edge of the 47¼ x 26-inch drawer shelf, allowing ⅜ inch on either end. To support the bench top, mount a furring strip horizontally on the back panel, with the upper edge of the strip 30½ inches from the bottom edge. Allow ¾ inch at each side.

Returning to the left-side panel, attach a 24½-inch piece of furring vertically ¾ inch in from the front edge. The drawer fronts will bear on this. Perpendicular to this piece attach two more strips to carry the left drawer slides. Mount one 6¾ inches and the other 18¾ inches, on center, from the bottom.

Assemble bottom, sides, shelves, and top with glue and screws. Before you attach the back to square up the workbench and make it rigid enough to stand, bevel the rear edges with a cove cutter in a router or with a sanding block.

Notch the rear of each of the 4½ x 26-inch top-drawer separators to fit around the furring on the back. Mount each separator 19⅜ inches from the side panels. The front edges should be flush with the shelf beneath. Glue, then use screws through the back panel and the shelf.

Place the 26 x 24½-inch bottom divider in position 14⅞ inches from the furring on the left, fitting it into the gaps in the furring at the rear of the workbench. The good face is to the right. This board must be perfectly perpendicular to the bottom and parallel to the left-side panel to insure proper drawer fit.

For ease of handling, mount the casters now. Glue and screw tapered 5/4-inch blocks to the bottom, positioned so that casters mounted on them will not protrude from underneath the workbench. Otherwise, they may jam against a wall.

For the drawer sides, rip the ½-inch pine to 10½ inches from the 12-inch (nominal) board and to 4 inches from the 5-inch (nominal) board. Before cutting them to length, run a ¼ x ¼-inch dado ½ inch from one edge on each board. (These will receive the drawer bottoms.) Then cut the sides to the lengths shown in the table of drawer dimensions. Cut ¼ x ¼-inch rabbets along both side edges of each back piece and along the rear edges of each side piece. Be sure that these cuts are on the same side as the dadoes.

On the larger drawer fronts, cut hand grips at the center of the lower edges with a jigsaw. With a 2-inch radius, you can cut a curve 1 inch high and 3½ inches wide. For the smaller drawer fronts, cut to the same dimensions, but tilt the jigsaw 30° to provide a good grip for your fingertips.

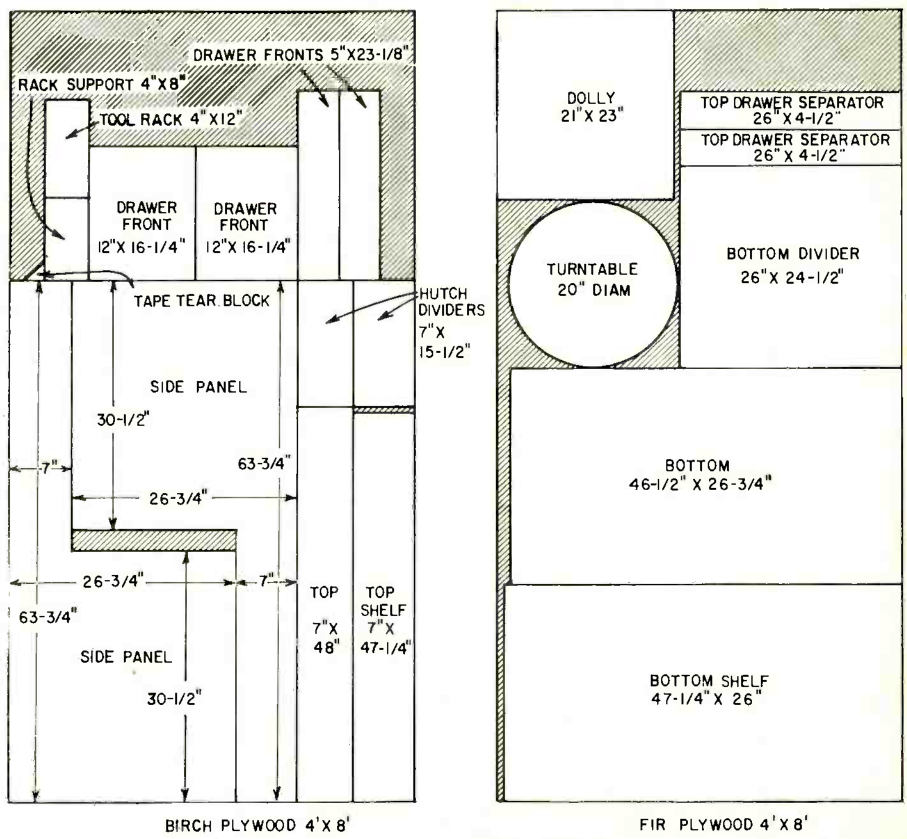
With a router, cut blind dadoes in the rear of the fronts to accept the sides and bottoms. On the large drawers, the bottom slots should be ½ inch above the finger cutouts and the side slots should be 1 9/16 inches from the edges. On the small drawers, the slots should be 1⅜ inches above the bottom edges, and 13/16 inch from the left and right edges. Glue and toe-nail the sides in their slots. Slip in the hardboard drawer bottoms, and glue the back pieces to the sides.

Attach the drawer slides to the sides of the large drawers, 4⅞ inches from the lower edge on the bottom drawer and 5¼ inches from the lower edge on the other. These slides should overhang the rear of the drawer by 2½ inches so that the drawer is fully accessible where it is open.

Attach the slides for the small drawers 1⅝ inches above the shelf, flush with the front edges of the dividers and ¾ inch in from the front edges of the side panels. Attach the other halves of the slides to the drawers 1½ inches above their bottoms.

Glue scrap wood blocks to the walls and shelves so that they press snugly against the backs of the drawers when they are closed. This will prevent strain on the drawer fronts if the drawers are slammed closed.

The storage-space dolly should be 23 inches from front to rear. The width depends on what equipment you plan to store alongside it. I allowed 9 inches to accommodate an oscilloscope; this left 21 inches for the dolly. Glue and screw a piece of furring to the rear edge of the dolly to prevent equipment from sliding off the back. Attach the slides to the bottom, 3 inches in from the



Figs. 1 and 2—Two 4 x 8-foot plywood sheets supply major parts when cut as indicated.

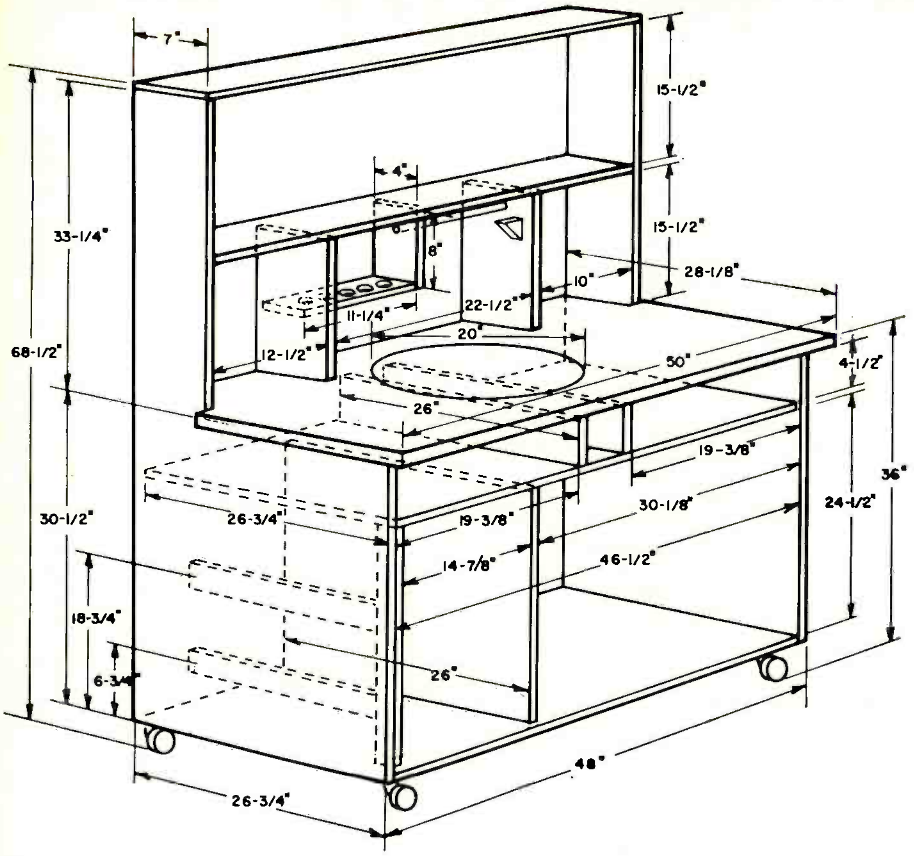


Fig. 3—This assembly diagram should be followed for construction and major dimensions.

front edge, wide apart for maximum stability, and flush with the front of the dolly.

The 5/4 x 10-inch pine (nominal) is used to form a solid bench top. Cut the board into three 50-inch lengths. Rip 1⅛ inches from one board to bring the combined width to 27¾ inches. Notch both ends of the narrow board 1¾ x 7 inches. Use glue and dowels to join the boards. Duplicate this top piece in hardboard or plastic laminate.

Just 25 inches in from either end, and 12 inches from the front, is the center of the turntable. Cut an accurate circle with a $10\frac{1}{16}$-inch radius. Mount the bench top without glue—you will probably have to remove the top when you are adjusting the turntable mechanism.

Cut accurate 20-inch circles from the ¾-inch fir plywood and the ¼-inch tempered hardboard or plastic laminate. This cutting is critical because the turntable will have to turn in its own kerf without binding. Now glue the hardboard disc to the plywood disc; use only spot gluing so you can replace the hardboard easily when it wears. Slide the hardboard work surface into place on the workbench.

Assembling the hutch

Now place the two 7 x 15½-inch hardwood dividers at the appropriate positions to accommodate your parts boxes. (Make them 7 x $15\frac{11}{16}$ inches if you are using a plastic-laminate top.) Check that the hardboard will readily slide out for replacement when necessary.

Drill a ¼ x ¼-inch hole 2½ inches from the top and back of the left side of the right divider; this will accommodate the wire- and tape-spool dowel. Then attach the board. Drill a ¼ x ⅝-inch hole 2½ inches from the top and back of the 4 x 8-inch tool-rack support on its right side. Attach it to the tool rack and fasten the assembly to the workbench. Place a ¼-inch lightly compressible ½-inch-long spring in the ⅝-inch hole. Cut a ¼-inch diameter dowel 10⅞ inches long. If you have any difficulty in inserting and removing this rod, widen and round the front edge of the left hole.

About 2 inches down on the right 7 x 15½-inch divider and 1 inch in from the front edge, glue a triangular block of hardwood with the metal cutting edge from a dispenser of electrical tape screwed to the upper front surface.

Mount a magnetic catch at the front edge of both inner surfaces of these 7 x 15½-inch boards, 1 inch up from the work surface. These will hold the folding door in place.

The door for the hutch area consists of two sections made of 1 x 2-inch solid birch, mitered at the corners and doweled. Make a 1 x 3½-inch cutout (2-inch radius) at the center of the lower edge for a hand grip. To create a uniform appearance, make the horizontal pieces at the center hinges from each half of a single ripped 1 x 2-inch board. Rabbet all inner edges in the rear ½ x ¼ inch deep to accept insert material.

Make the frame for the storage-space door in the same way, but with a hand-grip cutout on each side. This door fits into the opening, flush with the drawer fronts. Mount four magnetic catches around the opening to serve as both catches and stops. The dolly will clear the bottom catch.

You have your choice of a variety of materials for the inserts on the doors. Rice paper, fiberglass, speaker cloth, or fabric to match the room's decor—perhaps shirred to look like curtains—are good choices. The fabric or the rice paper would be cheapest.

Turntable mechanism

Mount a 6-inch lazy-susan bearing precisely at the center of the underside of the plywood turntable. Now remove it and mount it on two face-to-face glued pieces of ¾-inch plywood. 7 inches long (see Fig. 4). The width of this plywood sandwich will depend on the depth of the side bearing—whether nail-on or screw-on, ball or roller. Subtract double the side-bearing depth from 6¼ inches, which is the space available between the drawers. Place four bearings on each side. one at each corner. Repeat on the ends.

Cut two pieces of scrap 5/4-inch stock as long as the combined length of the 1½-inch plywood block and end bearings, and wide enough when set on edge (about 3⅛ inches) to support the turntable assembly exactly at table height. Next, 2 inches in front of center and 1 inch below the support blocks' top edge, drill ¼-inch holes ½ inch deep for a pivot rod.

Before proceeding further on the supports, bend an 8-inch length of ¾ x ⅛-inch aluminum bar stock as shown in Fig. 5. This is the elevating lever for raising the turntable. Drill a ¼-inch hole 2 inches behind the high point of the arch that bears on the underside of the turntable assembly and in the center of the width of the bar. Slip a 5-inch headless spike or other ¼-inch steel rod through the hole in the lever. Center the rod. place washers on each side, and burr it so the lever doesn't slide.

Slip the 5/4-inch blocks on the ends of this pivot rod. Place the assembly directly under the center of the plywood sandwich, gluing the 5/4-inch blocks to the 4½-inch uprights that support the drawer slides. At each end of these blocks, glue and screw 5/4 x 5/4 x 4½-inch blocks on end. Line all surfaces on which the bearings will ride with galvanized sheet metal.

Cut two bars of ¼ x 1-inch aluminum bar stock 7¾ inches long. At dead center on both, drill 5/32-inch holes to accept a 1-inch No. 8 round-head screw. At 1¾ inches from each end of one bar, make a bend so that, when this bar is laid across the other, the ends will be on the same plane. Keeping them in this position, drill 1/16-inch holes through the bars near facing edges of the side angles formed, 2½ inches from the ends (see Fig. 5. Fit 1-inch tension springs through the holes, linking the bars on both sides. On the corner of each bar, facing the front of the workbench, drill 1/16-inch holes. Pass 4-inch lengths of stranded wire through these ends and tie. Tie the other ends to a ring or other convenient finger pull. Attach the entire assembly with the 1-inch screw to dead center of the plywood sandwich. To raise the turntable, merely depress the lever. The spring-loaded locking bars will snap into place (on top of the 5/4 x 3⅛-inch blocks) and the turntable will rest on them, ¼ inch above the work surface. To lower the turntable, depress the lever, pull the wires and release the lever. The turntable will once again rest on the wooden blocks.

Finishing touches

Cover all exposed edges of the plywood—those facing front and the edges of the drawer fronts—with 1-inch veneer tape. Use 2-inch tape for the edges of the 5/4-inch bench top. Take care that the white glue does not spread to adjoining surfaces, or your finish will not take. You might have to follow up on unglued edges with a straight pin and glue. Butt meeting edges with square cuts. For a neat appearance, fold the veneer around corners, breaking the grain evenly, instead of running separate pieces. Light sanding will remove the splinters that form. When the glue has set, trim carefully with a razor blade and sand all surfaces.

With the bench top and hardboard in place, measure and cut the ⅞-inch corner-guard molding with mitered corners. Nail. This will hold the hardboard in place. If you use plastic laminate instead of the hardboard, no moldings are needed; just attach the laminate with contact adhesive.

Stain the unit, then oil or varnish it, or retain the natural color of the wood by using a penetrating sealer. Whatever finish you select, be sure to cover all surfaces to prevent warping.

If this nice piece of furniture doesn't quiet objections to your electronics hobby, better give it up. END

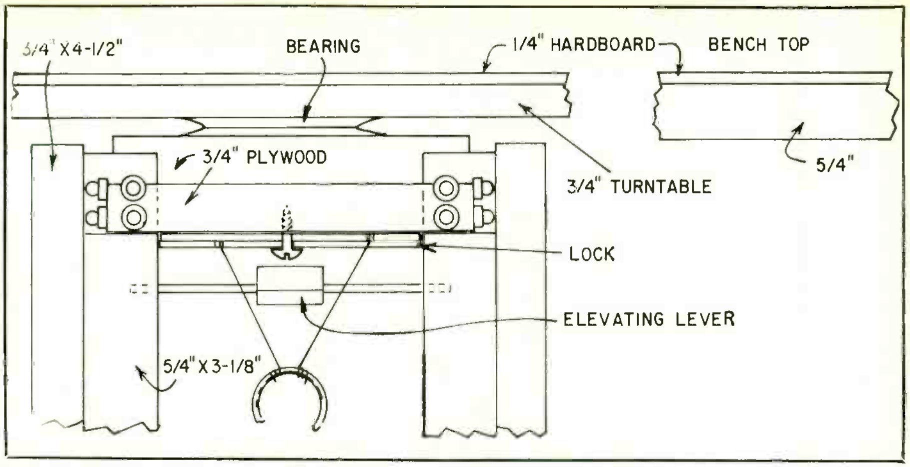
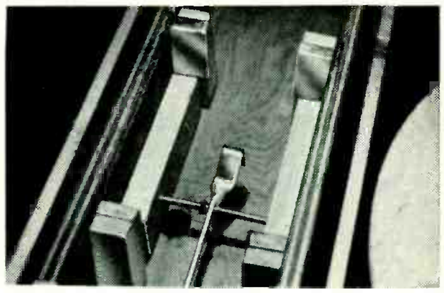


Fig. 4—Detail diagram showing assembly of rotatable turntable in center of work surface.

Underside of turntable assembly. Levers mount on plywood sandwich and turntable.



The turntable has been removed to show method of mounting the elevating lever.

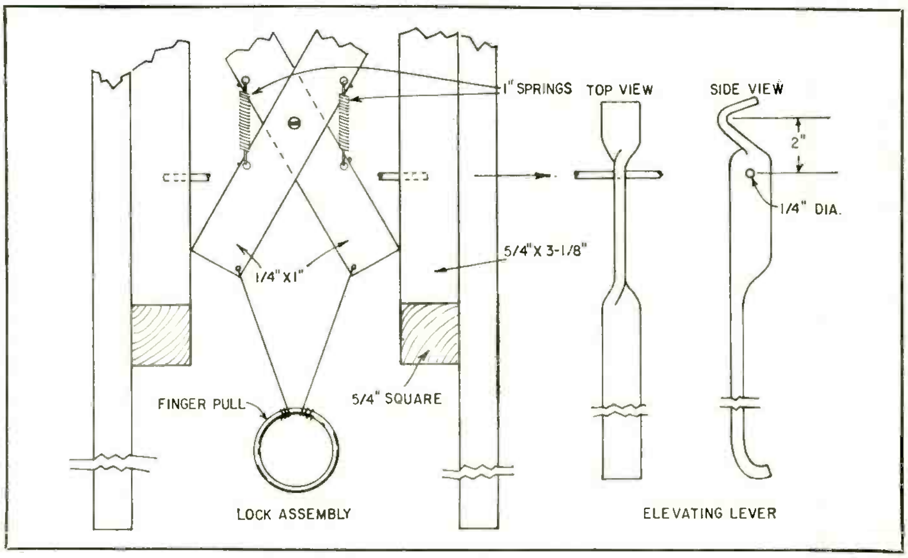


Fig. 5—Further construction details showing assembly of lock and elevating lever.

Materials

1 4 x 8-foot sheet of birch plywood, good two faces, ¾ inch
1 4 x 8-foot sheet of fir plywood, good one face, ¾ inch
1 4 x 8-foot sheet of fir plywood, good one face, ⅜ inch
1 4 x 8-foot sheet of tempered hardboard, ¼ inch
5/4 x 10 common pine, 14 feet
1 x 2 furring, 26 feet
½ x 5 common pine, 10 feet
½ x 12 common pine, 9 feet
1 3-foot ½-inch dowel
1 x 2 birch, 28 feet
⅞-inch corner guard, pine, 8 feet
5 rolls of 1-inch birch veneer tape (8 feet)
1 roll of 2-inch birch veneer tape (8 feet)
3 quarts of penetrating sealer
1 6-inch lazy-susan bearing
5 pairs of phono slides, 22 inches
3 pairs decorative butt hinges
1 fused and switched outlet panel scrap galvanized sheet
1 set of ball casters (Shepherd's Super-casters or equivalent)
16 inches of ¼ x 1-inch bar aluminum
8 inches of ⅛ x ¾-inch bar aluminum
1 5-inch spike or ¼-inch rod
ball or roller bearings for turntable assembly (see text)

Drawer Dimensions

Side drawers: 13½" wide x 20" deep x 10½" high
bottoms: ¼": 13" x 19½"
fronts: ¾": 12" x 16¼"

Top drawers: 18" wide x 20" deep x 4½" high
bottoms: ¼": 17½" x 19½"
fronts: ¾": 5" x 23-⅛"

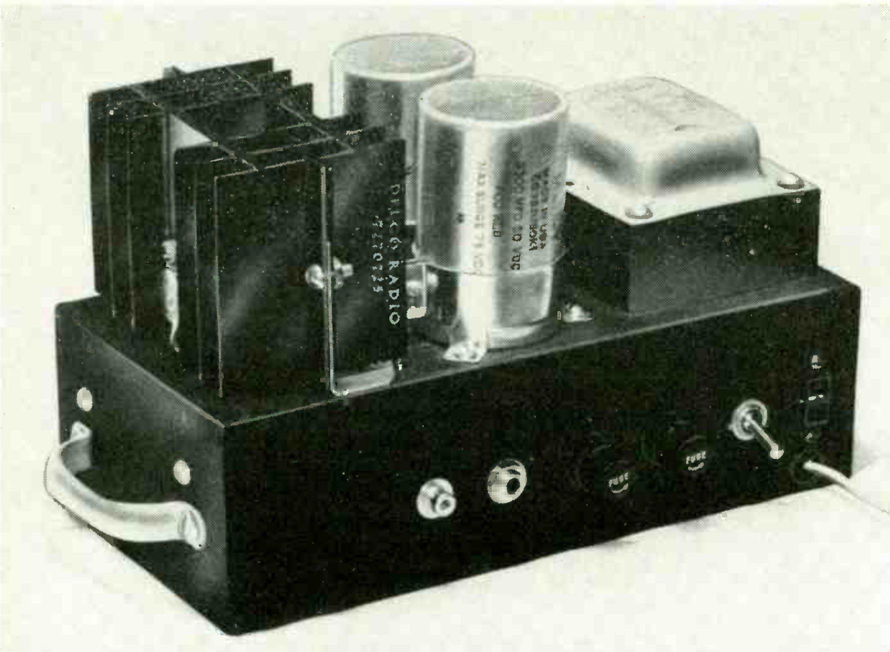
THUNDERbox—A 50-Watt Guitar Booster

A booster amplifier for electronic musical instrument, it has separate transistor heat sinks and computer-grade electrolytics

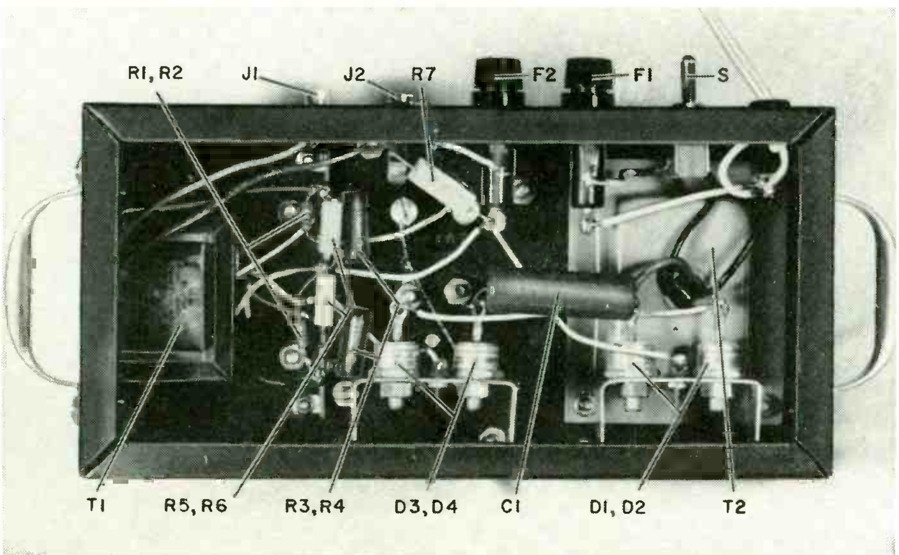
By W. T. PREWITT

IN THE PAST 5 YEARS, THE NUMBER and popularity of teen-age rock-and-roll combos has increased tremendously. The electric guitars and bass guitars used by these groups require amplifiers sufficiently powerful to provide adequate volume throughout the large halls and gymnasiums in which most teen dances are held. When a guitarist joins one of these groups, he usually finds, much to his dismay, that his 10- to 20-watt amplifier is not enough, and often considers trading it in for a larger and more expensive one.

There is a less expensive and more desirable solution to this problem. By adding a simple outboard booster power amplifier to the existing guitar amplifier, he can increase its output to the needed level without affecting either the resale value of the original amplifier or its usefulness as a practice instrument in quieter surroundings. And, as an additional feature, if the original amplifier is equipped with reverberation, the booster can be used in this system without producing feedback. (Most high-power commercial amplifiers omit reverberation because of this problem.)



The finished Thunderbox is a rugged-looking unit with two handles for easy carrying.



Amplifier underchassis view. Diode-mounting brackets must be insulated from chassis.

The outboard amplifier used in this system has a power output of 50 watts at low distortion, and utilizes a two-transistor circuit which has been thoroughly tested and is easy to duplicate. All parts including the speaker and material for the cabinet can be purchased for approximately $90.

The two power transistors (Fig. 1) are series-connected in a push-pull class-AB configuration. A dual-voltage power supply allows the usual output coupling capacitor to be omitted. A bifilar transformer isolates the input circuit and provides a low driving point impedance for the amplifier.

Transformer color codes on the schematic are for the Triad transformers specified in the parts list. The input connections shown to T1 will work best with most electronic instrument amplifiers. However, with some low-power guitar amplifiers, better performance will be obtained when the red/blue lead is connected to J1 instead of the red lead.

The amplifier is built on a 5 x 10 x 3-inch chassis. The power and input transformers are mounted at opposite ends to avoid hum pickup. The 1N3209 and 1N3209R (reverse-polarity) diodes are used in the power supply because their high surge-current rating enables them to withstand the charging-current demand of the filter capacitors. The diodes are mounted in pairs on separate aluminum brackets (see underchassis photo) which *must be insulated* from the chassis. The 1N3209's provide +35 volts and the 1N3209R's −35 volts, from the center-tapped power supply. A 0.1-μF capacitor is connected across the secondary of the power transformer to eliminate destructive voltage spikes.

The two transistors are mounted on individual heat sinks (see top view). Although it might be possible to get by with only one heat sink, two provide an added margin of safety. Use a standard TO-3 transistor-mounting kit to insulate each transistor from its heat sink. To improve heat transfer, apply a thin coat of silicone oil or grease to each side of the mica washers in the kit. After the transistors have been mounted, and before wiring them into the circuit, check each one for shorts from the case and both terminals to the heat sink. This is a very important step, since a short at this point in the circuit will destroy one or both transistors.

Resistor R7 (Fig. 1) across the output terminals is a safety load to prevent damage to the transistors if the amplifier should be turned on without the speaker connected. Fuse F2 provides protection in case of a short in the speaker wiring.

A speaker with a power-handling capability of at least 50 watts is necessary for use with this amplifier. Jensen, Lansing and Utah offer a series of speakers designed specifically for use with electronic musical instruments. All have stiff cones and suspensions, rugged voice coils, and heavy magnets. The speaker used in my unit is a Jensen EM-1250, rated at 100 watts. The extra power capability affords a desirable margin of safety, since this amplifier can deliver more than 100 watts if overdriven.

The speaker cabinet must be very solidly constructed for rattle-free high-power operation. Fir plywood ½ inch thick provides adequate strength without excessive weight. Suggested dimensions for a cabinet are 32 inches high, 22 inches wide and 11 inches deep. These figures are not critical, and may be adjusted to suit your taste or to match other equipment. You may want to increase each of these dimensions about 20% if the amplifier is to be used with a bass guitar. In that case, a Jensen EM-1220 speaker, which has a lower resonant frequency, is recommended.

Use 1-inch-square glue blocks along the entire length of all joints. Assemble the glue blocks and all parts of the cabinet, except the baffle board and the back, with white glue and either clamps or nails. Cloth-backed vinyl, which can be obtained from an automobile upholstery shop, is an attractive, durable and easily applied cabinet-covering material. Cut it wide enough to allow the edges to lap over the inside of the cabinet. Apply white glue evenly to the cabinet and stretch the vinyl over it, smoothing out the wrinkles as you go. Staple and glue the vinyl edges inside the cabinet.

