60c ■ OCT. 1970

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

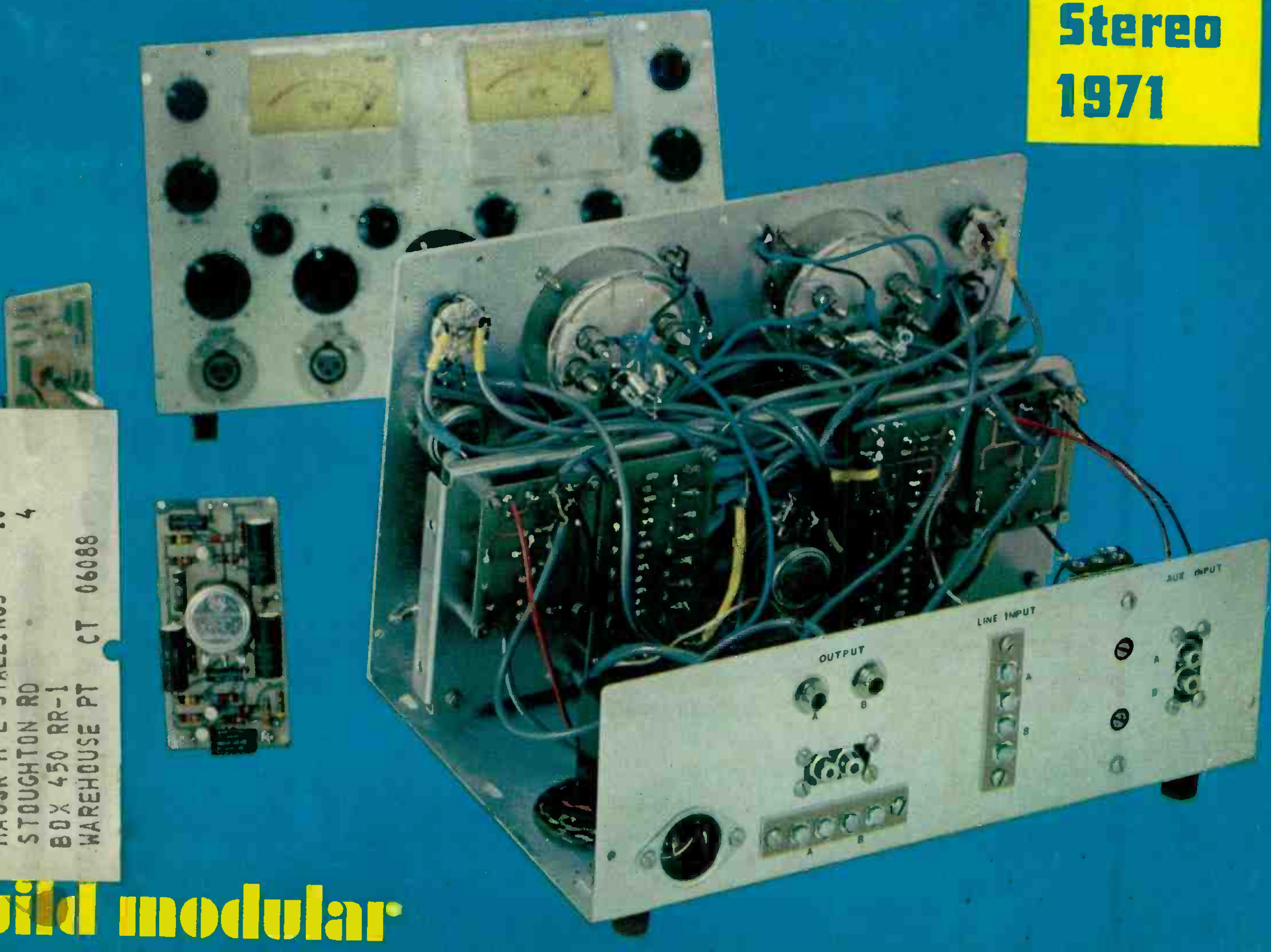
New 4-channel stereo techniques

Build FM stereo multiplex generator

Pro's tape recording quiz

Get better sound from your stereo

Special Issue Stereo 1971



Build modular 6-channel stereo mixer preamp

A GERNSBACK PUBLICATION

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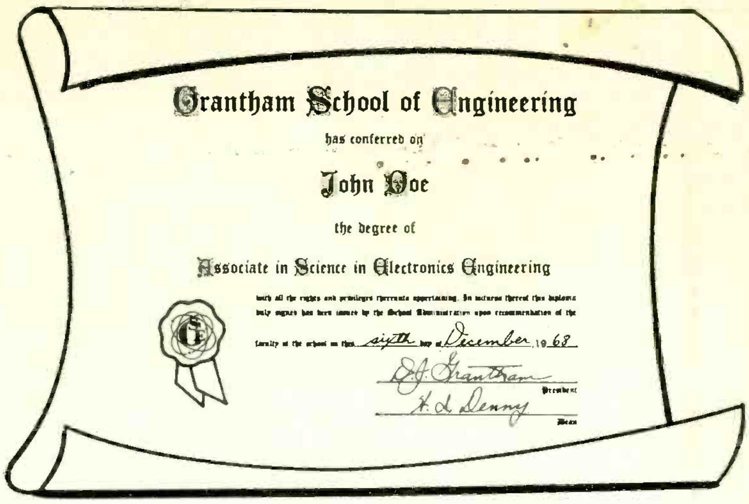

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Circle 2 on reader service card

NEW & TIMELY

Volume 41 Number 10 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS October 1970

The FERPICS are Coming

MURRAY HILL, N.J.—Think of an erasable, reusable 35-mm slide on which an operator can electronically erase all or part of the image, add new material, and reproject a new image on the screen.

Scientists at Bell Laboratories are investigating these devices which store images until they are electronically erased or changed.

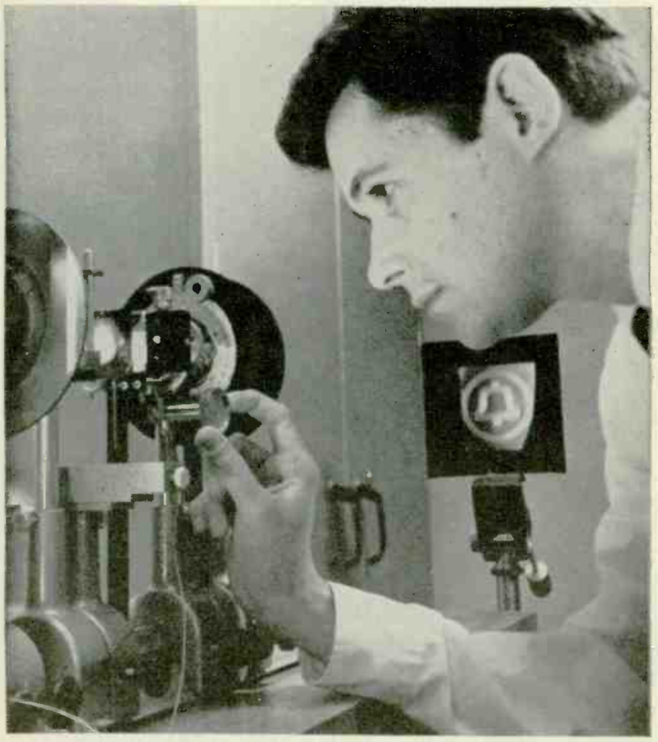
Called ferpics (ferroelectric ceramic picture devices), the devices are made of material first announced by Sandia Corporation.

The ferpic device is a sandwich structure consisting of transparent electrodes, a photoconductive film and a thin plate of fine-grained ferroelectric ceramic. To change the stored information in this simple structure, a new technique, called "strain-biasing" was developed at Bell Labs. The basic ferpic sandwich is bonded to a transparent substrate which is then flexed so as to stretch or "strain" the material.

In an ordinary film slide an image is stored in the form of variations of transparency across the film. In a ferpic the image is stored as a variation of the "birefringence" of the ceramic plate—as a variation in the way the plate transmits polarized light.

In one mode of operation, a scanned laser beam records an image on the photoconductive film—one picture element at a time as in a TV picture. A voltage applied to the transparent electrodes develops a field across the ceramic. When the field is removed, the image remains stored on the ceramic plate. The image store in the ferpic device can be viewed by putting light polarizing sheets over it, or the image can be projected on a screen using polarized light in a conventional projection system.

To erase the image, the entire structure is flooded with light in the presence of a reversed electric field; the plate is then ready to store another image.



FERPIC FOCUS ADJUSTMENT is made by Juan Maldonado on image of Bell System symbol projected onto small screen.

HANDFULL OF MEMORIES—Ann Karagines examines 250 feet of magnetically plated Mini-Wire at Honeywell's Aerospace Division in St. Petersburg, Florida. The wire, which is only two thousandths of an inch in diameter, has been combined with medium-scale integrated circuits in a new computer memory being tested at the division.

The device is being explored in the hope of obtaining efficient, low-cost solid-state information displays with features that are difficult to obtain in present display systems. Because the image stored in the ferpic device can be projected, very large displays can be obtained. Also ferpic slides can retain images for a long time without electrical power. A TV set must be fed signals continuously to retain an image; once power stops, the image fades.

ORIGINAL PHOTO (above) is conventional photo. FERPIC STORED IMAGE (below) shows loss of detail and clarity.

At the present stage of development ferpic devices can store and display, with high resolution, black and white images that fade only slowly. Thus present ferpics are suitable for the display of, for example, written text or figures, since such applications, while exploiting the unique image storage capabilities of the device, would not place severe demands on the speed or lifetime of the ceramic material. ★

Faster Fax

SADDLE BROOK, N.J.—A new, low cost, high speed facsimile telecommunications unit that can cut telephone costs by as much as one-half has been introduced by Magnavox Systems, Inc. Called Magnafax 860, the new unit is a two-

(continued on page 12)

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

October 1970 • Over 60 Years of Electronics Publishing

HI-FI——STEREO——AUDIO

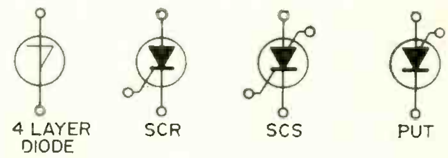
BUILD ONE OF THESE

TELEVISION

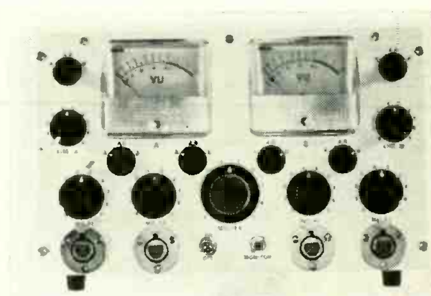
GENERAL ELECTRONICS

DEPARTMENTS

4-Channel Stereo is here. Take a careful look at the latest developments in this exciting area. . . . see page 33



How to Use the PUT (programmable unijunction transistor). Try some of these circuits. . . . see page 50



Stereo Mixer Preamp is solid-state dream unit. If you make tape recordings you need one. . . . see page 36

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LOOKING AHEAD

Volume 41 Number 10 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS October 1970

by **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

Technicians and X-rays

A little-publicized survey by the U.S. Department of Health, Education and Welfare so far has indicated that there may be no grounds for fears that service technicians are exposed to excessive amounts of X-radiation from color television receivers.

The tests are being conducted with the cooperation of technicians in Baltimore. At press time, surveys had been completed in about 50 shops and HEW was hoping to enlist about 50 more. In the tests, technicians used a new type of dosimeter to determine their exposure to radiation. The tiny instruments were mounted in eyeglass frames, on finger rings and on belts, to measure radiation exposures at various vital points of the body.

At the halfway point in the tests, Dr. Robert L. Elder, acting director of HEW's Division of Electronic Products, Bureau of Radiological Health, told us that analysis of the dosimeters showed "no significant exposure" to radiation of technicians servicing color sets. "To date there has been no radiation which warrants action."

Dr. Elder also said that the survey showed that technicians were being extremely diligent—at least in Baltimore—in checking high-voltage in every service job and setting it to the manufacturers' specifications.

How about the U.S. Surgeon General's admonition to "sit 6 to 10 feet away from color TV sets?" Dr. Elder indicated that this rule is being modified slightly with the improvement in new color sets, less radiation-prone replacement parts and good radiation discipline by technicians. "It's a guide, not a mandate," he said. To those who inquire, HEW is saying: "If you are concerned about possible radiation, sit 6 to 10 feet away and call a service technician."

Causes of radiation

While we're on the subject, another HEW study has found that the "predominant cause of X-radiation" in color sets is excessive high voltage on the picture tube. HEW made lab studies of sets which flunked factory radiation tests between June and September 1969 (there were 22 of them). The studies showed that none of the sets emitted excessive radiation when the high voltage was held down to the manufacturer's suggested maximum. On the basis of preliminary data, the studies indicated that Japanese-made color tubes "may be more poorly shielded than their American counterparts." Since the tests were made, Japanese glass manufacturers have increased the X-ray resistant content of their tube envelopes.

1970 TV-model sales

There's a recession on, but it hasn't affected total TV sales as much as you might think. Sales of 1970 model television sets totaled about 11.9 million units, only five percent below the record 12.55 million 1969 models sold. Of course, the difference was that black-and-white sales went up (about six percent) while color sales declined (16 percent) from the 1969 model year. And within the color category, portables—particularly foreign-made—accounted for a far greater percentage of sales than ever before.

Color sets carrying American manufacturers' brand names declined by 18 percent in the 1970 model year, while U.S.-brand monochrome sets dipped 14 percent. On the other hand, so-called "foreign brand" imports (sets without American manufacturers' names on them) increased their sales 12 percent in color and a big 170 percent in black-and-white during the 1970 model year.

Another videoplayer system

A dark-horse entry in the home videoplayer sweepstakes could be ABTO Inc. This firm, jointly owned by American Broadcasting Companies and Technical Operations Inc., was originally formed to sell to television stations an optical process which permits the recording and playback of color programming on black-and-white motion picture or slide film.

ABTO now is discussing a home version, in which a color television set would use a film-scanning system to produce color from low-cost Super-8 monochrome film cartridges. As an added plus, the TV-film player would be able to show conventional color home movies on a color TV screen. ABTO is interested in marketing the film system only, not the hardware.

Higher speed facsimile

Relatively low-cost facsimile systems which use regular voice telephone lines now have become accepted items of equipment in many offices, large and small. Their major drawback, particularly where long-distance telephone lines are used, heretofore has been their slow speed—normally six minutes to transmit one 8½-x-11-inch page. But now a speed-up is coming.

The first to announce a faster office fax machine available for sale has been the Magnavox Corporation (see New & Timely, this month, for full details).

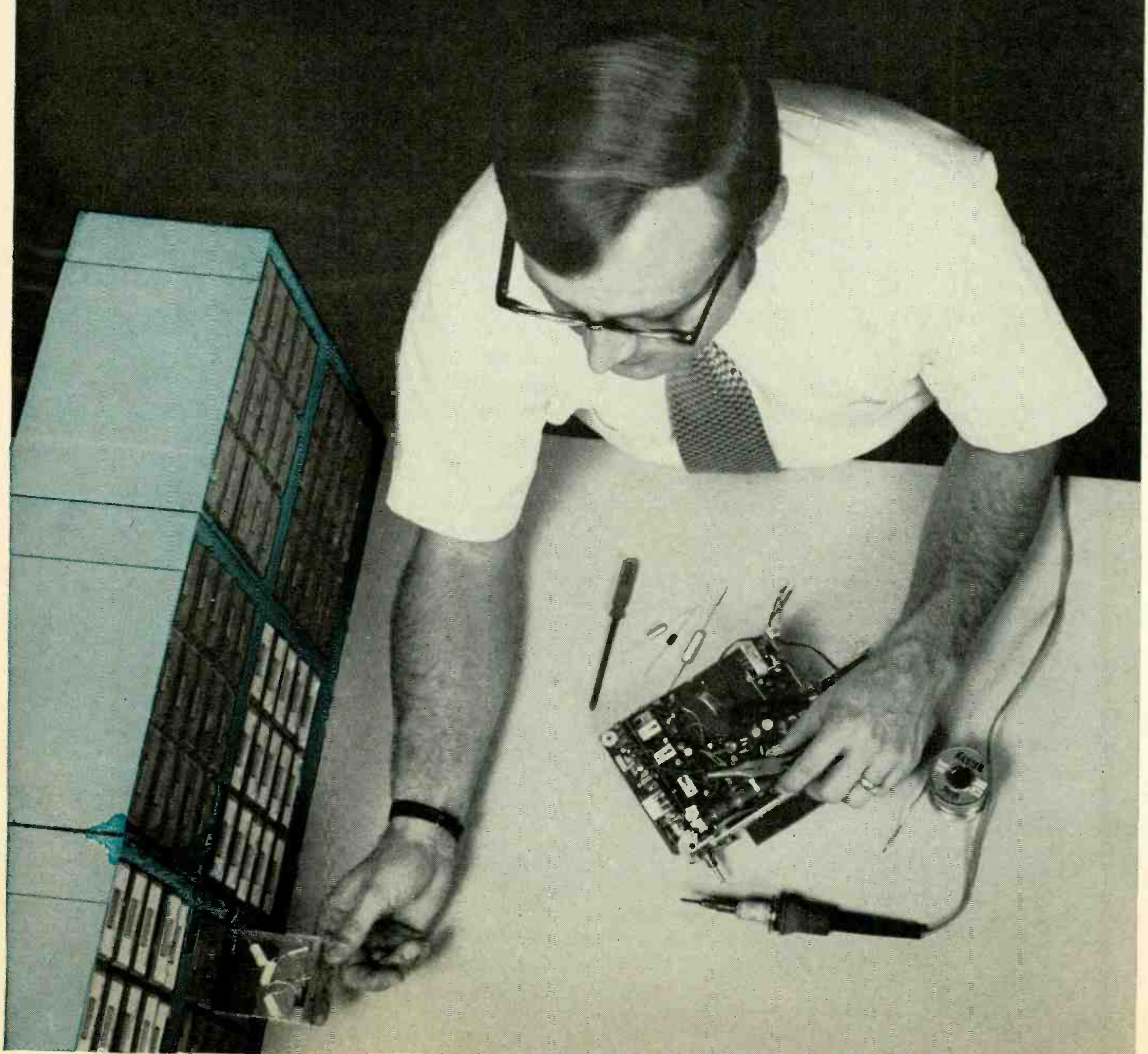
Other high-speed machines are on the way. Xerox is expected soon to introduce a 4-minute version of its 6-minute Telecopier. Comfax is developing a somewhat more elaborate machine which can transmit and receive a standard letter-size page in as little as 90 seconds.

TV fires evaluated

How big a problem is posed by burning television receivers? National Electronics Association has released results of a survey of its own service technician members which differ rather sharply from the "clear-and-present-danger" philosophy expressed in the recent report of the National Commission for Product Safety, NEA's survey covered the period of January 1 to March 30, 1970, but was projected to cover the entire United States.

On the basis of its survey, NEA made these projections: Some 4,000 television failures occur each year which show signs of combustion. Only about 20% of these, or 800, involve any fire which is not contained within the cabinet. With some 87 million TV sets now in use, the figure comes to less than one one-thousandth of one percent. Any TV set fire is one too many, but NEA's data seems to indicate a good safety record considering the number of sets in use and the amount of time the average family spends with the TV set.

NEA gave this breakdown of the causes of television set fires: On-off switch area, 38%; high-voltage and horizontal-output transformer area, 33%; short circuits causing power-supply overloads, 13%; miscellaneous, 16%. Since the report of the National Commission on Product Safety, Underwriters' Laboratory and the television manufacturing industry have developed new and tighter fire safety standards for receivers and components. **R-E**



Circle 3 on reader service card

Editorial

Veterans Educational Benefits

If you're a recent veteran, there are many kinds of educational benefits that are available to you. They are particularly important if you wish to increase your knowledge of electronics. Through the Veterans Administration it is possible to obtain up to $175 per month for 36 months (a grand total of $6400), to use toward your further education in electronics. This applies to both resident and home-study (correspondence) courses.

If you now know nothing about electronics, you can start with a basic course and go on through whatever specialty interests you. If you are already at the technician level, you can take specialized courses in communications, radar, broadcasting, computers, etc. As long as the school is approved (check with your local Veterans Administration Office) you will be entitled to financial assistance. In all instances, the school offering the course you are interested in can tell you if it is approved by the VA. They can also spell out the exact benefits you can expect to receive.

A reminder; in many instances these benefits will cover the complete cost of a correspondence course. So if you can't attend a resident school, don't write off further education as impossible. If you do take a correspondence course, all electronic equipment normally supplied with the course is included and is yours to keep.

Don't let this opportunity pass you by. These benefits are available to you for a limited time after your discharge from military service. If there's a school you want to attend, follow it up now. It's your future—get the training you need to make the most of it.

Radio-Electronics

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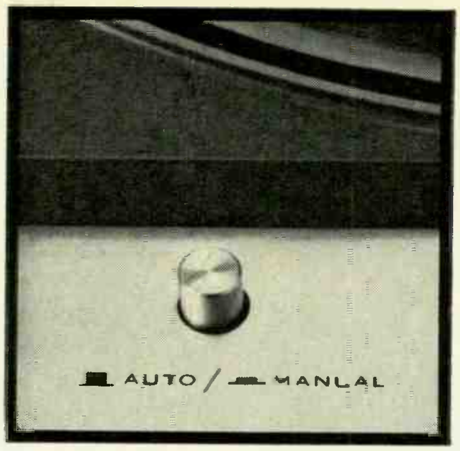
There wasn't room for a big improvement. So we made a little one.



Our engineers made three changes in Sony's popular PS-1800 playback system. They added a little button called "Automatic/Manual"; streamlined its appearance and added "A" after the PS-1800. Obviously, none of these, earth-shaking changes.

You might never use the little button labeled "Automatic/Manual," unless you ran across a non-standard record where the recorded material goes too far into the normally "dead" space surrounding the label. Such records are few and far between. If you run up against one of them, the automatic tonearm return on the Sony would ordinarily lift and return just *before* the record's end. However, if you push the button to "Manual" the arm will track the entire record until you lift it off by hand (or push the reject button).

The styling change means that this superb playback instrument will enhance any room. And the "A" will help you identify it as the new model when you visit your hi-fi specialist.

What's more important is what our engineers didn't do to the PS-1800; what they left well enough alone. The servo control DC motor that keeps wow and flutter at an inaudibly low 0.08; rumble down 60dB (ARLL). A variable pitch control from ±4% (if you don't need it, the built-in strobe disc assures that the variation is indeed tuned out). And the balanced, low mass tone arm is capable of tracking virtually any cartridge at its lowest recommended tracking force.

Not to mention the automation system, which uses a remarkable new solid-state device, the Sony Magnetodiode (SMD). Automatically, it lifts and returns the arm without imposing any drag on the arm during play. The SMD eliminates a variety of mechanical linkages formerly necessary for this function. And there's a reject button (on the front panel so you don't have to lift the dust cover to get at it).

The price of the PS-1800A? No change. $199.50 (suggested list), includes turntable, arm, base and dust cover (cartridge not included).
Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.

SONY® PS-1800A

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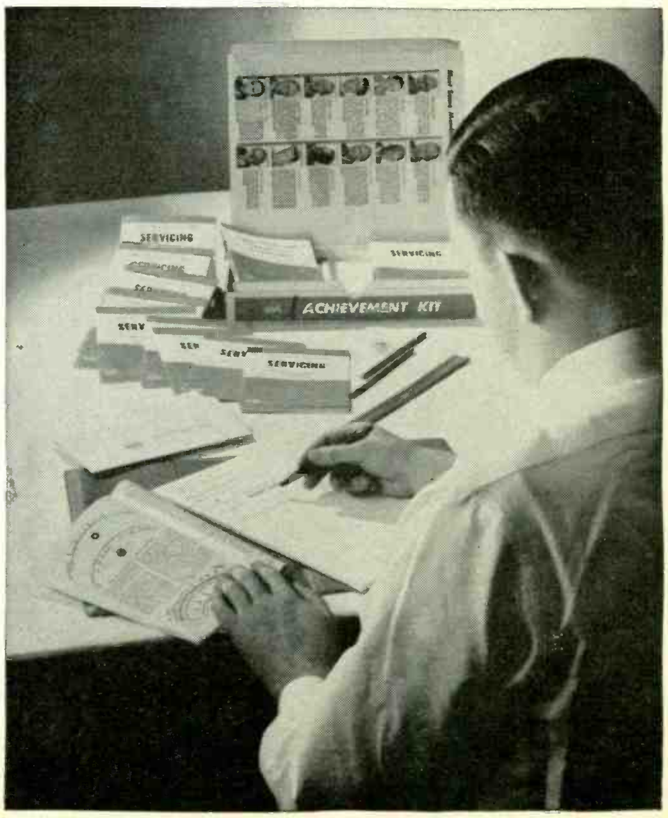

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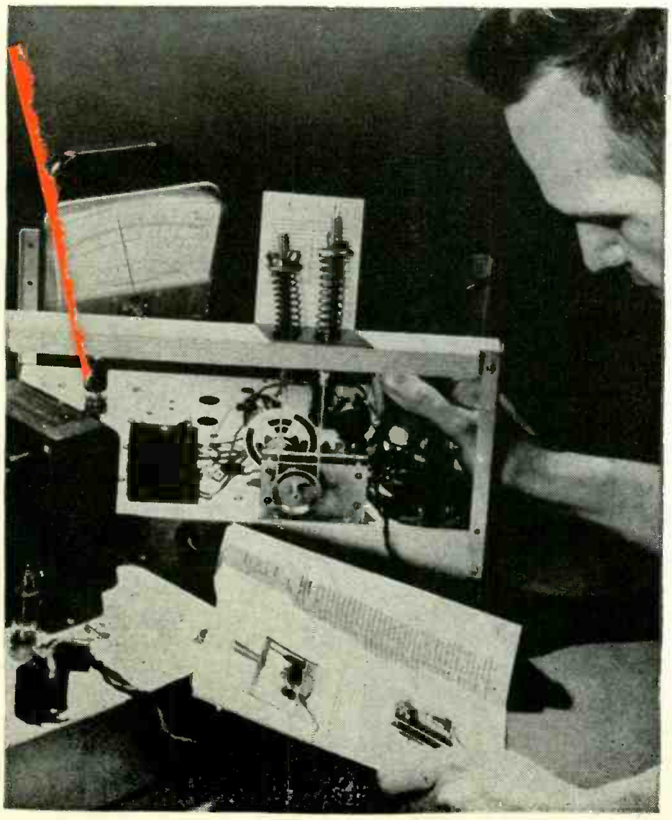
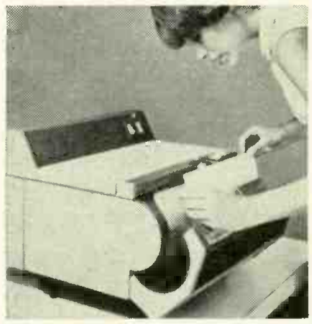


New & Timely

(continued from page 2)

speed model which offers the user the option of a 3 minute or 6 minute transmission for full-page documents (drawings, proofs, financial and priority reports, photographs) through a telephone coupling.



The two-speed model offers a significant reduction in both telephone line charges and operator time while operating in the 3-minute setting, and the 6-minute mode provides improved resolution and picture quality. In addition, the 6-minute setting permits the Magnafax 860 to speak to a wide number of facsimile devices installed in the USA. ★

Teleconsultation Is Now

TV PSYCHIATRIC CONSULTATION shows how system will operate in Boston.

BOSTON, MASS.—Television now links two large Greater Boston teaching hospitals in a way never attempted anywhere before.

Massachusetts General Hospital in Boston and the Veterans Administration Hospital, 25 miles away in Bedford, share their expertise over closed-circuit television. The unique venture embraces all three purposes of each institution: patient care, physical education, and research.

Dr. John H. Knowles, General Director of the MGH, and John J. Whalen, Director of the V. A. Hospital, primarily a psychiatric institution, announced the project recently. Newsmen watched a program beamed between the two hospitals. After a successful pilot period of two months, the project is now open on a regular basis.

The psychiatrist and patient at Bedford will also be able to see whoever is at the MGH Teleconsultation room.

The two-way nature of the system enables either of the two hospitals to seek medical or allied medical consultations. Residents in training at MGH—in dermatology, for example—with their instructor will be able to see skin disorders that would be rare or non-existent to MGH. At the same time, the Bedford patient will gain by the consultation that is part of the demonstration. And, an engineer at the MGH could examine a chart shown by an engineer at Bedford in addition to hearing a word description of a hospital engineering program. Medical and non-medical teaching programs

(continued on page 14)

ANY NUMBER CAN PLAY.

The time is tomorrow. The name is TEAC. The machines are the Simul-trak™ Series TCA-40. And they're here today.

This series of tape decks combines the best features of high-quality quarter-track, two-channel operation with four-channel stereo capability. It's the best of two worlds, in three versions, four channels.

All three models feature four-channel playback, as well as regular two-channel playback with auto reverse. What's more, Models 40 and 41 can be modified later to the full four-channel capability of Model 42, at moderate cost. Meanwhile, any one of these machines is compatible with your present equipment; no modifications or reassembly are necessary.

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TEAC

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General Specifications

- Speeds – 7½ and 3¾ ips
- Motors – 1 hyst. sync., 2 outer rotors
- Wow and Flutter – 0.12% @ 7½ ips
- Freq. Response – ±3 dB 50-15,000 Hz @ 7½ ips
- S/N Ratio – 50 dB
- Crosstalk – 48 dB

TCA-40

• ¼-track, 2-channel stereo playback, plus 4-channel stereo playback (in-line) • ¼-track, 2-channel erase and record heads for future "step-up • Automatic reverse for uninterrupted playback of conventional 2-channel tapes • Readily modified to TCA-41 or 42 • Built-in solid-state preamplifiers • Ideal for duplication master or copy deck

TCA-41 *(Illustrated)*

• ¼-track, 2-channel stereo playback, plus 4-channel stereo playback (in-line) • ¼-track, 2-channel record • Automatic reverse for uninterrupted playback of 2-channel tapes • Readily modified to future 4-channel recording capability, or TCA-42 • Solid-state playback and record preamplifiers • Off-the-tape monitoring selector

TCA-42

• ¼-track, 2-channel stereo playback, plus 4-channel stereo playback (in-line) • ¼-track 2-channel stereo record and 4-channel stereo record (in-line) • Automatic reverse for uninterrupted playback of 2-channel tapes • Total of 8 separate solid-state playback and record preamplifiers • Off-the-tape monitor selectors

New & Timely

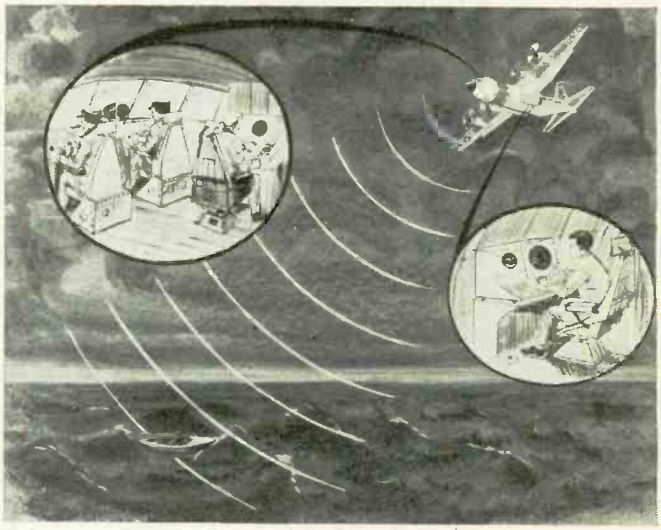
(continued from page 12)

will also be developed between the two institutions.

Physicians at the hospital in Boston have examined some 1,700 patients at the airport since the system originated. Both airport employees and passengers have availed themselves of the service aimed at making optimal use of the busy physician's time by eliminating travel to the airport medical station.

Late in the spring of 1969, Dr. Thomas F. Dwyer, an MGH psychiatrist, began interviewing psychiatric patients over the closed-circuit network. ★

New Coast-Guard Radar-TV



WASHINGTON, D.C.,—A new airborne search radar which converts radar information to daylight viewing will increase the U.S. Coast Guard's capabilities for small craft searches and rescues.

The new system, called Search and Rescue Airborne Radar, will be built by the AIL division of Cutler Hammer for the Coast Guard to detect objects as small as a 16-foot fiberglas boat in five-foot seas at distances of 10 miles from the searching Coast Guard aircraft. The system is designed to detect these objects in clear weather as well as heavy fog and rain.

The system will have a scanning antenna that will turn 300 revolutions per minute, a rate five times greater than that of today's operational radars. The resultant increase in radio beams, reflected by the consistency of the targets looked at, will reduce the interference from random objects in the ocean, such as wave crests which might normally appear on the radar scope as targets. Distinguishing this random "sea return" from small targets has been a major problem in the past.

One of the most important features of the system will be the conversion of the radar information to a television screen. This will be the first development of a motion compensated system that converts radar blips to a TV type bright display on board a flying aircraft.

