New 4-channel stereo techniques

Build FM stereo multiplex generator
Pro's tape recording quiz
Get better sound from your stereo

Build modular 6-channel stereo mixer preamp
*Audio magazine says:
“It is extremely attractive with its base and dust cover, both of which are optional accessories, and it performs superbly. In over twenty hours of use, the unit performed flawlessly, with never a fault in its changing operations during that time. Naturally, we cannot test any equipment to destruction and still produce a number of profiles each month. However, Garrard’s reputation practically guarantees continued high-quality performance for years, and any user should be completely satisfied with this model, which represents the culmination of many years of turntable manufacture.”

**Stereo Review says:
“At a time when most automatic turntable prices are soaring, it is encouraging to note that the price of the SL95B is unchanged from that of the SL95 ($129.50). A number of different bases are available ranging in price from $6.50 to $19.95. A dust cover that fits all bases is $6.50.”

Garrard’s SL95B
Automatic Turntable $129.50.
For literature write Garrard, Westbury, N.Y. 11590
British Industries Co.
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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 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.

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.

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-
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

Radio-Electronics is indexed in Applied Science & Technology Index (formerly Industrial Arts Index)
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-probe 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 Telescopier. 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: Off-on 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.
Instant inventory.

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OCTOBER 1970

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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.
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.
Learning electronics at home is faster, easier, more interesting with new achievement kit

GET A FASTER START IN THE COURSE YOU CHOOSE WITH NRI'S REMARKABLE ACHIEVEMENT KIT

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Whatever your reason for wanting knowledge of Electronics, you'll find the NRI "3 Dimensional" method makes learning exciting, fast. You build, test, experiment, explore. Investigate NRI training plans, find out about the NRI Achievement Kit. Fill in and mail the postage-free card. No salesman will call. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D. C. 20016

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**Teleconsultation Is Now**

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.

So what are you waiting for? Simul-trak "surrounds you with sound — and gives you a headstart on tomorrow.

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General Specifications
- Speeds — 7 1/2 and 3 3/4 ips
- Motors — 1 hyst. sync., 2 outer rotors
- Wow and Flutter — 0.12% @ 7 1/2 ips
- Freq. Response — ±3 dB 50-15,000 Hz @ 7 1/2 ips
- S/N Ratio — 50 dB
- Crosstalk — 48 dB

TCA-40
- 1/4-track, 2-channel stereo playback, plus 4-channel stereo playback (in-line)
- 1/4-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)
- 1/4-track, 2-channel stereo playback, plus 4-channel stereo playback (in-line) • 1/4-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
- 1/4-track, 2-channel stereo playback, plus 4-channel stereo playback (in-line) • 1/4-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 fiberglass 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 360 revolutions per minute, a rate five times greater than that of today's operational radars. The resultant increase in radar 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.

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134-174 MHz
VHF-FM 2 CHANNELS
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R-A-D-I-O-E-L-E-C-T-R-O-N-I-C-S

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.

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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?

Start with the Channel Master Opti-Vue Color CRT with the three year warranty, one TV set that needs a picture tube, and one customer.

Tell your customer how Opti-Vue guarantees the finest color he's ever seen for a full three years— not just one or two. And how, just in case something should go wrong, he gets a free replacement. So it may cost a little more, but it's worth it. And the price is right, too!

Now, you've secured the part of the set he's most worried about—he's sure to call you when any other part fails. You've tied up all his service business for a full three years by taking care of his knott est prob em, and, not unimportantly, your customer's very happy with his new color vision!

So gc ahead and tie one on with

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The line with 3 year warranty!

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- all solid state FET circuitry for instant-on action . . . first time in tube tester history
- New solid action push button function switches to speed up every test

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Circle 11 on reader service card

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 representative of that company. Then order the missing parts from that distributor. In some cases it may mean a delay of several weeks before 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)
WE HAD JUST REPRINTED OUR LITERATURE...
ADDING OUR FIFTH NEW PLANT...
WHEN WE DID IT AGAIN... PRECISION TUNER SERVICE

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WE HAD JUST REPRINTED OUR LITERATURE... ADDING OUR FIFTH NEW PLANT... WHEN WE DID IT AGAIN... PRECISION TUNER SERVICE

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![NTS Color TV 295 Sq. In. Picture](image)

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**OCTOBER 1970**

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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?

UBLADO ORIGNERO  
Calgary, Canada

We agree that tubes are not dead, but in many instances there is little excuse for using them. The transistor uses far less 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.

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.