Cut the speaker opening to a 10½-inch diameter, drill and countersink the four mounting holes, and then give the baffle board a coat of flat-black paint. Mount the speaker with flat-head No. 10 x 1¼-inch machine screws. Stretch the grille cloth evenly over the baffle board, stapling it securely to the back of the board. Staple an 18-inch square of fiberglass or other insulating material to the inside surface of the back panel directly behind the speaker. Wire the speaker. Then install the baffle board and back panel,

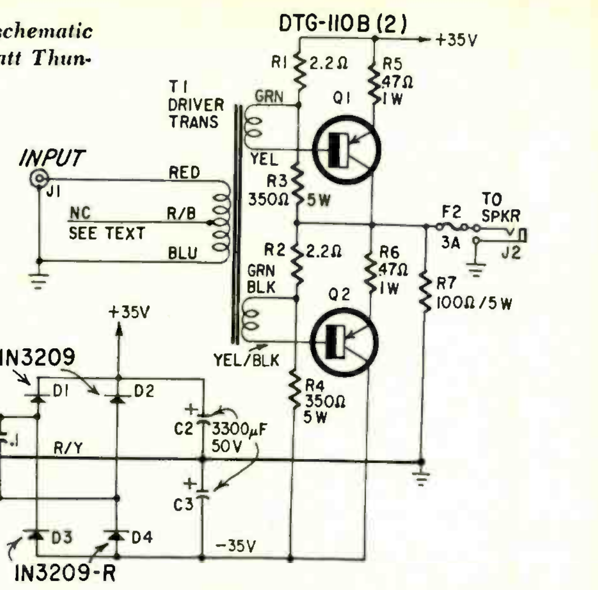


Fig. 1—Complete schematic diagram of the 50-watt Thunderbox booster amplifier. R7 and F2 provide overload and shorting protection for the output transistors.

Parts list

R1, R2—2.2 ohms, ½ watt
R3, R4—350 ohms, 5 watts
R5, R6—0.47 ohms, 1 watt
R7—100 ohms, 5 watts
C1—0.1 µF, 100 volts
C2, C3—3,300 µF, 50 volts, electrolytic with mounting brackets (Mallory CG332U50K1 or equiv)
D1, D2—Silicon diode; 1N3209
D3, D4—Silicon diode, 1N3209R
Q1, Q2—Transistor, DTG-110B (These Delco transistors are color-coded in gain groups. Any available label color will work as long as both transistors are the same color.)
T1—Transistor driver transformer with split primary sandwiching bifilar-wound split secondary. Turns ratio 6:1:1 (Triad TY-160X or equiv)
T2—Power transformer, 52 volts ct, 2 amps (Triad R-206B or equiv)
S—Switch, spst
F1—Fuse, 2 amps
F2—Fuse, 3 amps
J1, J2—See text
Heat sinks (2). Delco 7270725 or equiv
Transistor mounting kit (2) for TO-3 type transistor. Delco 7274775 or equiv
Speaker—Jensen EM-1250 or equiv
Chassis—5 x 10 x 3 in.
For speaker enclosure: 1 sheet ½-in. type AD fir plywood; cloth-backed vinyl, 1 yd by 60 in.; metal corners (8); carrying handles (2)
Fuse holders, line cord, miscellaneous hardware

using flat-head No. 10 x 1¼-inch wood screws and cup washers. Metal corners and handles complete the cabinet.

To adapt the guitar amplifier to drive the Thunderbox amplifier, wire a closed-circuit phone jack in the speaker lead as shown in Fig. 2. Mount the jack in an inconspicuous but convenient location on the back of the amplifier. A length of unshielded two-conductor wire with a phono plug on one end and a phone plug on the other is satisfactory for the interconnecting cable. Since the impedance level is very low, there is no hum pickup. Take great care preparing the interconnecting cable, since it must withstand rough treatment.

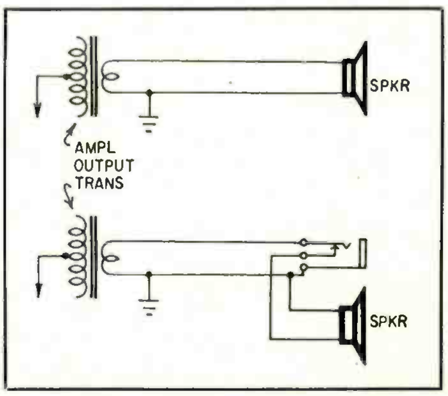


Fig. 2—Guitar amplifier output adapter.

To avoid an incorrect hookup, use noninterchangeable connectors for the outboard amplifier input and output. In particular, avoid using an output connector (on the amplifier) that will accept a guitar pickup cord.

Performance of the completed amplifier was measured in a commercial electronics laboratory. At a power output of 50 watts sine wave, total harmonic distortion was 1.6%, and frequency response was flat within 1 dB from 20 to 20,000 Hz. Hum and noise were 62 dB below rated output.

Measurements of transistor operating temperature were made with a thermocouple attached to the mounting base. With ambient temperature at 79°F, the thermocouple reading stabilized at 191°F after 5 minutes of operation at 50 watts sine wave. The calculated junction temperature under this worst-case condition is 210°, which is 28° below the maximum safe operating level for these transistors.

The amplifier was deliberately overdriven, and it delivered a square-wave power output of 102 watts. The transistor-case temperature dropped to 124°F. END

Understanding FM Auto Radios

The modern auto radio may combine AM and FM reception and include reverb and multiplex stereo among its features By E. F. RICE

A CAR EQUIPPED WITH AN FM STEREO receiver, or with reverberation, can provide a great new sound experience. The excellent fidelity of such systems produces an effect rarely achieved outside a hi-fi studio.

Because of the technical details involved, let's breeze through a study of some block diagrams of these systems and a brief examination of more complicated circuitry.

Fig. 1 depicts a typical AM/FM receiver. The first, second and third FM i.f.'s are also used as AM stages. Two separate agc systems, one for AM and another for FM, require separate detectors. The audio system is common to both AM and FM.

Fig. 2 shows the 1966 Buick receiver in which the AM radio is separate from the FM section, except for common audio stages. In some models, stereo and reverberation are on separate chassis. In others, like the Cadillac, the stereo is built in.

Figs. 3-a and 3-b show typical npn and pnp FM rf-amplifier stages. The signal is coupled to the emitter from the antenna coil, which is permeability-tuned and ganged with the output and oscillator coils. The capacitors are fixed trimmers, adjusted during alignment to improve tracking. The ferrite beads are chokes slipped over the leads to damp spurious oscillations. The 270-pF ca-

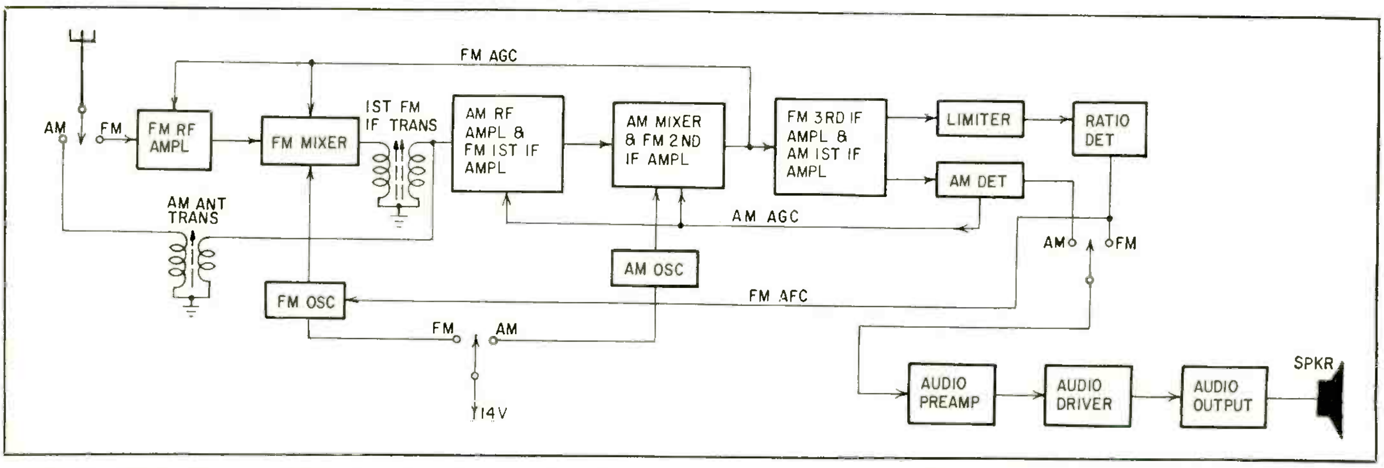


Fig. 1—Block diagram illustrates stage-by-stage functioning of a common type of AM-FM car radio using dual-purpose i.f.'s.

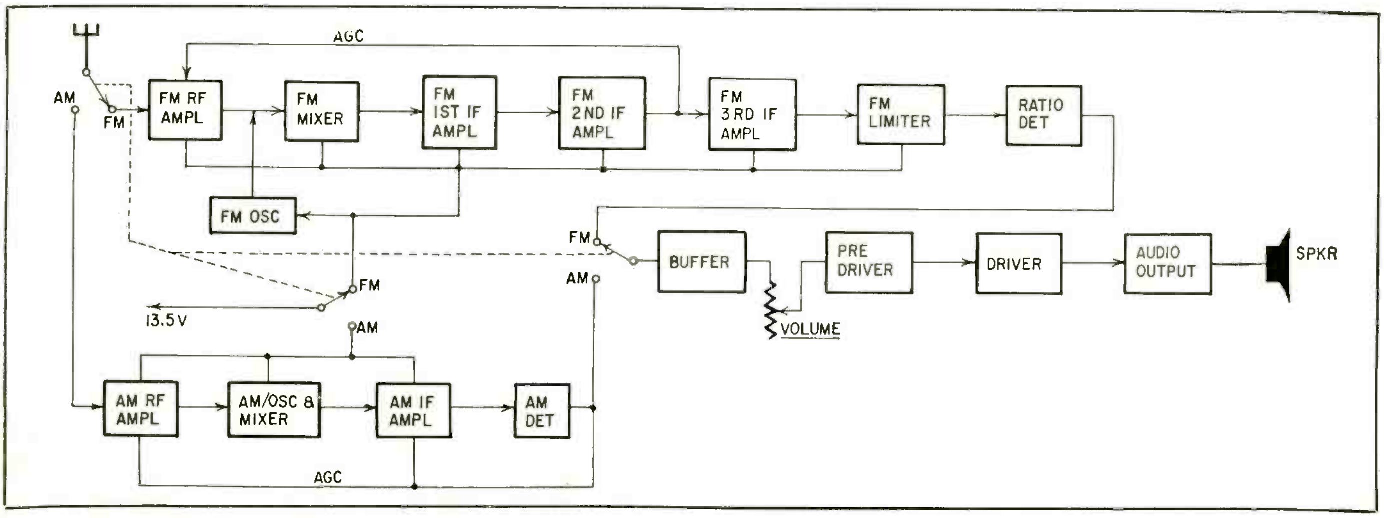


Fig. 2—Functional drawing of another system of automotive AM-FM. Separate front ends and i.f.'s are used here.

pacitors keep rf from getting into the power supply and causing birdies.

The stages shown in Fig. 4 are from the FM section of the 1966 Toronado. A thermistor in the base circuit of the oscillator increases temperature stability. A voltage from the ratio detector controls conduction of the afc diode to control the total capacitance across the oscillator tank.

The oscillator is coupled to the mixer by a length of shielded cable into which the station signal from the rf amplifier is also fed. The output transformer of the mixer is tuned to the FM i.f. amplifier frequency, 10.7 MHz.

In models which use some of the i.f. stages to amplify both AM and FM signals, some interesting circuits are used for interstage coupling.

For example, the first transistor in Fig. 5 is the AM rf amplifier and first FM i.f. stage. The second is the AM mixer and second FM i.f. The signal input to the first stage depends on the position of the bandswitch. On an FM station, the antenna is connected to the FM rf amplifier, and input to the i.f. stage will be through the 10.7-MHz transformer. The secondary of the input transformer has one end grounded for FM through the low impedance of C20, the other end going directly to the base of the transistor.

On an AM station, the antenna is connected to T1, and the AM signal finds a path to the base through the secondary of T2, which looks like merely a short piece of wire to signals at AM frequencies. The reactance of C20 is high enough to cause only slight attenuation of AM signals. C21 and C22 furnish the ground return for AM frequencies.

At the output side of Q1, the FM signal has a parallel-tuned transformer which couples only 10.7-MHz signals, and offers practically no impedance to an AM signal. The AM signal would go straight through to series-resonant circuit C30–L1–C32, and into the base of the next stage. The FM signal, prevented from reaching the base of the second stage because the series-resonant circuit has high impedance to everything except AM frequencies, is developed in the emitter of the second i.f. stage, Q2.

Both signals appear in the collector circuit of Q2, are separated again by two tuned circuits—each passes one frequency and blocks the other. The stage on the right in Fig. 5 is also the AM mixer. It is supplied through the 330-pF capacitor with the correct signal from the oscillator stage to convert the incoming AM stations to 262 kHz, the AM intermediate frequency. The FM i.f. signal is not affected because the output transformers are not tuned to select the heterodyne between the AM oscillator and the 10.7-MHz FM i.f. signal. Some models also use the

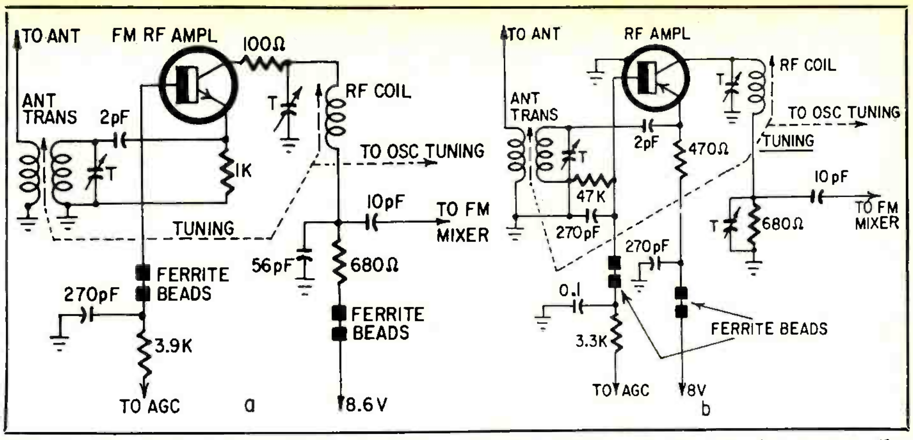


Fig. 3—Two typical car-radio rf amplifiers. The transistors may be npn (a) or pnp (b).

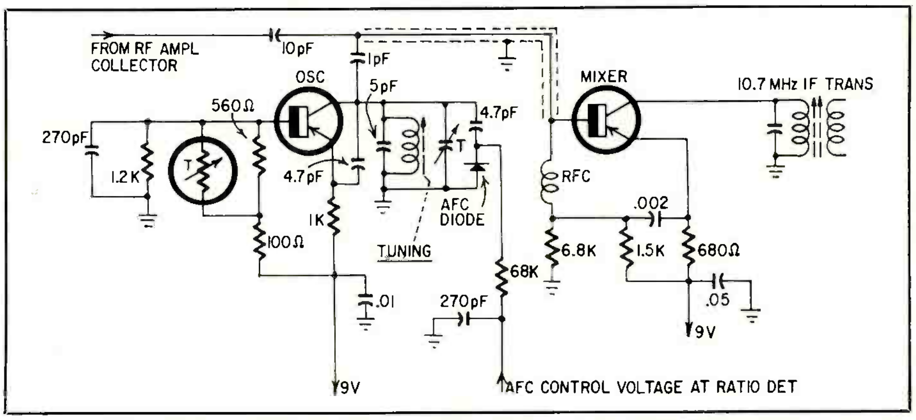


Fig. 4—FM oscillator/mixer circuits in receiver designed for 1966 Oldsmobile Toronado.

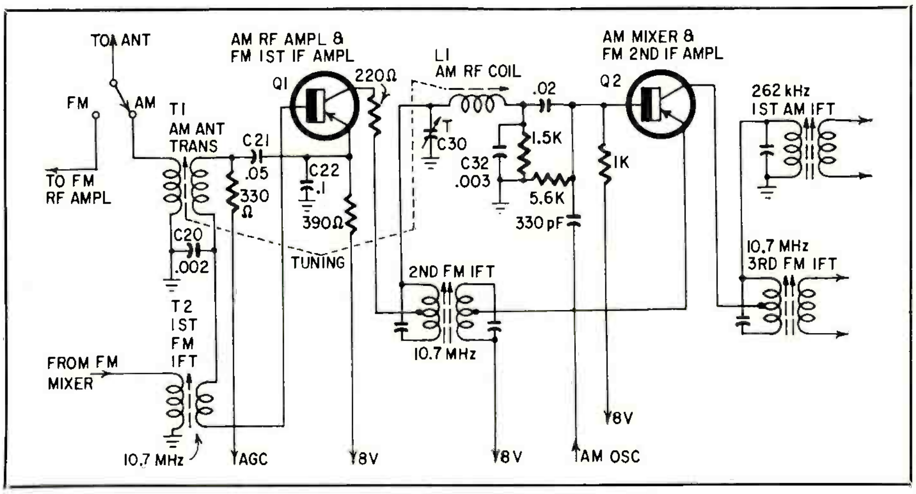


Fig. 5—In some car receivers, two FM i.f. amplifiers also serve in the AM front end.

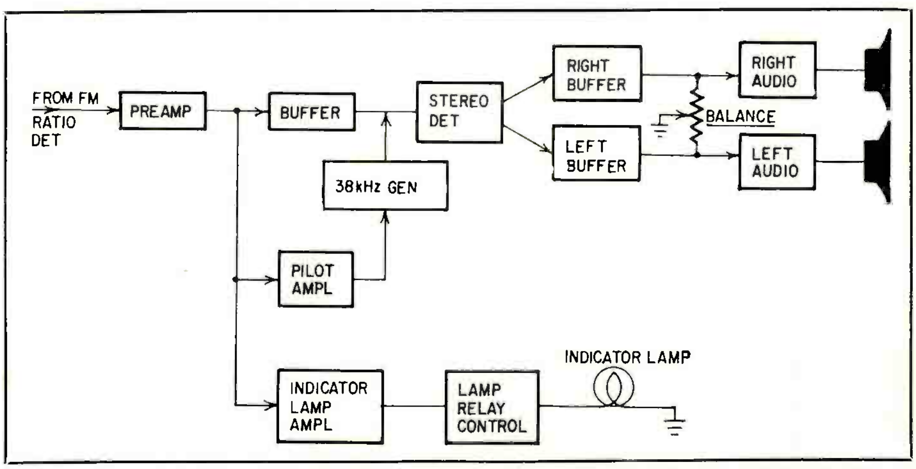


Fig. 6—Block diagram of the stereo-FM adapter in a radio used in some 1966 Cadillacs.

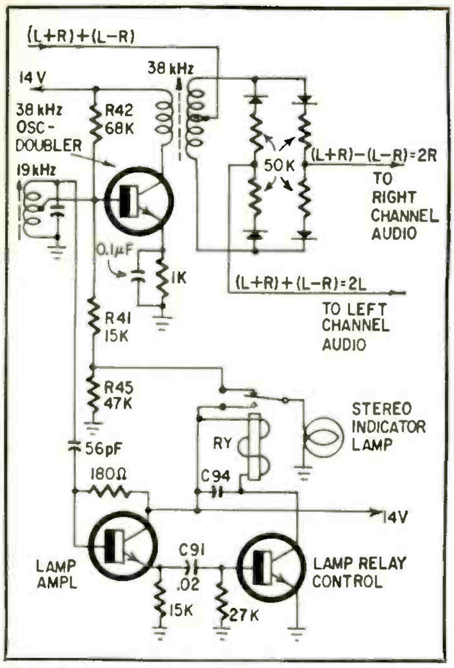


Fig. 7—Stereo switch and indicator circuits used in the multiplex adapter of Fig. 6.

bandswitch to disable whichever oscillator is not in use.

Fig. 6 is the stereo adapter used in the 1966 Cadillac. The 38-kHz generator and bridge-type diode switching circuit are shown in Fig. 7. The base circuit of the 38-kHz oscillator is tuned to the 19-kHz pilot for synchronization, and the collector is tuned to 38 kHz.

In the stereo-indicator lamp circuit, a 19-kHz signal from the base circuit of the oscillator doubler drives the lamp amplifier, producing positive pulses at its emitter. The lamp-relay control is operated with zero forward bias, keeping it cut off until it receives positive pulses through C91. Then it conducts, charging C94, to close the relay and light the bulb as long as a 19-kHz signal is present.

The relay also controls the forward bias on the 38-kHz oscillator. When there is no stereo, the relay contacts connect the low resistance of the bulb across R45 in the base circuit. There is not enough voltage to light the bulb, but the bias on the 38-kHz stage is reduced by causing more current to flow through R41 and R42. This cuts off the 38-kHz oscillator. Without this feature, supersonic noise in the vicinity of 19 and 38 kHz would beat with the 38-kHz signal and be converted to audio noise on a monophonic station.

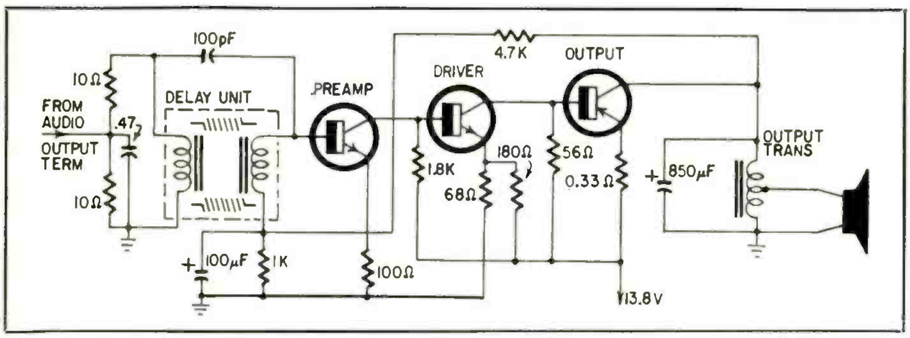


Fig. 8—This reverb device, which drives rear-seat speaker, is used in GM car radios.

How reverberation works

Reverberation seeks to simulate the acoustic properties of a large concert hall by feeding the audio output of the receiver into a delay unit followed by another amplifier. The delay is used only on the rear speaker (or speakers, in the case of stereo). Sound from the rear therefore arrives at the listener's ears about 30 msec after sound from the front, reproducing the reverberating effect of a "live" concert hall. The 30-msec delay corresponds to an echo from a distance of about 33 feet.

Fig. 8 is the reverb unit used in Buicks, Oldsmobiles and Pontiacs. The delay unit is a pair of springs mounted between two transducers. A similar unit, without amplifiers, is shown in Fig. 9, which includes a cutaway sketch of the input transducer.

Audio applied to the input induces a magnetic field in the pole pieces. Mounted between the pole pieces are small round magnets which twist slightly when a field is produced. Their motion (which is at the frequency of the audio signals being applied) is imparted to the springs. The length of the springs determines the amount of delay before the vibrations arrive at the opposite end, where another transducer is mounted. The two sections of the springs are of unequal length to prevent self-oscillation.

When using reverb units with a radio, be sure there is ample undistorted audio power to drive the delay unit and plenty of amplification after the delay. Quite a bit of energy is lost in the springs. It is important to match the input of the delay unit to the radio's output transformer, and its output impedance to the amplifier which follows the delay unit.

Auto receivers are becoming so specialized and their circuitry so complex that servicing and alignment can easily be an area for the specialist. It can be difficult to find your way around one of these chassis without a complete set of drawings and specs from the manufacturer. The out-of-ordinary circuits shown here should help you with most of the new sets. Besides learning the new circuitry and FM-stereo alignment techniques, the service technician must also be familiar with the symptoms of failure in the stereo section and the reverb units which now accompany so many AM/FM auto-radio installations. END

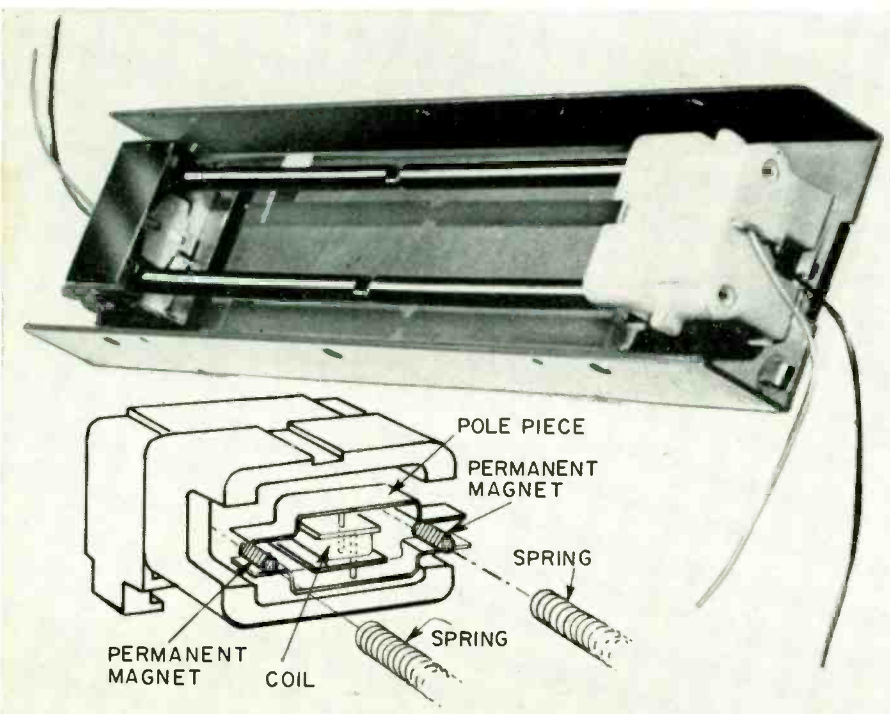


Fig. 9—Reverb delay line (top) is coupled to audio amplifier by transducers (bottom).

Stereo Sound for TV—A Report

Manufacturers want FCC to wait before deciding. Here are the systems that have been proposed

By ERIC LESLIE

YOU LISTEN TO THE BEST STEREO MUSIC on your high-fidelity equipment, and rarely dream of buying a monophonic record. (Yes, they are still sold!) And when you listen to FM, the chances are you will tune to a stereo program. Yet your TV, which probably takes up more of your time than FM and records put together, is still pathetically single-sound, as well as one-eyed.

Why this absurdity? Surely something can be done about such a condition? The answer is: Attempts have been made to do something about it, and what came of those attempts is a story in itself.

As far back as the beginning of the present decade, General Electric, Philco and others "respectfully requested" the FCC to "institute proceedings looking toward the adoption of compatible stereophonic sound transmission standards for the television broadcast service." A slight flurry of activity followed, and some experimental circuits were proposed.

But about that same time, high-fidelity audio—stereo and otherwise—began absorbing the attention of manufacturers and the public. As the years have ticked by since, the rising importance of color TV has demanded all the attention of electronic engineering departments. Therefore, early in 1965, several companies advised the FCC that they had changed their minds about stereo TV sound. The amount of engineering required, they said, was altogether too great to justify further investigation, especially as there seemed to be no great public demand.

Stereo TV sound was thereby given a decent—but possibly temporary—burial, and nothing has been heard of it since. But electronic developments have a habit of leaping suddenly into the limelight just when everybody is satisfied that they are finally disposed of. So it may be worthwhile to take another look at what stereo TV sound may be able to do, what it cannot do, and some of the methods proposed for making it an actuality.

The Westinghouse proposal

A circuit very much like that used in ordinary FM stereo is described by Westinghouse. The L+R signal (50–15,000 Hz) is transmitted exactly the same. The L−R signal is put on a subcarrier, with only one difference from our present FM approach; the subcarrier is a different frequency. The 15,750-Hz TV horizontal scanning signal and its strong harmonics would produce objectionable beats with a subcarrier at 38 kHz, as well as with a pilot signal at 19 kHz. There would be a number of strong audible beat frequencies at the output.