The relationship of small targets to other targets which appear on the radar screen will be accentuated because of a new design which takes the relationship of the input to the output amplifier logarithmically instead of linearly. R-E

Want to tie up the service market?

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CHANNEL MASTER

Div. of Avnet, Inc., Ellenville, N.Y. 12428

Circle 10 on reader service card

Correspondence

HOW TO FIND PARTS

I was sorry to read about John Sikara's complaint in the Correspondence Column about the difficulty in obtaining parts for construction articles.

I would like to suggest a method for the readers to find their parts. The first stop is, of course, their normal distributor from whom they can pick up all the standard parts. The second move is to find a distributor for the manufacturer of the parts they are missing. This usually can be done by checking the catalogues, yellow pages of the telephone book, or calling the nearest sales office or representative of that company. Then order the missing parts from that distributor. In some cases it may mean a delay of several weeks but the distributor can get the parts. If the parts still can not be purchased, then write directly to the company that makes them at the place they are made. The last resort, of course, is for the builder to write to the author in care of the magazine.

RICHARD W. FOX
Applications Engineer
General Electric Company
Auburn, New York, 13021

8-TRACK-DATA NEEDED

As a subscriber, I appeal to you or your readers for information—schematics and operating instructions—covering 8-track player/recorder manufactured by Kalof Electronics, Van Nuys, Calif. It is model U.T. 801, Serial No. D 1054. Will appreciate any information anyone has on subject player/recorder.

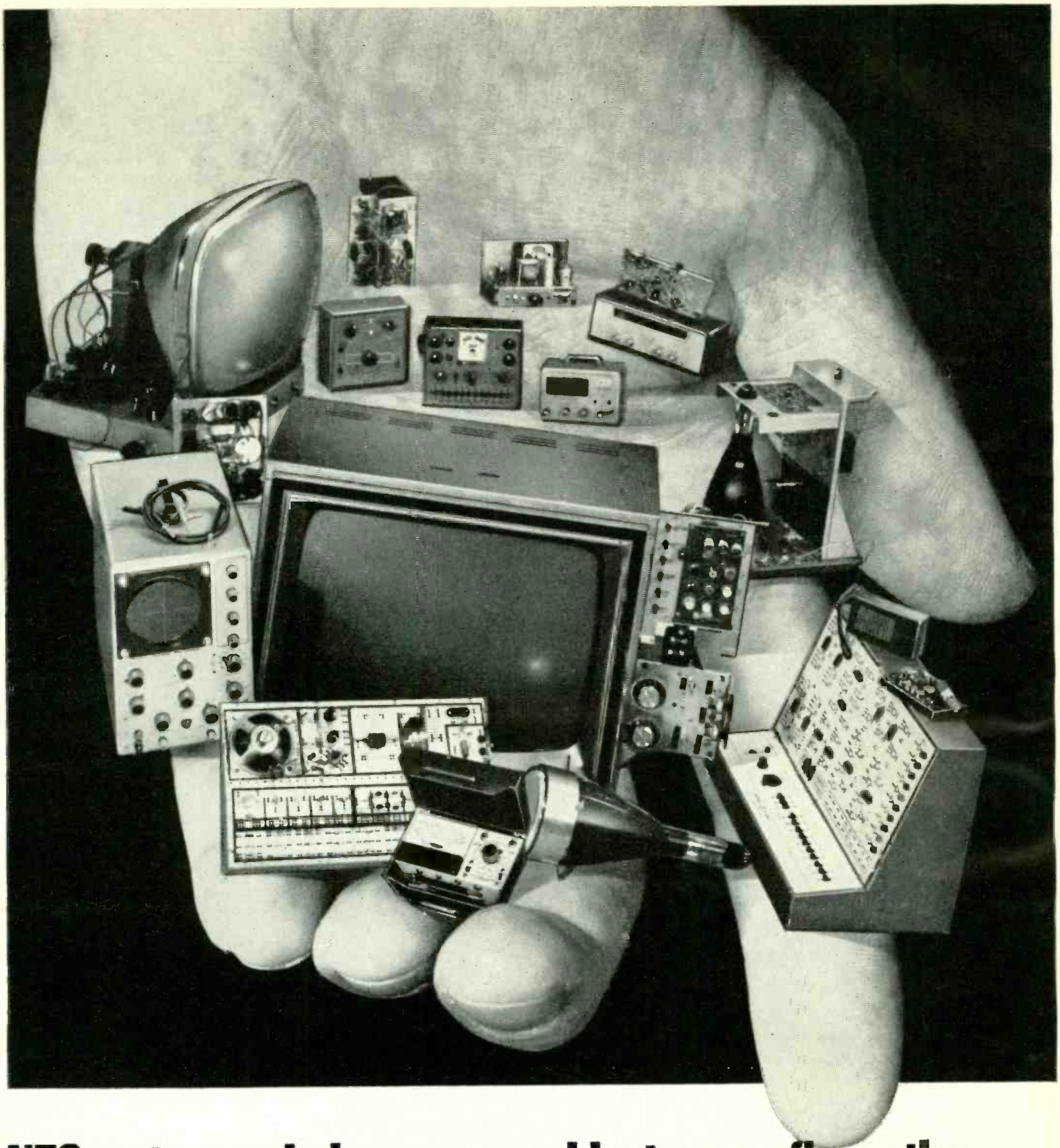
BOB SPICER
P. O. Box 191
Fort Gaines, Ga. 31751

OLD COPIES AVAILABLE

I have several vintage copies of *Radio News* magazine, forerunner of RADIO-ELECTRONICS. Available are issues for the years 1924, '25, '26, '27 and '28. I have all issues for the year 1925 and one copy of the March 1940 issue.

HAROLD DISHMAN
Route 5
Maryville, Tenn.

(continued on page 22)



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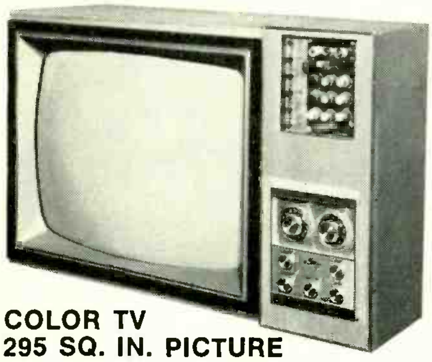

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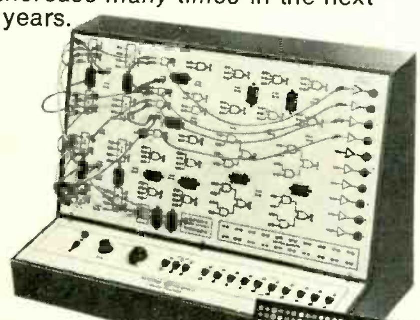

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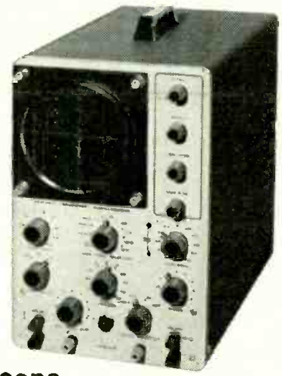

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CORRESPONDENCE
(continued from page 16)

PRINTED-CIRCUIT PATTERNS

I quite enjoy your magazine, especially the many fine construction articles you have presented in the past. However, I am experiencing difficulty in having negatives of the printed-circuit layouts reproduced, due to copyright laws which commercial print shops must abide by.

I would appreciate your sending me a release to photocopy the printed circuit layouts for photo-etching my boards.

HOWARD F. GARRISON
Englewood, Colo.

The photocopy shop is right. For them to go ahead and duplicate without permission does violate the copyright laws. However, it is our intent, when we present a printed circuit layout, to have our readers use the pattern to make boards for their own personal use. Therefore, we do authorize readers to use these patterns and make copies of them for their convenience in the construction of the particular article described; provided this is not for manufacture and is for their personal use.—Editor

WHY NOT TUBES?

I want to congratulate your magazine for the challenging projects that are published in its pages. But I notice that most of the electronics magazines publish only construction articles based on solid-state components. I agree that this type of project has its advantages over the tube-based ones, but I feel that tubes are not yet out and that the reader should have a chance to acquire some practical background on the operation of tube equipment.

Also, many readers have various amounts of tubes on hand and the surplus market is loaded with inexpensive ones. So how about some articles with vacuum tubes?

UBALDO ORGNERO
Calgary, Canada

We agree that tubes are not dead, but in many instances there is little excuse for using them. The transistor is often easier and less expensive to use, and always smaller. When you use tubes you have a much more complex power supply associated with the circuitry too.

We will present articles using tubes whenever the use of tubes gives the reader a tangible advantage; perhaps in high-frequency applications or extremely high-power circuits, otherwise we will continue to present projects based on solid-state components.—Editor

KWIK-FIX MIXUP

Two errors appeared in the June 1970 issue that should be of interest to all readers.

In the Kwik-Fix article, page 44, second column; the first paragraph reads "Both horizontal and vertical blanking are applied to the emitter of Q1 by R6. R5 and C2 shape the horizontal pulse. These *positive-going* pulses bias the transistor completely off for their duration. That makes high-amplitude *negative-going* pulses in the *collector*."

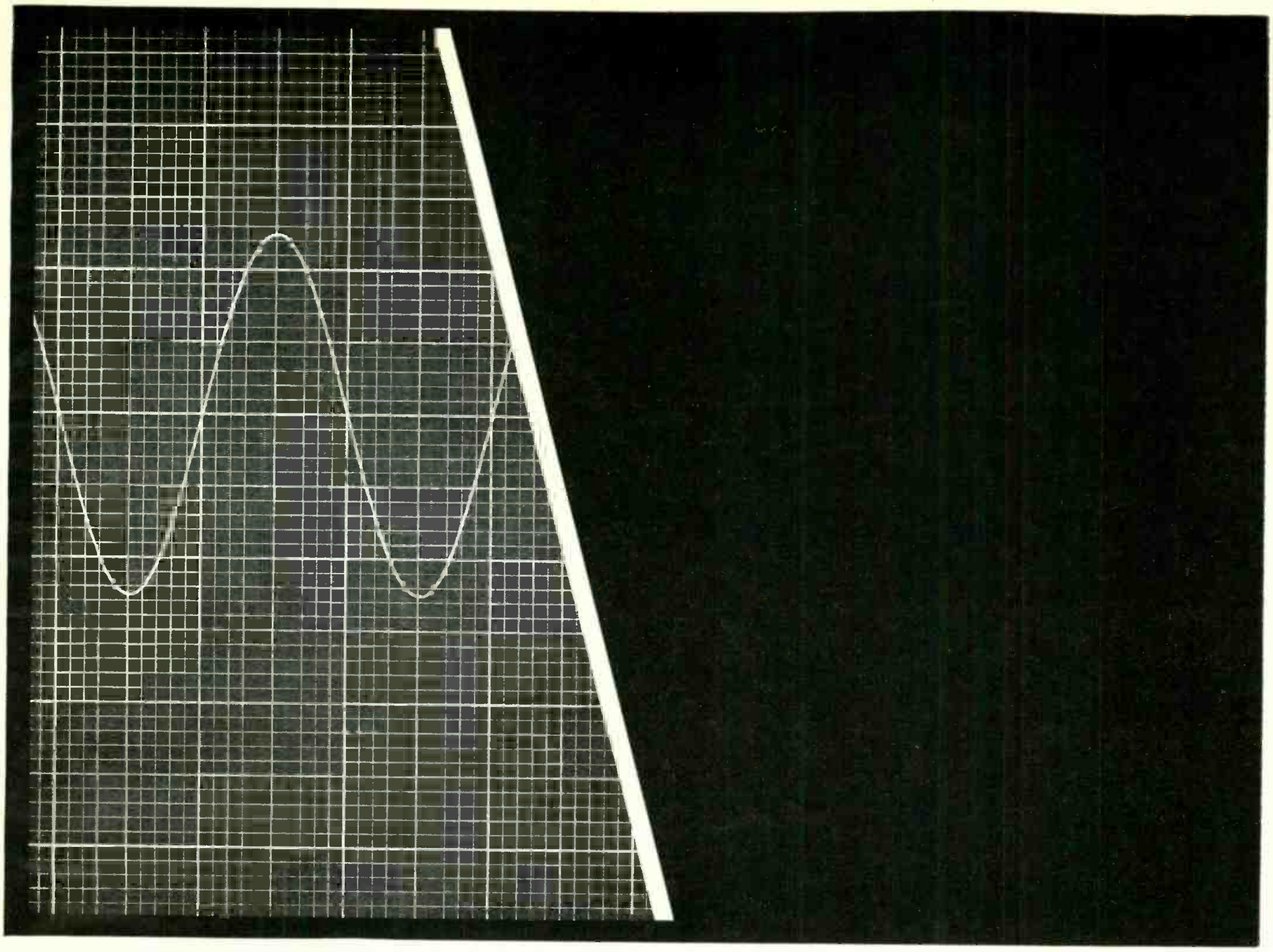
This is erroneous; there is no inversion when a signal is applied to the emitter. Applying a positive-going pulse to the emitter is the same as applying a negative-going pulse to the base.

The second sentence in the second column of the same article on page 44 reads "L2 and *L4* are a matched load for the load line." Actually L4 is the peaking coil of V2.

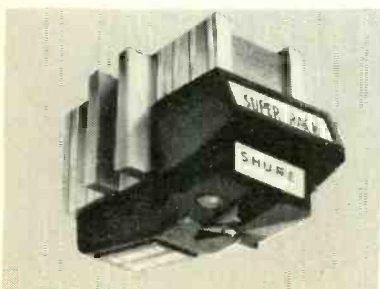
B. J. BROWN
Trion, Ga.

R-E

IN THIS ISSUE
Stereo system not delivering top performance. Better take a look at the article starting on page 40. Peter Sutheim tells how to get better sound from your stereo system.



Finally! A visually perfect sine wave!



The sine wave above was generated by Shure's design computer—it looks like the sine wave that was generated by the *Shure V-15 Type II Improved* Super Track Cartridge in the Hirsch-Houck testing laboratories . . . "the first cartridge we have tested to have done so," according to their published report. This perfect sine wave was generated during the playing of the heavy bass bands on the Cook Series 60 test record at ¾ gram, and the 30 cm/sec 1,000 Hz band of the Fairchild 101 test record at 1 gram. They were impressed, and we were pleased. And we'll be pleased to send you the full Hirsch-Houck Report on the "trackability champion." Shure Brothers Inc., 222 Hartrey Ave., Evanston, Ill. 60204.

SHURE

Circle 14 on reader service card

In the Shop . . . With Jack

By **JACK DARR**
SERVICE EDITOR

Ripple and Noise; Unfiltered Rig

"Ripple" is what you have left over after you get through filtering the dc power supply. Like all leftovers, it can cause trouble. Turkey hash for 6 days in a row is monotonous. It's not the actual 60- or 120-Hz ripple itself which causes the trouble—of course you can get a faint hum-bar or two in the picture, but this isn't the worst of it.

The presence of 60-Hz ripple indicates far more serious trouble. When this is above normal limits, your dc power supply filtering, or more accurately, decoupling, is a long way from being good enough. In all electronic circuits, one thing is common to all stages—the dc power supply. With the great number of different spikes, pulses, signals of all frequencies, and so on, that you have, it is absolutely imperative that you get rid of them after you've used them! If any of them is allowed to get into another stage, you'll really find some weird and unusual troubles.

This is caused by *feedback*. Even if it is only from the output of a stage to its input, this can cause oscillation or instability. If they happen to get back in the right phase, it can cause degeneration and "mysteriously" reduce the gain of a stage. If the feedback signal comes from a stage with different signals, we get some real howlers.

Example—a horizontal-frequency sawtooth or spike signal getting into the video amplifier stage. This causes horizontal shading of the raster—one side is darker than the other. Vertical-frequency feedback causes shading from top to bottom. If this is strong enough, you get the odd symptom of the picture "going out from top to bottom" as the brightness is turned off, as if you were pulling a shade down over it. The key clue in such cases is the *nature* of the effect. Side-to-side shading is coming from the horizontal circuits; top-to-bottom shading from the vertical.

In either case, the basic cause is the same—feedback. Feedback happens because the filtering is not good enough. In the "source-stage" this signal, after we've used it to sweep the screen, has to go *somewhere*. It's supposed to go back to the (common) power-supply, and from there straight to ground.

This signal is "ac." It goes to ground because the normal impedance of the dc power supply is *very* low. For example, a 50-μF capacitor has 63.7 ohms reactance at 50 Hz. At 5000 Hz, only 0.637 ohm. At 15,750 Hz, this gets down to about 0.2 ohm or so. (This is why you will see a greater 60-Hz ripple than the other frequencies—the lower the frequency the greater the reactance of a capacitor $Xc = \frac{1}{2\pi fC}$ In practical circuits, you'll find several capacitors totaling 200- to 300-μF or more, and a total impedance of practically zero ohms.

We've got to keep this impedance very low to prevent feedback at *any* frequency. The used signals must be "drained off" to keep them out of mischief. Think of this in terms of plain old resistance. If we had a 100 mA signal flowing through a 100 ohm resistance, we'd develop a 10-volt ripple. This will actually cause the plate voltage (or collector voltage) of stages fed from this line to vary 10 volts. You can see what kind of trouble that would cause!

The easiest way of finding this kind of trouble is with your scope. Just touch the direct probe to the hot terminals of all electrolytic capacitors anywhere near the circuit which is showing signs of trouble. A good trick is to set the scope up for a certain deflection at 1.0 volt p-p. Any ripple greater than this is very apt to cause trouble. Don't confine your efforts to 60-Hz ripple alone! Anything you see on there, except a nice straight "dc line" means trouble!

In tube circuits, you'll find 6 to 8 volts of ripple (60-Hz) at the rectifier output. However, at the filter output this had better be down to about 1.0 volt p-p maximum. One volt of ripple in a 300- to 400-volt circuit won't be too bad simply because of the very small *percentage*. In transistor power supplies, with their far lower voltages, a 1.0-volt ripple means difficulties; percentage again. Solid-state power supply circuits use very large filter capacitors. You'll find several thousand microfarads of filter capacitance.

The quickest check in a tube circuit is to bridge a good capacitor across the suspected unit. Look for the ripple to disappear. If it does, replace the capacitor. DO NOT (Repeat: DO NOT) bridge large filter capacitors across transistor power supply circuits. Turn it off, hook up the new unit, then turn it back on. The charging surge of a 2000-μF capacitor is fearsome and can easily blow a fuse or pop a transistor.

Sometimes the ripple won't go away, but will merely drop a little when a new capacitor is bridged across the old one. If this happens, the old capacitor probably has a high power factor (loss of filtering efficiency) and it will have to be taken completely out of the circuit and replaced by a good one to clear up the trouble. **R-E** don't miss this opportunity

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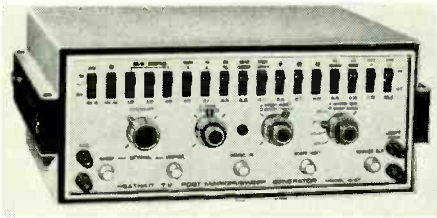
Circle 16 on reader service card

EQUIPMENT REPORT

Heathkit IG-57 Post-Marker Sweep Generator

For manufacturer's literature, circle No. 21 on Reader Service Card.



THE MORE THINGS A SINGLE TEST INstrument can do, the more valuable it is in the service shop. The Heathkit IG-57 TV Post-Marker Sweep Generator certainly meets this evaluation. With this versatile test instrument, you can use sweep-alignment techniques on any standard piece of electronic equipment "with the greatest of ease" and accuracy.

Many technicians have hesitated to use sweep alignment in the past, simply because it was such a hassle getting everything hooked up; also because of a nagging doubt that it wasn't accurate! Previous methods of putting markers on the sweep curve caused several troubles, the worst of which was actual distortion of the curve by the markers. In the end, we actually did not know whether we had helped alignment or made it worse.

With the system used in the IG-57, this doubt is gone. It uses the "post-marker" circuit; this is the only way in which frequency markers can be added to sweep-response curves without distortion of or interference with the actual frequency response of the unit being aligned. The markers are put on the curve *after* it has gone through the tuner circuits. A special "marker-amplifier" and mixer circuit is used. The marker frequencies cannot affect the response of the tuned circuits. Amplitude of the curve and the markers can be controlled individually.

Above all, the whole thing is *simple*. Two cables connect to the TV set, sweep input and output, and two to the scope, vertical and horizontal inputs. Turn it on and away you go. To further reduce clutter on the bench, the IG-57 even has two dc bias supplies on its front panel: many alignment instructions specify a fixed bias, especially in color TV i.f.'s. No separate bias box is needed. The dc voltage goes to 15 volts, and the polarity can be reversed, if necessary, for use with transistor forward-bias agc, etc.

The list of specifications for the IG-57 is fascinating. The instrument provides three sweep ranges: LOW, 2.5 to 5.5 MHz, for color bandpass and sound i.f. alignment. The 10.7-MHz i.f. of FM tuners can be swept by the 2nd harmonics on LOW. Next, IF for TV i.f. alignment covers 38 to 49 MHz, on fundamentals. Finally, the RF sweep goes from 64 to 72 MHz (channel 4) and a high band (192–198 MHz, channel 10) on the harmonic. All these have a minimum signal output of 0.5 volt (500,000 μV) which is, as one of my colleagues used to say, "enough to blow a signal through an inch pine plank!"

However, as in all sweep alignment, it is the markers which are the most important. Marker *accuracy* is the key to the usefulness of any sweep generator, and the thing which has caused us the most trouble in the past.

The IG-57 meets this requirement by using crystal oscillators. There are 16 of these, each individually controlled by switches on the top of the front panel.

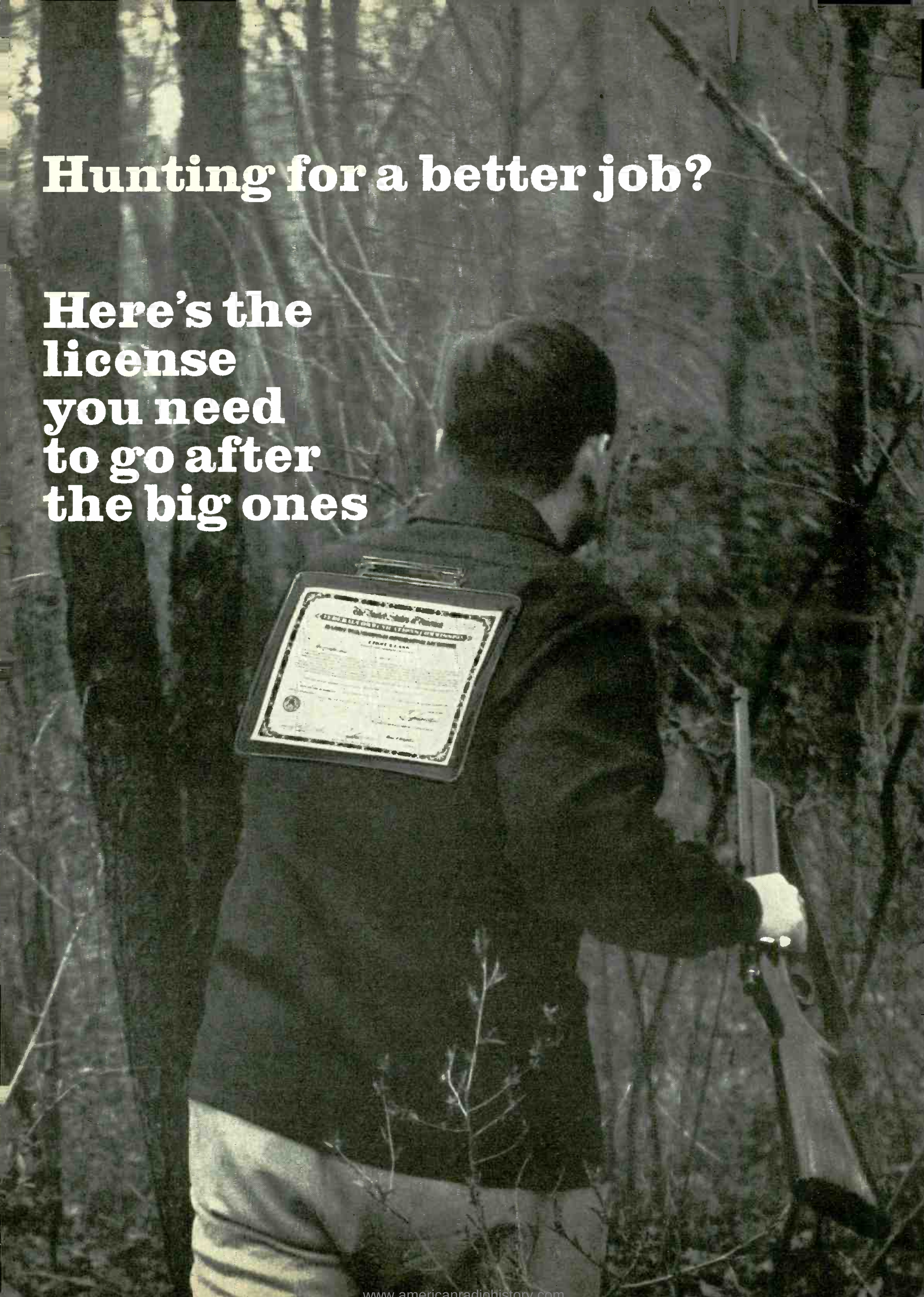
One very important part of the i.f. sweep alignment procedure is now much simpler—trap alignment. This is vital in color TV alignment. A misplaced trap can cause color suckouts and a multitude of other problems. (For a test, try running the 41.25-MHz trap up on the side of the curve till it gets the color carrier, and you'll find out!) With the crystal markers. the three most important traps—39.75, 41.25 and 45.75 MHz, can be tuned right on the nose.

For additional help in this, as well as in sound i.f., sound detector, stereo FM and aft alignment, a 400-Hz signal can be modulated onto the marker signal. The trap is simply tuned until audio modulation is at its lowest point, and there you are—the trap is now at its maximum attenuation. Or a sound detector is aligned for maximum AM rejection. which is the "right place."

Special connecting cables and probes are used. These have tiny clips for connecting into the circuits. An rf probe is used for i.f. and rf alignment, and a demodulator probe can be used at intermediate points through the TV i.f. (specified in some manufacturer's alignment instructions, for link and trap alignment). Incidentally, these probes are light and small.

Frequency modulation (sweep) is done with an all-electronic circuit using a controllable inductor. No more mechanical sweeps, with hums and buzzes. Tiny toroidal cores coupled to the inductor control the amount of frequency deviation (sweep width) and the centering. These two things are controlled by a concentric dual-knob on the panel, for one-hand operation. Incidentally, the "curve height" ("Trace Height") and marker pip amplitude ("Marker Height") are also a concentric dual control. This makes adjustment of the curve height on the scope and the marker heights on the curve *very* easy. A separate seven-step attenuator is provided for regulating the output signal voltage. This has 1.0-dB, 3.0-dB, 6.0-dB. two 10-dB and two 20-dB positions. Any or all of these can be used simultaneously. With this accurate attenuator, the scope can be calibrated in dB; this makes alignment with markers set "so many dB down" from a given point very simple.

The IG-57 is available from Heath as a ready-made instrument or in kit form. **R-E**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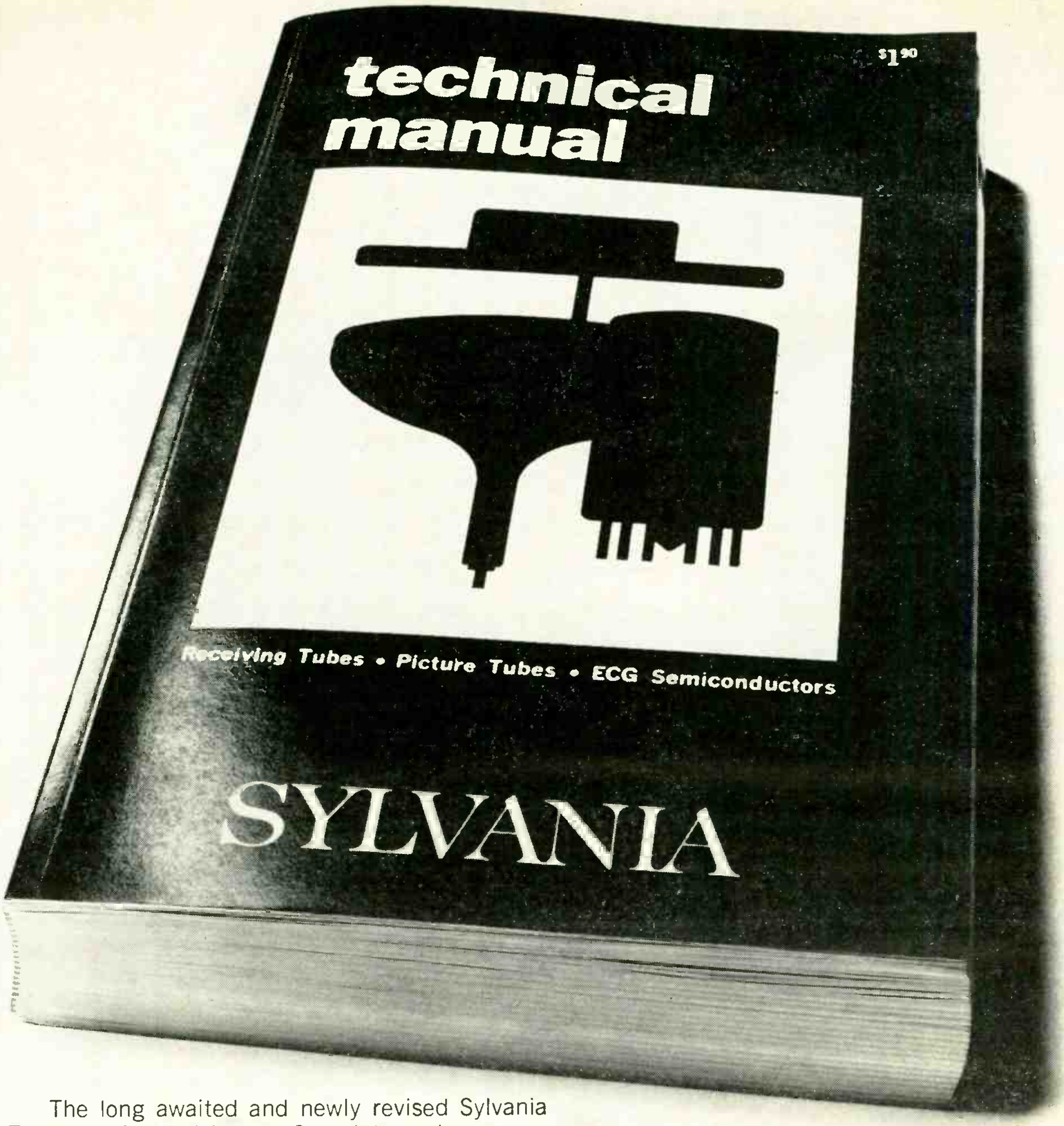
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Receiving Tubes • Picture Tubes • ECG Semiconductors
SYLVANIA

New 4-channel stereo techniques

by **WALTER G. SALM**

4-channel stereo is here to stay. Here's the latest on what's happening in this new race for solid sound that surrounds the listener

You better get ready for it, and get ready to answer lots of questions; quad is coming and it's the hottest thing in home entertainment since the stereo record was invented.

It's still very new and doesn't even have a permanent name yet. People are calling it quadrasonic stereo, four-channel stereo, tetraphonic sound, surround sound and who-knows-what-else. All the names are descriptive, but most of them are too tongue-twisting to become a household word. We're betting on the simplest of all: "Quad" and the broadcasts will be "quadcasts." Quad is fairly simple in itself—it just just adds two more audio channels to the already existing stereo pair. The first stereo pair continues as before, coming out of a pair of matched speakers at the front of the listening room. The two new channels are rear-of-the-room speakers, facing forward.

In its classic form, quad adds two channels of room reverberation—the minute echoes, phase and time delays that are characteristic of the hall where the recording was made. This can be done by placing an additional pair of microphones somewhere behind the original stereo pair, recording two extra channels on the tape, and playing them back through a second stereo amplifier and the two rear speakers. Treated this way, the extra two channels don't have to be the same high-quality you have up front. A mediocre amplifier and a couple of relatively inexpensive speakers will do the job.

But if this is all there is to quad, why not simply take existing two-channel stereo recordings, pipe some of the signal through a pair of inexpensive reverb units, and then through the second amplifier and speakers? Why not indeed? In fact, this technique will work very well for the vast majority of existing stereo recordings, and properly used, will prevent existing record and tape collections from becoming obsolete.

But true quad is much more than simple reverberation. In a recent Audio Engineering Society meeting devoted to quad, some spectacular demonstration tapes were played, amply demonstrating the dramatic ping-ping/pong-pong effect possible. Most spectaular of all was the motorcycle that ran in circles around the huge RCA recording studio where the meeting had assembled. That particular tape pointed up more than anything else the true effectiveness of surround sound.