99.99% reliable

Every now and then, one of our tubes fizzies—and somehow it’s the one you install. Even we don’t know how you happen to receive that particular tube. But we do know that it doesn’t happen more than once in thousands of times.

Raytheon receiving tubes—including Raytheon Tubes for Imported Sets—have to be extra reliable. Because, Raytheon is the leading independent supplier of receiving tubes to independent servicemen. We don’t have competing service trucks or retail outlets. So, we depend on you just as much as you depend on us.

Circle 13 on reader service card
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 3/4 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.
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 monotinous. 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 "dc." 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 = 1/2πfC. 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.
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Get the facts now! Just clip the coupon and send today for a FREE, fact-filled book describing the exciting opportunities in electronics, and how you can qualify for them. We'll rush your book by return mail so you can read it and decide for yourself. No obligation, of course. But don't delay — clip the coupon for your free book today!
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EQUIPMENT REPORT

Heathkit IG-57 Post-Marker Sweep Generator
For manufacturer's literature, circle No. 21 on Reader Service Card.

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THREE INPUT CHANNELS. One megohm FET high impedance input, two (2) low impedance inputs.

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DC OPERATING VOLTAGE. 45 volts.

DC OPERATING CURRENT. 10 ma. idle, 1 ampere at full IHF output.

OVERALL DIMENSIONS. 4 x 1/2 x 1/2 inches. PRICE. $16.50

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 scope, vertical and horizontal inputs, 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 up 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 if'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 age, 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 bandwidth and sound i.f. alignment. The 0.7-MHz i.f. of FM tuners can be swept by the 2nd harmonic. On low next, it 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 of this with 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 how much simpler—trap alignment. This is vital in color TV alignment. A misplaced trap can cause color cross talks and a multitude of other problems. (For a test, try running the 41.25-MHz trap up on the side of the current carrying wires and you'll find out!) With the crystal markers, the three most important traps—37.55, 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. If's, an IF meter, 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 switches, with hums and buzzes. Tiny provided coils 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. Indidentally, 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
Newest SAMS Books

Hi-Fi Stereo Servicing Guide
by ROBERT G. MIDDLETON. A complete guide to effective hi-fi and stereo servicing. Provides the basis for a full understanding of hi-fi tuners and amplifier circuitry and procedures for servicing this type of equipment. The proper use of audio test and measurement equipment and the basic principles of acoustics are also given. Covers all hi-fi components (except record players and tape recorders). Order 20785, only $3.95

ABC's of Avionics
by LEX PARRISH. Provides a basic understanding of avionics—the electronic equipment used to insure the safety of crew and passengers. The type of equipment and the techniques employed in private aircraft operations are featured. Discusses requirements for basic communications, navigation aids, instrument flight aids, weather guidance, and flight control safety devices. Order 20764, only $3.50

Mobile-Radio Systems Planning
by LEO G. SANDS. Here is practical, basic information about various types of mobile-radio systems, how they work, their capabilities and limitations, system requirements, licenses, channels, band and frequency selection, transmitter-receiver selection, antenna systems, and accessories. Includes an invaluable system-requirements form for planning a mobile-radio system. Order 20780, only $4.50

Transistor-TV Servicing Made Easy
by JACK DARE. This practical guide will help you become skilled in the special techniques of transistor-TV servicing. Covers tools and equipment required; transistors and transistor-servicing techniques; power supplies; horizontal and vertical sweep circuits; video i-f and output circuits; a.c. and sync-separator problems; tuners; audio circuits; and selecting replacement transistors. Order 20776, only $4.95

Security Electronics
by JOHN E. CUNNINGHAM. Explains the operating principles of modern electronic devices and systems used to provide security against crime. Describes intrusion alarms and intrusion-detection devices. Includes chapters on the detection of hidden metal objects, announcement of detected intrusions, bugging, debugging, and speech-scrambling systems, and future developments. Order 20767, only $4.50

How to Hear, Police, Fire, and Aircraft Radio
by LEN BUCKWALTER. After World War II, police, fire, and aircraft radio moved to the less crowded vhf bands, and the “police band”, which was found in many older radios, was silenced. Few listeners had receivers capable of covering the vhf band, because they were relatively expensive. With the advent of solid-state circuitry, a wide variety of relatively low-cost monitoring equipment is available. This book is a guide to the selection and use of vhf radio. Order 20781, only $3.50