The Westinghouse solution is simple—use the scanning frequency's second harmonic, 31.5 kHz, as the subcarrier frequency. This makes a pilot signal unnecessary—the stereo sound can be syncronized and phase-locked with the TV sinc pulses. Transmission and detection methods are roughly the same as for ordinary stereo FM.

In experimental closed-circuit and over-the-air tests, signals of this type were transmitted from a commercial FM exciter which had been modified to transmit on television channel 5. An ordinary TV receiver modified to detect stereo was used. The demultiplexer (Fig. 2) is familiar to stereo FM fans. Separation was greater than 20 dB. Westinghouse scientists believed that, with a little more refined equipment, they could have improved separation to the 29.7 dB prescribed for standard FM stereophonic broadcasting.

Sync buzz, a problem even in ordinary TV sound, was worse in this system of TV stereo. Video components near 31.5 kHz get into the sound system, and 60-Hz sync pulses ride along. Sync buzz rose 6 dB whenever the detector was switched to the stereo mode. Westinghouse researchers F. T. Thompson and J. E. Lambright point out that a separate

continued on page 66

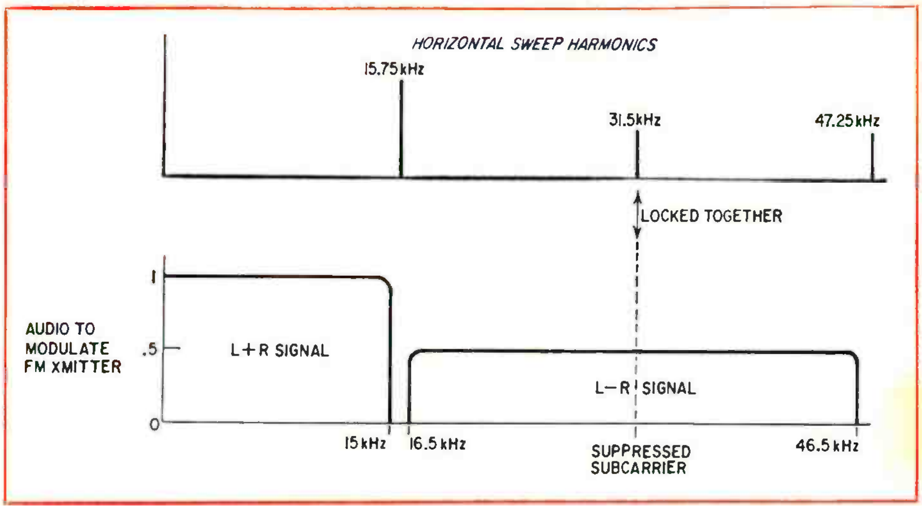


Fig. 1—Layout of sweep, audio, and subcarrier frequencies in Westinghouse proposal.

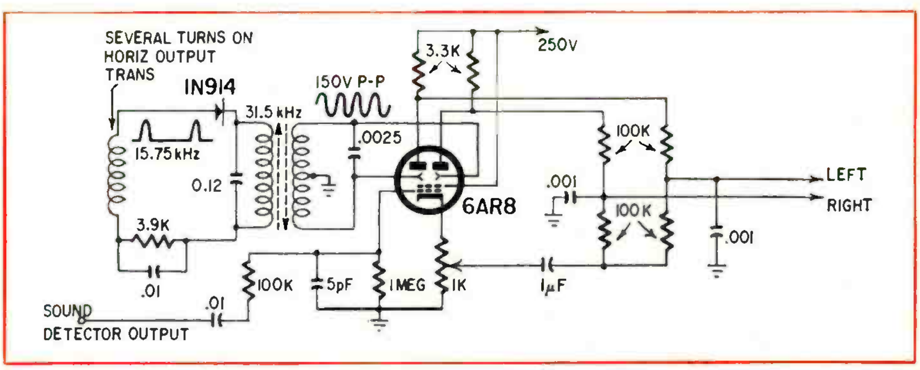
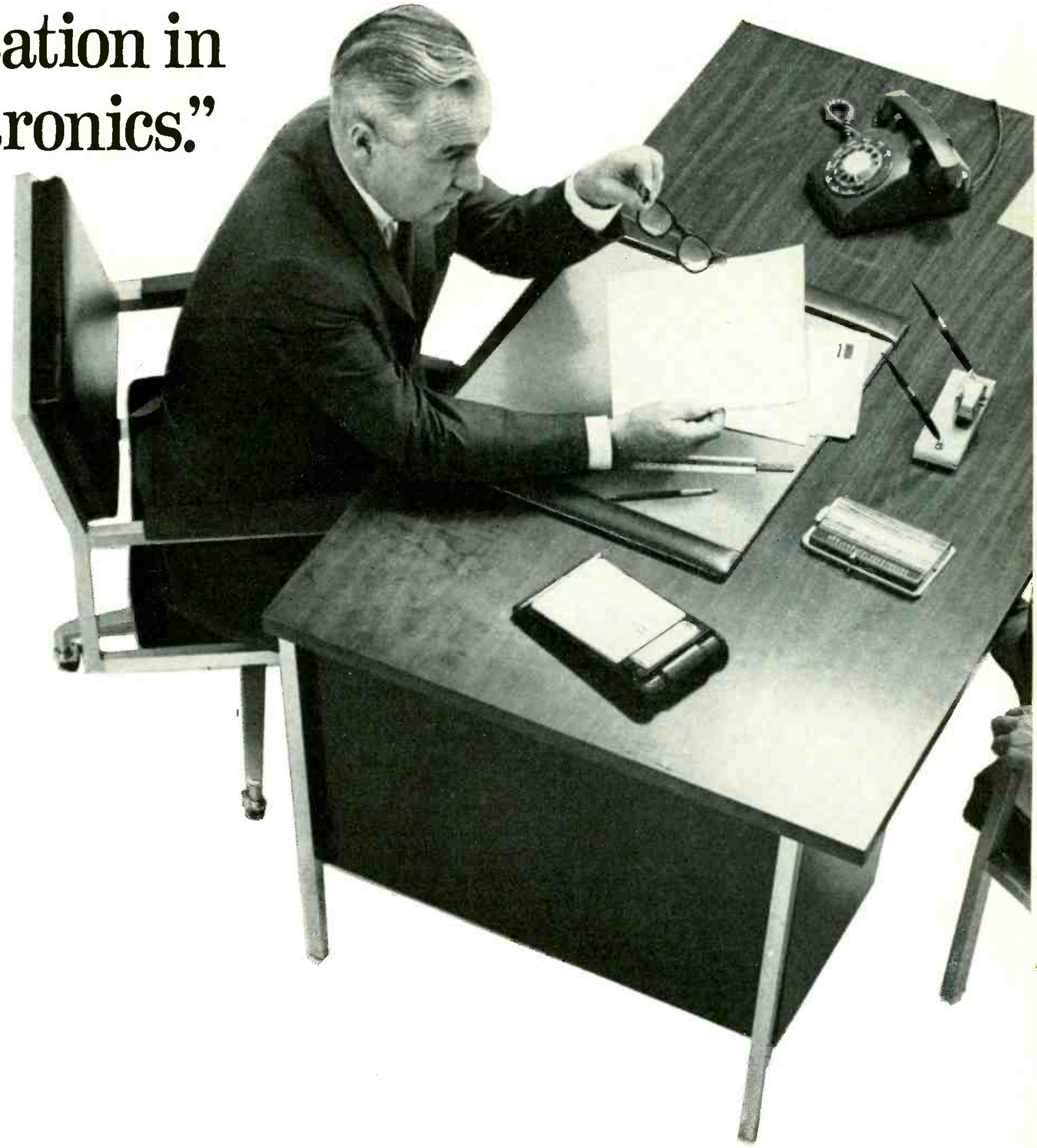


Fig. 2—Westinghouse stereo demodulator. Flyback transformer provides keying pulse.

"He's a good worker. I'd promote him right now if he had more education in electronics."



Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

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

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

You're eligible for a CREI Program if you work in electronics and have a high school education. Our FREE book gives complete information. Airmail postpaid card for your copy. If card is detached, use coupon below or write: CREI, Dept. 1421-D, 3224 Sixteenth Street, N.W., Washington, D.C. 20010.

Founded 1927

CREI

Accredited Member of the National Home Study Council

The Capitol Radio Engineering Institute
Dept. 1421-D, 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 ______ ☐ GI BILL

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

NOW! 2 NEW PROGRAMS!

- **Industrial Electronics for Automation**
- **Computer Systems Technology**

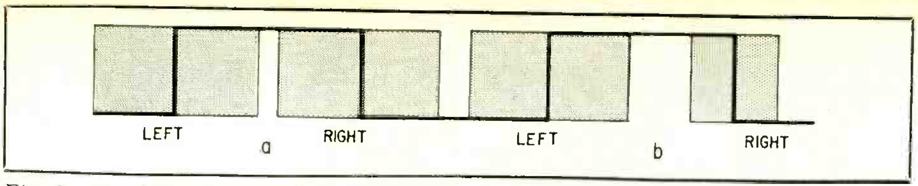


Fig. 3—Zenith's pulse modulation. L and R are equal at (a), while L is greater at (b).

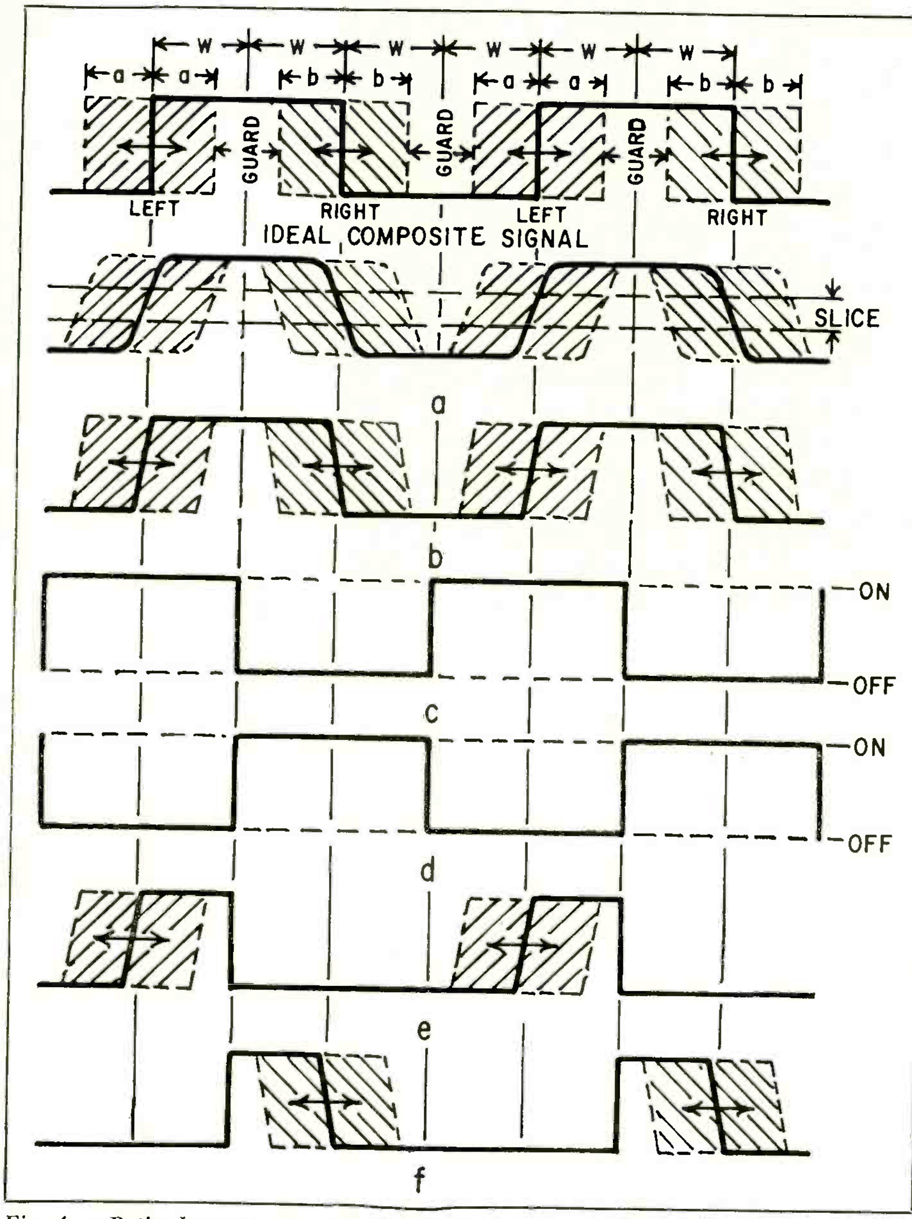


Fig. 4-a—Ratio detector output. b—"Sliced" signal. c, d—Channel gates. e, f—Result.

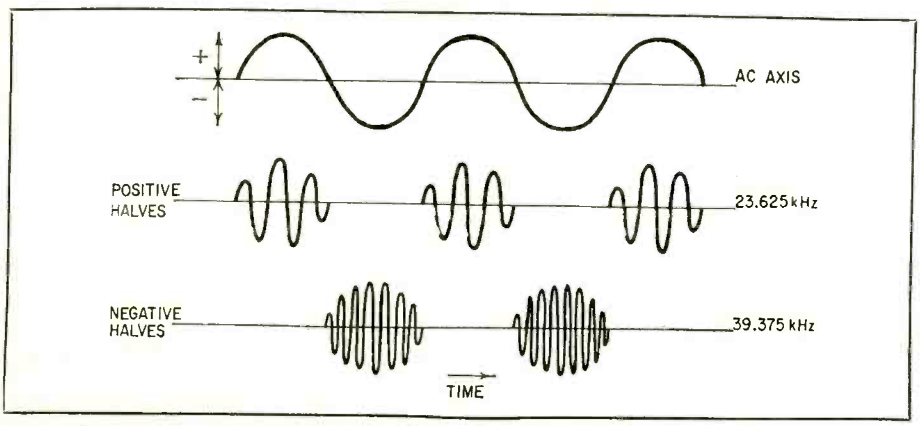


Fig. 5—How G-E splits the L—R signal and handles it on two subcarriers.

stage of video i.f. amplification and a separate video detector preceding the sound i.f. would free the sound i.f. carrier from video phase modulation and thus reduce buzz for both monophonic and stereophonic reception.

The Zenith approach

The system Zenith proposed uses a pulse-width modulation technique. Square waves at 31.5 kHz carry the signal. The leading edge of each square wave is modulated or timed by the left stereophonic audio signal, and the trailing edge by the right signal (Fig. 3). The complete square wave is then an L+R signal and the monophonic version of the signal can be recovered by an ordinary TV receiver. And of course the difference between the leading and trailing edges (the pulsewidth, in other words) represents the modulated left and right signals as L−R (see Fig. 3-b).

Detection is simple. A ratio detector demodulates the 4.5-MHz i.f. after limiting, and passes the modulated 31.5-kHz square wave to a gating circuit. (To reduce pulse noise, the signal may be amplitude-limited or "sliced," as indicated in Fig. 4-a. Fig. 4-b shows the slice enlarged.)

Gating (Figs. 4-c and 4-d) is controlled by a 31.5-kHz carrier generator, and produces the same result as an ordinary time-division demodulator circuit. Signals are separated as indicated by Fig. 4-e and 4-f, de-emphasized as in all stereo circuitry, and form the left- and right-channel signals.

Some compromises are made to maintain reasonable separation while keeping distortion below the level prescribed for monophonic TV sound broadcasting. The maximum frequency that can be separated properly is 8 kHz. Above that point the left and right signals blend into a monophonic output. Distortion at high modulation frequencies, according to Zenith's specifications, is something under 3.5%.

General Electric's stereo

G-E proposes a sum frequency (L+R) flat from 50 to 15,000 Hz and dropping to zero output at the horizontal frequency, 15,750 Hz. The difference (L−R) frequency would be flat from 50 to 5,000 Hz, and drop to zero at half the scanning frequency, 7,875 Hz.

The L−R signal is handled in an interesting way. The positive halves of the ac signal are modulated on a 23.625-kHz subcarrier; the negative halves on a 39.375-kHz subcarrier. Fig. 5 shows that one is centered at 1.5 times the horizontal scanning frequency, and the other at 2.5 times that frequency. So the two halves actually spread out in two directions from 31.5 kHz. Deviation is ±25

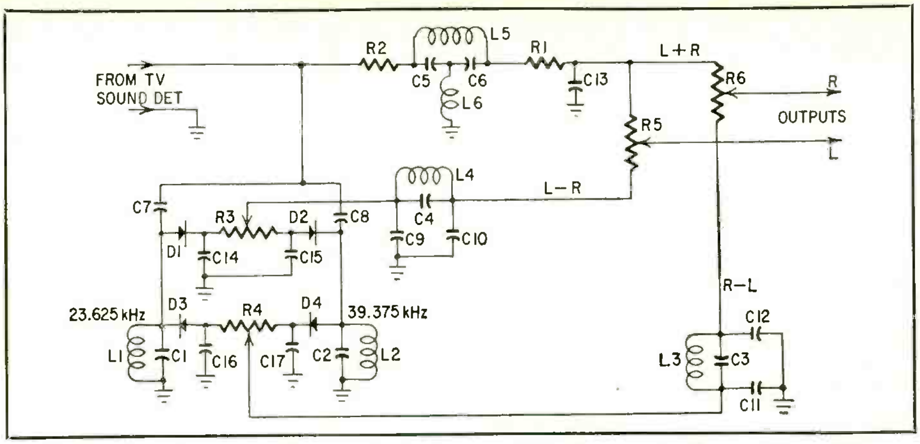


Fig. 6—The G-E stereo detector. Note the complete absence of tubes and transistors.

kHz for both L+R and L−R, and the subcarriers are suppressed to 40 dB below full output when no signal is being transmitted.

A detector (demultiplexer) circuit is shown in Fig. 6. Circuit L1, C1, C7 peaks at 23.625 kHz; circuit L2, C2, C8 at 39.375 kHz, L3, C3, C11 and C12 form a low-pass filter with a cutoff at 6,300 Hz and infinite attenuation near 7,875 Hz. L4, C4, C9 and C10 act as a similar filter. Bridged-T network L5, C5, C6, L6, R2 in the L+R line compensates for the phase delay encountered by the two L−R components in the low-pass filters just mentioned. C13, R1 is the de-emphasis circuit. L−R and R−L are recovered in the circuits that include R3 and R4 as well as D1 to D4 and C14 to C17. Pots R5 and R6 are adjusted for greatest separation. The output is taken from the sliders of the two potentiometers.

A somewhat similar, but simpler, circuit using a triode tube was also proposed. The output is L and −R, so the terminals of the R loudspeaker must be reversed to change −R to +R—a simple 180° phase shift.

The Philco system

Philco's proposal is the earliest of all. It was submitted to the FCC in February 1959, 2 years before standards were established for stereo FM.

As you might expect at that early date, the Philco technique is one of the less finished. The sound carrier would be modulated with an L+R signal in the frequency band from 30 to 7,000 Hz and an L−R signal from 8,750 to 15,750 Hz. The L+R and L−R signals combine at all frequencies below 500 Hz. The 15,750-Hz scanning frequency is the reference signal, as in later systems. The detector (Fig. 7) is an early time-division type. The R signal is in phase with the TV horizontal sync pulses. The filter shown is specified as being flat for frequencies up to at least 15.25 kHz. It is used to minimize sync and video buzz in the audio system.

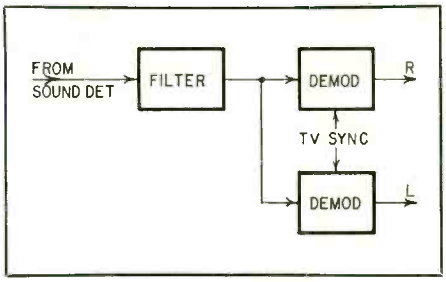


Fig. 7—Block diagram of Philco method.

To sum up

A number of the proposals commented extensively on the buzz problem. This, they pointed out, was caused by the nonlinear characteristic of the video carrier, due to its being located on the slope of the overall response curve of the receiver. An extra stage of composite i.f. amplification, with a bandwidth broad enough to put the video i.f. carrier on the flat portion of the overall i.f. characteristic, would reduce or eliminate this buzz. This was actually tried, and it worked as expected.

It appears that all the systems proposed have some limitations, in either audio bandwidth, separation, or some other factor, when compared with FM stereo broadcasting. This is to be expected, in view of the much narrower spectrum allotted to sound in the TV signal. Therefore, one system proposes a common low-frequency area with no stereo below 500 Hz. Another, in the interest of reducing distortion, limits the stereo effect to frequencies below 8,000 Hz.

Some of these proposals—you must remember—were made nearly a decade ago. At least one of the motives behind the recent move urging the FCC to go slow on stereo TV is the feeling that some of the proposed systems could be improved if they were resubmitted today.

The various plans do show a considerable amount of independent thinking, though, and some of the circuits may give readers ideas not directly connected with stereo TV sound. END

EQUIPMENT REPORT

EICO 378 Audio Generator

Circle 12 on reader's service card

THE EICO 378 AUDIO GENERATOR IS AN audio-signal source with extremely low distortion. It's an ideal generator for anyone who does even a little bit of serious audio design or measurement.

The 378 is the second generator of its type to appear on the market in kit form and at moderate price. What distinguishes it from the others is its digital frequency selection. Instead of a continuously-variable tuning dial, with decimal multiplying ranges selected by a switch, the Eico 378's frequencies are determined entirely by two 11-position rotary switches and one 4-position switch.

The two 11-position switches (numbered 0–10) select the two significant figures of the frequency, and the 4-position switch selects a decimal multiplier—1, 10, 100 or 1,000. Thus, it is possible to get frequencies at unit intervals. At the ×1 position of the multiplier switch, the range is from 1 to 110 Hz. At the ×10 setting, the range is scaled up by 10—going from 10 to 1,100 Hz. The remaining five multiplier positions scale up the frequency range by 100, then by 1,000, giving a top range of 110,000 Hz in increments of 1,000 Hz.

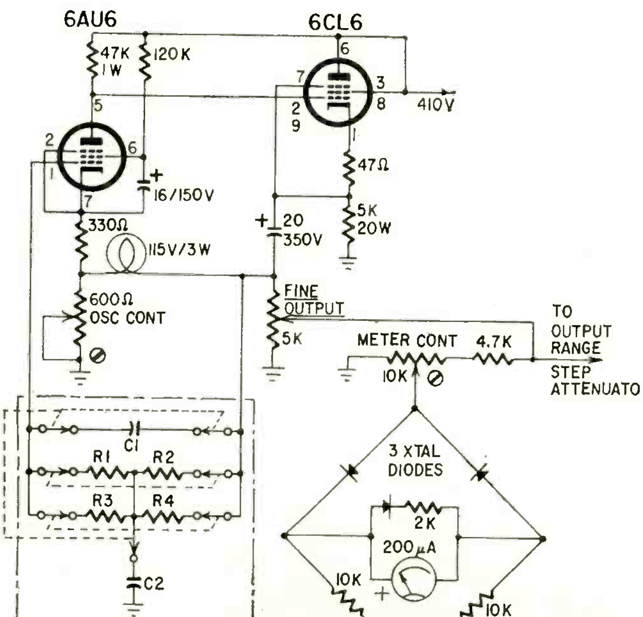
The increments get coarser as the range switch is moved to higher positions, but only in terms of absolute frequency; percentagewise, the increments stay the same. (The difference between 109 Hz and 110 Hz is 1 Hz, while the difference between 109 and 110 kHz is 1,000 kHz. The percentage difference is the same.) This switching scheme doesn't leave so many holes in the coverage as it might at first seem. We usually deal with frequency logarithmically. A 1-Hz frequency error in a musical pitch is pretty serious, while a 1-Hz error in a 100-kHz crystal frequency standard is an inaccuracy of only .001%, which is pretty fair.

The digital switching approach (see basic diagram) to frequency selection has one tremendous advantage over continuous rotation. It is extremely easy to return to a previously selected frequency within the accuracy capabilities of the generator. There can be no dial backlash, no parallax error from reading a dial scale off-axis. This is a great help in making accurate plots of frequency response or equalizer accuracy.

There are two kinds of work for which digital frequency selection is not ideal: (1) using the generator as a frequency meter for checking the cutoffs, notches, or resonances of audio-frequency filters; and (2) making rapid-rough checks of flatness of response.

Also, if both CYCLES switches were of the continuous-rotation (no stop) type, it would be possible to switch, for example, from 190 to 200 to 210 Hz without having to turn one of the switches back through all 10 positions between those frequencies. Besides increasing the wear on switches and knob inserts, running a switch back is a nuisance and time-waster. For those rough frequency-response *runs* on speakers and amplifiers, when I want to know only whether there are any gross dips or peaks in the response, I keep an Eico 377, with continuously variable capacitor tuning. It's also handy for finding speaker resonances—another job where continuous dial rotation is best.

The distortion of this generator is low enough for almost any high-quality audio work—below 0.1% total noise, hum and harmonics from 20 to 15,000 Hz (the limits of my measurements), and in the middle ranges as low as .02%. Flatness of frequency output response was only fair, though adequate; there was as much as 1.5-dB variation between some adjacent switch positions. This makes it



Introducing EICO's New "Cortina Series"!

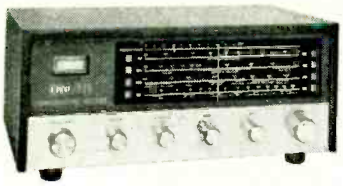
Today's electro-technology makes possible near-perfect stereo at moderate manufacturing cost: that's the design concept behind the new EICO "Cortina" all solid state stereo components. All are 100% professional, conveniently compact (3⅛"H, 12"W, 8"D), in an esthetically striking "low silhouette." Yes, you can pay more for high quality stereo. But now there's no need to. The refinements will be marginal and probably inaudible. Each is $89.95 kit, $119.95 wired.

Model 3070 All-Silicon Solid-State 70-Watt Stereo Amplifier: Distortionless, natural sound with unrestricted bass and perfect transient response (no interstage or output transformers), complete input, filter and control facilities, failure-proof rugged all-silicon transistor circuitry.

Model 3200 Solid-State FM/MPX Automatic Stereo Tuner: Driftless, noiseless performance, 2.4μV for 30db quieting. RF, IF, MX are pre-wired and pre-tuned on printed circuit boards — you wire only non-critical power supply.

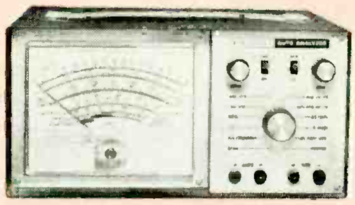
7 New Ways to make Electronics more Fun!

Save up to 50% with EICO Kits and Wired Equipment.



You hear all the action-packed capitals of the world with the **NEW EICO 711 "Space Ranger" 4-Band Short Wave Communications Receiver** — plus ham operators, ship-to-shore, aircraft, Coast Guard, and the full AM band. 550KC to 30MC in four bands. Selective, sensitive superhet, modern printed circuit board construction. Easy, fast pinpoint tuning, illuminated slide-rule dials, logging scale, "S" meter, electrical bandspread tuning, variable BFO for CW and SSB reception, automatic noise limiter. 4" speaker. Headphone jack. **Kit $49.95. Wired $69.95.**

More "ham" for your dollar than ever — with **the one and only SSB/AM/CW 3-Band Transceiver Kit, new Model 753** — "the best ham transceiver buy for 1966" — Radio TV Experimenter Magazine. 200 watts PEP on 80, 40 and 20 meters. Receiver offset tuning, built-in VOX, high level dynamic ALC, **silicon solid-state VFO.** Unequaled performance, features and appearance. Sensationally priced at **$189.95 kit, $299.95 wired.**



NEW EICO 888 Solid-State Engine Analyzer

Now you can tune-up, troubleshoot and test your own car or boat.

Keep your car or boat engine in tip-top shape with this completely portable, self-contained, self powered universal engine analyzer. Completely tests your total ignition/electrical system. The first time you use it — just to tune for peak performance — it'll have paid for itself. (No tune-up charges, better gas consumption, longer wear) 7 instruments in one, the EICO 888 does all these for 6V and 12V systems; 4, 6 & 8 cylinder engines.