There's no shortage of recorded material. Most record companies today keep their eight- (and 16-) channel master tapes in the vault, and these masters can be remixed into four-channel any time they're needed. Thus we will see lots of re-releases of well-known stereo recordings in quad. New masters are made with quad in mind, and many recordings of contemporary music can really make full use of this room-filling illusion. A few classical works—very few—were originally scored with orchestral elements in the rear of the concert hall. Quad lets the audiophile hear this music the way it was written, something he can't do with conventional stereo. Even so, such recordings sound hopelessly gimmicked up; after all, who ever heard trumpets blaring from the rear of the living room?

As an improvement in existing audio techniques, quad is probably as much an advance over conventional stereo as stereo was over mono. That's a whopping conclusion to make, but quad in one giant step puts huge concert-hall acoustics in the living room. We've bemoaned for years the fact that we'd never be able to recreate concert hall acoustics in the home. Various speaker manufacturers have tried, with limited degrees of success. Now it's possible.

Comparisons to two-channel stereo come easily. Quad is now approximately where stereo was in 1956-57. There's good reproduction equipment available; you can use two stereo amplifiers or one of the limited runs of new four-channel amplifiers, and there are program sources, at least on tape. As was the case with stereo in 1956, tape is the only readily available source of quad program material right now. Like 1956, conversion heads for four-channel playback are expensive, as are add-on preamplifiers. Like 1956, there's talk about compatible, single-groove discs and compatible FM broadcasts. Disc multiplexing techniques are being proposed, and at least one inventor, Peter Scheiber, claims to have devised the "ultimate solution," although it's far from perfect (and turns out not to be true four-channel).

There are debates raging about quad's true effectiveness, and wouldn't reverb-fed rear speakers be cheaper, just as effective and solve all these problems? And so it goes.

Here's what's happening now. Tape equipment is in the forefront, as it was in 1956. Companies now producing quad playback-capable equipment include: Crown International, Teac, H. H. Scott, 3M and Telex/Viking. Ampex has produced quad equipment for professional use, machines that will handle both ½-inch and ¼-inch tape, but an Ampex consumer quad unit may not be far away. At the CES show in New York Ampex showed a four-channel cassette player. Kenrich Purchasing, an importer of Japanese cassette recorders, plans to market an inexpensive quad conversion kit for cassette surround sound.

4-track in a cartridge

Possibly the easiest single format to work with for home entertainment use is the 8-track, continuous-loop cartridge. This cartridge has sufficient tape width to accommodate two four-channel programs with interleaved tracks, making playback heads easier and cheaper to build. Bearing this out have been twin announcements by Motorola and RCA. Motorola said it had a four-channel stereo 8-track tape player for the car and would be introducing it later this year. No mention was made of where the tapes were to come from.

At virtually the same time, RCA unveiled a living-room quad system also based on the 8-track cartridge. This one was more realistic, since RCA can make its own quad tape cartridges very easily and demonstrated some new ones in the prototype demonstration.

The basic unit looks little different from any living-room version of a cartridge player. It has two speakers built into its cabinet, but also has two outboard speakers at the rear of the listening room. And there in lies the difference. The same unit can be used with four outboard speakers, as is another unit that has no built-in speakers.

The cartridge machine is compatible with conventional 2-channel stereo tapes. All it takes is a flip of a front-panel switch to go from quad to old-fashioned stereo. The track arrangement is 1-3-5-7 for sequence A with 1 as left front, 3 left rear, 5 right

TYPICAL 4-CHANNEL STEREO AMPLIFIER. This one is the H. H. Scott model 499. Several other manufacturers have announced similar gear.

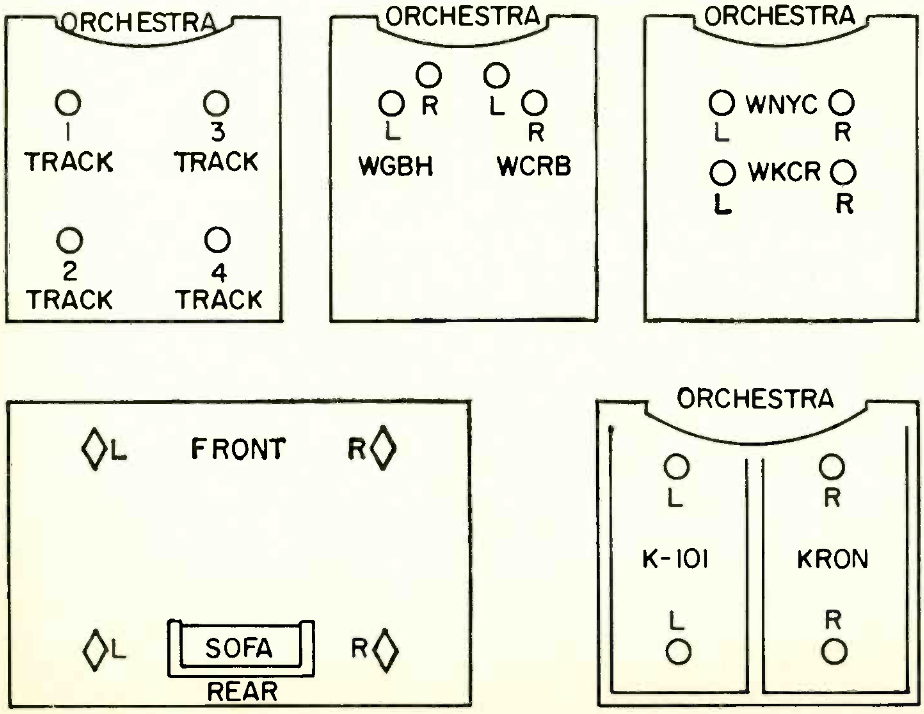
front and 7 right rear. At the end of sequence A, the head shifts down and plays tracks 2-4-6-8. Program time is halved by the quad format so a double-length tape becomes instead standard album-length. Presumably the tapes will be priced somewhat higher than standard 2-channel cartridges and because of the use of four tracks, will have half the playing time. Tapes should be available now.

One of the few amplifiers on the scene so far is the Scott "Quadrant"—a 35-watt-per-channel unit with an impressive number of front-panel controls and a staggering price tag of $600.00. Interestingly, the unit has two different stereo headphone jacks—one for the front speaker pair and one for the rear speaker pair. The front-pair jack is used when listening to conventional 2-channel stereo. Eventually, such amplifiers will no doubt have a single headphone jack with choices of various blends for both two-channel monitoring and the most suitable mix for casual listening, and the owner will make his choice.

The broadcast situation is far from clear. Even as we go to press, there's every chance that the FCC will grant that all-important experimental broadcast approval. In the meantime, the only quadcasts that have been legally possible have been via two stereo FM stations paired up with rented telephone lines. The listener needs two complete stereo receiver setups to listen to these limited quadcasts. Sound familiar? Other systems are available, but won't be heard by the public until the FCC issues the necessary experimental license.

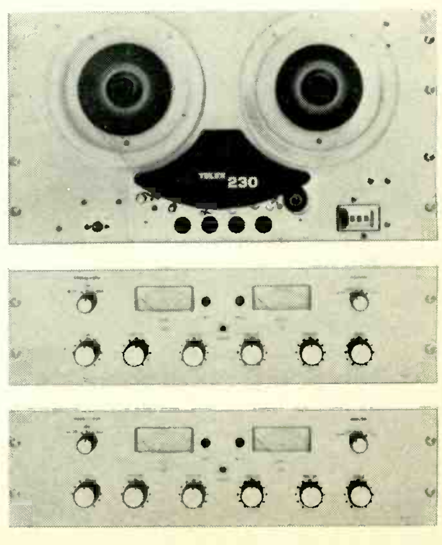
Latest word on the status of single-station broadcast is that no one can seem to make up their minds as to what is desirable and not. It's generally conceded that if a station's going to broadcast quad, then its SCA channel must go. SCA is that special service channel with a 67-kHz subcarrier that carries background music or other special programs to paying customers. SCA has in fact become the focal point of disputes between proponents of different kinds of quad transmission systems, and often the feuders have other, SCA-bred axes of their own to grind.

A basic system suggested by William Halstead ("Mr. Multiplex")



RECORDING, BROADCAST AND PLAYBACK techniques are shown on the left as they are now being used.

FOUR-CHANNEL TAPE, reel-to-reel is the Telex Quad/Sonic Model 230 below. QQ transport is for playback only; QQRM handles both recording and playback.



working with Leonard Feldman, uses two 8-kHz-wide subchannels for the two rear speakers, with subcarrier frequencies at 69 and 89 kHz. This technique has a certain amount of overlap with the alloted SCA channel (59 to 75 kHz), so the SCA capability is automatically eliminated in stations that quadcast. One serious problem here is the fact that any quad decoder for such a system would also be capable of picking up SCA channels, because of this overlap between SCA and the lower of the two quad subchannels.

To avoid any outcries of "SCA piracy," Feldman has installed a tiny reed relay in the quad decoder circuit that automatically mutes the detector's output when a 67-kHz subcarrier is received. This idea easily wins the Rube Goldberg medal and does nothing to stop the tinkerer who wants to bridge across the relay to get SCA.

Another technique, formally proposed to the FCC by McMartin Industries and later withdrawn, uses a form of time-division multiplexing (TDM). This technique intermixes the two signals at a 19-kHz rate. Channel bandwidth is held to 8-kHz per channel and in the playback, sampling is locked to the 19-kHz stereo pilot signal. This signal envelope embraces good old 67-kHz as a center frequency (suppressed) and is amplitude-modulated to prevent any eavesdroppers from illicitly picking up SCA broadcasts which happen to be McMartin's bread and butter. Main problem with the TDM technique is phase distortion. Add just one tiny bit of phase delay because of propagation conditions and the signal separation goes to pieces.

Actually, there's little reason not to adapt the Halstead/Feldman system by converting both channels to AM with suppressed carriers—the same transmission method used for the FM stereo subchannel. This way, quad decoders wouldn't pick up SCA, reed-relays notwithstanding, and broadcast modulation level could be held at reasonable proportions.

Some people, both in the FCC and out, are understandably nervous about the proposed additional use of the FM band. Anything above the assigned 150-kHz bandwidth is dangerous, they believe, and might cause co-channel interference. Not so. The actual bandwidth in use would never go above 150-kHz, simply because bandwidth use is a function modulation percentage. In the present setup, a station broadcasting mono FM can use 100% modulation which effectively eats up that full 150-kHz. If the station broadcasts FM stereo, it reduces its main-channel modulation to 80%, uses 10% for the 19-kHz pilot and 10% for the L − R stereo information on the subchannel. If the station carries SCA, it reduces the main channel another 10%. This brings us down to 70% main-channel modulation.

If two quad channels were to be added, they would each probably require 10% modulation. Since SCA can't be carried during a quadcast, there's 10% available right there. Chop off another 10% from the main carrier—leaving 60% and we have our quadcast setup. What would this do to signal-to-noise ratio? Not much. Each 10% reduction in main-channel modulation results in a loss of about 1.5 dB of S/N radio—a cheap price to pay for so much extra sound. Thus a quadcasting station would have about 1.5 dB poorer S/N ratio on its main channel than would a stereo station carrying SCA.

What will happen?

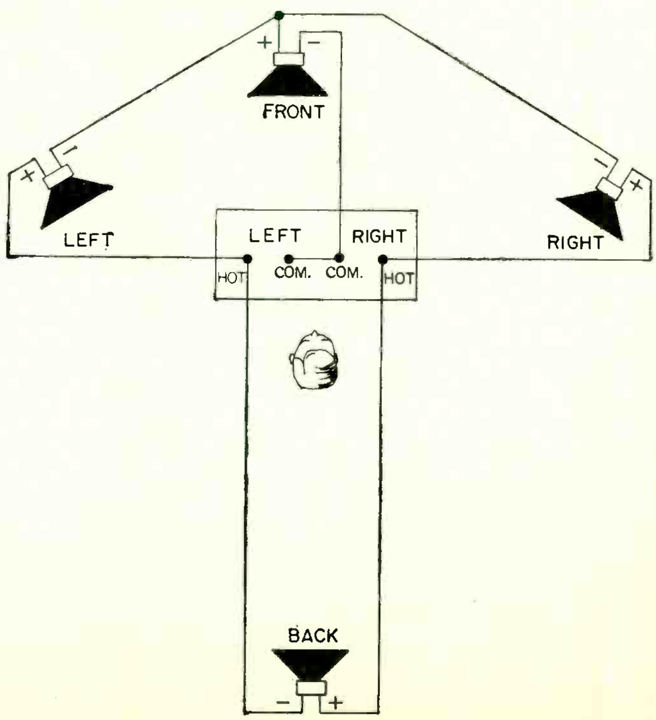
What actually happens will probably follow the pattern set in 1956-1961. Someone will propose a definite system that will be fully compatible with conventional stereo and mono reception. A limited number of decoders will be produced and sold at a premium price to experimenters who will use them to listen to perhaps one or two hours a week of test quadcasts. Other systems will be proposed, in increasing numbers. The closer the FCC comes to making a decision, the more companies will get into the act—each one with a quad transmission system of its own. Ultimately, the system selected as the industry standard will not be one of those that had had experimental quadcast experience, but will be one of convenience, and possibly one that will still permit SCA transmission!

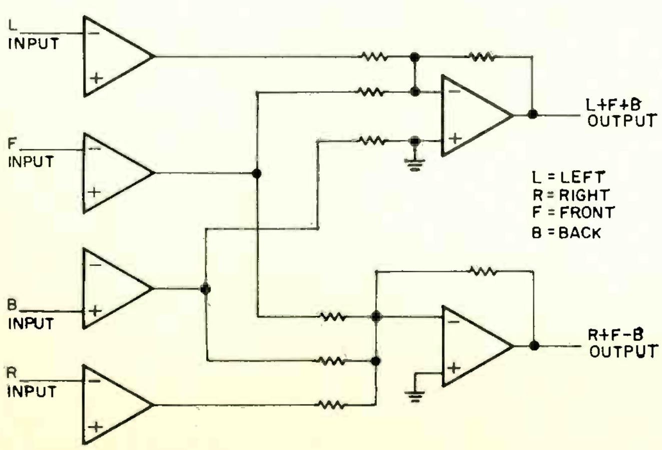
But perhaps the Commission will recognize the fact that SCA is no longer a matter of life and death for many FM stations the way it was 10 years ago. FM stations are making it on their own now, and many are making it in the big leagues.

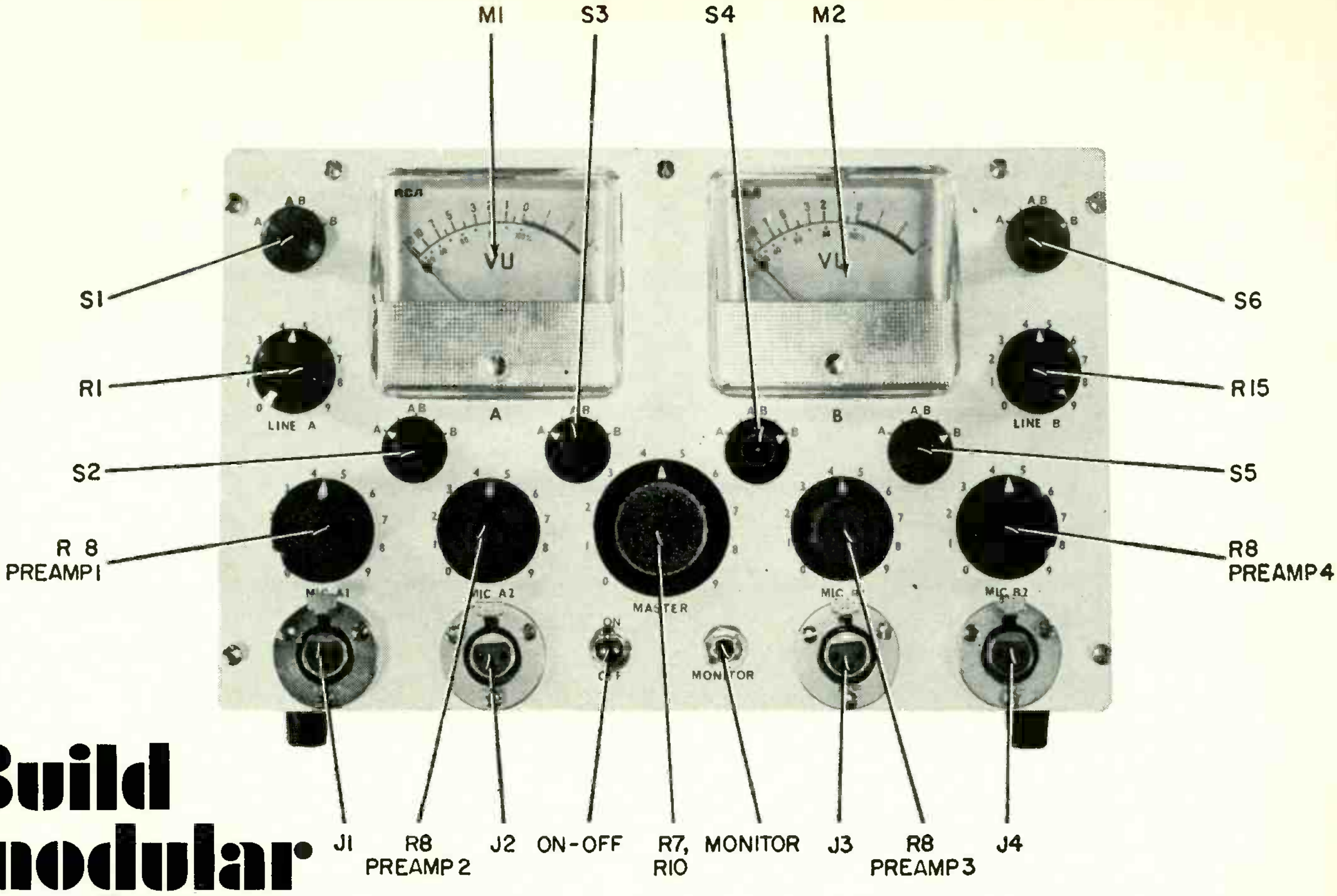
The FM-FM quadcasts that have taken place so far raise another interesting question: what is the optimum microphone placement for quad recording and broadcasts? In three

(continued on page 86)

SYSTEM USED BY DYNACO to add front (F) and back (B) information to left and right channels. SPEAKER ARRANGEMENT for turning existing 2-channel system into pseudo 4-channel. All you must add are two additional speakers and a special matrix network (shown below). When using this arrangement adjust the amplifier balance control for minimum sound in the back speaker when monophonic material is being played.







Build modular 6-channel stereo mixer preamp

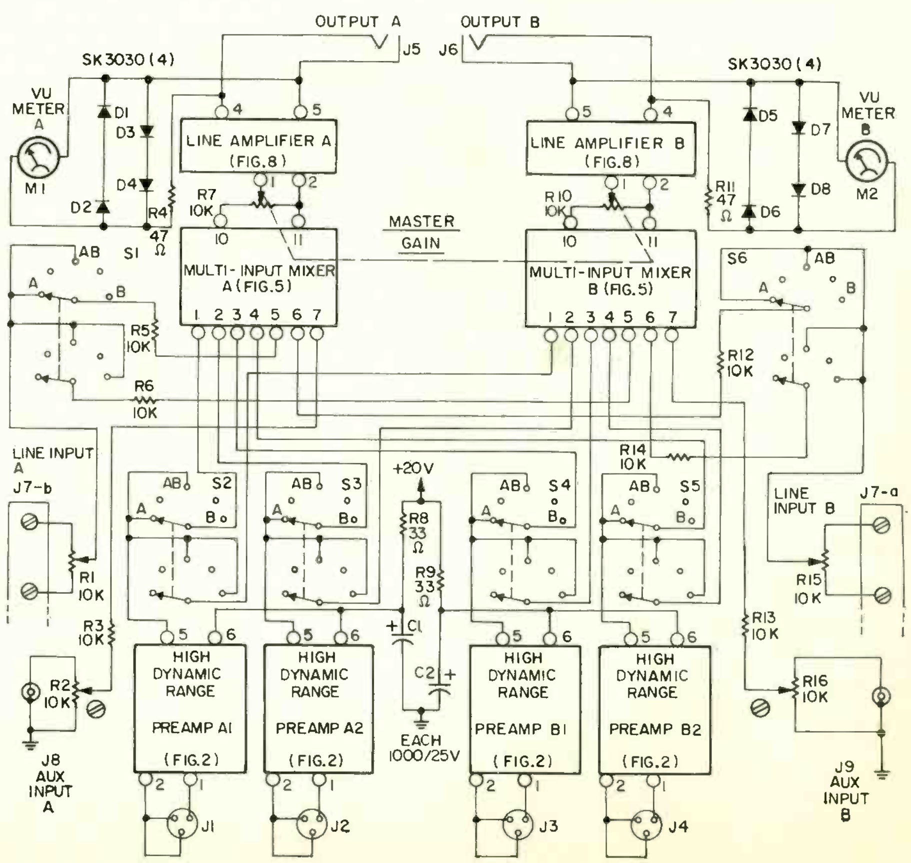
by GEORGE D. HANCHETT, Senior Engineer, RCA Solid State Div.

THIS STEREO PREAMPLIFIER AND mixer is particularly interesting to those who want to make high-quality tape recordings. The preamp has four microphone and two line inputs that can be switched to left, right, or both channels. In addition, two auxiliary inputs are provided, one for each channel. The auxiliary inputs cannot be switched. All inputs that can be switched are controlled from the front panel. The two auxiliary inputs are controlled from the rear of the unit. Each output channel has its own VU meter.

The stereo preamplifier and mixer is made up of three basic circuits and a minimum of interconnecting wiring. The three circuits are a high-dynamic-range microphone

PARTS LIST
(Fig. 1)

C1, C2—1000 μF, 25 volts, electrolytic
D1 through D8—SK3030 (RCA)
M1, M2—VU meter
R1, R2, R7, R10, R15, R16—potentiometer, 10,000 ohms (R7, R10 is a dual linear pot)
R3, R5, R6, R12, R13, R14—10,000 ohms, ½ watt, 10%
R4, R11—47 ohms, ½ watt, 10%
R8, R9—33 ohms, ½ watt, 10%
S1 through S6—rotary switch, 2 poles, 5 positions, shorting type
J1, J2, J3, J4—microphone jacks
J5, J6—phone jack
J7—4-lug terminal strip (screw terminals)
J8, J9—phono jack



preamp, a multi-input mixer, and a headphone or line amplifier. A block diagram of the total unit is in Fig. 1.

The output of each microphone preamp (see Fig. 1) is fed to a switch which can connect it to channel A, the left channel, channel B, the right channel, or both channels (A and B) simultaneously. The output of these switches as well as the line input for each channel is fed into the multi-input mixers. A master gain control combines or gangs the outputs from the mixers installed in each channel and passes the combined signal to the line amplifiers. The diode limiting circuit used with each VU meter keeps the meter from being damaged during the charging of the large coupling capacitors in the line-amplifier. Two R-C power-supply filters consisting of R8 and C1, and R9 and C2 assure circuit stability. Each filter services two microphone preamplifiers.

The stereo preamplifier and mixer is made up of a number of circuits as described above. The description of each of the three circuits includes circuit boards and component placement diagrams. The individual circuit boards and the interconnecting wiring required for the stereo preamp and mixer may be assembled as desired by the builder to form the kind of custom unit he needs.

CIRCUIT BOARDS

A complete set of 8 circuit boards needed to build this unit are available for $10. Order 1070B-1. A set of 4 boards for building a mono version are $6. Order 1070B-2. Boards are G-10 glass-epoxy, undrilled. Photo negative for making your own boards containing all board patterns is $1.50. Order from Photolume Corp., 118 E. 28 St., New York, N. Y.

The high-dynamic-range microphone preamplifier, intended to be used with low-impedance dynamic microphones, will handle loud passages of music and close talking without adverse effect on the output. The amplifier has a gain of 1500 to 2000 and can provide a maximum undistorted output voltage of 2 volts rms to a load impedance of 500 ohms or more. The maximum undistorted input is 400 mV rms. The frequency response is flat from 20 Hz to 30 kHz.

The circuit for the high-dynamic-range microphone preamp are in Fig. 2 The preamplifier consists of two stages of current-stabilized amplifiers separated by a gain control and an R-C filter, consisting of R7 and C5, that prevents motorboating. Resistors R5 and R12, placed in the emitter circuits of transistors Q1 and Q2, improve the frequency response of the preamplifier by providing some emitter degeneration. The output of the preamplifier is shunted with resistor, R15, to make the circuit compatible with the zero-point switching capability used in the master preamp. The output impedance of the preamp is low. The table shows the value of R1 to use with microphones of various impedances.

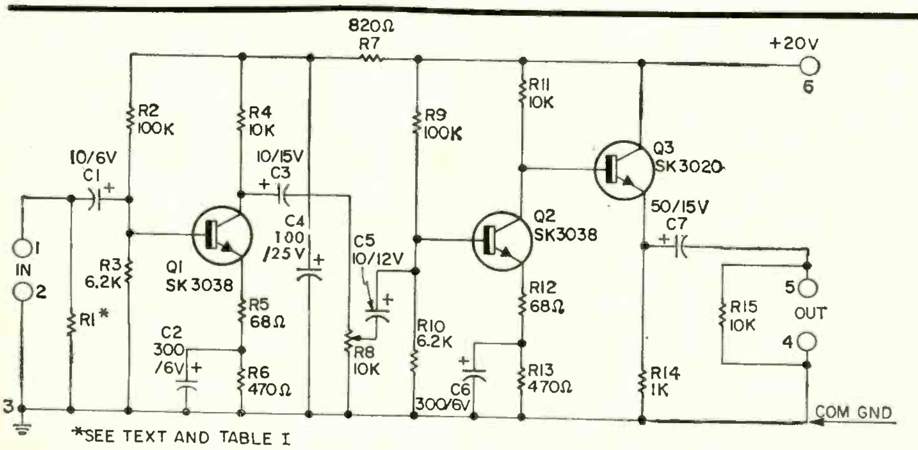
The printed-circuit-board layout for the microphone preamp is in Fig 3. A photograph of a completed board showing parts placement is in Fig. 4. All ground connections in this circuit must be made to the same point, as shown in Fig. 3, to avoid forming ground loops. This common-ground feature is built into the printed-circuit

TABLE I

Microphone Impedance	R1 (ohms)
200	220
500	560
4,000	R1 not used

R1 connected across microphone input jack.

Modular construction lets you build a custom mixer-preamp that meets your needs precisely, or duplicate the unit described here



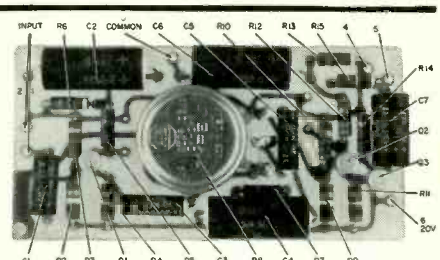
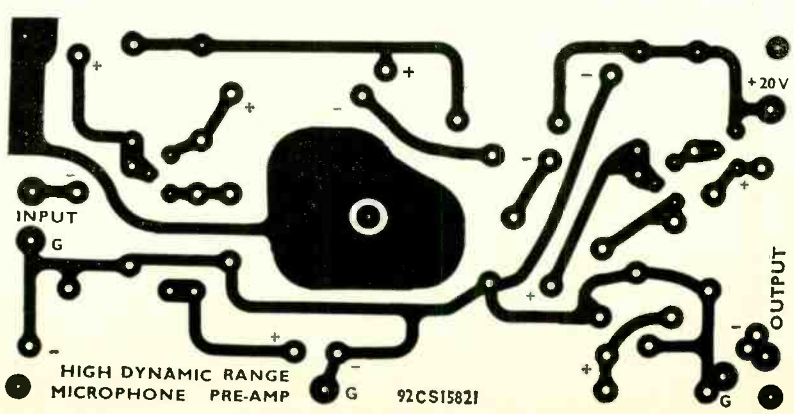


FIG. 1—(FACING PAGE) BLOCK DIAGRAM of complete mixer preamp. FIG. 2—(LEFT) MICROPHONE PREAMP schematic. Three transistors are used. FIG. 3—(BELOW) CIRCUIT BOARD PATTERN for the mike preamp. FIG. 4—(ABOVE) PHOTO OF ASSEMBLED BOARD showing parts placement details.

PARTS LIST
(Fig. 2)

C1, C5—10 μF, 6 volts, electrolytic
C2, C6—300μF, 6 volts, electrolytic
C3—10 μF, 15 volts, electrolytic
C4—100 μF, 25 volts, electrolytic
C7—50 μF, 15 volts, electrolytic
Q1, Q2—SK3038 (RCA)
Q3—SK3020 (RCA)
All Resistors ½-watt 10%
R1—see table I and text
R2, R9—100,000 ohms
R3, R10—6200 ohms
R4, R11, R15—10,000 ohms
R5, R12—68 ohms
R6, R13—470 ohms
R7—820 ohms
R8—potentiometer, 10,000 ohms, audio taper
R14—1000 ohms



board and must be followed if some method of circuit construction other than the printed board is used. In addition, all preamplifier connections to external circuits should be made to the same ground point.

Multi-input mixer

The multi-input mixer is designed to mix the inputs from up to seven sources, usually microphones, for input to an amplifier, recorder, or other piece of audio equipment. The mixer has a gain of approximately unity and, therefore, has no effect on the system in which it is installed. If more than seven inputs are required, as many as three mixers can be wired in parallel.

How it works

The circuit for the multi-input audio mixer is in Fig. 5. The resistance network shown at the left not only provides the mixing function but also to make possible zero-point switching of the inputs.

In the zero-point switching, as used in this unit, the capacitors at the output of the microphone preamps as well as the input capacitor of the mixer are kept charged. This is done by connecting a resistor across the output and input. Thus there is no disturbance, no cracks or pops, when inputs are switched in or out. The amplifier portion of the circuit, shown at the right in the schematic, is current stabilized by the emitter resistor. This resistor is not bypassed, and provide a greater degree of degeneration and reducing the overall gain of the mixer to unity.

Some adjustment of resistor values is required if less than seven inputs are used. Table II shows these resistor values for from 2 to 7 inputs.

TABLE II
RESISTANCE VALUES

No. of inputs	R17	R18
2	8.2k	120 ohms
3	7.5k	110 ohms
4	6.8k	91 ohms
5	6.8k	82 ohms
6	6.2k	75 ohms
7	6.2k	68 ohms

When three or more mixers are paralleled to accommodate more than seven inputs, not only must the outputs of the mixers be paralleled but the ground points on each circuit board must be connected. The gain of the mixer thus connected is somewhat less than unity.

Component placement and circuit board pattern for the multi-input mixer are in Figs 6 and 7 along with a photograph of a completed board.

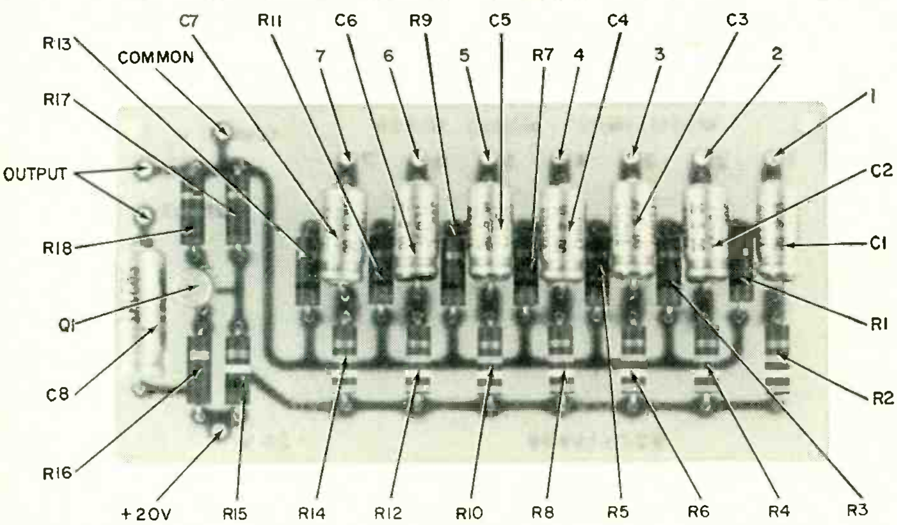
Headphone or line amplifier

The headphone or line amplifier is very useful when the power amplifier is located some distance from the microphone. If preceded by a microphone preamp, the amplifier makes a very useful remote pickup. It is also very useful for driving the line inputs of tape recorders.

The headphone or line amplifier has a voltage gain of 100 and can drive any line impedance of 250 ohms or more. It has a maximum undistorted output of 3 volts rms into a 500-ohm line and has a frequency response flat from 20 Hz to more than 25,000 Hz. The input impedance is 1,800 ohms.