101 Questions and Answers About Transistor Circuits
by LEO G. SANDS. Answers the most commonly asked questions about transistor circuitry. Explains transistor nomenclature, biasing, the three basic circuit configurations, input and output impedances, current gain, and other basic considerations. Covers power supplies and circuits; a.f. circuits; r.f. circuits, and oscillators. Order 20782, only $3.95

1-2-3-4 Servicing Automobile Stereo
by FOREST H. BELT. This book first applies the ingenious “1-2-3-4” repair method to both mechanical and electrical equipment. Then it proceeds to cover the electronic and mechanical principles of automobile stereo, fm multiplex and tape cartridge systems. Finally, the book shows how to apply the method to auto stereo systems. Order 20737, only $3.95

by VANE A. JONES. Lists all radio and TV stations in the U.S., Canada, Mexico, and the West Indies. Includes operating a-m, fm, and television stations, as well as those that are about to start operating, or are temporarily off the air. Separate listings arranged by geographical location, frequency (or channel), and call letters make this guide the most useful one available. Order 20779, only $2.95

Aviation Electronics, 2nd Edition
by KEITH W. BOSE. This practical handbook for aircraft owners, pilots, technicians, and engineers explains the design, operation, and maintenance of aviation electronics equipment. Covers automatic direction-finders, distance-measuring equipment, omnirange, ATC transponders and weather radar, communications and instrument-landing systems, and related devices and systems used in aviation today. Order 20743, only $9.95

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

If you're out to bag a better job in Electronics, you'd better have a Government FCC License. For you'll need it to track down the choicest, best-paying jobs that this booming field has to offer.

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

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

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

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

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

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

CIE courses are so effective that better than 9 out of 10 CIE graduates who take the exam pass it. That's why we can back our courses with this ironclad Warranty: Upon completing one of our FCC courses, you must be able to pass the FCC exam and get your license—or you'll get your money back!

They got their licenses and went on to better jobs
The value of CIE training has been demonstrated time and again by the achievements of our thousands of successful students and graduates.

2 NEW CIE CAREER COURSES
1. BROADCAST (Radio and TV) ENGINEERING... now includes Video Systems, Monitors, FM Stereo Multinex, Color Transmitter Operation and CATV.
2. ELECTRONICS ENGINEERING... covers steady-state and transient network theory, solid state physics and circuitry, pulse techniques, computer logic and mathematics through calculus. A college-level course for men already working in Electronics.

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

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

Eugene Frost, Columbus, Ohio, was stuck in low-paying TV repair work before enrolling with CIE and earning his FCC License. Today, he's an inspector of major electronics systems for North American Aviation. "I'm working 8 hours a week less," says Mr. Frost, "and earning $228 a month more."

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

With it you will also receive a second FREE book, "How To Succeed In Electronics," To get both books without cost or obligation, just mail the attached postpaid card. Or, if the card is missing, just mail the coupon below.

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www.americanradiohistory.com
The long awaited and newly revised Sylvania Technical Manual is out. Complete and unexpurgated. The fantasy of every Independent Service Technician. Written anonymously by an agile team of Sylvania engineers. 32,000 components described in breathtaking detail. Including thousands of unretouched diagrams and illustrations. Discover the unspeakable thrill of new color TV Tubes, listed as never before. The ecstasy of 28,000 ECG Semiconductors.

From exotic Deflection Oscillators to a lurid account of Transistors and Rectifiers.

This book has what you want. Components for the man who knows what to do with them.


SYLVANIA
GENERAL TELEPHONE & ELECTRONICS
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.

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 pinging-pong-pong effect possible. Most spectacular of all was the motorcycle that ran in circles around the huge RCA recording studio where the most 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...
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 is 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 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")

**TYPICAL 4-CHANNEL STEREO AMPLIFIER.** This one is the H. H. Scott model 495. Several other manufacturers have announced similar gear.

**ORCHESTRA**

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<td>L SOFA R</td>
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**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 allotted 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 ratio—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)
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—potentiometer, 10,000 ohms (R7, R10 is a dual linear pot)
R3, R5, R6, R12, R13, R14—10,000 ohms, 1/2 watt, 10%
R4, R11—47 ohms, 1/2 watt, 10%
R8, R9—33 ohms, 1/2 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

RADIO-ELECTRONICS
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.

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 board patterns shown in Fig. 3.