The EICO 888 comes complete with a comprehensive Tune-up and Trouble-shooting Manual including RPM and Dwell angle for over 40 models of American and Foreign cars. The **Model 888** is an outstanding value at **$44.95 kit, $59.95 wired.**

New EICOCRAFT® easy-to-build solid-state electronic TruKits:® great for beginners and sophisticates alike. As professional as the standard EICO line — only the complexity is reduced to make kit building faster, easier, lower cost. Features pre-drilled copper-plated etched printed circuit boards, finest parts, step-by-step instructions, no technical experience needed — just soldering iron and pliers. Choose from: Fire Alarm, Intercom, Burglar Alarm, Light Flasher, "Mystifier", Siren, Code Oscillator, Metronome, Tremolo, Audio Power Amplifier, AC Power Supply. **From $2.50 per kit.**

There's more **PUNCH** in the **new EICO "Sentinel-Pro" 23-channel Dual Conversion 5-watt CB Transceiver.** New advanced Big-Reach **"Range Plus"** circuitry lengthens "talk-power" reach. Automatic noise limiter super-sensitizes for weak signals. "Finger Tip" antenna loading and transmitter tuning controls. 23 crystal-controlled transmit and receive channels — **all crystals supplied.** Rear-illuminated S/RF meter. Transistorized 12VDC and 117VAC dual power supply. **Wired only, $169.95.** Positive-Negative Ground/Mobile Marine Modification kit (optional) $5.95.

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. **$99.95 kit, $139.50 wired.**

FREE 1967 CATALOG

EICO Electronic Instrument Co., Inc.
131-01 39th Ave., Flushing, N. Y. 11352

Send me FREE catalog describing the full EICO line of 200 best buys, and name of nearest dealer. I'm interested in:

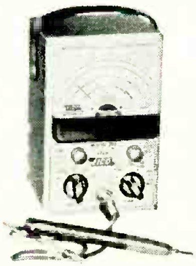
- ☐ test equipment
- ☐ ham radio
- ☐ stereo/hi-fi
- ☐ Citizens Band radio
- ☐ automotive electronics

Name ____________________

Address ____________________

City ____________________

State ____________ Zip ______



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.**

Circle 29 on reader's service card

necessary to keep an eye on the panel meter when running response measurements to make sure the input level to the amplifier stays the same.

The meter is large, clear, and easy to read. Its reading does not change with the output-attenuator switch, only with the FINE output control. For 1-volt output, you throw the attenuator switch to 1 VOLT, then set the FINE control so the meter reads 1 (full scale). For 25-mV output, you'd put the attenuator at the .03 position, then set the FINE control so the meter reads 2.5.

The step attenuator is accurate to within 5% when used either with the built-in 600-ohm load or an external 600-ohm load. A switch on the front panel removes the internal load if the generator is to be fed into a line that is already terminated in 600 ohms. The attenuator markings and meter calibrations hold on the .003- to 1-volt ranges only if the generator works into exactly 600 ohms—internal or external. On the remaining two attenuator positions (3 and 10 volts) the internal load is out of the circuit regardless of the position of the LOAD switch, and the generator should be fed only into loads 10,000 ohms or higher. Otherwise, output level falls and distortion rises.

If you like a large, handsome, imposing instrument, the Eico 378 is for you. Actually, the unit's massive construction (lots of steel) may account for its mechanical stability. The frequency and amplitude remained rock-steady when I banged on the cabinet (always an important test of any instrument).—*Peter Sutheim*

Dynaco Stereo 120 Solid-State Power Amplifier

Circle 20 on reader's service card

THIS IS AN AMPLIFIER THAT RADIO-ELECTRONICS tested with more than a little curiosity. Dynaco has a reputation for well-engineered, high-fidelity electronics at low prices. The company has refused to jump into the transistor-ampli-

fier market until good and ready, as they announced at the 1963 and 1964 New York hi-fi shows. They debunked the notion of "transistor sound" and disputed the claims that transistor amplifiers are more reliable than tube ampli-

continued on page 76

How To Save Up To $279 On A Guitar & Amplifier

Just Build One Of These Famous HARMONY-By-HEATHKIT® Guitars In An Evening – No Woodworking ...And Build The New HEATHKIT® Guitar Amplifier In 8-10 Hours!

A $300 Value! Only $129.95

B $329.50 Value! Only $219.95

C $158.50 Value! Only $119.95

D $145 Value! Only $99.95

No Special Skills Or Knowledge Needed
Now you can save up to $109.55 on a famous American-made Harmony electric guitar — plus another $170 on the new Heathkit transistor guitar amplifier — by assembling them yourself the easy Heathkit way.

And all you need are some ordinary tools and a few spare-time hours . . . no technical skills or knowledge are required. The famous Heathkit instructions (so simple a child can understand) and giant pictorials guide you every step of the way. Nothing is left to chance.

You'll have your guitar kit finished in one evening. To give you a head start, all the wood parts are preassembled, finished and buffed at the Harmony factory. You just mount the trim parts, pickups and controls in the pre-drilled holes and install the strings. All woodwork and mechanical parts guaranteed a full year.

Each guitar kit includes a handsome chipboard carrying case with plush lining, instruction book, tuning record, pick, connecting cord, and a cushioned leather neck strap.

The guitar amplifier kit will probably take you a couple of evenings. Only one small circuit board to wire (don't worry about soldering, the Heathkit manual shows you exactly how), plus a few parts to mount on the chassis, and two speakers, controls and switches to install. The cabinet is already prebuilt and finished. It's easy fun.

Full Details FREE — Liberal Credit Terms
Compare the features of each kit. For complete details, plus information on the convenient Heath Time-Payment plan send for the FREE Heathkit Catalog. Or better yet, use the coupon below to order your guitar and amplifier now!

A **Deluxe Transistor Guitar Amplifier Kit . . . All The Features Guitarists Want Most.** • 60 watts peak power — maximum power from Fail-Safe output circuit • Two channels — one for accompaniment, accordian, organ or mike, — the other for special effects with both variable reverb and tremolo • 2 inputs per channel • Two foot switches for hands-free control of tremolo & reverb • Two special design 12" heavy-duty speakers • Line bypass reversing switch for hum reduction • 28" W x 9" D x 19" H leather-textured black vinyl cabinet of ¾" stock • Extruded aluminum front panel
Kit TA-16, 44 lbs... Save $170 . . . . **Only $129.95**

B **Deluxe Hollow Body Electric Guitar . . . Three Golden Tone Pickups . . . Flat Wound Strings** • Double-cutaway style for easy fingering of all frets • Ultra-slim fingerboard—24½" scale • Ultra-slim, "uniform-feel" neck with adjustable Torque-Lok reinforcing rod • 3 pickups with individually adjustable pole-pieces under each string for emphasis and balance • 3 silent switches select 7 pickup combinations • 6 controls for tone and volume • Professional Bigsby vibrato tail-piece • Curly maple arched body with "F" holes — 2" rim — shaded cherry red • Engraved headpiece, matching pick guard
Kit TG-46, 17 lbs... Save $109.55 .. **Only $219.95**

C **"Rocket" Hollow Body Electric Guitar . . . Two Golden Tone Pickups** • Single cut-away style for easy fingering • Ultra-slim fingerboard . . . 24½" scale for easy chording • Ultra-slim neck, Torque-Lok steel rod reinforced • 2 pickups with individually adjustable pole-pieces for each string • Silent switch selects 3 combinations of pickups • 4 controls for tone and volume • Harmony type "W" vibrato tailpiece • Laminated maple Ultra-thin arched body with "F" holes, 2" rim, shaded cherry red • White plastic pick guard
Kit TG-36, 16 lbs... Save $38.55 ... **Only $119.95**

D **"Silhouette" Solid-Body Electric Guitar . . . Two Golden Tone Pickups . . . Modern Design** • Modified double cutaway leaves 15 frets clear of body for playing comfort and ease • Ultra-slim fingerboard of black rosewood — 24½" scale • Ultra-slim neck for "uniform feel" • Torque-Lok adjustable reinforcing rod • 2 pickups with individually adjustable pole-pieces under each string • 4 controls for tone and volume • Harmony type "W" vibrato tailpiece • 6-in-line tuning keys • Hardwood solid-body, 1½" rim, shaded cherry red • Extra large pick guard
Kit TG-26, 13 lbs... Save $45 . . . . . . **Only $99.95**

FREE!
World's Largest Electronic Kit Catalog
108 pages . . . describe these and over 250 kits you can build . . . stereo/hi-fi, color TV, electronic organs, radios, marine, home & hobby items. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

HEATHKIT®

Heath Company, Dept. 20-11
Benton Harbor, Michigan 49022
In Canada, Daystrom Ltd.

☐ Please send FREE Heathkit Catalog
☐ Enclosed is $________, plus shipping.
Please send model (s)________

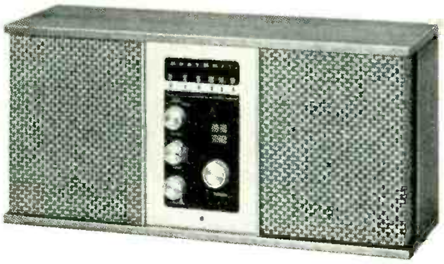
Name________
Address________
City________ State________ Zip________

Prices & specifications subject to change without notice. TG-100

Circle 33 on reader's service card

Now 9 New Kits From HEATH...

NEW! Deluxe Solid-State FM/FM Stereo Table Radio

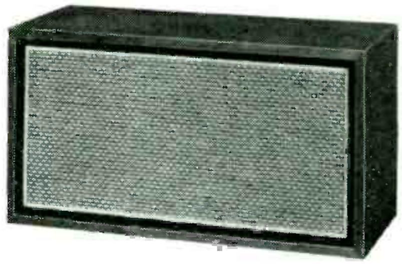


Kit GR-36
$69.95

Tuner and IF section same as used in deluxe Heathkit transistor stereo components. Other features include automatic switching to stereo; fixed AFC; adjustable phase for best stereo; two 5¼" PM speakers; clutched volume control for individual channel adjustment; compact 19" W x 6½" D x 9¼" H size; preassembled, prealigned "front-end"; walnut cabinet; simple 10-hour assembly. 24 lbs.

NEW! Compact 2-Way 2 Speaker System With Acoustic Suspension Design

Kit AS-16
$49.95



Handles 10 to 25 watts of program material. Features wide 45 to 20,000 Hz response; 8" acoustic suspension woofer with 6.8 oz. magnet; 3½" tweeter with 4.8 oz. magnet; high frequency level control; 8 ohm impedance; 1500 Hz crossover frequency; assembled walnut veneer cabinet has scratch-proof clear vinyl covering for easy cleaning. Measures 10" H x 19" W x 8½" D. Speakers are already mounted; just wire the crossover and connect cables — complete in one or two hours! 17 lbs.

NEW! Amateur Radio Single-Bander Transceivers ... New Features ... Choose 75, 40 or 20 Meters

Kit HW-12A
75-Meter
$99.95

Now features upper or lower sideband operation on all models; new deluxe styling; more convenient control locations; 200 watts P.E.P. input; single knob tuning with 2 kHz dial calibration; new ALC input for use with external linear amplifiers; improved audio and AVC response; crystal filter type SSB generation; built-in S-meter, VOX, PTT and ALC; fixed or mobile operation. 15 lbs. Kit HW-22A, 40-meter.. $104.95. HW-32A, 20-meter.. $104.95

NEW! Deluxe Amateur Station Console ... 4 Separate Units In One!

Kit SB-630
$74.95

Includes 24-hour clock, SWR meter, hybrid phone patch and an all-electronic 10-minute timer with audio/visual signaling in one compact unit. Matched in styling and performance with the famous Heath Deluxe SB-Series amateur radio equipment. Measures a compact 6" H x 10" W x 11⅛" D. 9 lbs.

NEW Heathkit® /Magnecord® 1020 4-Track Stereo Recorder Kit

Kit AD-16
$399.50
(less cabinet)

Save $170 By Doing The Easy Assembly Yourself
Takes around 25 hours. Features solid-state circuitry; 4-track stereo or mono playback and record at 7½ & 3¾ ips; sound-on-sound, sound-with-sound and echo capabilities; 3 separate motors; solenoid operation; die-cast top-plate, flywheel and capstan shaft housing; all push-button controls; automatic shut-off at end of reel; plus a host of other professional features. 45 lbs. Optional walnut base $19.95, adapter ring for custom or cabinet installation $4.75

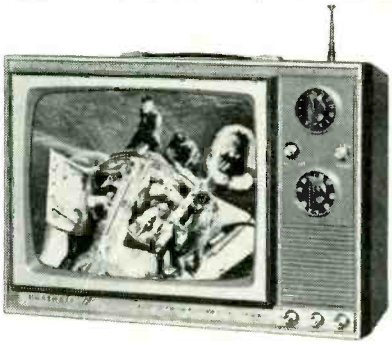
Now Play In Minutes Instead Of Months ... Heathkit® /Thomas COLOR-GLO Organ

Kit GD-325B
$394.90

Color-Glo Key Lights Show You the correct notes and chords . . . you play melody, harmony and bass notes instantly . . . even if you've never played an organ before! When you're finished, just flip a switch and the key lights disappear, leaving a beautiful spinet organ. Includes 10 voices, repeat percussion, 13-note bass pedals, two 37-note keyboards, assembled walnut cabinet & bench and more. Fully transistorized. Builds in around 50 hours and you save up to $150! 172 lbs.

Plus New FREE 1967 Catalog

NEW 12" Transistor Portable TV Kit



Kit GR-104
$119⁹⁵

First Kit With Integrated Circuit . . . replaces 39 parts! Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); preassembled, prealigned tuners; high gain IF strip; Gated AFC for steady, jitter-free pictures; assembles in only 10 hours. Cabinet measures 11½" H x 15¾" W x 9⅜" D. 23 lbs.

NEW Transistor Portable Phonograph Kit

Kit GD-16
$39⁹⁵

Worth At Least 50% More! And it sounds better. Assembles in just 1 to 2 hours . . . simply wire one small circuit board, mount the 4" x 6" speaker and plug in the preassembled changer . . . ideal beginner's kit. Features automatic mono play of all 4 speeds; dual Sapphire styli for LP's or 78's; 45 rpm adapter; olive and beige polyethylene over sturdy, preassembled cabinet. Operates on 117 v. AC. 23 lbs.

NEW Deluxe SB-301 Amateur Receiver Kit
NEW Deluxe SB-401 Amateur Transmitter Kit

Kit SB-301
$260⁰⁰
(less speaker)

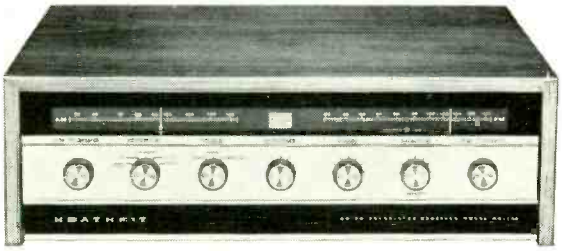
New SB-301 receiver for 80 Thru 10 Meters with all crystals furnished, plus 15 to 15.5 MHz coverage for WWV; full RTTY capability; switch-selected ANL; front-panel switching for control of 6 and 2 meter plug-in converters; crystal-controlled front-end for same tuning on all bands; 1 kHz dial calibrations — 100 kHz per revolution. 23 lbs. Matching SB-401 transmitter, now with front-panel selection of independent or transceive operation . . . $285.00

NEW 2-Watt Transistor Walkie-Talkie

Assembled GRS-65A
$99⁹⁵

Completely Assembled. Features 2 watts of power for up to 6 mile range . . . up to 10 miles when working a 5-watt CB rig; $20 rechargeable battery; 9 silicon transistor, 2 diode circuit; superhet receiver; adjustable squelch, ANL; aluminum case. 3 lbs. Optional 117 v. AC battery charger cord plus cigarette lighter cord $9.95. Crystals extra @ $1.99 each with order.

66-Watt Solid-State AM/FM/FM Stereo Receiver



Just Add 2 Speakers For A Complete Stereo System. Boasts AM, FM and FM stereo tuning; 46 transistor, 17 diode circuit for cool, instant operation and natural transistor sound; 66 watts IHF music power (40 watts RMS) at ± 1 db from 15 to 30,000 Hz; automatic switching to stereo; preassembled & aligned "front-end" & AM-FM IF strip; walnut cabinet. 35 lbs.

Kit AR-13A
$184⁰⁰

30-Watt Solid-State FM/FM Stereo Receiver

World's Best Buy In Stereo Receivers. Features 31 transistors, 10 diodes for cool, natural transistor sound; 20 watts RMS, 30 watts IHF music power @ ± 1 db, 15 to 50,000 Hz; wideband FM/FM stereo tuner; plus two preamplifiers; front panel stereo headphone jack; compact 3⅞" H x 15¼" W x 12" D size. Custom mount it in a wall, or either Heath cabinets (walnut $9.95, beige metal $3.95). 16 lbs.

Kit AR-14
$99⁹⁵
(less cabinet)

FREE!

World's Largest Electronic Kit Catalog!

Describes these and over 250 kits for stereo/hi-fi, color TV, amateur radio, shortwave, test, CB, marine, educational, home and hobby. Save up to 50% by doing the easy assembly yourself. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022

HEATHKIT

HEATH COMPANY, Dept. 20-11
Benton Harbor, Michigan 49022
In Canada, Daystrom Ltd.

☐ Enclosed is $________________, plus shipping.

Please send model (s)________________________

☐ Please send FREE 1967 Heathkit Catalog.

Name________________________________

Address______________________________

City________________State________Zip________

Prices & specifications subject to change without notice. CL-261

Circle 33 on reader's service card

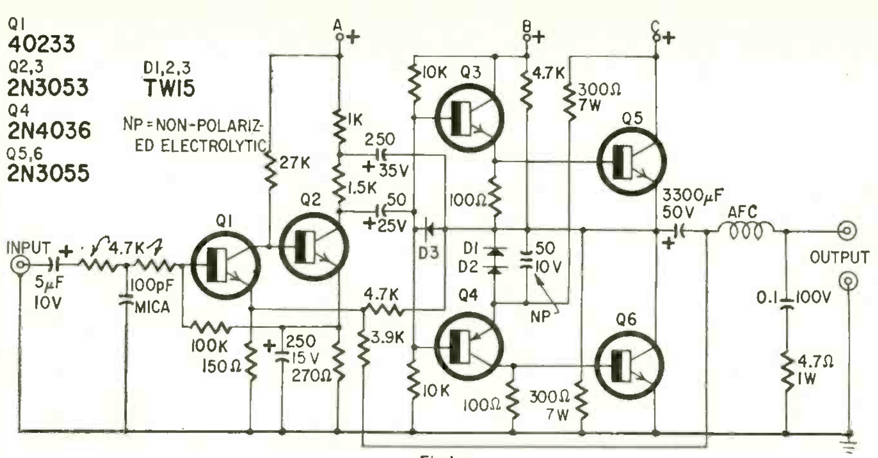


Fig. 1-a

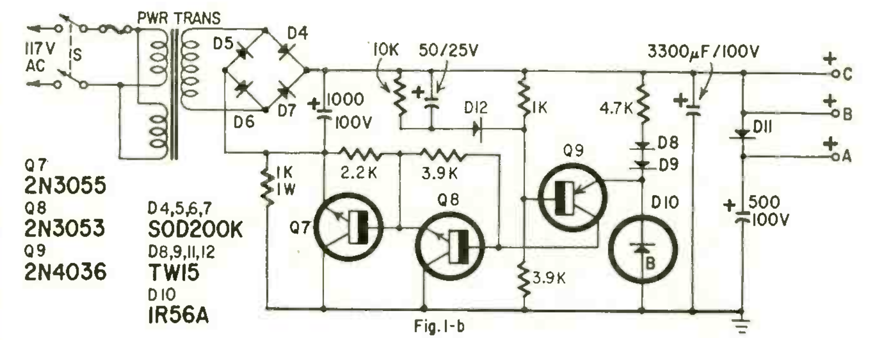


Fig. 1-b

EQUIPMENT REPORT continued

fiers and that they cost less. Dynaco's claim: For equivalent quality and reliability, a transistor amplifier must cost more than a tube amplifier.

Dynaco's long-awaited solid-state amplifier is called the Stereo 120, and it *does* produce 120 watts (60 watts per channel) in 4-ohm or 8-ohm loads. It's a power amplifier only (no controls or preamp) and can be bought in kit form for $160 or wired for $200. This, Dynaco points out, is just the price of two of its (tube) Mark III 60-watt mono power amplifiers.

Radio-Electronics used the Stereo 120 in a series of audience-perception tests which you'll be reading about in a later issue. The tests attempted to determine whether listeners can really perceive a difference between recorded or broadcast music reproduced through a very wideband system (one whose frequency response extends beyond the normally accepted limits of human hearing, roughly 20 to 16,000 Hz) and through a system whose response is limited to that range. As part of the procedure, the same signal (white noise in one series, music in another) was passed to a speaker alternately through the Dyna Stereo 120 and through a top-quality tube amplifier.

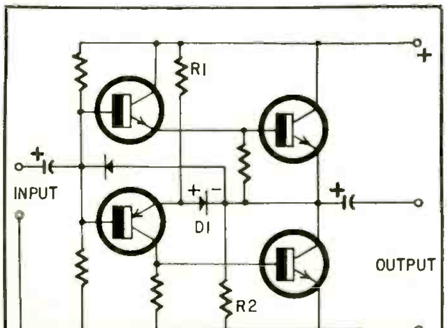


Fig. 2

The results were analyzed statistically. The listeners' judgements about which amplifier was being used were shown conclusively to be pure guesswork. The obvious conclusion is that the Dynaco Stereo 120 does not *sound* different in any way from the best available tube amplifier.

I compared the Stereo 120 with a Dyna Stereo 70, a 35-watt-per-channel tube amplifier. After setting the levels across the speakers to within ¼ dB, I switched quickly back and forth between the two amplifiers on approximately the same passage of music. There was a noticeable difference in favor of the 120. The test was not completely fair, because of the power-output difference.

The loudness difference between the two is barely perceptible. But when the two amplifiers are set to produce the same level, one may be operating near

Get this $65 RCA color TV course FREE

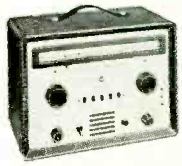
when you buy this

WR-64B RCA Color Bar/Dot/Crosshatch Generator

or this

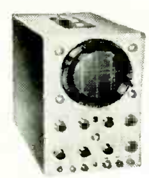
WR-69A RCA TV-FM Sweep Generator

or this



WR-99A RCA Marker Generator

or this



WO-91B RCA 5" Scope

That's right! RCA Institutes famous Home Study Color TV Servicing Course FREE, when you buy ANY ONE of the instruments shown here. Buy all four...get four courses. Enroll all your technicians while you equip your shop with the instruments you'll need for color TV servicing anyway.

Here's how it works: Simply buy one, or all, of the four instruments shown, the WR-64B, WR-69A, WR-99A, or WO-91B—ALL essential color TV test instruments—from your Authorized RCA Test Equipment Distributor between now and November 15, 1966. Fill out your warranty registration card and attach the white identification label on the carton. Send them to RCA, Test Equipment Headquarters, Bldg. 17-2, Harrison, New Jersey. We will send you the enrollment form and a binder containing the first two lessons. When you complete the lessons and forward them to RCA Institutes for grading, the next lessons will be supplied to you directly from RCA Institutes, all without charge to you.

But do it now. This offer is good only for equipment purchased between September 1, and November 15, 1966. To allow for postal delay, we will honor cards received up until December 1, 1966. Here's your chance to equip your shop for color servicing while we train your people for FREE!

Electronic Components and Devices, Harrison, N.J.

RCA

The Most Trusted Name in Electronics

its maximum output, possibly clipping peaks, while the other, at the same level, is still in some low-distortion middle range of power. The 120 sounded very clear, while the 70's sound came through a light curtain and was a wee bit muddier at times.

Measurements confirmed Dynaco's specifications. The 120 has the widest power bandwidth of any amplifier I've tested.

Another feature of the Dyna Stereo 120 is that its distortion does not increase at low power levels. It is not difficult to produce 50 or 60 watts at 1% harmonic distortion from a transistor amplifier. What is seldom listed in the specifications is the harmonic distortion at 1 watt, or 50 mW. At such levels, distortion is often 5 times higher because of *crossover distortion.* It's caused by class-B operation of output stages. Most hi-fi transistor amplifier distortion rises at low power levels. Not the 120, though.

The circuit of the Stereo 120 is not drastically different from many other "quasi-complementary-symmetry" designs—output transistors of the same "sex" (polarity) driven by a complementary-symmetry driver which is also a phase inverter. The amplifier is dc-coupled throughout, except that a giant electrolytic (3,300 μF) keeps dc out of the speaker voice coil. Fig. 1-a is the complete schematic of one channel. Fig. 1-b is the power supply.

Dynaco claims that, unlike other transistor amplifiers, the 120 is almost immune to damage by shorting or open-circuiting the output—even with full signal input. The protective circuit does not use circuit breakers or fuses. Instead, a novel biasing circuit for the driver and output transistors does the trick. Fig. 2 is a simplified circuit of the protective circuit.

The input bases are at one-half the supply potential as is the output which is taken at the junction of the output series pair. The output will follow the input through the signal cycle because any deviation between the output and input in also a deviation which varies the emitter potential of the pnp driver as compared to its base potential. Actually, there is a feedback connection from the collector of the lower output transistor back to the emitter of the pnp. This feedback tends to correct any difference between input and output potentials.

Thus the whole group of four transistors has no voltage gain, but it has an impedance transformation from high to low impedance. Its linearity is a function of the feedback path. Diode D1 is connected in this feedback path and is forced into conduction by the two bleeder resistors (R1 and R2).

However, when the current in the pnp is equal to the current in the bleeder resistors, D1 no longer conducts, the feedback path is broken, and the output no longer follows the input. Under conditions which require heavy drive current such as overload by input signal or excessive load on the output, the output transistors reach a current limit which is a function of their own Beta and the amount of bleeder current. Thus, the output current can be kept under a maximum which might be destructive.

D1 also serves to give forward bias on the transistors. In addition, its position forces a small dc offset between input and output. This has two effects: (1) The high-impedance input cannot drive the low-impedance load, and the drive is reduced. (2) The connection is regenerative in the sense that the output transistors become high-impedance devices (instead of remaining in their normal low-impedance state) which cannot pass high currents. The net result is that the current in the output transistors *decreases* under conditions which in other circuits would cause excessive current. Dynaco has applied for patents on this circuit.

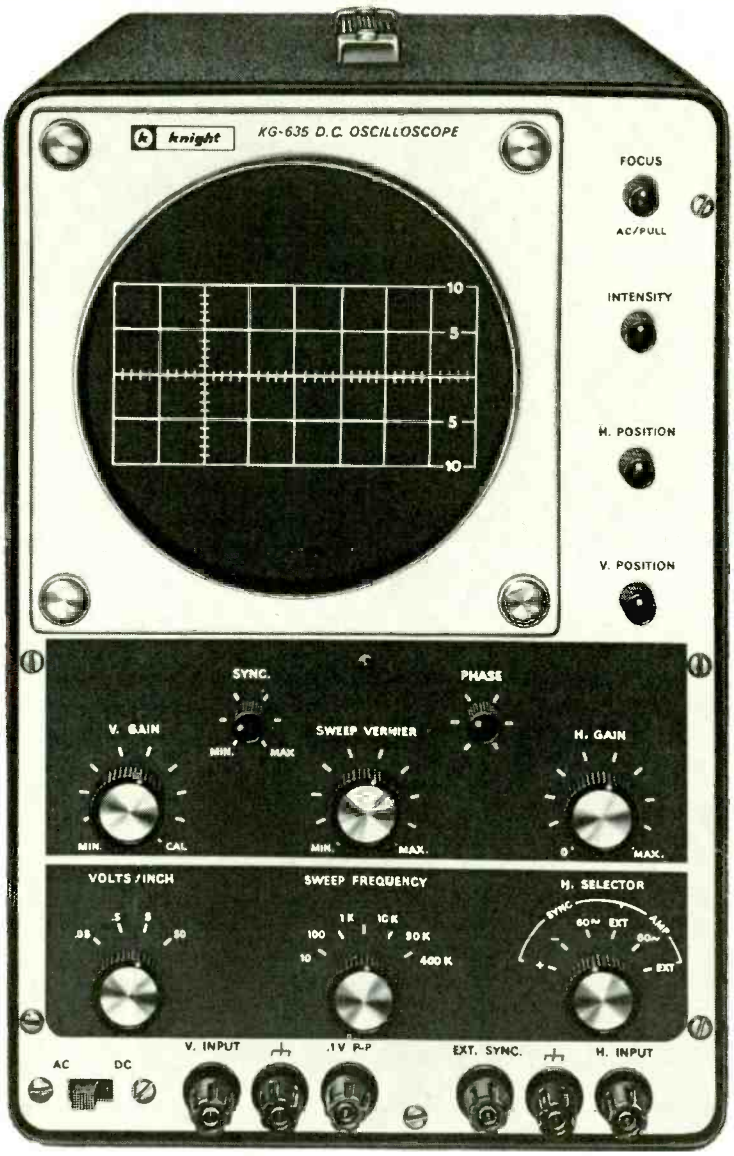
One of the design differences between the Stereo 120 and most other commercial transistor amplifiers is the use of a regulated power supply. This goes a long way toward insuring low distortion at high power levels with both channels driven, and allowing the amplifier to produce full power at 20 Hz and lower frequencies. The power-supply regulator is unique, and is the subject of another patent application.