Amplifier operation

The circuit for the headphone or line amplifier is in Fig. 8. The interconnection of the transistors in the



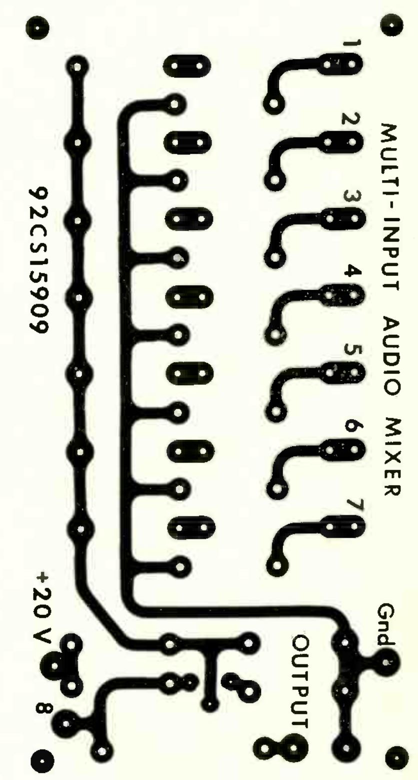
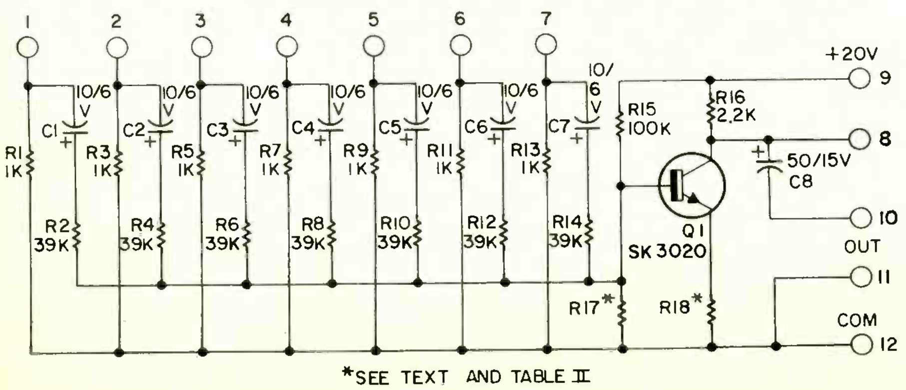
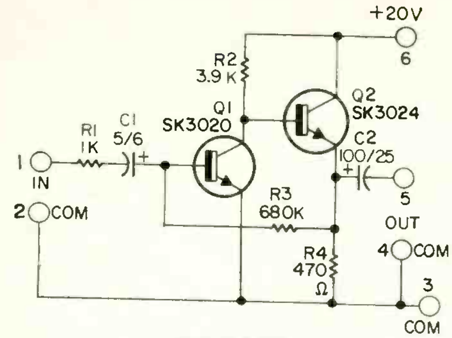


FIG. 5—(BELOW) CIRCUIT of multi-input audio mixer. Two are needed to build the unit described in this article. FIG. 6—(RIGHT) CIRCUIT BOARD PATTERN for the audio mixer. FIG. 7—(ABOVE) PHOTO OF MIXER shows parts placement on the circuit board. Refer to Fig. 1 for interconnection details of the complete preamp.

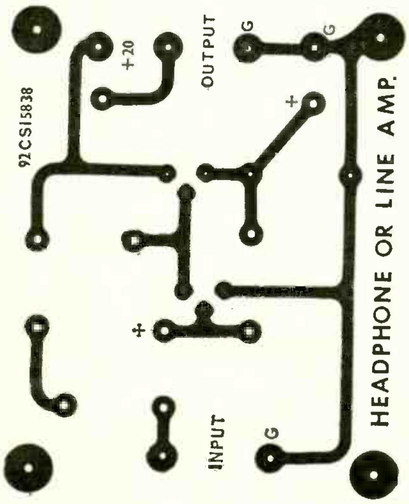


PARTS LIST
(Fig. 5)

C1 through C7—10 μF, 6 volts, electrolytic
C8—50 μF, 15 volts, electrolytic
Q1—SK3020 (RCA)
R1, R3, R5, R7, R9, R11, R13—1000 ohms, ½ watt, 10%
R2, R4, R6, R8, R10, R12, R14—39,000 ohms, ½ watt, 10%
R15—100,000 ohms, ½ watt, 10%
R16—2200 ohms, ½ watt, 10%
R17, R18—see table II and text



PARTS LIST
(Fig. 8)
C1—5 μF, 6 volts, electrolytic
C2—100 μF, 25 volts, electrolytic
Q1—SK3020 (RCA)
Q2—SK3024 (RCA)
R1—1000 ohms, ½ watt, 10%
R2—3900 ohms, ½ watt, 10%
R3—680,000 ohms, ½ watt, 10%
R4—470 ohms ½ watt, 10%



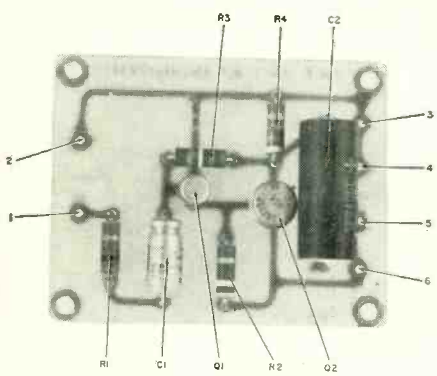


FIG. 8—(TOP) LINE AMPLIFIER circuit uses two transistors. FIG. 9—(CENTER ABOVE) CIRCUIT BOARD pattern for the line amplifier is shown actual size. FIG. 10 (ABOVE) COMPLETED BOARD showing parts placement. See Fig. 1 for circuit board interconnections.

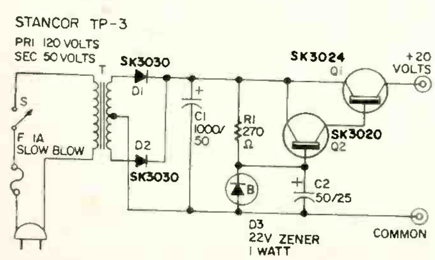
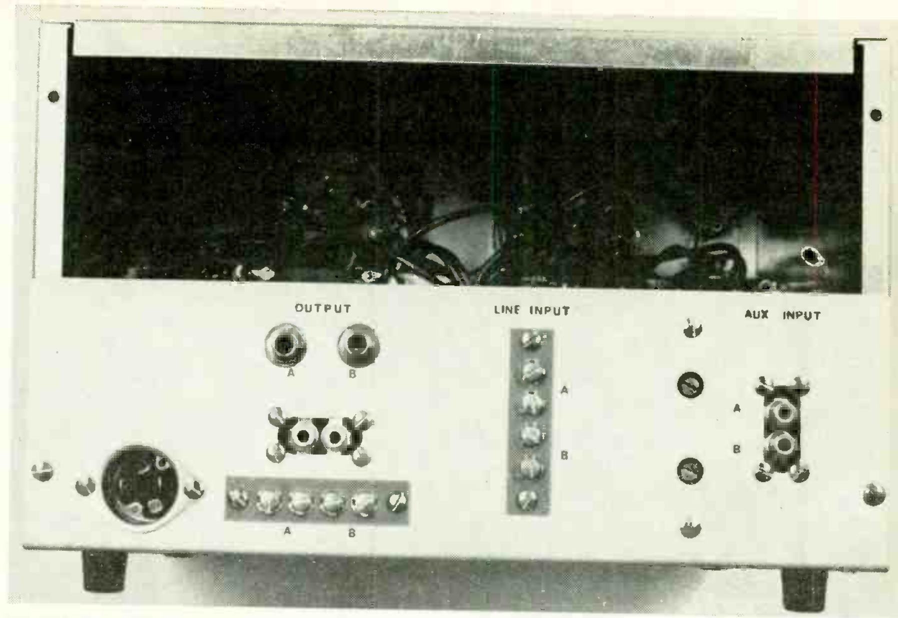
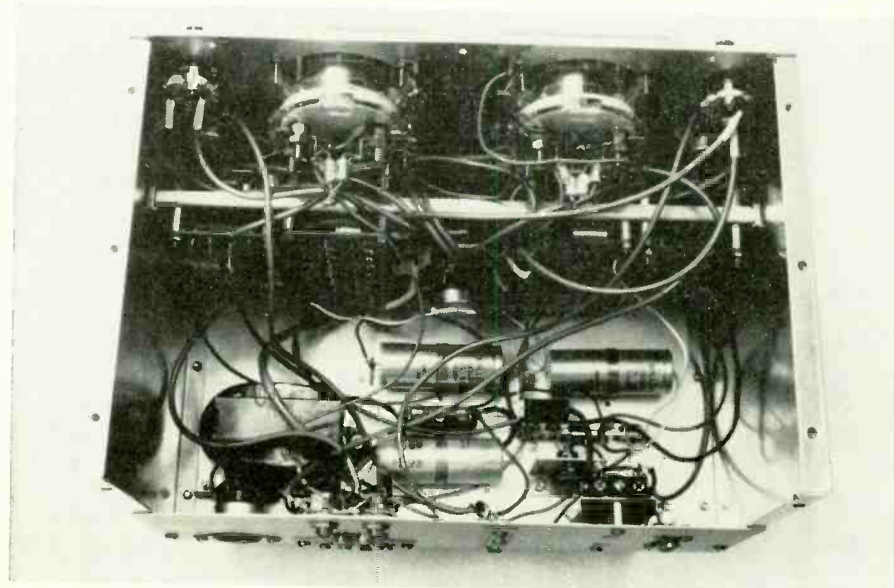


FIG. 11—POWER SUPPLY is regulated circuit. It is built right on the main chassis of the mixer reamp as you can see in the photo at the right.



FROM THE REAR OF THE MIXER-PREAMP you can see the auxiliary input and line input jacks. Three sets of outputs were connected in parallel to provide connectors for all likely applications.



LOOKING IN FROM THE TOP you can see the power-supply components in the lower right of the photo. The two VU meters are at the top. Most of the jumble of wiring consists of leads connecting outputs to the circuit boards.

amplifier makes the operating condition of the amplifier self-adjusting, (i.e.; the amplifier can maintain itself in a stable operating state in spite of variations in power-supply voltage and ambient temperature. Stability is insured by feedback through R3. If Q1's emitter current should increase, the base voltage of Q2 would decrease because of the additional voltage drop in R3. However, the decreased base voltage of Q2 results in a drop in Q2's emitter current, a reduction of feedback voltage to Q1, and hence a decrease in Q1's collector current. This decreased collector current causes an increase in Q2's base voltage that compensates for the original decrease and the amplifier is stabilized. The interconnection of transistors just described also makes possible the low output impedance of the amplifier.

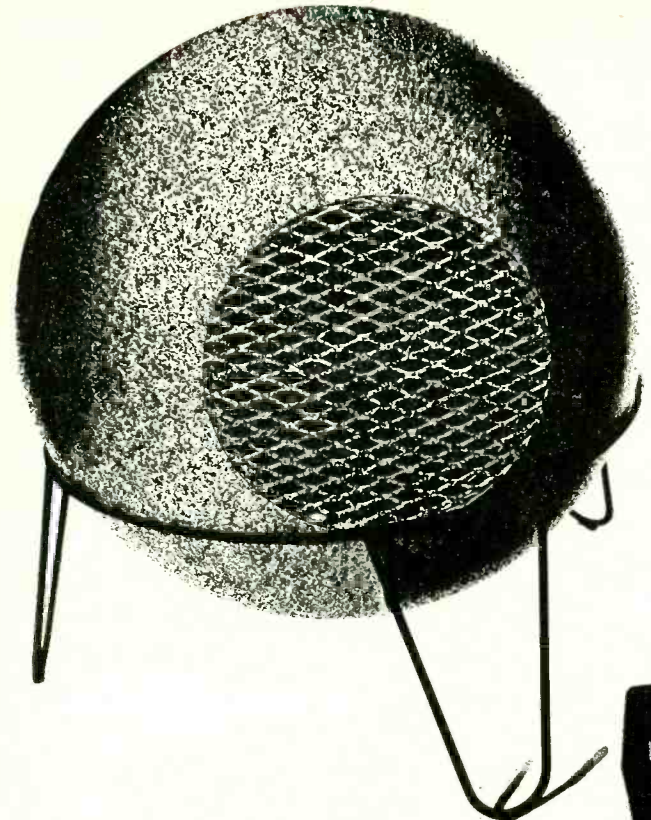
The printed circuit board pattern for this circuit, and a photo of a completed board, are in Figs. 9 and 10.

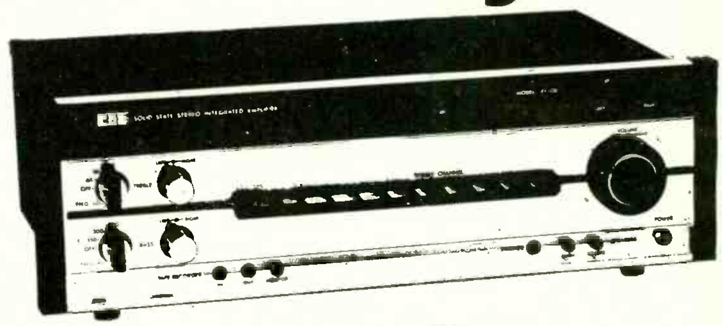
Power supply is last

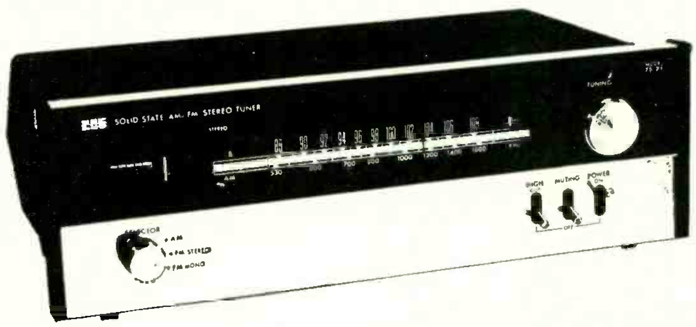
A simple power supply completes the unit. This supply is shown in Fig. 11. It is assembled directly on the chassis of the unit and is not built onto a circuit board. Once you have completed the power supply, selected the desired number of input, mixer and output boards you can proceed to assemble your custom mixer-preamp. We are sure you will enjoy it.

This article is presented through the courtesy of the RCA Solid-State Hobby Circuits Manual, HM-91, $1.95, which will be published early this fall. **R-E**

Get better from your







A do-it-yourself guide to maintenance and simple adjustments to get the best from your stereo rig.

by **PETER SUTHEIM**

This article is one of a series intended as a sort of supplement to the operating booklet that comes with hi-fi components. The manuals are often pretty short on information that doesn't have to do directly with turning the unit off or on, using the controls, and such basics. Since most customers for hi-fi components are not at all technically inclined, the makers feel it's pointless to take up space describing maintenance and the more subtle adjustments. But for those who enjoy getting a feel for the equipment they use, the warning, "no user-serviceable parts inside" does not need to apply.

One caution before we begin, though. Nothing in this article is intended to contradict anything in the instruction manuals. We may suggest occasional lubrication, for example; but if your booklet says very explicitly *not* to oil this or that, then don't oil it. They know more about what they've made than you do, or than we do.

This month we discuss tuners and amplifiers. Later we will cover such components as speakers, record players and tape recorders.

Harman-Kardon's Citation 12 120-watter. The latest in stereo power amplifiers.

Keeping the amplifier fit

Well-designed transistor amplifiers tend to deteriorate a lot less with age than tube amplifiers do, partly because of the inherently long life of transistors when they are not abused, and partly because of lower voltages and lower temperatures in solid-state equipment. There is usually not as much preventive maintenance to do in solid-state gear.

It is important, though, especially in dusty or smoggy regions, to clean air vents, grilles and heat sinks. Heat held in by restricted air flow can cause premature failure of transistors and other parts, especially in marginally designed equipment. Use a whiskbroom, brush, rag, or vacuum cleaner.

Noisy or intermittent switches and controls can sometimes be fixed by cleaning the contacts. Seldom-used switches and controls are the most likely to cause trouble. Often just twisting the switch or control rapidly from one stop to the other several times is enough. Sometimes you will have to use a switch and control cleaner, or some ethyl chloride, to help dissolve dirt. Inspection of a switch will sometimes turn up the cause for intermittent operation—bent or corroded contacts, dirt, a bad solder connection.

A fairly common cause for noisy volume and tone controls in transistor amplifiers is dc leakage through the control. The tendency to use relatively low-resistance controls in solid-state amplifiers (10,000 ohms, for example) requires coupling capacitors of 5 or 10 μF, typically. In all but the most expensive equipment, these are electrolytics, which tend to leak more than other types of capacitor. Leakage also tends to increase with age and temperature. The only answer is to replace the offending capacitors. If you can afford to, use tantalum capacitors, which have far less leakage current for a given capacitance.

Many early solid-state amplifiers and preamps had objectionably noisy phono preamp stages. It is sometimes

sound STEREO

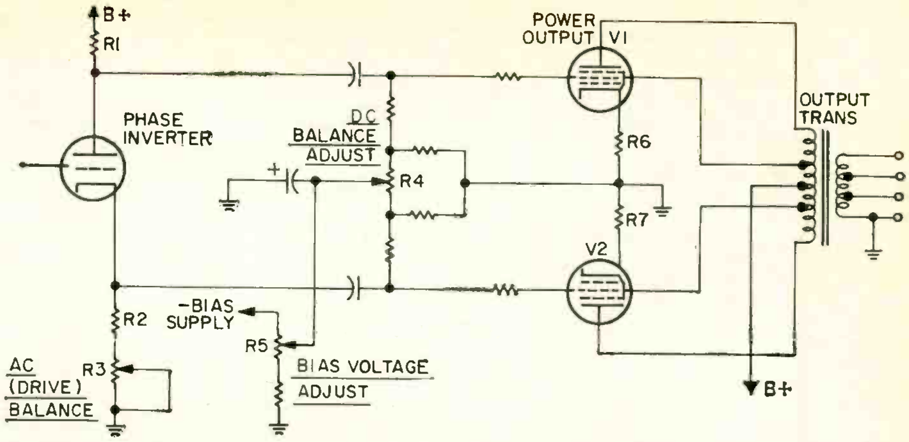
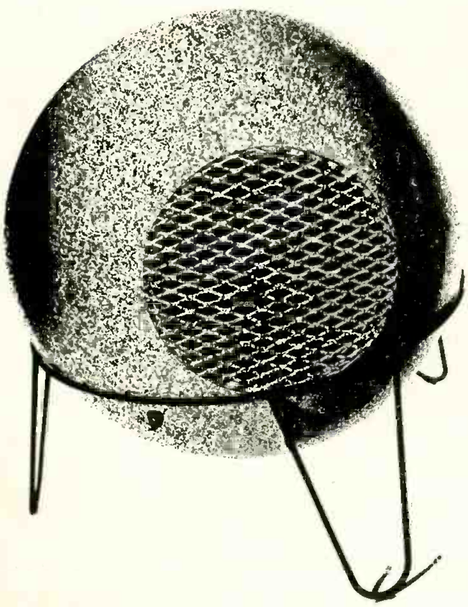


Fig. 1—ADJUSTMENTS IN HI-FI AMPLIFIER. Not all amplifiers have all these adjustments. Usually, R2 plus R3 equals R1. Pot R3 sets equal drive to tubes V1 and V2. R5 sets the dc bias level, while R4 sets equal cathode currents through R6-R7.



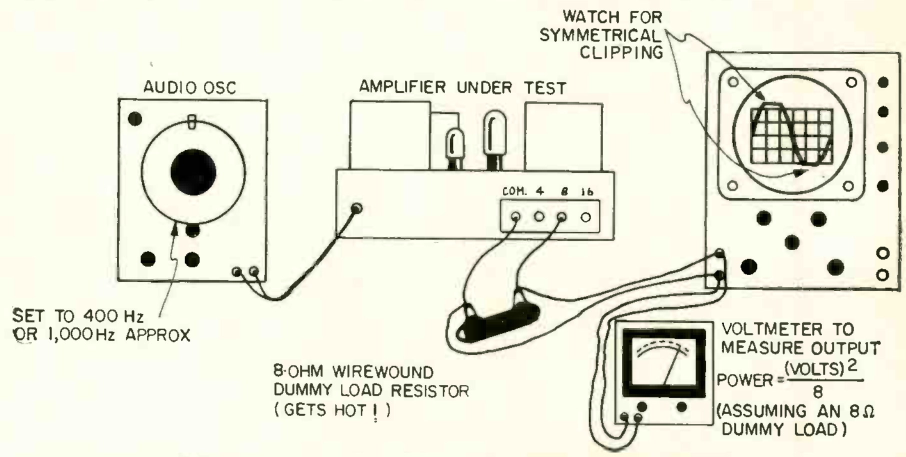


Fig. 2—POWER AND OUTPUT BALANCE CHECK. Assymetrical clipping not correctable by balance adjustments is probably developed in earlier stage. To measure power output, adjust the 400- or 1000-Hz input signal to just below point where clipping is seen on scope. Square the voltage reading and divide it by the value of the load resistor.

possible to improve them with newer transistors. The General Electric or Sprague 2N3391-A is a good, low-noise, low-cost silicon planar npn transistor now being used by many manufacturers; it can replace other silicon npn types probably without any changes in circuitry. An even better transistor is the Fairchild SE4010, though it may be harder to come by. Both cost well under $1.00.

Several designs used the RCA 2N2613, a pnp germanium transistor especially recommended for low noise. Performance was sometimes disappointing; buying a handful of 2613's and finding the one with the lowest noise may bring significant improvement. A possible replacement is a *silicon* pnp transistor by Fairchild, the 2N4250 (or its brother and sister, the 2N4248 and 2N4249). Depending on the circuit, this may require some changes in first-stage bias-resistor values. Its gain is very high even at collector currents around 10μA, where noise is extremely low. The 2N4248-50 series also cost well under $1.00.

Sometimes replacing first-stage emitter, base and collector resistors with some of better quality helps. Any resistor with dc flowing through it is a potential source of extra noise. Ohmite, IRC or Allen-Bradley composition resistors are likely to be better than unknown or "bargain" resistors. It is impossible to tell by looking at a resistor how noisy it is, so pulling out resistors and replacing them with new ones is a gamble. But it may be worth the effort if you are annoyed by hiss.

If yours is a tube amplifier, much of what has been said about cleaning applies to it also. If the tubes are more than about 3 years old, replace them. Use matched pairs in output stages unless your amplifier provides dc balance adjustments. Run through the balance and bias adjustment (Fig. 1) in any case; follow the manufacturer's instructions. The idea is to get the two push-pull output tubes in each channel to draw equal current through the output transformer primary winding. Since the currents drawn by each tube flow in opposite directions, the magnetic fluxes they generate in the transformer core cancel each other. This reduces distortion and extends the bass power capability.

Several tube amplifiers provide metering terminals or some other way of adjusting output-stage current. Another good way to check is to set the amplifier up for a power measurement (as in Fig. 2—400- or 1,000-Hz tone to the input, 8-ohm resistor and scope across the output), and adjust the tone level and the output-stage balance until the clipping of the output waveform is symmetrical. Still a third way is to connect a harmonic distortion meter to the amplifier output and adjust the bias and balance controls for minimum distortion at a power output near the rated maximum.

A few amplifiers have adjustments for balancing the signal drive to the two sides of the push-pull output stage (Fig. 1 again). These too should be checked after the tubes are replaced, and checked again after the first hundred hours' use. The symmetrical-clipping test can be used here, but the best way is to adjust for lowest harmonic or intermodulation distortion.

If an amplifier does not meet its power or distortion specifications (at rated line voltage) after you have replaced its tubes, perhaps some resistors have drifted off their original values, paper capacitors have become leaky, or electrolytics have become inefficient. If you can, check supply voltages against the schematic. They should be within 10% of their specified values. If they seem low, and you know your line voltage is normal, replace the electrolytic filter and decoupling capacitors. This should also help cure hum or instability that may have developed over the years.

But don't be too hard on an old amplifier. First of all, remember that a 10% drop in power (as from an original rating of 20 watts down to 18) is only ½ dB, and completely inaudible. A loss of even half the power (3 dB) may not be noticeable in many situations. Secondly, many amplifiers were (and are) sold on the basis of exaggerated or "best of the run" figures. If this is the first time you've made measurements on your old amplifier, you may be discovering that it never did perform as well as you were led to believe.

The noise level of the preamplifier stages can vary enormously with the tube used. Not all 12AX7's are the same. By general consensus in the industry, the quietest are the ones made by Telefunken in Germany; several manufacturers imported them for inclusion in original equipment, often stamping them with their own brand names. Such premium tubes may be available as replacements if you write to the manufacturer. Good bets also are the ECC83 tubes (European type number corresponding to the American 12AX7) made by Mullard (British) and Amperex (Dutch). The American premium versions of the 12AX7 never quite came up to the standard set by the European types, although the G-E or RCA 7025 may be worth trying. If you have the money and the patience, buy several and find the ones that have the lowest hiss, hum and "flicker noise". If your amplifier uses 12AX7's in tone-control or other later stages as well, you can safely use the noisier tubes there, where the signal level is higher and less susceptible to tube noise.

Tuners

For tuners with vacuum tubes, replace all the tubes if they are more than about 3 years old. In all tuners except the Marantz 10B, which uses i.f. filters instead of tuned transformers, it would be wise to follow tube replacement with an alignment job. FM alignment, especially in a stereo multiplex tuner, is much more critical than AM alignment, and the safest procedure is to follow the manufacturer's service instructions.

In general, though, you can check i.f. alignment easily enough by tuning in a weak station, or by weakly coupling a signal generator to the i.f. strip. Assume, if you use a generator, that the i.f. strip is basically tuned to the correct frequency (that is, 10.7 MHz). It is probably more accurate than your generator, so connect a vtvm (switched to a relatively low dc range) between the last limiter grid and ground, and introduce a weak signal from the generator. Then tune the *generator* until the meter peaks (or until the tuner's own signal-strength meter peaks). Don't worry if the generator's dial reads something other than 10.7 MHz. This way you'll avoid the risk of unnecessarily realigning the whole i.f. strip to a new frequency, with possibly very evil effects on the tuner's performance. It is important to use a weak signal for peaking the alignment of an FM i.f. strip. Strong signals will cause limiter stages to saturate, and when they do, their tuning characteristic will be very broad and the peak hard to find. You can also use a weak FM broadcast station for the same purpose.

Aligning the detector in a high-quality tuner is more difficult, and best done with a sweep generator and a scope, with the help of the manufacturer's service manual. It is best to leave the ratio detector or discriminator alone unless you have reason to believe that it's seriously out of whack (if, for example, there is audible distortion on almost all FM stations, or if you've diddled with the alignment already). Fig. 3 shows a

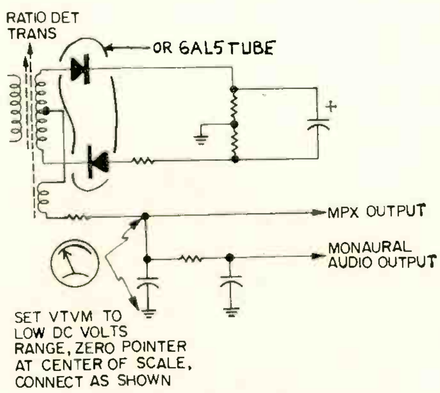


Fig. 3—TOUCHING-UP FM DETECTOR. With input from FM generator or station, adjust secondary slug for zero output.

quick "field expedient" method for at least "centering" the detector with a signal generator or FM station as the signal source, and a vtvm.

If the dial calibration is off, check to see whether it's off by a linear amount (a certain fraction of an inch) all the way across the dial. If so, the error is probably due to dial-cord slippage, or some other kind of mechanical slippage. Slipping dial cords can often be restored just by cleaning them with a greaseless solvent, like isopropyl alcohol or ethyl chloride. Or perhaps the pointer has simply slipped slightly. Even if it hasn't, you can sometimes restore dial calibration reasonably well by sliding the pointer to the correct spot on the dial when the tuner is centered on a station whose frequency you know. (Remember that FM broadcast station frequencies are far more accurate than service-type signal-generator calibrations.)

If the calibration seems to be precise at one end of the dial or in the middle, but off by an increasing amount elsewhere, the error is almost certainly due to a drift of value of some component in the oscillator tank circuit. It is often possible to restore accurate calibration by juggling *very slightly* the adjustment of the oscillator coil and the oscillator trimmer, but this can be tricky and time-consuming. Under no circumstances make any gross adjustments unless you know exactly what you are doing and why you are doing it, otherwise you may have a full-scale alignment job on your hands. If the error is not serious it is sometimes better to play it chicken and live with it, or to move the dial pointer slightly to "split the difference" in the calibration error.

If you choose to replace the dial cord altogether, be sure to make an accurate sketch of how it is installed before you remove the old cord, else you may have several hours' intensely frustrating work ahead.

Unless you have had experience, leave the multiplex section alone. Any kind of alignment work on a multiplex decoder requires at least an accurate source of 19-kHz and 38-kHz signal. The procedure is too long to go into here. Numerous books and articles dealing with the adjustment of stereo multiplex decoders have been published.

Many complaints of poor FM reception are due not to the tuner but the antenna and lead-in. An outdoor antenna should be inspected at least once a year, especially in industrial areas where corrosive pollution runs high, or in seacoast locations. The polyethylene insulation of twin-lead deteriorates with exposure to sun and air pollutants, and its electrical loss increases. Connections between the lead-in and the antenna or lightning arrestor can corrode and break. Insulating blocks on the antenna itself can become coated with conductive salts, greatly decreasing the effectiveness of the antenna.

Other things change with time, too; a new tall building may have altered reception conditions in your home, and that could be responsible for worsened quality on some stereo stations. A change of antenna location, or a different antenna, may be needed to solve the problem. **R-E**

how to buy audio tape

There's more to magnetic tape than the box it's packed in. Here's the story on what goes into those white boxes.

by BYRON G. WELS

YOU'VE BOUGHT YOUR FIRST TAPE RECORDER, and now you want to buy tape, so you can put it to use. You're faced with a fantastic assortment of brands, types, lengths, thicknesses and prices. Chances are, if you're like most people, you will try a bit of this and a bit of that, until finally you learn what you like and what you don't like. However, although this process works, it is horribly expensive. You can often get stung by the cost until you learn, and more costly, you might even entrust a valuable recording session to a shoddy tape and wind up losing money and recording.

In this article, we will outline what to look for and what to look out for in tape, so if you do spot a bargain and go for it, you'll at least know what you're getting and won't be surprised.

Prerecorded tapes

The newcomer (and many old hands) at tape recording look upon a tape machine more as a means to play music than to record it, and this is fine. These people invest in "albums" of prerecorded tapes, collecting the music they like.

But you've got to be on your guard. Today, most tape albums are sealed in plastic wrap, and you can't open the package to look at what you're getting, let alone listen to the tape before you buy! The best rule here is to know what you are buying beforehand. You can do this by listening to your better FM music stations, those that announce the name of the tape producer and the number of the tape either before or after playing. This gives you the chance to listen and judge in advance. Another good rule is to stick to the names you know, both in producers and performers.

Because artists' fees are high, some of the smaller music producing companies will go abroad and hastily organize a "pickup" symphony orchestra to play into a recorder. This master tape is then brought back home for processing, duplicating and sale. Such tapes can be spotted by the fact that the box will rarely mention the performing orchestra, featuring the title of the work for a big play instead! Somewhere on the box, if you can find it, the orchestra will be identified. But if you spot a name like the "Lower Slobovia Penultimate Symphonette," watch your step.

Another thing to watch for are certain key words. "Suite" and "Excerpts" both imply abbreviated versions of a work. Unfortunately, we often accept such words as part of the actual title. However, "Swan Lake Ballet Suite" means a shortened version of the full ballet. The word "Suite" is French for *fast*. Another trick word is "Overture" or in French, if you want to add class to your record or tape box, "Ouvreture." This is really just an introduction, not an entire opera.

Finally, take a look at what you've bought when you get home. Maybe you bought a box that's a full 7 inches across, and maybe it contains a reel 7 inches in diameter, but you might find a huge plastic hub at the center, up to 4 or 5 inches across. The result? A heck of a lot less music than you expected!

If you can get stung with recorded tapes, the problem is even worse for blank tape. Let's take a look at what's generally available.

First, you've got to choose your base material. This is the plastic on which the oxide recording medium is applied. You have a choice of acetate or Mylar, in varying thicknesses. The acetate is more prone to breakage and embrittlement, unless you go for the thicker base. Of course, using a thicker base means that they can't put quite as much tape on each reel!

The Mylar is far longer-lasting and in the thin ½-mil and thinner ¼-mil varieties you get a lot more on each reel. Of course, you pay more, and if you set the record level too high you may get print through. That is, the recorded information on the tape is transferred to the next layer, with all kinds of echo effects that were never recorded in the first place!

More critical is the oxide itself. How well has it been designed, how well has it been milled, and how good a binder has been used in making it adhere to the base? These are all critical factors. Why? If the oxide hasn't been properly milled, it will be lumpy, and each lump will make the tape rise from the head, causing dropouts in your recording. If the binder isn't good, the oxide will shed, again leaving blank spots in your tape. It can also speed head wear.