**TABLE 1**

<table>
<thead>
<tr>
<th>Microphone Impedance</th>
<th>R1 (ohms)</th>
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<tbody>
<tr>
<td>200</td>
<td>220</td>
</tr>
<tr>
<td>500</td>
<td>560</td>
</tr>
<tr>
<td>4,000</td>
<td>R1 not used</td>
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</tbody>
</table>

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.**
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 amplifiers 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 provides 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. 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

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**TABLE II
RESISTANCE VALUES**

<table>
<thead>
<tr>
<th>No. of inputs</th>
<th>R17</th>
<th>R18</th>
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<tr>
<td>2</td>
<td>8.2k</td>
<td>120 ohms</td>
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<tr>
<td>3</td>
<td>7.5k</td>
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<tr>
<td>4</td>
<td>6.8k</td>
<td>91 ohms</td>
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<tr>
<td>5</td>
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<td>82 ohms</td>
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<tr>
<td>6</td>
<td>6.2k</td>
<td>75 ohms</td>
</tr>
<tr>
<td>7</td>
<td>6.2k</td>
<td>68 ohms</td>
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</tbody>
</table>

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**FIG. 5—(BELOW) CIRCUIT of multi-input audio mixer. Two are needed to build the unit described in this article. FIG. 5—(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.**

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**PARTS LIST (FIG. 9)**

- 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, 1/2 watt, 10%
- R2, R4, R6, R8, R10, R12, R14—39,000 ohms, 1/2 watt, 10%
- R15—100,000 ohms, 1/2 watt, 10%
- R16—2200 ohms, 1/2 watt, 10%
- R17, R18—see table II and text

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**RADIO-ELECTRONICS**

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**www.americanradiohistory.com**
OCTOBER 1970

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, select 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.
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.

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 whisk-broom, 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

Harman-Kardon's Citation 12 120-watter. The latest in stereo power amplifiers.
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 100 \mu A, 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 0.5 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 level and "thicker 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 vtm (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 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 quick "field expedient" method for at least "centering" the detector with a signal generator or FM station as the signal source, and a vtm.

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 dialcord slippage, or some other kind of mechanical slippage. Slipping dial cords can often be restored just by cleaning them with a greasy 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 signals. 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 detectors with time can deteriorate due to sun and air pollutants, and its electrical loss increases. Connections between the lead-in and the antenna or lightning arrester 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 exposure to sun and air stations. A change of antenna location, or a different antenna, may be needed to solve the problem.
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, "Ouverture." 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 1/4 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 underside of the test tape in the light. If it shows any flaked oxide, accept it only if the oxide flakes off during playback and are not evident on the recording itself.

**MODULAR TV SETS (A rundown of the new sets)**

- **MOTOROLA (TS 915.9'B)**
  - Color: Cyanar Solid
  - State: Panel
  - Circuit: AFC
  - Description: AFC discriminator & amplifiers
  - Video IF amp., AGC amp., video det., video det amp., 5.5 Mfg det.
  - Audio demod., output amp.
  - Noise inv., AGC gate, sync sep., vert sync in, & oscillator, 1st video amp., 2nd video amp., brightness stabilizer
  - Color gate pulse former, horz. osc., color output amp.
  - Vert. punctuation amp., 1st, reg. amp. & driver
  - Vert. limiter & Vert. out., vert. & horz. convergence assy.
  - RGB demodulators, RGB video driver, blanker amp., RGB video outputdriver & adjust.
  - ACC amp., color killer amp., color IFs, color oscillator output & drivers

- **MOTOROLA (Hybrid)**
  - Color: Quasar 2
  - Circuit: Panel
  - Description: Video IFs, video amp., audio IC, audio out.
  - Sync sep., vert. osc./out., H phase det., horz. osc., color driver
  - Convergence assembly
  - AFC discriminator & output
  - Color sync & osc., color killer, ACC amp., 2nd video amp., sync & AGC takeoff, color IFs, RGB demodulators, volt. reg., RGB video outputs
  - Transistor supply regulator (±20 watts) with fieldback current limiting

- **ZENITH (Hybrid)**
  - Color: 1281452
  - Circuit: Panel
  - Description: 9-23 (AGC Module)
  - AGC gate, AGC delay, AGC output, noise gate driver, noise gate, sync limiter
  - IC subcarrier oscillator, APC, ACC, output amp.
  - 9-73 (Chroma Mod.)
  - ICR ams & IC demodulator
  - 150-146 (IF Ass)
  - Three IFs, Audio Det., Video Det., 1st video amp.
  - Dynamic convergence assy.