The regulator provides a second overload protective circuit for the output transistors. Should a continuous-tone signal be applied to the amplifier to drive it to full output for a prolonged period, it is possible for the output transistors to draw excess current, overheat and be damaged. The regulated power supply prevents this. The supply's output impedance is zero or even slightly negative (voltage increases slightly as loading gets heavier) until a certain predetermined current drain is reached. Then the supply instantly cuts off, preventing the output transistors from destroying themselves under a severe overload.

The circuit, shown in Fig. 1-b, is an astonishingly simple one: a series-pass regulator (Q7, Q8, Q9) that uses both positive and negative feedback. Most such regulators use only negative feedback, as a way of getting low or nearly zero output impedance (no change in voltage with a finite change in load current) over a certain range of load values. This one uses a combination of negative *voltage* feedback and positive *current* feedback. Both reduce effective output impedance. The

Don't just take our word for it...

READ WHAT THE EXPERTS HAVE TO SAY ABOUT THE knight-kit® KG-635 5-inch DC to 5.2 Mc OSCILLOSCOPE KIT



Read the unique money-back guarantee below . . . exclusive in the industry . . . then mail the coupon at right for full details and Special Introductory Offer.

KNIGHT-KIT GUARANTEE

Build a Knight-Kit in accordance with our easy-to-follow instructions. When you have completely assembled the kit, you must be satisfied or we will return your money, less transportation charges, under the Allied guarantee of satisfaction.

ALLIED RADIO

From May, 1966, RADIO-ELECTRONICS: "This is a real-solid, honest-to-gosh kit! The instructions are superb. This scope is about as close as you can get to a "professional" or "lab" scope . . . The sweep circuit is a sophisticated one with amplified, polarity-switchable sync . . . The trace is bright enough for most shop applications . . . The kit was a joy to build . . . All parts, structural, mechanical, electronic, were obviously of good quality and everything fit together perfectly."

From November, 1965, ELECTRONICS WORLD: "Midway between the low-cost simple, general-purpose scope and the expensive, elaborate laboratory scope lies a class of instrument called a "wide-band service scope." The new Knight-Kit KG-635 is just such an instrument. A sync limiter circuit keeps the trace steady at just about any input signal level that the scope can handle. Also contributing to the stability of the waveforms on the 5-inch CRT is the use of polystyrene and Mylar capacitors in the sweep-generating circuits. All in all, the instrument is well-engineered and a very worthwhile addition to the bench."

Yes, the Knight-Kit KG-635 5-inch Wideband Oscilloscope handles virtually every service and test requirement. Exceeds the critical demands of color TV for fast profitable servicing.

The unique Knight-Kit dynamic sync limiter assures uniform traces. Five linear time base ranges provide wide versatility. Calibrated vertical attenuator directly reads volts-per-inch. Polystyrene and Mylar capacitors assure sweep stability. Sharp, bright displays with 1650-volt potential on CRT. Auto astigmatism correction. Easily and quickly calibrated without extra equipment and without removing from case.

Complete with all parts, tubes, CRT, case, instructions and assembly manual . . . $109.95

Available factory assembled for $159.95

ALLIED RADIO, Knight-Kit Div.
Dept. 2-LL, P.O. Box 8528
Chicago, Illinois 60680

Please rush—FREE and without obligation—full details and Special Introductory Offer on **Knight-Kit KG-635 Oscilloscope Kit.**

Name________________________
PLEASE PRINT

Address________________________

City__________State__________Zip________

Circle 37 on reader's service card

feedback is normally governed by Zener diode D10.

If the load current rises above a predetermined maximum value, the Zener diode is "starved" and becomes a high impedance. Positive feedback then predominates, and the circuit suddenly snaps into a high-impedance "deregulator" state between the power supply and the load. The voltage and current fall to some very small value until the excessive load is removed. When it is, the amplifier instantly resumes normal operation, without the need for resetting a circuit breaker. Because of the high impedance of the "deregulator," little current flows through it and little power is dissipated in it or in the load.

I didn't get to try the kit, but I did inspect the construction of the early production model RADIO-ELECTRONICS received for testing. All stages except the output of each channel are on etched circuit boards, so there's little chance of trouble there. There is a lot of open space inside the chassis in the finished amplifier—one gets the impression that the 120 could have been compressed into about two-thirds the space—so wiring should be very easy. There are minor details of mechanical assembly that hint of having been conceived by a person with skinny fingers on three hands, but nothing in comparison to, say, stringing a dial cord in a tuner kit.

Speaker connections are made to twin binding posts which, being recessed, are not too easy to use. Since the ordinary owner will probably connect them once and never again, this is not a serious problem. They do have the advantage of being spaced ¾ inch apart. This makes it possible to plug in dual banana plugs for lab applications.

Nice job. The Stereo 120 should continue Dynaco's excellent reputation for moderately priced high-quality sound.—*Peter E. Sutheim*

MANUFACTURER'S SPECIFICATIONS

Power bandwidth: (3-dB power points) for 0.5% total harmonic distortion: 5 Hz to 50 kHz
Harmonic distortion: less than 0.25% at any power up to 60 watts (per channel) at any frequency from 20 Hz to 20 kHz
Intermodulation: less than 0.15% at any power up to 60 watts, with any combination of test frequencies
Noise: 95 dB below rated output, unweighted
Separation: better than 70 dB from 20 Hz to 20 kHz
Damping factor: about 40 with 8-ohm loads from 20 Hz to 20 kHz
Input: 100K; 1.5 volts for 60 watts output
Size: 13 x 10½ x 4 in.
Weight: 20 lb
Price: $159.95 kit, $199.95 wired

END

Radio-Electronics Adopts Hertz

RADIO-ELECTRONICS is now using the term *hertz* in place of cycles in all references to frequency. Hz, kHz and MHz, abbreviations for hertz, kilohertz and megahertz, are replacing cycles, kc and mc in all recently edited material.

What you don't know about TV, Transistors & Test Instruments, may be costing you a promotion or a pay raise!

Here is an extraordinary offer to introduce you to Gernsback Library's famous Electronics Book Club, specially designed to help you increase your know-how and earning power.

WHY SHOULD YOU JOIN!

Whatever your interest in electronics—radio and TV servicing, audio and hi-fi, industrial electronics, communications, electronics as a hobby—you'll find that the Electronics Book Club will help you get the job you want, keep it, improve it, or make your leisure hours more enjoyable. By broadening your knowledge and skills, you'll build your income and electronics enjoyment as well.

WHAT BOOKS ARE OFFERED?

From Gernsback Library and other leading publishers come the country's most respected books in the field of electronics. All are deluxe, hard-covered books of permanent value, offered at considerable cash savings to members, regardless of higher retail prices.

HOW THE CLUB WORKS

The Electronics Book Club will send you, every other month, the News Bulletin describing a new book on a vital area of electronics. As a member, *you alone* decide whether you want a particular book or not. You get 3 books now for $1.99 and need take only 4 more within a year, from a wide selection to be offered. And the Club *saves you money* on the books you take, regardless of higher retail prices.

HOW TO JOIN

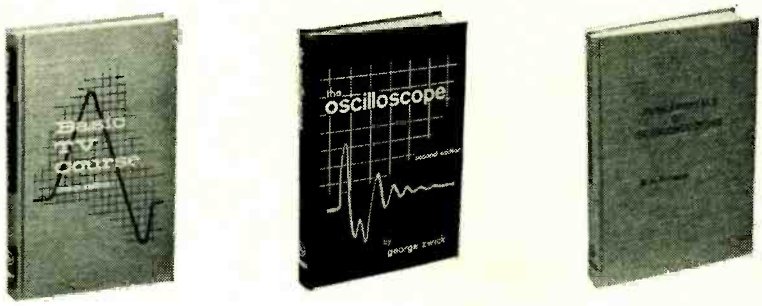
Simply mail the coupon today. You will be sent your three handbooks—BASIC TV COURSE, FUNDAMENTALS OF SEMICONDUCTORS and THE OSCILLOSCOPE (regular retail price $15.55). We will bill you $1.99 (plus a few cents postage). If you are not pleased with the books, send them back within 10 days and membership will be cancelled. Otherwise you will enjoy these benefits:

- ★ Get three books immediately for $1.99 (regular $15.55 value).
- ★ Free 10-day examination privilege.
- ★ Continuous cash savings.
- ★ Free charts and reports given with many books.
- ★ You alone decide which books you want. Books are returnable.
- ★ Club Books are practical working tools, written by experts.

Get these three income-boosting books . . . a $15.55 value

only $1.99

by joining the Electronics Book Club today!



BASIC TV COURSE

By George Kravitz. Perfect introduction to TV, in clear, non-mathematical language. Starting with the forming of the picture, the book shows how the picture tube works, the television signal, the television receiver, antennas and tuners, how the video IF works, the video detector and AGC, the video amplifier at work, how the sync section works, horizontal output and high voltage supply, how the sound section works, how transistor portable TV's work. 224 pages, completely illustrated. Retail Price $5.75.

FUNDAMENTALS OF SEMICONDUCTORS

By M. G. Scroggie. Provides a complete background in semiconductor devices, beginning with basic facts on electrical conduction through transistors, rectifiers, photoelectric devices, thermistors, varistors, diodes, cryosars, etc. Supplies enough theory in a simple way to make it possible to understand more advanced literature. Also explains how the special properties of semiconductors are being applied in many kinds of useful devices. Dozens of charts, diagrams and photos. 160 pages. Retail Price $4.60.

THE OSCILLOSCOPE

By George Zwick. (Revised Edition). Teaches you how to operate the scope. how to use it for alignment and shows you how to solve every type of service testing problem you are likely to encounter. Demonstrates how to interpret waveforms correctly, how to use scope probes, how to measure low input voltages, how to perform specific experiments using the oscilloscope, etc. 224 illustrated pages. Retail Price $5.20.

Gernsback Library, Inc., Electronics Book Club, Dept. RE 116

154 West 14th Street, New York, N.Y. 10011

Please enroll me in the Electronics Book Club and send me the 3 income-boosting handbooks: BASIC TV COURSE; FUNDAMENTALS OF SEMICONDUCTORS; THE OSCILLOSCOPE. Bill me only $1.99 plus shipping (for this $15.55 value). If not pleased, I may return the books in 10 days and this membership will be cancelled.

As a member, I need only accept as few as 4 additional books a year—and may resign any time after purchasing them. All books will be described to me in advance, every other month, in the Club Bulletin, and a convenient form will always be provided for my use if I do not wish to receive a forthcoming book. You will bill me the special Club price for each book I take (plus a few cents postage)—regardless of higher retail prices. Offer good in U.S.A. and Canada only.

Name ....
(Please Print)

Address ....

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

☐ SAVE: Enclose your $1.99 now with this coupon and we will pay postage. Same return guarantee privilege; prompt refund if not satisfied.

The following free advertising material is available through

RADIO-ELECTRONICS READER'S SERVICE

AMPEREX ELECTRONIC CORP. (Second Cover) **Circle 7**
Information on Amperex replacement electron tubes.

AMPLIFIER CORP. OF AMERICA (Pg. 70) **Circle 30**
Complete specifications and free 12-page booklet on flutter.

ARROW FASTENER CO., INC. (Pg. 88) **Circle 114**
Information on automatic staple guns.

BROOKS RADIO & TV CORP. (Pg. 100-101) **Circle 124**
Information sheets and price list of tubes and parts.

BURSTEIN-APPLEBEE CO. (Pg. 99) **Circle 123**
Catalog.

CASTLE TV TUNER SERVICE, INC. (Pg. 14) **Circle 15**
Information on complete tuner overhaul by mail.

CITADEL RECORD CLUB (Pg. 7) **Circle 11**
Details on Record Club.

CLEVELAND INSTITUTE OF ELECTRONICS (Pg. 1) **Circle 8**
Booklet describing Electronics Slide Rule and Electronics Data Guide.

CORNELL ELECTRONICS CO. (Pg. 110) **Circle 133**
Catalog and price list of tubes and parts.

DELTA PRODUCTS, INC. (Pg. 95) **Circle 121**
Literature and complete technical data on Mark Ten SCR capacitive discharge ignition system.

DE VRY TECHNICAL INSTITUTE (Pg. 5) **Circle 9**
Free booklets, "Pocket Guide to Real Earnings," and "Electronics in Space Travel."

DYNACO, INC. (Pg. 80) **Circle 36**
Complete specifications on Dynaco Stereo 120.

EASTMAN KODAK CO. (Pg. 23) **Circle 22**
Information and booklet, "Plain Talk from Kodak about Sound Recording Tape."

EICO ELECTRONIC INSTRUMENT CO. (Pg. 69) **Circle 29**
1967 catalog.

ELECTRO-VOICE, INC. (Pg. 76) **Circle 34**
Technical data on Electro-Voice products.

ELPA MARKETING INDUSTRIES INC. (Pg. 86) **Circle 108**
Information on EDItabs.

THE FINNEY COMPANY (Pg. 27) **Circle 26**
Information on 75-ohm Color Ve-Log Antennas.

GARRARD (Pg. 22) **Circle 21**
Complimentary copy of Comparator Guide describing all models.

HEALD'S ENGINEERING COLLEGE (Pg. 105) **Circle 129**
Catalog and registration application.

HEATH CO. (Pg. 71-75) **Circle 33**
Information on 9 new kits from Heath and 1967 catalog.

INTERNATIONAL CRYSTAL MFG. CO. (Pg. 112) **Circle 135**
Information on the MO-23 transceiver.

INTERNATIONAL RADIO EXCHANGE (Pg. 86) **Circle 109**
Complete list of equipment in stock.

JACKSON ELECTRICAL INSTRUMENT CO. (Pg. 26) **Circle 25**
Complete catalog.

JENSEN MFG. CO. (Third Cover) **Circle 136**
Information on X-40 ultra-compact loudspeaker system.

JERROLD ELECTRONICS CORP. (Pg. 17) **Circle 19**
Information on Paralog Plus Antenna.

KNIGHT-KIT DIV., ALLIED RADIO CORP. (Pg. 81) **Circle 37**
Full details and special introductory offer on Knight-Kit KG-635 Oscilloscope kit.

LAFAYETTE RADIO ELECTRONICS CORP. (Pg. 93-94) **Circle 120**
Catalog.

MUSIC ASSOCIATED (Pg. 90) **Circle 117**
Information on Sub Carrier Detector for "music only" programs on FM Broadcast Band.

OLSON ELECTRONICS INC. (Pg. 87) **Circle 111**
Catalog.

PERMA-POWER CO. (Pg. 89) **Circle 115**
Information on VU-Brites and TU-Brites.

PERMOFLUX CORP. (Pg. 86) **Circle 107**
Information on Permoflux headphones.

PIONEER ELECTRONICS (Pg. 15) **Circle 16**
Information on speakers and speaker systems.

POLY PAKS INC. (Pg. 111) **Circle 134**
Catalog on semiconductors, Poly Paks and parts.

PRECISE ELECTRONICS (Pg. 90) **Circle 118**
Information and specs on complete power supplies, scopes, VTVM's, signal generators, tube testers, decade boxes, probes.

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.

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 listing 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, or use the convenient checking list in the column at the left.

3. Mail the card to us (no postage required in U. S. A.)

QUAM-NICHOLS CO. (Pg. 68) **Circle 28**
Information on speakers.

QUIETROLE CO. (Pg. 70) **Circle 31**
Information on TV and radio lubricants and cleaners.

RYE SOUND CORP. (Pg. 99) **Circle 122**
Information on tape file.

S & A ELECTRONICS, INC. (Pg. 91) **Circle 119**
Information on Free Space Standing Wave Magnetic antenna.

SAMS, HOWARD W., CO. INC. (Pg. 85) **Circle 106**
Booklist.

H. H. SCOTT, INC. (Pg. 67) **Circle 27**
1967 catalog of stereo components.

SENCORE (Pg. 88) **Circle 113**
Information on Sencore CG10 Lo-Boy and CG138 Lo-Boy standard color bar generator.

SHURE BROTHERS, INC. (Pg. 88) **Circle 112**
Literature on High Fidelity Phono Cartridges.

SOLID STATE SALES (Pg. 109) **Circle 132**
Catalog.

SONY CORP. OF AMERICA (Pg. 6) **Circle 10**
Information on recording tape.

SONY CORP. OF AMERICA (Pg. 25) **Circle 24**
Information on model nos. TA-1120 & TA-3120 transistorized amplifiers.

SPRAGUE PRODUCTS CO. (Pg. 16) **Circle 18**
Comprehensive Electrolytic Capacitor Replacement Manual K-107.

SUPEREX ELECTRONICS (Pg. 70) **Circle 32**
Information on Superex headphones.

SURPLUS CENTER (Pg. 106) **Circle 130**
3 catalogs.

TEXAS CRYSTALS (Pg. 87) **Circle 110**
Catalog with circuits.

TURNER MICROPHONE CO. (Pg. 24) **Circle 23**
Information on the +2 microphone with volume control.

UNITED RADIO CO. (Pg. 108) **Circle 131**
Complete parts catalog.

UNIVERSITY SOUND (Pg. 78) **Circle 35**
Information and application data for CS-2 weatherproof sound column.

WARREN ELECTRONIC COMPONENTS (Pg. 102) **Circle 126**
Information on silicon rectifiers.

WINEGARD CO. (Pg. 105) **Circle 128**
Information on TV antenna pre-amps.

NEW PRODUCTS

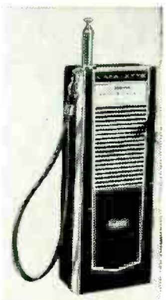
More information on new products is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 82 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card. Hz = hertz = cycles per second; kHz = kilocycles; MHz = megacycles

GUITAR AND AMPLIFIER KITS, *models TG-46, TG-36, TG-26* guitars and *model TA-16* amplifier. *TG-46* is electroacoustic, double cutaway, 3 pickups with a switch and tone volume control for each, Bigsby tailpiece (for "bending" notes).

TG-36 is electroacoustic, cutaway, 2 pickups with separate tone and volume controls for each, but common switch. *TG-26* is solid-body free-form profile, same electronic features as *TG-36*. All 3 have steel-rod-reinforced neck, come with strings, case, accessories. *Model TA-16* amplifier, 13 transistors, 2 diodes, 60-watts (peak) COP, 2 channels, one with tremolo and reverberation, 2 inputs per channel. 2 heavy-duty 12-inch speakers, 2 footswitches for tremolo and reverb. 120/240V, 50-60 Hz.—**Heath Company.**

Circle 46 on reader's service card

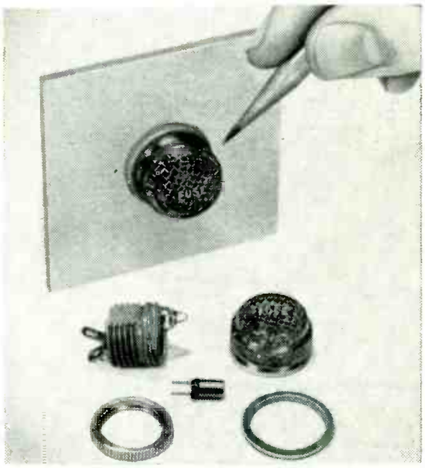
HIGH-POWER CB WALKIE-TALKIE, *model HA-711,* 3 channels, 1-watt input power. 12-transistor, 2 diode circuit. Temperature-compensating components. Earphone jack, external antenna jack and telescoping antenna. Eight size-Z penlight cells, carrying strap, earphone. Comes with FCC license form 505 and pair of crystals for channel 11. Modified model available for government frequency 27.575 MHz or C.A.P. frequency of 26.62 MHz.



3 x 8 x 1¾ in., 2½ lb.—**Lafayette Radio Electronics Corp.**

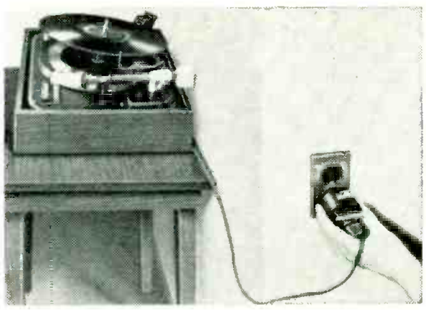
Circle 47 on reader's service card

RFI SHIELDED MICROFUSE HOLDER, (*Q.P.L.*) *FHL44G 1-6 and FHL45G,* with mesh impregnated molded plastics lens and mesh imbedded silicon gasket. Eliminates possible rf leakage from



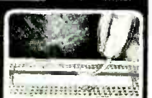
equipment itself. Indicating light in amber lens goes on when fuse blows. Voltage ratings from 2½-130 volts. Holder extends approx. ⅝ in. from mounting surface. Lens ¾ x ½ in. Terminals for circuit interconnection provided.—**Littelfuse**

Circle 48 on reader's service card



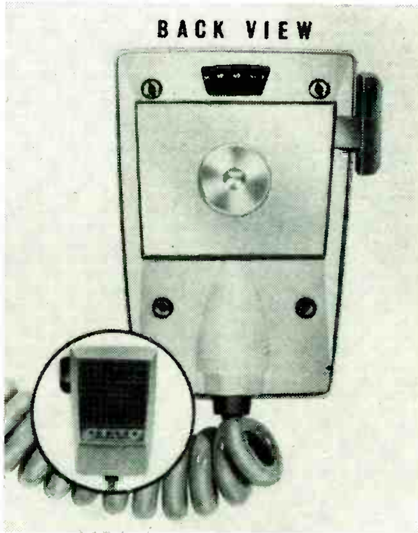
ELECTROCHEMICAL ELAPSED-TIME METER, *model 550-TP2-X,* for high-fidelity, appliance, office use. Operates from the secondary of saturable transformer. Mounted in epoxy-encapsulated nylon package, plugs directly into 115-Vac outlet. Device to be timed plugs into meter. Records only when appliance is turned on. Timer operates from current signal; eliminates internal wiring changes. Special models include red-line warning

Circle 106 on reader's service card



signals for phonograph needles, tape heads. Meter uses a mercury microcoulometer. Operating range: 0.25–15 amps for 500–5,000-hr scale; 0.75–15 amps for 50-500 hr. Accuracy: ±4%. Maximum voltage drop: 1 volt at 15 amps; minimum operating time: 100 msec. Operating temperatures: −20°C to +85°C; stores at −35°C. Reusable by resetting to zero.—**Curtis Instruments, Inc.**

Circle 49 on reader's service card



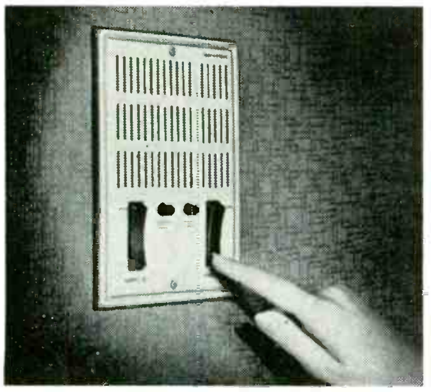
MOBILE TYPE MICROPHONE, the M+2, for mobile transceivers that need extra or variable output. Volume control on back of case adjusts output level. Self-contained 2-transistor preamp. Voice response range: 300–3,500 Hz. Battery, dash bracket, 5-ft coiled cord. Electronic switching model also available.—**Turner Microphone Co.**

Circle 50 on reader's service card

COMPACT STEREO SYSTEM, *models 2501, 2502, 2503*. 3-speed automatic turntable, magnetic cartridge, diamond stylus. Direct-coupled all-silicon output circuitry; microphone/guitar mixer input, controls. Facilities for plugging in tape recorder, tape cartridge machine; headphones or extra speakers. Dual loudness, bass, treble; speaker balancing control, tape monitor control. *Model 2502* has field-effect transistor AM/FM stereo tuner, automatic stereo switching, stereo indicator light; precision signal-strength meter. *Model 2503* includes extended-range speakers, removable grilles. Frequency response: 18–25,000 Hz. Music power: at 4 ohms, 36–40 watts. *2501, 2502* measure 15½ x 16⅝ x 4⅝ in., speakers: 14 x 8⅝ x 6 in. *2503* measures 15½ x 16⅝ x 8⅝ in., speakers: 23½ x 11¾ x 9 in.—**H. H. Scott, Inc.**

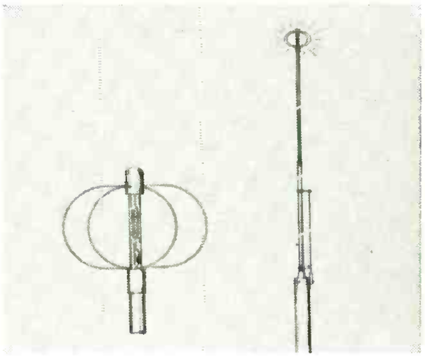
Circle 51 on reader's service card

APARTMENT-HOUSE INTERCOM SYSTEM, *model TA-2,* features 2 independent door-opener buttons. Connects to pushbutton in front and service vestibules; can be used with external signals such as chimes. Individual volume selector. Built-in fanning strip, factory-



supplied treminal block. Accommodates either ½- or ¾-in. conduit, or both. 4$^{13}/_{16}$ x 7$^{3}/_{16}$. Operates with Talk-A-Phone *TA-R* or *TA-S* Vestibule Intercom unit.—**Talk-A-Phone Co.**

Circle 52 on reader's service card



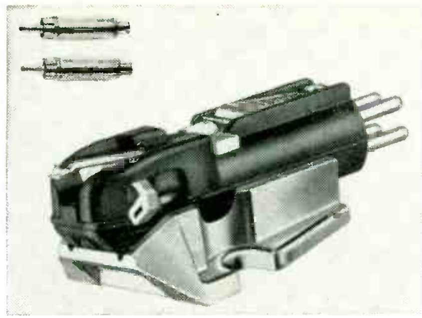
CB BASE ANTENNA, the *Speakin' Beacon,* 27-MHz omnidirectional coaxial antenna. Permanent-circuit neon light built into tip. When transmitter is keyed, tube glows, verifies rf output. "Statilight" ball around tube dissipates static electricity. Withstands 80-mph wind; contains built-in lightning protection. Low angle of radiation; gamma matched, has low VSWR. Heavy-gauge polished aluminum. 19 ft, 3 in.—**Antenna Specialists Co.**

Circle 53 on reader's service card

SOLID-STATE STEREO CARTRIDGE, the *Velocitone Mark V,* piezoelectric construction. Response: 20–20,000 Hz. Tracks at less than 2 grams; vertical

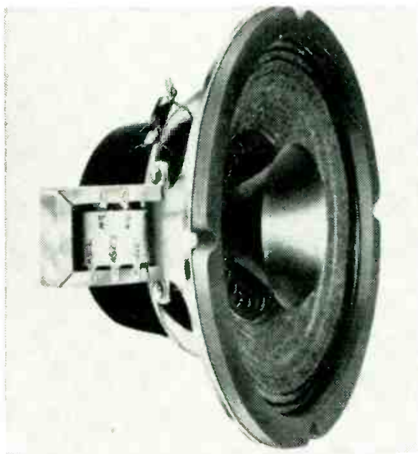
Circle 110 on reader's service card

Circle 111 on reader's service card



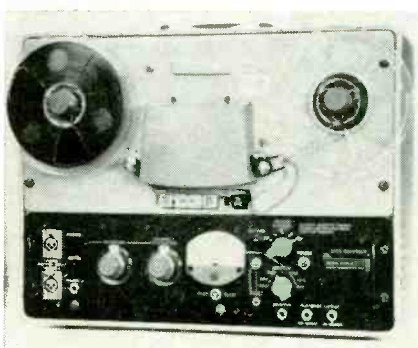
stylus force: 1.5–2.5 grams. Compliance: 15×10^{-6} cm/dyne. Sensitivity at 1-kHz output point (with matched networks) for either channel: 6 mV. Integrated mounting bracket fits standard changers and professional pickup arms. Weighs 1.5 grams. *Sonoflex* diamond needles.—**Electronic Products Div., Singer Products Co., Inc.**

Circle 54 on reader's service card



PAGING AND TALK-BACK SPEAKER, *models DLC and DLC-T*. Front-loaded compression cone driver with single reflex baffle. Mounting bracket adjustable over 180°. Power-handling capacity: 6 watts (music power); frequency response: 400–10,000 Hz. Speaker provides 120° dispersion with sound pressure level of 104 dB. Impedance: can be specified for 8 or 45 ohms. *DLC-T* has adjustable power taps for 25- and 70-volt lines. Speaker diameter 5⅞ in. Overall length of *DLC*, 4 in.; of *DLC-T*, 6⅛ in. Spun aluminum housing, baked acrylic finish.—**University Sound.**

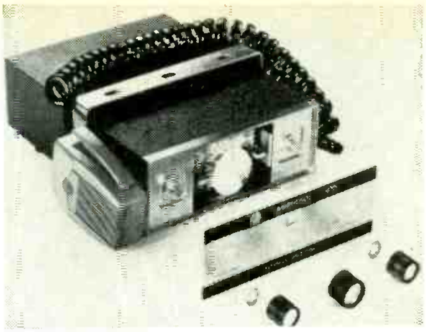
Circle 55 on reader's service card



ACOUSTICAL MEASUREMENT TAPE RECORDER, *type 1525-A*. 2

channels. Records on-site noise signals, intermittent or short-duration noise; reverse playback inverts time scale. Source of prerecorded test signals; one channel applies signals, other records system's output. Frequency response: at 7½ ips ± 3 dB, 15 Hz–16 kHz; at 15 ips, ± 2 dB, 50 Hz–15 kHz. Input-level range, with ceramic microphone: 34–140 dB. NAB and standard sound-level meter weighting characteristics also available.—General Radio Co.