Chances are that if you buy a name brand, you'll get good quality. Your choice really depends to a great extent on what you plan to use the tape for. But you also ought to select your tape to fit the application in light of what that application is. If you anticipate recording level problems, use a high-output tape. If you're going to be recording long sessions with no opportunity to clean the heads, use sandwich tape, in which the oxide is sandwiched between two layers of plastic, the top layer being very thin. No oxide touches the heads, so there's no need to clean.

White-box tape

As Barnum said, "There's one born every minute." White-box is tape that is usually sold in a plain white box, with no manufacturer's name or reputation to back it up.

It's usually sold at a comparatively low price, and usually there are more than enough customers ready to shell out their money for this stuff. What white-box tape is, however, is a story in itself.

Usually it's computer tape that was 1 or 2 inches wide and reslitted to the required ¼ inch. Unfortunately, computer tape is required only to register the fact that it has been magnetized or not magnetized. The fidelity of this stuff is often not suited to audio work. Sometimes, white-box is reslitted video tape, which has a better frequency response but can bring other problems. The safest rule is to stay away from this stuff.

Another good source for the white-box packagers is mill ends or rejects. When a tape manufacturer starts or finishes a run of tape he must adjust his coaters. Until they are set properly, quality will suffer. However, he can and does sell these mill ends or rejects to the white-box people. Fortunately, many tape manufacturers have begun to realize that they are actually doing themselves a disservice by this practice, and simply throw away the subgrade material.

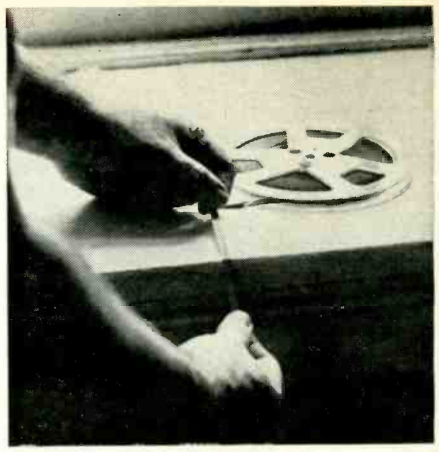
Testing tape

The proof of the tape pudding is usually in the playing, but there are tests that you can use to find out how good (or bad) a reel of tape is.

One good test is to take a look at the new reel of tape, holding it up to an even, strong light. The layers of tape on the reel should be smooth and even, with no sign of buckling. If you see a slight "hump" in the tape, unwind it to that point to see whether you've got a buckling overwind or a splice.

Next, unwind about 4 or 5 feet of the tape in a room where the air is quite still, and let it hang from the reel. If the tape does not hang evenly, with no "pulling" to either side, this indicates that the tape slitters were dull and that the tape has "warped" as a result. Such tape may jump the idlers during a session.

Next, draw the tape tightly over a straight edge, such as a table edge. Look carefully for any sign that the oxide has flaked off. As a final test of shedding, place the tape on a flat surface, oxide side up. Press a piece of pressure-sensitive tape over the oxide, and pull it away quickly. Examine the



IF OXIDE FLAKES OFF when you run it over a table edge, it could be a bad buy.

tape carefully under a good light to see if any oxide pulled off.

Tape recording is a wonderful hobby, but it can be marred by a poor purchase. Know what you're going to buy, and then go to the store and buy it. Remember, you're buying tape—not fancy four-color packages, not low prices—just good, high-quality recording tape.

And watch out for glib, smooth-talking salesmen, too. They do not always have your best interests at heart! Some stores give the salesmen what are called "P.M.'s" or Push-Merchandise bonuses. If they sell products so listed, it's more money in their pockets, so don't be fooled.

More than anything, else, remember to *Caveat* the heck out of Emptor! **R-E**

MODULAR TV SETS (A rundown of the new sets)

	Panel	Circuits
MOTOROLA (TS-915-'19) Cuasar Solid State Color	AFC	AFC discriminator & amplifiers
	B	Video IF amps., AGC amp., video det., video det amp., 4.5 MHz det.
	D	Audio demods, & output amps.
	E	Noise inv., AGC gate, sync sep., vert. sync inv. & oscillator, 1st video amp., 2nd video amp., brightness stabilizer
	F	Color gate pulse former, horz, osc., horz. output
	G	Vert. pincusion amp., H. reg. amp. & driver
	H	Vert. limiter & Vert out., vert. and horz. convergence assy.
	L	RGB demodulators, RGB video driver, blanker amp., blanker out., brightness controls
	M	RGB video out. amplifiers & drive adjust.
	S	ACC amp., color killer amp., color IFs, color oscillator output & drivers
MOTOROLA (Hybrid) CTV5, CTV6 Quasar 2 Color	BA	Video IFs, video amp., audio IC, audio out.
	FA	Sync. sep., vert. osc./out., H. phase det., horz. osc., horz. driver
	HA	Convergence assembly
	KA	AFC discriminator & output
	SA	Color sync & osc, col. killer, ACC amp., 2nd video amp., sync & AGC takeoff, color IFs, RGB demodulators, volt. rg., RGB video outputs
	ZA	Transistor supply regulator (+20 volts) with foldback current limiting
ZENITH (Hybrid) 4B25C17,19 Color	**Panel**	**Circuits**
	9-23 (AGC Module)	AGC gate. AGC delay, AGC output, noise gate driver, noise gate, sync limiter
	9-27 (Sub-Gen. Module Assy.)	IC subcarrier oscillator, APC, ACC, output amp.
	9-37 (Chroma Mod.)	IC chroma ampa. & IC demodulator
	150-166 (IF Assy.)	Three IFs, Audio Det., Video Det., 1st video amp.
ZENITH (Hybrid) 12B14C52 Color	S-85579 (Conv. Assy)	Dynamic convergence assy.
	9-47 (Color Module)	2nd color amplifier & IC demodulator
ZENITH (Solid State) 22AB55 Monochrome	150-20 (IF Assy.)	Three IFs, video det., & driver
	150-204 (Sound Mod.)	Sound IC demodulator, amplifier
	9-22 (Video-sound Mod.)	Video out, sound driver, sound output
	9-23 (Sync-AGC Mod.)	AGC gate. AGC out, AGC delay, noise gate driver, noise gate, syn limiter
	9-24 (Vert. Mod.)	Vert. osc., vert. driver, vert. output
	9-25 (Horz. Mod.)	AFC, horz. osc., horz. driver
HEATHKIT (Solid State) GR-270, GR-370 Color	**Panel**	**Circuits**
	IF Assy.	Three IFs & video detector, driver
	Luminance Board	Lum. Amps., blanker, brightns lim. & control, dot generator
	Sound Board	IC amp.-discriminator, driver, audio out.
	Video Out Board	IC demodulator, lum. amp., RGB outputs
	AGC/Syn Board	AGC inv., gate & gated amp., AGC amp., RF AGC, noise inv., sync gate, sync. sep.
	Chroma Board	ACC amp., color killer, 1st & 2nd color amps., band pass amp.
	Osc. Circuit Board	Burst amp., ACC, APC phase diodes, IC 3.58 MHz oscillator, CW amp.
	AFT Circuit Board	IC amp., discriminator,
	Convergence Board	RLC circuits for dynamic convergence
	Vert. Osc. Board	Vert. switch, vert. predriver, linearity clamp, vert. driver
	Horz. Osc. Board	Phase splitter, AFC diodes, horz. osc.
	Horz. Out Board	SCR HV drivers, HV regulator
RCA (KCS 184, 177,176) Solid State Monochrome	**Panel**	**Circuits**
	Pix Module	IF amps, video detector, video drivers, AGC circuits
	Video Module	Video out, sync, AGC keyer
	Sound Module	IC sound det., amp., audio output

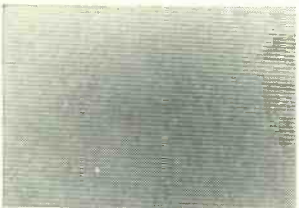
Focus stages—four major versions in color chassis

NEW R-E EXCLUSIVE

Kwik-Fix™ picture and waveform charts

by Forest H. Belt & Associates*

SCREEN SYMPTOMS AS GUIDES — WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	For reference: Raster lines in focus (closeup)	Normal	Normal	Normal
	Raster out of focus and shaded (closeup)	Focus anode of CRT	No help	Bleeder resistor
	No raster	Focus anode of CRT	No help	Focus rectifier
	Raster out of focus (with picture)	Focus anode of CRT	No help	100k resistor (diagram B)
	No raster	Focus anode and no tube current	No help	Focus transformer

NOTES:

Screen symptoms are only of marginal help in tracking down trouble in focus stages.
Study the screen as you turn the FOCUS *control.*
Only helpful clues are at the points indicated.

Check focus voltage or horizontal-output cathode current as indicated.
For quick check, test or substitute parts shown as most likely cause of the screen symptom you see.

THE STAGES

All color picture tubes except recent small-screen types require a high dc focus voltage. Its value must be at all times from 18-20 percent of whatever value of high voltage is applied. If the high voltage varies, the focus voltage must vary with it. Otherwise, there will be poor focus at high and low brightness. In practice, that means focus voltage must vary from about 4200 to 5500 volts dc.

Color picture tubes use electrostatic focus. This makes a "dry" circuit; that is, there's NO normal current flow to or from the focus electrode in the CRT. The only electron flow in the entire focus stage is a very tiny current where there's a bleeder resistor. That's normally a very large value—66 megs or more.

Focus voltage is developed by rectifying a high-energy pulse taken from the plate of the horizontal output tube. Its value is usually about 5000 volts peak to peak (p-p). The pulse is fed to the focus rectifier anode, usually directly from the horizontal output plate. Only in an occasional chassis is there a small bit of flyback winding between horizontal output plate and focus rectifier.

The stage in diagram A has the control potentiometer across part of the flyback winding. The pot slider picks off enough of the pulse to develop the correct value of dc at the output of the 1V2 focus rectifier. This version is seldom used anymore.

Diagram B is popular in middle-age color sets. Sometimes a solid-state rectifier is used in place of the tube. The distinctive part is the focus transformer, which has a movable core in part of the windings. The rectifier anode is

DC VOLTAGES AS GUIDES

Voltage change	to zero	very low	low	slightly low	slightly high	high
Diagram A V1 cathode Normal— 20% of HV	R1 open V1 open					
Diagram A focus anode lead Normal— 20% of HV	R1 open R2 open V1 open	R1 leaky* V1 socket bad	R1 faulty* R2 arcing* CRT socket (pin 9)	R2 v. high	R3 open	
Diagram B V1 or X1 cathode Normal— 20% of HV	V1 open X1 open V1 socket bad T2 shorted	C1 shorted X1 shorted T2 shorted	T2 open R1 open CRT socket (pin 9)	R3 open R2 high C1 open		
Diagram B focus anode lead Normal— 20% of HV	R2 open			R2 v. high		
Diagram B H-O Tube cathode current Normal— 200–240 mA						C1 shorted T2 shorted X1 shorted
Diagram C focus anode lead Normal— 20% of HV	R1 open	R1 faulty		R2 faulty*	R1 open R2 faulty* R3 open	
Diagram D focus anode lead	R1 open R2 open		R1 v. high		R2 open R3 open	

NOTES
**erratic voltage usually depicts internal arcing.*
Use this guide to help you pinpoint the faulty part.
Measure each key voltage with vtvm and high-voltage probe.
Measure key current with current function of vom.
For each, move across to the column that best describes the change you find.
Notice which parts the chart says might cause that change.
Finally, notice which parts are repeated in whatever combination of voltage changes you find.
Test those parts individually for the fault described.
NOTE: Use the chart rows for the diagram closest like the focus stage you're servicing.
NOTE: All these voltage guides assume the high voltage is within 1000 volts of normal.

driven from the horizontal output plate, as in other focus stages. The focus-transformer windings are fed out-of-phase with each other, and at a different phase than the voltage pulses at the rectifier anode. The adjustable core determines how much and what phase of pulse is fed to the rectifier *cathode* through the 130-pF capacitor. The net dc at the cathode depends on the relative values and phases of pulses applied to the rectifier. The core adjustment therefore in effect controls dc focus voltage.

Some early models—and a few small-screen recent ones—use a focus stage like diagram C. A specially built divider resistor develops focus dc directly from the high-voltage source. That takes care of tracking very simply; focus voltage is automatically a fixed percentage of the high voltage at all times. A high-value potentiometer at the ground end of the bleeder provides manual adjustment.

In diagram D, a voltage sextupler, of the half-wave variety, builds an input pulse voltage into the 25 kV dc needed for the color picture tube second anode. A tap in the voltage multiplier picks off about 30 percent of the total voltage value for focus. Divider resistors and a pot set the exact value of dc sent to the CRT focus anode. This version is found in recent-model solid-state color receivers.

SIGNAL BEHAVIOR

There is only one "signal" or waveform in any of these focus stages. That's the high-energy pulse from the horizontal output tube plate. It is above 5 kV p-p, far beyond the rating of almost any scope or probe. You seldom need to know its voltage, anyway.

If you want to view the pulse waveform, clip the scope probe tip *to the insulation* of one of the leads. The lead from the plate cap of the horizontal output tube is fine, if the connection is direct. DO NOT LET THE PROBE TIP TOUCH the terminals or windings of the focus-transformer or flyback. If a focus transformer is used, the pulse taken at one of its leads (see Waveform Guide) varies considerably in shape and size as the core is adjusted.

DC DISTRIBUTION

Actual dc voltage in a focus stage may be different from that given on the schematic for the chassis. So much depends on the particular CRT. But the difference won't be great. A lot also depends on the value of the high voltage. That, in turn, depends on the settings of the screen and drive controls, brightness, and in some sets the contrast.

Dc focus voltage is usually fed to pin 9 of the picture tube. There may be a series resistor, or none. Since no current flows, the value doesn't affect dc voltage. The resistor is mainly a filter to smooth out any pulse "hash" that gets past the rectifier.

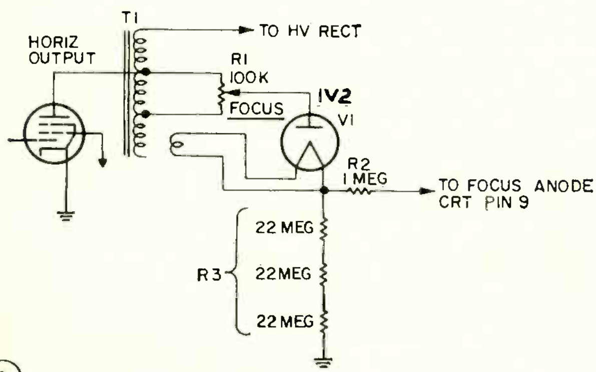
To stabilize the load on the focus rectifier and pulse-supply circuits, there is often a bleeder. Changes in its value, or in the values of any resistors in series with it, can alter focus voltage seriously.

SIGNAL AND CONTROL EFFECTS

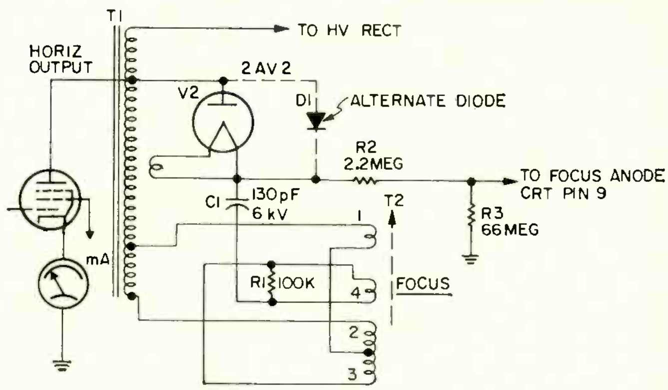
Controls are of three main types. One is the potentiometer version shown in diagram A. This kind has almost disappeared. It was dangerous because so much hot rf from the flyback was present. The control didn't last long, either.

More popular is a different kind of potentiometer hookup, shown in diagrams C and D. A pot in a resistive divider network has a comparatively small dc voltage—only a few thousand volts, and dc at that.

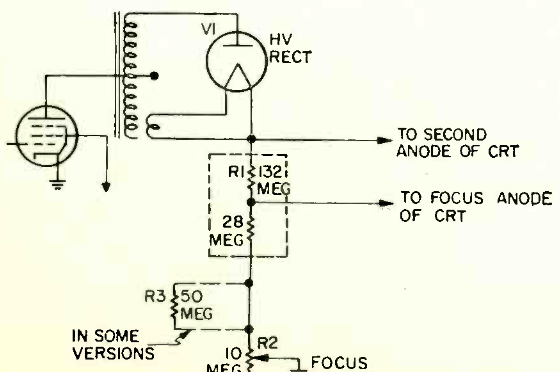
The third type of focus control is the adjustable-core



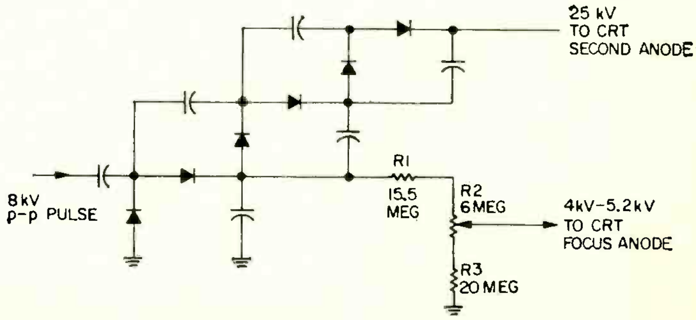
A



B



C



D

focus transformer (diagram B). Its operation has been explained: it controls dc output of the rectifier by altering the net pulse voltages applied to the focus rectifier.

The object of any focus control is to vary the average focus voltage to suit the CRT and the settings of other controls in the chassis. To a small extent, the video in the station signal can affect focus voltage. If you put a dc meter on focus voltage, you'll see it vary with brightness content of the picture. More brightness over the screen loads down the high voltage, so the focus shifts downward enough to track. The high-voltage regulator should take care of voltage shifts, but small changes are normal as scenes change.

QUICK TROUBLESHOOTING

The quickest way to spot a focus problem is to look at a blank raster on the picture-tube screen. If the set has a SERVICE switch with a RASTER position, use that. Or, turn the AGC control to produce a whiteout. Or, just pull an i.f. tube temporarily.

If horizontal scanning lines are not clear and sharp, turn the focus control in both directions. One way should bring the raster to sharp focus. If not, the set has focus trouble.

For a first check, measure the high voltage with a normally bright raster. If it is within 1000 volts of the value recommended by the manufacturer, yet the raster will not focus, the trouble is definitely in the focus stage. The high voltage must be within tolerance before you can make any meaningful tests in the focus circuits. That's because, one way or another, the focus stage gets its drive from the sweep-and high-voltage section.

Compare the two voltages to their normal values. If the high voltage is, say, 10 percent low, and focus voltage is perhaps 50 percent low, that points to focus trouble.

If *both* voltages are either high or low by the same percentage, the trouble is common to both. The horizontal output tube, flyback, B-plus, boost voltage—all could affect the pulse reaching the HV and focus stages.

You can measure focus voltage conveniently at pin 9 of the socket for standard color picture tubes. Or, it may be easier to reach at the focus-rectifier socket or terminal, or at the hot end of the 66-meg resistor. Most high-voltage probes or voltmeters can read focus voltage accurately.

While you're near the CRT socket, take a look at pin 9. This terminal often corrodes, turning green and sometimes eating the wire through. The cure is a new CRT socket, and then fill the pin-9 socket terminal with silicone grease to keep air from it.

SPECIAL CLUES

If focus voltage drops to a very low value or zero, there can be no raster. With focus voltage at about 50 percent of normal, you probably can see fuzzy blobs of color—the highlights of the picture—floating around the screen. But be sure high voltage is up; if it's not, you can't do a thing with the focus stage.

If the high voltage is only half of normal and the horizontal output tube overheats, a selenium focus rectifier may be shorted. Also check for a shorted pulse-coupling capacitor (diagram B). Shorted turns in the focus transformer can overload and destroy the flyback.

Cathode current in the horizontal output tube is a good clue. Measure it. If it is high, yet the circuit tries to produce high voltage, disconnect the focus transformer. If it's shorted, disconnecting it returns the cathode current and high voltage almost to normal.

If high voltage is normal and cathode current within reasonable limits, yet focus voltage is very low or zero, suspect an open focus rectifier. The solid-state type rarely open. Usually, they partially short and overload the flyback and output tube.

A change in value of a high-resistance bleeder can raise or lower focus voltage. If a plastic-encased one goes bad, use an exact duplicate.

Check potentiometers. The kind in diagram A is especially critical. Never spray it to clean it. If contact gets poor, or the element starts arcing to ground, replace the pot. Use a thick sheet of polyethylene film between the control and the mounting—it increases the insulation path.

It's best to replace pots in divider circuits, too, if they begin to get scratchy. Cleaning rarely lasts more than a few days (or hours). They can also change value, which upsets the voltage.

If sets with voltage multipliers (diagram D), any high-voltage trouble also affects focus voltage. If an individual rectifier in one of these goes bad, it's a good idea to replace the whole "board-full" of rectifiers. All of them have probably been subjected to overload. **R-E**

WAVEFORMS AS GUIDES

WF 1 Normal Unknown V p-p

This waveform is sample picked up by holding scope probe near focus transformer (diagram B). It has little practical value for diagnosis. It varies in shape and peak-to-peak amplitude as the core of the focus transformer is adjusted. The changes verify that the core is affecting coupling in the transformer, but the changing value of dc voltage at the rectifier cathode tells you the same thing. Changing parts values elsewhere in the circuit have little or no effect on the waveform. See *DC Voltages As Guides* for better help in diagnosis.

NEW BOOKS

LOGIC CIRCUITS, by N. M. Morris. McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. 199 pages, 6 x 9 in. $13.50.

A general guide to design and use of logic devices and systems with chapter review questions for self-study. Chapters describe numbering systems and codes, arithmetic processes, the flip-flop, counting systems and hardware. Advantages of Karnaugh map method are described.

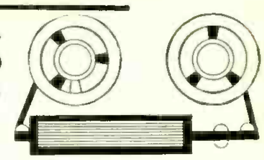
MOTOROLA COLOR TV SERVICE MANUAL, by Forest H. Belt. Tab Books, Blue Ridge Summit, Pa. 17214. 160 pp., 8½ x 11". Softcover, $4.95.

Covers all models using TS-907-TS-924 chassis. First chapters are on monochrome purity, gray-scale tracking, static and dynamic convergence adjustments, as well as tuner repair. Remaining chapters are devoted to analysis of each chassis.

HANDBOOK OF PRACTICAL ELECTRONIC TESTS AND MEASUREMENTS, by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. 302 pages, 6¼ x 9¼ in. $15.

Guide to most practical electronic test and measurement procedures encountered by electronic technicians. Covers component tests and quantity measurements. Generally, a quick procedure with simple equipment is described along with a detailed lab procedure. **R-E**

Constant-Speed Motors for Tape Recorders



by AL WILLIAMS*

THIS SUMMER, IF YOU LIVE IN A REAsonably large city, you found that at various times many of your appliances—from toasters to refrigerators, to blenders—were working at something less than maximum efficiency. Worse, some of your high-fidelity equipment did not work up to standard. It wasn't the fault of the appliances or components. The plain fact is that there were serious voltage drops at certain times of the day. Actually, voltage under the best conditions may vary considerably from the standard 115 to 120-volts supposedly delivered to your houschold outlets.

It's not just a summer problem, when air conditioners create a tremendous demand on available power. It can happen almost anywhere, anytime. A case in point is a busy ski area in Southern Vermont. During the evening, with every lodge filled to capacity, there is a definite loss in light levels compared with other times of the year.

A serious voltage drop can affect tape recording quality. The problem can be as sticky for the amateur home recordist as for the professional working on location. Let's take a look at specifics and the part that the motor drive—and hysteresis synchronous motors—can do to help the situation.

The fundamental task of a transport system is the smooth, constant movement of recording tape through the tape head contact area. Achieving and maintaining this movement under varying ambient conditions is the transport designer's challenge.

Some of the annoying results of inadequate transport design include change in key or pitch of recorded audio information and random fluctuations detectable as wow and flutter. These problems can occur due to ac input power line variations as well as loading changes within the transport system.

The drive motor is the prime mover in the transport system. All tape speed deviations, whether stationary or time varying ones, can ultimately be referred back to the drive motor. Therefore, the essential specification for a tape transport drive motor is constant speed. In terms of practical design the linkage between drive motor and the rest of the tape transport system will typically involve belts or friction wheels. And in order to keep a reserve of momentum at the point of contact between the tape and drive system (the capstan), inertia is supplied with a flywheel attached to the capstan shaft directly.

The flywheel removes short term disturbances in the transport motion, but its average angular velocity must be maintained with the drive motor.

The types of motors or motor systems which might be selected by the designer include **dc motors** with mechanical or electronic regulation; **ac induction motors;** and **ac synchronous motors.**

Dc motors with governors are widely used in and generally restricted to low cost portable battery operated recorders, but have been used, occasionally, in component class recorders where battery supplies are not used. The disadvantages of the dc system include brush and contact noise if mechanical regulation is employed, the need to supply dc, and usually some additional circuitry such as amplifiers and/or filters. Remote control of motor speed is a possible but very minor advantage of the dc system.

Ac induction motors of single- or two-phase design are often found in a variety of tape recorders primarily because of their simplicity and low cost. In the single-phase induction motor the rotor speed is highly dependent on the ac source voltage and will change significantly with minor changes in source voltage. A two-phase induction motor may be coupled with a detector and servo amplifier to provide motor speed control. This approach is complicated, costly, and commonly relegated to control functions such as head motor speed in video recorders.

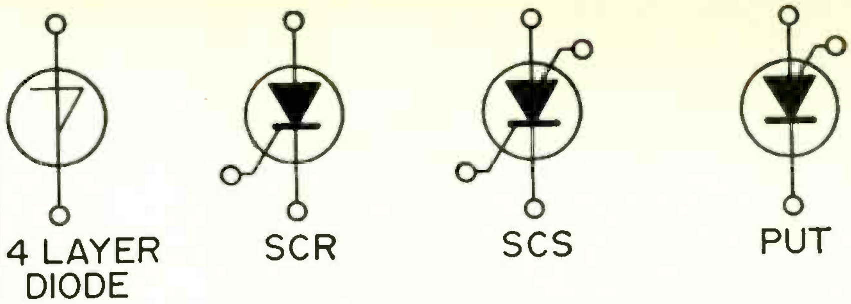
Ac synchronous motors represent a class of motors that are self-correcting relative to rotor speed and consequently deserve first consideration in tape transport design especially for the component type recorder. A "self-correcting" mechanism implies some form of servo system which will oppose fluctuations in both input power and output load in order to maintain some predetermined characteristic in the overall system output. A servo system is comprised of a detector and feedback mechanism usually incorporating amplification.

Comparative transport performance has proven the superiority of the hysteresis synchronous motor particularly in large cities where ac voltage fluctuations are extreme during high demand periods of the day and in heavy industrial locations where extreme fluctuations may be more frequent if not more severe. While the amplitude of the ac power undergoes large changes, the frequency (60 Hz standard) remains closely controlled. Such circumstances clearly suggest preference of the synchronous motor over ordinary induction motors in selecting a tape transport drive. The transport speed of Concord MK series decks has been controlled to within 0.7% for ac power fluctuation of between 100 and 128 Vac and within 1.0% over an 80 to 140 Vac range, surpassing the dynamic range of either ac induction or dc servo-controlled machines tested under identical circumstances.

The hysteresis synchronous motor takes special advantage of the phenomenon of hysteresis for detection of an error signal and generation of a correction signal. Hysteresis as related to the synchronous motor means the lag in magnetic effect which in the synchronous motor is used to store and compare the phase of the angular velocity of the rotor with the electrical phase of the ac source, some of which flows in the stator windings. The synchronous motor then performs magnetic amplification of the correction signal that subsequently alters the angular velocity of the rotor just enough to eliminate the error signal. This process is a dynamic one taking place on a continuous basis. The result is a phase lock between the frequency of the ac source and the frequency (rpm) of the rotor. Once locked in phase the motor speed is highly dependent on the frequency of the ac source and remarkably independent of the voltage level of the ac source. Phase lock will be lost only when the ratio of motor load to input power is excessive. In addition to the basic synchronous motor windings, others are included which serve two important purposes, that of self-starting and dynamic damping in case of large sudden changes in rotor load. Hence, the hysteresis synchronous motor is a self-contained closed loop phase lock servo system that can furnish constant speed over a wide range of power levels. **R-E**

*Chief Engineer
Concord Electronics Corp.

How To Putter With The Put



The PUT or complementary SCR is new solid-state device. Here is how it works and how to use it.

by R. W. FOX

About three years ago, the General Electric Company introduced the fourth member of the pnpn structure. This device has been called both a Programmable Unijunction Transistor (PUT), since it may be used in place of the unijunction transitor, and a complementary SCR. The former name is to show a major use of the device while the latter is a more descriptive name. General Electric has at present two devices on the market, the C13 Complementary SCR and the D13T PUT. These two devices are specified for their respective tasks, but to a degree may be interchanged. This article is devoted mainly to the D13T PUT. Several of the applications and much of the theory can apply equally to both devices. Included are theory, UJT replacement, switching circuits and many examples of their use.

Theory of the PUT

In Fig. 1, the equivalent circuit shows the two transistor analogue of a pnpn structure. For an SCR, the gate is the base of the npn transistor, but for the PUT the gate is the base of the pnp transistor. This is the difference between a PUT (and/or a complementary SCR) and an SCR. The theory follows normal thyristor theory for turn-on, turn-off and latching, etc.

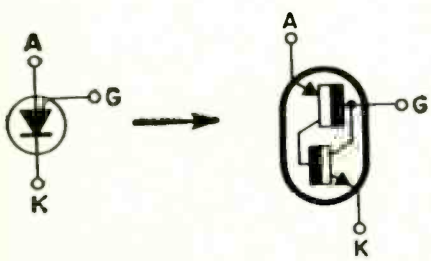


Fig. 1—PROGRAMMABLE UNIJUNCTION transistor and its equivalent circuit.

The device is turned on by making the gate negative with respect to the anode by a little more than the diode offset voltage so that enough anode current exists through the first pn junction (i.e., the anode-anode gate junction) to cause regeneration to occur. This current can be considered base current for the pnp transistor. The current required to trigger is typically on the order of a microampere. The current at which regeneration takes place is defined as the peak-point current (I_p). As the regeneration causes the anode-cathode voltage to collapse the device switches to the conducting state. The time for device turn-on is about 50 to 100 nanoseconds. (This turn-on, it should be noted, is an order of magnitude faster than the conventional unijunction transistor.) This results in a steep pulse for high di/dt SCR trigger applications. The device is now in the on-state, and in this region there are two parameters of great interest. These parameters (shown in Fig. 2) are I_V or valley current and I_H or holding current. Valley current is the point at which the PUT starts out of saturation, however, because of the beta shifts in the two transistors, the device will remain in conduction until the holding current is reached. The device at this point returns to a non-conducting state.

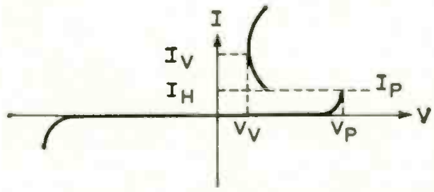


Fig. 2—ANODE-CATHODE CHARACTERISTICS based on the I_V: and I_H parameters.

The PUT in relaxation oscillators

Figure 3 shows a typical PUT relaxation oscillator. This circuit has two allowable states. State 1 will be for the PUT in the off or non-conducting state and state 2 will be for the PUT in the on-state.

First let's analyze the steady state conditions. Assume that the PUT is in state 1. After sufficient time the capacitor will be charged to $(V_{AA} - R_A I_{CL})$, where I_{CL} is capacitor leakage current. The anode-cathode voltage would be $(V_{AA} - R_A I_{CL} - R_L I_L)$, where I_L is the cathode leakage current

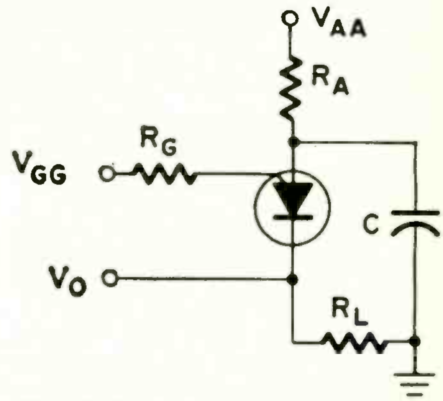


Fig. 3—A PUT RELAXATION OSCILLATOR. Like most circuits of this type, the active element is either on or off.

(which usually may be neglected). The voltage would be $(V_{GG} - R_G I_{GO})$, where I_{GO} would be the gate current with device off. (At room temperature I_{GO} will be less than 10 nanoamperes). If this state is allowed then:

$$V_{AA} - R_A (I_L + I_{OL}) < V_{GG} - R_G I_{GO} + V_T \qquad \text{Eq. 1}$$

Where V_T is the gate offset voltage to trigger.