- **ZENITH (Hybrid)**
  - Color: (Constr. Ass)
  - Circuit: Panel
  - Description: 9-47 (Color Module)
  - 2nd color amplifier & IC demodulator

- **ZENITH (Hybrid)**
  - Color: 177.170
  - Circuit: Panel
  - Description: RCA
  - (XCS 185, Solid State)
  - Monochrome
  - Sound Module
  - IC sound det., amp., audio output

- **HEATHKIT (Solid State)**
  - Color: GR-270, GR-370
  - Panel: IF Ass.
  - Three IFs & video detector, driver
  - Luminance Board
  - Sound Board
  - Video Out
  - Osc. Circuit
  - Burst ass, ACC, phase detector, IC 3.58 MHz oscillator, CW amp.
  - AFT Circuit
  - IC amp., discriminator, driver
  - Convergence Circuit
  - RL circuits for dynamic convergence
  - VR, osc.
  - Vert. switch, predriver, linearity clamp, vert. driver
  - Phase splitter, ACC diodes, horz. osc.
  - SCR HV drivers, HV regulator
  - Panel
  - IF amps, video detector, video drivers, AGC circuits
  - Video Module
  - Video out, sync, ACC keyer
  - Sound Module
  - IC sound det., amp., audio output

- **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.**

- **Testing tape**
  - 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-Off Merchandise bonuses. If they sell products so listed, it's more money in their pockets, so don't be fooled.**

- **More than anything, remember to Caveat the heck out of Empor!**

R-E
### NEW R-E EXCLUSIVE

**Kwik-Fix™ picture and waveform charts**

by Forest H. Belt & Associates®

<table>
<thead>
<tr>
<th>SCREEN SYMPTOMS AS GUIDES</th>
<th>WHERE TO CHECK FIRST</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMPTOM PIC</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>For reference:</td>
<td>Raster lines</td>
</tr>
<tr>
<td></td>
<td>in focus (closeup)</td>
</tr>
<tr>
<td>Raster out of focus and</td>
<td>Focus anode of</td>
</tr>
<tr>
<td>shaded (closeup)</td>
<td>CRT</td>
</tr>
<tr>
<td>No raster</td>
<td>Focus anode of</td>
</tr>
<tr>
<td></td>
<td>CRT</td>
</tr>
<tr>
<td>Raster out of focus</td>
<td>Focus anode of</td>
</tr>
<tr>
<td>(with picture)</td>
<td>CRT</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>No raster</td>
<td>Focus anode</td>
</tr>
<tr>
<td></td>
<td>and no tube</td>
</tr>
<tr>
<td></td>
<td>current</td>
</tr>
</tbody>
</table>

**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.

**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 ngs 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

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

**NOTES**

*Erratic voltage usually depicts internal arcing.*

Use this guide to help you pinpoint the faulty part.

Measure each key voltage with voltmeter and high-voltage probe.

Measure key current with current function of voltmeter.

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
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 age 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 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 opens. 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.

**WAVEFORMS AS GUIDES**

**WF 1 Normal Unknown V p-p**

This waveform is sampled 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 charging 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**


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. Bell. 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.


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.

RADIO-ELECTRONICS
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 household 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 selfcorrecting 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.

Chief Engineer
Concord Electronics Corp.

October 1970

*Chief Engineer
Concord Electronics Corp.
How To

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 transistor, 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, UIT 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 (Iₚ). 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 Iₚ, or valley current and Iₚ, 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.

The PUT in relaxation oscillators

Figure 3 shows a typical PUT relaxation oscillator. This circuit has two possible 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 (Vₕₜₕ - RₜₕCₜₕ), where Iₜₕ is cathode leakage current. The anode-cathode voltage would be (Vₕₜₕ - RₜₕCₜₕ - RₜₕLₜₕ), where Iₜₕ is the cathode leakage current (which usually may be neglected). The voltage would be (Vₖₙₜₕ - RₜₕCₜₕ), where Iₕₙₜₕ would be the gate current with device off. (At room temperature Iₕₙₜₕ will be less than 10 nanoamperes). If this state is allowed then:

Vₕₜₕ - Rₜₕ (Iₜₕ + Iₜₕ) < Vₖₙₜₕ - RₜₕIₕₙₜₕ + Vₜₕ

Eq. 1

Where Vₜₕ is the gate offset voltage to trigger.

If this equation is satisfied then this state is a permissible state, and the output voltage (Vₒ) is IₜₕRₜₕ. Assuming that Iₜₕ, Iₜₕ, and Iₕₙₜₕ are negligible, Equation 1 reduces to:

Vₕₜₕ ≤ (Vₖₙₜₕ + Vₜₕ)

Eq. 2

Equation 2 points out vividly that as long as the anode supply voltage is less than the effective gate source voltage (Vₕₙₜₕ + Vₜₕ) the PUT will remain non-conducting.