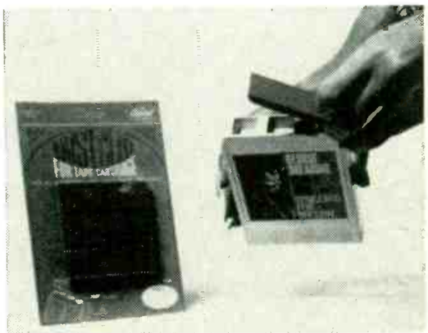
Circle 56 on reader's service card



CB MOBILE TRANCEIVER, the *Slimline 675*, 10 channels, 5 watts. Permits addition of transmitter and receiver crystals by removal of 3 knobs and 2 shaft nuts from front-panel controls. Has built-in PA system. Adjacent-channel rejection: more than 40 dB. Image rejection: 50 dB. Sensitivity: more than 0.4 μV for 10-dB signal/noise ratio. Frequency stability: ± .005% from − 20°C to + 85°C. Modulation: 100%. Average transmitted power output: 3.5 watts. 2½ x 6½ x 9 in.—Amphenol Corp.

Circle 59 on reader's service card

INSTRUMENT REPAIR KIT, *No. K-50*, contains 35 small precision hand tools. Includes 10-watt soldering iron,

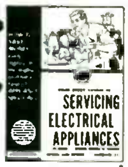


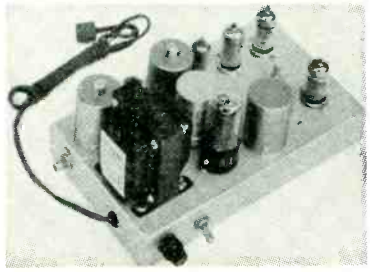
DUST CLIPS. Special pack contains 3 dust clips for 8-track stereo tape cartridges. Clip snaps over end of cartridge to protect it from dirt and other foreign matter.—Capitol Records Distributing Corp.

Circle 57 on reader's service card

4-TRACK SOLID-STATE RECORDER, *model RK-810*. For vertical or horizontal use. 5-position selector control, includes pause. 2 heads, ¼-track lamination-type record/playback; ¼-track double-gapped high-efficiency erase. Record-safety button prevents accidental erasure. Stereo tape head output jacks (for use with external amplifier); 2 inputs for microphone and auxiliary. External speaker jack and push-pull speed selector. Self-contained 5-in. speaker. Response: 40–15,000 Hz at 7½ ips; 40–10,000 Hz at 3¾ ips. Wow and flutter: less than 0.25% rms at 7½ ips; less than 0.35% at 3¾ ips. S/N: 40 dB or better. Bias and erase: 60 kHz. Crosstalk: 55 dB or better. Sensitivity: microphone, 0.6 mV; aux., 200 mV. External speaker: 16 ohms. Motor: 4 poles. Power output: 2.5 watts. 110–120-volt 60-Hz ac. 11⅝ x 12½ x 6¾ in.—Lafayette Radio Electronics Corp.

Circle 58 on reader's service card



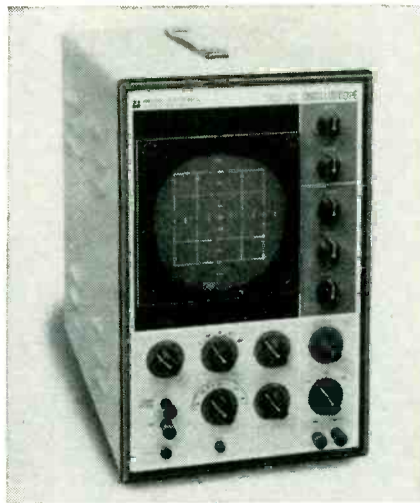


Circle 117 on reader's service card

Circle 118 on reader's service card

4-in. flush-cutting taper-jaw diagonal cutter, 4-in. needlenose pliers with radius edges, 5-piece screwdriver set, Phillips-type screwdriver with No. 0 point, snub-nosed scissors, 10-power eye loupe, 8-piece 4-in. needle-file set, 11-piece knife set, 6-piece hex-wrench set, 6-piece spline-wrench set, 3-piece soldering-aid set, and No. 5 DuMont-style tweezer. In heavy plastic hinged case, 9½ x 6½ x 1½.—**Telvac Instrument Co.**

Circle 60 on reader's service card



WIDEBAND OSCILLOSCOPE, *model 315A*. 5-in. CRT, for audio and industrial testing as well as TV servicing. Vertical response to 5 MHz with 10-mV rms/cm sensitivity; 3-step frequency-compensated vertical attenuator with separate stepless control; 2-stage push-pull vertical amplifier; cathode-follower input. Astigmatism control for sharp trace adjustment; drift-free positioning control; negligible rise-time, overshoot and square-wave tilt; automatic sync.—**Precise Electronics, Div. of Designatronics, Inc.** END

Circle 61 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here are free for the asking with a Reader's Service number. Turn to the Reader's Service Card facing page 82 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

MICROPHONE CATALOG. 18 pages, photographs, specs, price lists. Includes stands, dash brackets, components, accessories of selected models.—**Turner Microphone Co.**

Circle 62 on reader's service card

AUDIO PRODUCTS CATALOG. *Bulletin SE-07,* 4 pages. Includes amplifiers, filters, equalizers, power supplies, system components; also digital metronome and reverberation unit.—**Universal Audio Products.**

Circle 63 on reader's service card

BASE STATION BROCHURE, *No. TIC-2042B.* Describes new series for indoor and outdoor use.—**Motorola Communications & Electronics Inc.**

Circle 64 on reader's service card

AUDIO ACCESSORIES CATALOG, *No. A-40 1b;* 14 pages, looseleaf-punched. Audio mixers, speaker controls, couplers, adapters, selector switches, molded cable assemblies, audio connectors. Includes adapters for foreign recorders.—**Switchcraft, Inc.**

Circle 65 on reader's service card

TEST EQUIPMENT CATALOG. *Bulletin No. 2074,* 15 pages, looseleaf-punched. Specs, illustrations, price lists. Includes test instruments for radio, TV, communications, automotive, air conditioning, refrigeration, heating.—**Simpson Electric Co.**

Circle 66 on reader's service card

BUSHING AND SHAFT SPECIFIER CHART for radio replacement controls. Replacement can be determined with chart without knowing part number of original. Plastic-laminated.—**Centralab**

Circle 67 on reader's service card

DECAL AND LABEL CATALOG, 16 pages, looseleaf-punched. Covers variety of decals, labels, pressure-sensitive signs. Technical data, price information, color illustrations. Includes quotation request forms, order forms.—**Seton Name Plate Corp.**

Circle 68 on reader's service card

POCKET-SIZED GUIDEBOOKS, *"How to Use Screwdrivers"* and *"Helping Hand for Electrical Wiring."* "How to" facts, illustrations, pointers, charts.—**Vaco Products Co.**

Circle 69 on reader's service card

POCKET-SIZED AUTO RADIO SPEAKER REPLACEMENT GUIDE, for front- and rear-seat speakers for automobile models from 1955–1966.—**Quam-Nichols Co.**

Circle 70 on reader's service card

COMBINED CATALOG/REPLACEMENT GUIDE, *No. 166, 66.* 150 pages, 5-hole-punched. 100 pages of exact coil replacement parts numbers. 68-page general catalog of rf chokes, i.f. transformers, coils, with index and price list.—**J. W. Miller Co.** END

Circle 71 on reader's service card

Circle 119 on reader's service card

Automotive Electronics Featured In December

Four lively, stimulating articles on automotive electronics including "New Twist In Automotive Analysis," which explains what's going on and how you can learn more about servicing and maintenance of electronic testing equipment for autos . . . plus other bonus articles . . . TV Remote Controls, Electronic Steering For Cars, Multi-Substitution Box . . . Experimenter's Friend, Selling The Chassis Overhaul, Color AFC Adjustments, Versatile Tester For Semiconductors, Removing Mysticism From Matching, and the 1966 Editorial Index.

December RADIO-ELECTRONICS on sale at newsstand and parts distributors November 22.

LAFAYETTE RADIO ELECTRONICS
P.O. BOX 10
SYOSSET, L.I., N.Y. 11791

PLACE
STAMP
HERE

Live Better Electronically With

LAFAYETTE RADIO ELECTRONICS

Mail The Card Today for Your

FREE!

1967 Catalog 670

Shop At The "World's Hi-Fi & Electronics Center"
For Widest Selection, Low Prices

Stereo Hi-Fi • Citizens Band • Ham Gear • Tape Recorders • Test Equipment • TV and Radio Tubes and Parts • Cameras • Auto Accessories • Musical Instruments • Tools • Books

Everything In Electronics for Home • Industry • Laboratory

Exclusively Yours at Lafayette

A Complete Assortment of Musical Instruments

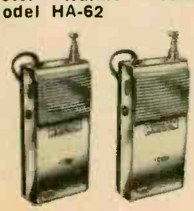
25-Channel, Solid-State C.B. Transceiver with Business Band, Model HB-600

New! Criterion Hi-Fi Bookshelf Speakers

No Money Down • Up to 24 Months to Pay

New! 65-Watt AM-FM Solid-State Stereo Receiver, Model LR-900T

New! 2-Channel 6-Transistor Walkie - Talkie Model HA-62



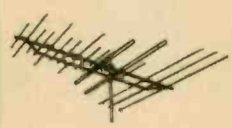
New! All Solid - State Tape Recorders and Decks—Model RK-830

Satisfaction Guaranteed or Money Refunded

Lafayette Mobil-Ade™ 12-Channel Solid-State CB Transceiver, Model HB-555

50 - Watt Solid - State Stereo Amplifier, Model LA-248

New! Complete Line of Lafayette TV Antennas



LAFAYETTE RADIO ELECTRONICS
P.O. BOX 10
SYOSSET, L.I., N.Y. 11791

PLACE
STAMP
HERE

Do A Friend A Favor...

Have a friend interested in hi-fi or electronics? Send us his name and address and we will send him his own personal copy of the 1967 Lafayette Catalog 670.

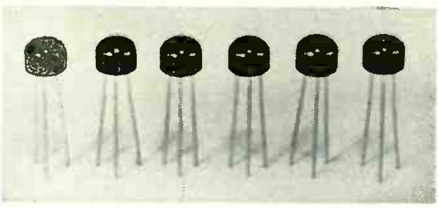
FREE

MAIL THE CARD TODAY!

NEW SEMICONDUCTORS, MICROCIRCUITS & TUBES

RECENTLY-DEVELOPED PRODUCTS APpearing this month include a high-brightness CRT, epoxy transistors, a vhf FET, an IGFET pair, an n-channel FET, a uhf transistor, and microminiature variable-capacitance diodes.

The M1237 is a round, flat-faced, 5-inch CRT having greater-than-normal brightness for use in areas having high ambient light. An aluminized phosphor is deposited on a very-thin glass sheet mounted within the tube behind the standard faceplate. The tube costs $500 and is available from General Atronics Corp, Philadelphia, Pa. 19118.



A line of epoxy transistors costing as little as 15¢ each (in large quantities) has been introduced by General Instrument Corp., Hicksville, N.Y. 11802. The product line covers applications ranging from dc to uhf, and includes six medium power amplifier/switching transistors registered with the EIA. 2N4140 and 2N4141 (npn) are electrically equivalent to the 2N2221 and 2N2222. 2N4142 and 2N4143 (pnp) are electrically equivalent to the 2N2906 and 2N2907. 2N4227 and 2N4228 are npn and pnp complementary devices featuring tight gain specifications.

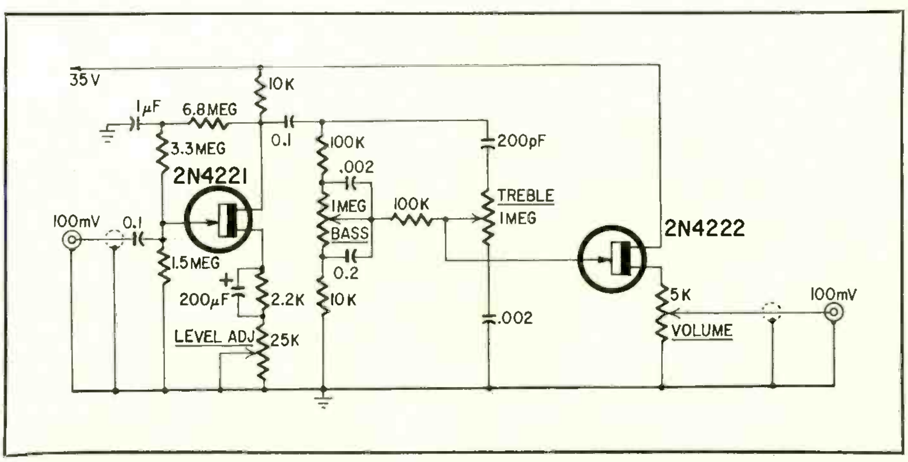
Motorola has introduced a vhf amplifier/mixer FET which is claimed to have extremely low cross-modulation and intermodulation distortion, as well as a guaranteed maximum noise figure of 2.5 dB at 100 MHz. The 2N3823 comes in a TO-72 package, costs $8.60 when bought in quantities of 100 or more.

The same company has registered with the EIA a complementary pair of insulated-gate field-effect transistor (IGFET) switches. The 2N4351 (n-channel) and 2N4352 (p-channel) are designed for low-power switching applications. Specifications show I_{DSS} ratings of 10 nA dc for the 2N4351 and 5 nA dc for the 2N4352, with zero volts on the gate, assuring low power drain in the "off" condition. Maximum channel resistance (r_{ds}) is also low: 300 ohms for the 2N4351 and 600 ohms for the 2N4352. These IGFET's cost $4.50 in 100-up quantities.

Motorola has also released some design information (see diagrams) for af amplifier FET's (2N4220-22) and rf amplifier FET's (2N4223-24). Because of the FET's high impedance, designers can use vacuum-tube-type circuits while retaining the advantages of small size and solid-state reliability.

Operation as high as 1.3 GHz is the feature of the A485, an npn silicon planar epitaxial transistor. Noise figures are 3.5 dB at 200 MHz and 4.5 dB at 450 MHz. Intermodulation distortion rating is −53 dB. This device is made by Amperex Electronics Corp., Slatersville, R.I. 02876.

Microminiature variable capacitance diodes have been introduced by Somerset Electronics Corp., Manville, N.J. 08835. Each diode is .09 inch long and .075 inch in diameter. They are rated to 100 volts and 50 MHz, with values from 6.8 to 56 pF, ±10% tolerance. END



Keeping Big Amplifiers POWerful

Lots of audio power means lots of current and heat, and lots of caution

By WILLIAM DARRAGH

"LITTLE" AUDIO AMPLIFIERS ARE EASY to fix: radio parts, low voltages—no trouble. But get into the Big Boomers—the 50-, 75- or even 100-watt jobs—and look out! You'll find high voltages, heavy currents, some different circuits, and the chance of damaging the amplifier by a careless connection in the wrong place! So here are some hints on taking care of this kind of system.

Check the power supply first, as usual. Fig. 1 shows a circuit found in several popular amplifiers. See the two filter capacitors? These are not a voltage doubler—they're in series to get a higher working-voltage rating. Two 1-meg resistors shunted across each filter equalize the charge and discharge the capacitors when the amplifier is turned off.

House lamp makes an acceptable dummy load for high-power amplifiers in an emergency.

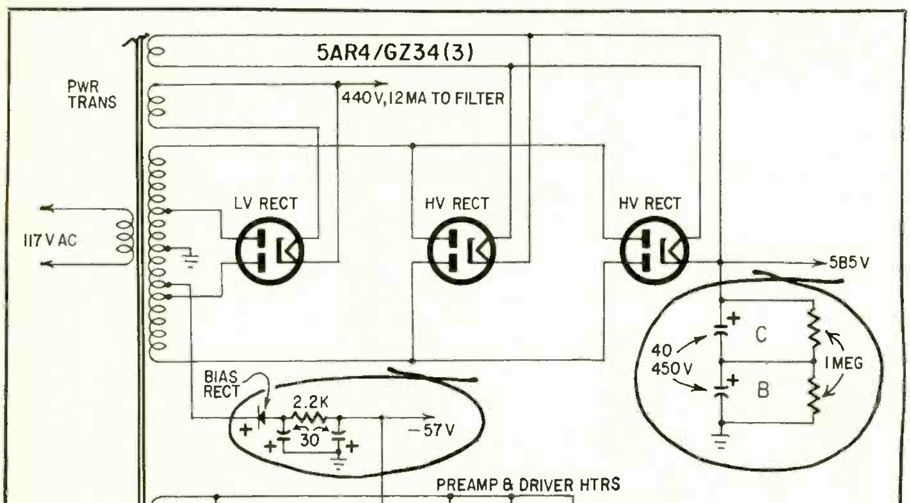


Fig. 1—Power supply of 72-watt amplifier. Series filter capacitors and negative bias supply are but a few of the unusual circuits. Note hum-bucking control in heater supply.

If you find one of these capacitors shorted, replace both of them. The survivor will have had a bad voltage overload and may have suffered from it. Check the new ones for leakage *before* you put them in! Use only high-quality parts. These amplifiers are used in industrial applications, where dependable service is far more important than saving a few cents in parts costs. (Be sure to put the insulating sleeve back on the can of capacitor C. The can is almost 400 volts above ground!)

Notice the negative bias supply in Fig. 1. These amplifiers use tubes like the 7027, 7581, etc. Fixed-bias supplies keep the tubes from burning themselves up. If the amplifier suddenly quits, and you find the output tubes have red-hot plates, check the bias supply first. In some circuits, the bias voltage is also applied to the hum-bucking circuit. A heater-cathode short in one of the other tubes can short out the power tube's bias supply. Check the schematic to make sure.

Voltage regulators are used in some chassis. Fig. 2 shows a twin-triode regulator; pentode regulators are used in others. Regulated supply voltage is usually fed to the screens of the power output stage and to the plates of voltage-amplifying stages earlier in the circuit.

Bias adjustments are provided in most. Fig. 3 shows the circuit used in one 60-watter. A pair of shorting links is connected across 10-ohm resistors in the cathodes. To measure bias, these are opened, and a voltmeter hooked across them, one at a time. The bias pots are adjusted for a 0.5-volt reading across each resistor (which corresponds to 50 mA of tube current). This is done with no signal, balancing the idling currents in each tube.

Bench testing

Hooking one of these high-power jobs up for bench testing takes some precautions. You don't turn it on, and then go hunt up the test speaker! If these high-power output stages are fired up without a load, there will be such plate-voltage spikes that the output transformer will flash over and burn up. The change in loading causes it.

So, use a dummy load. You can get adjustable 75–100-watt resistors from surplus stores. Or a plain incandescent lamp makes a good load (photo). [If you do a lot of audio work, you might consider something like the high-power PA load described in the March 1966 issue.—*Editor*.] You can hook an output meter across the lamp or resistor load to check the power. If you use a variable resistor, it should be set at the correct load. For 70.7-volt line terminals (used on most units), the value ranges from 45 to 85 ohms.

To listen to the output, hook your test speaker to one of the low-impedance taps. This can be done while you are operating with the dummy load, but don't try to run full-power tests through a 4-ohm 10-watt speaker! (Don't ask how I found out. Just don't do it.)

If the output transformer must be replaced, use an exact duplicate. Same for the power transformer. Watch out for polarity on the output-transformer secondary; in most circuits, a voltage-feedback tap is taken from the 70.7-volt line. If you get the polarity reversed, you'll get the grandfather of all feedback howls. Check the schematic: Feedback is usually carried back about three stages.

For mysterious distortion, check for equal grid-drive signals on the power output stage, driver stage, etc. Watch out for coupling capacitors with very small leakages; these will often leak under high voltage stress but not show up on low-voltage leakage tests. [The open-end vtvm test, with the other end of the capacitor still connected to B+, is the most dependable.—*Editor*]

For a final test of the amplifier, hook up the load lamp, feed a signal into the amplifier, turn it up full blast, and leave it on the bench to cook for a couple of hours. You certainly won't want to listen to 50 or 75 watts of audio in the shop; and if something happens the lamp will go out. Be sure the primary fuse is the right size. Don't fuse too heavily, just enough to hold it under normal line-voltage conditions.

This kind of amplifier servicing takes extreme care and the use of the very best replacement parts. But it pays off—you can usually charge what the job is really worth! END

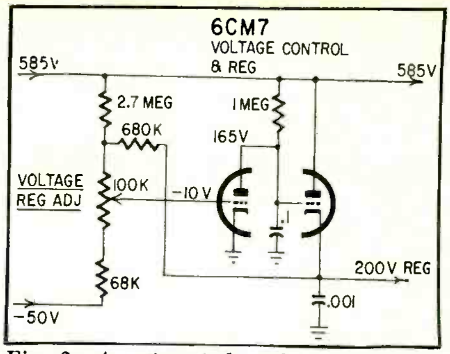


Fig. 2—A twin triode voltage regulator.

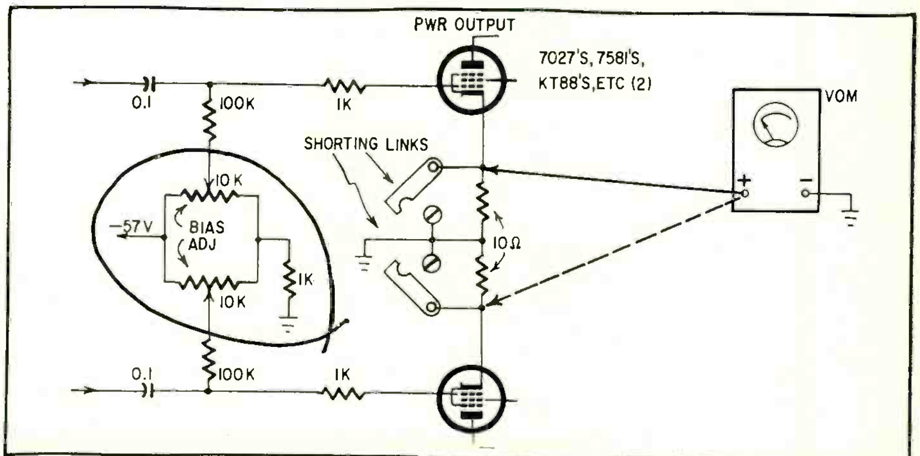


Fig. 3—Adjustable bias allows balancing of idling currents in high-power output tubes.

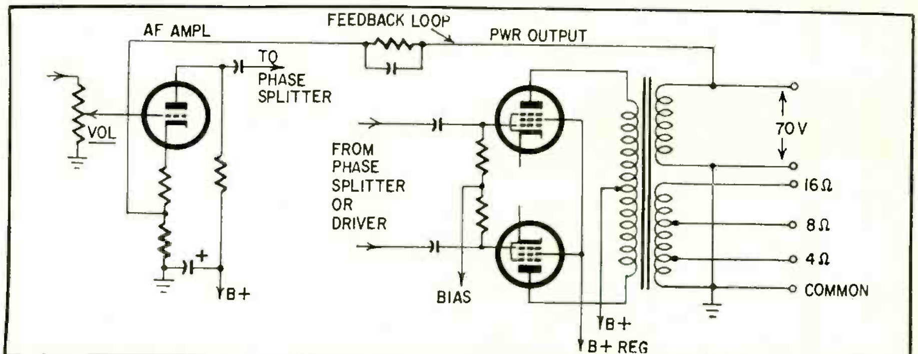


Fig. 4—Feedback from an output winding. Reverse connections if amplifier oscillates.

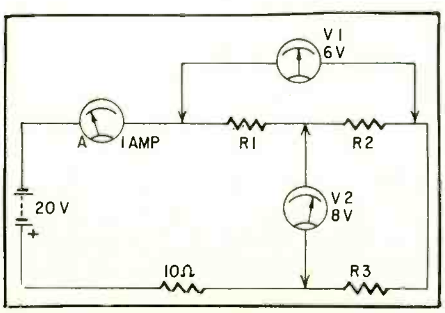
WHAT'S YOUR EQ?

Conducted by E. D. CLARK

Series Circuit

In the diagram, the ammeter reads 1 amp, voltmeter (V1) reads 6 volts and voltmeter (V2) reads 8 volts.

Can you determine the resistance of R1, R2 and R3?—*James C. Bentley*



Connections

You have six 13-ohm resistors. How can they be connected so that the resulting resistance is 11 ohms?—*Robert F. Wallace*

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

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

Answers to this month's puzzles are on page 105.

50 Years Ago

In Gernsback Publications
In November 1916
Electrical Experimenter

Experiments with a Radioson Detector

Wireless "Hound" Dogs Your Footsteps

Wireless and Aeroplanes Aid European "Gun Spotters"

Radiation Current in Radio Antennas

TECHNOTES

RIVET FAILURE

The type of failure described here is fairly common. It was brought to mind recently by trouble with an Electr-O-Probe level detector, a solid-state capacitance relay for measuring the amount of granular material in bins.

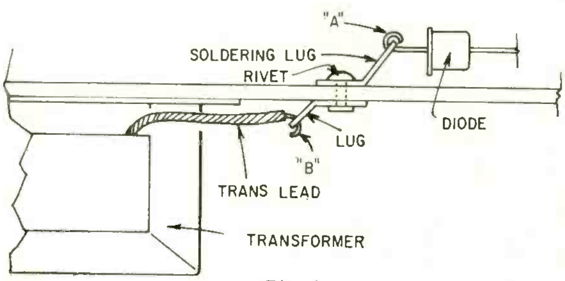


Fig. 1

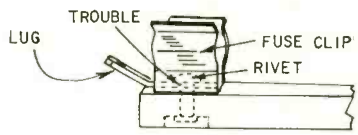


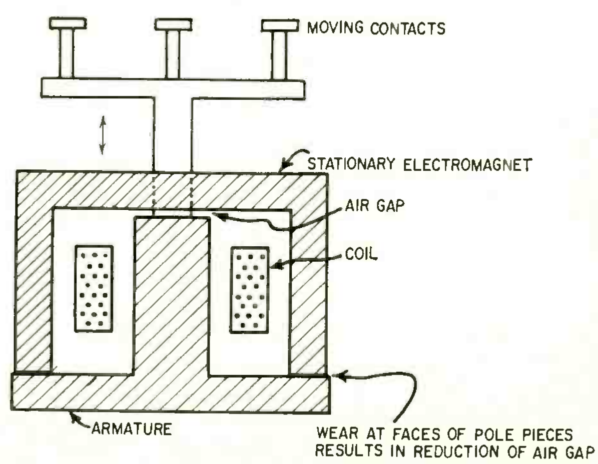
Fig. 2

Referring to Fig. 1, no voltage was measured at point A although full transformer secondary voltage appeared at B. I don't know why the continuity of the riveted connection dropped so far it couldn't supply a pair of milliwatt transistors, but the repair is obvious, a jumper from A to B.