If this equation is satisfied then this state is a permissible state, and the output voltage (V_o) is $I_L R_L$. Assuming that I_L, I_{CL} and I_{GO} are negligible, Equation 1 reduces to:

$$V_{AA} \leq (V_{GG} + V_T) \qquad \text{Eq. 2}$$

Equation 2 points out vividly that as long as the anode supply voltage is less than the effective gate source voltage ($V_{GE} \triangleq V_{GG} - V_T$) the PUT will remain non-conducting.

If the PUT is initially in state 2, then the following relationships will hold:

$$V_{GG} = (R_G + R_L) I_G + R_L I_{AR} \qquad \text{Eq. 3}$$

$$V_{AA} = (R_A + R_L) I_G + R_L I_G \qquad \text{Eq. 4}$$

$$V_O = R_L (I_G + I_{AK}) \qquad \text{Eq. 5}$$

Where I_{AK} is anode-cathode current and V_F is the forward voltage drop.

If

$$I_{AK} > I_H \qquad \text{Eq. 6}$$

then the PUT will remain in conduction.

If V_{GG} is applied to the circuit of Fig. 3 and then V_{AA} is applied, capacitor C will charge exponentially toward V_{AA}. If Equation 2 is satisfied then the PUT does not turn-on. If, on the other hand $V_{AA} > (V_{GG} + V_T)$ then it may be possible for the PUT to turn on. As the capacitor charges the current through R_A decays exponentially. When $V_C = (V_{GG} + V_T)$ the current through R_A is:

$$I_A = (V_{AA} - V_C)/R_A \qquad \text{Eq. 7}$$

It is at this point the PUT will trigger, if at all. For the PUT to be triggered

$$I_A \geq I_P \qquad \text{Eq. 8}$$

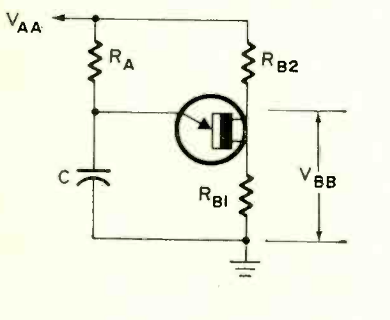
For if I_A is less than I_P then regeneration cannot occur and the device remains in State 1.

If regeneration occurs then the anode-cathode voltage collapses and V_O appears across R_L. Voltage V_O will now follow V_C on an exponential decay less the forward drop of the PUT to one of two end points. The first is the case where equation 6 holds; the second where it does not. It can be seen, if the capacitor has been discharged, and Equation 6 still holds, then, as a consequence the PUT will remain conducting. In the other case, as the capacitor discharges, there will be a point in the discharge at which the anode current has dropped below the holding current. At this point the PUT returns to State 1 and the capacitor is recharged through R_A. This is the free-running relaxation oscillator.

PUT fudge factors

In the above discussion, I_P, I_V, V_T and V_{GG} were assumed. The parameters, though, are not just single numbers that are merely plugged into equations. Each of these may be varied over a considerable range.

Factor No. 1—**Stand-Off Ratio** (η)



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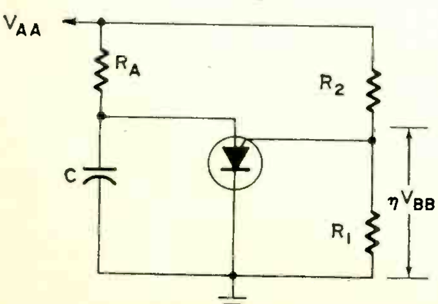


b

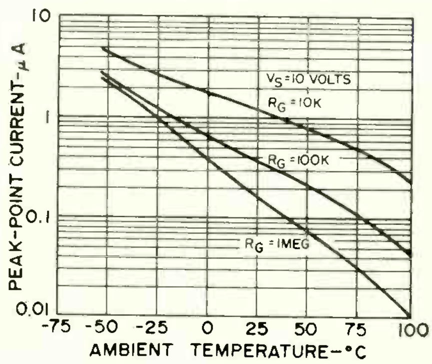
Fig. 4-a—A UJT RELAXATION OSCILLATOR and (b) a comparable PUT circuit.

In the above example two power supplies were used for the relaxation oscillator. In a conventional unijunction circuit (Fig. 4-a) only one supply is used and the peak capacitor voltage at turn-on is expressed as a function of the inter base voltage (V_{BB}). However, between UJT's of the same type this function, the stand-off ratio (η), varies by 10 to 20%. With the PUT each and every peak-point will be essentially the same and the designer may pick his peak-point over the range from 0.1 to 0.9. The stand-off ratio is merely the ratio of resistors in divider R1–R2 in Fig. 4-b. Thus, for the PUT, the stand-off ratio is:

$$\eta = R_1/(R_1 + R_2) \qquad \text{Eq. 9}$$

Factor No. 2—Peak Point Current (I_P)

Peak-point current is a function of gate source impedance and temperature, one is an advantage but one a disadvantage. As gate source impedance and temperature are raised the peak-point current decreases. Temperature compensation will be discussed in a later section. Figure 5-a and 5-b show



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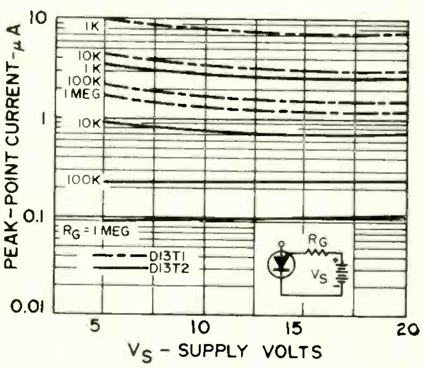


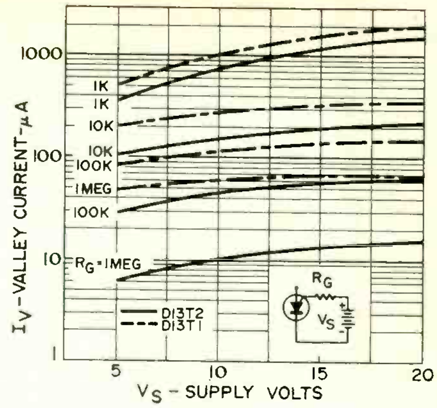
b

Fig. 5—PEAK-POINT CURRENT is a function of gate source impedance and of temperature. Chart (a) plots peak-point current against temperature and chart (b) against supply voltage (V_S) for different values of gate source impedance R_G.

the typical variations of peak-point current with changes in temperature and V_S (gate supply volts) for different values of gate series resistance (R_G).

Factor No. 3—Valley Current (I_V)

Valley current can be varied the same way the peak-point current is



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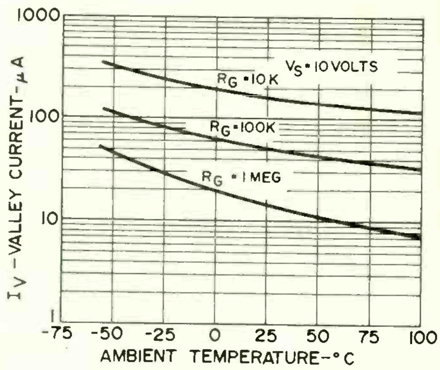

b

Fig. 6—VALLEY CURRENT characteristics, for given gate impedance, varies with V_G (chart a) and temperature (b).

varied. Figures 6-a and 6-b show this variation.

Factor No. 4—Offset Voltage (V_T)

Since the PUT, like most thyristors, is current triggered, the offset voltage is a function of gate source impedance. In reality this offset is due to the diode voltage drop between anode and gate, hence it is a function of temperature. Figure 7 shows the

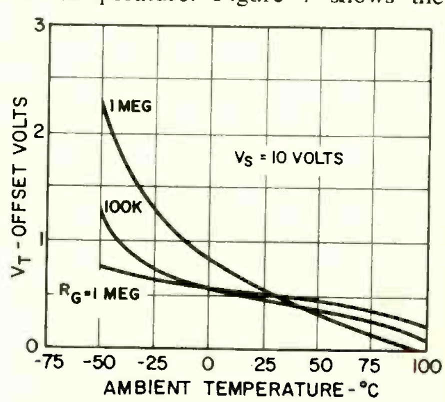

Fig. 7—TRIGGER OFFSET VOLTAGE for a programmable unijunction transistor varies with ambient temperature level and with the series impedance at the gate.

typical variation of V_T with gate source impedance and temperature.

Replacing UJT's with PUT's

In many cases a designer will wish to replace a UJT with a PUT to obtain a cost or performance advantage. Using the PUT (D13T) in a circuit in place of an unijunction is easily understood. Figure 8-a shows a basic unijunction circuit. Figure 9-a shows the identically same circuit except the unijunction transistor is replaced by the D13T plus the resistors R1 and R2. Comparing the equivalent circuits of Figs. 8-b and 9-b, it can be seen that both circuits have a diode connected to a voltage divider. When this diode is forward biased in the unijunction transistor, R1 becomes strongly modulated to a lower resistance value. This action generates a negative resistance characteristic between the emitter (E) and base one (B1). For D13T, resistors R1 and R2 control the voltage at which the anode-gate diode becomes forward biased. After the diode conducts, the regeneration inherent in a thyristor causes the PUT to switch on. This generates a negative resistance characteristic from anode to cathode simulating the modulation of R_1 in the conventional unijunction.

Resistors R_{B2} and R_{B1} (Figure 8-a) are generally unnecessary when the D13T replaces a conventional UJT. This is illustrated in Fig. 9-c. Resistor R_{B1} is often used to bypass the interbase current of the unijunction which would otherwise trigger the SCR. Since R1 in the case of the PUT (D13T), can be returned directly to ground there is only the peak-point current of the PUT (about 1μA) to bypass. Resistor R_{B2} is used for temperature compensation and for limiting the dissipation in the UJT during capacitor discharge. Since R2 (Fig. 9) is not modulated, R_{B2} can be absorbed into it. The result is the circuit of Fig. 9-b which contains the same number of components as the UJT circuit but at a lower cost and with better performance.

Resistors R1 and R2 have been removed from the pulse circuit, there is no reason why they cannot be changed in impedance to change the peak-point and valley currents as required by the application.

Applications of the PUT

The PUT with its flexibility can be tailored to fit many places where a UJT would not be acceptable; but before proceeding to some examples of this type of circuitry, there is a need to examine some final UJT applications of the PUT.

It was noted above and shown in Fig. 5 and 6 that peak and valley current were functions of gate source impedance. Since they both decrease with increase in gate source impedance there could be a problem if we wish to vary them independently. Figure 10 shows some variations on the gate circuitry.

In normal UJT circuitry the interbase resistance is normally about 10,000 ohms, with the PUT impedance level as a design factor. Figure 10-a shows a high-impedance divider which gives low I_p and low I_v. If you want characteristics closer to the UJT's, use the circuit in Fig. 10-b. Remembering that at the peak-point the anode (point E) of the PUT (D13T) is above the gate potential by V_T. Thus the diode is reversed biased and the gate source impedance is high (1-megohm in this case). But at the valley-point the gate is near cathode potential (point B1), so that the diode is forward biased and the gate source impedance is low (about 1000 ohms).

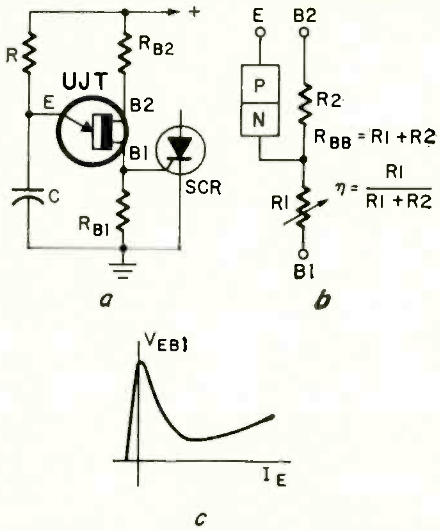

Fig. 8-a—A TYPICAL UNIJUNCTION driving an SCR. b—UJT equivalent circuit and (c) negative-resistance characteristic.

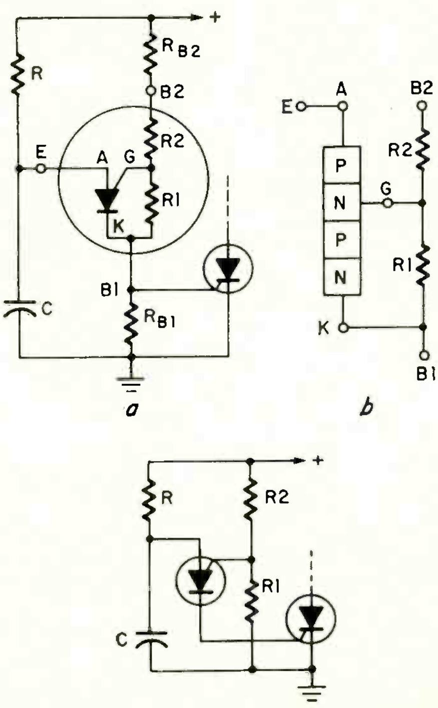

Fig. 9—HOW A PUT REPLACES UJT in circuit in Fig. 8-a. b—UJT equivalent circuit using programmable unijunction. c—The simplified PUT version of Fig. 8-a.

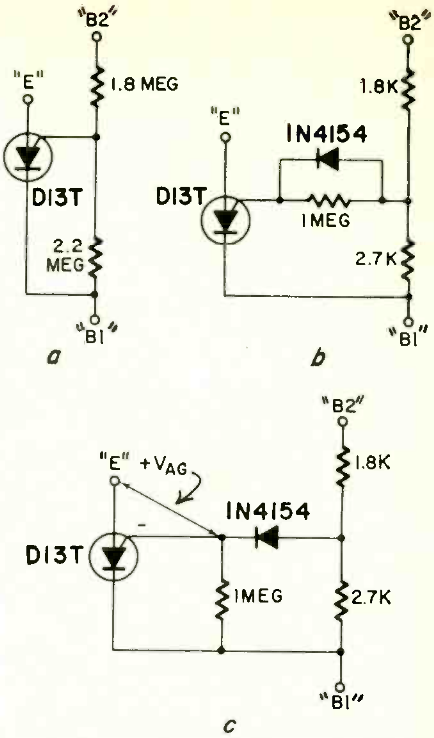

Fig. 10—TYPICAL UNIJUNCTION circuit configurations. a—For low I_p and low I_v. b—Use paralleled diode and resistor for low I_p-high I_v and (c) for low I_p and high I_v with temperature compensation.

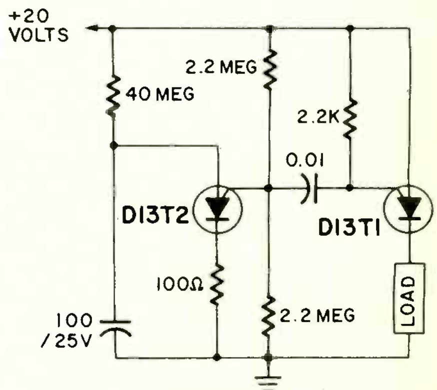

Fig. 11—A ONE HOUR TIMER using a pair of PUT's. The first does the timing; the second one triggers the load circuit.

This circuit has a low I_p and relatively high I_v.

Figure 10-c shows a similar diode network that provides temperature compensation of $V_T(V_{AG})$. When the peak-point is approached, the trigger point is when

$(V_E - V_T) = (V_{GG} - V_D)$ Eq. 10

where V_{GG} is the effective gate source voltage; V_E is the emitter of the equivalent UJT and V_D is the diode forward drop. Equation 10 shows that temperature compensation is obtained when the diode's temperature coefficient is the same as V_T.

In Fig. 11 there is shown a one-hour timer using a single D13T2 PUT for timing and to develop a trigger pulse for the D13T1 at the end of the delay.

(continued next month)

TAPE RECORDING

by DAVID K. KIRK

facts and fallacies

You probably don't know all the answers, but if you get all of these right, class yourself an expert!

PERHAPS IT'S BECAUSE NOBODY HAS yet decided what magnetic fields really are. Maybe the reason is simply the comparative youth of the system. The fact remains that magnetic tape recording is both the most fascinating and the most mystifying aspect of modern audio. If you find this hard to swallow, try your hand at these.

The upper limit of recorded frequency range is set by the length of the record head gap. False. At high frequencies, only one side of the record head gap needs to be operative to place a related signal pattern on the tape. Most audio recorders have a record bandwidth of well over 40 kHz at 7½ ips and record their own high-frequency bias. Pull the tape along at 1 ips and you will hear it.

The effect can be quite annoying to anyone trying to edit a 15 ips tape, where it is necessary to rock the tape slowly back and forwards across the playback head. The main factor limiting overall bandwidth is the *replay* head gap, where the "trailing edge" recording effect does not apply.

Storing tape without rewinding reduces print-through. True but how many followers of this common studio practice realize why? The general theory, and it's wrong, is that post-echo rather than pre-echo is printed when the tape is stored without rewinding and post-echo is less audible, being drowned in the decay of the transient that caused it. Actually, print-through travels in both directions by equal degrees, causing equal amounts of pre- and post-echo.

Then why does storage without rewinding work? Because print-through is largely a temporary effect that disappears after a few seconds out of contact with the responsible field. Storing tape before rewinding means that a program must be rewound a few minutes before playback. This act alone gives the print-through time to decay. On some tape transports, the time lag between the tape leaving the feed reel and reaching the play head is great enough for the

(continued on page 58)

REEL-TO-REEL TEAC A-7010 is typical of high-quality professional-type equipment for home use.

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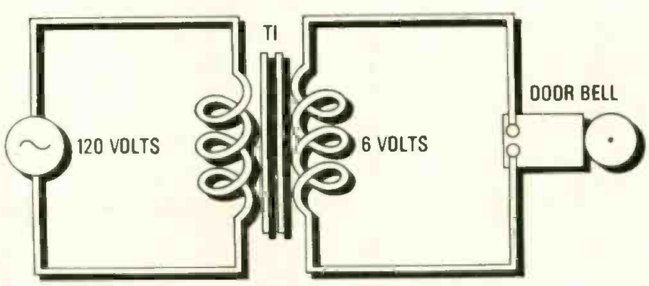
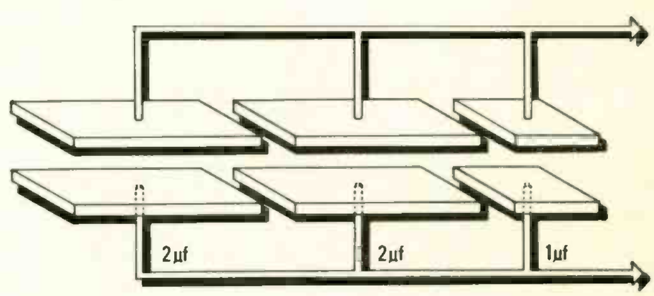


In this door bell circuit, which kind of transformer is T_1 — step-up or step-down?

Note: if you had completed only the first lesson of *any* of the RCA Institutes Home Study programs, you'd easily solve this problem.

This one is more advanced.



What is the total capacitance in the above circuit?

Note: you'd know the solution to the problem if you'd taken only the first two lessons in RCA's new Communications Electronics Program.

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This license is a requirement for servicing all types of transmitting equipment and can help open doors to jobs commanding high income in communications, radio and broadcasting, aerospace, industrial automation and many others.

For a rewarding career with good pay, take that first step now. Send for complete information—mail the attached card.

Answers: Step-down.
5 µf

(*continued from page 53*)
print to fall below audibility; so no need for preplayback winding.

Magnetic tape wears out. False. Run a brand new tape through a recorder with clean heads and measure the frequency response. Rewind, clean the heads once more, and measure again. The 7–20-kHz response should be at least 2 dB up on the virgin figures. Far from wearing out, professional and high-quality tape actually improves with age, the oxide coating smoothing out to a level, dust-free surface. By contrast, most new tapes are covered in a fine powder of loose excess oxide. This clogs the record and play heads, causing high-frequency attenuation. A brand new tape should always be fast-wound a few times before serious use.

The best way to dub a tape is backwards. This one is true, strange though it may seem, and is applied by at least one major tape recording manufacturer. Run any recording backwards and you will notice an apparent lack of high frequencies that makes you reach for the treble boost. The reason is that the reversed tape is devoid of sudden transients; our ears are climbing relatively slowly up what would naturally be the decay. The sudden cutoff at the "end" of each transient has little impact on our ears. Under normal conditions, the amplifiers would be prone to "ringing" on the leading edge of strong transients. Reversed, the only sudden change they have to make is in downward level.

VARIABLE NOISE FILTER is featured in Ampex AX-300. Other versions offer automatic threading too.

Residual head magnetism builds up over several hours. False, or at best only half true. The major cause of residual head magnetism is dc from the tape amplifier reaching the record and/or play heads. This occurs to some extent in almost all recorders, particularly where a high-value capacitor is in circuit close to the heads. A degaussed head can become remagnetized within minutes, depending on the circuit design, input load and operational switching sequence.

A 30 Hz–20 kHz +3 dB frequency response gives better quality than 30 Hz–12 kHz +3 dB. This may be true of amplifiers but with tape equipment is a very false assumption indeed. When a manufacturer or service engineer sets the bias current of a recorder, he usually goes for wide frequency range simply because the customer, reared on specifications, expects it.

Most studios, however, rightly set the bias at a higher level in order to secure maximum signal-to-noise ratio and minimum distortion for a particular brand or (tape is very variable) individual reel of tape. Studios appreciate that lifting the high-frequency response to extremes inevitably brings in an extra octave of noise, both from the tape and from the preemphasis circuits. It's no good throwing figures at the public.

A dealer who wants to guarantee himself regular customers should let them hear an A-B comparison of two machines, one biased for maximum frequency range at 3% distortion, the other for maximum signal-to-noise ratio at around 1.5% distortion. Most people will go for the latter because most people don't like hiss. [A few so-called non-professional recorders (e.g., Tandberg's model 6000) offer extended frequency response with excellent signal-to-noise ratios and low distortion. Also, Dolby noise reducers (Advent, Harmon-Kardon) now permit extended response without tape hiss.—EDITORS]

RECORD AMPLIFIERS ARE STACKED below the tape deck in the Roberts model 771X.

Quarter-track systems produce more hiss than ½-track. False. When you switch from a ¼-track playback head on a stereo recorder to a ½-track head, the hiss will go *up*, not *down* as a lot of people seem to expect. The ½-track head theoretically produces 3 dB more hiss than the ¼-track, so an A-B test on background noise alone will show ½-track to be the "inferior" system. The important fact is that ½-track produces a full 6 dB increase in signal level and, when the 3 dB hiss is allowed for, this makes a 3 dB improvement in signal-to-noise ratio. It is the latter 3 dB that counts.

Finally a question the reader might like to puzzle over. The answer requires nothing more than a basic understanding of equalization. When asked to make copies of a 3¾ ips master on 15 ips speed-to-speed equipment for later playback at 3¾ ips, for what speed do you set (a) the equalization of the playback machine and (b) the preemphasis of the recorder? **R-E**

COLOR TV ANTENNA INSTALLER'S GUIDE

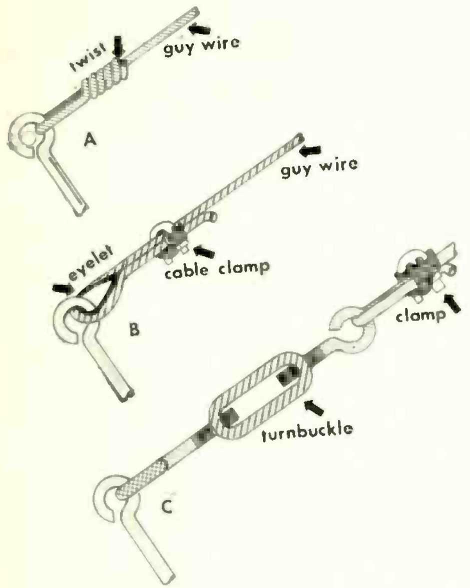
This month Section II of your Radio-Electronics Reference Manual continues to grow. We present the final part of an article on TV antenna installation.

If you wish, you can purchase a special hardcover binder to keep your Reference Manual pages together. It has a dark blue fabric cover and is gold-stamped Radio-Electronics Reference Manual. The cost is $1.00 postpaid. Order from N. Estrada, 17 Slate Lane, Central Islip, L. I., N. Y. 11722.

ANTENNA INSTALLER'S GUIDEBOOK

by JAMES A. GUPTON, JR. (PART II)

wire-twist connections that will secure any antenna. A disadvantage of wire-twist fastening is the difficulty in removal for antenna or motor repairs. Use cable clamps for fastening the guy wires to the mast guy rings. If you want to do a real bang-up job, use cable clamps and turnbuckles at the anchor eyebolts. Cable clamps are all that is really



Three methods of fastening guy wire to guy ring or eyebolt. A wire wrap will hold OK but may cause trouble if mast must be lowered for antenna repairs. Use a cable clamp or a clamp and turnbuckle for easy installation and guy tension adjustments. The drawings show the correct way to install cable clamps. Cable's free end passes under the bight.

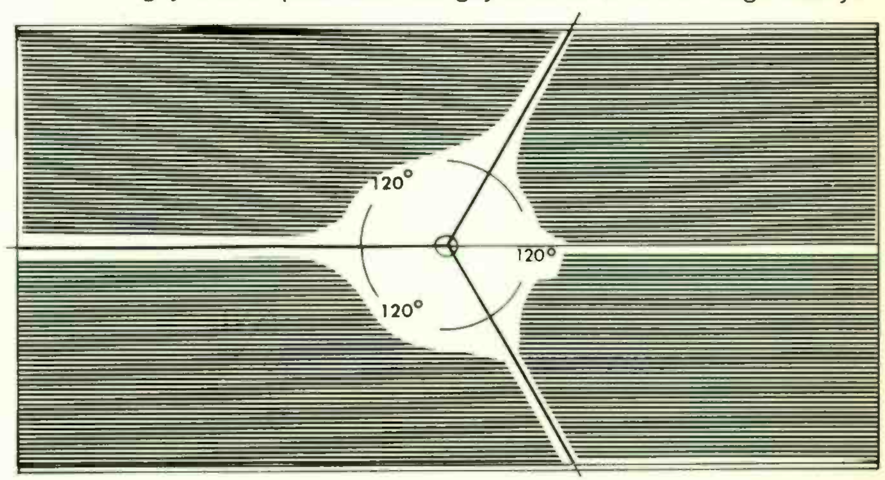
needed at the anchor points, but the turnbuckles permit easy guy wire tension adjustment without freeing the ends of the guy wire. This prevents the antenna from falling if the guy wires get away from you.

After attaching the guy wires to the guy rings on the mast, be sure you keep the wire in the original loops or hanks. Hours can be wasted trying to straighten out the kinks and tangles if the loops are allowed to unravel. Now the antenna is carried to the roof. Tall antennas are definitely a two-man job.

WIND VELOCITY (miles per hour)	PRESURE ON ANTENNA (pounds per square ft.)	CITY	WIND (max. mph)
10	0.25	ALBANY, N. Y.	71
20	1.0	CHARLESTON, S.C.	76
30	2.3	CHICAGO, ILL.	87
40	4.0	HATTERAS, N.C.	110
50	6.3	MIAMI, FLA.	132
60	9.0	MINNEAPOLIS, MINN.	92
70	12.3	MOBILE, ALA.	87
80	16.0	MT. WASHINGTON, N.H.	188
90	20.3	NEW YORK, N.Y.	99
100	25.0	NORTH PLATTE, NEB.	72
110	30.3	WASHINGTON, D.C.	62

wire and unroll it towards the side guy-anchor eyebolt. Run all the remaining guy wire through the eyebolt and let it hang down from the roof. Repeat the process for the top guy point and each of the remaining guy wires.

Each guy anchor point now has guywires threaded through the eye-

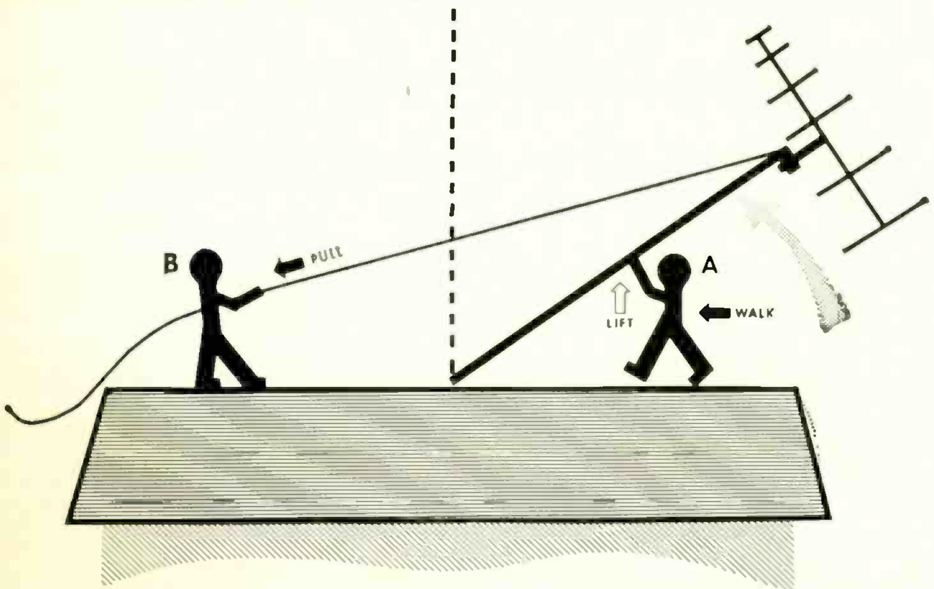


3 WIRE GUYING

In a 3-wire guy system, guy points are 120 degrees apart around mast base. Number of guys used depends on the height and type of mast.

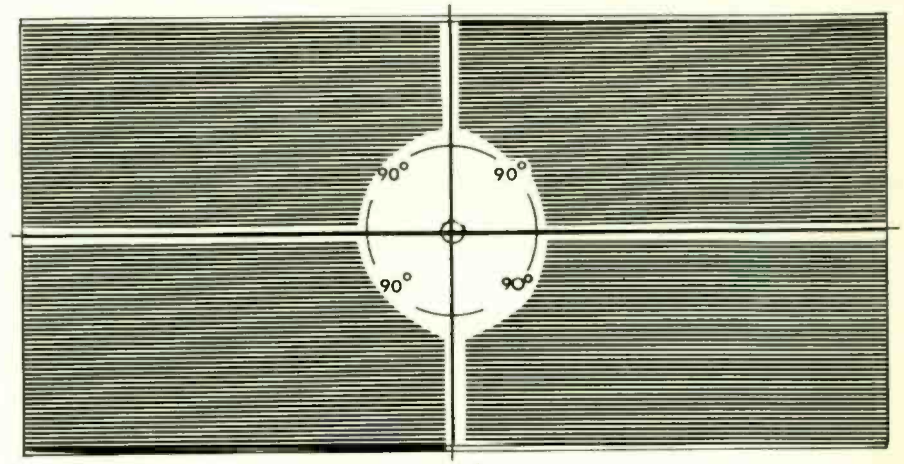
Of course there are two ways to erect tall antennas. One is to use telescoping mast sections. The telescoping mast is base mounted and the first 10-foot section guyed. By standing on a stepladder, the topmost section is hand-pulled out of the nest of mast sections. It is securely locked to the top of the second section with a through-hole bolt. The second section is then hand raised and also through-hole bolted to the bottom section, and the two topmost sets of guy wires pulled straight and fastened. While this sounds easy, it is very difficult to do—almost impossible for one man.

Here is a better way. Try mounting the base mount and turning the mast holder down the roof ridge in the direction the antenna and mast will lay. Remember the guy-anchor eyebolt must be in the opposite direction. Now bring up the antenna assembly and lay the mast section along the ridge of the roof. Very long mast sections will cause the antenna hang over the roof edge. Have someone hold up the antenna



Masts of 20 or 30 feet must have guys at intermediate levels (see page II-16). Man B maintains tension on all guys on same side of mast.

section for shorter masts. Insert the mast into the mast holder and run the through-hole bolt through holder and mast. Now take a roll of guy



4 WIRE GUYING

The guy points should be same distance from mast base. If impractical, then guys on opposite sides should make same angle with vertical.

bolts. It's a good idea to have someone to playout the guy wire at each side anchor point, but not essential. With one man located at the roof ridge guy anchor point and you at the antenna motor point, the antenna is now ready to be erected.

Lift the antenna over your head while the second man pulls up the slack on the guy wires. The walk-up process simply means that as you walk towards the mast base pushing the antenna mast upward, your partner keeps a constant tension on the guy wires. This push-pull action allows the antenna and mast to rise upward while tension on the guy wires prevents the mast bending from the antenna weight.