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

Vₕₕₒₕ = (Rₕₕ + Rₜₕ) Iₕₕₒₕ + RₜₕIₜₕ

Eq. 3

Vₕₕₐₕ = (Rₕₕ + Rₜₕ) Iₕₕₐₕ + RₜₕIₕₕₐₕ

Eq. 4

Vₕₕ = Rₜₕ (Iₕₕ + Iₜₕ)

Eq. 5

Where Iₕₕ is anode-cathode current and Vₕₕ is the forward voltage drop.

If

Iₜₕ > Iₕₕ

Eq. 6

then the PUT will remain in conduction.

If Vₕₕₒₕ is applied to the circuit of Fig. 3 and then Vₕₕ is applied, capacitor C will charge exponentially toward Vₕₕ. If Equation 2 is satisfied then the PUT

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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 \( \eta \), 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:

\[
\eta = \frac{R_1}{R_2 + R_3}
\]

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

Factor No. 3—Valley Current (\( I_v \))

Valley current can be varied the same way the peak-point current is varied. Figures 6-a and 6-b show this variation.

Factor No. 4—Offset Voltage (\( V_{os} \))

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 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 cir-

---

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

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

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

**Fig. 7**—TRIGGER OFFSET VOLTAGE for a programmable unijunction transistor varies with ambient temperature level and with the series impedance at the gate.
circuit in place of an unijunction is easily understood. Figure 8-a shows a basic unijunction circuit. Figure 9-a shows the identical 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 R1 in the conventional unijunction.

Resistors $R_m$ and $R_n$ (Figure 8-a) are generally unnecessary when the D13T replaces a conventional UJT. This is illustrated in Fig. 9-c. Resistor $R_m$ 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 $R_n$ is used for temperature compensation and for limiting the dissipation in the UJT during capacitor discharge. Since R2 (Fig. 9) is not modulated, $R_m$ 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 $I_1$ and low $L$. 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 $V_E$. 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).

To see this, Figure 10-c shows the characteristic between $V_E$ and $V_B$ for the same PUT. It shows a high characteristic near the peak point which would otherwise trigger the SCR. Since $R_1$ 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 $R_n$ is used for temperature compensation and for limiting the dissipation in the UJT during capacitor discharge. Since R2 (Fig. 9) is not modulated, $R_m$ 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.

This circuit has a low $I_1$ and relatively high $I_1$.

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

$$V_B = V_E = V_{de} = V_{de}$$

where $V_{de}$ is the effective gate source voltage; $V_n$ is the emitter of the equivalent UJT and $V_0$ 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)
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)
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OCTOBER 1970
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.

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...]

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.

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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 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.

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 hight.

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(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

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.

R-E Reference Manual  II-17
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 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

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.

<table>
<thead>
<tr>
<th>WIRE SIZE</th>
<th>WIRE TYPE</th>
<th>WEIGHT PER 1000 FT</th>
<th>APPROX. STRENGTH / LB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16 in.</td>
<td>6 STRAND, GALVANIZED</td>
<td>8.2</td>
<td>130</td>
</tr>
<tr>
<td>1/8 in.</td>
<td>6 STRAND, GALVANIZED</td>
<td>31.8</td>
<td>540</td>
</tr>
<tr>
<td>3/16 in.</td>
<td>6 STRAND, GALVANIZED</td>
<td>72.9</td>
<td>1,150</td>
</tr>
<tr>
<td>No. 12</td>
<td>COPPERWELD, SOLID</td>
<td>54.6</td>
<td>510</td>
</tr>
</tbody>
</table>
According to the National Electrical Code, the mast and metal support structures of the antenna must be permanently and effectively grounded without an intervening splice or connection. This code requires all conductors of a lead-in or transmission line to be grounded. The leading conductor must be at least No. 10 stranded copper wire or No. 8 solid aluminum wire and at least 8-feet long. The mast must be driven into rock formations or the ground at a depth of at least 3-feet. The ground must be driven into the ground at a depth of at least 4-feet. The lightning arresters must be grounded and can share a common ground with the mast. The proper place for the grounding conductor is at the point of entrance to the house.

The 300-Ohm twin lead is run along the antenna to the mast using clip-on standoffs to support the wire. Make all turns gentle curves down the line. This is particularly true for uhf signals. To connect the 300-Ohm line to the antenna, strip the insulation and solder the 300-Ohm line to the middle of the transmission line contacts with wax or paint. This prevents trouble later.