Similar trouble has been experienced with fuse clips (Fig. 2) and with the ground connections of tuning capacitors mounted on printed-circuit boards.—*R. C. Roetger*

AIR GAP VITAL IN MAGNETIC CONTACTORS

It is important to check the air gap (see diagram) on some types of magnetic contactors, to keep residual magnetism in the core from causing the armature to stick. It seemed almost incredible that residual magnetism could overcome the weight of moving parts plus the pressure of contact springs, on a size-3 vertical-action contactor. But I found this to be the case after one had hung on and ruined (by overheating), an ex-



pensive part in an oven for curing plastics.

Wear on the pole pieces after years of operation had reduced the gap to zero. I milled off the end of the center leg to restore the gap, which should be .010 to .012 inch for a size 3, as shown. Too great a gap will cause the coil to overheat.

Some contactors have a permanent air gap in the magnetic circuit. Consult the manufacturer's specs—*Eric Barschel*

INTERCOM CROSSTALK

In the Talk-A-Phone T-LM-10 intercom, calls from master to remote are heard on other (uncalled) remote stations. While not loud, this crosstalk is annoying. It is caused by af voltage drop (or coupling) across the single ground-return wire used for all stations. Since all stations tie to the same ground-return line, any voltage drop on this line will appear as a signal at all stations. Problem is eliminated by using a separate ground-return wire between the master and each remote station.—*Sandor Mentler*

SWEEP ANALYZERS SHOULDN'T ARC

I was checking a set with my analyzer (Sencore SS-117) when I heard arcing within the instrument. Routine troubleshooting revealed that the blocking capacitor in the output of the oscillator section of the SS-117 was shorted. Even after I replaced the capacitor, I couldn't get the instrument to work properly. Oscillator output was intermittent and the level adjustment wouldn't stay put. I reasoned the shorted capacitor had allowed too much dc to go through the 50K output-level pot. Since the pot proved noisy, my guess was correct. The arcing had occurred when the resistive element in the pot had burned. The damaged element was too far gone for control-cleaner touchup. A new pot restored the analyzer to normal operation.—*Klaus Halm*

PHILCO 15M91 COLOR CHASSIS

In the event of sync buzz, check the position of the bottom slug in interstage transformer L2. The circuit can be peaked for maximum output at two slug positions. Use the one with the slug nearest the printed-circuit board. This slug can be adjusted from the top of the transformer can so there is no need to pull the chassis.—*Philco Service Bulletin*

END

"Don't give me that jazz about having too much feedback. I happen to know that's a starved-current arrangement."

Stereo FM Stations: U.S. and Canada

RADIO-ELECTRONICS, July 1966, carried a listing (pages 41–43) of North American stereo FM stations. Each month since then, more stations have begun broadcasting in stereo. Following are additions and corrections to the July listing.

ADDITIONS

ALABAMA

Albertville	WAVU-FM	105.1
Andalusia	WNBX	98.1

ARIZONA

Phoenix	KHEP-FM	101.5

ARKANSAS

Texarkana	KOSY-FM	102.5

CALIFORNIA

Carlsbad	KARL-FM	95.9
Coachella	KCHQ-FM	93.7
Fresno	KFRE-FM	93.7
Los Angeles	KBBI	107.5
	KLAC-FM	94.7
	KXLU	89.1
Newport Beach	KOCM	103.1
Palm Springs	KDES-FM	104.7
Sacramento	KCRA-FM	96.1
San Francisco	KKHI-FM	95.7
Santa Ana	KWIZ-FM	96.7

COLORADO

Boulder	KRNW	97.3

CONNECTICUT

New Haven	WYBC-FM	94.3

FLORIDA

Boca Raton	WWOG	99.9
Miami	WGBS-FM	96.3
W. Palm Beach	WPBF	107.9

IDAHO

Boise	KBOI-FM	97.9
Lewiston	KOZE-FM	96.7

ILLINOIS

Chicago	WSDM	97.9
Peoria	WMBD-FM	92.5
Quincy	WTAD-FM	99.5
Springfield	WTAX-FM	103.7

INDIANA

Marion	WMRI-FM	106.9
South Bend	WSBT-FM	101.5

IOWA

Cedar Rapids	KHAK-FM	98.1
	WMT-FM	104.5
Fort Dodge	KWMT-FM	94.5

KANSAS

Kansas City	KCJC	98.1

KENTUCKY

Ashland	WCMI-FM	93.7

LOUISIANA

Alexandria	KALB-FM	96.9
Houma	KCIL-FM	107.1
La Place	WCKW	92.3
Monroe	KNOE-FM	101.9
New Orleans	WWMT	95.7
	WWOM-FM	98.5

MARYLAND

Baltimore	WBAL-FM	97.9
	WFMM-FM	93.1
	WITH-FM	104.3
Salisbury	WBOC-FM	94.3

Circle 124 on reader's service card

MASSACHUSETTS

Framingham	WKOX-FM	105.7
Worcester	WSRS	96.1

MINNESOTA

Rochester	KNXR	97.5

MONTANA

Great Falls	KOPR-FM	106.3

NEBRASKA

Lincoln	KWHG	106.3

NEVADA

Las Vegas	KRGN	101.9

NEW MEXICO

Santa Fe	KSNM	95.5

NEW YORK

Elmira	WENY-FM	92.7
New York	WNEW-FM	102.7

NORTH CAROLINA

Fayetteville	WFNC-FM	98.1
Jacksonville	WXQR-FM	105.5

OHIO

Cincinnati	WCXL	105.1
Salem	WSOM-FM	105.1

OKLAHOMA

Oklahoma City	KOCY-FM	96.1
	KOFM	104.1
	KYFM	98.9

PENNSYLVANIA

Ebensburg	WEND-FM	103.9
Erie	WWYN-FM	99.9
Lancaster	WGAL-FM	101.3
Philadelphia	WPBS	98.9
	WPEN-FM	102.9
Reading	WRFY-FM	102.5
Red Lion	WGCB-FM	96.1

PUERTO RICO

Arecibo	WNIK-FM	106.3
Mayaguez	WKJB-FM	99.1
Ponce	WLEO-FM	101.9
San Juan	WIAC-FM	102.5

RHODE ISLAND

Providence	WPFM	94.1

SOUTH CAROLINA

Columbia	WCOS-FM	97.9

TENNESSEE

Greeneville	WGRV-FM	94.9

TEXAS

Bryan	KORA-FM	98.3
Dallas	KBOX-FM	100.3
Fort Worth	KXOL-FM	99.5
Houston	KQUE	102.9
Longview	KLUE-FM	105.7
San Antonio	KMFM	96.1

UTAH

Salt Lake City	KLUB-FM	97.1
	KWHO-FM	93.3

WASHINGTON

Richland	KCYS	95.1
Spokane	KDNC-FM	93.7
	KHQ-FM	98.1

WEST VIRGINIA

Beckley	WBKW	99.5
Wheeling	WTRF-FM	107.5

WISCONSIN

Janesville	WCLO-FM	99.9

CANADA

MANITOBA

Brandon	CKX-FM	96.1

ONTARIO

Kingston	CKWS-FM	96.3

CORRECTIONS

CALIFORNIA

Los Angeles KMLA 100.3 should be listed as KFOX-FM

FLORIDA

Milton WXMB-FM 102.3 should be listed as WXBM-FM

ILLINOIS

Chicago WNUS-FM 107.5 should be deleted

MARYLAND

Towson WAQE-FM 101.9 should be listed as Baltimore

OHIO

Medina WDBN 94.9 should be listed as Barberton

TEXAS

Beaumont KFHM 95.1 should be listed as KHGM

Fort Worth KBAP-FM 96.3 should be listed as WBAP-FM

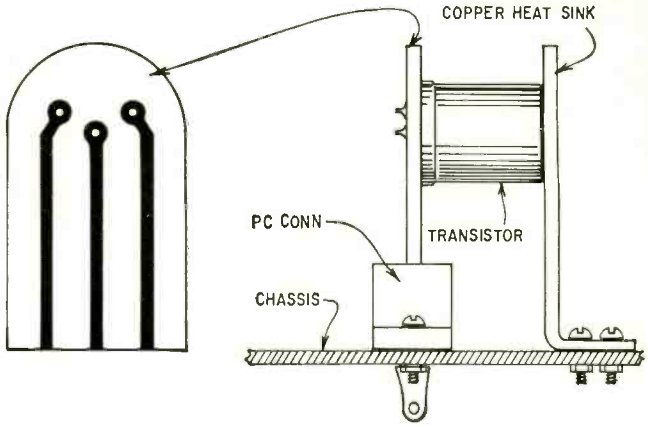
ONTARIO, CANADA

Cobourg CHUC-FM 103.1 should be listed as Cobourg-Port Hope CHWC 103.1

END

TRY THIS ONE

MAKE TRANSISTOR-LEAD SAVERS



To save the leads on experimental transistors, I make little printed-circuit boards, on which the transistors are soldered. The circuit boards are designed to fit into standard PC connectors. Thus, a heat sink can be mounted next to the connector so that a transistor inserted in place will automatically be pressed against it and cooled.

—Tom Jaski

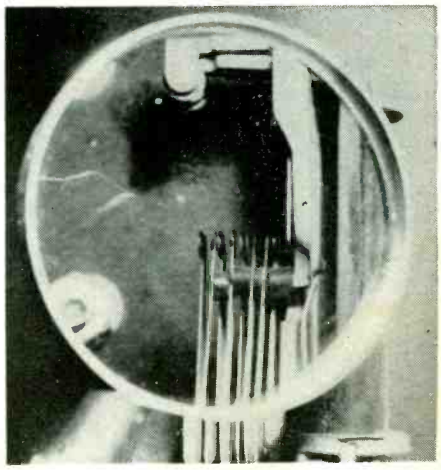
MAGNIFIER AS RELAY SERVICE AID

Anyone who services equipment that uses relays should welcome the addition of an inexpensive magnifying glass to his set of tools.

The magnifer allows the technician to inspect the make-and-break action of tiny contacts and check for pitting and wear. Relay adjustment is also aided; the enlarged image can often prevent ruining an expensive relay by accidentally "bending too far."

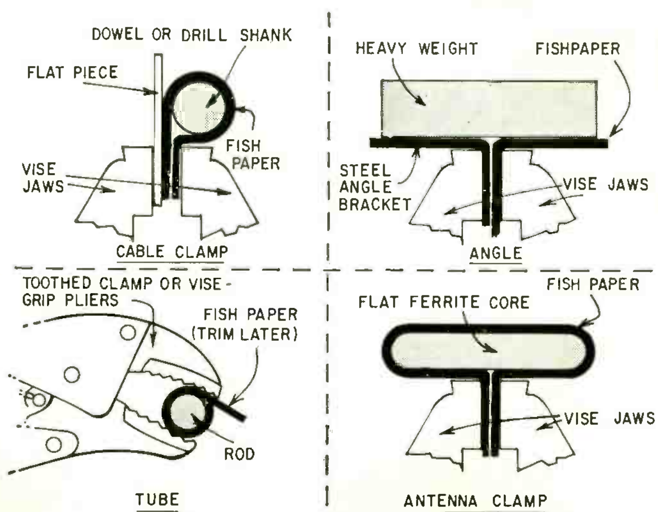
Suitable magnifying glasses come in a variety of sizes and prices. For portable use, at least one inexpensive glass on the market has a protective leather cover and provides plenty of magnification.

—Robert E. Kelland



HOMEMADE CLIPS AND CLAMPS FROM FISH PAPER

You can easily custom-make your own clips, clamps, or insulators from fish-paper, just like the ones you find in commercial equipment. Fish paper is that tough, stiff, dark-gray, fibrous, half-paper, half-cardboard material often used as insulation in connectors, transformers, under tie-points and in many other places. You can buy it at electrical supply stores.



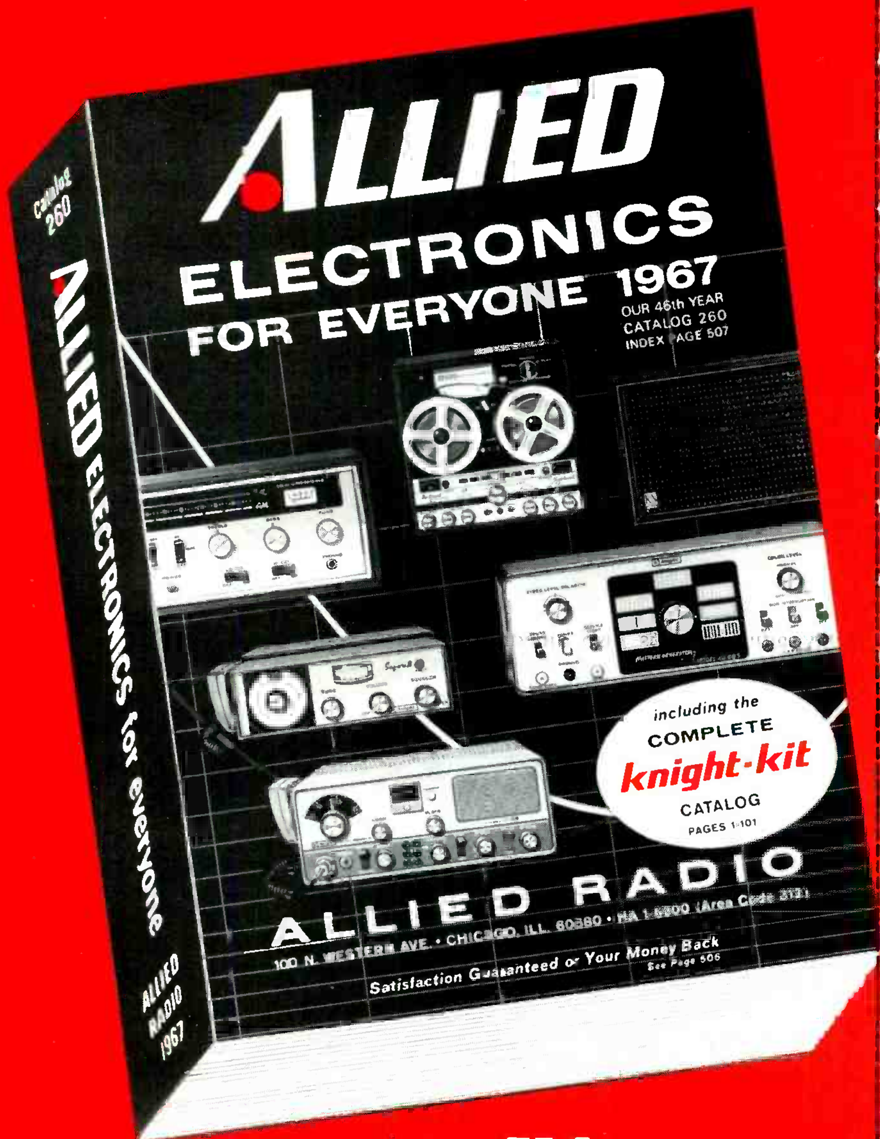
The secret to forming the stuff is to soak it in water for about 30 minutes first. Then shape it around something suitable, as suggested in the drawings here, and clamp it in a vise or in vise-grip pliers, or even with rubberbands, until it dries hard (overnight).

You can punch holes in fish-paper with a bit of sharpened metal tubing.

—George L. Garvin

END

FREE ALLIED 1967 CATALOG



NEW 514-PAGE ALLIED CATALOG

TOP SAVINGS ON THE BEST IN ELECTRONICS FOR EVERYONE . . .

- Famous Knight-Kits • Stereo Hi-Fi • Tape Recorders & Tape
- CB 2-Way Gear • Walkie-talkies • FM-AM & AM Radios
- Short Wave Radios • Portable TV • Phonographs, Accessories
- Amateur Gear • Intercoms & P.A. • Automotive Electronics
- Test Instruments • TV Antennas & Tubes • Power Tools • Parts
- Hardware • Tubes • Transistors • Batteries • Books

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

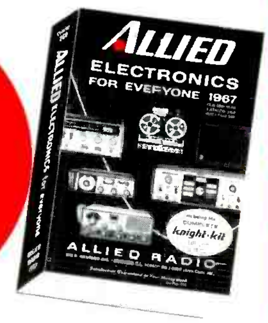
NAME—PLEASE PRINT

ADDRESS

CITY

STATE 2L ZIP

FREE ALLIED 1967 CATALOG



CHOOSE FROM THE WORLD'S LARGEST SELECTION IN ELECTRONICS . . . AND SAVE!

Buy from the world's largest electronics supplier. Use the Allied Credit Fund Plan to enjoy what you want NOW—no money down, 24 months to pay.

RUSH THIS CARD NOW!

Important! PRIORITY CATALOG REQUEST

TO:
ALLIED RADIO
P. O. BOX 4398
CHICAGO, ILLINOIS 60680

PLACE STAMP HERE

Important! PRIORITY CATALOG REQUEST

TO:
ALLIED RADIO
P. O. BOX 4398
CHICAGO, ILLINOIS 60680

PLACE STAMP HERE

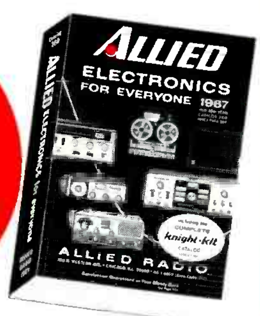
NAME—PLEASE PRINT

ADDRESS

CITY

STATE 2L ZIP

FREE ALLIED 1967 CATALOG



CHOOSE FROM THE WORLD'S LARGEST SELECTION IN ELECTRONICS ... AND SAVE!

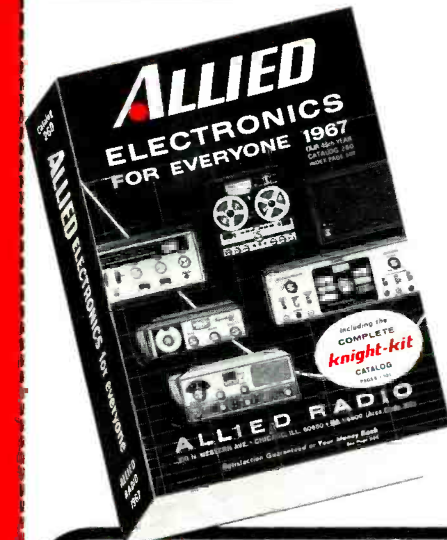
Buy from the world's largest electronics supplier. Use the Allied Credit Fund Plan to enjoy what you want NOW—no money down, 24 months to pay.

RUSH THIS CARD NOW!

RUSH THIS CARD TODAY

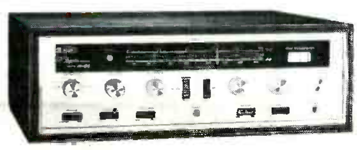
FREE

NEW 1967 ALLIED CATALOG



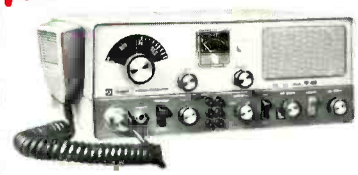
514 pages! See everything new in electronics ... featured first at Allied, the world's largest electronics headquarters!

New! for the audiophile ...



Knight-Kit® Deluxe Stereo FM-AM Tuner. Easy-to-build solid-state design.

New! for the ham operator ...



Knight-Kit® 6-Meter Amateur Transceiver with universal solid-state power supply.

New! for the CB user...

KNIGHT® 2-Way Radio. Compact solid-state design at amazingly low cost!

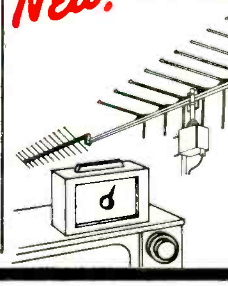
New! for the serviceman ...

Knight-Kit® Portable Solid-State Color/Bar Pattern Generator. A top value!

New! for everyone ...

Ampex 6200 HVR Home Videotape Recorder. Make videotapes at home!

New! for TV and FM owners ..



Antenna and Rotor Systems for color and black-and-white TV ... FM, too!

Plus hundreds more new and exclusive items, and scores of special Allied values!

NO MONEY DOWN!

Enjoy the things you want now, while you take 24 months to pay for them on the Allied easy-on-the-budget Credit Fund Plan.

ALLIED RADIO P.O. BOX 4398 CHICAGO, ILLINOIS 60680

DO A FRIEND A FAVOR—give him this card to send for his FREE ALLIED CATALOG

WHAT'S YOUR EQ?

These are the answers. Puzzles are on page 97.

Series Circuit

With a series current of 1 amp, the drop across the 10-ohm resistor is 10 volts. This leaves 10 volts across R1 + R2 + R3 which have a total resistance of 10 ohms.

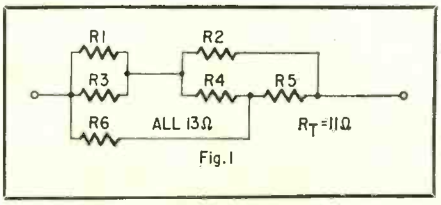
The drop across R1 + R2 is 6 volts. Therefore, the drop across R3 is 4 volts and its resistance is 4 ohms.

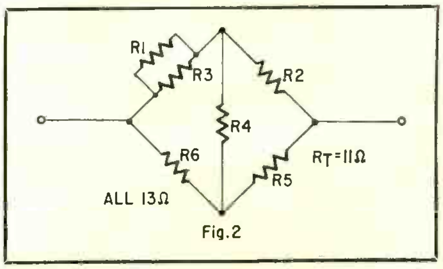
The drop across R2 + R3 is 8 volts. Therefore, the drop across R1 is 2 volts and its resistance is 2 ohms.

The drop across R2 is 4 volts and its resistance is 4 ohms.

Connections

The resistors are connected as shown in Fig. 1.





Note: As shown redrawn in Fig. 2, the circuit amounts to an unbalanced bridge. R1 could also be paralleled across either R2, R5 or R6 with no change in the total resistance. Possibly the easiest proof is by the loop-current method.

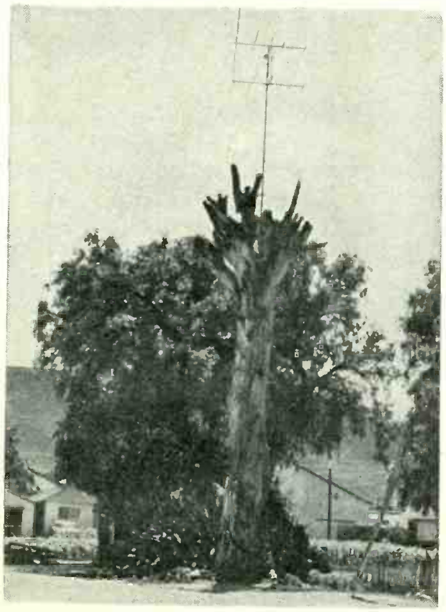
Correction

The solution to the "Tapered Network" puzzler (August 1966 EQ) contains an error. The first equation should read:

$$R = 1 + \frac{\frac{1}{4} R}{\frac{1}{2} + \frac{1}{2} R}$$

Otherwise, the answer is correct as printed. END

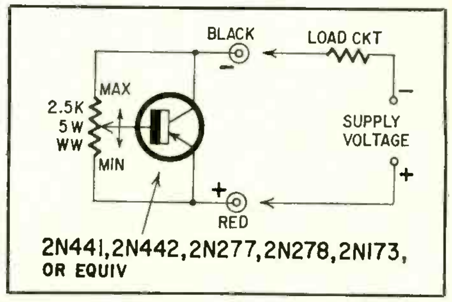
This is the "strange sight" on page 14.



NOTEWORTHY CIRCUITS

TRANSISTOR POWER RHEOSTAT

An electronic experimenter at one time or another has to adjust high direct currents in low-voltage, high-wattage circuits. Usually a high-wattage rheostat is not readily available; besides, its cost is prohibitive. In most instances this difficulty can be overcome by using the "transistor power rheostat" (see diagram) as a current-controlling device. Now that it is possible to purchase power transistors for less than a buck each from several suppliers, the economy of the transistor power rheostat is apparent.

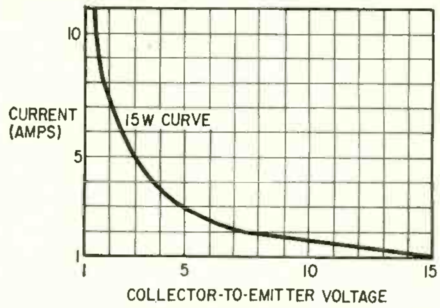


It can be used to control the speed of a low-voltage dc motor, or to adjust the brilliance of a high-current 6- or 12-volt lamp or as a variable load for checking out a low-voltage power supply for regulation and current capability.

Build the transistor power rheostat on a scrap of aluminum if you wish, but keep in mind that the maximum power the transistor can safely dissipate is determined by the size of the heat sink used.

I used a 3 x 6 x 1¼-inch aluminum chassis. The transistor is in the center; the potentiometer is at one end of the chassis and binding posts at the other.

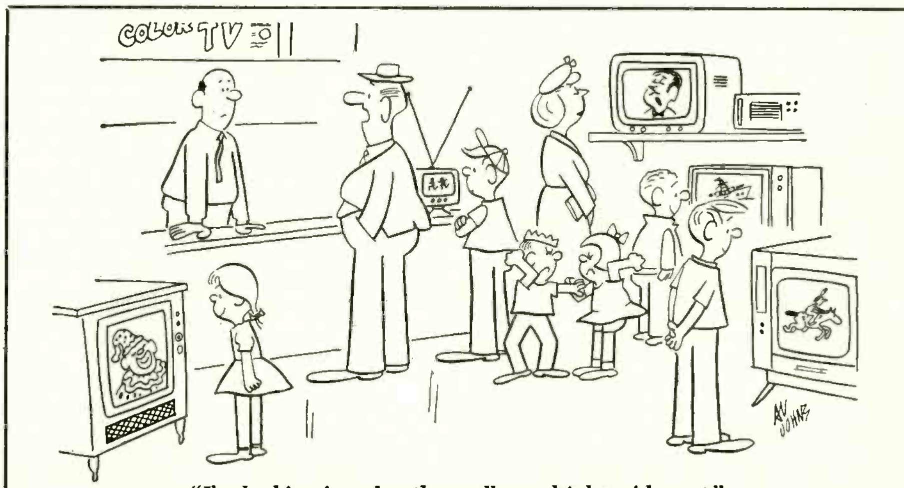
There is no trick involved in using the transistor power rheostat; just insert it in series with the load and voltage supply. Be sure the *emitter* terminal (marked positive, *red* binding post) is connected to the *positive* side of the supply, and the *collector* terminal to the *negative* side of the circuit. Always return the potentiometer to the emitter end of its range before connecting the unit in any circuit. This limits the initial load current to a few mA.



You'll need to know the actual power being dissipated under load conditions, so you can keep the transistor within the maximum dissipation limits. You can calculate the power dissipated under load conditions from the collector-to-emitter voltage and the current flowing through the transistor, using the power formula $P = E \times I$.

With the aid of a power-dissipation curve, you can readily determine at what voltage and current values the power transistor is dissipating a maximum power.

The graph is for 15-watt transistors. Inexpensive transistors with much higher ratings are available. Prepare a power-dissipation graph for the transistor you select. Be sure the heat sink is adequate.—*Charles D. Rakes* END



"I'm looking for what they call a multiplex video set."

NEW BOOKS

TRANSISTOR ELECTRONICS, by Karl-Heinz Rumpf and Manfred Pulvers. *Pergamon Press, 44-01 21 St., Long Island City, N. Y. 11101. 5½ x 8 in., 282 pp. Cloth, $10*

Almost entirely on switching transistors. Design-engineer-oriented. Besides fundamental principles, the book considers the parts used in conjunction with transistors, and goes deeply into the principles of connecting them into circuits. Several practical circuits are included. Goes on into systems design, electronic assemblies, and computing techniques. A good little book for the designer of digital and switching equipment.