Once the mast has been raised to a vertical position, it is easy to

WIRE SIZE	WIRE TYPE	WEIGHT PER 1000 FT.	APPROX. STRENGTH/LB.
$\frac{1}{16}$" dia.	6 STRAND, GALVANIZED	8.2	130
$\frac{1}{8}$" dia.	6 STRAND, GALVANIZED	31.8	540
$\frac{3}{16}$" dia.	6 STRAND, GALVANIZED	72.9	1,150
No. 12	COPPERWELD, SOLID	54.6	510

hold it steady while your partner quickly applies tension to all guywires and completes a temporary fastening at the anchor eyebolts. Check the straightness of the antenna mast. Any bowing of the mast can be corrected by alternately increasing and decreasing tension on opposing guy wires. Be sure the antenna is pointing North for correct motor alignment. Now secure all guy wires by tightening with cable clamps.

One bit of advice in the use of turnbuckles. Most of us are prone to adjust turnbuckles to drum-tight tension. Leave just a little slack or sag in the guy wires to permit a very slight mast movement. An unyielding antenna mast will collapse in high winds while the flexible mast will yield and spring back without collapsing.

Antenna mast grounding

According to the National Electrical Code, the mast and metal supporting structures of the antenna must be permanently and effectively grounded, without an intervening splice or connection. In addition, the code requires all conductors of a lead-in or transmission line to be provided with a lightning arrestor when the lead-in conductors are enclosed in a continuous metallic shield and the metallic shield is appropriately grounded. The grounding conductors must be copper, aluminum, copper-clad steel, bronze, or any corrosion-resistant material. Grounding conductors may or may not be insulated but must be securely fastened in place.

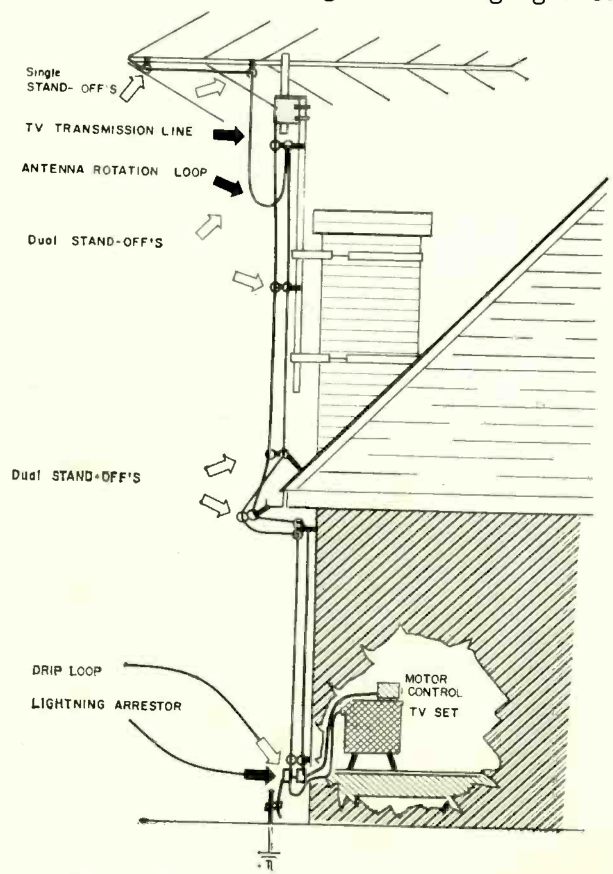
The ground conductor must be run as straight as possible from the antenna mast and/or lightning arrestor to the grounding electrode. The code further specifies that the grounding conductor must be at least No. 10 solid copper wire or No. 8 solid aluminum wire.

The only acceptable ground electrodes are: cold water underground ground pipes (providing they are metallic construction and not plastic). The grounding electrode may be of iron or steel with a minimum ⅝-inch diameter; non-ferrous rod or pipe may be used with a ½-inch diameter minimum. The pipe must be driven below the permanent moisture level or at least 8 feet unless rock formations prevent it being driven to this depth. If you run into rock formations, the grounding electrode can be buried horizontally at a depth of 4 feet.

1. The lightning arrestors must be grounded and can share a common ground with the mast. The proper place for the ground is at the point of entrance to the house.

line; this is particularly true for uhf signals.

To connect the 300 ohm-line to the antenna, strip the insulation down the middle 6 inches. This permits the line to spread wide enough for the antenna terminals. Form a half loop on the stripped wire with the open end on the right. The loop will close when the antenna screws or wing nuts are tightened, thus making a secure connection. Seal the transmission line contacts with wax or paint. This prevents trouble later from copper oxide forming and reducing signal strength.



Typical TV antenna installation. Stand-offs prevent lead-in and rotor cables from rubbing metal gutter. Special lightning arresters are made for use on rotator cables. Make all grounds to water pipe or ground rod driven close to the point where the cables enter the house.

The 300-ohm twinlead is run along the antenna to the mast using clip-on standoffs to support the wire. Make all turns gentle curves

2. Only the mast and supporting metal parts must be grounded; the antenna **is not required to be grounded.** Therefore, if you have a TV set of the transformerless variety, commonly called ac-dc, you could have a **"hot" chassis shorted to ground through the tuner's antenna coil.** This can be prevented by insulating the antenna from the mast or by installing additional high resistance-capacitance networks in series with your TV set's antenna terminals.

This can be eliminated if you have an ohmmeter. Just check the ac line plug for direct connection to the TV set's chassis. If there is no low-resistance path from plug to chassis, you are o.k. In event there is a low-resistance path to the chassis, mark that prong of the plug and always insert the grounded prong into the wide slot or ground connection of your wall receptacle.

3. Check your insurance agent about your home-owners insurance coverage for TV antennas and the grounding requirements of your insurance company. This way, you **know** your insurance will cover your antenna installation in case of lightning, windstorm, or other damage.

Running transmission lines

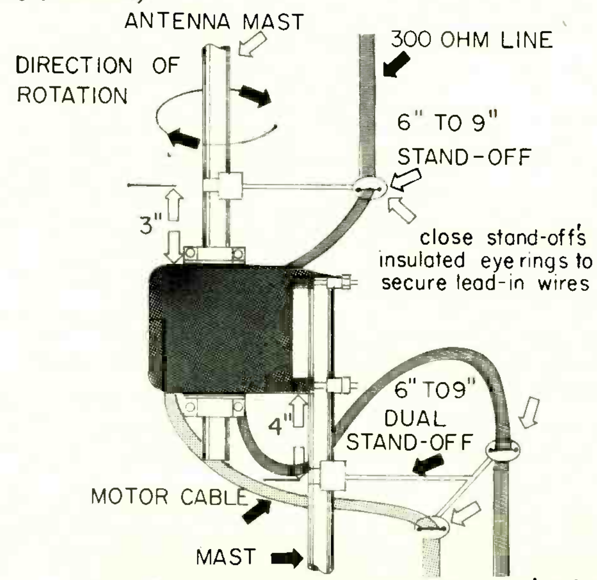
Most antennas have a characteristic impedance of 300 ohms, and to effectively transfer the maximum amount of signal energy to the set, the antennna should "see" a 300-ohm impedance. Shielded coxial cable has a number of advantages over 300-ohm twinlead: it can be run close to metal objects without interference, and it will not pick up ghost-causing secondary signals or interference from automobile ignitions.

If you decide to use coaxial cable, which has an impedance of 75 ohms, it's a good idea to purchase an antenna with a 75-ohm impedance. Then, unless the TV set has a 75-ohm input terminal, you can use a 75-to-300-ohm matching transformer at the set. Otherwise, a 300-ohm antenna requires a matching transformer installed between the antenna and coax and another transformer at the set.

There are many varieties of 300-ohm transmission line suitable for vhf reception. When both uhf and vhf signals are to be received, shielded 300-ohm twinlead or uhf foamline 300-ohm twinlead is best. These heavy-duty lines eliminate signal fade due to moisture on the

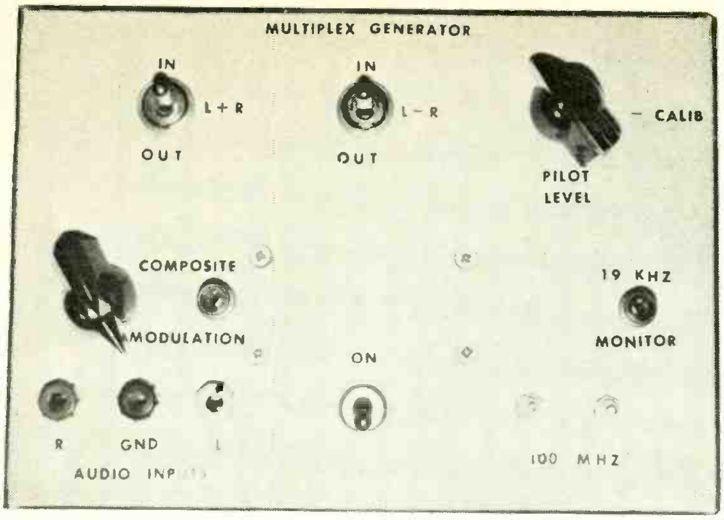
instead of sharp angles. (Uhf signals are inclined to travel on the surface of the conductors and the surface effect permits the signal to leave the wires at sharp right-angle turns. Stand-offs on the mast hold the transmission line and "stand-off" the line from the effects the mast may have on high frequency signals.

When the transmission line nears the rotor motor, it is anchored firmly to the mast with a stand-off, then formed into a "rotation loop". You must have sufficient slack to permit 360° rotation. It could break the line in two if not enough loop slack is formed. (Most motors rotate clockwise.)



Lead-in breakage due to flexing by wind and antenna rotation can be prevented by using stand-offs directly above and below rotator. Be sure that loop permits antenna to turn through 360° without putting strain on lead-in.

Carrying the assembled antenna and rotor motor to the roof is a two man job for fringe antennas. One man should be on the roof to pull the antenna up as the second man climbs the ladder, guiding the antenna. When the antenna is on the roof, it is raised to a vertical position, lifted above the chimney clamp and gently lowered until the bottom of the mast engages the lower chimney clamp. Tighten both clamps lightly. Turn the antenna to North by rotating the mast and motor assembly. Now firmly tighten the chimney-mount clamps. R-E



Build FM stereo multiplex generator

by AL FRANSON

With the popularity of FM stereo receivers, test equipment to align these sets is a must for service technicians and anyone interested in building FM receivers. To get good stereo separation from a receiver, a multiplex generator is much better than adjusting the set by "ear."

The stereo generator described here is designed for low cost and simplicity. It compares favorably to commercial units in stereo performance, but does not have self-contained audio signals or i.f. test signals. Only a 1-kHz signal and a general-purpose scope are required for aligning this generator. An FM receiver should also be available. The generator provides over 30 dB stereo separation between 300 and 20,000 Hz. Total parts cost is around $50, but many parts are common and can be found in your spare parts box.

This unit does have an rf output to check an entire receiver's performance without an external rf generator. The high-frequency oscillator works at 106 ±2 MHz and is frequency modulated by a variable-capacitance diode. A regulated power supply is incorporated and gives exceptional rf stability.

Theory of operation

A basic understanding of FM stereo transmission will aid the user in understanding the generator operation and design theory. The FCC controls the method of stereo transmission. The baseband spectrum is shown in Fig. 1. The

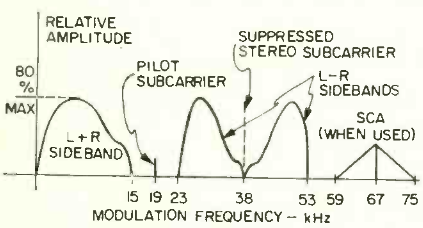


Fig. 1—FREQUENCY SPECTRUM in a frequency modulated stereo broadcast.

monaural information or average left plus right (L+R) signal is contained in the 0 to 15 kHz useful audio range. The L−R information required for stereo demodulation is transmitted as an amplitude modulated 38-kHz suppressed-subcarrier signal. This will result in frequency components ±15 kHz around 38 kHz, or 23 to 53 kHz. The 38-kHz subcarrier must be reinserted in the correct phase at the receiver to obtain the complete stereo information. To do this, a low-level 19-kHz pilot signal is transmitted which has a definite phase relationship with the orginal 38-kHz subcarrier at the transmitter. This pilot phasing is one of the most important properties of the transmitted composite signal and is discussed in greater detail in the section on alignment procedures.

A few FM stations also transmit a 67-kHz storecast subcarrier. This signal is a frequency modulated subcarrier occupying the spectrum from 59 to 75 kHz. This subcarrier was not included in this generator since it has nothing to do with aligning stereo separation of a receiver.

The composite baseband signal shown in Fig. 1 now frequency modulates the rf carrier between 88 and 108 MHz at a maximum deviation of ±75 kHz peak. Broadcast stations use pre-emphasis of the audio inputs which increases the level of audio frequencies above 2 kHz. This makes a de-emphasis necessary in stereo FM receivers to restore correct frequency response. This pre-emphasis at the transmitter occurs before multiplexing. In other words, the subcarriers previously mentioned are not pre-emphasized. This makes it unnecessary to include pre-emphasis in a stereo generator which is used for alignment purposes. If pre-emphasis is desired, it can be applied to the audio input signals before they are fed to this generator.

Circuit description

Transistor Q1 in Fig. 2 operates as a 19-kHz oscillator with the exact frequency of oscillation determined by the twin-T feedback network. The twin-T network makes a very stable oscillator once R2 is adjusted for 19 kHz. The 11-volt peak-to-peak output of the oscillator (Fig. 3) is fed to a phase-shift network through

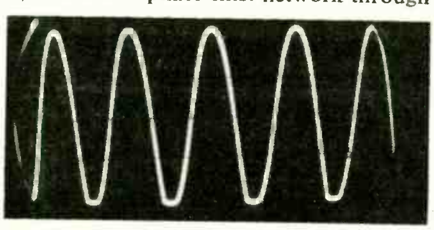


Fig. 3—PILOT SUBCARRIER signal generated in 19-kHz Twin-T oscillator Q1.

buffer amplifier Q2. The phase-shifter is also isolated from the summer through buffer amplifier Q3. The phase-shifter provides a means of correcting phase relationship between the 19-kHz pilot and the 38-kHz subcarrier. The range of phase shift available is about 120°. A maximum phase shift variation of 90° is necessary.

Transistor Q4 is the doubler amplifier which delivers two equal but opposite polarity signals to diodes D1 and D2 which full-wave rectify the 19-kHz signal. Germanium diodes are used for highest rectification efficiency. This distorted waveform (shown in Fig. 4) is

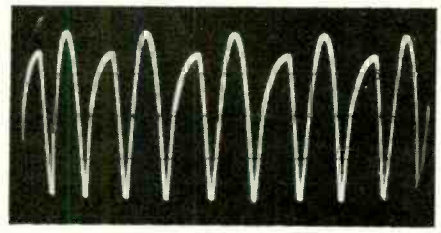


Fig. 4—DISTORTED SIGNAL results when 19-kHz subcarrier is rectified.

passed through an active bandpass filter consisting of Q5, Q6, and Q11. This is a twin-T filter which has excellent selectivity. The filter output is shown in Fig. 5.

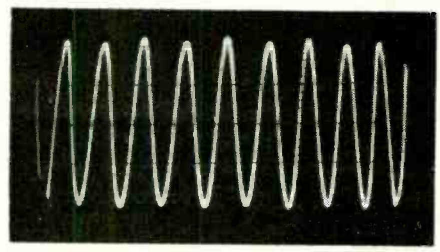


Fig. 5—THE STEREO SUBCARRIER is cleaned up by sharp 38-kHz Twin-T filter.

The two audio inputs representing left and right channels must be conditioned to give L+R and L−R signals for proper stero transmission. The left and right inputs are fed to the summer, Q10, which is a feedback amplifier that provides greater than 20 dB isolation between L and R inputs. The actual isolation is partially determined by the generator internal impedances used to fed the L and R signal inputs. Source impedances below 100 ohms should be used to give greater than 40 dB isolation. Transistor Q7 is operated as an inverter to give −R at its output. This is summed with L by Q8 to give R−L at its output. R31 and R22 must be adjusted to give proper stereo separation.

The R—L signal is used to modulate the 38-kHz subcarrier delivered by Q11. This is done with a ring modulator with

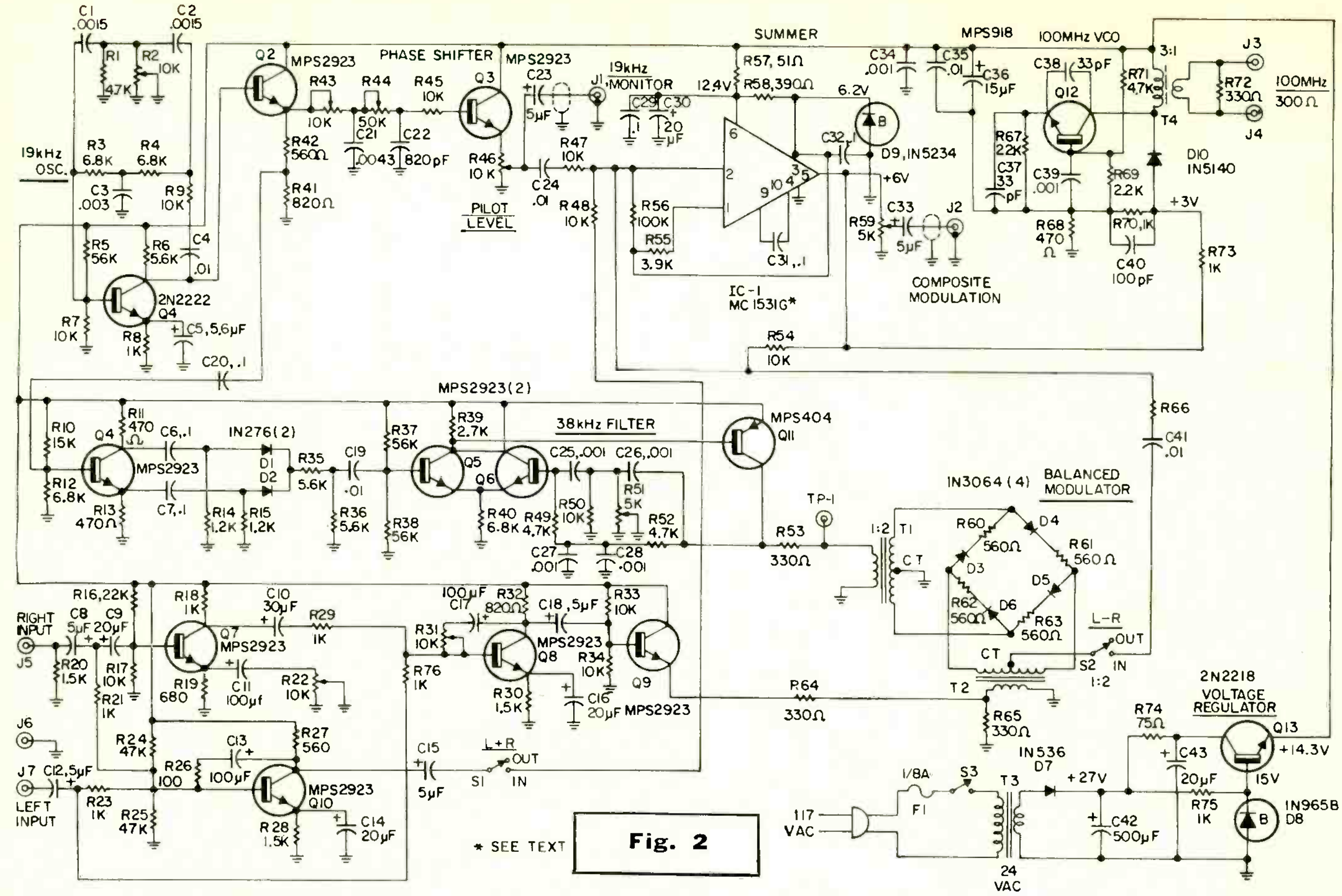


Fig. 2

All resistors ¼ watt, 5% unless noted

R1, R49, R52, R71—4700 ohms
R2, R22, R31, R43, R46—potentiometer, 10,000 ohms, linear taper
R3, R4, R12, R40—6800 ohms
R5, R37, R38—56,000 ohms
R6, R35, R36—5600 ohms
R7, R9, R17, R33, R34, R45, R47, R48, R50, R54—10,000 ohms
R8, R18, R21, R23, R29, R70, R73, R75, R76—1000 ohms
R10—15,000 ohms
R11, R13, R68—470 ohms
R14, R15—1200 ohms
R16—22,000 ohms
R19—680 ohms
R20, R28, R30—1500 ohms
R24, R25—47,000 ohms
R26—100 ohms
R27, R42, R60, R61, R62, R63—560 ohms
R32, R41—820 ohms
R39—2700 ohms
R44—potentiometer, 50,000 ohms, linear taper
R51, R59—potentiometer, 5000 ohms, linear taper
R53, R64, R65, R72—330 ohms
R55—3900 ohms
R56—100,000 ohms
R57—51 ohms
R58—390 ohms
R66—27,000 ohms
R67, R69—2200 ohms
R74—75 ohms, 5 watts
C1, C2—1500 pF, 2%, mica
C3—3000 pF, 2%, mica
C4, C19, C24, C35, C41—.01 μF, ceramic
C5—56 μF, 15 volts, tantalum
C6, C7, C20, C29, C31, C32—0.1 μF, ceramic
C8, C12, C15, C18, C23, C33—5 μF, 6 volts, tantalum
C9, C14, C16, C30, C43—20 μF, 50 volts, tantalum
C10—30 μF, 15 volts, tantalum
C11, C13, C17—100 μF, 6 volts, tantalum
C21—4300 pF, 5% mica
C25, C26, C27, C28—1000 pF, 2%, mica
C34, C39—1000 pF, ceramic
C36—15 μF, 20 volts, tantalum
C37, C38—33 pF, 5%, mica
C40—100 pF, 5%, mica
C42—500 μF, 30 volts
C22—820 pF, 5%, mica
T1, T2—Three 60-turn windings on CF111-06 core (see text), Newark Electronics Stock No. 59F1510. $2.05
T3—24 volts, 0.3 amp transformer (B.A. #13A903)
T4—3-turn primary, 1 turn secondary, #26 enameled wire, 3/16" dia form, brass slug
S1, S2, S3—spst toggle switch
D1, D2—1N276 diode, Hughes
D3, D4, D5, D6—1N3064 diode, TI
D7—1N536 rectifier, G.E.
D8—1N965B, 15-volt Zener, I.R.
D9—1N5234, 6.2-volt Zener, Mot.
D10—1N5140, Mot. or MV1624 (see text)
Q1—2N2222, Mot.
Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10—MPS2923, Mot.
Q11—MPS404, Mot.
Q12—MPS918, Mot.
Q13—2N2218, T.I.
IC-1—MC1531G op amp, Mot. or MC1709C (see text)
J1, J2—phone jacks
J3, J4—teflon feedthru
J5, J6, J7—bannana Jacks
F1—⅛ amp fuse
Case—3" x 5" x 7" aluminum minibox (Bud CU3008A)
Miscellaneous: 12 pin printed circuit connector, 300 ohm twinlead, fuse holder, 1/16" single sided p.c. board—4½x6 inches.

diodes D3–D6. This type modulator is doubly balanced with two center-tapped transformers so the 38-kHz component is canceled at the output as desired. The output of the modulator consists of the amplitude modulation components of the 38-kHz suppressed subcarrier. Resistors R60–R63 are used to improve balance or carrier suppression. The carrier is more than 40 dB below the input, which is adequate.

Transformer T1 must respond past 50 kHz without any resonances. *Most commercial audio interstage transformers do not meet this requirement.* Therefore, a special toroid transformer was designed. The construction details for this transformer are in Fig. 6 on page 67.

Transformer T2 can be identical to T1. I used a commercial 2:1 center tapped transformer instead. At audio frequencies below 300 Hz the reactance of T2's primary introduces an undesired phase shift which results in decreased stereo separation. This can be improved only at the expense of a larger transformer winding or by reducing R65 and R64 which requires more transistor current. A higher current transistor could be used for Q9.

The total composite modulation consists of L+R audio, L−R information on the 38-kHz suppressed subcarrier, and the 19-kHz pilot signal. These are summed together by operational amplifier IC1. An op amp is used to give greater than 60 dB isolation between the three inputs. Summing resistors R47, R48, and R66 can be varied to adjust the individual gains of each input. The individual gain is equal to R54 divided by the series resistor. I used an MC1531G which is rather expensive. Newer and cheaper op amps are available, such as the MC1709C, and can be used instead.

The summer output modulates variable-capacitance diode D10, which is part of the resonant tank circuit of the 100-MHz oscillator. The diode, a Motorola 1N5190 Epicap, makes this a voltage-controlled oscillator which results in an FM signal output. The center fre-

(continued on page 67)

(continued from page 64)

quency of the oscillator can be varied about ± 2 MHz by adjusting the slug in T4. My unit oscillated between 102 and 106 MHz. The exact frequency will be affected by stray wiring capacitance and layout. Be sure to prevent ground currents from modulating the oscillator. This is the reason for the decoupling consisting of R68, C35, and C36. The oscillator is especially susceptible to 19-kHz ground currents. Too much leakage will cause the pilot to be transmitted even though R46 is set at minimum. The oscillator output can be suitably loaded with a 300-ohm twin lead. Diode D10 can be any of a number of 10-pF units now available. One low cost unit is the MV1624 ($1.42). The difference in operation between it and the 1N5140 ($5.85) will be a slight difference in modulation sensitivity but should be negligible.

A regulated dc power supply and an ac rectifier circuit is used. The Zener diode reference provides a low output impedance. This is necessary to keep both oscillators at their correct frequencies and prevent power line modulation of oscillator Q12.

Construction and alignment

The circuit layout is not critical except for the 100-MHz oscillator, for which component leads should be kept to an absolute minimum. A piece of 300-ohm twin lead connects the oscillator coil to the feedthru terminals in the chassis. The circuit board is laid out so it can be unplugged from the chassis. It is held in place by one screw and a threaded standoff to the chassis.

The first step in aligning this generator is to set the frequency of the 19-kHz oscillator. The easiest way to do this is to monitor the signal at J1 with an electronic counter while adjusting R2. Another way was devised which doesn't require a counter. A 19-kHz signal is available in all multiplex demodulators when the FM radio is tuned to a station broadcasting stereo. This signal can be used to compare with the generator pilot frequency using the simple phase detector shown in Fig. 7. R2 is adjusted until the phase-detector output contains a low-frequency beat note. This oscillator can be adjusted for a beat note of around 2 Hz which is plenty accurate—meaning the two frequencies are within 2 Hz of each other. One of the phase detector inputs should be greater than 4 volts p-p to turn the diodes on. The chassis cover should be in place for this test in case stray capacitance changes the oscillator frequency. This requires an access hole in the side or back of the unit for adjusting R2.

Next, the 38-kHz filter is aligned by adjusting R51 for maximum output at Q11's collector. Oscillation in this type of active filter is possible. Therefore, the 19-kHz oscillator should be disabled by shorting R7 and checking to see that no signal appears at Q11. The ac voltage at Q11's collector should be near 10 volts p-p and can be adjusted by selecting the value of R41.

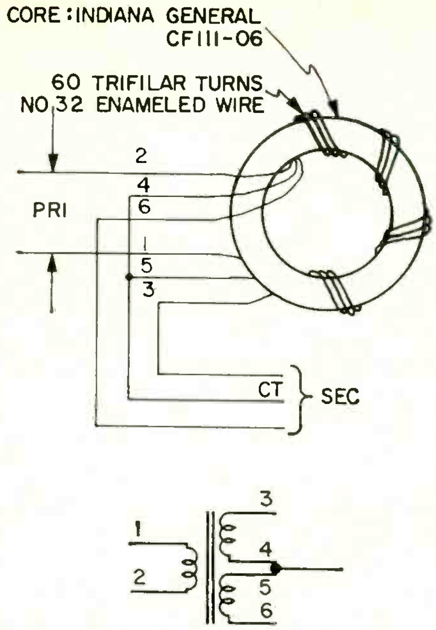


Fig. 6—TOROIDAL CONSTRUCTION increases bandwidth without resonances.

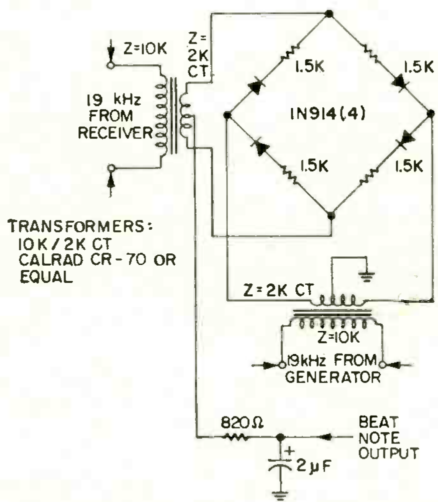


Fig. 7—SIMPLE PHASE DETECTOR eases adjustment of the 19-kHz oscillator.

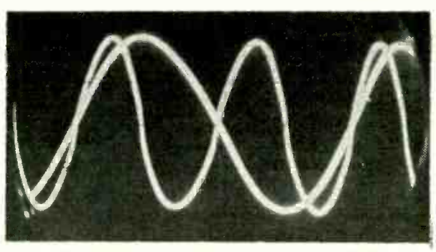


Fig. 8—PILOT AND SUBCARRIER are in phase in this double-exposure photo.

The next step is to adjust the phase relationship between the pilot signal and 38-kHz subcarrier. To do this, you must either sync the scope on one of the signals or use a chopper input on the scope if available. The chopped input method allows direct viewing of both waveforms simultaneously. I used another method. The scope is externally synchronized by the 38-kHz signal at test point TP-1. Then the 38-kHz waveform here is viewed on the scope and the scope settings adjusted so the sine-wave zero crossing occurs at the center of the grid. Next the scope input is placed at J1 and R3, R4 are adjusted for a zero crossing of 19-kHz at the same point as the 38-kHz waveform. This is shown by the double exposure photo in Fig. 8. Now the pilot signal transmitted is in the proper phase relationship for stereo demodulation.

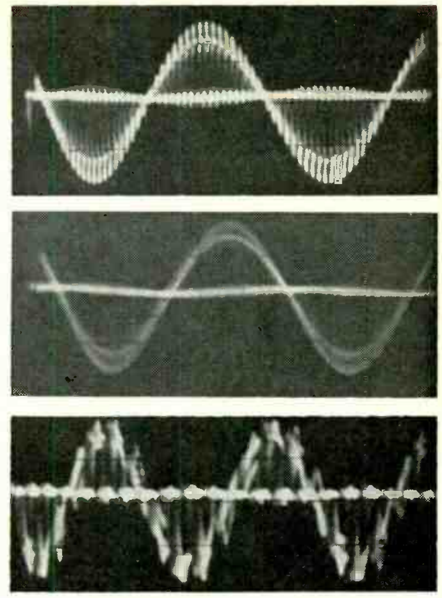


Fig. 9—MODULATION WAVEFORMS. a—Left-only or right-only signal with 1-kHz input at zero pilot level. b— and c—Waveforms at J2 with right or left inputs at 500 and 5000 HZ, respectively.

The audio mixing circuits must now be adjusted to give proper stereo separation. First apply a 1-kHz signal to the left channel. The pilot level is turned to minimum. The L+R and L−R switches must be closed. With the scope input at J2, adjust R31 until one of the 1-kHz envelopes is minimum in amplitude as shown in Fig. 9-a. Figures 9-b and 9-c show the same point for audio input frequencies of 500 Hz and 5 kHz respectively. These photos demonstrate a separation of about 40 dB. Next, remove the signal from L and apply to R only. A waveform similar to Fig. 9 will appear at J2 when R22 is adjusted for maximum separation.

The only calibration remaining is the 19-kHz pilot level required to give the proper oscillator deviation. I determined this with the help of an FM stereo receiver. For this measurement the L+R and L−R switches are in the OUT positions. Somewhere in the receiver multiplex you can check the 19-kHz level being received from the discriminator with a scope. Knowing this level, you can receive the signal from this multiplex generator and adjust the pilot level to equal that from a broadcast station. The exact level is not extremely important but some multiplex demodulators are sensitive to pilot level as separation is affected. I found that 0.2 volt p-p 19 kHz at J1 output is correct and should be accurate enough for alignment. At this point the knob on the PILOT LEVEL control was adjusted to read "CALIBRATE." I found it convenient to place

(continued on page 83)

CAREERS in ELECTRONICS

blueprint to your future

You're a technician today, but you don't have to still be a technician tomorrow. Here are some of the other doors open to you

by L. L. FARKAS*

Last month we introduced the service technician to several other kinds of jobs that he is qualified to handle. This month we present ten more opportunities for the future. They take training, but they are available.

Computer field engineer/programer

The technician who has worked on computers and has a good knowledge of their theory and operation can often find a job as a computer field engineer. In this position he will service computers leased or sold by a computer company within a certain region. Such service includes preventive maintenance, troubleshooting and repair, and helping the customer determine what additional equipment he may need to perform specific tasks.

Normally the computer company hiring a technician will send him to school to learn the intricacies and operation of their product. It will help the technician also to learn computer programing. With this additional knowledge he can help his customer further in establishing various programs which in turn may mean the sale of additional computer components or subsystems.