To hold the 300-Ohm line to the mast, strip the insulation and solder the 300-Ohm line to the middle of the transmission line contacts with wax or paint. This prevents trouble later.
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 antenna should "see" a 300-ohm impedance. Shielded coaxial 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 rotor. 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.
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."

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

The two audio inputs representing left and right channels must be conditioned to give L+R and L−R signals for proper stereo 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 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 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 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 modulated power supply gives exceptional rf stability.

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 a low-level 19-kHz pilot signal is transmitted which has a definite phase relationship with the original 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, 19-kHz 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 preemphasis 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 preemphasis 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.

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

Monaural information or average level 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 or 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 original 38-kHz subcarrier at the transmitter.
All resistors \( \frac{1}{4} \) watt, 5% unless noted

- R1, R49, R52, R71—4700 ohms
- R2, R22, R3, R43, R46—potentiometer, 20,000 ohms, linear taper
- R3, R4, R12, R40—6800 ohms
- R5, R37, R38—56,000 ohms
- R6, R35, R36—5600 ohms
- R7, R9, R17, R33, R45, R47, R48, R50, R54—10,000 ohms
- R8, R18, R21, R23, R29, R70, R73, R75, R76—1000 ohms
- R10—15,000 ohms
- R11, R36—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, R24, R66, R61, R63—550 ohms
- R32, R41—870 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
R61—27,000 ohms
R67, R69—2200 ohms
R74—75 ohms, 5 watts
C1, C2—1500 pF, 2%, mica
C3—3000 pF, 2%, mica
C4, C13, C24, C35, C41—0.1 f, ceramic
C5—56 f, 15 volts, tantalum
C6, C7, C20, C29, C31, C32—0.01 f, ceramic
C8, C12, C15, C23, C33—5 f, 6 volts, tantalum
C9, C14, C16, C30, C34—20 f, 50 volts,
C10—30 f, 15 volts, tantalum
C11, C13, C17—100 f, 6 volts, tantalum
C21—4300 pF, 5% mica
C25, C26, C27, C28—1000 pF, 2%, mica
C34, C39—1000 pF, ceramic
C36—15 f, 20 volts, tantalum
C37, C38—33 pF, 5%, mica
C40—100 pF, 5%, mica
C42—500 f, 30 volts
C22—820 fP, 5%, mica

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 frequency is

(continued on page 67)
frequency 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 50-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 IN5140 ($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 feedthrough 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 strong 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 2 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 R4.

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.

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.

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 adversely affected by this separation. 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 from page 66)
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/programmer

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 programming. 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 programming 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 programming 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

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. A radio operator's knowledge 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

An interim step between a tech-
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

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, troubleshooting 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.

Instructor

Not have to take the formal training, obtaining all the information he needs by self-study and practice.

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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Circle 33 on reader service card

STEREO AM/FM TUNER KIT, model KG/98, Easy-to-follow instructions require soldering connections between circuit boards. Includes all silicon transistors a tuning meter and edge-lit tuning dial. FM-1HF sensitivity, 3µV; AM, 50µV. Complete kit plus dipole antenna, $79.95—Allied Radio Corp. 100 N. Western Ave., Chicago, Ill. 60680.

Circle 32 on reader service card

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Circle 31 on reader service card

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FOGHORN/HAILER, Model MD-19 has 5 functions. Is a foghorn, boathorn, hailer, listener, and with MDA-19-I 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.

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

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3 models in 295 sq. in.

Luxurious Mediterranean Cabinet...factory assembled of fine furniture grade hardwoods and finished in a flawless Mediterranean pecan. Statuary bronze trim handle. 30-1/32" H x 47" W x 17-3/8" D. Assembled GRA-204-23, 95 lbs. .................. $129.95*

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Circle 68 on reader service card

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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.

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.

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.

OCTOBER 1970
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**Service by Jack Darr**

**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 vtm. 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 vtm. When you find out where the signal stops, then use the vtm.

**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 a/c and run a complete horizontal oscillator/a/c setup adjustment, and check the a/c 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. C., 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.
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Write for your copy today — and also for Service Aid No. 4 on "Understanding Related Circuits — Multiple Trouble." Previous Service Aids (or PTM's) are either being revised or have been updated into No. 5. See your Triad Distributor for all your replacement transformer needs, and get the Triad Catalog & Replacement Guide while you're at it. Triad Distributor Division, 305 North Briant Street, Huntington, Ind. 46750.