FEEDBACK CIRCUIT ANALYSIS, by S. S. Hakim, Ph.D., B.Sc., AMIEE. *Iliffe Books Ltd., Dorset House, Stamford St., London SE1, Eng. 5½ x 8½ in., 392 pp. Cloth, 96s2d ($13.50)*

Heavily mathematical presentation covering both tubes and transistor circuits. Besides the theory or feedback itself, the book covers its effect on frequency response and impedance, plus its application to both amplifiers and oscillators. Comprehensive, and very deep.

THE COMPLEAT STRATEGYST, by J. D. Williams. *McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 10036. 6½ x 9½ in., 270 pp. Cloth, $6.95*

Revised edition. Mathematical games. Engagingly written. Breaks strategies down into two-strategy games, three-strategy games and larger ones. Many easily read examples make this a book you'd like to read even if you weren't interested in the theory of strategy of games.

TROPOSPHERIC RADIO WAVE PROPAGATION BEYOND THE HORIZON, by Francois Ducastel. *Pergamon Press, 44-01 21 St., Long Island City, N. Y. 11101. 6 x 9 in., 236 pp. Cloth, $11.50*

Translation of a French work on radio propagation above 50 MHz, reaching to 10 gHz. Includes the mathematics of propagation along with a lot of experimental data. Filled with charts and graphs. A whole series of charts in a pocket that is part of the back cover. Well written, and not unusually dull.

ELECTRONICS CONSTRUCTION TECHNIQUES, by George L. Ritchie. *Holt, Rinehart & Winston, 383 Madison Ave., New York, N. Y. 10017. 8½ x 11 in., 227 pp. Paper, $4.95*

Primarily for constructors of prototype models. this book can be used to advantage by anyone who constructs electronic equipment. It covers the use of tools, chassis assembly and wiring, marking and labeling, and finishing. It does this by the project method, and each 1- to 3-page item is an assignment that is intended to show how a particular technique works. Even includes the drafting techniques prefatory to construction designing. Lots of practical sketches and illustrations. END

SCHOOL DIRECTORY

MARKET CENTER

Circle 131 on reader's service card

GENERAL

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume responsibility for any errors which may appear in the index below.

WANTED

QUICK CASH . . . for Electronic EQUIPMENT, COMPONENTS, unused TUBES. Send list now! **BARRY,** 512 Broadway, New York, N. Y. 10012, 212 WALKER 5-7000.

INVENTIONS WANTED. Financial Assistance Free protection forms, information. Contact: **INTERNATIONAL INVENTION INSTITUTE,** Dept. 29, 160 Broadway, New York, N.Y. 10038.

MERCURY, platinum, gold, silver. FREE circular. **MERCURY REFINERS,** Norwood, Mass.

WANTED: Radar Equipment AN/TPS-10D, APT-9, SCR-584, AN/GPG-1, M-33 etc., **P. J. PLISHNER,** 550 Fifth Avenue, N. Y. Tele: 212 JU 6-4691

SERVICES

Transistorized products dealers catalog. $1. **INTERMARKET,** CPO 1717, Tokyo, Japan.

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.

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.

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 Equipment at largest discount. Catalog. **MENDOTA FURNITURE CO.,** Mendota, Minnesota.

STEREO TAPES. Save up to 60% (no membership fees, postpaid anywhere USA). Free 60-page catalog. We discount batteries, recorders, tape accessories. Beware of slogans "not undersold," as the discount information you supply our competitor is usually reported to the factory. **SAXITONE,** 1776 Columbia Road, Washington, D. C. 20009

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.

HI FI Equipment At Dealer. Wholesale Cost. Catalog. **MACALESTER CORPORATION,** 355 Macalester, Saint Paul, Minnesota 55105.

EXCHANGE stereo tapes, catalog. **ART,** 4431 Avocado Street, Hollywood, Calif. 90027

McGEE RADIO COMPANY. Big 1966-1967 catalog sent free. America's best values, hifi—amplifiers—speakers—electronic parts. Send name, address and zip code number to **McGEE RADIO COMPANY,** 1901 McGee Street, Dept. RE, Kansas City, Missouri 64108.

Stereo tapes. America's foremost outlet offers wholesale prices to everyone. **ROBERTS,** 4554 Broadway, Chicago, Ill. 60640

HI-FIDELITY COMPONENTS, Ham Marine and Communication equipment at considerable savings. If you want to save money write us for our low prices on all your needs. **AIREX RADIO CORP.,** 132 (RE) Nassau St., New York, N.Y. 10038

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. New Hyde Park 5, N.Y.

1,000 Business Cards, "Raised Letters" $3.95 postpaid. Samples. **ROUTH,** 5717 Friendswood, Greensboro, N. C. 27409.

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

_______ No. of Words @ .30 Non-Commercial Rate / @ .60 Commercial Rate = $_____

Total Enclosed $__________

Insert_______time(s)

Starting with__________issue

Payment must accompany order unless placed through accredited advertising agency 116

NAME__________

ADDRESS__________

CITY__________ **STATE**______ **ZIP**______

SIGNATURE__________

MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 154 WEST 14TH ST., NEW YORK, N.Y. 10011

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 December issue must reach us before October 10th.
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.

SPECIAL INTRODUCTORY OFFER

15 Epoxy Rectifiers With Every $5.00 Purchase. Many Over 600 PIV. No Shorts or Opens.

"N" Channel Fet's Similar To C-610 Used As Amp, Switch, Chopper—Very High Input Z $1.50 Each

Silicon Power Rectifiers

PRV	3A	20A	40A
50	.05	.20	.50
100	.10	.40	1.00
200	.20	.60	1.50
400	.25	.80	2.00
600	.35	1.20	2.50
800	.45	1.50	3.00
1000	.65		

5A Insul Base

PRV	
50	.10
100	.20
200	.40
400	.60
600	1.00
800	1.25
1000	1.40
1200	1.60

Top Hat & Epoxy 750 MA

PRV	
50	.05
100	.07
200	.09
400	.12
600	.20
800	.25
1000	.50
1200	.65
1400	.85

Silicon Control Rectifiers

PRV	7A	PRV	7A
50	.35	300	1.35
100	.60	400	1.75
200	.90	500	2.25

☐ **SIM. to 2N1640 (PNP)** Bi-directional transistors. A to-5 silicon unit in which collector & emitter are interchangeable. Ea. . . . . . **$.40**

☐ **SIM. to 2N728.** A high frequency to-18 unit extending to the UHF range . . . . **5/$1.00**

☐ **SIM. to 2N1648 (NPN)** high voltage 20 Watt silicon unit, used in power output stages & power transistor drivers . . . **2/$1.00**

☐ **GLASS DIODES** color coded. Silicon . . . . **20/$1.00**
6E . . . . **30/$1.00**

☐ **SIM. to 2N995 (PNP).** Silicon in to-18 case. 500 MW power, to 180 MHz frequency . . . . **4/$1.00**

☐ **SIM. to 2N2875 (PNP).** Silicon 20 watts with 30 MHz cut off **2/$1.00**

☐ **SIM. to 2N255 (PNP),** 20 watts in to-3 case . . . . **4/$1.00**

☐ **10 WATT ZENERS.** 2-70 volts. State desired voltages. Ea. **$.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**

☐ **GaAs VARACTORS,** sim. to AP-1, AP-6, etc. 70 GHz at 150 MW. Ea. **$4.00**

☐ **4" x 10" SPEAKERS.** 10 Ω. 1.5 oz Magnet. Ea. **$2.50**

☐ **6" x 9" SPEAKERS.** 20 Ω. 1.5 oz Magnet. Ea. **$2.50**

☐ **4" SPEAKERS.** 3.2 Ω. 1 oz Magnet. Ea. **$1.25**

☐ **DUAL 1 MEG. POT.** with off-on switch . . . . **4/$1.00**

☐ **24 V 60 Hz 6 PDT** 3 open, 3 closed 15 A Contacts . . **$4.00**

☐ **455 KHz IF XRMRS** . . . **3/$1.00**

☐ **262 KHz IF XRMRS** . . . **3/$1.00**

☐ **DUAL 20 μF at 350 V** Electrolytics . . . . **3/$1.00**

☐ **28-101 P CERAMIC TRIMMERS** . . . . **6/$1.00**

Terms: FOB Cambridge, Mass. Send check or Money Order. Include Postage, Average Wt. per package ½ lb. Allow for C.O.D. Minimum Order $2.00

SOLID STATE SALES

POST OFFICE BOX 74
SOMERVILLE, MASS. 02143
SEND FOR FREE CATALOG

Name __________
Address __________
City __________ State ______

Circle 132 on reader's service card

MARKET CENTER

BUSINESS OPPORTUNITIES

INVENTIONS-IDEAS developed: Cash/Royalty sales. Member: **UNITED STATES CHAMBER COMMERCE,** Raymond Lee, 130-U W. 42nd, New York City 10036

INVENTIONS NEEDED! Free analysis. Dependable service. Experienced personnel. **WALL STREET PROMOTIONS, INC.,** 99 Wall Street, New York, New York 10005

Continental Airlines has immediate opportunities for Radio Navigation Overhaul Mechanics, Radio Line Mechanics, Second Class FCC License required. Write to Mechanic Employment, **CONTINENTAL AIRLINES,** Los Angeles International Airport, Los Angeles, California 90009

ELECTRONICS

BARGAINS in Canadian Electronic equipment and surplus. Send $1.00 for giant catalogs. **ETCO,** Dept. R, 520 Fifth Avenue, New York 36, N.Y.

DIAGRAMS, service information, Radio $1.00. Television $2. **BEITMAN,** 1760 Balsam, Highland Park, Illinois 60035

PROFESSIONAL ELECTRONICS PROJECTS — Organs. Timers. Computers. etc.—$1 up. Catalog 25¢. **PARKS,** Box 25565, Seattle, Wash. 98125.

TUBES. "Oldies", latest. Lists free. **STEINMETZ,** 7519 Maplewood, Hammond, Indiana, 46324.

Circle 133 on reader's service card

FREE Catalog. Electronic parts, tubes. Wholesale. Thousands of Items. Unbeatable prices. **ARCTURUS ELECTRONICS RE,** 502-22 St., Union City, N. J. 07087

BEFORE You Buy Receiving Tubes, Transistors, Diodes, Electronic Components & Accessories . . . send for Giant Free Zalytron Current Catalog, featuring all STANDARD BRAND TUBES all Brand New Premium Individually Boxed. One Year Guarantee—all at BIGGEST DISCOUNTS in America! We serve professional servicemen, hobbyists, experimenters, engineers, technicians. WHY PAY MORE? **ZALYTRON TUBE CORP.,** 469R Jericho Turnpike, Mineola, N. Y. 11502

TV CAMERAS, converters, etc. Lowest factory prices. Catalog 10¢. **VANGUARD,** 196-23 Jamaica Ave., Hollis, N.Y. 11423.

SURPLUS PARTS CATALOG. Send for free catalog listing hundreds of up-to-date electronic components at down-to-earth prices. **ELECTRONIC CONTROL DESIGN COMPANY,** P.O. Box 1432-P, Plainfield, N.J. 07061.

MESHNA CONVERTER KITS, converts car radio for shortwave reception. Police, fire, marine. 30-50mc, 100-200mc, marine. Any kit $5.00. Completely wired for use $15.00. **MESHNA,** No. Reading, Mass.

RADIO & TV TUBES 33¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL,** 4217-E University, San Diego, California 92105.

TRANSISTORS-DIODES — Components. Large selection. Write for FREE catalogue. **ELECTRONIC COMPONENTS CO.** Box 2902B, Baton Rouge, La. 70821

BEGINNERS, BUILDERS' Giant catalog—25¢, refundable. **LABORATORIES,** 12041-B Sheridan, Garden Grove, Calif. 92640

TV CAMERA KITS including printed circuit and transistor models $18.95 up! Send 10¢ for 1966 catalog. **ATV RESEARCH,** Box 396-R, So. Sioux City, Nebr. 68776

BUILD TRANSISTOR Treasure finder. Details free. **DEL RESEARCH,** Box 436 F, Centerville, Georgia.

GOVERNMENT SURPLUS

72 page illustrated Government Surplus Radio, Gadgeteers Catalog 25¢. **MESHNA,** Nahant, Mass.

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.

FCC LICENSE in 6 weeks. First Class Radio Telephone. Results Guaranteed. **ELKINS RADIO SCHOOL,** 2603E Inwood, Dallas, Tex.

SLEEP LEARNING. Hypnotism! Tapes, records, books, equipment. Details, strange catalog FREE. **RESEARCH ASSOCIATION,** Box 24-RD, Olympia, Wash.

BROADCASTING, Communications Electronics taught quickly—resident classes; correspondence. Free details. Write: Dept. 4, **GRANTHAM SCHOOLS,** 1505 N. Western, Hollywood, Calif. 90027

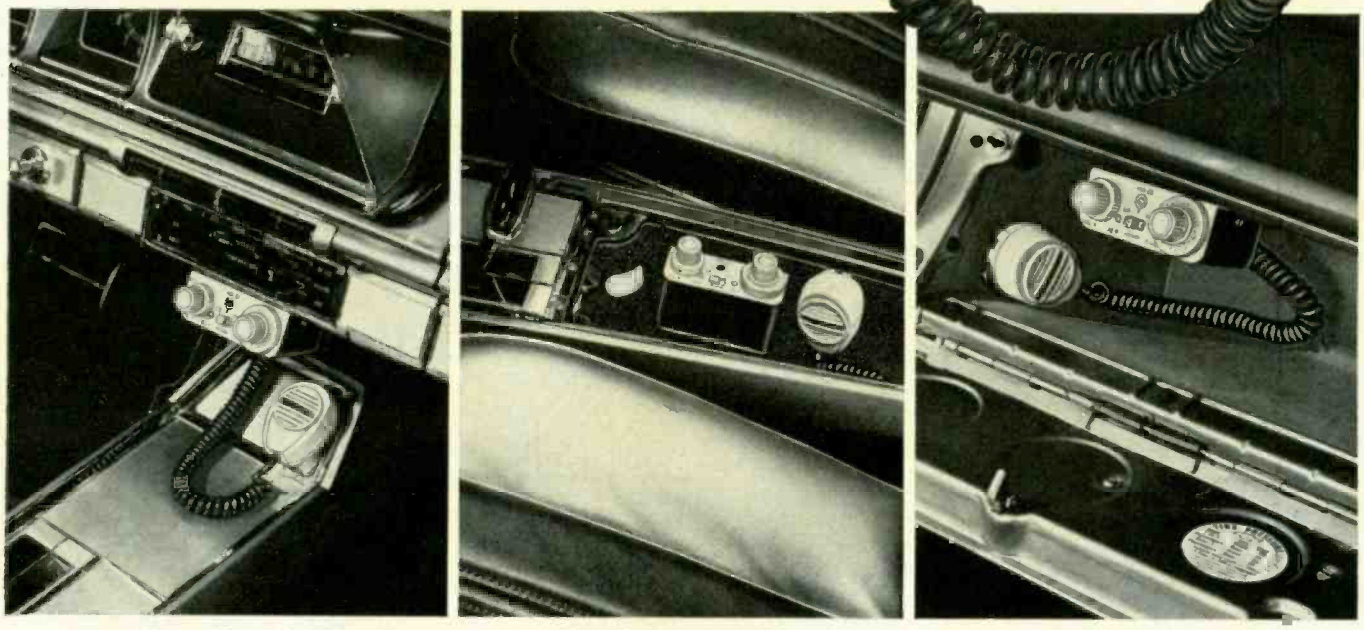
REI First Class Radio Telephone License in (5) weeks Guaranteed. Tuition $295.00. Job placement free. **RADIO ENGINEERING INSTITUTE,** 1336 Main Street, Sarasota, Fla.

PROFESSIONAL Engineering, Electronics, Free Prospectus. **CIST,** Suite 656, 263 Adelaide Street, West, Toronto, Canada

SPANISH BOOKS! "Motores Electricos" $6.00, "Instalaciones Electricas" $8.00—Catalog 25¢. **BURKE ASSOCIATES,** Manchester, Mass.

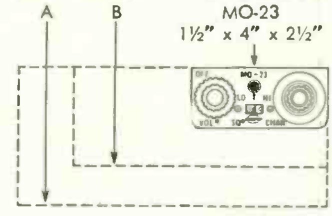
Circle 134 on reader's service card

the International MO-23 citizens radio transceiver hides...



under the dash .... in the console ...... in the glove compartment

The MO-23 remote control unit is so small it will rest on the palm of your hand (1½″ H x 4″ W x 2½″ D). You can install the MO-23 under the car dash . . . in the glove or console compartment. Compare this versatile mobile two-way radio with other makes. See for yourself how little space this unit really requires. Technically speaking, the MO-23 combines the best advantages of tubes and silicon transistors.



Compare the size of the MO-23 remote control unit with other sets.

CHECK THESE FEATURES:

- 23 Crystal Controlled Channels
- Miniature Solid State Remote Control
- Illuminated Channel Selector
- Transmit/Receive Trunk Unit
- Transistor Power Supply

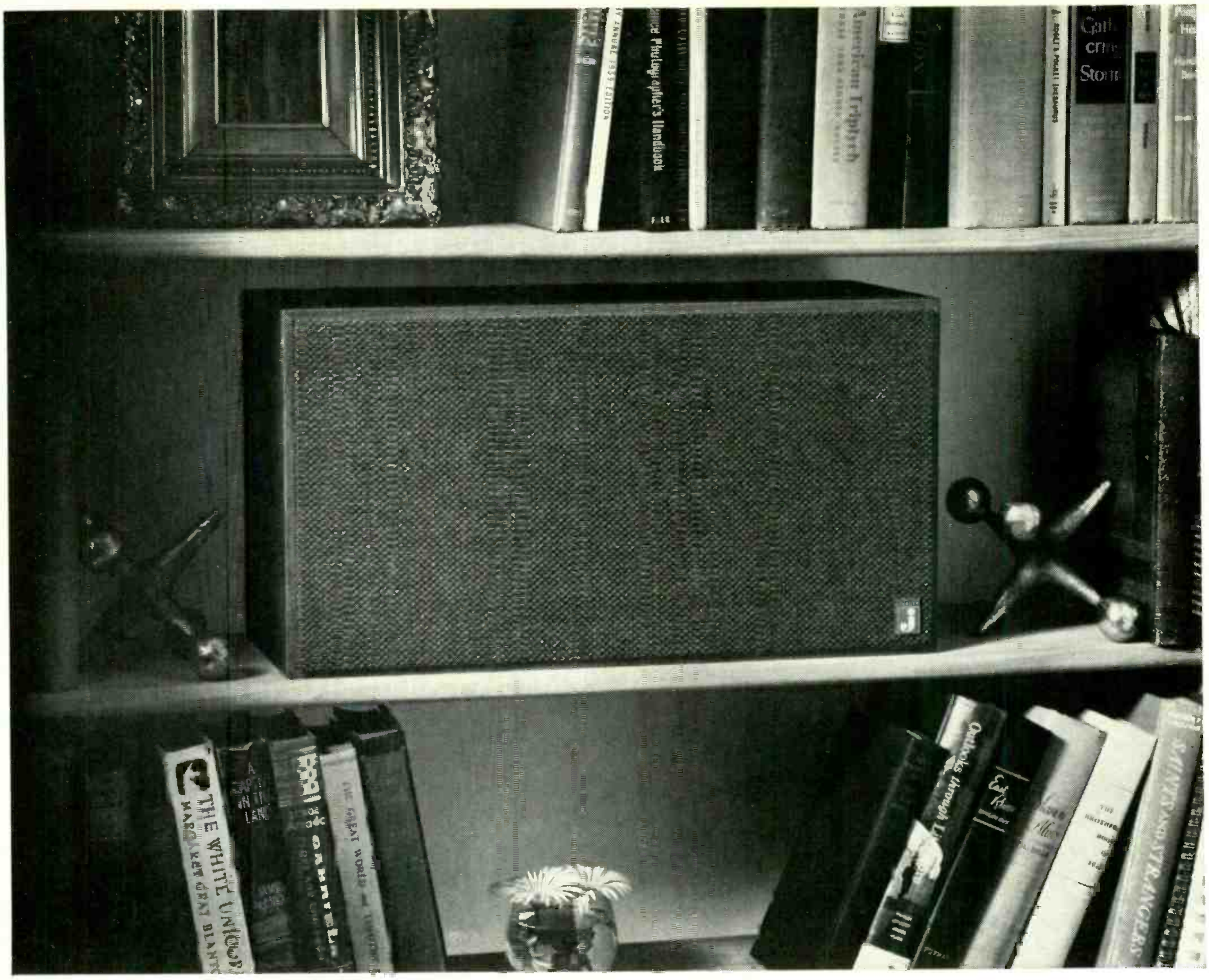
FCC Citizens Radio license required. All use must conform with Part 95, FCC Rules and Regulations.

Ask your dealer to show you the International MO-23. We think it's a great new transceiver. You will too!

WATCH FOR INTERNATIONAL "FLYING SHOWROOM '66". *WELCOME ABOARD!*

INTERNATIONAL CRYSTAL MFG. CO., INC.
18 NO. LEE · OKLA. CITY, OKLA 73102

Circle 135 on reader's service card



Listen!

Put big sound between your bookends

Here's the exciting new Jensen X-40, ultra-compact loudspeaker system. Physical dimensions: One cubic foot. Sound dimensions: It's way ahead of anything else in its class.

Jensen engineers have created this big-system sound with an 8-inch, long travel FLEXAIR® woofer and a 3-inch direct radiator tweeter housed in a fine oiled walnut cabinet. And for only $57.

Don't miss hearing the X-40 in a monaural or stereo demonstration at your Jensen dealer. If you prefer the highs of a horn-loaded tweeter, ask to hear the dynamic new X-45 loudspeaker system, too. (It costs only six dollars more.)

Both models have high frequency balance controls. Both are two-way systems that cover the complete audio range from 30 to 16,000 cycles.

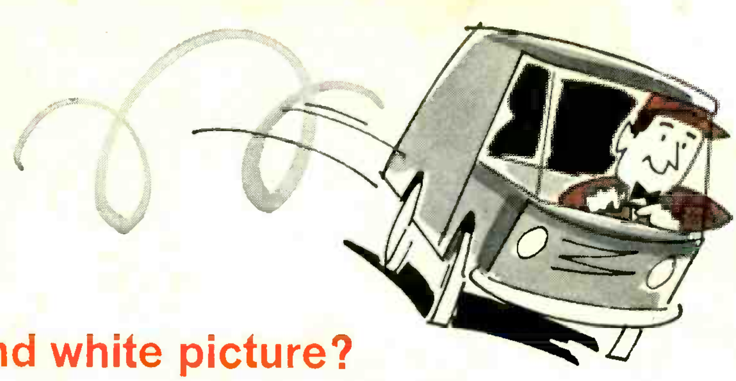
And that's a lot of sound between anyone's bookends.

Jensen

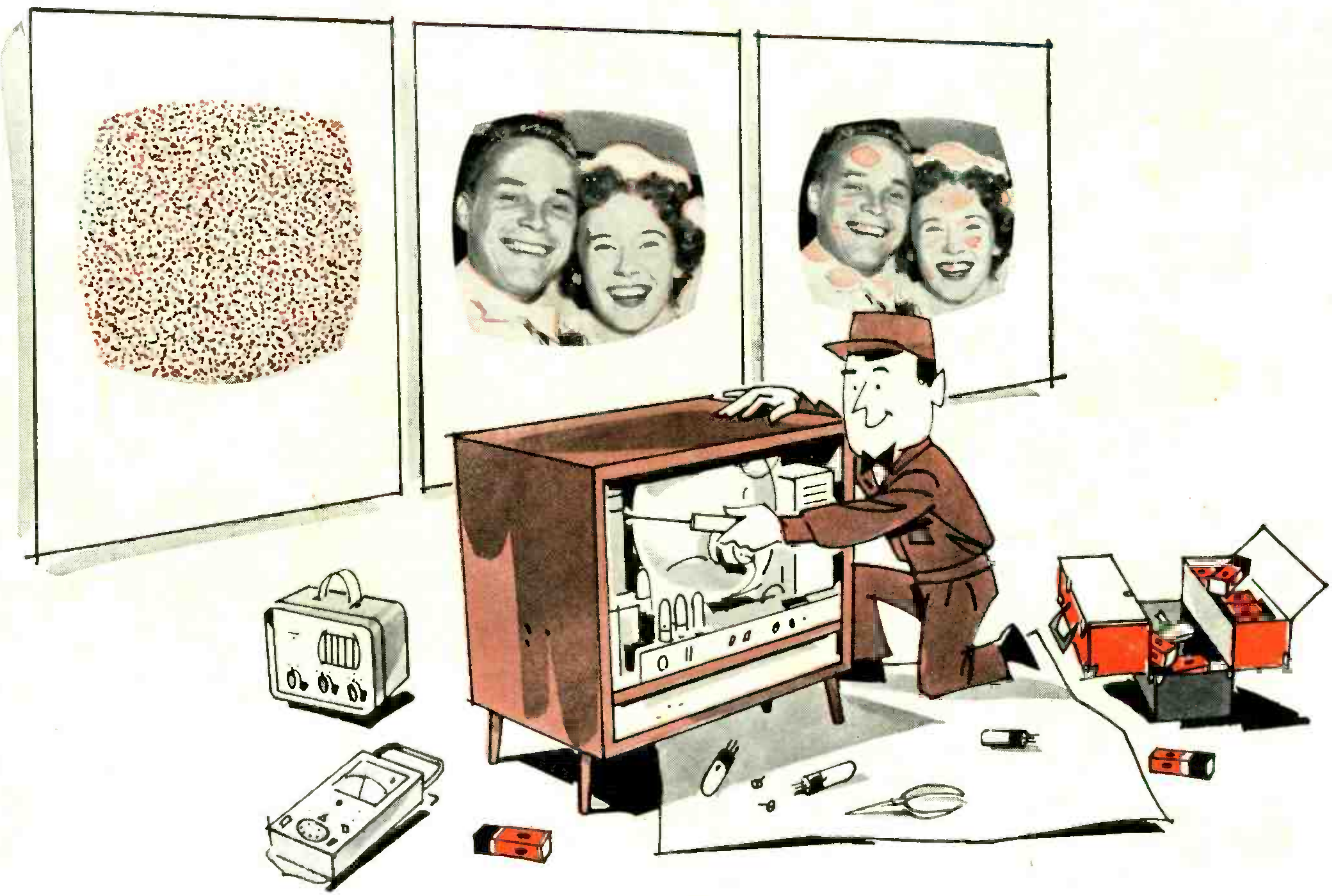
Jensen Manufacturing Division, The Muter Company
6601 South Laramie Avenue, Chicago, Illinois 60638

Circle 136 on reader's service card

RCA's COLOR TV FASTCHECK #4



Color in a black and white picture?



First, determine the exact nature of the undesired color...

One of the best performance indicators of a color TV receiver is the quality of its black and white picture. It should be free of all color fringing and tinted areas. Because undesired color effects can be due to several causes, the exact nature of the unwanted color should be determined before adjustments are attempted.

Make sure that rf interference is not present. Then, follow these steps in order:

1. Tune in a black and white picture, adjusting fine-tuning correctly.
2. Check for color fringing (misconvergence) around picture elements, and for tinted patches. If fringing is evident, use an RCA WR-64B Color-Bar/Dot/Crosshatch Generator and readjust convergence. Eliminate tinted raster areas by degaussing the picture tube and resetting purity if required.
3. Tune to an unused channel and look for colored snow. If colored snow is present, adjust the color-killer threshold control to the point where color disappears from the snow.
4. Tune in a black and white picture. Set controls for normal brightness and contrast. The highlights should be white and the lowlights should be gray. If highlights and/or lowlights are tinted, adjust gray-scale tracking.
5. If proper gray-scale tracking cannot be achieved, check tubes and components in the chroma amplifier stages.
6. If these checks fail to correct the trouble, use an RCA WT-115A Color Picture Tube Tester to check emission of the three electron guns of the picture tube.

This is another in a series of color TV service hints from RCA. For more satisfied customers always replace with top quality RCA receiving tubes. Your local RCA tube distributor can supply all your tube needs for color TV, black and white TV, radio and hi-fi.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

RCA® **The Most Trusted Name in Electronics**