Computer programing courses are available at many schools and all the technician needs is the desire to enroll in such a course and the tenacity to complete it. If he happens to be working on computers at the time, he can readily obtain programing experience that will help him progress on the job.

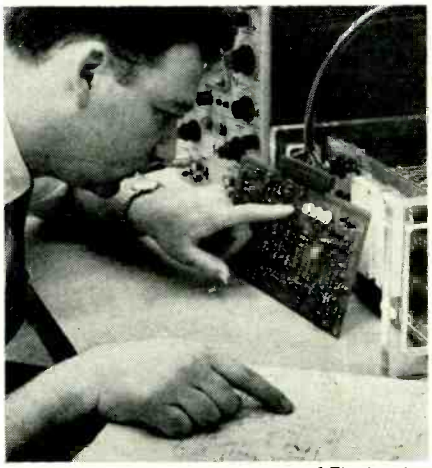
Equipment sales

The equipment sales field can be interesting and profitable to the technician who has sales ability. There is, of course, the job of salesman in an electronic supply house, where knowledge of part characteristics and usage is a must.

Here the technician must know what new parts are available and can be used, or what substitutions can be made to meet a customer's design or operating requirements. He may also work as a salesman of various types of electronic equipment or electronic systems. In this last function he will often have to contact top officials of companies and government to whom he will have to demonstrate and sell his product. To do this effectively he will have to be able to speak well, but over and above this, he must know how to plan and implement a good presentation or demonstration.

The training for this type of work, besides gaining a thorough technical knowledge of the equipment, includes courses on salesmanship, audio-visual aids, creative thinking and psychology. Again, such courses are generally offered by community evening programs.

Junior or associate engineer



Courtesy Cleveland Institute of Electronics

To the technician who wants to further his career in the technical area of electronics the next logical step is to become a junior or associate engineer. In the past there were many opportunities for promotion to this level simply on the basis of experience on the particular equipment or system being produced. In the last few years, however, companies have tightened their educational requirements so that promotion to a junior or associate engineer level requires at least an associate science degree that includes courses in math, physics and chemistry.

Most companies encourage technicians to update their education to this level. Some firms offer refunds or provide loans for college tuition. The smart technician will take advantage of such help. Even at the rate of one course per semester, credits accumulate fast and soon the technician will find he has gained the education that permits him to progress.

Radio operator

An electronic technician can also become a good radio operator. Certainly it shouldn't take him long to learn the operation and maintenance of communications transmitters and receivers, motor generators, radar and other electronic equipment used for communications and navigation. Radio operator jobs can be found at fixed installations, such as a shore or airport radio station, in aircraft and on ships. Some operators are also used in airplane blind-landing systems.

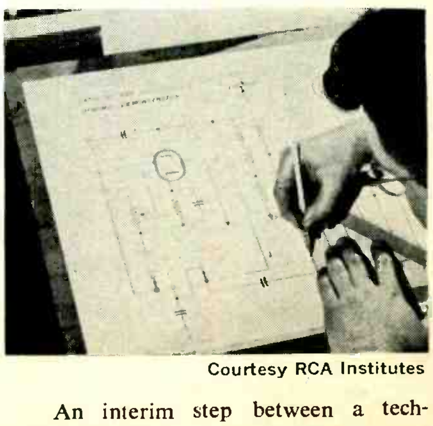
The radio operator must pass an examination given by the Federal Communications Commission to obtain a radio telephone or telegraph operator's license. For the telegraph endorsement the operator must take a code test in which his code sending and receiving skill is checked. For all licenses he must pass a test on the theory and operation of equipment and his knowledge of communication laws.

A radio operator on board a ship or aircraft is an officer with great responsibility. He must insure that his equipment is always in good operating condition and be ready to make emergency repairs.

A number of technical schools provide courses leading to a radio operator's license. Subjects covered include basic electricity, theory and operation of communications components and systems, theory and operation of radar systems and code practice. In most cases the electronic technician covers these courses pretty fast, needing only the code practice and a knowledge of FCC laws to meet the requirements of the FCC examinations.

Of course, if your hobby is amateur radio, you may be able to short-cut the education span since you'll already have acquired most of the necessary knowledge and practice in communications.

Circuit draftsman



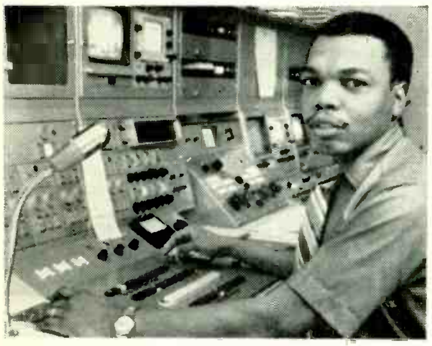
Courtesy RCA Institutes

An interim step between a tech-

*Martin Marietta Corp., Vandenberg Operations nician and engineer can be taken via the drafting route. Here the technician can work on layouts of electronic circuits and, in some cases, as he gathers knowledge and experience, he may be given some original circuit design.

This type of job requires a basic knowledge of drafting methods which can be obtained in high schools or in trade school evening classes. Of course, if the technician wants to progress from there to engineering he will also have to acquire the training and education indicated for junior and associate engineers.

Broadcast or television engineer



Courtesy Cleveland Institute of Electronics

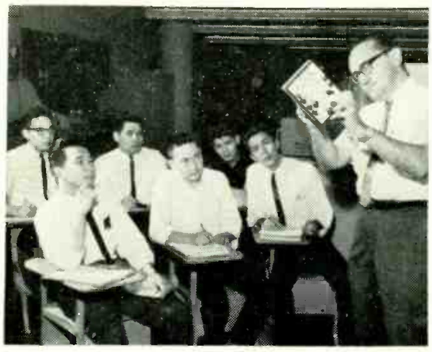
The electronic technician looking for different and interesting work should investigate technical positions with radio broadcasting or television stations. He can work in the studios, the master control room, in the field or at the transmitter.

The studio engineer sets up microphones and cameras, and then controls gain and mixes audio or video channels. The master control engineer monitors and switches programs from different studios, field pickups or other remote locations. The field engineeer puts on broadcast or television programs from remote or field locations. He uses portable or mobile equipment to make pickups from the ground, air or from ships.

Transmitter engineers must have an FCC operator's license since they handle the operation, maintenance and repair of one or more high-powered transmitters. Maintenance engineers handle the maintenance, troubleshooting and repairs of all radio broadcast or television electronic equipment, except perhaps in the area of the field engineer. The field engineer, distant from station facilities, must not only operate his field equipment, but also do all the maintenance and emergency repairs to insure "the show always goes on."

Training for all these areas is based upon a series of courses, usually given at a technical school, which progresses from electronic and electrical component basics to broadcast and television systems. In this type of work the electronic technician can usually start as a maintenance engineer and then, as he gains experience with equipment, assume the position at the station that fit his interests and temperament. Often he does not have to take the formal training, obtaining all the information he needs by self-study and practice.

Instructor



Courtesy RCA Institutes

A natural evolution from technician on a specific electronic subsystem or system is that of an instructor on that equipment. Having worked on the hardware, troubleshot its defects and performed its maintenance, the technician should be able to tell others about it. However, teaching calls for certain capabilities:

- The teacher should be able to describe the components of the equipment and discuss their theory of operation. This is not as easy as it sounds, for often a man can keep a piece of equipment operational without knowing exactly how it works. Thus before doing any teaching the technician must review the equipment in detail to make sure that he understands exactly how it operates.
- The teacher must have the skill of imparting his knowledge to his students. Most companies using technical instructors provide a short course in methods of presentation which include handouts, visual aids and practice in the best ways of making the subject interesting.

Part of the instructor's job entails gathering the technical material he needs and compiling it in a student guide. This guide can vary from a series of outlines and line drawings to a detailed book of instructions, depending on the time allocated for its completion.

To do this effectively, the technician should be able to write on technical subjects and to organize his written material. He should also be able to create or arrange visual aids to enhance his presentation. Public speaking experience or training will also help to make his lectures informative, while courses on effective writing or technical writing will be invaluable in handling his written work.

Other tasks that the instructor must perform are: to write examinations, test his students, then grade the papers. An analysis of the results will then help him determine the success of the course. A number of training and evaluation methods can be learned by taking a basic education course.

Training coordinator

Just as important as the instructor on an educational program is the training coordinator. He plans and establishes the technical training program for his company. This entails determining the need for courses, obtaining course outlines, scheduling the courses, arranging for classrooms and necessary classroom equipment and insuring competent instructors are assigned. Once classes are organized he must enroll students, review student guides, even monitor classes to check on the quality of the instruction. Finally, he must establish and keep records on the results of examinations taken by the students so technical personnel can be fully trained to perform required tasks.

To do this type of work a technician must be able to plan and take care of details. Rather than performing many of the functions, he coordinates them. He must also be able to set up and maintain records and communicate with supervisors to make sure they are aware of the training program and have taken the steps necessary to make their workers attend the courses. For the evaluation of courses he should be capable of putting himself in the place of the students and, based upon his own knowledge of the technical subjects, determine whether the instructor is providing the explanation and details necessary to understand the subject. Here the technician's experience will provide a basis of reference. Educationally, a course in business management will be useful in providing data on planning and implementation of various types of tasks and handling personnel.

Technical writer

If a technician has an aptitude for writing he can become a technical writer. Having worked with test procedures he should have a good idea of their form and content. Of course he does not necessarily have to originate them. Rough test procedures, or at least test specifications, are generally written by engineers. His task is then to place them in the step-by-step format used by technicians in testing equipment. With his experience he should have little difficulty.

Another technical writing area is handbooks and technical manuals. These are more complex than test procedures as they generally cover simplified equipment operation, theory of component functions, setup and operation of equipment and maintenance routines.

Normally the technical writer works with the engineers who designed the equipment and then with the men who set the first model in operation. He gathers a great deal of technical information from which he writes a rough draft of the manual. Once this draft has been reviewed by various project personnel, the writer corrects and finalizes the manual, making sure illustrations and photographs are included to clarify the text.

A number of courses and books on technical writing are available in evening education programs.

Probably one of the toughest jobs a

(continued on page 90)

NEW PRODUCTS

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card on page 92 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

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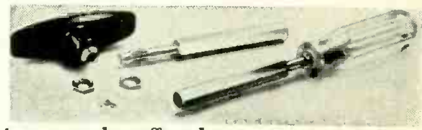

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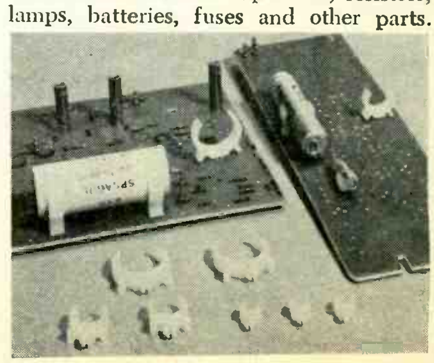

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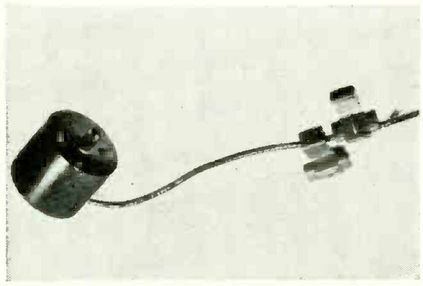
Circle 61 on reader service card

Easy to remove. Dimpled sides assure a tight holding action. Clips snap into holds .125" to .156" diameter. Available in sizes ⅛", ⅜", ½", and ¾". Made of virgin nylon, will accommodate over-size parts as well.—**Lorain Tool & Mfg. Co.,** 1817 Iowa Ave., Lorain, Ohio 44052.

Circle 35 on reader service card

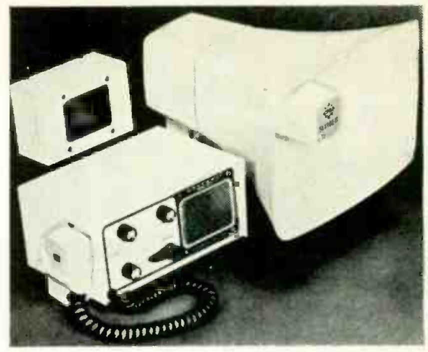
COLOR TV SERVICE ACCESSORY, *model B-150.* Single-Brite gun control, permits the restoration of color picture balance when a single color gun weakens prematurely. The potentiometer-type device lets the technician adjust the bias between the G1 and G2 grid leads of the weakened gun, per-



mitting color intensity variation as needed for balanced picture. Easy installation requires two simple connections and no soldering.—**Perma-Power Div., Chamberlain Mfg. Corp,** 845 Larch Ave., Elmhurst, Ill. 60126

Circle 36 on reader service card

FOGHORN/HAILER, *Model MD-19* has 5 functions. Is a foghorn, boathorn, hailer, listener, and with *MDA-19-1* speaker becomes an intercom. Has push-to-talk mike and weather-proof speaker

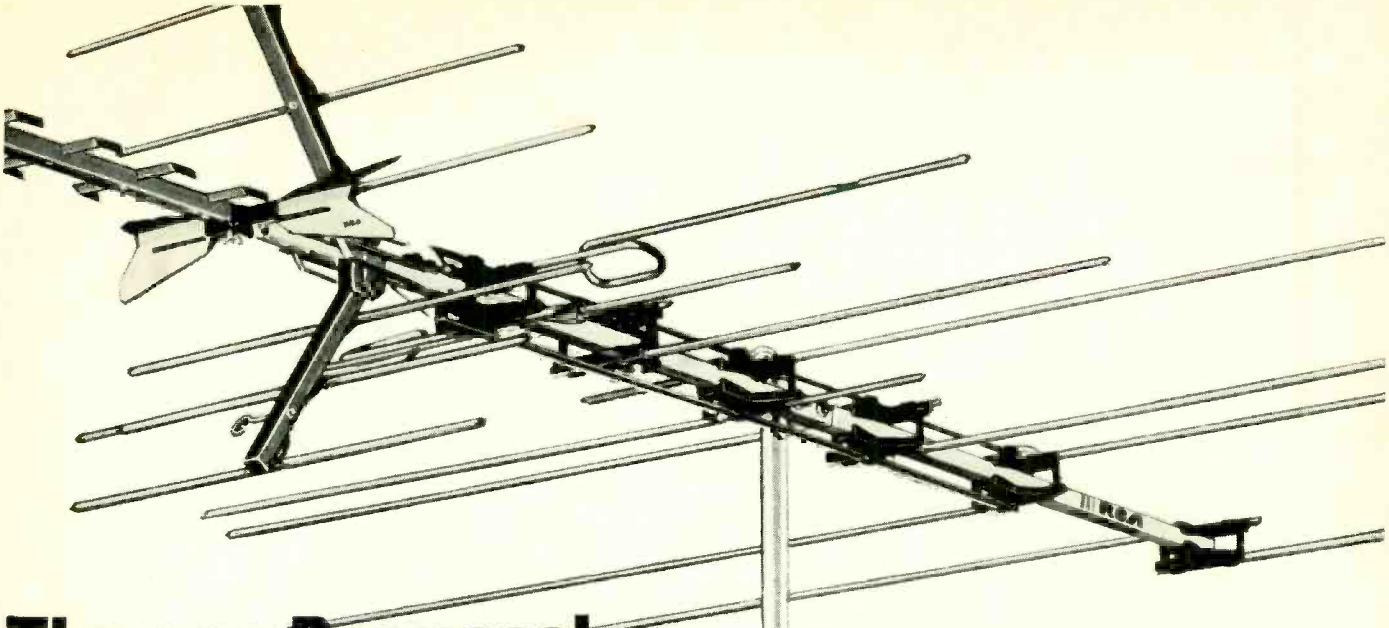


with mounting base. Operates from 12 V. Includes mounting bracket and 20 ft. of cable. Kit $84.95, accessory speaker $9.50.—**Heath Co.** Benton Harbor, Mich.

Circle 37 on reader service card

PROFESSIONAL TAPE DECK, *model CAD5,* tape cassette recorder incorporates the Dolby-B noise reduction

processor as part of the record and play-



The new Permacolor antenna from RCA has:

"Long-lasting" element/ feed line connections.

Waterproof, polypropylene insulators that pivot.

Integrated UHF bow tie.

Rigid, square boom.

Tough vinyl finish.

That ought to prove RCA is serious about the antenna business.

So serious we've set up a new production facility at our Memphis plant. But before we manufactured a single antenna, our engineers literally started designing from scratch. The result? Permacolor.

Here are just a few reasons why RCA Permacolor antennas are different, and are an improvement over what you're now selling.

1. Durable connections/Perma-tuned circuits. All active elements (many perform more than one function) are solidly connected to a symmetrical aluminum feed line by riveted straps. This reduces reception failure due to flimsy or intermittent connections.

2. "Single unit" insulator/element. Insulators are polypropylene. Elements extend 5½ inches into the insulators. Elements and insulators pivot as a unit—lock in place—have no loose connections. No high stress points.

3. Bow tie and 110° corner reflector UHF Section integrated into a single downlead for better UHF reception.

4. Easy installation. Simply unfold and install. Permacolor antennas go up in one piece. No bag of bolts. Nothing to take apart and reassemble. Snap-off elements let you quickly tailor the antenna to reception requirements.

5. Tough, handsome blue and gold vinyl coating protects against weather and airborne chemicals.

The new RCA Permacolor Antenna is the antenna you can put up for good. See it now at your RCA Parts and Accessories distributor.

Parts and Accessories, Deptford, N.J.

RCA

back electronics. Extends in frequency response beyond 12.5 kHz. Acts as a compressor/expander only without its inherent weakness. The Dolby processor boosts low-level, high-frequency signals before they are recorded and then attenuates these signals in a mirror image during playback. Electronic speed control assures minimum speed variation with reduction of wow and flutter. Professional sliding potentiometers set recording level and the recording overmodulation light works in conjunction with the dual recording meters and flashes when the sound level is too high. Automatic digital counter with pushbutton reset, records and plays back in mono and stereo, pushbutton switches for all functions.—$229.95—**Harman-Kardon, Inc.** 55 Ames Court, Plainview, LI, N.Y. 11803

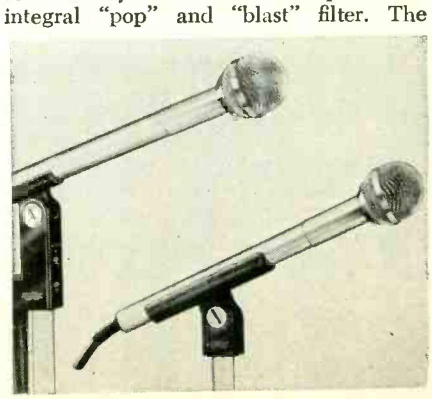
Circle 38 on reader service card

COMPACT TV CAMERA, *model TVC-500.* Develops clear, sharp monochrome pictures in video or rf signal at a switch-selected output. Video is viewed on a monitor but when the camera is switched to rf output, the pictures are displayed on a standard TV receiver. Simple screwdriver adjustment selects output frequency covering channels 2 through 6. Output level on a composite

signal is 1.4 V p–p, video is 1 V p–p. Rf output is greater than 29.5 dBmV (30mV) and impedance is 75 ohms. Horizontal resolution of center is 550 lines on video and 300 on rf output. Each 6 pound camera is supplied with a 25 mm F/1.8 lens. Wide angle and telephoto are available. $325.00—**Jerrold Electronics Corp.,** 401 Walnut St., Philadelphia, Pa. 19105

Circle 39 on reader service card

PROFESSIONAL MICROPHONES, *models 860 and 860s.* Ball-head omnidirectional dynamic mikes incorporate an integral "pop" and "blast" filter. The



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NOVEMBER 1970

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- **PLUS:**

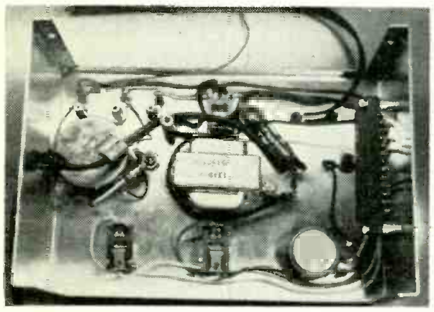
Jack Darr's Service Clinic
How To Putter With The PUT
Power Tool Reference Manual

MULTIPLEX GENERATOR
(continued from page 67)

an access hole in the chassis to permit external adjustment of T4's slug. This allows changing the oscillator frequency to a spot where no local station is operating.

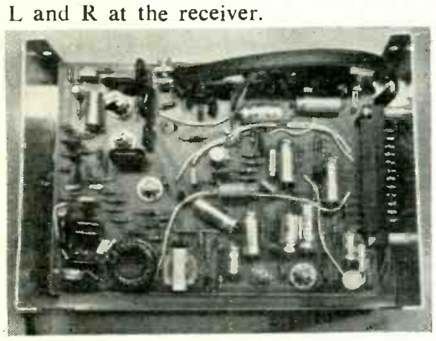
Using the generator

The composite modulation output is used mainly for applying the stereo signal to a multiplex demodulator for checking it separately. For this, the 19-kHz level is not calibrated and must be set to a predetermined level which the discriminator will supply from broadcast stations. This is also true for the remaining composite signal level. The audio input levels to the generator must be kept below about 1.5 Vrms or saturation occurs.



POWER TRANSFORMER AND JACKS are on front panel with the pots and switches.

Receiver separation versus frequency can be checked between 300 Hz and 20 kHz with this generator. This also provides a convenient way to determine if the receiver de-emphasis circuit is correct. The easiest way to measure receiver separation is to apply an audio tone to only R or L of the generator and measure the ratio of outputs on L and R at the receiver.



COMPONENTS ON PLUG-IN BOARD are visible when the rear cover is removed.

The rf VCO in this unit is very convenient. It lets you check the effect of i.f. amplifier selectivity on overall separation. It also lets the technician adjust a multiplex unit incorporated in the radio without disconnecting it. A direct connection from the rf output is not required as the receiver will pick up the signal from a few feet away.

This stereo generator will result in a professional alignment job on any FM stereo receiver. Its relatively low cost and versatility make it a valuable piece of test equipment for any technician.

R-E

Service

By JACK DARR
SERVICE EDITOR

Signal Tracing Transistor TV

I've read a lot of articles, including some of yours and I still haven't found an easy way to check a transistor TV, stage by stage, with only a vtvm. I've been doing this for years in tube TV's. Why can't I do it in solid-state stuff?—H. J., Highland Falls, N.Y.

Several reasons. First and most important, is the different *method of construction*—PC boards vs terminal-point wiring. Second, the transistors are soldered in. Can't pull 'em and replace with a known good one without a lot of trouble.

So! Use the same methods you've used for so long, but use a different *test-instrument*. The scope! It is just as simple as a vtvm. When you find out where the *signal stops*, then use the vtvm.

Dark Bars On Left Of Raster

I have a Zenith 14N27 portable, which has a dark bar at the left side of the raster. I can move it back and forth with the horizontal hold control. It has what looks like vertical retrace lines near the top of the screen. My customer says this has been there ever since he got the set.

All tubes have been replaced, parts checked, shields tightened, etc.—B. T., Bayonne, N.J.

After you recheck the horizontal afc and run a complete horizontal oscillator/afc setup adjustment, and check the afc tube grid bypass capacitor, check the yoke. In a very few cases, we've found that a defective yoke can cause troubles something like this. Never pinned down the exact cause; could be too much air-gap or something in one of the windings, but a new yoke often cures it.

Too Much Capacitance?

Following a suggestion of yours in the Service Clinic quite a while ago, I added more capacitance to the filters of a TV set to get out a 120-Hz humbar in the picture. I had to add 400 μF, but I got rid of it. Isn't this too much?—A.D., N.J.

Not if you got rid of the hum! There's no such thing as too much capacitance in a filter circuit; at least not if you still have hum-bars which are a definite indication that there isn't *enough* capacitance in the circuit.

It's possible that if you took every one of the original capacitors out of the circuit and checked them very

Clinic

carefully you'd find high power-factor in several of them. This reduces the "filtering efficiency" of the unit. However, if the operation is satisfactory with the added capacitance, I'd take it.

Open Transistor?

I'm studying TV repair. The other day I replaced an open transistor in the output of a stereo amplifier. It wouldn't work! Collector voltage read normal. I took the new transistor out and it tests ok!—R. G., Tulsa, Okla.

Most likely possibility (because it happened to *me* only the other day!) is a completely bad contact on the lug which makes the collector connection on the output transistor collector! Most of these are bolted in, and any oxide, coating, etc. on the case of the transistor (the collector contact) will keep the solder-lug from making good contact.

Test from the *case* of the transistor instead of the lug. If you can't get any voltage on it, put a good sharp lockwasher between the lug and the case and tighten well, or scrape the case clean at that point.

Super Hearing Aid

I have a customer who wants to get a mike and amplifier, battery-operated, with a "rifle-type" mike that he can point at the preacher, so he can hear church services. Could I use one of the little cassette tape-recorders, or something like that?—A. A., Vienna, Va.

Doubt if one of those little recorders would have enough gain. Better idea would be to use a small IC amplifier. Motorola has one in their HEP IC booklet, called a "Super High Gain Amplifier." It uses a HEP-580 IC. Should have ample gain to drive a single earphone from any good mike.

The whole thing could be mounted in the case from a junked transistor radio, with the batteries, using the original earphone jack. R-E

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, 200 Park Ave. S., New York 10003.

4 CHANNEL STEREO
(continued from page 35)

cities—Boston, New York and San Francisco—FM stations have used three different pairing and placement techniques, each for its own good reasons. In Boston the four microphones, which carried live concerts of the Boston Symphony Orchestra, were ranged more as a "curtain of sound" than as a true quad pickup. One station used the left and right mikes placed at the left half of the stage, while the other took left and right channels for the right half of the stage. This way, both stations had a two-channel stereo signal of sorts, even though the total quad effect lacked true surround sound placement, directivity and separation. The stations involved were educational station WGBH-FM and commercial WCRB-FM.

In New York, FM Guide Publisher Harry Maynard introduced quad on his weekly show for stereo buffs, "Men of High Fidelity." New York City-owned WNYC-FM carried the front left and right channels and Columbia University station WKCR carried the rear two channels. Understandably, the WKCR signal left something to be desired for the majority of listeners who couldn't set up two complete FM stereo systems in their living rooms. But WNYC-FM did provide a full two-channel (and mono) signal for conventional listening setups. This program and its successors were rebroadcast weekday afternoons so stereo dealers could demonstrate quad in their showrooms.

In San Francisco, a one-shot broadcast by Pacifica station KPFA and Metromedia's KSAN carried left front and rear on one station; right front and rear on the other. The thinking here was that the stereo dealer could most easily arrange two stereo consoles along opposite walls of his store. Actually, it looks like an ideal arrangement to keep either station from gaining a competitive edge during the experimental quadcast. Later, the Bay Area quadcast gauntlet was picked up by KLOL and KRON, both commercial stations, who interestingly use the same split as in the KPFA/KSAN quadcasts. The Chicago and Cleveland areas are next on the list, and one program packaging company is selling a single syndicated one-hour quad concert by the Boston Symphony Orchestra.

The quad disc is the biggest question mark of all. There are private inventors and engineers with huge laboratories all bent on a single quest—the single-groove quad disc. They're convinced it's possible, just as they were convinced in 1956 that a true two-channel program could be put into a single record groove. They may be right. But there are just as many skeptics around now for quad as there were for stereo in 1956. *They* may be right.

So far, whatever results that have been publicly demonstrated have left much to be desired. The long-awaited public unveiling of Peter Scheiber's disc came at the March AES meeting before standing-room-only crowd in RCA's spanking-new recording studios. Those of us who heard it came away convinced that the Schieber disc just doesn't have what it takes for true quad.

Scheiber's technique is supposed to condense quad's four channels into two stereo channels that are fully compatible with all conventional types of playback equipment. A master disc would be cut with the same Westrex stereo cutting head, and the record would be played back with any conventional stereo cartridge—even the cheapest crystal types. The output signal would be processed through a black box (patent applied for) decoder which would have four-channel output to feed a quad amplifier (or two stereo amplifiers if you will).

The same technique would compress quad into two ordinary stereo tracks on tape or into an FM station's conventional two-channel FM stereo broadcast. The secret of all playback would be in the little black box decoder. Equipment without the decoder would simply play back a normal two-channel program. The whole idea sounds especially captivating since its compatibility would eliminate a lot of headaches and retrofitting now seen as needed for quad playback.

The system, alas, isn't all it's cracked up to be. In Scheiber's own words, it's a "psycho-acoustic effect." Purists take note: it's a **psycho-acoustic** effect; not the real thing. But you don't have to be a purist to be convinced of the system's shortcomings.

What it does is place the apparent sound source at any two selected speakers out of the four at a given instant, with some other assorted sounds coming from the other two, with lots of spillover. The Scheiber system is perhaps best described as "2½ channels of stereo." It's definitely not true quad.

So the search goes on. Familiar names are in the fray again. Jerry Minter is back with his multiplexing technique. Columbia Records is working on something that's still a closely guarded secret. And there are others, names that may someday be household words, or simply inventors that won't quite make the grade.

In the meantime, the smart money's on tape and FM. **R-E**

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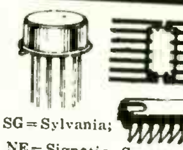

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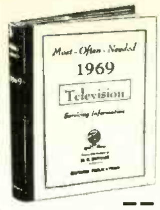

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BLUEPRINT TO PROGRESS

(continued from page 69)

technician can tackle is that of a free-lance writer of technical material. This is a highly competitive area, for his material must match or even surpass the standards of writing in the field. Furthermore the subjects he chooses and the way he handles them must attract the attention of editors.

But even with the best of presentation, the market is limited. Unless the writer can produce a terrific amount of good material, he will have a difficult time making a living. He may be able to obtain a contract to do one or more specific jobs that will pay well for a short time. One such area is writing technical films; but the competition is fierce and the chances of landing such a job are fairly limited.

Requirements for free-lance writing include the ability to plan and write clearly, but even more, an aptitude for recognizing a salable subject and the incentive and energy to do the research necessary to make an article or book interesting and different. There are any number of writing courses at colleges and correspondence schools that will give a technician the basic tools he needs. But he must be ready to serve a long apprenticeship before his material will be regularly requested and paid for.

The different positions discussed do not exhuast all the possibilities open to a technician seeking to progress from an hourly to a salary position. They should, however, indicate that the path is definitely not closed. Assuming he has begun his education program early to anticipate openings. he then should indicate his qualifications to his supervisors and his readiness to move into a salaried position. With his technical experience he should have a decided advantage. **R-E**

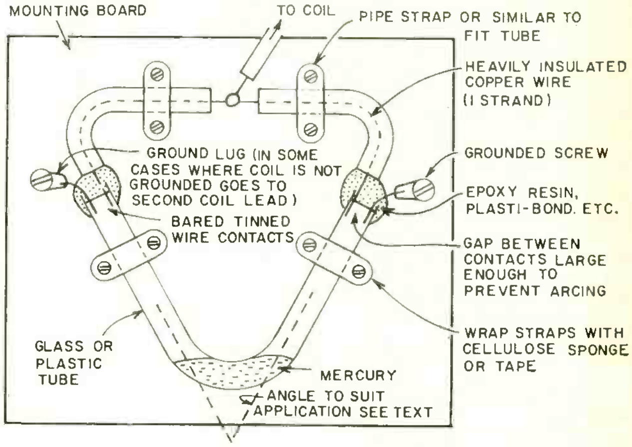
NOTEWORTHY CIRCUIT

SAFETY SWITCH FOR MINI-BIKES

One index of the ever-increasing popularity of the minibike with the younger set—particularly those too young to own or operate cars—is the number of injuries noted by hospitals and pediatricians. Many of these injuries occur when the rider's clothes or some part of his person gets caught in the rear-wheel spokes or between the chain and sprocket after a spill. Being aware that the rider does not have time to cut the ignition when he realizes he is about to spill; Mr. Lindsey Ford, Balwyn, Australia developed a simple switch that kills the engine when the bike tips.

The diagram shows how he described the switch in *Electronics Australia*. It is actually a simple mercury switch made by sealing two contacts in each end of a 5-inch length of glass or plastic tubing bent in the form of a "V". One contact on each end is grounded to the frame and the other goes to the high side of the coil or to the "hot" lead to the spark plug.

The switch is clamped to a piece of ¼" plywood and mounted vertically across the frame parallel to the handlebars. It should be wrapped in foam rubber to protect against shock and enclosed in a small box to protect against the elements and gas and oil spillage from the engine. The angle of the "V" is determined by the type of vehicle. If the angle is too large, the ignition will short out on a normal leaning turn. If it is too small, the ignition might not cut off if the rider takes a spill on a hill. **R-E**



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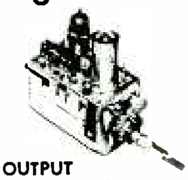

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CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

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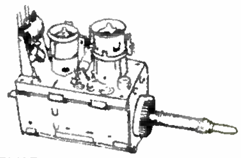

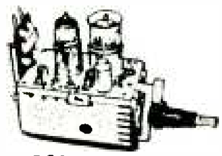

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