NEW TRIAD 1971/72 CATALOG AND REPLACEMENT GUIDE

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 issue 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 Scheiber 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.

OCTOBER 1970 R-E

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The IC is particularly suited to cable or closed-circuit TV and TV test instruments such as bar and raster generators, as well as for CRT character displays. It is compatible with commercial TV sync systems when used in conjunction with proper vertical sync separators.

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**Type** Description Case
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2 FL. 2-flip-flop optical fiber linepipe $1.00
709 OP AMPLIFIER
2 IN UNIJUNCTION transistors $1.19
1-G MDX PNP p channel $1.19
5 CLAIREX trigger diodes $1.00
3 TRIGGER diodes for Sectors $1.00
1 J-1900 PIV relays $1.00
10-1 AMP 800 PIV relays $1.00
2 NIXIE tube decoders $1.00
2-7 AMP 200 PIV cores $1.00
1 WATT WESTINGHOUSE audio amp $3.98
1-15 AMP TUBE 200 PIV $3.98
1 DUAL DUAL SHEET MOUNTED $1.50
2 MICRO circuit switches $1.00
2-100 TRANSISTOR TESTER $1.00
WESTINGHOUSE power voll regulator $1.19

**Texas-National TTL IC's**

**Type** Description Case
---
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SN7404N Quad 2 input gate .99
SN7400N Inverter 1.19
SN7405N 4 Input Nand gate .99
SN7406N Quad 4 input buffer .99
SN74LS6 Enumerated 6 FL. Inverter .99
SN74LS24N INDICATING 2 FL. Decrdr .95
SN74L67N Dual 3-FL. master slave flip-flop .16
SN74LS74N Dual 4-FL. master slave flip-flop 1.40
SN74LS75N Quad 2 FL. flip-flop with preset .19
SN74LS76N Quad 2 FL. flip-flop with preset & clear 1.40
SN7457N Divide by 2 counter .45
SN74LS90N D-C to C-2 FL. decoder .45
SN74LS121N Divide by 12 counter .45
SN74LS194N D-C to C-12 FL. buffer .45
SN74LS192N D C to C-12 FL. buffer 1.25
SN74L305N D-C to C-12 FL. flip-flop preset .19
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<tr>
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<th><strong>Description</strong></th>
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<tr>
<td><strong>TRIACS</strong></td>
<td>7A SCR's (6 sets) $1.00</td>
<td>114/25 stud (10 amp, rectifiers, 20 amp SCR's) $5.00</td>
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<tr>
<td><strong>MRTL IC's</strong></td>
<td>905 FULL ADDER .75</td>
<td>912 HALF ADDER .75</td>
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<td></td>
<td>913 REGISTER .75</td>
<td>940 JK FLIP FLOP .50</td>
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<tr>
<td><strong>TTL IC SERIES</strong></td>
<td><strong>DECade Divider</strong> $3.95</td>
<td><strong>5412 Dual JK Flip Flop</strong> .85</td>
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<td><strong>MC 415 JK Flip Flop</strong> .85</td>
<td><strong>MC 400 Dual 4 Input NAND/NOR gate</strong> .70</td>
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<td></td>
<td><strong>4 Bit Storage Register</strong> 1.25</td>
<td><strong>9301 MSI ONE-OF-TEN DECODER</strong> 2.95</td>
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<th><strong>Description</strong></th>
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<td><strong>Silicon Power Rectifiers</strong></td>
<td><strong>PVR</strong> PRV</td>
<td><strong>PVR</strong> PRV</td>
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<td>3A 12A 20A</td>
<td>100 .09 .24 .50</td>
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<td>200 .16 .35 .80</td>
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<td>500 .50 1.10 2.20</td>
<td>1000 .50 1.10 2.20</td>
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**Silicon Control Rectifiers**

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<tr>
<td><strong>PVR</strong></td>
<td>PRV</td>
<td>PRV</td>
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<tr>
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<td>3A 7A 20A 70A</td>
<td>50 .30 .50 .70</td>
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<td>100 .40 .55 1.00 4.00</td>
<td>200 .60 .80 1.30 8.00</td>
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<td>300 .80 1.00 1.70</td>
<td>500 1.00 2.10 12.00</td>
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<td>700 1.50 2.50 4.00</td>
<td>1000 1.90 3.00 16.00</td>
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The diagram shows how he described the switch in Electronics Australasia. 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 1/4" 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.

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